SEL-2411

Programmable Automation Controller

Instruction Manual

20250228

SCHWEITZER ENGINEERING LABORATORIES

Part Number: PM2411-01

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Preface

Safety Information

⚠CAUTION
To ensure proper safety and operation, the equipment ratings, installation instructions, and operating instructions must be checked before commissioning or maintenance of the equipment. The integrity of any protective conductor connection must be checked before carrying out any other actions. It is the responsibility of the user to ensure that the equipment is installed, operated, and used for its intended function in the manner specified in this manual. If misused, any safety protection provided by the equipment may be impaired.

Dangers, Warnings, and Cautions

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

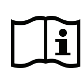
⚠DANGER
Indicates an imminently hazardous situation that, if not avoided, **will** result in death or serious injury.

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

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

Safety Symbols

The following symbols are often marked on SEL products.

	**⚠CAUTION** Refer to accompanying documents.	**⚠ATTENTION** Se reporter à la documentation.
	Earth (ground)	Terre
	Protective earth (ground)	Terre de protection
	Direct current	Courant continu
	Alternating current	Courant alternatif
	Both direct and alternating current	Courant continu et alternatif
	Instruction manual	Manuel d’instructions

Safety Marks

The following statements apply to this device.

General Safety Marks

⚠CAUTION There is danger of explosion if the battery is incorrectly replaced. Replace only with Rayovac no. BR2335 or equivalent recommended by manufacturer. See Owner's Manual for safety instructions. The battery used in this device may present a fire or chemical burn hazard if mistreated. Do not recharge, disassemble, heat above 100°C or incinerate. Dispose of used batteries according to the manufacturer's instructions. Keep battery out of reach of children.	⚠ATTENTION Une pile remplacée incorrectement pose des risques d'explosion. Remplacez seulement avec un Rayovac no BR2335 ou un produit équivalent recommandé par le fabricant. Voir le guide d'utilisateur pour les instructions de sécurité. La pile utilisée dans cet appareil peut présenter un risque d'incendie ou de brûlure chimique si vous en faites mauvais usage. Ne pas recharger, démonter, chauffer à plus de 100°C ou incinérer. Éliminez les vieilles piles suivant les instructions du fabricant. Gardez la pile hors de la portée des enfants.
⚠CAUTION To ensure proper safety and operation, the equipment ratings, installation instructions, and operating instructions must be checked before commissioning or maintenance of the equipment. The integrity of any protective conductor connection must be checked before carrying out any other actions. It is the responsibility of the user to ensure that the equipment is installed, operated, and used for its intended function in the manner specified in this manual. If misused, any safety protection provided by the equipment may be impaired.	⚠ATTENTION Pour assurer la sécurité et le bon fonctionnement, il faut vérifier les classements d'équipement ainsi que les instructions d'installation et d'opération avant la mise en service ou l'entretien de l'équipement. Il faut vérifier l'intégrité de toute connexion de conducteur de protection avant de réaliser d'autres actions. L'utilisateur est responsable d'assurer l'installation, l'opération et l'utilisation de l'équipement pour la fonction prévue et de la manière indiquée dans ce manuel. Une mauvaise utilisation pourrait diminuer toute protection de sécurité fournie par l'équipement.
For use in Pollution Degree 2 environment.	Pour l'utilisation dans un environnement de Degré de Pollution 2.
Per UL compliance, ambient air temperature shall not exceed 50°C (122°F).	Conforme à la norme UL, la température de l'air ambiant ne doit pas dépasser 50°C (122°F).
For use on a flat surface of a Type 1 enclosure.	Destiné à l'utilisation sur une surface plane d'un boîtier de Type 1.
Terminal Ratings Wire Material Use 75°C (167°F) copper conductors only. Tightening Torque CT Terminal Blocks: 0.9–1.4 Nm (8–12 in-lb) Compression Plug: 0.5–1.0 Nm (4.4–8.8 in-lb) Compression Plug Mounting Ear Screw: 0.18–0.25 Nm (1.6–2.2 in-lb)	Spécifications des bornes Type de filage Utiliser seulement des conducteurs en cuivre spécifiés à 75°C (167°F). Couple de serrage CT bornes : 0,9–1,4 Nm (8–12 livres-pouce) Fiche à compression : 0,5–1,0 Nm (4,4–8,8 livres-pouce) Vis à oreille de montage de la fiche à compression : 0,18–0,25 Nm (1,6–2,2 livres-pouce)

Hazardous Locations Safety Marks

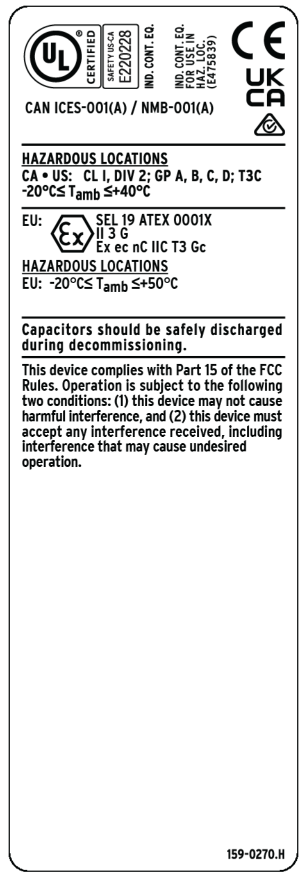
⚠WARNING – EXPLOSION HAZARD Open circuit before removing cover.	⚠AVERTISSEMENT – DANGER D'EXPLOSION Ouvrir le circuit avant de déposer le couvercle.
⚠WARNING – EXPLOSION HAZARD Substitution of components may impair suitability for Class I, Division 2.	⚠AVERTISSEMENT – DANGER D'EXPLOSION La substitution de composants peut détériorer la conformité à Classe I, Division 2.
CA & US Hazardous Locations Operating Temperature Range: –20°C ≤ Ta ≤ +40°C EU Hazardous Locations Operating Temperature Range: –20°C ≤ Ta ≤ +50°C	Plage de températures de fonctionnement dans les lieux dangereux, Canada et États-Unis : –20°C ≤ Ta ≤ +40°C Plage de températures de fonctionnement dans les lieux dangereux, Union européenne : –20°C ≤ Ta ≤ +50°C

Hazardous Locations Approval

The SEL-2411 is UL Listed for hazardous locations to U.S. and Canadian standards. In North America, the device is approved for Class I, Division 2, Groups A, B, C, and D, and temperature class T3C in a maximum surrounding air temperature of 40°C. The SEL-2411 shall be installed in an indoor or outdoor (extended) locked enclosure that provides a degree of protection to personnel against access to hazardous parts. In either environment, the device shall be protected from direct sunlight, precipitation, and full wind pressure.

To comply with the requirements of the European ATEX Directive (2014/34/EU), the SEL-2411 shall be installed in an enclosure that provides a minimum ingress protection of IP54 in accordance with IEC 60079-0. The enclosure shall be limited to a surrounding air temperature range of –20°C ≤ Ta ≤ +50°C.

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



Product Compliance Label for Hazardous Locations Approval

Other Safety Marks (Sheet 1 of 2)

⚠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.
⚠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 blessures ou la mort.
⚠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.

Other Safety Marks (Sheet 2 of 2)

⚠WARNING Have only qualified personnel service this equipment. If you are not qualified to service this equipment, you can injure yourself or others, or cause equipment damage.	⚠AVERTISSEMENT Seules des personnes qualifiées peuvent travailler sur cet appareil. Si vous n’êtes pas qualifiés pour ce travail, vous pourriez vous blesser avec d’autres personnes ou endommager l’équipement.
⚠WARNING Always isolate the relay control circuits before performing any modifications to the relay.	⚠AVERTISSEMENT Il faut toujours isoler les circuits de commande du relais avant d'apporter des modifications au relais.
⚠WARNING Before working on a CT circuit, first apply a short to the secondary winding of the CT.	⚠AVERTISSEMENT Avant de travailler sur un circuit TC, placez d’abord un court-circuit sur l’enroulement secondaire du TC.
⚠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 accès non-autorisé á l’équipement peut être possible. SEL décline toute responsabilité pour tout dommage résultant de cet accès non-autorisé.
⚠WARNING To install an option card, the relay must be de-energized and then re-energized. When re-energized, the relay will reboot. Therefore, de-energize the protected equipment before installing the option card to prevent damage to the equipment.	⚠AVERTISSEMENT Pour installer une carte à option, le relais doit être éteint et ensuite rallumé. Quand il est rallumé, le relais redémarrera. Donc, il faut éteindre l’équipement protégé avant d’installer la carte à option pour empêcher des dégats à l’équipement.
⚠WARNING Do not perform any procedures or adjustments that this instruction manual does not describe.	⚠AVERTISSEMENT Ne pas appliquer une procédure ou un ajustement qui n’est pas décrit explicitement dans ce manuel d’instruction.
⚠WARNING During installation, maintenance, or testing of the optical ports, use only test equipment qualified for Class 1 laser products.	⚠AVERTISSEMENT Durant l’installation, la maintenance ou le test des ports optiques, utilisez exclusivement des équipements de test homologués comme produits de type laser de Classe 1.
⚠WARNING Overtightening the mounting nuts may permanently damage the relay chassis.	⚠AVERTISSEMENT Une pression excessive sur les écroux de montage peut endommager de façon permanente le chassis du relais.
⚠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 services.	⚠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 Looking into optical connections, fiber ends, or bulkhead connections can result in hazardous radiation exposure.	⚠ATTENTION Regarder vers les connecteurs optiques, les extrémités des fibres oules connecteurs de cloison peut entraîner une exposition à des rayonnements dangereux.
⚠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 tests de fonctionnement différents de ceux décrits ci-après peuvent entraîner l’exposition à des radiations dangereuses.
⚠CAUTION Do not connect power to the relay until you have completed these procedures and receive instruction to apply power. Equipment damage can result otherwise.	⚠ATTENTION Ne pas mettre le relais sous tension avant d’avoir complété ces procédures et d’avoir reçu l’instruction de brancher l’alimentation. Des dommages à l’équipement pourraient survenir autrement.

General Information

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.
ENABLE	Device front- or rear-panel labels and pushbuttons.
MAIN > METER	Device front-panel LCD menus and device responses visible on the PC screen. The > character indicates submenus.

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
Relative humidity	5%–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 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

SEL-2411 LED Information

Item	Detail
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.

⚠CAUTION
Looking into optical connections, fiber ends, or bulkhead connections can 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, use only 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	Insulation Voltage
Grounding (Earthing) Connection	14 AWG (2.5 mm^2)	14 AWG (2.5 mm^2)	300 V min
Current Connection	16 AWG (1.5 mm^2)	12 AWG (4 mm^2)	300 V min
Potential (Voltage) Connection	18 AWG (0.8 mm^2)	14 AWG (2.5 mm^2)	300 V min
Contact I/O	18 AWG (0.8 mm^2)	14 AWG (2.5 mm^2)	300 V min
Other Connection	18 AWG (0.8 mm^2)	14 AWG (2.5 mm^2)	300 V min

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. Recommended strip length for the wires is 8 mm (0.31 inches). The use of an 8 mm wire ferrule is also recommended.

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 Support

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

Schweitzer Engineering Laboratories, Inc.
2350 NE Hopkins Court
Pullman, WA 99163-5603 U.S.A.
Tel: +1.509.338.3838
Fax: +1.509.332.7990
Internet: selinc.com/support
Email: info@selinc.com

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 as many as four additional input/output cards to tailor the SEL-2411 to specific applications.

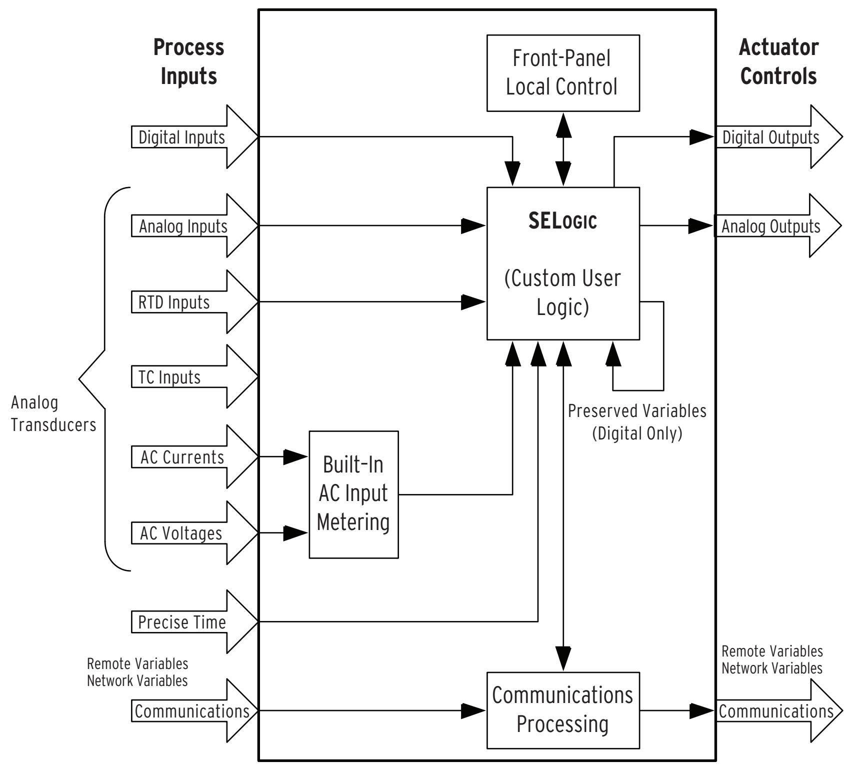


Figure 1.1 Block Diagram

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

NOTE: The SEL-3010 is obsolete and no longer available to order.

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 Events Recorder (SER), which features the following capabilities:
➤ Trigger on as many as 96 change-of-state conditions
➤ Store as many as 512 nonvolatile change-of-state records
➤ Time-stamp resolution ±1 ms
➤ Change-of-state (time of initial state change, not time of state change after debounce)
Record event data through use of 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	Yes	
SNTP	No	Yes
PTP	No	Yes
Optional		
DNP3 Level 2 Outstation	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 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 switchgear 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 main board. 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 selinc.com/products/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 (Sheet 1 of 2)

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	Horizontal Rack Mount Kit—For single unit 19” rack-mounting plate
915900008	Horizontal Rack Mount Kit—For dual unit 19” rack-mounting plate
915900009	Horizontal Rack Mount Kit—For single unit and a test switch
915900050	Vertical Rack Mount Kit—For single unit 19” rack-mounting plate
915900051	Vertical Rack Mount Kit—For dual unit 19” rack-mounting plate
915900052	Vertical Rack Mount Kit—For single unit and a test switch
915900047	Wall Mount Bracket
915900063	Hinged Wall Mount Bracket
915900116	Horizontal Surface-Mount Kit
915900203	Vertical Surface-Mount Kit
915900062	Outdoor Enclosure + FT-1 Cutout, Horizontal
915900092	Outdoor Enclosure, No FT-1 Cutout, Horizontal
915900066	Outdoor Enclosure + FT-1 Cutout, Vertical
915900093	Outdoor Enclosure, No FT-1 Cutout, Vertical
915900170	Dust-Protection Assembly
915900236	SEL-241X Wetting Voltage Jumper Kit, Eight 4-Prong Jumpers

Table 1.2 Optional Accessories (Sheet 2 of 2)

Product	Description
915900241	Wetting Voltage Jumpers Bulk, 100 pack 4-Prong Jumpers
915900222	90 Degree Connector Kit
9260027	SEL-2411 Configurable Labels (Vertical)
9260024	SEL-2411 Configurable Labels (Horizontal)
SEL-2401	Precise Timing Source—Satellite-Synchronized Clock
SEL-3010	Event Messenger—Automatic Voice Notification
SEL-3021	Secure Communications—Serial Encrypting Transceiver
SEL-2925	Secure Communications—BLUETOOTH® 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.

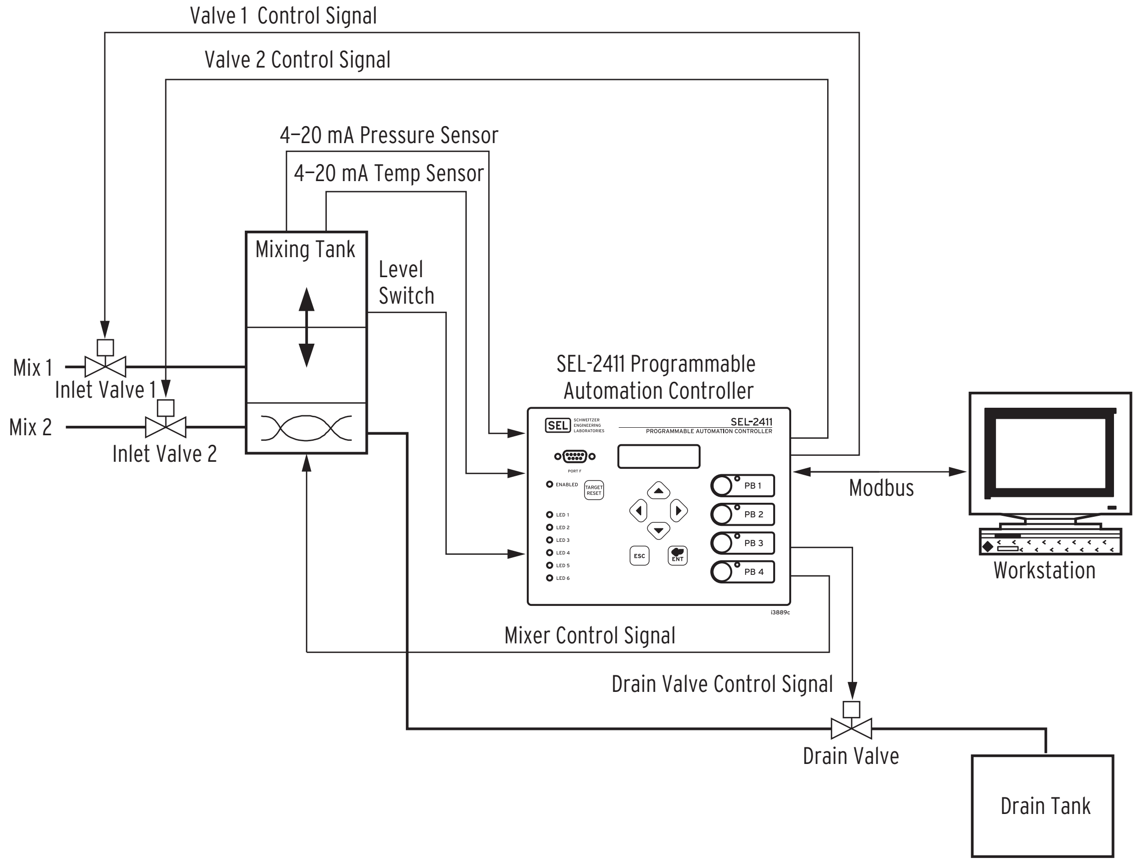


Figure 1.2 Batch Processing PLC

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 by using SELOGIC with minutes-since-midnight (MINSM), day-of-week (DAYW), and day-of-year (DAYY) variables.

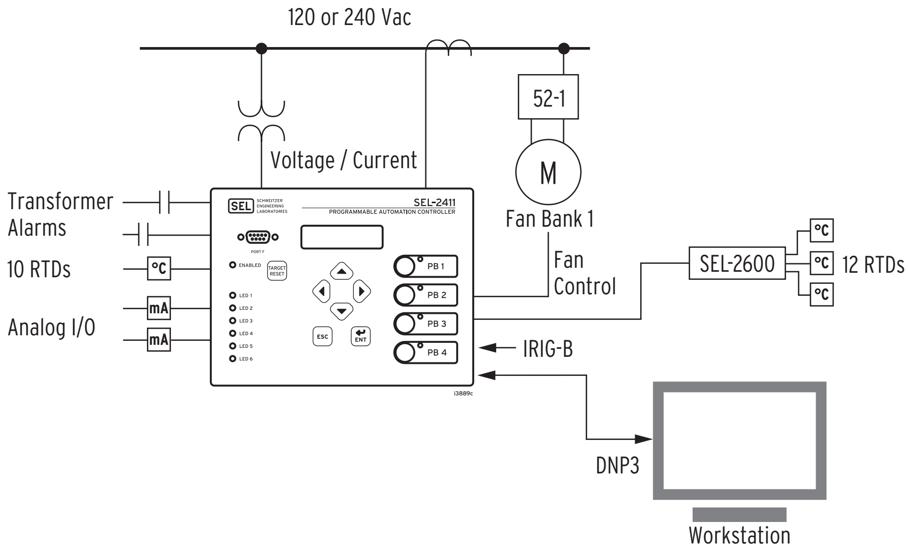


Figure 1.3 Transformer Monitor and Cooling System Control

Specifications

Compliance

Designed and manufactured under an ISO 9001 certified quality management system

47 CFR 15B, Class A

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

CE Mark in accordance with the requirements of the European Union.

RCM Mark in accordance with the requirements of Australia

UKCA Mark in accordance with the requirements of United Kingdom

Normal Locations

UL Listed to U.S. and Canadian safety standards (File E220228; NRAQ, NRAQ7)

–20°C ≤ Ta ≤ 40°C

Hazardous Locations

UL Listed for Hazardous Locations to Canadian and U.S. Standards (File E475839; NRAG, NRAG7)

CL 1, DIV 2; GP A, B, C, D; T3C

–20°C ≤ Ta ≤ 40°C

EU

SEL 19 ATEX 0001X
II 3 G
Ex ec nC IIC T3 Gc

–20°C ≤ Ta ≤ 50°C

EN 60079-0:2018
EN 60079-7:2015/A1:2018
EN 60079:15:2019

Note: Where so marked, ATEX and UL Hazardous Locations Certification tests are applicable to rated supply specifications only and do not apply to the absolute operating ranges, continuous thermal, or short circuit duration specifications.

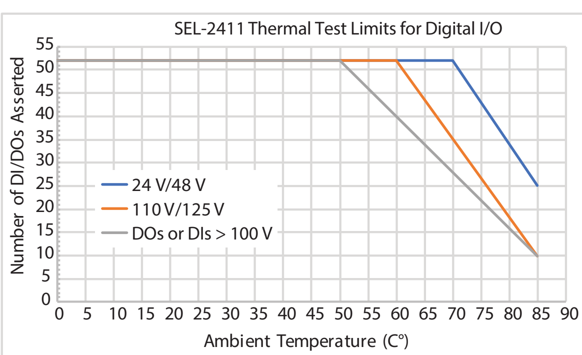
General

Operating Temperature Range

IEC Performance Rating:	–40° to 85°C (–40° to 185°F) IEC 60068-2-1 and 60068-2-2

Note: Not applicable to UL applications.

Note: The front-panel display is impaired for temperatures below –20°C and above 70°C.



UL/CSA Thermal Derating

Design to ensure that no more than 30 digital I/O are simultaneously energized. This applies to all outputs carrying < 2 A current and digital inputs rated above 100 V. Inputs rated below 100 V only add half the heat.

Operating Environment

Insulation Class	1
Pollution Degree:	2
Overvoltage Category:	II
Atmospheric Pressure	80–110 kPa
Relative Humidity:	5%–95%, noncondensing
Maximum Altitude Without Derating (Consult the Factory for Higher Altitude Derating):	2000 m

Dimensions

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

Weight

2.0 kg (4.4 lb) (Typical configuration)

Power Supply

Rated Supply Voltage

Low-Voltage Model:	24/48 Vdc
High-Voltage Model:	125/250 Vdc 120/240 Vac, 50/60 Hz

Input Voltage Range

Low-Voltage Model:	19.2–60 Vdc
High-Voltage Model:	85–300 Vdc 85–264 Vac

Power Consumption (With Front-Panel LCD)

AC:	<40 VA
DC:	<15 W

Power Consumption (With Front-Panel 5″ Color Touchscreen)

AC:	<75 VA
DC:	<25 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

Fuse Rating

High-Voltage Model:	3.15 A, high breaking capacity, time lag T, 250 V (5x20 mm, T3.15AH 250 V)
Low-Voltage Model:	3.15 A, high breaking capacity, time lag T, 250 V (5x20 mm, T3.15AH 250 V)

Inputs

AC Current Input Phase

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

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 Current Input Neutral

I_{NOM}	5 A	1 A (4 ACI Only)
Rated Range:	0.05–10.0 A (according to IEC 60255–5, 60664–1)	0.01–2.00 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

V_{NOM}	300 V	8 V
Rated Operating Voltage (U_e):	100–250 Vac	2.67-6.67 Vac
Rated Insulation Voltage:	300 Vac	8 Vac
10-Second Thermal:	600 Vac	16 Vac
Rated Frequency:	50/60 ± 5 Hz	50/60 ± 5 Hz
Burden:	<0.1 W	<0.1 W

DC Transducer (Analog) Inputs

Input Impedance	
Current Mode:	200 Ω
Voltage Mode:	>10 kΩ
Input Range (Maximum):	±20 mA (transducers: 4–20 mA, 0–20 mA, or 0–1 mA typical) ±10 V (transducers: 0–5 V or 0–10 V typical)
Sampling Rate:	At least 5 ms
Step Response:	1 s
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
Step Response:	1 s
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

Auxiliary DC Transducer (Analog) Inputs

(Available only with 8 V 3 ACI/3 AVI card with VSCALE = CUSTOM)

Input Range (Maximum):	±7.5 V
Sampling Rate:	16 samples/cycle
Step Response:	<2 ms
Accuracy at 25°C	
With User Calibration:	<0.1% of full scale
Without Calibration:	<4% of full scale

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 below 5 Vdc

When Used With AC Control Signals:

250 V	ON for 170.6–275 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 24 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:	–200° to 850°C (PT100) –80° to 250°C (Ni100, Ni120) –200° to 250°C (Cu10)
ADC Resolution:	24 bit
Accuracy:	
CU10, PT100, NI100, NI120:	±0.1°C typical at 25°C ±2°C worst case
Resolution:	0.1°C
Update Rate:	<3 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:	
RTDs:	
PT100:	–200° to 850°C
NI100:	–80° to 250°C
CU10:	–200° to 250°C

Thermocouples (TCs):	
J:	–200° to 1200°C
K:	–200° to 1370°C
T:	–200° to 400°C
E:	–200° to 950°C
ADC Resolution:	24 bit
Accuracy:	
RTDs:	
PT100, NI100, NI120, CU10:	±0.1°C typical at 25°C
PT100, NI100, NI120, CU10:	±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 ms

Time-Code Input (Demodulated IRIG-B)

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

Time-Code Input (SNTP)

High-Priority Server Accuracy:	±5 ms
Low-Priority Server Accuracy:	±25 ms

Time-Code Input (PTP)

IEEE 1588-2008 Firmware Based Accuracy:	±1 ms

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 Thermal Derating):	0–2 A per output if no more than 30 digital outputs and inputs are energized simultaneously. 2–5 A continuous carry is allowed if the output counts as 3 outputs towards the quantity limit.
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 Vdc	0.75 A	L/R = 40 ms
	48 Vdc	0.50 A	L/R = 40 ms
	125 Vdc	0.30 A	L/R = 40 ms
	250 Vdc	0.20 A	L/R = 40 ms
Cyclic Capacity (2.5 Cycles/Second) per IEC 60255-0-20:1974:	24 Vdc	0.75 A	L/R = 40 ms
	48 Vdc	0.50 A	L/R = 40 ms
	125 Vdc	0.30 A	L/R = 40 ms
	250 Vdc	0.20 A	L/R = 40 ms

Fast Hybrid (High-Speed High-Current Interrupting)

Make:	30 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 (10,000 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:	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)

Matches DC Output Ratings

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 (10,000 Operations):

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

Cyclic Capacity (4 Cycles in 1 Second, Followed by 2 Minutes Idle for Thermal Dissipation):

48 Vac	10.0 A	L/R = 40 ms
125 Vac	10.0 A	L/R = 40 ms
250 Vac	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
Step Response:	100 ms

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 (RJ45 connector)
Single or Dual 100BASE-FX (LC connector)

EIA-232 Multimode Fiber-Optic Port (Optional)

Location:	Rear Panel
Data Speed:	300–38400 bps

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 µm
Approximate Range:	~6.4 km
Data Rate:	100 Mbps
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 Mbps
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 Outstation (LAN/WAN and Serial)
IEC 61850 Communications
Ethernet FTP
SNTP
PTP (firmware-based)
RSTP
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

Modbus Slave:	2[a]
DNP3 Level 2 Outstation:	5[a]
Ethernet FTP:	2
Telnet:	3
IEC 61850 MMS:	7
IEC 61850 Goose:	64 Incoming 8 Outgoing

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

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

Frequency

±0.05 Hz (V1 > 60 V) with voltage tracking from 44.00–66.00 Hz
±0.10 Hz (I1 > 0.8 • I_{NOM}) with current tracking from 44.00–66.00 Hz

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

Fast Analog Alarm Pickup

1 A CT: ±5% ± 0.01 A

5 A CT: ±5% ± 0.05 A

Voltage: ±5% of setting ± 0.5 V

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

Timer Accuracy

±0.5% of settings and ± 1/4 cycle

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

Timer Accuracy

±0.5% of settings and ± 1/4 cycle

Processing Specifications and Oscillography

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: Four times per power system cycle or 4 ms if no current or voltage card (except for math variables and analog signals used in logic, which are processed every 100 ms)

Oscillography

Length: 15 or 64 cycles

Sampling Rate: 16 samples per cycle unfiltered
4 samples per cycle filtered

Trigger: Programmable with Boolean expression

Format: ASCII and Compressed ASCII
Binary COMTRADE (16 samples per cycle unfiltered)

Note: Binary COMTRADE format as per IEEE C37.11-1999, IEEE Standard Common Format for Transient Data Exchange (COMTRADE) for Power Systems.

Sequential Events Recorder

Time-Stamp Resolution: 1 ms

Time-Stamp Accuracy (with respect to Time Source): ±1 ms

Type Tests

Environmental Tests

Enclosure Protection: IEC 60529:2001 + CRDG:2003
IP65 enclosed in panel (2-line display models)
IP54 enclosed in panel (touchscreen models)
IP50 for terminals enclosed in the dust-protection assembly (protection against solid foreign objects only) (SEL Part #915900170). The 10°C temperature derating applies to the temperature specifications of the relay.
IP10 for terminals and the relay rear panel

Vibration Resistance: IEC 60255-21-1:1988, Class 1
IEC 60255-27:2013, Section 10.6.2.1
Endurance: Class 2
Response: Class 2

Shock Resistance: IEC 60255-21-2:1988, Class 1
IEC 60255-27:2013, Section 10.6.2.2
IEC 60255-27:2013, Section 10.6.2.3
Withstand: Class 1
Response: Class 2
Bump: Class 1

Seismic (Quake Response): IEC 60255-21-3:1993
IEC 60255-27:2013, Section 10.6.2.4
Response: Class 2

Cold: IEC 60068-2-1:2007
IEC 60255-27:2013, Section 10.6.1.2
IEC 60255-27:2013, Section 10.6.1.4
–40°C, 16 hours

Dry Heat: IEC 60068-2-2:2007
IEC 60255-27:2013, Section 10.6.1.1
IEC 60255-27:2013, Section 10.6.1.3
85°C, 16 hours

Damp Heat, Steady State: IEC 60068-2-78:2013
IEC 60255-27:2013, Section 10.6.1.5
40°C, 93% relative humidity, 10 days

Damp Heat, Cyclic: IEC 60068-2-30:2005
IEC 60255-27:2013, Section 10.6.1.6
25 to 55°C, 95% relative humidity, 6 cycles

Change of Temperature: IEC 60068-2-14:2009
IEC 60255-1:2010, Section 6.12.3.5
–40° to +85°C, ramp rate 1°C/min, 5 cycles

Dielectric Strength and Impulse Tests

Dielectric (HiPot): IEC 60255-27:2013, Section 10.6.4.3
IEEE C37.90-2005
1.0 kVac on analog outputs, Ethernet ports, Port 3, IRIG
2.0 kVac on analog inputs
2.5 kVac on contact I/O
3.6 kVdc on power supply, current, and voltage inputs

Impulse: IEC 60255-27:2013, Section 10.6.4.2
0.5 J, 5 kV on power supply, contact I/O, ac current, and voltage inputs
0.5 J, 1 kV on Port 3, RTD, and IRIG ports
0.5 J, 530 V on analog outputs
IEEE C37.90:2005
0.5 J, 5 kV
0.5 J, 530 V on analog outputs

RFI and Interference Tests

Front-port serial cable (non-fiber) lengths are assumed to be <3 m.

EMC Immunity

Electrostatic Discharge Immunity: IEC 61000-4-2:2008
IEC 60255-26:2013; Section 7.2.3
IEEE C37.90.3:2001
Severity Level 4
8 kV contact discharge
15 kV air discharge

Radiated RF Immunity: IEC 61000-4-3:2010
IEC 60255-26:2013; Section 7.2.4
10 V/m
IEEE C37.90.2-2004
20 V/m

Fast Transient, Burst Immunity: IEC 61000-4-4:2011
IEC 60255-26:2013; Section 7.2.5
4 kV @ 5.0 kHz
2 kV @ 5.0 kHz for comm. ports

Surge Immunity: IEC 61000-4-5:2005
IEC 60255-26:2013; Section 7.2.7
2 kV line-to-line
4 kV line-to-earth

Surge Withstand Capability Immunity: EN 61000-4-18:2010
IEC 60255-26:2013; Section 7.2.6
2.5 kV common mode
1 kV differential mode
1 kV common mode on comm. ports
IEEE C37.90.1-2002
2.5 kV oscillatory
4 kV fast transient
Comm. ports, IRIG, and PTC ports Zone B, 2 kV line-to-earth
LEA ports compliant with IEC 61869-13 tested to 1 kV, 1 MHz common mode

Conducted RF Immunity: IEC 61000-4-6:2008,
IEC 60255-26:2013; Section 7.2.8
10 Vrms

Magnetic Field Immunity: IEC 61000-4-8:2009
IEC 60255-26:2013, Section 7.2.10
Severity Level: 1000 A/m for 3 seconds, 100 A/m for 1 minute; 50/60 Hz
IEC 61000-4-9: 2001
Severity Level: 1000 A/m
IEC 61000-4-10:2001
Severity Level: 100 A/m (100 kHz and 1 MHz)

Power Supply Immunity: IEC 61000-4-11:2004
IEC 61000-4-17:1999
IEC 61000-4-29:2000
IEC 60255-26:2013, Section 7.2.11
IEC 60255-26:2013, Section 7.2.12
IEC 60255-26:2013, Section 7.2.13

EMC Emissions

Conducted Emissions: IEC 60255-26:2013, Class A
FCC 47 CFR Part 15.107, Class A
Canada ICES-001 (A) / NMB-001 (A)
EN 55011:2009 + A1:2010, Class A
EN 55022:2010 + AC:2011, Class A
EN 55032:2012 + AC:2013, Class A
CISPR 11:2009 + A1:2010, Class A
CISPR 22:2008, Class A
CISPR 32:2015, Class A

Radiated Emissions: IEC 60255-26:2013, Class A
FCC 47 CFR Part 15.109, Class A
Canada ICES-001 (A) / NMB-001 (A)
EN 55011:2009 + A1:2010, Class A
EN 55022:2010 + AC:2011, Class A
EN 55032:2012 + AC:2013, Class A
CISPR 11:2009 + A1:2010, Class A
CISPR 22:2008, Class A
CISPR 32:2015, Class A

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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 60255-27 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 1.8*). For EN 60255-27 certification, the SEL-2411 rating is 2000 m (6560 feet) above mean sea level.

The SEL-2411 is UL Listed for hazardous locations to U.S. and Canadian standards. In North America, the device is approved for Class I, Division 2, Groups A, B, C, and D, and temperature class T3C in a maximum surrounding air temperature of 40°C. The SEL-2411 shall be installed in an indoor or outdoor (extended) locked enclosure that provides ingress protection of at least IP1X to the back of the device. In either environment, the device shall be protected from direct sunlight, precipitation, and full wind pressure.

To comply with the requirements of the European ATEX Directive (2014/34/EU), the SEL-2411 shall be installed in an enclosure that provides a minimum ingress protection of IP54 in accordance with IEC 60079-0. The enclosure shall be limited to a surrounding air temperature range of –20°C ≤ Ta ≤ +50°C.

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*.

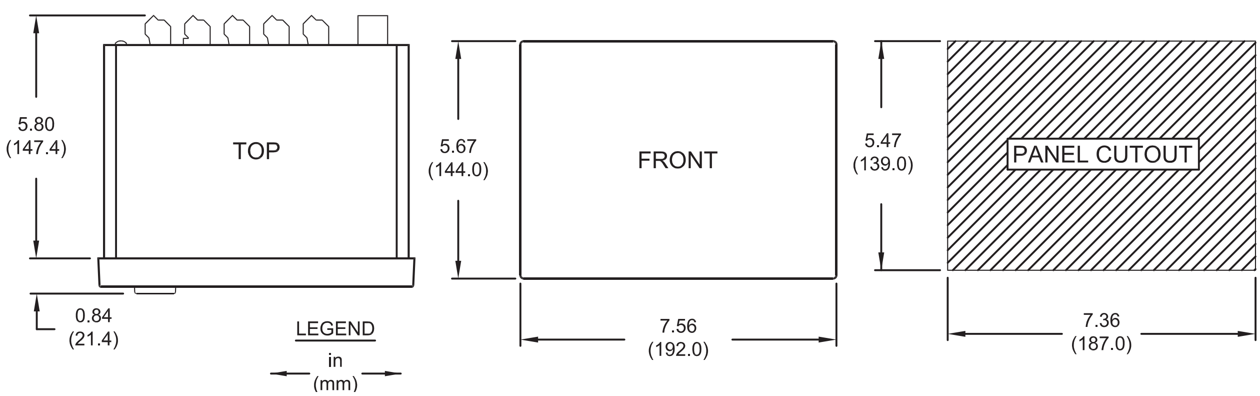


Figure 2.1 Programmable Automation Controller Horizontal Panel-Mount Dimensions

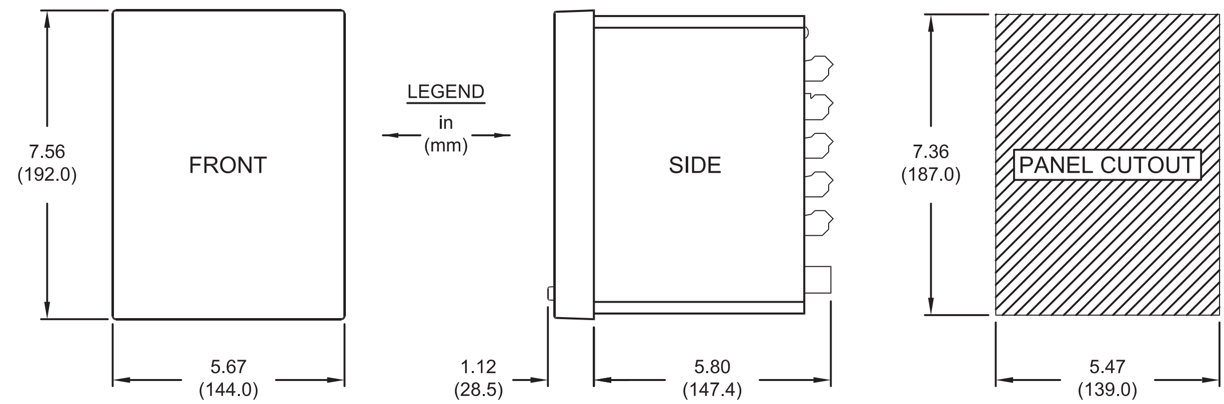


Figure 2.2 Programmable Automation Controller Vertical Panel-Mount Dimensions

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 are shown below in *Figure 2.3*.

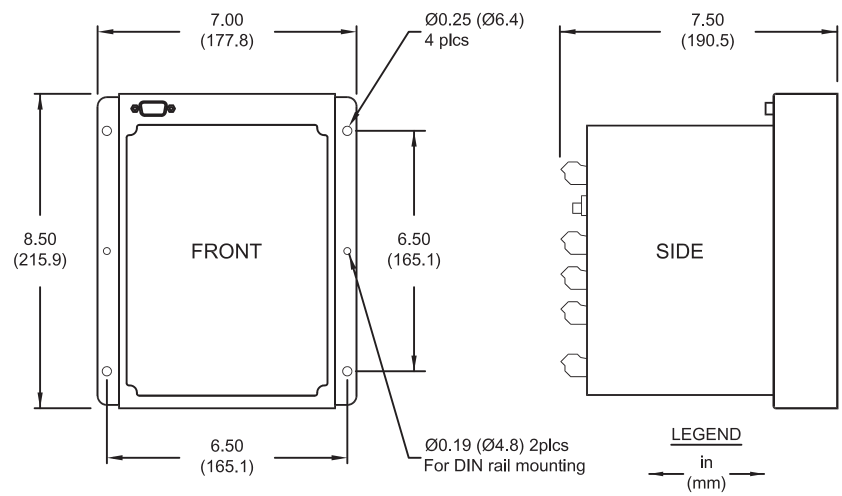


Figure 2.3 Programmable Automation Controller Surface-Mount Dimensions

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 or when accessing rear panel cards or connectors, 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 Temperature 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 as many as three serial ports. Select the communications ports necessary for your application from those shown in *Table 2.2*. *Table 7.7* shows the protocols supported by each port.

Table 2.2 Communications Ports

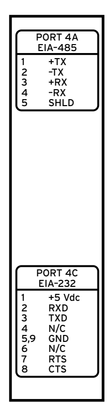
Port	Location	Feature	Description
1	Rear Panel	Optional	One or two (failover) rear Ethernet ports
2	Rear Panel	Optional	Isolated multimode fiber-optic port with ST connectors
3	Rear Panel	Standard	Nonisolated EIA-232 serial port

Communications Card (EIA-232/EIA-485)

Supported in Slot **C** only, this card provides one serial port with two serial port interfaces. *Table 2.3* shows the port number, interface, and type of connector for the two protocols. *Table 7.7* shows the protocols supported by each port.

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

<table>
<tr><th>Terminals</th><th>Label</th><th>Description</th></tr>
<tr><td rowspan="2">

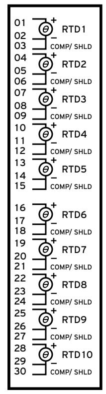

</td><td rowspan="2">


</td><td>Port 4A, an isolated EIA-485 serial port interface on a 5-pin plug-in connector</td></tr>
<tr><td>Port 4C, a nonisolated EIA-232 serial port interface, supporting the +5 Vdc interface on a D-sub connector</td></tr>
</table>

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.

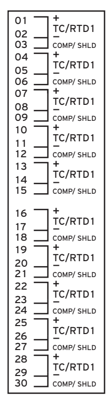
Table 2.4 RTD (10 RTD) Card Terminal Allocation

Terminals	Label	Description
		RTD1, drives analog quantity INTRTD1 RTD2, drives analog quantity INTRTD2 RTD3, drives analog quantity INTRTD3 RTD4, drives analog quantity INTRTD4 RTD5, drives analog quantity INTRTD5 RTD6, drives analog quantity INTRTD6 RTD7, drives analog quantity INTRTD7 RTD8, drives analog quantity INTRTD8 RTD9, drives analog quantity INTRTD9 RTD10, drives analog quantity INTRTD10

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

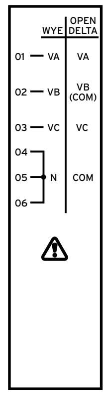
Terminals	Label	Description
		RTD1/TC1, drives analog quantity INTEMP01 RTD2/TC2, drives analog quantity INTEMP02 RTD3/TC3, drives analog quantity INTEMP03 RTD4/TC4, drives analog quantity INTEMP04 RTD5/TC5, drives analog quantity INTEMP05 RTD6/TC6, drives analog quantity INTEMP06 RTD7/TC7, drives analog 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 1.12* 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)

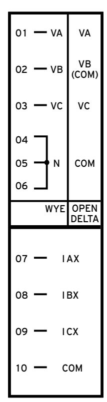
⚠CAUTION
If CT inputs are connected to external CTs, ensure that the external CTs are shorted prior to removing CT connections.

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

NOTE: The 8V LEA inputs can be configured to read DC analog inputs (VSCALE = CUSTOM).

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 current 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 1.12* 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

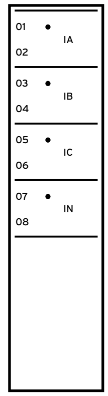
Current Card (4 ACI)

⚠CAUTION
If CT inputs are connected to external CTs, ensure that the external CTs are shorted prior to removing CT connections.

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 1.12* 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).

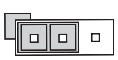
Table 2.8 Current Card (4 ACI) Terminal Designation

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

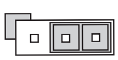
Analog Input Card (8 AI)

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

For current (default), install jumper on JMPX position 1 – 2.


1 2 3

For voltage, install jumper on JMPX position 2 – 3.


1 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

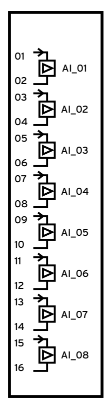
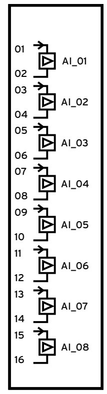
Terminals	Label	Description
		AI*x*01, Transducer Input number 1 AI*x*02, Transducer Input number 2 AI*x*03, Transducer Input number 3 AI*x*04, Transducer Input number 4 AI*x*05, Transducer Input number 5 AI*x*06, Transducer Input number 6 AI*x*07, Transducer Input number 7 AI*x*08, Transducer Input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

Table 2.10 Extended Range Analog Input Card Terminal Allocation

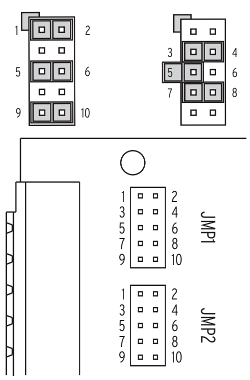
Terminals	Label	Description
		AI*x*01, Transducer Input number 1 AI*x*02, Transducer Input number 2 AI*x*03, Transducer Input number 3 AI*x*04, Transducer Input number 4 AI*x*05, Extended Range Transducer Input number 5 AI*x*06, Extended Range Transducer Input number 6 AI*x*07, Extended Range Transducer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

Analog Input/Output 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.

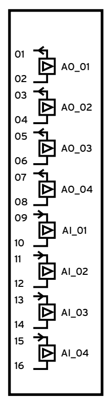
NOTE: Jumper x (x = 1 through 4) determines the nature of each analog output channel. Jumper x (x = 5 through 8) determines the nature of each analog input channel.

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.
For current input, connect the middle pin with the one labeled I.
For voltage input, connect the middle pin with the one labeled V.



NOTE: Maximum of one (1) 4 AI/4 AO card per chassis.

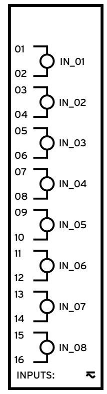
Table 2.11 Four Analog Input/Four Analog Output Card (4 AI/4 AO) Terminal Allocation

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.

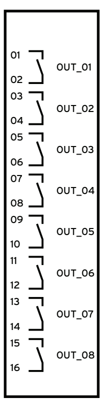
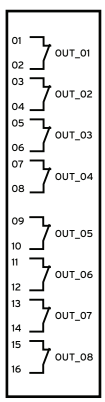
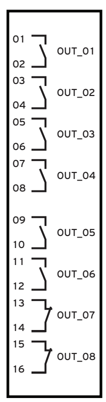
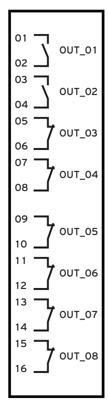
Table 2.12 Eight Digital Input Card (8 DI) Terminal Allocation

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)

Supported in any expansion slot (Slot **C** through Slot **Z**), this card has eight contact outputs. *Table 2.13* shows the terminal allocation. When ordering, select eight normally open (Form A) contact outputs, eight normally closed (Form B) contact outputs, six normally open (Form A) and two normally closed (Form B) contact outputs, or six normally closed (Form B) and two normally open (Form A).

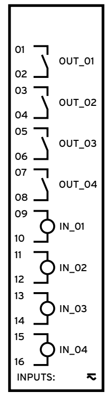
Table 2.13 Digital Output Card (8 DO) Terminal Allocation

Terminals	Form A	Form B	6 Form A/ 2 Form B	2 Form A/ 6 Form B	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.

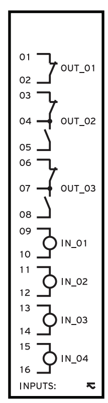
Table 2.14 Four Digital Input/Four Digital Output Card (4 DI/4 DO) Terminal Allocation

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.

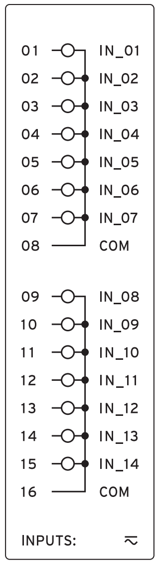
Table 2.15 Four Digital Input/Three Digital Output Card (4 DI/3 DO) Terminal Allocation

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

Digital Input Card (14 DI)

Supported in expansion Slot **C**, **D**, and **E**, this card has fourteen digital inputs. *Table 2.16* shows the terminal designations.

Table 2.16 Fourteen Digital Inputs (14 DI) Card Terminal Designations

Side-Panel Connections Label	Terminal Number	Description[a]
	01	IN*x*01, drives IN*x*01 element
	02	IN*x*02, drives IN*x*02 element
	03	IN*x*03, drives IN*x*03 element
	04	IN*x*04, drives IN*x*04 element
	05	IN*x*05, drives IN*x*05 element
	06	IN*x*06, drives IN*x*06 element
	07	IN*x*07, drives IN*x*07 element
	08	COM
	09	IN*x*08, drives IN*x*08 element
	10	IN*x*09, drives IN*x*09 element
	11	IN*x*10, drives IN*x*10 element
	12	IN*x*11, drives IN*x*11 element
	13	IN*x*12, drives IN*x*12 element
	14	IN*x*13, drives IN*x*13 element
	15	IN*x*14, drives IN*x*14 element
	16	COM

[a] x = 3, 4, 5, or 6 (e.g., IN401, IN402, etc. if the card is installed in Slot D).

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 with 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.

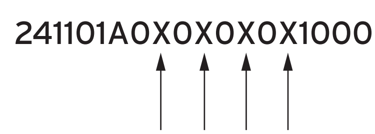


Figure 2.4 Digits That Remain Unchanged After Device Reconfiguration

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

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. *Figure 2.5* shows the jumper locations for the three versions supported.

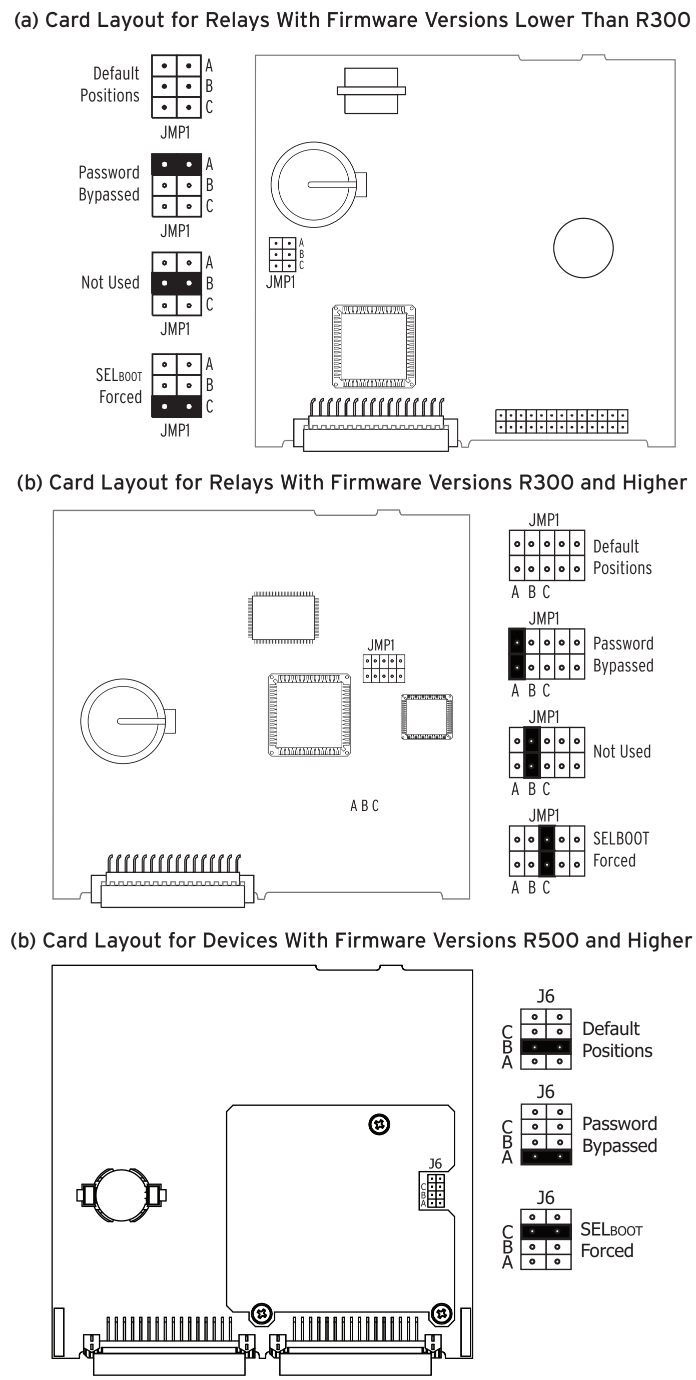


Figure 2.5 Pins for Password Jumper and SELBOOT Jumper

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 2.17* tabulates the functions of the three sets of pins and jumper default positions.

Table 2.17 Jumper Functions and Default Positions

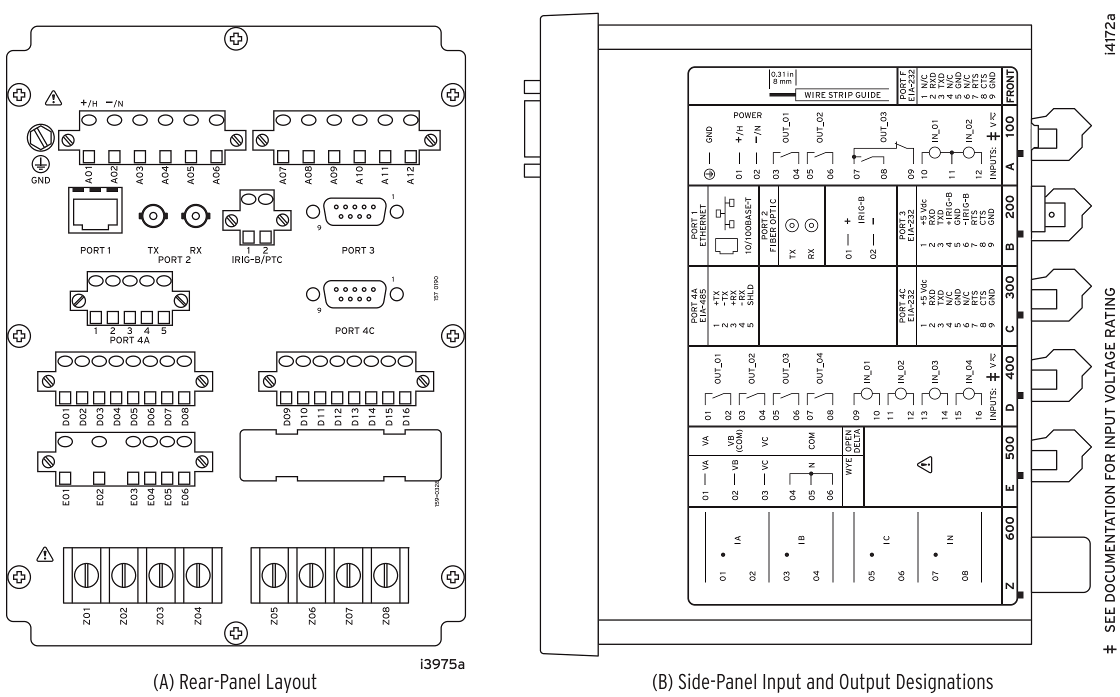
Pins	Jumper Default Position	Description
A	Not bypassed (requires password)	Password bypass
B	Not used	Not used
C	Not bypassed (not forced SELBOOT)	Forced SELBOOT

Rear-Panel Connections

Rear-Panel and Side-Panel Diagrams

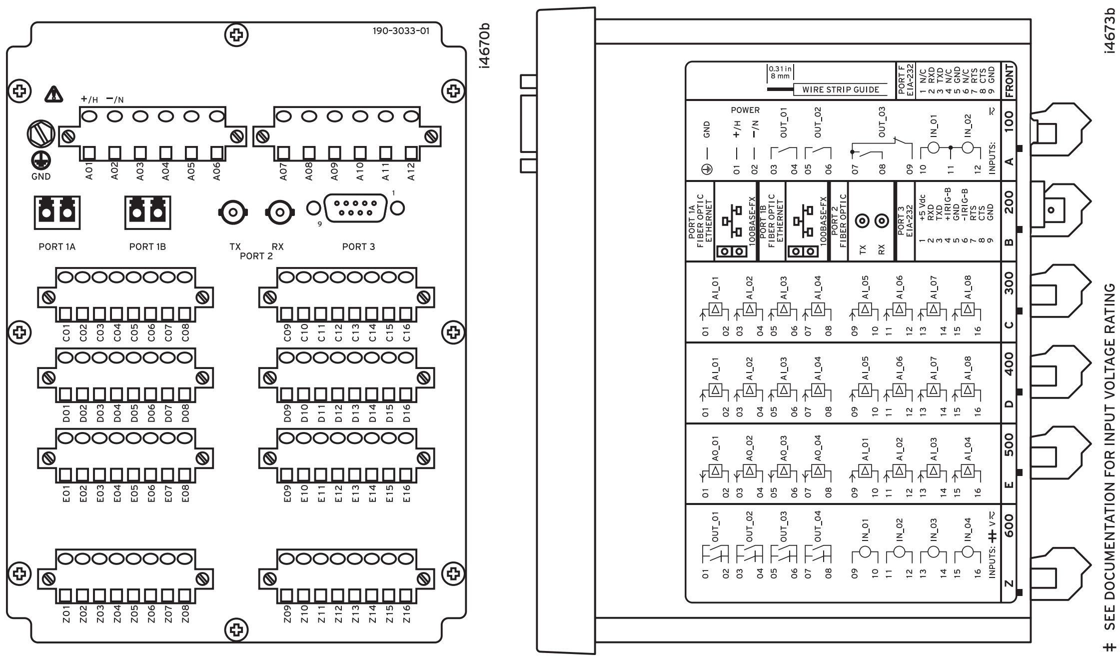
⚠CAUTION
The device contains devices sensitive to Electrostatic Discharge (ESD). When working on the device with the front panel removed or when accessing rear panel cards or connectors, work surfaces and personnel must be properly grounded or equipment damage may result.

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

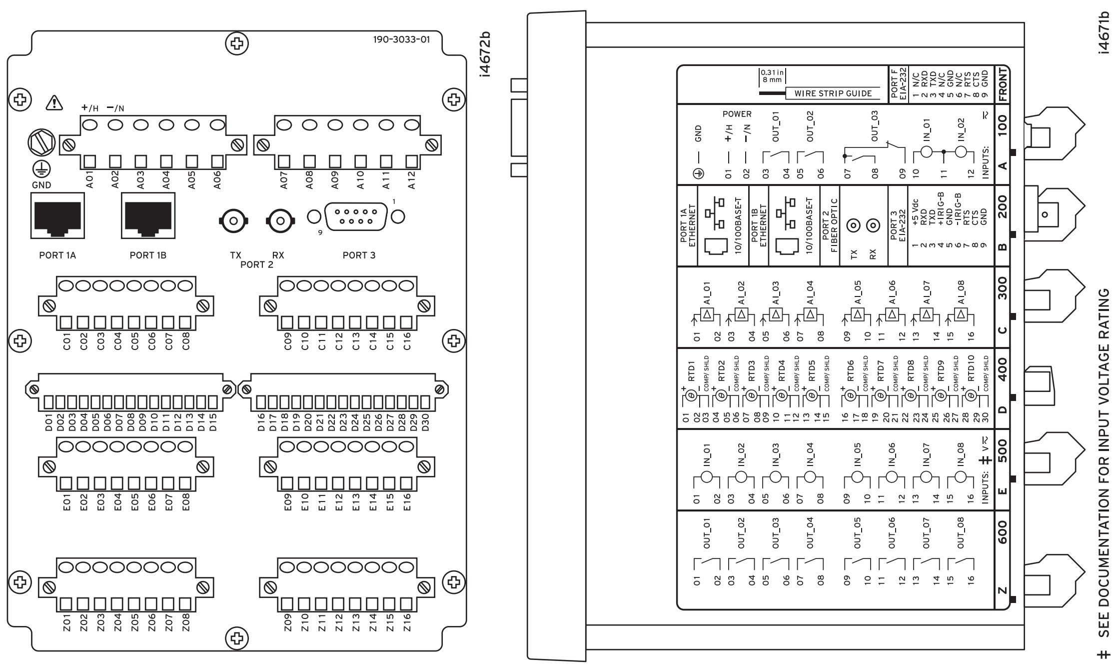
Figure 2.6 IRIG-B, Ethernet, EIA-232 Communication, 4 DI/4 DO, Voltage and Current Option



Rear-Panel Layout

Side-Panel Input and Output Designations

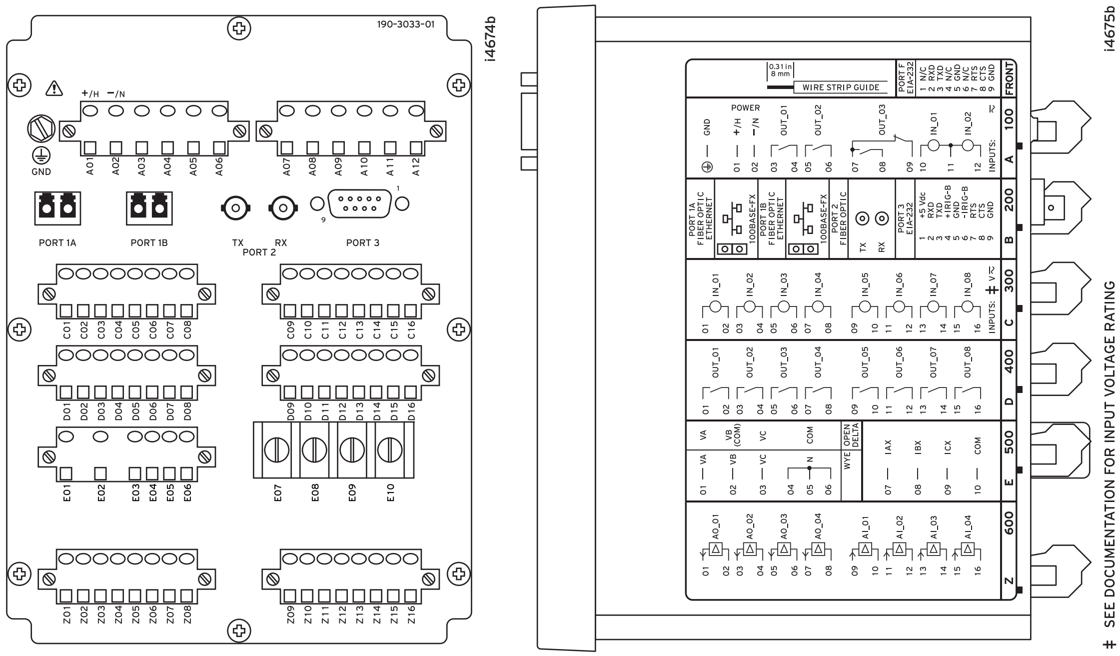
Figure 2.7 Dual Fiber Ethernet, 8AI, 4 AI/4 AO, and Fast Hybrid 4 DI/4 DO Option



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.

⚠CAUTION
Devices manufactured before May 2022 may not include an orange connector for the 24/48 Vdc power supply. Check your device's part number to ensure that you are using an appropriate voltage for your power supply.

The **POWER** terminals on the rear panel (**A01(+/H)** and **A02(−/N)**) must connect to 110–240 Vac, 110–250 Vdc, or 24–48 Vdc (orange connector) (see *Power Supply on page 1.8* for complete power input specifications.) The **POWER** terminals are isolated from chassis ground. Use 16–14 AWG (1.5–2.5 mm^2) wire of sufficient current capacity and insulation voltage rating to connect to the **POWER** terminals.

The SEL-2411 comes with an orange Euro connector on the Slot A card for the 24–48 Vdc low-voltage power supply option. *Figure 2.10* shows the orange Euro connector with the 24–48 Vdc power supply rating.

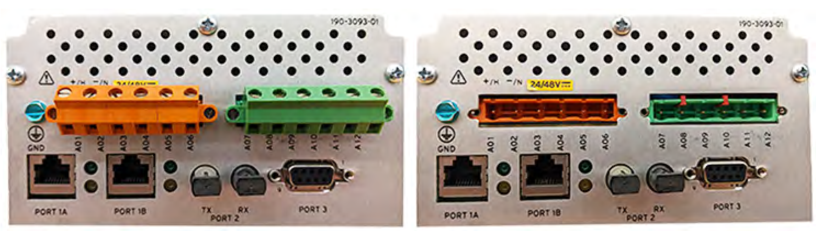


Figure 2.10 Slot A Euro Connector

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 less than 2 m (6.6 feet) of 14 AWG (2.5 mm^2) wire of sufficient current capacity and insulation voltage rating for the ground connection.

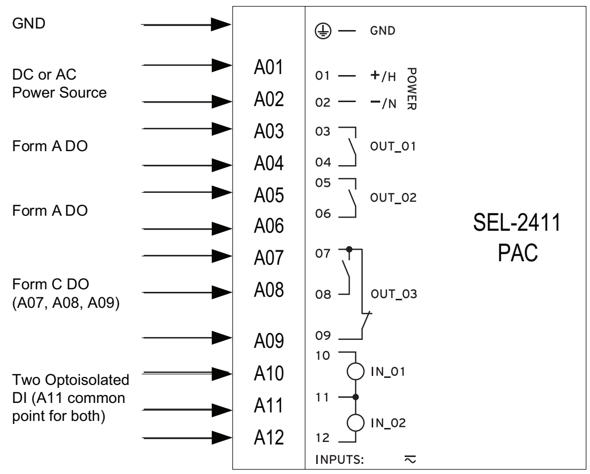


Figure 2.11 Power Connections

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 communications interface COMMINF setting to select between EIA-485 and EIA-232.

The Serial Port 4 EIA-485 plug-in connector accepts wire size 26 AWG through 14 AWG. Strip the wires 8 mm (0.31 inches) and install with a small slotted screwdriver. All EIA-232 ports accept 9-pin D-subminiature male connectors. Port **3** includes the IRIG-B time-code signal input.

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 (e.g., SEL RTAC) via fiber-optic Port **2** or Serial Port **3** may be used. See *Table 6.20* for selecting the IRIG source for either Port **2** or Port **3**.

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 by using a standard RJ45 connector for the copper port or 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) by using the cable shown in *Table 2.18*. 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 2.18 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)	SEL-C287
EIA-232 Port 2 (Fiber)	SEL-2600 RTD Module, SEL-2812/SEL-2814 Transceiver	SEL-C807Z
EIA-232 Port 3	SEL Communications Processors and SEL-2100 without IRIG-B	SEL-C272A
EIA-232 Port 3	SEL Communications Processors and SEL-2100 with IRIG-B	SEL-C273A

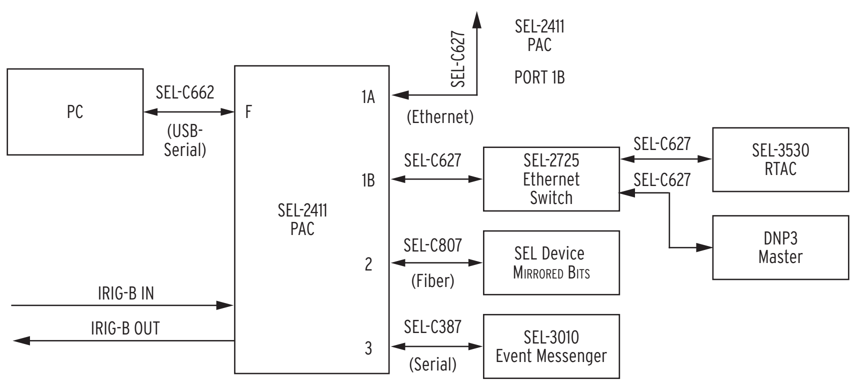


Figure 2.12 Communications Ports

I/O Connections

When the relay is ordered with the 24 Vdc/Vac or 48 Vdc/Vac input voltage option, the digital inputs come with the orange Euro connector on the slot. *Figure 2.13* shows the orange Euro connector for the 3 DI/4 DO/1 AO digital inputs option on Slot C.

Figure 2.13 Slot C Euro Connector

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.

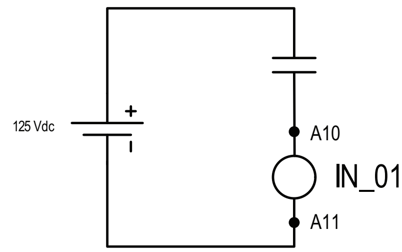


Figure 2.14 Digital Inputs

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.

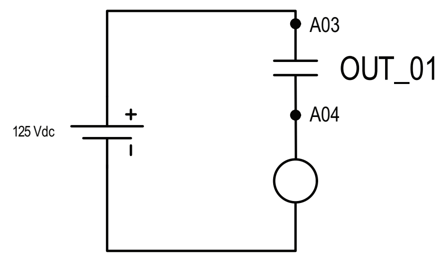


Figure 2.15 Digital Outputs

Analog Inputs and Outputs

Be sure to connect wiring to the analog inputs and analog outputs with the correct polarity. *Figure 2.16* 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.

The best noise and transient rejection is typically obtained using shielded twisted pair, grounded on only one end.

Figure 2.16 Analog Input and Analog Output

Thermocouple Inputs

The device supports as many as ten J, K, T, or E-type thermocouple inputs with a measurement range of –210°C to 250°C for J-type thermocouples and –270°C to 250°C for K-, T-, and E-type thermocouples. Inputs are divided into two isolated banks of five channels each. See *Specifications on page 1.8* for type test performance and compliance.

Each channel provides a plus and minus terminal that will accept wire as large as 18 AWG. Thermocouples should be installed according to standardized and accepted practices. Some thermocouple cables include shielding to increase immunity to EMI. If a shield is available, 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 2.17* for a proper installation example.

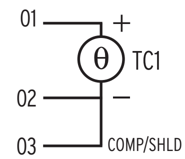


Figure 2.17 RTD Card and Universal Temperature Card 3-Wire RTD Wiring

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_high*gain) or offset = Set_low – (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 (Internal)

The device supports as many as 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 1.8* 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 2.18* applies to both the RTD card and Universal Temperature card.

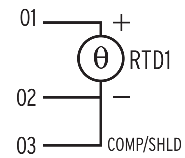


Figure 2.18 RTD Card and Universal Temperature Card 3-Wire RTD Wiring

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 2.19* 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.

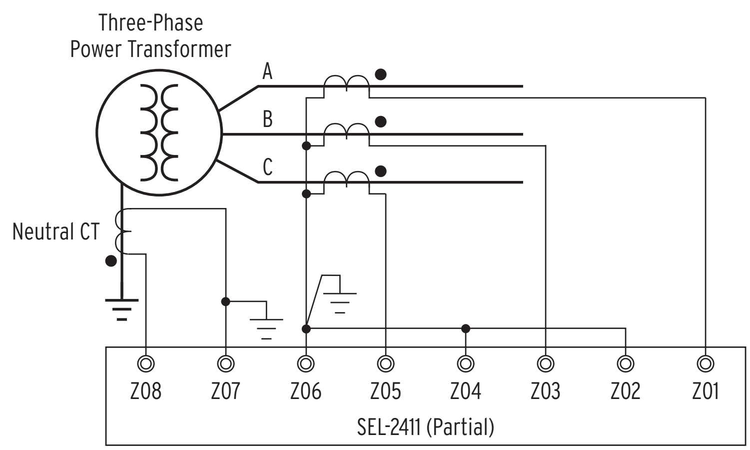


Figure 2.19 Current Connections Through CTs

If the startup current and full-load current are within the thermal specifications of the SEL-2411, connect loads directly to the device. *Figure 2.20* 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.

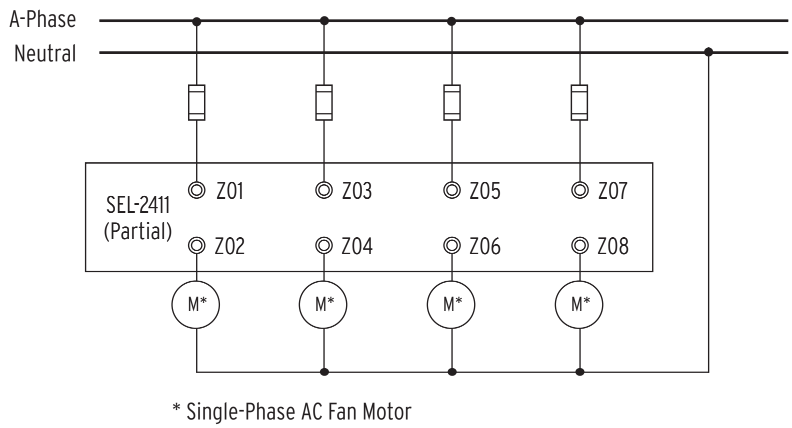


Figure 2.20 Direct Current Connections

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 2.21* through *Figure 2.23*):

- 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 2.21*), 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.

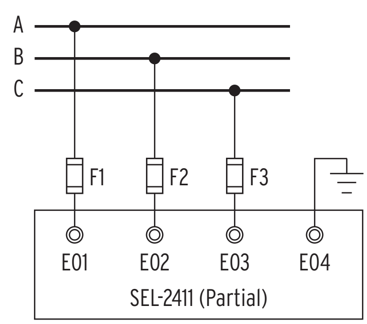


Figure 2.21 Direct Voltage Connection

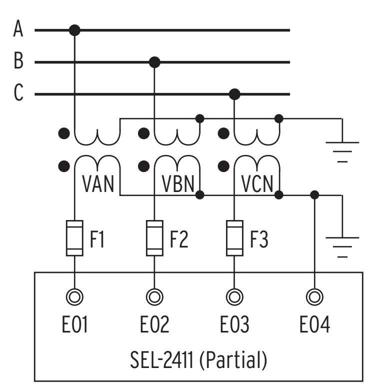


Figure 2.22 Wye-Wye VT Connection

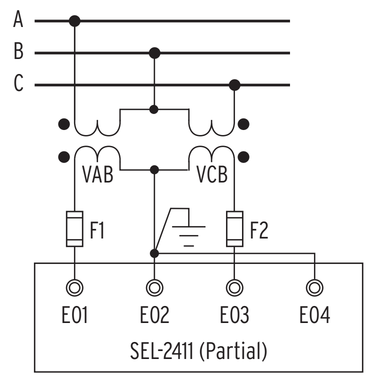


Figure 2.23 Open-Delta VT Connection

Because the SEL-2411 uses the A-phase voltage as reference when displaying metered values (see *METER Command (Metering Data) on page 7.29*), connecting voltages other than the voltages shown in *Figure 2.21* through *Figure 2.23* 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, Rayovac 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 Rayovac no. BR2335 or equivalent recommended by manufacturer. See Owner's Manual for safety instructions. The battery used in this device may present a fire or chemical burn hazard if mistreated. Do not recharge, disassemble, heat above 100°C or incinerate. Dispose of used batteries according to the manufacturer's instructions. Keep battery out of reach of children.

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.

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 2.16* and *Grounding (Earthing) Connections on page 2.17*. Once connected to power, the device does an internal self-check and the **ENABLED** LED illuminates.

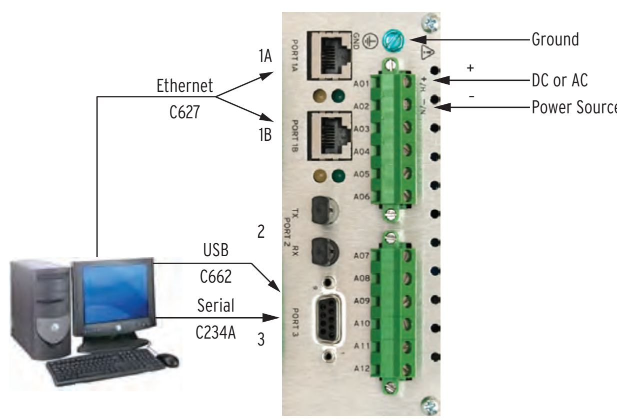


Figure 3.1 Power, Ground, and Communications Connections

QuickSet

Overview

ACSELERATOR QuickSet® SEL-5030 Software 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 QuickSet applications provided for the SEL-2411.

Table 3.1 QuickSet Applications

Terminal	Provides a direct connection to the SEL device. Use this communication method to interface directly with the device.
Rules Based Settings Editor	Provides online or offline 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	QuickSet uses a database to manage the settings of multiple devices.
Help	Provides general QuickSet and device-specific 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-5045	ACSELERATOR TEAM® SEL-5045 Software	This application automatically collects event reports.
SEL-5601-2	SEL-5601-2 SYNCHROWAVE® Event Software	Plots COMTRADE and SEL Compressed ASCII format event report oscillography; performs custom calculations on analog, and digital quantities.

Installation

Install QuickSet on your personal computer. Once QuickSet is installed, launch the application and a launch pad similar to *Figure 3.5* will appear.

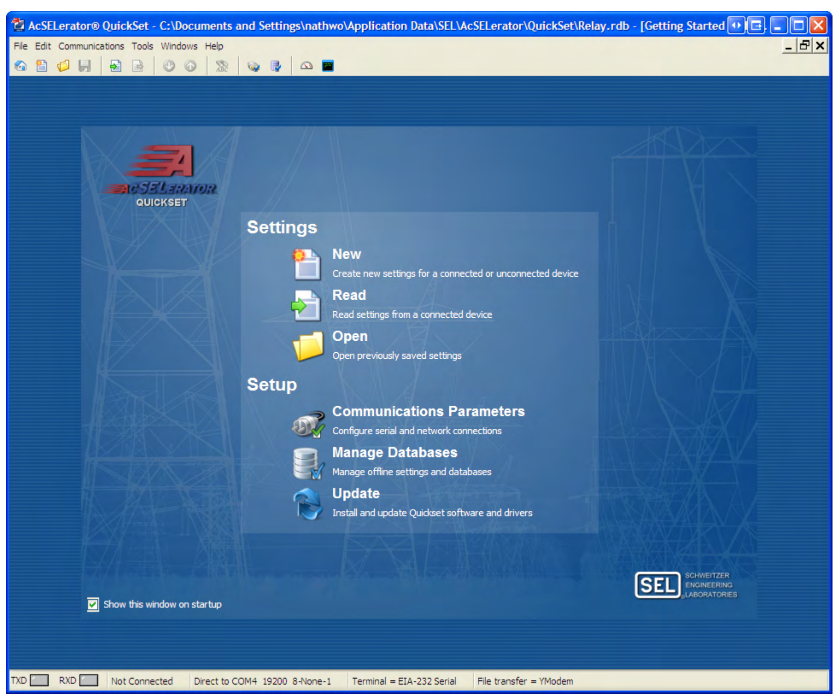


Figure 3.2 QuickSet Launch Pad

Connection Parameters

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

QuickSet uses relay communications Port 1 through Port 4 or Port F (front panel) to communicate with the SEL-2411. Access the settings menus shown in *Figure 3.3* and *Figure 3.4* by selecting **Parameters** in the Communications menu.

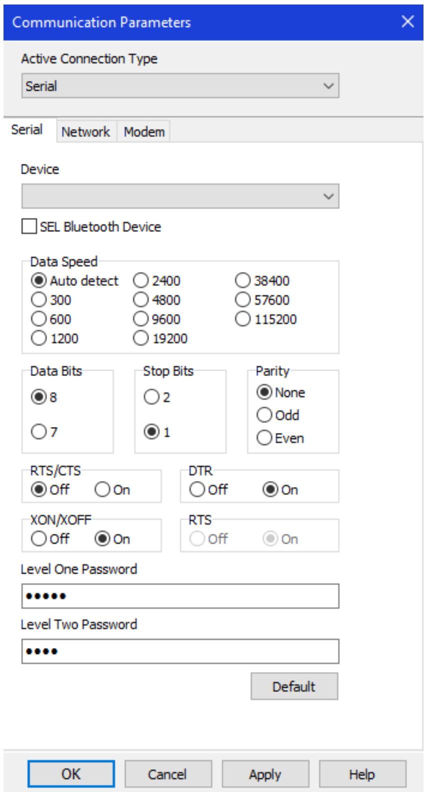


Figure 3.3 Serial Port Communication Parameters Dialog Box

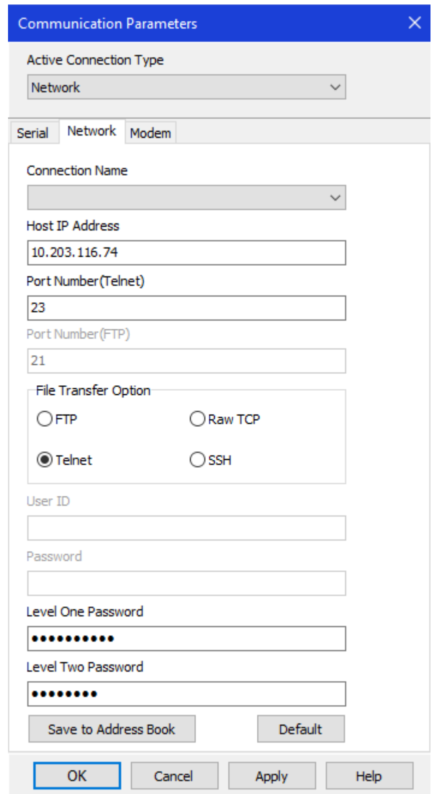


Figure 3.4 Network Communication Parameters Dialog Box

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 3.5* 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 7.58* provides the definition of each status field.

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

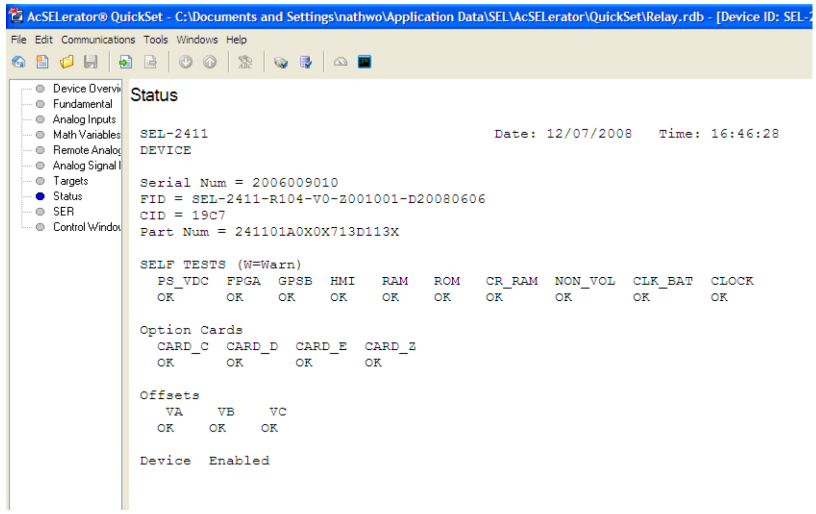


Figure 3.5 Communication Menu

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 the text above the square you want to change. After double-clicking 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 select the **Update** button to assign the Device Word bit to the LED. To change the color of the LED, select 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.

Select **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, select the appropriate square, then select the operation.

Update

Select **Update** from the launch pad to update the 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 launch pad. 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 launch pad shown in *Figure 3.2*, QuickSet launch pad, or by selecting **File** > **New**, **File** > **Open**, or **File** > **Read** from the menu bar, as shown in *Figure 3.2*.

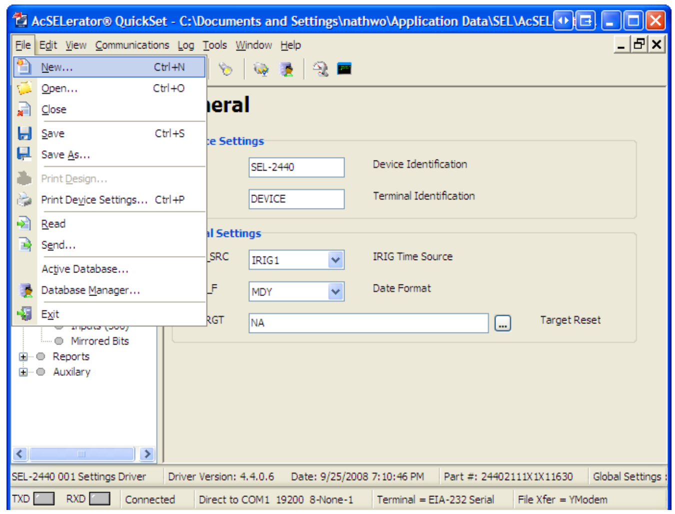


Figure 3.6 Creating a New Settings File

File > New

Selecting the **New** menu item creates new settings files. QuickSet makes the new settings files from the driver that you specify in the **Settings Editor Selection** dialog box. 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 3.7*.

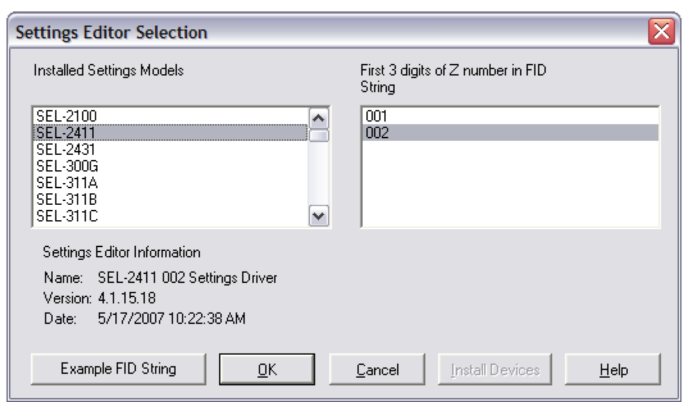


Figure 3.7 Selection of Drivers

After device model and settings driver selection, 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 3.8*. Press **OK** when finished.

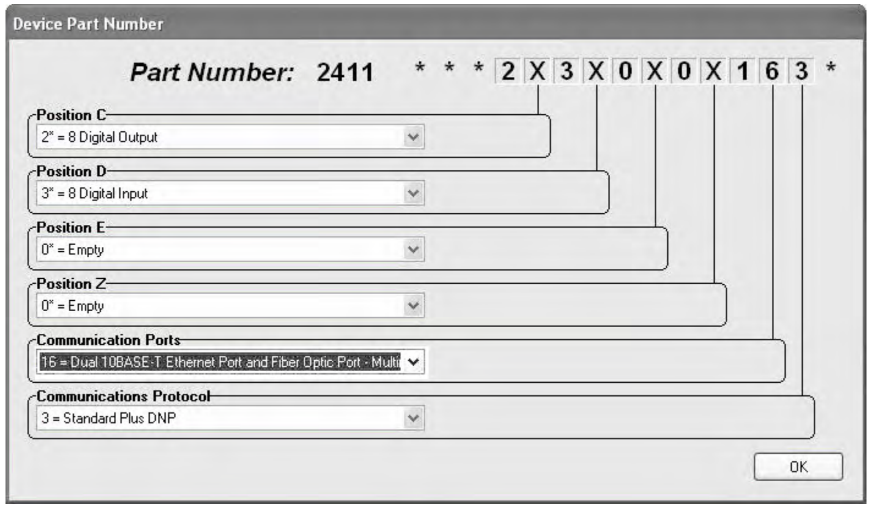


Figure 3.8 Update Part Number

Figure 3.9 shows the **Settings Editor** screen. View the bottom of the Device Editor window to check the **Settings Driver** number. Compare the 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. QuickSet uses this first portion of the Z-number to determine the correct **Device Editor** to display.

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

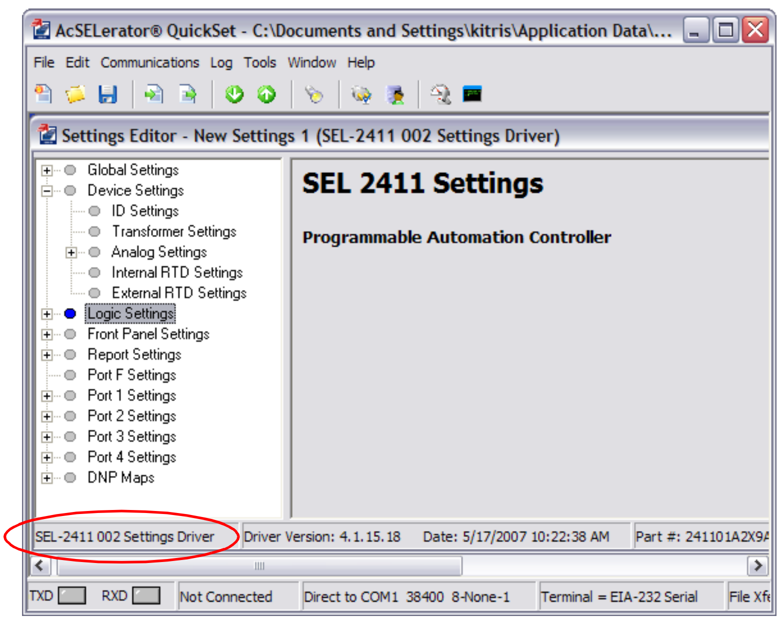


Figure 3.9 New Setting Screen

File > Open

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

File > Read

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

Event Analysis

QuickSet has integrated analysis tools that help you retrieve information about device operations quickly and easily. Use the event information stored in the device to evaluate the performance of a system (select **Tools > Events > Get Event Files**). *Figure 3.10* shows the event retrieval screen.

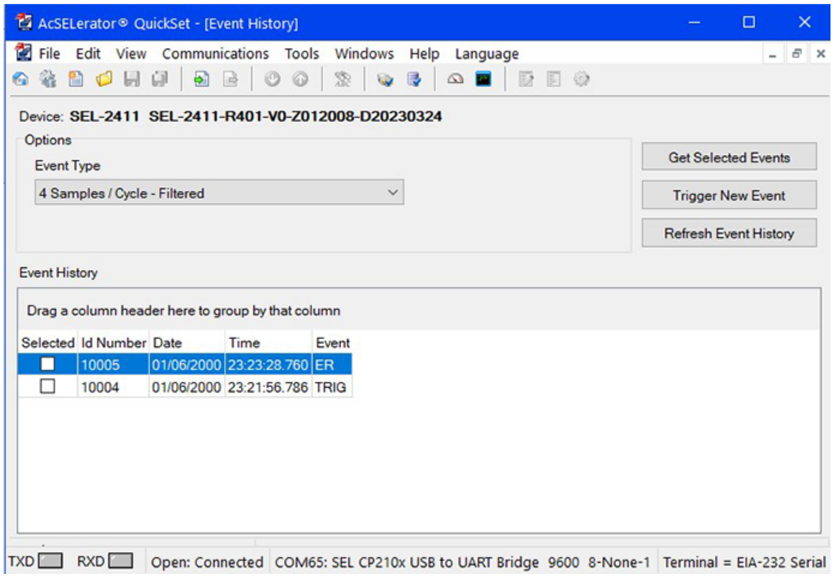


Figure 3.10 Retrieve Events Screen

You can retrieve event files stored in the relay and transfer these files to a computer. For information on the types of event files and data capture, see *Section 9: Analyzing Events*. To download event files from the device, select **Tools > Events > Get Event Files**. The Event History dialog box appears, as shown in *Figure 3.10*.

View Event History

The SEL-2411 is capable of capturing three types of events (4 samples/cycle filtered and 16 samples/cycle). These events can be captured in either compressed ASCII (.cev) or COMTRADE format. QuickSet allows you to download the .cev events. Use the Event Type dropdown list shown in *Figure 3.10* to select the event type. For information on how to download COMTRADE events from the relay, see *Retrieving COMTRADE Event Files on page 9.22*.

Get Event

Highlight the event you want to view (see *Figure 3.10*), select the event type from the Event Type dropdown menu (4 samples or 32 samples), and select **Get Selected Event**. QuickSet then queries where to save the file on your computer, as shown in *Figure 3.11*.

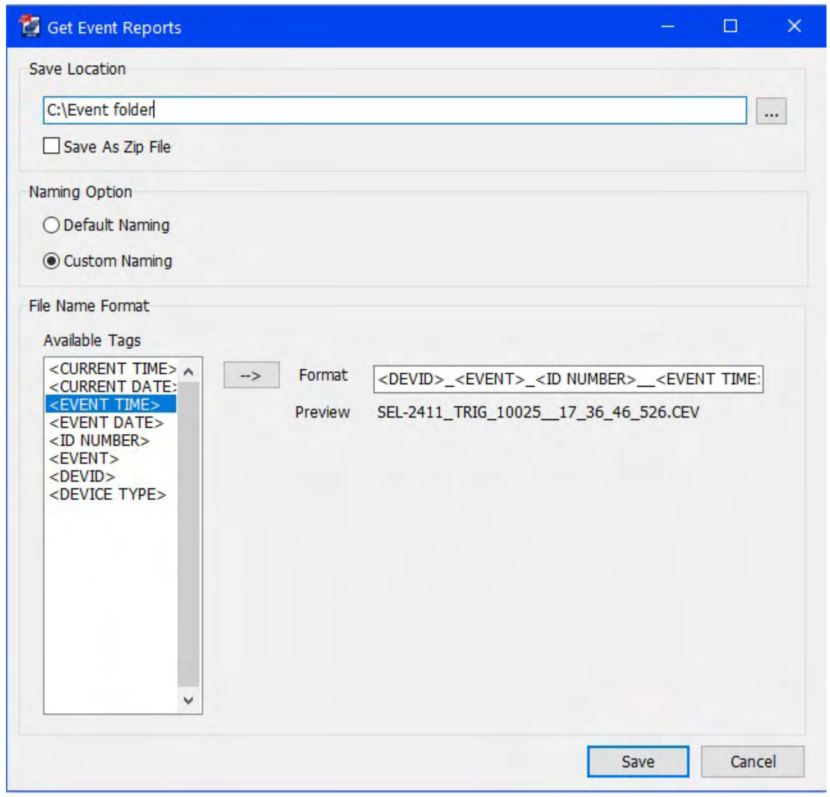


Figure 3.11 Save the Retrieved Event

When saving an event report, select a save location and a file name for your report. Select either **Default Naming** or **Custom Naming**. Default naming has predefined tags and organization, which appears in the Format text box when default naming is selected. You can use custom naming to create a file name specific to your application by selecting and organizing your own tags (listed in Available Tags).

View Event Files

Select **Tools > Events** to view an event with SYNCHROWAVE Event. You can view multiple events by selecting **Load Event > Add New Event** in SYNCHROWAVE Event.

Help

Various forms of 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 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

QuickSet Graphical Logic Editor

Use the QuickSet Graphical Logic Editor to create SELOGIC settings easily by creating a logic diagram with standard logic gates.

QuickSet Design Templates

QuickSet allows you to create personalized templates for relay applications. Use the templates within QuickSet to implement such various schemes as transformer protection or fan control. These templates hide settings you do not want to change (e.g., SELOGIC® control equations), while making visible the minimum necessary settings (e.g., timer and pickup settings) to implement the scheme. All settings can use aliases and allow mathematical manipulation for simple end-user interfacing. Create QuickSet Design Templates that include the most commonly used relay features and settings for your application.

QuickSet Design Templates are stored locally on the PAC. This ensures that users connecting with different computers will retrieve the correct template.

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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* and *Figure 4.2*.

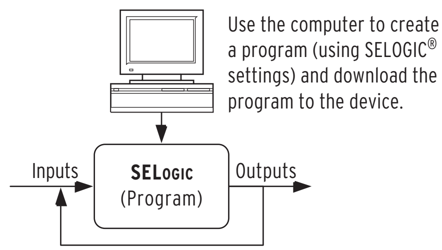

Figure 4.1 Program Model Overview

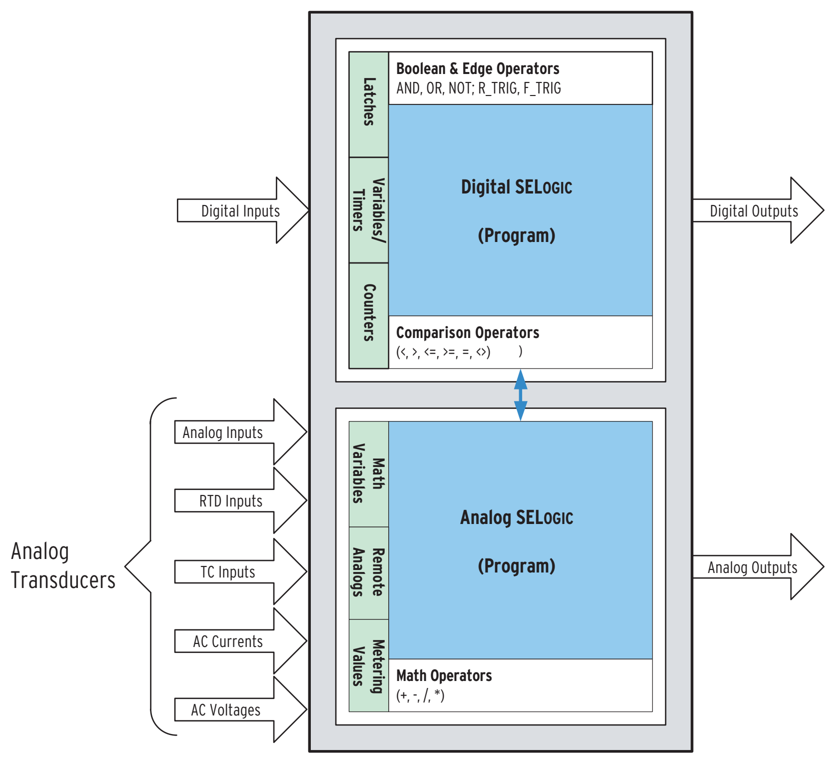

Figure 4.2 Detailed Program Model

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*.

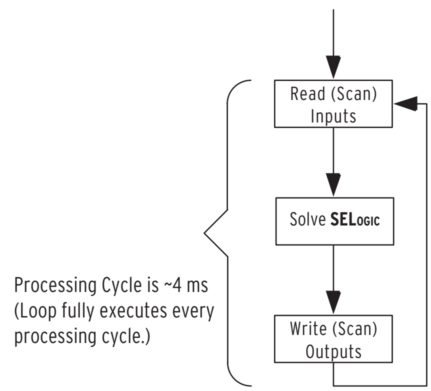

Figure 4.3 Operation Sequence

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 *p*	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–MV64). R_TRIG and F_TRIG only function with individual Device Word bits. 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–MV64). 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).

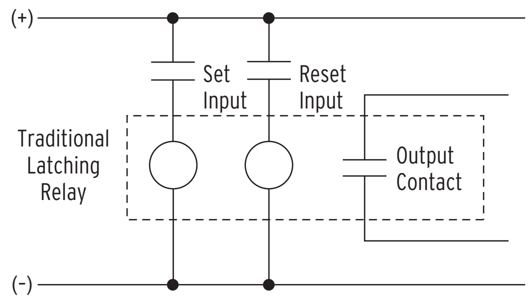

Figure 4.4 Schematic Diagram of a Traditional Latching Device

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.

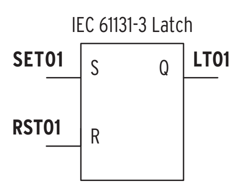

Figure 4.5 Logic Diagram of a Latch Switch

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*.

Latch Settings

Latch states are stored in battery-backed RTC SRAM. An operational battery in the Real-Time Clock is necessary to ensure that Latch settings are not compromised.

Settings SET*n* and RST*n* cannot result in continuous cyclical operation of latch bit LT*n*. Use timers to qualify conditions set in settings SET*n* and RST*n*. If you use any optoisolated inputs in settings SET*n* and RST*n*, the inputs each have a separate debounce timer that can help in providing the necessary time qualification.

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 SV64T in *Figure 4.6* have a setting range of 0.000–86400.00 seconds. This timer setting range applies to both pickup and dropout times (Sv*n*PU and SV*n*DO; *n* = 1 through 64). You can enter as many as 15 elements per SELOGIC equation.

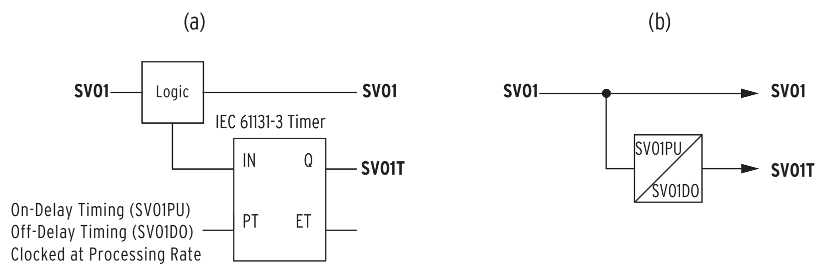

Figure 4.6 SELOGIC Control Equation Variable/Timers SV01/SV01T–SV32T

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* = 01–64) reset to logical 0 after power restoration or a settings change.

Run-Time Configurable Timers

Run-time configurable timers function just like standard SELOGIC variables/timers except the PU and DO settings are set dynamically by using specific analog quantities. Run-time configurable timers are only available in the SEL-2411 and replace the standard SELOGIC timers in the SEL-2411. There are 64 run-time configurable timers in the SEL-2411.

Table 4.5 Run-Time Configurable Timer Settings

Setting	Description
SV*n*	SELOGIC Variables 1–64
SV*n*PU	SELOGIC pickup threshold. A constant value or the analog quantities: MV*xx*, ACV*xx*, or RA*xxx*
SV*n*DO	SELOGIC dropout threshold. A constant value or the analog quantities: MV*xx*, ACV*xx*, or RA*xxx*

SV*n*PU and SV*n*DO are clamped between 0.000 and 86400.000 (86400.000 is a PU or DO of 24 hours). If a variable assigned to SV*n*PU or SV*n*DO exceeds these limits, they will be clamped to these values.

Analog Control Variables

Analog control variables (ACVs) provide a means of easily adjusting and defining limits and thresholds used in SELOGIC control equations. Thirty-two ACVs are available for use with SELOGIC expressions and for display. ACVs are nonvolatile analog registers that you can modify through the front panel, SEL ASCII Terminal, DNP, or Modbus. ACVs are useful for quick and easy adjustment of control limits and threshold settings.

Table 4.6 ACV Settings

EACV	Number of ACVs to enable
EACV	Number of ACVs to enable
ACV*nn*A	ACV alias
ACV*nn*P	Prompt displayed in the ACV data entry screen
ACV*nn*MIN	ACV minimum value
ACV*nn*MAX	ACV maximum value
ACV*nn*RV	ACV reset value
ACV*nn*U	ACV display units
ACV*nn*RST	ACV SELOGIC reset equation

Use the Analog Control Variables Alias (ACVA) setting to customize a label under the **SET/SHOW** menu on the front panel. For example, assume that you are using ACV registers to change the length of time a pump will run. You can set the ACVA setting to PUMP RUNTIME.

Use the ACVA*nn* settings to customize labels for each ACV register. Following the example above, you might choose to set ACV01A to PUMP RUNTIME and ACV01U to HOURS. By default, the aliases are set to the Analog Quantity name of the ACV register, ACV*nn*.

Use the ACV*nn*MAX and ACV*nn*MIN settings to limit the range of values that ACV registers accept. The SEL-2411 returns an out-of-range error if an attempt is made to set an ACV outside of this range.

You can change the value of an ACV using the methods listed below:

- Use the **CON** command: **CON ACV ACV*nn value***
- Use the **Control** menu on the front panel
- Send a DNP3 Analog Output Write (Object 41)
- Send a Modbus Holding Register Write (function code 06h and 10h)

Analog Values input from the front panel or communication protocols will be rejected if outside the range defined by ACV*nn*MIN and ACV*nn*MAX

ACV*nn* will accept the newest value entered from either the front panel, a terminal, or a communication protocol.

NOTE: The SEL-2411 applies new ACVs to all interfaces when writing to the ACV from any interface.

ACV*nn*RV is the value to which ACV*nn* is set if the value in ACV*nn* is invalid (e.g., ACV*nn* is outside new MIN/MAX values configured during a settings change, or there is no value currently in ACV*nn*).

ACV*nn*RST evaluating to TRUE will force the ACV to remain at ACV*nn*RV until ACV*nn*RST evaluates to FALSE.

Counters

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.

SELOGIC counters can be saved in nonvolatile storage to restore the value after a power cycle. SC*nn*NV enables nonvolatile storage of each counter. When enabled, the unit will store the present value of the counter every 2–5 seconds and automatically restore the value after reboot. In a controlled power cycle, the present value will be stored before the reboot even if it occurs before the automatic save interval.

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.

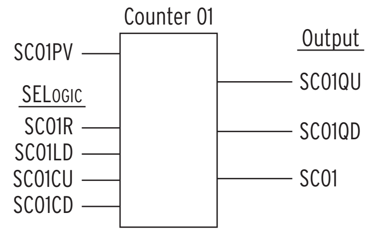

Figure 4.7 Counter 01

Table 4.7 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 4.7 Counter Input/Output Description

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). The counter will not increment higher than this value.
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. Set SC*nn*CU to 0 if it is unused.
SC*nn*CD	Rising edge input	Count-down decrements the counter (SELOGIC setting). Setting this to NA disables the counter. Set SC*nn*CD to 0 if it is unused.
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 counter equals the preset value (maximum count) (SC*n* = SC*n*PV, *n* = 01 to 32).
SC*nn*QD	Active high output	This count-down output asserts when the counter equals 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.

Because there are only 7 bits available for the fractional portion, the result of multiplication and division with decimals will have lower accuracy than one would expect with a floating-point processor. As illustrated by the results of in *Table 4.8*, the results vary from 20 percent at the smallest end of the fractional values to 0.2 percent at the largest. Using scaling factors where possible is recommended to avoid the error introduced by the fixed-point processor when multiplying and dividing fractional numbers.

Table 4.8 Math Variable Fractional Multiplication Results

MV01 := 0.01*10	Result = 0.08	Error = 20%
MV01 := 0.05*10	Result = 0.47	Error = 6%
MV01 := 0.1*10	Result = 1.02	Error = 2.0%
MV01 := 0.5*10	Result = 5.00	Error = 0%
MV01 := 0.99*10	Result = 9.92	Error = 0.2%

SELOGIC math variables can be saved in nonvolatile storage to restore the value after a power cycle. MV*nn*NV enables nonvolatile storage of each math variable. When enabled, the unit will store the present value of the math variable every 2–5 seconds and automatically restore the value after reboot. In a controlled power cycle, the present value will be stored before the reboot even if it occurs before the automatic save interval.

Table 4.9 shows example settings using nonvolatile math storage to maintain the maximum value of a temperature input.

Table 4.9 Nonvolatile Max Temperature Example

SV01:= INTEMP01 > MV01
MV01NV:=Y
MV01:= (SV01*INTEMP01)+MV01*(NOT SV01)

Device Word bits provided for math are shown in *Table 4.10*.

Table 4.10 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 4.11*. Math SELOGIC control equation settings operate on numerical values through use of one or more of the Mathematical operators listed in *Table 4.11*. 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 4.11 SELOGIC Control Equation Operators (Listed in Operator Precedence)

Operator	Function	Function Type
( )	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	Mathematical
/	Divide	Mathematical
+	Add	Mathematical
-	Subtract	Mathematical
<, >, <=, >=	Comparison	Boolean
=	Equality	Boolean
<>	Inequality	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 as many as 14 sets of parentheses in a single SELOGIC control equation setting. The parentheses can 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*.

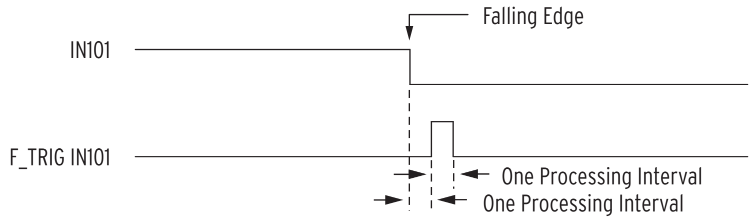

Figure 4.8 Result of Falling-Edge Operator on a Deasserting Input

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 similarly to the comparison operators.

Other

Table 4.12 shows other operators and values that you can use in writing SELOGIC control equations.

Table 4.12 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

Fast Analog Logic

Use Fast Analog Alarms to detect overvoltage, undervoltage, and overcurrent conditions on the inputs of the 3 AVI, 3 AVI/3 ACI, and 4 ACI SELECT I/O cards. Two warning levels and an alarm level are available for each ACI and AVI input channel that are processed every 1/4 cycle. The analog math delay of 100 ms does not apply to these alarms. Every processing interval, the instantaneous value is compared to the warning level and alarm set points and asserts any of those alarms if applicable. Each warning level and alarm is available for use in logic for tripping or logging purposes. Each channel has threshold settings for each level and can be turned off if desired. The threshold settings are entered in secondary current/voltage values. *Figure 4.9* illustrates the behavior of the Fast Analog Logic blocks.

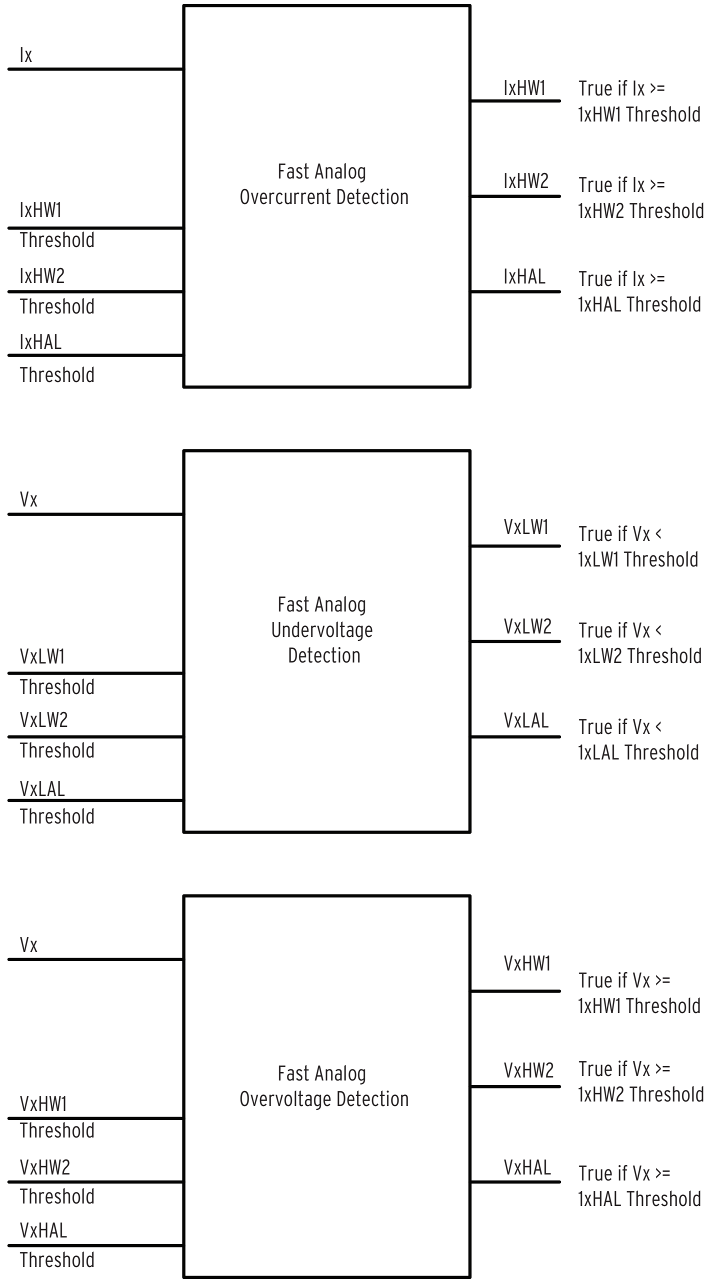

Figure 4.9 Fast Analog Logic

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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 Outstation via EIA-232 port
- DNP3 Level 2 Outstation 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-to-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*.

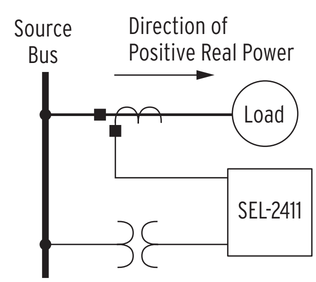

Figure 5.1 Primary Plant Connections

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).

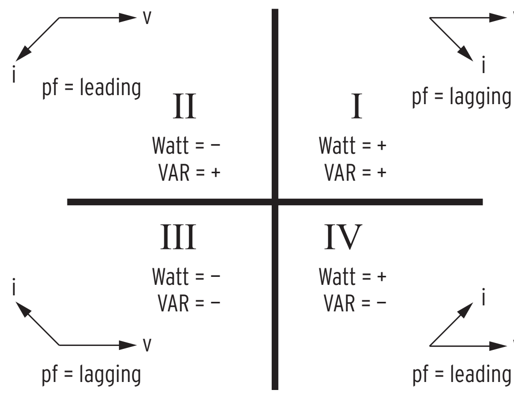

Figure 5.2 Complex Power Measurement Conventions—Motor Action

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 messages 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. *Table 5.5* shows the energy meter values.

Table 5.5 Energy Meter Values When the PT Is Measuring Source Voltage and the CT Is Measuring Load Current

Values	Units	Description
MWHXO[a], MWHO[b]	MWh pri	Real 3-Phase Energy Out (from source to load)
MWHXI[a], MWHI[b]	MWh pri	Real 3-Phase Energy In (from load to source)
MVARHXO[a],MVARHO[b]	MVARh pri	Reactive 3-Phase Energy Out (from source to load)
MVARHXI[a], MVARHI[b]	MVARh pri	Reactive 3-Phase Energy In (from load to source)

[a] A 3 ACI/3 AVI card installed on Slot E measures the auxiliary energy values.
[b] A 4 ACI card installed on Slot Z measures the energy values.

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-to-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 the following minimum thresholds are 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 7.29*.

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").

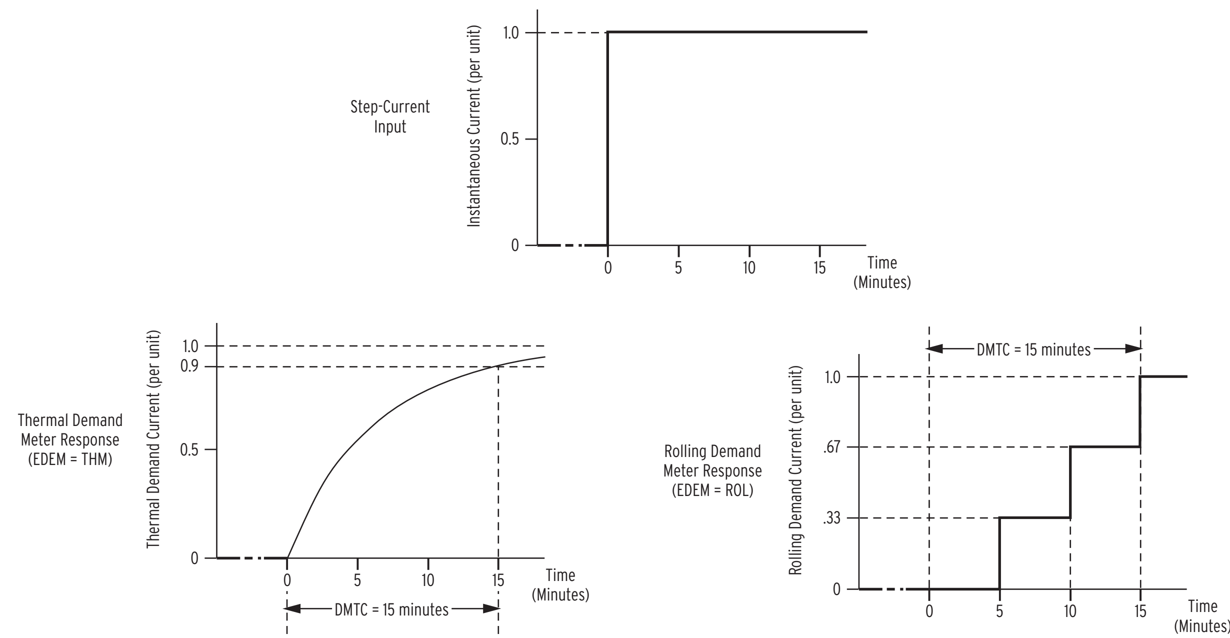

Figure 5.5 Response of Thermal and Rolling Demand Meters to a Step Input (Setting DMTC = 15 Minutes)

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*.

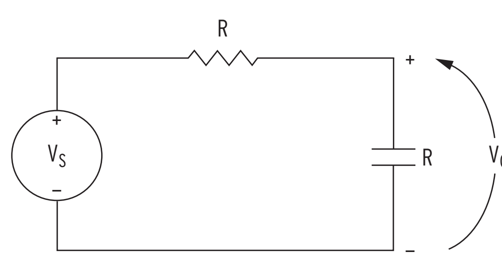

Figure 5.6 Voltage V_S Applied to Series RC Circuit

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 towards 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 two 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 7.29*, *MET Demand/Peak Demand Metering on page 7.31*. 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 as many as 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.

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 6: Settings* 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 64 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 64) you require through use of the EMV setting in the Logic setting category. *Figure 5.8* shows the device response to the **MET MV** (math variable) command with eight of the 64 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 can still use the phase-to-neutral voltage quantities (VA, VB, VC) in math variable equations, but the SEL-2411 zeros these values out.

Remote Analog Metering

NOTE: Setting ERAFAST enables updating RA001–RA032 at the SELOGIC processing interval instead of the standard 100 ms analog processing interval.

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 are lost when changing either SPLIST1 or SPLIST2 settings.

Use the analog signal profiling function to record and track values of as many as 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

Enter as many as 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	As many as 16 analog quantities	NA
SPLIST2	Signal Profile List	As many as 16 analog quantities	NA
SPAR	Signal Profile Acquisition Rate	1, 5, 10, 15, 30, 60 min	5
SPEN[a]	Signal Profile Enable	SV	1

[a] Enter as many as 14 nested parentheses and as many as 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 are 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** (clear) command to clear all profile data.

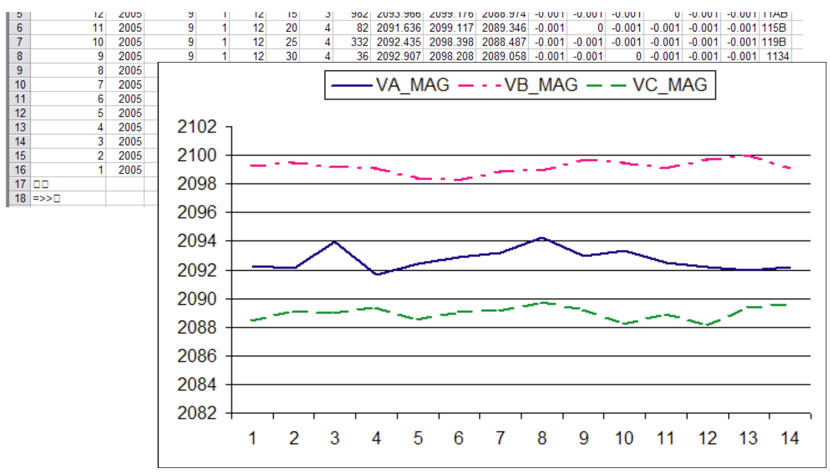

Figure 5.10 Profile Data in an Excel Spreadsheet and Graph

Load Tap Changer

The SEL-2411 supports implementation of a load tap changer (LTC) control application and separates the control into two categories namely, LTC control (LTCC) and load tap position and control monitoring (LTPC).

Load Tap Changer Control

The LTC control supports SELOGIC control equations RSE_CTRL, LWR_CTRL, and PAR_OP for controlling the raise, lower, and parallel operations of an LTC controller, respectively. These serve as the central settings for tying local custom logic or remote logic to the LTC control outputs on the device.

NOTE: Because the SEL-2411 is a Programmable Automation Platform, it does not support voltage regulation algorithms natively. Implement regulation logic according to your specific application.

NOTE: The IED capability Description file (ICD) version R119 or higher supports the ATCC logical Node. See Logical Nodes on page F.38 for the data objects in the ATCC node.

For example, *Figure 5.11* shows a schematic of the raise output contact control. See *Local/Remote Control on page 6.28* for details on local/remote control.

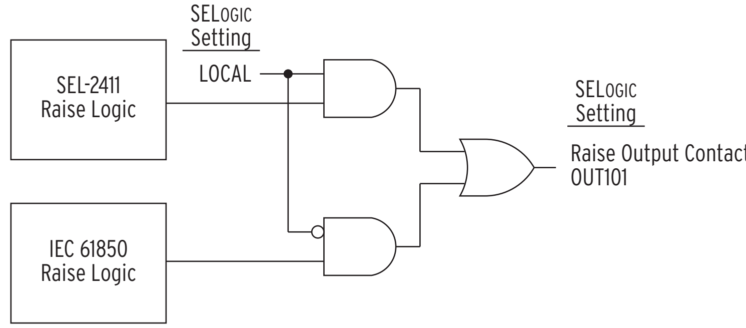

Figure 5.11 Implementing Raise Control on the Output Contact OUT101

Load Tap Position and Control Monitoring

The SEL-2411 supports load tap position and control monitoring (LTPC) by using digital inputs in the binary-coded decimal (BCD) or binary format. The SEL-2411 can monitor as many as 32 tap positions with one or three neutral tap positions. Additionally, it monitors the raise and lower controls to assert alarms for tap position change failures or unexpected tap positions. *Figure 5.12* illustrates the settings, tap position inputs, and raise and lower control status inputs that the SEL-2411 uses to evaluate the tap position monitoring information and alarms.

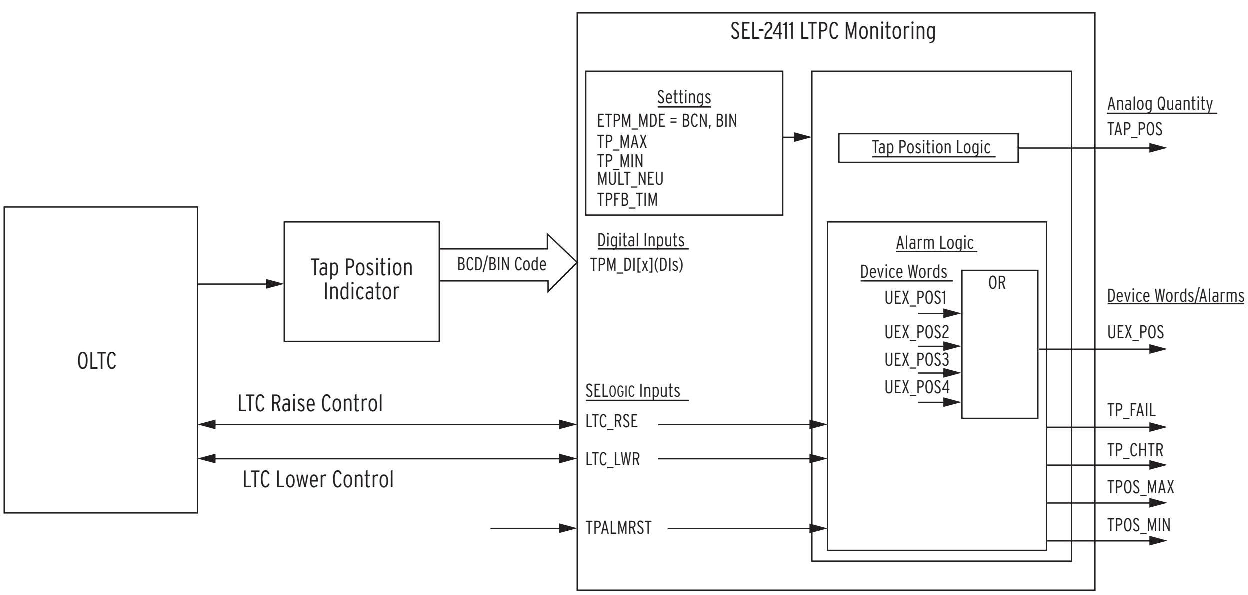

Figure 5.12 LTPC Monitoring Block Diagram

Implement individual tap position statistics monitoring with the nonvolatile counters and voltage regulation by using measured voltages, timers, and analog control variables.

Tap Position Inputs and Settings

Provide the maximum and minimum tap positions on the OLTC to the device using the TP_MAX and TP_MIN settings. The device supports monitoring of unipolar or bipolar tap positions. For a unipolar OLTC with 32 tap positions, set TP_MAX = 32 and TP_MIN= 0; for a bipolar OLTC with 32 tap positions, set TP_MAX = 16 and TP_MIN = –16.

Set the tap position indicator (TPI) input format using the ETPM_MDE setting. *Table 5.10* includes the setting options for ETPM_MDE.

Table 5.10 ETPM_MDE Selections

ETPM_MDE	TPI Format
OFF	Not Connected
BCD	Binary Coded Decimal
BIN	Binary Code

Associate the individual bits of the digital tap information to the digital inputs of the SEL-2411 using the TPM_DI setting. The first digital input in the list is the least significant bit of the code. For example, assuming an SEL-2411 with a 14 DI card in Slot **C** monitoring a 32-position OLTC, using the BCD format (six digital inputs), set TPM_DI = IN308 IN309 IN310 IN311 IN312 IN314. In this case, IN308 represents the least significant bit of the BCD format.

Tap Position Calculations

The SEL-2411 calculates the tap position as an analog quantity, TAP_POS.

When ETPM_MDE = BIN, the SEL-2411 calculates the TAP_POS by using *Equation 5.1*.

$$TAP\_POS = TPM\_DI1 + TPM\_DI2 \bullet 2 + TPM\_DI3 \bullet 4 + TPM\_DI4 \bullet 8 + TPM\_DI5 \bullet 16 + TPM\_DI6 \bullet 32 + TP\_MIN$$

Equation 5.1

When ETPM_MDE = BCD, the SEL-2411 calculates the TAP_POS by using *Equation 5.2*.

$$TAP\_POS = TPM\_DI1 + TPM\_DI2 \bullet 2 + TPM\_DI3 \bullet 4 + TPM\_DI4 \bullet 8 + TPM\_DI5 \bullet 10 + TPM\_DI6 \bullet 20 + TP\_MIN$$

Equation 5.2

See *Table 5.11* for examples of calculated tap positions for various combinations of the TPM_DI inputs. Implement tap position statistics by monitoring TAP_POS using the available nonvolatile SELogic counters.

Set MULT_NEU = N to monitor one neutral position and MULT_NEU = Y to monitor three neutral positions.

Table 5.11 TAP_POS Calculation for ETPM_MDE = BCD, TP_MAX = 16, TP_MIN = –16 and MULT_NEU = N (Sheet 1 of 2)

TPM_DI6	TPM_DI5	TPM_DI4	TPM_DI3	TPM_DI2	TPM_DI1	Position Number	TAP_POS
1	1	0	0	1	0	32	16
1	1	0	0	0	1	31	15
1	1	0	0	0	0	30	14

Table 5.11 TAP_POS Calculation for ETPM_MDE = BCD, TP_MAX = 16, TP_MIN = –16 and MULT_NEU = N (Sheet 2 of 2)

TPM_DI6	TPM_DI5	TPM_DI4	TPM_DI3	TPM_DI2	TPM_DI1	Position Number	TAP_POS
1	0	1	0	0	1	29	13
1	0	1	0	0	0	28	12
1	0	0	1	1	1	27	11
1	0	0	1	1	0	26	10
1	0	0	1	0	1	25	9
1	0	0	1	0	0	24	8
1	0	0	0	1	1	23	7
1	0	0	0	1	0	22	6
1	0	0	0	0	1	21	5
1	0	0	0	0	0	20	4
0	1	1	0	0	1	19	3
0	1	1	0	0	0	18	2
0	1	0	1	1	1	17	1
0	1	0	1	1	0	16	0
0	1	0	1	0	1	15	–1
0	1	0	1	0	0	14	–2
0	1	0	0	1	1	13	–3
0	1	0	0	1	0	12	-4
0	1	0	0	0	1	11	–5
0	1	0	0	0	0	10	–6
0	0	1	0	0	1	9	–7
0	0	1	0	0	0	8	–8
0	0	0	1	1	1	7	–9
0	0	0	1	1	0	6	–10
0	0	0	1	0	1	5	–11
0	0	0	1	0	0	4	–12
0	0	0	0	1	1	3	–13
0	0	0	0	1	0	2	–14
0	0	0	0	0	1	1	–15
0	0	0	0	0	0	0	–16

Table 5.12 TAP_POS Calculation for ETPM_MDE = BIN, TP_MAX = 16, TP_MIN = –16 and MULT_NEU = N (Sheet 1 of 2)

TPM_DI6	TPM_DI5	TPM_DI4	TPM_DI3	TPM_DI2	TPM_DI1	Position Number	TAP_POS
1	0	0	0	0	0	32	16
0	1	1	1	1	1	31	15
0	1	1	1	1	0	30	14
0	1	1	1	0	1	29	13
0	1	1	1	0	0	28	12
0	1	1	0	1	1	27	11
0	1	1	0	1	0	26	10

Table 5.12 TAP_POS Calculation for ETPM_MDE = BIN, TP_MAX = 16, TP_MIN = –16 and MULT_NEU = N (Sheet 2 of 2)

TPM_DI6	TPM_DI5	TPM_DI4	TPM_DI3	TPM_DI2	TPM_DI1	Position Number	TAP_POS
0	1	1	0	0	1	25	9
0	1	1	0	0	0	24	8
0	1	0	1	1	1	23	7
0	1	0	1	1	0	22	6
0	1	0	1	0	1	21	5
0	1	0	1	0	0	20	4
0	1	0	0	1	1	19	3
0	1	0	0	1	0	18	2
0	1	0	0	0	1	17	1
0	1	0	0	0	0	16	0
0	0	1	1	1	1	15	–1
0	0	1	1	1	0	14	–2
0	0	1	1	0	1	13	–3
0	0	1	1	0	0	12	–4
0	0	1	0	1	1	11	–5
0	0	1	0	1	0	10	–6
0	0	1	0	0	1	9	–7
0	0	1	0	0	0	8	–8
0	0	0	1	1	1	7	–9
0	0	0	1	1	0	6	–10
0	0	0	1	0	1	5	–11
0	0	0	1	0	0	4	–12
0	0	0	0	1	1	3	–13
0	0	0	0	1	0	2	–14
0	0	0	0	0	1	1	–15
0	0	0	0	0	0	0	–16

Tap Position Control Monitoring

Associate the LTC_RSE and LTC_LWR SELOGIC control equations to digital inputs or custom logic to provide the raise and lower control signal status to the device. For example, if the SEL-2411 is controlling the LTC raise and lower operations with OUT101 and OUT102, set LTC_RSE = OUT101 and LTC_LWR = OUT102, respectively.

After a raise or lower control signal asserts, an OLTC can require 1–10 seconds to change the tap position. Furthermore, a TPI may take additional time to indicate a valid tap position output after the tap position changes. Set the TPFB_TIM setting equal to the total expected time to transpire between the assertion of LTC_RSE or LTC_LWR and a successful change in tap position from the TPI.

Tap Position Alarms

The SEL-2411 asserts the following Device Word bits as alarms:

NOTE: The device considers TPM_DI state changes to be stable if the changes persist for at least 25 control processing intervals plus the digital input pickup or dropout time.

NOTE: The device considers TPM_DI state changes to be chattering if the changes persist for fewer than 25 control processing intervals plus the digital input pickup or dropout time. TP_CHTR asserts if the chatter occurs repeatedly over the duration of TPFB_TIM since the first state change.

- UEX_TPOS indicates unexpected tap position

  In order for UEX_TPOS to assert, TPM_DI state changes must be stable.
- TP_FAIL indicates that the tap position did not change within the set feedback time after a tap change control signal has been issued
- TP_CHTR indicates that the TPM_DI inputs have been chattering for at least TPFB_TIM
- TPOS_MAX indicates that the tap position is equal to TP_MAX
- TPOS_MIN indicates that the tap position is equal to TP_MIN

The UEX_TPOS Device Word bit is a logical OR of the following Device Word bits/alarms:

- UEX_POS1 indicates a tap position change without a preceding control signal assertion
- UEX_POS2 indicates a tap position change greater than one
- UEX_POS3 indicates a tap position change in a direction opposite to that of the control signal
- UEX_POS4 indicates invalid BCD codes (1010, 1011, 1100, 1101, 1110, or 1111) on the four least significant bits of TPM_DI

Use the TPALMRST SELOGIC control equation to reset all the alarms. Alarm reset occurs when TPALMRST evaluates to true.

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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 **ENT** pushbutton. The display shows the following message:

```
SET/SHOW
Device
```

Select the underlined `Device` message with the **ENT** 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 **ENT** pushbutton. Select **Yes** to save the settings changes and **No** to discard the changes.

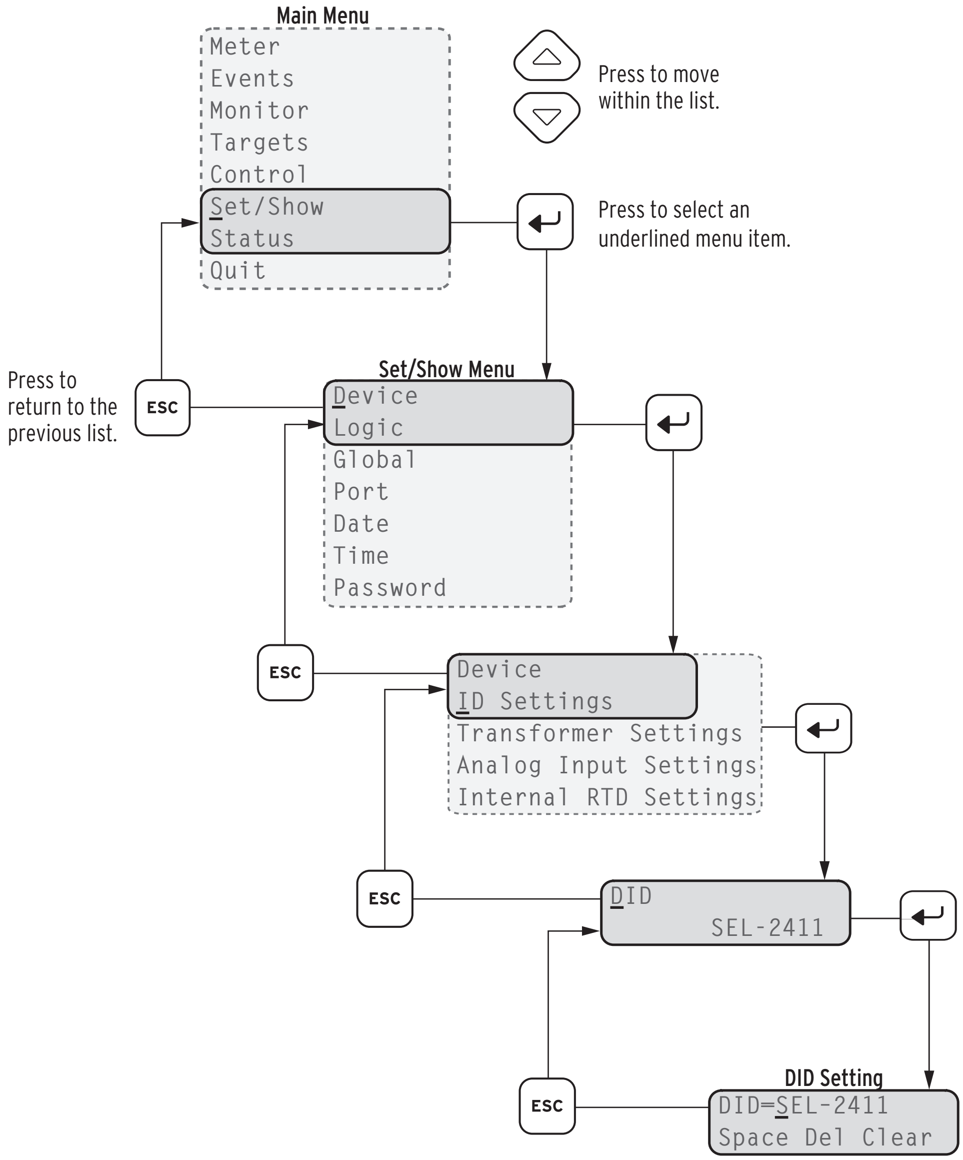


Figure 6.1 Front-Panel Setting Entry Example

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. The alarm contact closes for one second when saving new settings.

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 as many as 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 2.21*.

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:

$$\text{setting PTR} = (\text{PTR}_{\text{LEA}}) \bullet \left(\frac{7.686}{300}\right) \qquad \textbf{Equation 6.1}$$

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:

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

$$= 10000 \bullet \left(\frac{7.686}{300}\right) = 256.20 \qquad \textbf{Equation 6.2}$$

$$\frac{7200\ \text{V}}{10000} = 0.72\ \text{V}$$ (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 a 7.686 V base)

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

The PTR setting 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 6.26*.

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:

global setting VARCF = 0.900 (< 1.000; set below unity)

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

7.686 V • 0.900 = 6.9174 V (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:

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

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.

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

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 1.12* 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).

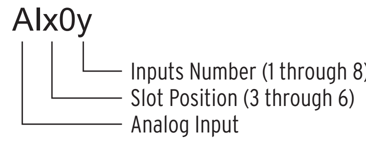


Figure 6.2 Analog Input Names

Analog Input Field 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 µA 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 AI*xxx*TYP, AI*xxx*L, and AI*xxx*H settings.
3. Set AI*xxx*EL equal to AI*xxx*L and AI*xxx*EH equal to AI*xxx*H.
4. Using a calibrated source, drive the signal line from the transducer end to the low value (e.g., 4 mA).
5. Issue the command **MET AI 10** to obtain ten measurements for each channel.
6. 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 experimental low value (e.g., 3.9 mA).
7. Enter this value in AI*xxx*L.
8. Drive the line to the high value (e.g., 20 mA).
9. Issue the command **MET AI 10** to obtain ten measurements for each channel.
10. 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 experimental high value (e.g., 20.012 mA).
11. Enter this value in AIxxxH.
12. Set AI*xxx*EL and AI*xxx*EH to the desired values (e.g., –50 to +150).

Auxiliary Analog Input Calibration Process

Auxiliary Analog Inputs are only available on the LEA inputs on the 8 V 3 ACI/3 AVI card with VSCALE = CUSTOM.

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 mV.

Signal offset compensation factor calculation procedure:

Step 1. Apply power to the SEL-2411 and allow it to warm up for a few minutes.

Step 2. Set VSCALE to CUSTOM.

Step 3. Set VA_LOW and VA_HIGH for each voltage channel to the desired range (e.g., VA_LOW = 0.00 Vdc, VA_HIGH = 7.00 Vdc), using the **SET G** command.

Step 4. Set VA_ELOW equal to VA_LOW and VA_EHIGH equal to VA_HIGH for all voltage input channels.

Step 5. Using a calibrated source, drive the signal line from the transducer end to the low value (e.g., 0.00 V).

Step 6. Issue the **TRI** command to record raw sampled values.

NOTE: It is possible that the calculated values from Step 7 and Step 13 will be outside of the range of VA_LOW and VA_HIGH. If this is the case, use a larger or smaller value to drive the input with the transducer. For example, at Step 7, if the input signal is 0 Vdc, increase it to the expected value of 1 Vdc, then continue through the steps. At Step 14, be sure to set VA_ELOW and VA_EHIGH to values that are proportional to the driving signal.

Step 7. Issue the **EVE R 1** command to view the raw sampled values once the event has finished recording.

Step 8. Record the first ten measurements in the event, then calculate the average of the ten measurements by adding the ten values algebraically, and dividing the sum by ten. This is the experimental low value (e.g., 0.17 V).

Step 9. Enter this value in VA_LOW.

Step 10. Drive the line to the high value (e.g., 7.00 V).

Step 11. Issue the **TRI** command to record raw sampled values.

Step 12. Issue the **EVE R 1** command to view the raw sampled values once the event has finished recording.

Step 13. 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 experimental high value (e.g., 7.26 Vdc).

Step 14. Set VA_ELOW and VA_EHIGH to the desired values (e.g., 0 A to 50 A).

Step 15. Optional: Issue the **HIS C** command to clear all event data. This command will delete *all* event data.

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. When the SEL-2411 is turned on, allow approximately five seconds for it 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 AIxOyNAM 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 as many as eight valid tag name characters to name the analog quantity. Valid tag name 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° 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	AI301LW2 := 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).

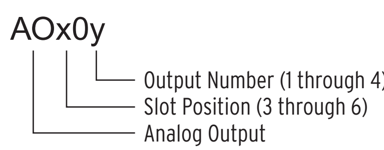


Figure 6.4 Analog Output Names

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 settings prompt, settings 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 AO401AQ TERSE <Enter>

Device

Analog Output 401 Settings

AO401 Analog Quantity (1 analog quantity)
AO401AQ := OFF
? AI301 <Enter>
AO401 Type (I,V)                               AO401TYP:= I         ? <Enter>
AO401 Analog Quantity Low (-2147483647.000 to 2147483647.000)
                                               AO401AQL:= 4.000     ? 4 <Enter>
AO401 Analog Quantity High (-2147483647.000 to 2147483647.000)
                                               AO401AQH:= 20.000    ? 20 <Enter>
AO401 Low Output Value (-20.480 to 20.480 mA)  AO401L  := 4.000     ? <Enter>
AO401 High Output Value (-20.480 to 20.480 mA) AO401H  := 20.000    ? <Enter>

Analog Output 402 Settings

AO402 Analog Quantity (1 analog quantity)
AO402AQ := 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	IRTD1TY := NONE
IRTD2TY	Internal RTD Card	PT100, NI100, NI120, CU10, NONE	IRTD2TY := NONE
IRTD3TY	Internal RTD Card	PT100, NI100, NI120, CU10, NONE	IRTD3TY := 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	IRTD4TY := NONE
IRTD5TY	Internal RTD Card	PT100, NI100, NI120, CU10, NONE	IRTD5TY := NONE
IRTD6TY	Internal RTD Card	PT100, NI100, NI120, CU10, NONE	IRTD6TY := NONE
IRTD7TY	Internal RTD Card	PT100, NI100, NI120, CU10, NONE	IRTD7TY := NONE
IRTD8TY	Internal RTD Card	PT100, NI100, NI120, CU10, NONE	IRTD8TY := NONE
IRTD9TY	Internal RTD Card	PT100, NI100, NI120, CU10, NONE	IRTD9TY := NONE
IRTD10TY	Internal RTD Card	PT100, NI100, NI120, CU10, NONE	IRTD10TY := 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	TEMP1TY := NONE
TEMP2TY	Internal RTD/TC Card	PT100, NI100, NI120, CU10, J, K, T, E, NONE	TEMP2TY := NONE
TEMP3TY	Internal RTD/TC Card	PT100, NI100, NI120, CU10, J, K, T, E, NONE	TEMP3TY := NONE
TEMP4TY	Internal RTD/TC Card	PT100, NI100, NI120, CU10, J, K, T, E, NONE	TEMP4TY := NONE
TEMP5TY	Internal RTD/TC Card	PT100, NI100, NI120, CU10, J, K, T, E, NONE	TEMP5TY := NONE
TEMP6TY	Internal RTD/TC Card	PT100, NI100, NI120, CU10, J, K, T, E, NONE	TEMP6TY := NONE
TEMP7TY	Internal RTD/TC Card	PT100, NI100, NI120, CU10, J, K, T, E, NONE	TEMP7TY := NONE
TEMP8TY	Internal RTD/TC Card	PT100, NI100, NI120, CU10, J, K, T, E, NONE	TEMP8TY := NONE
TEMP9TY	Internal RTD/TC Card	PT100, NI100, NI120, CU10, J, K, T, E, NONE	TEMP9TY := NONE
TEMP10TY	Internal RTD/TC Card	PT100, NI100, NI120, CU10, J, K, T, E, NONE	TEMP10TY := 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	ERTD1TY := NONE
ERTD2TY	External RTD from SEL-2600 Modules	PT100, NI100, NI120, CU10, NONE	ERTD2TY := NONE
ERTD3TY	External RTD from SEL-2600 Modules	PT100, NI100, NI120, CU10, NONE	ERTD3TY := NONE
ERTD4TY	External RTD from SEL-2600 Modules	PT100, NI100, NI120, CU10, NONE	ERTD4TY := NONE
ERTD5TY	External RTD from SEL-2600 Modules	PT100, NI100, NI120, CU10, NONE	ERTD5TY := NONE
ERTD6TY	External RTD from SEL-2600 Modules	PT100, NI100, NI120, CU10, NONE	ERTD6TY := NONE
ERTD7TY	External RTD from SEL-2600 Modules	PT100, NI100, NI120, CU10, NONE	ERTD7TY := NONE
ERTD8TY	External RTD from SEL-2600 Modules	PT100, NI100, NI120, CU10, NONE	ERTD8TY := NONE
ERTD9TY	External RTD from SEL-2600 Modules	PT100, NI100, NI120, CU10, NONE	ERTD9TY := NONE
ERTD10TY	External RTD from SEL-2600 Modules	PT100, NI100, NI120, CU10, NONE	ERTD10TY := NONE
ERTD11TY	External RTD from SEL-2600 Modules	PT100, NI100, NI120, CU10, NONE	ERTD11TY := NONE
ERTD12TY	External RTD from SEL-2600 Modules	PT100, NI100, NI120, CU10, NONE	ERTD12TY := 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.

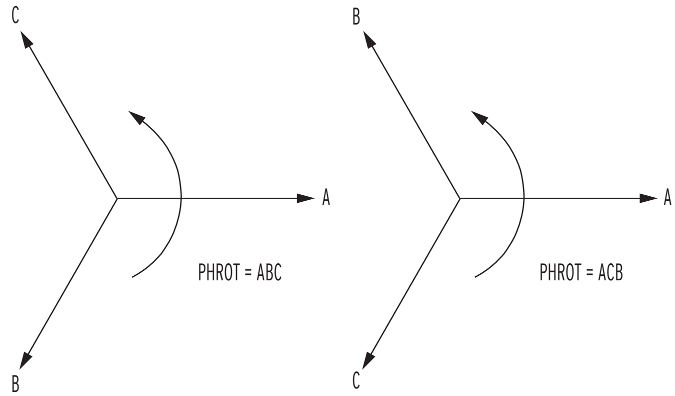


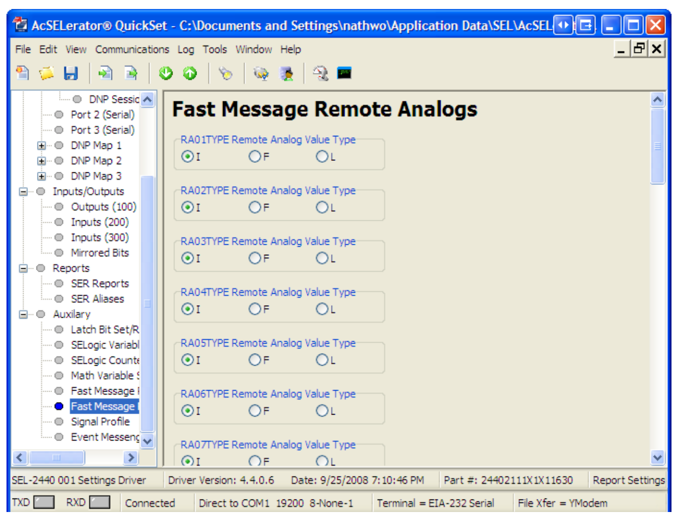
Figure 6.6 Phase Rotation Setting

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 through use of 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, 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 (Sheet 1 of 2)

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

Table 6.14 Event Messenger Points (Sheet 2 of 2)

Setting Prompt	Setting Range	Setting Name := Factory Default
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 a 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, but 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 and 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 (as many as 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

NOTE: Slot Z does not support the 14 Digital Input card.

You can configure the SEL-2411 with as many as 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)

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
09, 10	IN*x*05
11, 12	IN*x*06
13, 14	IN*x*07
15, 16	IN*x*08
17, 18	IN*x*09
19, 20	IN*x*10
21, 22	IN*x*11
23, 24	IN*x*12
25, 26	IN*x*13
27, 28	IN*x*14

[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).

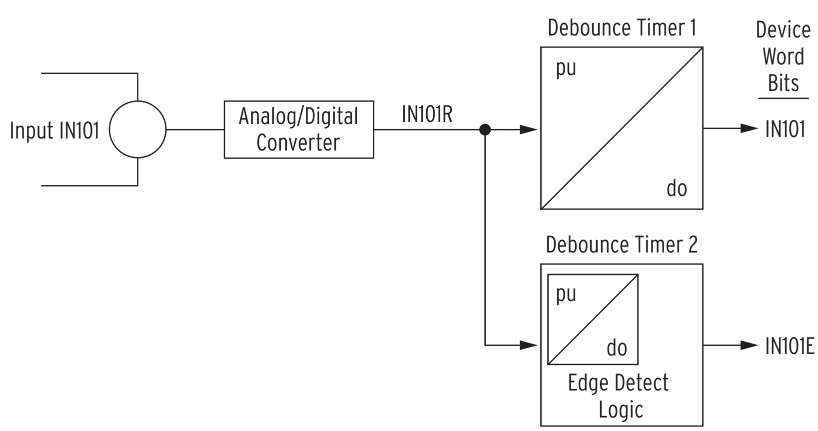


Figure 6.7 DC Mode Processing

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*.

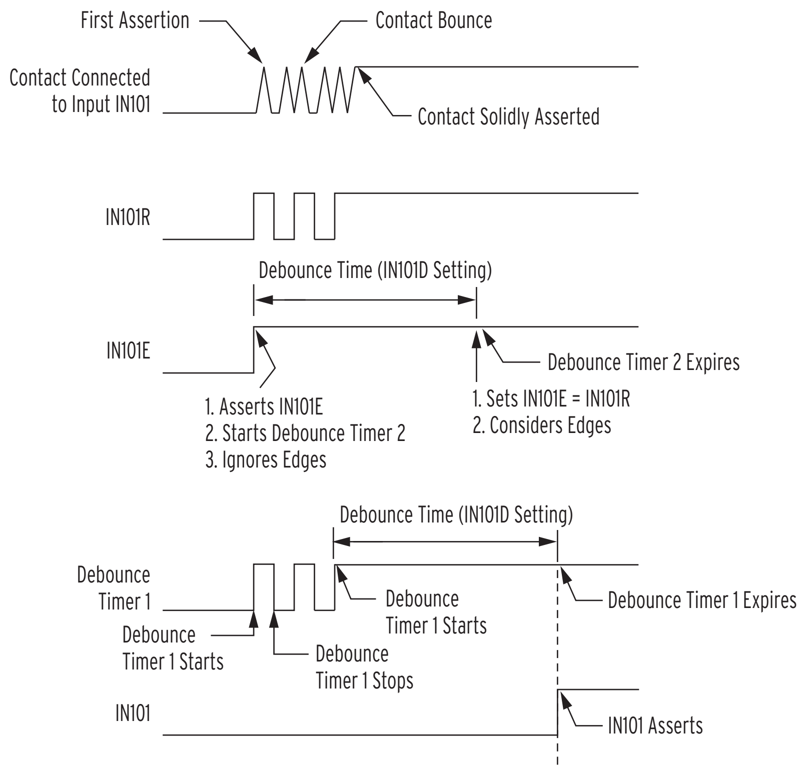


Figure 6.8 Timing Diagram When IN101R Changes From the Deasserted State to the Asserted State

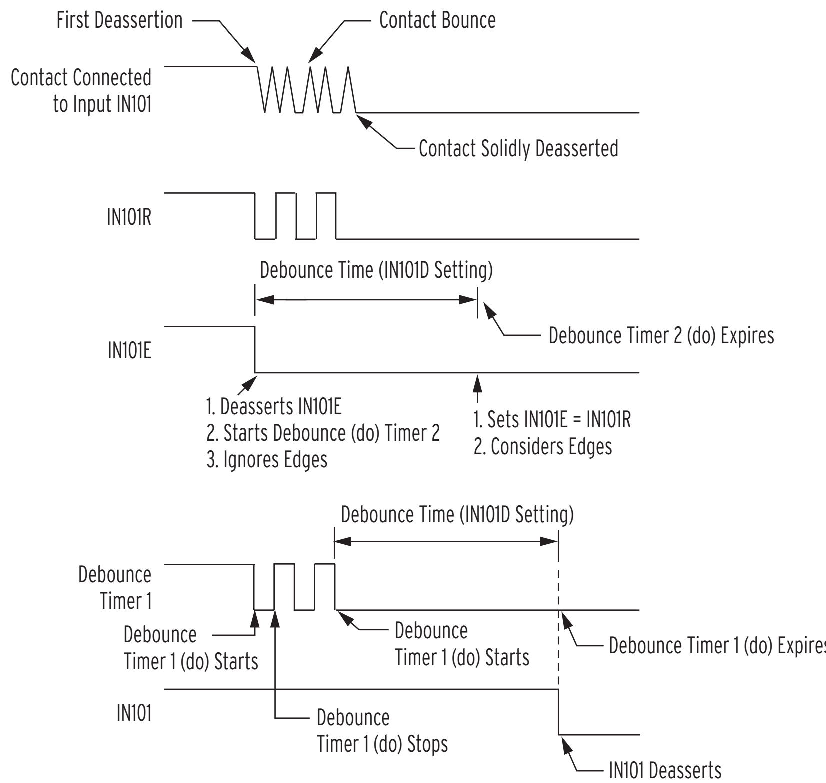


Figure 6.9 Timing Diagram When Input IN101 Changes From the Asserted State to the Deasserted State

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.

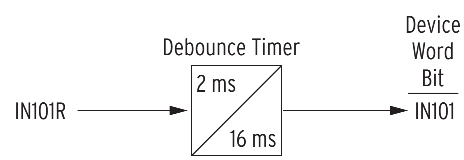


Figure 6.10 AC Mode Processing

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.

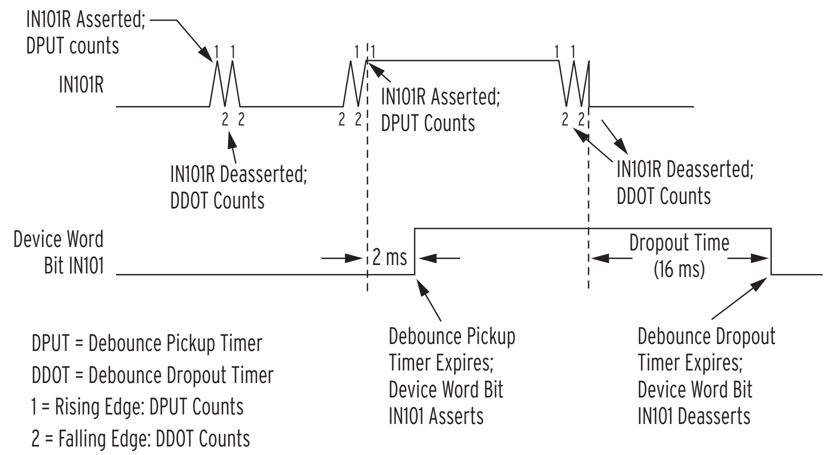


Figure 6.11 Timing Diagram for Debounce Timer Operation When Operating in AC Mode

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, settings 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
IN309 Debounce	AC, 0–65000 ms	IN309D := 10
IN310 Debounce	AC, 0–65000 ms	IN310D := 10
IN311 Debounce	AC, 0–65000 ms	IN311D := 10
IN312 Debounce	AC, 0–65000 ms	IN312D := 10
IN313 Debounce	AC, 0–65000 ms	IN313D := 10
IN314 Debounce	AC, 0–65000 ms	IN314D := 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 and Date Management Settings

The SEL-2411 supports several methods of updating the relay time and date. For IRIG-B, refer to *Time-Synchronization Source on page 6.25*. For SNTP applications, refer to *Simple Network Time Protocol (SNTP) on page 7.40*. For time update from a DNP Master, see *Time Synchronization on page D.4*.

Table 6.19 shows the time and date management settings that are available in the Global settings.

Table 6.19 Time and Date Management Settings

Setting Description	Setting Range	Setting Name := Factory Default
OFFSET FROM UTC	–24.00 to 24.00 hours, rounds up to nearest 0.25 hour	UTC_OFF := 0.00
MONTH TO BEGIN DST	OFF, 1–12	DST_BEGM := OFF
WEEK OF THE MONTH TO BEGIN DST	1–3, L	DST_BEGW := 2
DAY OF THE WEEK TO BEGIN DST	SUN, MON, TUE, WED, THU, FRI, SAT, SUN	DST_BEGD := SUN
LOCAL HOUR TO BEGIN DST	0–23	DST_BEGH := 2
MONTH TO END DST	1–12	DST_ENDM := 11
WEEK OF THE MONTH TO END DST	1–3, L	DST_ENDW := 1
DAY OF THE WEEK TO END DST	SUN, MON, TUE, WED, THU, FRI, SAT, SUN	DST_ENDD := SUN
LOCAL HOUR TO END DST	0–23	DST_ENDH := 2

Coordinated Universal Time (UTC) Offset Setting

The SEL-2411 has a Global setting UTC_OFF, settable from –24.00 to 24.00 hours, in 0.25 hour increments. The relay also uses the UTC_OFF setting to calculate local (relay) time from the UTC source when configured for Simple Network Time Protocol (SNTP) updating via Ethernet. When a time source other than SNTP is updating the relay time, the UTC_OFF setting is not considered because the other time sources are defined as local time.

Automatic Daylight-Saving Time Settings

The SEL-2411 can automatically switch to and from daylight-saving time, as specified by the eight Global settings DST_BEGM through DST_ENDH. The first four settings control the month, week, day, and time that daylight-saving time shall commence, while the last four settings control the month, week, day, and time that daylight-saving time shall cease.

Once configured, the SEL-2411 changes to and from daylight-saving time every year at the specified time. Device Word bit DST asserts when daylight-saving time is active.

The SEL-2411 interprets the week number settings DST_BEGW and DST_ENDW (1–3, L = Last) as follows:

- ➤ The first seven days of the month are considered to be in week 1.
- ➤ The second seven days of the month are considered to be in week 2.
- ➤ The third seven days of the month are considered to be in week 3.
- ➤ The last seven days of the month are considered to be in week “L”.

This method of counting of the weeks allows easy programming of statements like “the first Sunday”, “the second Saturday”, or “the last Tuesday” of a month.

As an example, consider the following settings:

DST_BEGM := 3
DST_BEGW := L
DST_BEGD := SUN
DST_BEGH := 2
DST_ENDM := 10
DST_ENDW := 3
DST_ENDD := WED
DST_ENDH := 3

With these example settings, the relay enters daylight-saving time on the last Sunday in March at 0200 h, and leave daylight-saving time on the third Wednesday in October at 0300 h. The relay asserts Device Word bit DST when DST is active.

When you use an IRIG-B time source, the relay time follows the IRIG-B time, including daylight-saving time start and end, as commanded by the time source. If there is a discrepancy between the daylight-saving time settings and the received IRIG-B signal, the relay follows the IRIG-B signal.

Simple Network Time Protocol (SNTP)

The SEL-2411 Port 1 (Ethernet Port) supports the SNTP Client protocol. See *Section 7: Communications*, *Simple Network Time Protocol (SNTP) on page 7.40* for a description and *Table 7.63* for the settings.

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 6.20 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 6.21* shows the settings prompt, setting range, and factory-default settings.

Table 6.21 Setting Change Disable Setting

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

Voltage Ratio Correction Factor

Table 6.22 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).

Local/Remote Control

The SEL-2411 supports local/remote control supervision function through the LOCAL Device Word bit. The supervision can be enabled or disabled with Global setting EN_LRC.

Table 6.23 Local/Remote Control Settings

Setting Prompt	Setting Range	Setting Name := Factory Default
Enable Local Remote Control	Y, N	EN_LRC := N
Local control[a]	SELOGIC	LOCAL := 0

[a] This setting is hidden when EN_LRC := N.

To enable the supervision, set EN_LRC := Y. When EN_LRC := Y, the LOCAL SELOGIC control equation is available. For example, to toggle the Local/Remote on the device by pressing Pushbutton 01, use the following Global and Logic settings.

Global Settings:

EN_LRC := Y

LOCAL := LT01

Logic Settings:

SET01 := PB01_PUL AND NOT LT01

RST01 := PB01_PUL AND LT01

Use the LOCAL Device Word bit to implement custom logic to operate in local mode or remote mode. For example, *Figure 6.12* shows the output contact OUT101 being controlled by custom logic when LOCAL := 1 or by remote bit, RB01 when LOCAL := 0.

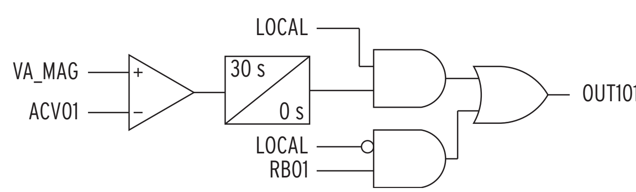


Figure 6.12 OUT101 Logic

As seen in *Figure 6.12*, in Local mode, OUT101 asserts when VA_MAG exceeds the analog control variable setting for at least 30 s. In Remote mode, OUT101 is controlled by the Remote bit.

On units with the five-inch touchscreen, the SEL-2411 supports control of switch bits in the Local mode only. See *Local/Remote Control on page 8.41* for more details.

Multilevel Local/Remote Control

The SEL-2411 supports implementation of multilevel Local/Remote Control supervision through the LOCSTA and MLTLEV Device Word bits. This device supports this feature on devices ordered with IEC 61850 communications. Enable multilevel supervision through Global settings SC850LS and MLTLEV.

Table 6.24 Additional Local/Remote Control Settings

Setting Prompt	Setting Range	Setting Name := Factory Default
Enable Station Level Authority for Local Control	0, SELOGIC	SC850LS := 0
Enable Multilevel Authority for Local Control	0, SELOGIC	MLTLEV := 0

The SC850LS setting controls the Device Word bit that indicates the local station supervision, LOCSTA. The multilevel supervision setting, MLTLEV controls the Device Word bit MLTLEV.

For example, *Figure 6.13* extends the implementation shown in *Figure 6.12* to allow controls from the station level and remote level. Use the following Global and Logic settings to control OUT101 from multiple levels.

Global Settings:

SC850LS := LT02

MLTLEV := LT03

Logic Settings:

SET02 := PB02_PUL AND NOT LT02

RST02 := PB02_PUL AND LT02

SET03 := PB03_PUL AND NOT LT03

RST03 := PB03_PUL AND LT03

NOTE: Although multilevel supervision can be implemented using SELOGIC control equations and communications protocols, the IEC 61850 MMS implementations are simpler. Over MMS, depending on the local/remote Device Word bits, the device blocks the operation of controls based on the originator categories. See Local/Remote Control Authority on page F.17.

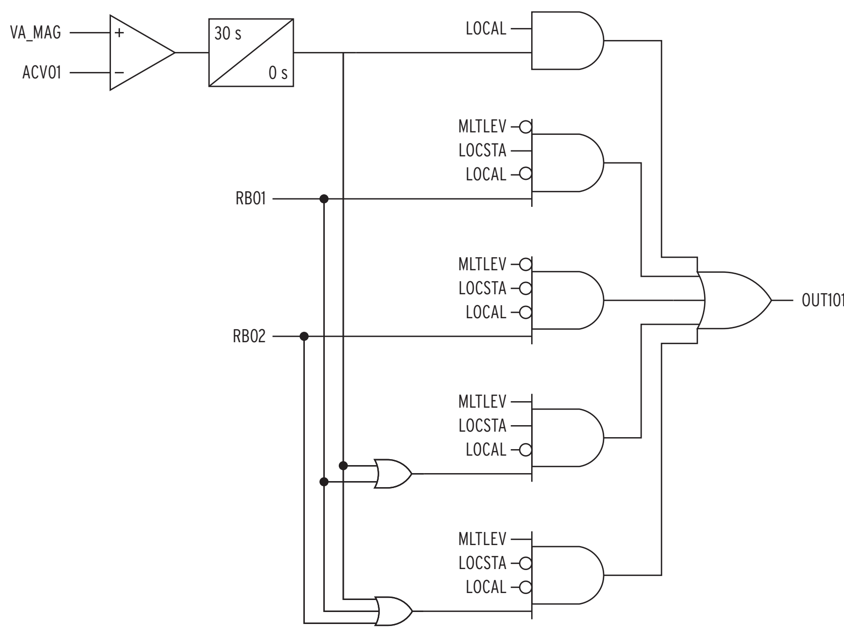


Figure 6.13 In the Local mode (Bay level), OUT 101 asserts when VA_MAG exceeds ACV01 for at least 30 s. RB01 is controlled by a station level device while RB02 is controlled by a remote level device.

Test/Blocked Mode Control

The IEC 61850-7-4:2010 standard defines behaviors of different modes to facilitate testing. The SEL-2411 supports the following modes:

- On
- Blocked
- Test
- Test/Blocked
- Off

IEC 61850 Behavior is jointly determined by the logical device mode and its logical node mode according to the IEC 61850 standard. For the SEL-2411, the selected IEC 61850 Mode/Behavior applies to the entire IED, including all its logical devices and all logical nodes. The behavior of the IED is always the same as the selected mode. Refer to *Appendix F: IEC 61850 Communications* for details on the IEC 61850 communications in the SEL-2411.

Control IEC 61850 Mode/Behavior by using the settings SC850TM and SC850BM SELOGIC variables. *Table 6.25* show the selected IEC 61850 Mode/Behavior depending on the states of these two settings.

Table 6.25 IEC 61850 Mode/Behavior

SC850TM	SC850BM	Selected IEC 61850 Mode/Behavior
0	0	See [a]
1	0	Test
0	1	Blocked
1	1	Test/Blocked
See [b]	See [b]	Off

[a] The SELOGIC controls have higher priority than MMS clients in controlling the Test mode and Blocked mode. When SC850TM and SC850BM both evaluate to 0 (false), IEC 61850 Mode/Behavior control is available to MMS clients. If either SC850TM or SC850BM evaluates to 1 (true), SELOGIC determines the IEC 61850 Mode/Behavior of the IED regardless of MMS control values.

[b] You cannot control Off mode by using SC850TM and SC850BM. When an MMS client causes the IED to be in Off mode, the SELOGIC controls are disabled and SC850TM and SC850BM are not evaluated.

Simulation Mode Control

You can configure the SEL-2411 to operate in simulation mode for processing IEC 61850 GOOSE messages. In this mode, the device continues to process GOOSE messages until a simulated GOOSE message is received from a subscription. Once a simulated GOOSE message is received, only simulated GOOSE messages are processed from that subscription. All normal GOOSE messages from all subscriptions are discarded. The simulated mode only terminates when the Device Word bit SC850SM is returned to FALSE. When the relay is not in the simulation mode, only normal GOOSE messages are processed for all subscriptions.

Use SELOGIC variable SC850SM to control the Device Word bit SC850SM.

A rising edge on SC850SM enables and a falling edge disables the simulation mode, respectively. When you use SC850SM to enter simulation mode, the device rejects MMS attempts to enter or exit simulation mode until SC850SM deasserts.

Port Access Control

Port access control provides a flexible way to manage access permissions on designated ports. For example, a remote administrator (e.g., SCADA) can use this feature to grant temporary or limited access to personnel in the field. Set port setting EPAC = Y to enable access control on a particular port. Use the Global SELOGIC equations EACC and E2AC to define the access criteria for all EPAC enabled ports. If EACC and E2AC evaluate to 0, all access requests are denied. If EACC evaluates to 1, Access Level 1 requests are permitted. If E2AC evaluates to 1, all access level requests are permitted (see *Figure 6.14*). Note that passwords are still required to escalate privilege.

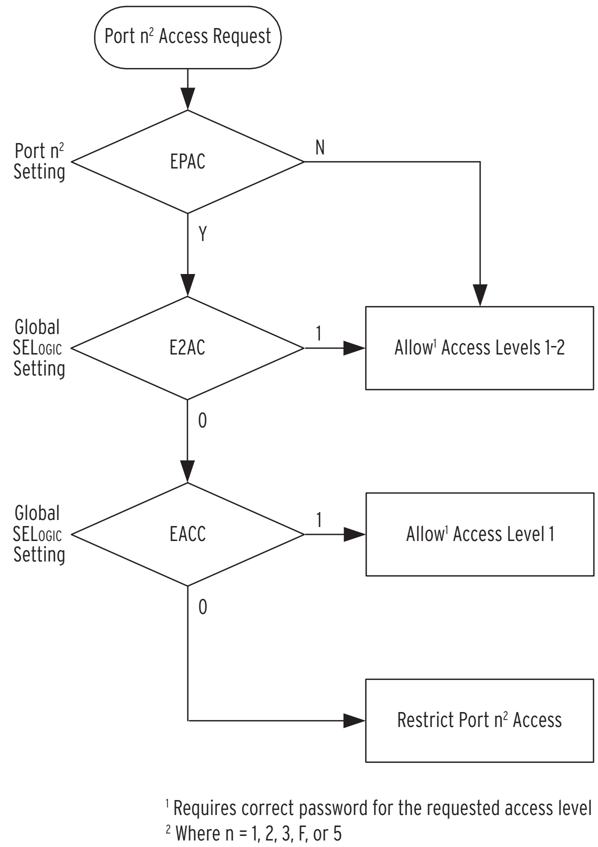


Figure 6.14 Port Access Control Flow Chart

Port access control does not apply when the relay is disabled, the password jumper is installed (PASSDIS = 1), or when EPAC = N, nor can it be used to decrease a user's current access level or exceed the MAXACC setting level of the port.

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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.

Device 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**	:= ________

Demand Metering

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

Phase Overcurrent Threshold

(hidden if 4 ACI card is not installed)

IA Overcurrent Warning Level 1 (OFF, 0.20–91.15 for 5 A nominal, 0.04–18.23 for 1 A nominal)	**IAHW1**	:= ________
IA Overcurrent Warning Level 2 (OFF, 0.20–91.15 for 5 A nominal, 0.04–18.23 for 1 A nominal)	**IAHW2**	:= ________
IA Overcurrent Alarm (OFF, 0.20–91.15 for 5 A nominal, 0.04–18.23 for 1 A nominal)	**IAHAL**	:= ________
IB Overcurrent Warning Level 1 (OFF, 0.20–91.15 for 5 A nominal, 0.04–18.23 for 1 A nominal)	**IBHW1**	:= ________
IB Overcurrent Warning Level 2 (OFF, 0.20–91.15 for 5 A nominal, 0.04–18.23 for 1 A nominal)	**IBHW2**	:= ________
IB Overcurrent Alarm (OFF, 0.20–91.15 for 5 A nominal, 0.04–18.23 for 1 A nominal)	**IBHAL**	:= ________
IC Overcurrent Warning Level 1 (OFF, 0.20–91.15 for 5 A nominal, 0.04–18.23 for 1 A nominal)	**ICHW1**	:= ________
IC Overcurrent Warning Level 2 (OFF, 0.20–91.15 for 5 A nominal, 0.04–18.23 for 1 A nominal)	**ICHW2**	:= ________
IC Overcurrent Alarm (OFF, 0.20–91.15 for 5 A nominal, 0.04–18.23 for 1 A nominal)	**ICHAL**	:= ________

Neutral Overcurrent Threshold

(hidden if 4 ACI card is not installed)

IN Overcurrent Warning Level 1 (OFF, 0.10–9.45 for 5 A nominal, 0.02–1.89 for 1 A nominal)	**INHW1**	:=
IN Overcurrent Warning Level 2 (OFF, 0.10–9.45 for 5 A nominal, 0.02–1.89 for 1 A nominal)	**INHW2**	:=
IN Overcurrent Alarm (OFF, 0.10–9.45 for 5 A nominal, 0.02–1.89 for 1 A nominal)	**INHAL**	:=

Auxiliary Phase Overcurrent Threshold

(hidden if 3 ACI/3 AVI card is not installed)

IAX Overcurrent Warning Level 1 (OFF, 0.20–91.15)	**IAXHW1**	:=
IAX Overcurrent Warning Level 2 (OFF, 0.20–91.15)	**IAXHW2**	:=
IAX Overcurrent Alarm (OFF, 0.20–91.15)	**IAXHAL**	:=
IBX Overcurrent Warning Level 1 (OFF, 0.20–91.15)	**IBXHW1**	:=
IBX Overcurrent Warning Level 2 (OFF, 0.20–91.15)	**IBXHW2**	:=
IBX Overcurrent Alarm (OFF, 0.20–91.15)	**IBXHAL**	:=
ICX Overcurrent Warning Level 1 (OFF, 0.20–91.15)	**ICXHW1**	:=
ICX Overcurrent Warning Level 2 (OFF, 0.20–91.15)	**ICXHW2**	:=
ICX Overcurrent Alarm (OFF, 0.20–91.15)	**ICXHAL**	:=

Phase Undervoltage Threshold

(hidden if 3 ACI/3 AVI or 3 AVI card is not installed or if DELTA_Y = DELTA)

VA Undervoltage Warning Level 1 (OFF, 4.00–284.50)	**VALW1**	:=
VA Undervoltage Warning Level 2 (OFF, 4.00–284.50)	**VALW2**	:=
VA Undervoltage Alarm (OFF, 4.00–284.50)	**VALAL**	:=
VB Undervoltage Warning Level 1 (OFF, 4.00–284.50)	**VBLW1**	:=
VB Undervoltage Warning Level 2 (OFF, 4.00–284.50)	**VBLW2**	:=
VB Undervoltage Alarm (OFF, 4.00–284.50)	**VBLAL**	:=
VC Undervoltage Warning Level 1 (OFF, 4.00–284.50)	**VCLW1**	:=
VC Undervoltage Warning Level 2 (OFF, 4.00–284.50)	**VCLW2**	:=
VC Undervoltage Alarm (OFF, 4.00–284.50)	**VCLAL**	:=

Phase-to-Phase Undervoltage Threshold

(hidden if 3 ACI/3 AVI or 3 AVI card is not installed or if DELTA_Y = WYE)

VAB Undervoltage Warning Level 1 (OFF, 4.00–284.50)	**VABLW1**	:=
VAB Undervoltage Warning Level 2 (OFF, 4.00–284.50)	**VABLW2**	:=
VAB Undervoltage Alarm (OFF, 4.00–284.50)	**VABLAL**	:=
VBC Undervoltage Warning Level 1 (OFF, 4.00–284.50)	**VBCLW1**	:=
VBC Undervoltage Warning Level 2 (OFF, 4.00–284.50)	**VBCLW2**	:=
VBC Undervoltage Alarm (OFF, 4.00–284.50)	**VBCLAL**	:=
VCA Undervoltage Warning Level 1 (OFF, 4.00–284.50)	**VCALW1**	:=
VCA Undervoltage Warning Level 2 (OFF, 4.00–284.50)	**VCALW2**	:=
VCA Undervoltage Alarm (OFF, 4.00–284.50)	**VCALAL**	:=

Phase Overvoltage Threshold

(hidden if 3 ACI/3 AVI or 3 AVI card is not installed or if DELTA_Y = DELTA)

VA Overvoltage Warning Level 1 (OFF, 4.00–284.50)	**VAHW1**	:=
VA Overvoltage Warning Level 2 (OFF, 4.00–284.50)	**VAHW2**	:=
VA Overvoltage Alarm (OFF, 4.00–284.50)	**VAHAL**	:=
VB Overvoltage Warning Level 1 (OFF, 4.00–284.50)	**VBHW1**	:=
VB Overvoltage Warning Level 2 (OFF, 4.00–284.50)	**VBHW2**	:=
VB Overvoltage Alarm (OFF, 4.00–284.50)	**VBHAL**	:=
VC Overvoltage Warning Level 1 (OFF, 4.00–284.50)	**VCHW1**	:=
VC Overvoltage Warning Level 2 (OFF, 4.00–284.50)	**VCHW2**	:=
VC Overvoltage Alarm (OFF, 4.00–284.50)	**VCHAL**	:=

Phase-to-Phase Overvoltage Threshold

(hidden if 3 ACI/3 AVI or 3 AVI card is not installed or if DELTA_Y = WYE)

VAB Overvoltage Warning Level 1 (OFF, 4.00–284.50)	**VABHW1**	:=
VAB Overvoltage Warning Level 2 (OFF, 4.00–284.50)	**VABHW2**	:=
VAB Overvoltage Alarm (OFF, 4.00–284.50)	**VABHAL**	:=
VBC Overvoltage Warning Level 1 (OFF, 4.00–284.50)	**VBCHW1**	:=
VBC Overvoltage Warning Level 2 (OFF, 4.00–284.50)	**VBCHW2**	:=
VBC Overvoltage Alarm (OFF, 4.00–284.50)	**VBCHAL**	:=
VCA Overvoltage Warning Level 1 (OFF, 4.00–284.50)	**VCAHW1**	:=
VCA Overvoltage Warning Level 2 (OFF, 4.00–284.50)	**VCAHW2**	:=
VCA Overvoltage Alarm (OFF, 4.00–284.50)	**VCAHAL**	:=

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.

Auxiliary DC Voltage Inputs

(hidden if 8 V 3 ACI/3 AVI card is not installed and VSCALE = DEFAULT)

VA Tag Name (6 characters)	**VA_NAME**	:=
VA Low Input (0.000–7.686 V)	**VA_LOW**	:=
VA High Input (0.000–7.686 V)	**VA_HIGH**	:=
VA Engineering Units (8 characters)	**VA_EU**	:=
VA Engineering Units Low (–99999.000 to +99999.000)	**VA_ELOW**	:=
VA Engineering Units High (–99999.000 to +99999.000)	**VA_EHIGH**	:=
VB Tag Name (6 characters)	**VB_NAME**	:=
VB Low Input (0.000–7.686 V)	**VB_LOW**	:=
VB High Input (0.000–7.686 V)	**VB_HIGH**	:=
VB Engineering Units (8 characters)	**VB_EU**	:=
VB Engineering Units Low (–99999.000 to +99999.000)	**VB_ELOW**	:=
VB Engineering Units High (–99999.000 to +99999.000)	**VB_EHIGH**	:=
VC Tag Name (6 characters)	**VC_NAME**	:=
VC Low Input (0.000–7.686 V)	**VC_LOW**	:=
VC High Input (0.000–7.686 V)	**VC_HIGH**	:=

VC Engineering Units (8 characters)	**VC_EU**	:= ________
VC Engineering Units Low (–99999.000 to +99999.000)	**VC_ELOW**	:= ________
VC Engineering Units High (–99999.000 to +99999.000)	**VC_EHIGH**	:= ________

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) (Does not apply to Extended Range)	**AI*x*05TYP**	:=
If AI*x*05TYP = I		
AI*x*05 Low (–20.480 to +20.480; mA) (Does not apply to Extended Range)	**AI*x*05L**	:=
AI*x*05 High (–20.480 to +20.480; mA) (Does not 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) (Does not apply to Extended Range)	**AI*x*06TYP**	:=
If AI*x*06TYP = I		
AI*x*06 Low (–20.480 to +20.480; mA) (Does not apply to Extended Range)	**AI*x*06L**	:=
AI*x*06 High (–20.480 to +20.480; mA) (Does not 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) (Does not apply to Extended Range)	**AI*x*07TYP**	:=
If AI*x*07TYP = I		
AI*x*07 Low (–20.480 to +20.480; mA) (Does not apply to Extended Range)	**AI*x*07L**	:=
AI*x*07 High (–20.480 to +20.480; mA) (Does not 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) (Does not apply to Extended Range)	**AI*x*08TYP**	:=
If AI*x*08TYP = I		
AI*x*08 Low (–20.480 to +20.480; mA) (Does not apply to Extended Range)	**AI*x*08L**	:=
AI*x*08 High (–20.480 to +20.480; mA) (Does not 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 Average for Thermocouples	**ESAMPAVG**	:=

Load Tap Changer Settings

Load Tap Changer Control

Enable Load Tap Changer Control (Y,N)	**EN_LTCC**	:=
Raise Tap Control (SELOGIC)	**RSE_CTRL**	:=
Lower Tap Control (SELOGIC)	**LWR_CTRL**	:=
Parallel Operation Control (SELOGIC)	**PAR_OP**	:=

Load Tap Position and Control Monitoring Settings

Tap Position Monitoring Mode (OFF, BCD, BIN)	**ETPM_MDE**	:=
Highest Tap Position available on the Load Tap Changer (0–32)	**TP_MAX**	:=
Lowest Tap Position available on the Load Tap Changer (–32–0)	**TP_MIN**	:=
3 Neutral positions present on the Load Tap Changer (Y, N)	**MULT_NEU**	:=
Feedback time interval for load tap control monitoring alarms, in seconds (1–10)	**TPFB_TIM**	:=

Load Tap Position and Control Monitoring Inputs

Digital inputs of the BCD/Binary Tap Position code list in LSB to MSB (Off, IN101–IN608 maximum 6 bits without duplicates)	**TPM_DI**	:=
SELOGIC input that indicates the raise operation control status (SELOGIC)	**LTC_RSE**	:=

SELOGIC input that indicates the lower operation control status (SELOGIC)	**LTC_LWR**	:=
SELOGIC input to reset load tap control monitoring alarms (SELOGIC)	**TPALMRST**	:=
Controlled Line Voltage (Off, 1 analog quantity)	**LIN_VOLT**	:=

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, 1–64)	**EMV**	:=
SELOGIC Analog Control Variable (N, 1–32)	**EACV**	:=
SELOGIC Fast Update Remote Analogs (N, 1–32)	**ERAFAST**	:=

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 (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV01PU**	:=	
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV01DO**	:=	
SELOGIC Variable Input (SV)	**SV02**	:=	
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV02PU**	:=	
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV02DO**	:=	
SELOGIC Variable Input (SV)	**SV03**	:=	

SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV03PU**	:= ________________
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV03DO**	:= ________________
SELOGIC Variable Input (SV)	**SV04**	:= ________________
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV04PU**	:= ________________
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV04DO**	:= ________________
SELOGIC Variable Input (SV)	**SV05**	:= ________________
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV05PU**	:= ________________
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV05DO**	:= ________________
SELOGIC Variable Input (SV)	**SV06**	:= ________________
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV06PU**	:= ________________
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV06DO**	:= ________________
SELOGIC Variable Input (SV)	**SV07**	:= ________________
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV07PU**	:= ________________
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV07DO**	:= ________________
SELOGIC Variable Input (SV)	**SV08**	:= ________________
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV08PU**	:= ________________
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV08DO**	:= ________________
SELOGIC Variable Input (SV)	**SV09**	:= ________________
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV09PU**	:= ________________
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV09DO**	:= ________________
SELOGIC Variable Input (SV)	**SV10**	:= ________________
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV10PU**	:= ________________
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV10DO**	:= ________________
SELOGIC Variable Input (SV)	**SV11**	:= ________________
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV11PU**	:= ________________
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV11DO**	:= ________________
SELOGIC Variable Input (SV)	**SV12**	:= ________________
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV12PU**	:= ________________
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV12DO**	:= ________________
SELOGIC Variable Input (SV)	**SV13**	:= ________________
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV13PU**	:= ________________
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV13DO**	:= ________________

SELOGIC Variable Input (SV)	**SV14**	:=
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV14PU**	:=
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV14DO**	:=
SELOGIC Variable Input (SV)	**SV15**	:=
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV15PU**	:=
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV15DO**	:=
SELOGIC Variable Input (SV)	**SV16**	:=
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV16PU**	:=
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV16DO**	:=
SELOGIC Variable Input (SV)	**SV17**	:=
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV17PU**	:=
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV17DO**	:=
SELOGIC Variable Input (SV)	**SV18**	:=
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV18PU**	:=
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV18DO**	:=
SELOGIC Variable Input (SV)	**SV19**	:=
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV19PU**	:=
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV19DO**	:=
SELOGIC Variable Input (SV)	**SV20**	:=
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV20PU**	:=
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV20DO**	:=
SELOGIC Variable Input (SV)	**SV21**	:=
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV21PU**	:=
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV21DO**	:=
SELOGIC Variable Input (SV)	**SV22**	:=
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV22PU**	:=
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV22DO**	:=
SELOGIC Variable Input (SV)	**SV23**	:=
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV23PU**	:=
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV23DO**	:=
SELOGIC Variable Input (SV)	**SV24**	:=
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV24PU**	:=

SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV24DO**	:=
SELOGIC Variable Input (SV)	**SV25**	:=
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV25PU**	:=
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV25DO**	:=
SELOGIC Variable Input (SV)	**SV26**	:=
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV26PU**	:=
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV26DO**	:=
SELOGIC Variable Input (SV)	**SV27**	:=
SELOGIC Variable Timer Pickup(0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV27PU**	:=
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV27DO**	:=
SELOGIC Variable Input (SV)	**SV28**	:=
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV28PU**	:=
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV28DO**	:=
SELOGIC Variable Input (SV)	**SV29**	:=
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV29PU**	:=
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV29DO**	:=
SELOGIC Variable Input (SV)	**SV30**	:=
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV30PU**	:=
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV30DO**	:=
SELOGIC Variable Input (SV)	**SV31**	:=
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV31PU**	:=
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV31DO**	:=
SELOGIC Variable Input (SV)	**SV32**	:=
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV32PU**	:=
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV32DO**	:=
SELOGIC Variable Input (SV)	**SV33**	:=
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV33PU**	:=
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV33DO**	:=
SELOGIC Variable Input (SV)	**SV34**	:=
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV34PU**	:=
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV34DO**	:=
SELOGIC Variable Input (SV)	**SV35**	:=

SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV35PU**	:=
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV35DO**	:=
SELOGIC Variable Input (SV)	**SV36**	:=
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV36PU**	:=
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV36DO**	:=
SELOGIC Variable Input (SV)	**SV37**	:=
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV37PU**	:=
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV37DO**	:=
SELOGIC Variable Input (SV)	**SV38**	:=
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV38PU**	:=
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV38DO**	:=
SELOGIC Variable Input (SV)	**SV39**	:=
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV39PU**	:=
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV39DO**	:=
SELOGIC Variable Input (SV)	**SV40**	:=
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV40PU**	:=
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV40DO**	:=
SELOGIC Variable Input (SV)	**SV41**	:=
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV41PU**	:=
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV41DO**	:=
SELOGIC Variable Input (SV)	**SV42**	:=
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV42PU**	:=
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV42DO**	:=
SELOGIC Variable Input (SV)	**SV43**	:=
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV43PU**	:=
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV43DO**	:=
SELOGIC Variable Input (SV)	**SV44**	:=
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV44PU**	:=
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV44DO**	:=
SELOGIC Variable Input (SV)	**SV45**	:=
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV45PU**	:=
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV45DO**	:=

SELOGIC Variable Input (SV)	**SV46**	:= __________
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV46PU**	:= __________
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV46DO**	:= __________
SELOGIC Variable Input (SV)	**SV47**	:= __________
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV47PU**	:= __________
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV47DO**	:= __________
SELOGIC Variable Input (SV)	**SV48**	:= __________
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV48PU**	:= __________
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV48DO**	:= __________
SELOGIC Variable Input (SV)	**SV49**	:= __________
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV49PU**	:= __________
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV49DO**	:= __________
SELOGIC Variable Input (SV)	**SV50**	:= __________
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV50PU**	:= __________
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV50DO**	:= __________
SELOGIC Variable Input (SV)	**SV51**	:= __________
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV51PU**	:= __________
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV51DO**	:= __________
SELOGIC Variable Input (SV)	**SV52**	:= __________
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV52PU**	:= __________
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV52DO**	:= __________
SELOGIC Variable Input (SV)	**SV53**	:= __________
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV53PU**	:= __________
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV53DO**	:= __________
SELOGIC Variable Input (SV)	**SV54**	:= __________
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV54PU**	:= __________
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV54DO**	:= __________
SELOGIC Variable Input (SV)	**SV55**	:= __________
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV55PU**	:= __________
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV55DO**	:= __________
SELOGIC Variable Input (SV)	**SV56**	:= __________
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV56PU**	:= __________

SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV56DO**	:= ____________
SELOGIC Variable Input (SV)	**SV57**	:= ____________
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV57PU**	:= ____________
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV57DO**	:= ____________
SELOGIC Variable Input (SV)	**SV58**	:= ____________
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV58PU**	:= ____________
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV58DO**	:= ____________
SELOGIC Variable Input (SV)	**SV59**	:= ____________
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV59PU**	:= ____________
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV59DO**	:= ____________
SELOGIC Variable Input (SV)	**SV60**	:= ____________
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV60PU**	:= ____________
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV60DO**	:= ____________
SELOGIC Variable Input (SV)	**SV61**	:= ____________
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV61PU**	:= ____________
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV61DO**	:= ____________
SELOGIC Variable Input (SV)	**SV62**	:= ____________
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV62PU**	:= ____________
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV62DO**	:= ____________
SELOGIC Variable Input (SV)	**SV63**	:= ____________
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV63PU**	:= ____________
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV63DO**	:= ____________
SELOGIC Variable Input (SV)	**SV64**	:= ____________
SELOGIC Variable Timer Pickup (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV64PU**	:= ____________
SELOGIC Variable Timer Dropout (0.000–86400.000 s, MV*nn*, ACV*nn*, RA*nnn*)	**SV64DO**	:= ____________

Analog Control Variables

Enable Analog Control Variables (NA, 1–32)	**EACV**	:= ____________
Analog Control Variable Alias (15 characters)	**ACV01A**	:= ____________
Analog Control Variable Prompt (64 characters)	**ACV01P**	:= ____________
Analog Control Variable Minimum	**ACV01MIN**	:= ____________
Analog Control Variable Maximum	**ACV01MAX**	:= ____________
Analog Control Variable Reset Value	**ACV01RV**	:= ____________
Analog Control Variable Display Units (5 characters)	**ACV01U**	:= ____________
Analog Control Variable Reset Equation	**ACV01RST**	:= ____________

Analog Control Variable Alias (15 characters)	**ACV02A**	:= ______________
Analog Control Variable Prompt (64 characters)	**ACV02P**	:= ______________
Analog Control Variable Minimum	**ACV02MIN**	:= ______________
Analog Control Variable Maximum	**ACV02MAX**	:= ______________
Analog Control Variable Reset Value	**ACV02RV**	:= ______________
Analog Control Variable Display Units (5 characters)	**ACV02U**	:= ______________
Analog Control Variable Reset Equation	**ACV02RST**	:= ______________
Analog Control Variable Alias (15 characters)	**ACV03A**	:= ______________
Analog Control Variable Prompt (64 characters)	**ACV03P**	:= ______________
Analog Control Variable Minimum	**ACV03MIN**	:= ______________
Analog Control Variable Maximum	**ACV03MAX**	:= ______________
Analog Control Variable Reset Value	**ACV03RV**	:= ______________
Analog Control Variable Display Units (5 characters)	**ACV03U**	:= ______________
Analog Control Variable Reset Equation	**ACV03RST**	:= ______________
Analog Control Variable Alias (15 characters)	**ACV04A**	:= ______________
Analog Control Variable Prompt (64 characters)	**ACV04P**	:= ______________
Analog Control Variable Minimum	**ACV04MIN**	:= ______________
Analog Control Variable Maximum	**ACV04MAX**	:= ______________
Analog Control Variable Reset Value	**ACV04RV**	:= ______________
Analog Control Variable Display Units (5 characters)	**ACV04U**	:= ______________
Analog Control Variable Reset Equation	**ACV04RST**	:= ______________
Analog Control Variable Alias (15 characters)	**ACV05A**	:= ______________
Analog Control Variable Prompt (64 characters)	**ACV05P**	:= ______________
Analog Control Variable Minimum	**ACV05MIN**	:= ______________
Analog Control Variable Maximum	**ACV05MAX**	:= ______________
Analog Control Variable Reset Value	**ACV05RV**	:= ______________
Analog Control Variable Display Units (5 characters)	**ACV05U**	:= ______________
Analog Control Variable Reset Equation	**ACV05RST**	:= ______________
Analog Control Variable Alias (15 characters)	**ACV06A**	:= ______________
Analog Control Variable Prompt (64 characters)	**ACV06P**	:= ______________
Analog Control Variable Minimum	**ACV06MIN**	:= ______________
Analog Control Variable Maximum	**ACV06MAX**	:= ______________
Analog Control Variable Reset Value	**ACV06RV**	:= ______________
Analog Control Variable Display Units (5 characters)	**ACV06U**	:= ______________
Analog Control Variable Reset Equation	**ACV06RST**	:= ______________
Analog Control Variable Alias (15 characters)	**ACV07A**	:= ______________
Analog Control Variable Prompt (64 characters)	**ACV07P**	:= ______________
Analog Control Variable Minimum	**ACV07MIN**	:= ______________
Analog Control Variable Maximum	**ACV07MAX**	:= ______________
Analog Control Variable Reset Value	**ACV07RV**	:= ______________
Analog Control Variable Display Units (5 characters)	**ACV07U**	:= ______________
Analog Control Variable Reset Equation	**ACV07RST**	:= ______________
Analog Control Variable Alias (15 characters)	**ACV08A**	:= ______________
Analog Control Variable Prompt (64 characters)	**ACV08P**	:= ______________
Analog Control Variable Minimum	**ACV08MIN**	:= ______________
Analog Control Variable Maximum	**ACV08MAX**	:= ______________
Analog Control Variable Reset Value	**ACV08RV**	:= ______________

Analog Control Variable Display Units (5 characters)	**ACV08U**	:= ________________
Analog Control Variable Reset Equation	**ACV08RST**	:= ________________
Analog Control Variable Alias (15 characters)	**ACV09A**	:= ________________
Analog Control Variable Prompt (64 characters)	**ACV09P**	:= ________________
Analog Control Variable Minimum	**ACV09MIN**	:= ________________
Analog Control Variable Maximum	**ACV09MAX**	:= ________________
Analog Control Variable Reset Value	**ACV09RV**	:= ________________
Analog Control Variable Display Units (5 characters)	**ACV09U**	:= ________________
Analog Control Variable Reset Equation	**ACV09RST**	:= ________________
Analog Control Variable Alias (15 characters)	**ACV10A**	:= ________________
Analog Control Variable Prompt (64 characters)	**ACV10P**	:= ________________
Analog Control Variable Minimum	**ACV10MIN**	:= ________________
Analog Control Variable Maximum	**ACV10MAX**	:= ________________
Analog Control Variable Reset Value	**ACV10RV**	:= ________________
Analog Control Variable Display Units (5 characters)	**ACV10U**	:= ________________
Analog Control Variable Reset Equation	**ACV10RST**	:= ________________
Analog Control Variable Alias (15 characters)	**ACV11A**	:= ________________
Analog Control Variable Prompt (64 characters)	**ACV11P**	:= ________________
Analog Control Variable Minimum	**ACV11MIN**	:= ________________
Analog Control Variable Maximum	**ACV11MAX**	:= ________________
Analog Control Variable Reset Value	**ACV11RV**	:= ________________
Analog Control Variable Display Units (5 characters)	**ACV11U**	:= ________________
Analog Control Variable Reset Equation	**ACV11RST**	:= ________________
Analog Control Variable Alias (15 characters)	**ACV12A**	:= ________________
Analog Control Variable Prompt (64 characters)	**ACV12P**	:= ________________
Analog Control Variable Minimum	**ACV12MIN**	:= ________________
Analog Control Variable Maximum	**ACV12MAX**	:= ________________
Analog Control Variable Reset Value	**ACV12RV**	:= ________________
Analog Control Variable Display Units (5 characters)	**ACV12U**	:= ________________
Analog Control Variable Reset Equation	**ACV12RST**	:= ________________
Analog Control Variable Alias (15 characters)	**ACV13A**	:= ________________
Analog Control Variable Prompt (64 characters)	**ACV13P**	:= ________________
Analog Control Variable Minimum	**ACV13MIN**	:= ________________
Analog Control Variable Maximum	**ACV13MAX**	:= ________________
Analog Control Variable Reset Value	**ACV13RV**	:= ________________
Analog Control Variable Display Units (5 characters)	**ACV13U**	:= ________________
Analog Control Variable Reset Equation	**ACV13RST**	:= ________________
Analog Control Variable Alias (15 characters)	**ACV14A**	:= ________________
Analog Control Variable Prompt (64 characters)	**ACV14P**	:= ________________
Analog Control Variable Minimum	**ACV14MIN**	:= ________________
Analog Control Variable Maximum	**ACV14MAX**	:= ________________
Analog Control Variable Reset Value	**ACV14RV**	:= ________________
Analog Control Variable Display Units (5 characters)	**ACV14U**	:= ________________
Analog Control Variable Reset Equation	**ACV14RST**	:= ________________
Analog Control Variable Alias (15 characters)	**ACV15A**	:= ________________
Analog Control Variable Prompt (64 characters)	**ACV15P**	:= ________________
Analog Control Variable Minimum	**ACV15MIN**	:= ________________

Analog Control Variable Maximum	**ACV15MAX**	:= __________
Analog Control Variable Reset Value	**ACV15RV**	:= __________
Analog Control Variable Display Units (5 characters)	**ACV15U**	:= __________
Analog Control Variable Reset Equation	**ACV15RST**	:= __________
Analog Control Variable Alias (15 characters)	**ACV01A**	:= __________
Analog Control Variable Prompt (64 characters)	**ACV16P**	:= __________
Analog Control Variable Minimum	**ACV16MIN**	:= __________
Analog Control Variable Maximum	**ACV16MAX**	:= __________
Analog Control Variable Reset Value	**ACV16RV**	:= __________
Analog Control Variable Display Units (5 characters)	**ACV16U**	:= __________
Analog Control Variable Reset Equation	**ACV16RST**	:= __________
Analog Control Variable Alias (15 characters)	**ACV17A**	:= __________
Analog Control Variable Prompt (64 characters)	**ACV17P**	:= __________
Analog Control Variable Minimum	**ACV17MIN**	:= __________
Analog Control Variable Maximum	**ACV17MAX**	:= __________
Analog Control Variable Reset Value	**ACV17RV**	:= __________
Analog Control Variable Display Units (5 characters)	**ACV17U**	:= __________
Analog Control Variable Reset Equation	**ACV17RST**	:= __________
Analog Control Variable Alias (15 characters)	**ACV18A**	:= __________
Analog Control Variable Prompt (64 characters)	**ACV18P**	:= __________
Analog Control Variable Minimum	**ACV18MIN**	:= __________
Analog Control Variable Maximum	**ACV18MAX**	:= __________
Analog Control Variable Reset Value	**ACV18RV**	:= __________
Analog Control Variable Display Units (5 characters)	**ACV18U**	:= __________
Analog Control Variable Reset Equation	**ACV18RST**	:= __________
Analog Control Variable Alias (15 characters)	**ACV19A**	:= __________
Analog Control Variable Prompt (64 characters)	**ACV19P**	:= __________
Analog Control Variable Minimum	**ACV19MIN**	:= __________
Analog Control Variable Maximum	**ACV19MAX**	:= __________
Analog Control Variable Reset Value	**ACV19RV**	:= __________
Analog Control Variable Display Units (5 characters)	**ACV19U**	:= __________
Analog Control Variable Reset Equation	**ACV19RST**	:= __________
Analog Control Variable Alias (15 characters)	**ACV20A**	:= __________
Analog Control Variable Prompt (64 characters)	**ACV20P**	:= __________
Analog Control Variable Minimum	**ACV20MIN**	:= __________
Analog Control Variable Maximum	**ACV20MAX**	:= __________
Analog Control Variable Reset Value	**ACV20RV**	:= __________
Analog Control Variable Display Units (5 characters)	**ACV02U**	:= __________
Analog Control Variable Reset Equation	**ACV20RST**	:= __________
Analog Control Variable Alias (15 characters)	**ACV21A**	:= __________
Analog Control Variable Prompt (64 characters)	**ACV21P**	:= __________
Analog Control Variable Minimum	**ACV21MIN**	:= __________
Analog Control Variable Maximum	**ACV21MAX**	:= __________
Analog Control Variable Reset Value	**ACV21RV**	:= __________
Analog Control Variable Display Units (5 characters)	**ACV21U**	:= __________
Analog Control Variable Reset Equation	**ACV21RST**	:= __________

Analog Control Variable Alias (15 characters)	**ACV22A**	:=
Analog Control Variable Prompt (64 characters)	**ACV22P**	:=
Analog Control Variable Minimum	**ACV22MIN**	:=
Analog Control Variable Maximum	**ACV22MAX**	:=
Analog Control Variable Reset Value	**ACV22RV**	:=
Analog Control Variable Display Units (5 characters)	**ACV22U**	:=
Analog Control Variable Reset Equation	**ACV22RST**	:=
Analog Control Variable Alias (15 characters)	**ACV23A**	:=
Analog Control Variable Prompt (64 characters)	**ACV23P**	:=
Analog Control Variable Minimum	**ACV23MIN**	:=
Analog Control Variable Maximum	**ACV23MAX**	:=
Analog Control Variable Reset Value	**ACV23RV**	:=
Analog Control Variable Display Units (5 characters)	**ACV23U**	:=
Analog Control Variable Reset Equation	**ACV23RST**	:=
Analog Control Variable Alias (15 characters)	**ACV24A**	:=
Analog Control Variable Prompt (64 characters)	**ACV24P**	:=
Analog Control Variable Minimum	**ACV24MIN**	:=
Analog Control Variable Maximum	**ACV24MAX**	:=
Analog Control Variable Reset Value	**ACV24RV**	:=
Analog Control Variable Display Units (5 characters)	**ACV24U**	:=
Analog Control Variable Reset Equation	**ACV24RST**	:=
Analog Control Variable Alias (15 characters)	**ACV25A**	:=
Analog Control Variable Prompt (64 characters)	**ACV25P**	:=
Analog Control Variable Minimum	**ACV25MIN**	:=
Analog Control Variable Maximum	**ACV25MAX**	:=
Analog Control Variable Reset Value	**ACV25RV**	:=
Analog Control Variable Display Units (5 characters)	**ACV25U**	:=
Analog Control Variable Reset Equation	**ACV25RST**	:=
Analog Control Variable Alias (15 characters)	**ACV26A**	:=
Analog Control Variable Prompt (64 characters)	**ACV26P**	:=
Analog Control Variable Minimum	**ACV26MIN**	:=
Analog Control Variable Maximum	**ACV26MAX**	:=
Analog Control Variable Reset Value	**ACV26RV**	:=
Analog Control Variable Display Units (5 characters)	**ACV26U**	:=
Analog Control Variable Reset Equation	**ACV26RST**	:=
Analog Control Variable Alias (15 characters)	**ACV27A**	:=
Analog Control Variable Prompt (64 characters)	**ACV27P**	:=
Analog Control Variable Minimum	**ACV27MIN**	:=
Analog Control Variable Maximum	**ACV27MAX**	:=
Analog Control Variable Reset Value	**ACV27RV**	:=
Analog Control Variable Display Units (5 characters)	**ACV27U**	:=
Analog Control Variable Reset Equation	**ACV27RST**	:=
Analog Control Variable Alias (15 characters)	**ACV28A**	:=
Analog Control Variable Prompt (64 characters)	**ACV28P**	:=
Analog Control Variable Minimum	**ACV28MIN**	:=
Analog Control Variable Maximum	**ACV28MAX**	:=
Analog Control Variable Reset Value	**ACV28RV**	:=

Analog Control Variable Display Units (5 characters)	**ACV28U**	:=
Analog Control Variable Reset Equation	**ACV28RST**	:=
Analog Control Variable Alias (15 characters)	**ACV29A**	:=
Analog Control Variable Prompt (64 characters)	**ACV29P**	:=
Analog Control Variable Minimum	**ACV29MIN**	:=
Analog Control Variable Maximum	**ACV29MAX**	:=
Analog Control Variable Reset Value	**ACV29RV**	:=
Analog Control Variable Display Units (5 characters)	**ACV29U**	:=
Analog Control Variable Reset Equation	**ACV29RST**	:=
Analog Control Variable Alias (15 characters)	**ACV30A**	:=
Analog Control Variable Prompt (64 characters)	**ACV30P**	:=
Analog Control Variable Minimum	**ACV30MIN**	:=
Analog Control Variable Maximum	**ACV30MAX**	:=
Analog Control Variable Reset Value	**ACV30RV**	:=
Analog Control Variable Display Units (5 characters)	**ACV30U**	:=
Analog Control Variable Reset Equation	**ACV30RST**	:=
Analog Control Variable Alias (15 characters)	**ACV31A**	:=
Analog Control Variable Prompt (64 characters)	**ACV31P**	:=
Analog Control Variable Minimum	**ACV31MIN**	:=
Analog Control Variable Maximum	**ACV31MAX**	:=
Analog Control Variable Reset Value	**ACV31RV**	:=
Analog Control Variable Display Units (5 characters)	**ACV31U**	:=
Analog Control Variable Reset Equation	**ACV31RST**	:=
Analog Control Variable Alias (15 characters)	**ACV32A**	:=
Analog Control Variable Prompt (64 characters)	**ACV32P**	:=
Analog Control Variable Minimum	**ACV32MIN**	:=
Analog Control Variable Maximum	**ACV32MAX**	:=
Analog Control Variable Reset Value	**ACV32RV**	:=
Analog Control Variable Display Units (5 characters)	**ACV32U**	:=
Analog Control Variable Reset Equation	**ACV32RST**	:=

SELOGIC Counter Settings

Counter Nonvolatile Storage Enable SC01NV (Y, N)	**SC01NV**	:=
Counter Preset Value SC01PV (1–65000)	**SC01PV**	:=
Counter Reset Input SC01R (SELOGIC)	**SC01R**	:=
Counter Load PV Input SC01LD (SELOGIC)	**SC01LD**	:=
Count Up Input SC01CU (SELOGIC)	**SC01CU**	:=
Count Down Input SC01CD (SELOGIC)	**SC01CD**	:=
Counter Nonvolatile Storage Enable SC02NV (Y, N)	**SC02NV**	:=
Counter Preset Value SC02PV (1–65000)	**SC02PV**	:=
Counter Reset Input SC02R (SELOGIC)	**SC02R**	:=
Counter Load PV Input SC02LD (SELOGIC)	**SC02LD**	:=
Count Up Input SC02CU (SELOGIC)	**SC02CU**	:=
Count Down Input SC02CD (SELOGIC)	**SC02CD**	:=
Counter Nonvolatile Storage Enable SC03NV (Y, N)	**SC03NV**	:=

Counter Preset Value SC03PV (1–65000)	**SC03PV**	:=
Counter Reset Input SC03R (SELOGIC)	**SC03R**	:=
Counter Load PV Input SC03LD (SELOGIC)	**SC03LD**	:=
Count Up Input SC03CU (SELOGIC)	**SC03CU**	:=
Count Down Input SC03CD (SELOGIC)	**SC03CD**	:=
Counter Nonvolatile Storage Enable SC04NV (Y, N)	**SC04NV**	:=
Counter Preset Value SC04PV (1–65000)	**SC04PV**	:=
Counter Reset Input SC04R (SELOGIC)	**SC04R**	:=
Counter Load PV Input SC04LD (SELOGIC)	**SC04LD**	:=
Count Up Input SC04CU (SELOGIC)	**SC04CU**	:=
Count Down Input SC04CD (SELOGIC)	**SC04CD**	:=
Counter Nonvolatile Storage Enable SC05NV (Y, N)	**SC05NV**	:=
Counter Preset Value SC05PV (1–65000)	**SC05PV**	:=
Counter Reset Input SC05R (SELOGIC)	**SC05R**	:=
Counter Load PV Input SC05LD (SELOGIC)	**SC05LD**	:=
Count Up Input SC05CU (SELOGIC)	**SC05CU**	:=
Count Down Input SC05CD (SELOGIC)	**SC05CD**	:=
Counter Nonvolatile Storage Enable SC06NV (Y, N)	**SC06NV**	:=
Counter Preset Value SC06PV (1–65000)	**SC06PV**	:=
Counter Reset Input SC06R (SELOGIC)	**SC06R**	:=
Counter Load PV Input SC06LD (SELOGIC)	**SC06LD**	:=
Count Up Input SC06CU (SELOGIC)	**SC06CU**	:=
Count Down Input SC06CD (SELOGIC)	**SC06CD**	:=
Counter Nonvolatile Storage Enable SC07NV (Y, N)	**SC07NV**	:=
Counter Preset Value SC07PV (1–65000)	**SC07PV**	:=
Counter Reset Input SC07R (SELOGIC)	**SC07R**	:=
Counter Load PV Input SC07LD (SELOGIC)	**SC07LD**	:=
Count Up Input SC07CU (SELOGIC)	**SC07CU**	:=
Count Down Input SC07CD (SELOGIC)	**SC07CD**	:=
Counter Nonvolatile Storage Enable SC08NV (Y, N)	**SC08NV**	:=
Counter Preset Value SC08PV (1–65000)	**SC08PV**	:=
Counter Reset Input SC08R (SELOGIC)	**SC08R**	:=
Counter Load PV Input SC08LD (SELOGIC)	**SC08LD**	:=
Count Up Input SC08CU (SELOGIC)	**SC08CU**	:=
Count Down Input SC08CD (SELOGIC)	**SC08CD**	:=
Counter Nonvolatile Storage Enable SC09NV (Y, N)	**SC09NV**	:=
Counter Preset Value SC09PV (1–65000)	**SC09PV**	:=
Counter Reset Input SC09R (SELOGIC)	**SC09R**	:=
Counter Load PV Input SC09LD (SELOGIC)	**SC09LD**	:=
Count Up Input SC09CU (SELOGIC)	**SC09CU**	:=
Count Down Input SC09CD (SELOGIC)	**SC09CD**	:=
Counter Nonvolatile Storage Enable SC10NV (Y, N)	**SC10NV**	:=

Counter Preset Value SC10PV (1–65000)	**SC10PV**	:= ________________
Counter Reset Input SC10R (SELOGIC)	**SC10R**	:= ________________
Counter Load PV Input SC10LD (SELOGIC)	**SC10LD**	:= ________________
Count Up Input SC10CU (SELOGIC)	**SC10CU**	:= ________________
Count Down Input SC10CD (SELOGIC)	**SC10CD**	:= ________________
Counter Nonvolatile Storage Enable SC11NV (Y, N)	**SC11NV**	:= ________________
Counter Preset Value SC11PV (1–65000)	**SC11PV**	:= ________________
Counter Reset Input SC11R (SELOGIC)	**SC11R**	:= ________________
Counter Load PV Input SC11LD (SELOGIC)	**SC11LD**	:= ________________
Count Up Input SC11CU (SELOGIC)	**SC11CU**	:= ________________
Count Down Input SC11CD (SELOGIC)	**SC11CD**	:= ________________
Counter Nonvolatile Storage Enable SC12NV (Y, N)	**SC12NV**	:= ________________
Counter Preset Value SC12PV (1–65000)	**SC12PV**	:= ________________
Counter Reset Input SC12R (SELOGIC)	**SC12R**	:= ________________
Counter Load PV Input SC12LD (SELOGIC)	**SC12LD**	:= ________________
Count Up Input SC12CU (SELOGIC)	**SC12CU**	:= ________________
Count Down Input SC12CD (SELOGIC)	**SC12CD**	:= ________________
Counter Nonvolatile Storage Enable SC13NV (Y, N)	**SC13NV**	:= ________________
Counter Preset Value SC13PV (1–65000)	**SC13PV**	:= ________________
Counter Reset Input SC13R (SELOGIC)	**SC13R**	:= ________________
Counter Load PV Input SC13LD (SELOGIC)	**SC13LD**	:= ________________
Count Up Input SC13CU (SELOGIC)	**SC13CU**	:= ________________
Count Down Input SC13CD (SELOGIC)	**SC13CD**	:= ________________
Counter Nonvolatile Storage Enable SC14NV (Y, N)	**SC14NV**	:= ________________
Counter Preset Value SC14PV (1–65000)	**SC14PV**	:= ________________
Counter Reset Input SC14R (SELOGIC)	**SC14R**	:= ________________
Counter Load PV Input SC14LD (SELOGIC)	**SC14LD**	:= ________________
Count Up Input SC14CU (SELOGIC)	**SC14CU**	:= ________________
Count Down Input SC14CD (SELOGIC)	**SC14CD**	:= ________________
Counter Nonvolatile Storage Enable SC15NV (Y, N)	**SC015NV**	:= ________________
Counter Preset Value SC15PV (1–65000)	**SC15PV**	:= ________________
Counter Reset Input SC15R (SELOGIC)	**SC15R**	:= ________________
Counter Load PV Input SC15LD (SELOGIC)	**SC15LD**	:= ________________
Count Up Input SC15CU (SELOGIC)	**SC15CU**	:= ________________
Count Down Input SC15CD (SELOGIC)	**SC15CD**	:= ________________
Counter Nonvolatile Storage Enable SC16NV (Y, N)	**SC16NV**	:= ________________
Counter Preset Value SC16PV (1–65000)	**SC16PV**	:= ________________
Counter Reset Input SC16R (SELOGIC)	**SC16R**	:= ________________
Counter Load PV Input SC16LD (SELOGIC)	**SC16LD**	:= ________________
Count Up Input SC16CU (SELOGIC)	**SC16CU**	:= ________________
Count Down Input SC16CD (SELOGIC)	**SC16CD**	:= ________________
Counter Nonvolatile Storage Enable SC17NV (Y, N)	**SC17NV**	:= ________________

Counter Preset Value SC17PV (1–65000)	**SC17PV**	:=
Counter Reset Input SC17R (SELOGIC)	**SC17R**	:=
Counter Load PV Input SC17LD (SELOGIC)	**SC17LD**	:=
Count Up Input SC17CU (SELOGIC)	**SC17CU**	:=
Count Down Input SC17CD (SELOGIC)	**SC17CD**	:=
Counter Nonvolatile Storage Enable SC18NV (Y, N)	**SC18NV**	:=
Counter Preset Value SC18PV (1–65000)	**SC18PV**	:=
Counter Reset Input SC18R (SELOGIC)	**SC18R**	:=
Counter Load PV Input SC18LD (SELOGIC)	**SC18LD**	:=
Count Up Input SC18CU (SELOGIC)	**SC18CU**	:=
Count Down Input SC18CD (SELOGIC)	**SC18CD**	:=
Counter Nonvolatile Storage Enable SC19NV (Y, N)	**SC19NV**	:=
Counter Preset Value SC19PV (1–65000)	**SC19PV**	:=
Counter Reset Input SC19R (SELOGIC)	**SC19R**	:=
Counter Load PV Input SC19LD (SELOGIC)	**SC19LD**	:=
Count Up Input SC19CU (SELOGIC)	**SC19CU**	:=
Count Down Input SC19CD (SELOGIC)	**SC19CD**	:=
Counter Nonvolatile Storage Enable SC20NV (Y, N)	**SC20NV**	:=
Counter Preset Value SC20PV (1–65000)	**SC20PV**	:=
Counter Reset Input SC20R (SELOGIC)	**SC20R**	:=
Counter Load PV Input SC20LD (SELOGIC)	**SC20LD**	:=
Count Up Input SC20CU (SELOGIC)	**SC20CU**	:=
Count Down Input SC20CD (SELOGIC)	**SC20CD**	:=
Counter Nonvolatile Storage Enable SC21NV (Y, N)	**SC21NV**	:=
Counter Preset Value SC21PV (1–65000)	**SC21PV**	:=
Counter Reset Input SC21R (SELOGIC)	**SC21R**	:=
Counter Load PV Input SC21LD (SELOGIC)	**SC21LD**	:=
Count Up Input SC21CU (SELOGIC)	**SC21CU**	:=
Count Down Input SC21CD (SELOGIC)	**SC21CD**	:=
Counter Nonvolatile Storage Enable SC22NV (Y, N)	**SC22NV**	:=
Counter Preset Value SC22PV (1–65000)	**SC22PV**	:=
Counter Reset Input SC22R (SELOGIC)	**SC22R**	:=
Counter Load PV Input SC22LD (SELOGIC)	**SC22LD**	:=
Count Up Input SC22CU (SELOGIC)	**SC22CU**	:=
Count Down Input SC22CD (SELOGIC)	**SC22CD**	:=
Counter Nonvolatile Storage Enable SC23NV (Y, N)	**SC23NV**	:=
Counter Preset Value SC23PV (1–65000)	**SC23PV**	:=
Counter Reset Input SC23R (SELOGIC)	**SC23R**	:=
Counter Load PV Input SC23LD (SELOGIC)	**SC23LD**	:=
Count Up Input SC23CU (SELOGIC)	**SC23CU**	:=
Count Down Input SC23CD (SELOGIC)	**SC23CD**	:=
Counter Nonvolatile Storage Enable SC24NV (Y, N)	**SC24NV**	:=

Counter Preset Value SC24PV (1–65000)	**SC24PV**	:= ________________
Counter Reset Input SC24R (SELOGIC)	**SC24R**	:= ________________
Counter Load PV Input SC24LD (SELOGIC)	**SC24LD**	:= ________________
Count Up Input SC24CU (SELOGIC)	**SC24CU**	:= ________________
Count Down Input SC24CD (SELOGIC)	**SC24CD**	:= ________________
Counter Nonvolatile Storage Enable SC25NV (Y, N)	**SC25NV**	:= ________________
Counter Preset Value SC25PV (1–65000)	**SC25PV**	:= ________________
Counter Reset Input SC25R (SELOGIC)	**SC25R**	:= ________________
Counter Load PV Input SC25LD (SELOGIC)	**SC25LD**	:= ________________
Count Up Input SC25CU (SELOGIC)	**SC25CU**	:= ________________
Count Down Input SC25CD (SELOGIC)	**SC25CD**	:= ________________
Counter Nonvolatile Storage Enable SC26NV (Y, N)	**SC26NV**	:= ________________
Counter Preset Value SC26PV (1–65000)	**SC26PV**	:= ________________
Counter Reset Input SC26R (SELOGIC)	**SC26R**	:= ________________
Counter Load PV Input SC26LD (SELOGIC)	**SC26LD**	:= ________________
Count Up Input SC26CU (SELOGIC)	**SC26CU**	:= ________________
Count Down Input SC26CD (SELOGIC)	**SC26CD**	:= ________________
Counter Nonvolatile Storage Enable SC27NV (Y, N)	**SC27NV**	:= ________________
Counter Preset Value SC27PV (1–65000)	**SC27PV**	:= ________________
Counter Reset Input SC27R (SELOGIC)	**SC27R**	:= ________________
Counter Load PV Input SC27LD (SELOGIC)	**SC27LD**	:= ________________
Count Up Input SC27CU (SELOGIC)	**SC27CU**	:= ________________
Count Down Input SC27CD (SELOGIC)	**SC27CD**	:= ________________
Counter Nonvolatile Storage Enable SC28NV (Y, N)	**SC28NV**	:= ________________
Counter Preset Value SC28PV (1–65000)	**SC28PV**	:= ________________
Counter Reset Input SC28R (SELOGIC)	**SC28R**	:= ________________
Counter Load PV Input SC28LD (SELOGIC)	**SC28LD**	:= ________________
Count Up Input SC28CU (SELOGIC)	**SC28CU**	:= ________________
Count Down Input SC28CD (SELOGIC)	**SC28CD**	:= ________________
Counter Nonvolatile Storage Enable SC29NV (Y, N)	**SC29NV**	:= ________________
Counter Preset Value SC29PV (1–65000)	**SC29PV**	:= ________________
Counter Reset Input SC29R (SELOGIC)	**SC29R**	:= ________________
Counter Load PV Input SC29LD (SELOGIC)	**SC29LD**	:= ________________
Count Up Input SC29CU (SELOGIC)	**SC29CU**	:= ________________
Count Down Input SC29CD (SELOGIC)	**SC29CD**	:= ________________
Counter Nonvolatile Storage Enable SC30NV (Y, N)	**SC30NV**	:= ________________
Counter Preset Value SC30PV (1–65000)	**SC30PV**	:= ________________
Counter Reset Input SC30R (SELOGIC)	**SC30R**	:= ________________
Counter Load PV Input SC30LD (SELOGIC)	**SC30LD**	:= ________________
Count Up Input SC30CU (SELOGIC)	**SC30CU**	:= ________________
Count Down Input SC30CD (SELOGIC)	**SC30CD**	:= ________________
Counter Nonvolatile Storage Enable SC31NV (Y, N)	**SC31NV**	:= ________________

Counter Preset Value SC31PV (1–65000)	**SC31PV**	:=
Counter Reset Input SC31R (SELOGIC)	**SC31R**	:=
Counter Load PV Input SC31LD (SELOGIC)	**SC31LD**	:=
Count Up Input SC31CU (SELOGIC)	**SC31CU**	:=
Count Down Input SC31CD (SELOGIC)	**SC31CD**	:=
Counter Nonvolatile Storage Enable SC32NV (Y, N)	**SC32NV**	:=
Counter Preset Value SC32PV (1–65000)	**SC32PV**	:=
Counter Reset Input SC32R (SELOGIC)	**SC32R**	:=
Counter Load PV Input SC32LD (SELOGIC)	**SC32LD**	:=
Count Up Input SC32CU (SELOGIC)	**SC32CU**	:=
Count Down Input SC32CD (SELOGIC)	**SC32CD**	:=

Math Variable SELOGIC Equations

Math Variable Nonvolatile Storage Enable MV01NV (Y, N) **MV01NV** :=

MV01 :=

Math Variable Nonvolatile Storage Enable MV02NV (Y, N) **MV02NV** :=

MV02 :=

Math Variable Nonvolatile Storage Enable MV03NV (Y, N) **MV03NV** :=

MV03 :=

Math Variable Nonvolatile Storage Enable MV04NV (Y, N) **MV04NV** :=

MV04 :=

Math Variable Nonvolatile Storage Enable MV05NV (Y, N) **MV05NV** :=

MV05 :=

Math Variable Nonvolatile Storage Enable MV06NV (Y, N) **MV06NV** :=

MV06 :=

Math Variable Nonvolatile Storage Enable MV07NV (Y, N) **MV07NV** :=

MV07 :=

Math Variable Nonvolatile Storage Enable MV08NV (Y, N) **MV08NV** :=

MV08 :=

Math Variable Nonvolatile Storage Enable MV09NV (Y, N) **MV09NV** :=

MV09 :=

Math Variable Nonvolatile Storage Enable MV10NV (Y, N) **MV10NV** :=

MV10 :=

Math Variable Nonvolatile Storage Enable MV11NV (Y, N) **MV11NV** :=

MV11 :=

Math Variable Nonvolatile Storage Enable MV12NV (Y, N) **MV12NV** :=

MV12 :=

Math Variable Nonvolatile Storage Enable MV13NV (Y, N) **MV13NV** :=

MV13 :=

Math Variable Nonvolatile Storage Enable MV14NV (Y, N) **MV14NV** :=

MV14 :=

Math Variable Nonvolatile Storage Enable MV15NV (Y, N) **MV15NV** :=

MV15 :=

Math Variable Nonvolatile Storage Enable MV16NV (Y, N) **MV16NV** :=

MV16 :=

Math Variable Nonvolatile Storage Enable MV17NV (Y, N) **MV17NV** := ______
MV17 := ______
Math Variable Nonvolatile Storage Enable MV18NV (Y, N) **MV18NV** := ______
MV18 := ______
Math Variable Nonvolatile Storage Enable MV19NV (Y, N) **MV19NV** := ______
MV19 := ______
Math Variable Nonvolatile Storage Enable MV20NV (Y, N) **MV20NV** := ______
MV20 := ______
Math Variable Nonvolatile Storage Enable MV21NV (Y, N) **MV21NV** := ______
MV21 := ______
Math Variable Nonvolatile Storage Enable MV22NV (Y, N) **MV22NV** := ______
MV22 := ______
Math Variable Nonvolatile Storage Enable MV23NV (Y, N) **MV23NV** := ______
MV23 := ______
Math Variable Nonvolatile Storage Enable MV24NV (Y, N) **MV24NV** := ______
MV24 := ______
Math Variable Nonvolatile Storage Enable MV25NV (Y, N) **MV25NV** := ______
MV25 := ______
Math Variable Nonvolatile Storage Enable MV26NV (Y, N) **MV26NV** := ______
MV26 := ______
Math Variable Nonvolatile Storage Enable MV27NV (Y, N) **MV27NV** := ______
MV27 := ______
Math Variable Nonvolatile Storage Enable MV28NV (Y, N) **MV28NV** := ______
MV28 := ______
Math Variable Nonvolatile Storage Enable MV29NV (Y, N) **MV29NV** := ______
MV29 := ______
Math Variable Nonvolatile Storage Enable MV30NV (Y, N) **MV30NV** := ______
MV30 := ______
Math Variable Nonvolatile Storage Enable MV31NV (Y, N) **MV31NV** := ______
MV31 := ______
Math Variable Nonvolatile Storage Enable MV32NV (Y, N) **MV32NV** := ______
MV32 := ______
MV33 := ______
MV34 := ______
MV35 := ______
MV36 := ______
MV37 := ______
MV38 := ______
MV39 := ______
MV40 := ______
MV41 := ______
MV42 := ______
MV43 := ______
MV44 := ______
MV45 := ______
MV46 := ______
MV47 := ______

MV48 := ____________________
MV49 := ____________________
MV50 := ____________________
MV51 := ____________________
MV52 := ____________________
MV53 := ____________________
MV54 := ____________________
MV55 := ____________________
MV56 := ____________________
MV57 := ____________________
MV58 := ____________________
MV59 := ____________________
MV60 := ____________________
MV61 := ____________________
MV62 := ____________________
MV63 := ____________________
MV64 := ____________________

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**	:= ______________
Voltage Channel Scaling (DEFAULT, CUSTOM) *(Hidden if Slot E is not 8 V 3 ACI/3 AVI)*	**VSCALE**	:= ______________

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**	:= ______________
IN309 Debounce (AC, 0–65000 ms)	**IN309D**	:= ______________
IN310 Debounce (AC, 0–65000 ms)	**IN310D**	:= ______________
IN311 Debounce (AC, 0–65000 ms)	**IN311D**	:= ______________
IN312 Debounce (AC, 0–65000 ms)	**IN312D**	:= ______________
IN313 Debounce (AC, 0–65000 ms)	**IN313D**	:= ______________
IN314 Debounce (AC, 0–65000 ms)	**IN314D**	:= ______________

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**	:= ______________
IN409 Debounce (AC, 0–65000 ms)	**IN409D**	:= ______________
IN410 Debounce (AC, 0–65000 ms)	**IN410D**	:= ______________
IN411 Debounce (AC, 0–65000 ms)	**IN411D**	:= ______________
IN412 Debounce (AC, 0–65000 ms)	**IN412D**	:= ______________
IN413 Debounce (AC, 0–65000 ms)	**IN413D**	:= ______________
IN414 Debounce (AC, 0–65000 ms)	**IN414D**	:= ______________

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**	:=
IN509 Debounce (AC, 0–65000 ms)	**IN509D**	:=
IN510 Debounce (AC, 0–65000 ms)	**IN510D**	:=
IN511 Debounce (AC, 0–65000 ms)	**IN511D**	:=
IN512 Debounce (AC, 0–65000 ms)	**IN512D**	:=
IN513 Debounce (AC, 0–65000 ms)	**IN513D**	:=
IN514 Debounce (AC, 0–65000 ms)	**IN514D**	:=

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 (IRIG1, IRIG2)	**TIME_SRC**	:=

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

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

Time and Date Management Settings

Month To Begin DST (NA, 1–12)	**DST_BEGM**	:=
Offset from UTC (–24.00 to 24.00 hours)	**UTC_OFF**	:=
Month To Begin DST (NA,1–12)	**DST_BEGM**	:=
Week Of The Month To Begin DST (1–3, L)	**DST_BEGW**	:=
Day Of The Week To Begin DST (SUN, MON, TUE, WED, THU, FRI, SAT)	**DST_BEGD**	:=
Local Hour To Begin DST (0–23)	**DST_BEGH**	:=
Month To End DST (1–12)	**DST_ENDM**	:=
Week Of The Month To End DST (1–3, L)	**DST_ENDW**	:=
Day Of The Week To End DST (SUN, MON, TUE, WED, THU, FRI, SAT)	**DST_ENDD**	:=
Local Hour To End DST (0–23)	**DST_ENDH**	:=

Control Configuration

Enable Local Remote Control (Y, N)	**EN_LRC**	:=
Local Control (SELOGIC)	**LOCAL**	:=
Enable Station Level Authority for Local Control (SELOGIC)	**SC850LS**	:=
Enable Multilevel Authority for Local Control (SELOGIC)	**MLTLEV**	:=

IEC 61850 Mode/Behavior Configuration

IEC 61850 Blocked Mode Control Equation (SELOGIC)	**SC850BM**	:=
IEC 61850 Test Mode Control Equation (SELOGIC)	**SC850TM**	:=

		:= ________

IEC 61850 Simulation Configuration

IEC 61850 Process Simulated GOOSE Messages Control Equation (SELOGIC)	**SC850SM**	:= ________

Port Access Control Settings

Enable ACC Access (SELOGIC)	**EACC**	:= ________
Enable 2AC Access (SELOGIC)	**E2AC**	:= ________

Port Settings (SET P Command)

Port F

Port Enable (Y, N)	**EPORT**	:= ________
Maximum Access Level (ACC, 2AC)	**MAXACC**	:= ________
Port Access Control Enable (Y, N)	**EPAC**	:= ________
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 (0–30 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)

Port Security Settings

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

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

Ethernet Settings

ENABLE ETHERNET FIRMWARE UPGRADE (Y, N)	**EETHFWU**	:= ________
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) (*Hidden if ETCPKA := N*)	**KACNT**	:= ________
OPERATING MODE (Fixed, Failover, Switched, PRP) (*Hidden if not dual redundant Ethernet port option*)	**NETMODE**	:= ________
FAILOVER TIMEOUT (OFF, 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**	:= ________
PRP Entry Timeout (400–10000 ms)	**PRPTOUT**	:= ________
PRP Destination Address LSB (0–255)	**PRPADDR**	:= ________

PRP Supervision TX Interval (1–10 s)	**PRPINTV**	:= ________
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 Telnet (Y, N)	**ETELNET**	:= ________
TELNET PORT (23,1025–65534)	**TPORT**	:= ________
TELNET TIME-OUT (1–30 min)	**TIDLE**	:= ________
Enable FTP (Y, N)	**EFTP**	:= ________
FTP USER NAME (20 characters)	**FTPUSER**	:= ________
Enable Modbus (0–2)	**EMODBUS**	:= ________
Modbus TCP Port 1 (15–900 seconds) (*Hidden if EMODBUS < 1*)	**MODNUM1**	:= ________
Modbus TCP Port 2 (15–900 seconds) (*Hidden if EMODBUS < 2*)	**MODNUM2**	:= ________
Seconds to Communications Time-Out (0–3600 seconds) (*Hidden if EMODBUS < 1*)	**MOD_TO1**	:= ________
Seconds to Communications Time-Out (0–3600 seconds) (*Hidden if EMODBUS < 2*)	**MOD_TO2**	:= ________
Enable IEC 61850 Protocol (Y, N) (*Hidden if 61850 not supported*)	**E61850**	:= ________
Enable MMS File Transfer Services (Y, N) *(Hidden if 61850 := N)*	**EMMSFS**	:= ________
Enable IEC 61850 GSE (Y, N) (*Hidden if E61850 := N*)	**EGSE**	:= ________
Enable 61850 Mode/Behavior Control (Y, N) (*Hidden if E61850 := N*)	**E850MBC**	:= ________
Enable Goose Tx In Off Mode (Y, N) (*Hidden if E61850 := N*)	**EOFFMTX**	:= ________

RSTP Settings

Enable RSTP (Y, N)	**ERSTP**	:= ________
Bridge Priority (0–61440)	**BRIDGEPRI**	:= ________
PORTA Priority (0–240)	**PORTAPRI**	:= ________
PORTB Priority (0–240)	**PORTBPRI**	:= ________

SNTP Client Protocol Configuration

Enable SNTP Client (OFF, UNICAST, MANYCAST, BROADCAST)	**ESNTP**	:= ________
SNTP Primary Server IP Address (zzz.yyy.xxx.www)	**SNTPPSIP**	:= ________
SNTP Backup Server IP Address (zzz.yyy.xxx.www)	**SNTPBSIP**	:= ________
SNTP IP (Local) Port Number (1–65534)	**SNTPPORT**	:= ________
SNTP Client Request Update Rate (15–3600)	**SNTPRATE**	:= ________
SNTP Client Response Time-out (5–20)	**SNTPTO**	:= ________

PTP Settings

Enable PTP (Y, N)	**EPTP**	:= ________
PTP Profile (DEFAULT, C37.238)	**PTPPRO**	:= ________
PRP Transport Mechanism (LAYER2, UDP)	**PTPTR**	:= ________
PTP Domain Number (0–255)	**DOMNUM**	:= ________
PTP Path Delay Mechanism (P2P, E2E, OFF)	**PTHDLY**	:= ________
Peer Delay Request Interval (1, 2, 4, 8, 16, 32, 64 seconds)	**PDINT**	:= ________
PTP Number of Acceptable Masters (1–5, OFF)	**AMNUM**	:= ________
PTP Acceptable Master [*n*] IP (zzz.yyy.xxx.www) ([*n*] = 1 to 5)	**AMIP1**	:= ________
	AMIP2	:= ________
	AMIP3	:= ________
	AMIP4	:= ________
	AMIP5	:= ________

PTP Alternate Priority for Master [*n*] MAC (xx-xx-xx-xx-xx-xx) ([*n*] = 1 to 5)	**AMMAC1**	:=
	AMMAC2	:=
	AMMAC3	:=
	AMMAC4	:=
	AMMAC5	:=
PTP Alternate Priority for Master [*n*] (0–255) ([*n*] = 1 to 5)	**ALTPRI1**	:=
	ALTPRI2	:=
	ALTPRI3	:=
	ALTPRI4	:=
	ALTPRI5	:=
PTP VLAN Identifier (1–4094)	**PVLAN**	:=
PTP VLAN Priority (0–7)	**PVLANPR**	:=
Enable DNP Sessions (0–5) (*Hidden if DNP not supported*)	**EDNP**	:=

Port 2

Port Enable (Y, N)	**EPORT**	:=
Maximum Access Level (ACC, 2AC)	**MAXACC**	:=
Port Access Control Enable (Y, N)	**EPAC**	:=
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**	:=
Seconds to Communications Time-Out (*0–3600 seconds*)	**PROTO_TO**	:=
Minutes to Port Time-out (0–30 min) *(0 is only valid for SEL protocol to disable the time-out)*	**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**	:=
Port Access Control Enable (Y, N)	**EPAC**	:=
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**	:=
Seconds to Communications Time-Out (*0–3600 seconds*)	**PROTO_TO**	:=
Minutes to Port Timeout (0–30 min) *(0 is only valid for SEL protocol to disable the timeout)*	**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**	:=
Port Access Control Enable (Y, N)	**EPAC**	:=
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**	:=
Seconds to Communications Time-Out (*0–3600 seconds*)	**PROTO_TO**	:=
Minutes to Port Timeout (0–30 min) *(0 is only valid for SEL protocol to disable the timeout)*	**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 Username (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 0 LATCH (Y, N)	**T00LEDL**	:=
LED0 EQUATION (SELOGIC)	**T00_LED**	:=
Target T00_LED Assert Color (R,G,A)	**T00_LEDC**	:=
LED 1 LATCH (Y, N)	**T01LEDL**	:=
LED1 EQUATION (SELOGIC)	**T01_LED**	:=
Target T01_LED Assert Color (R,G,A)	**T01_LEDC**	:=
LED 2 LATCH (Y, N)	**T02LEDL**	:=
LED2 EQUATION (SELOGIC)	**T02_LED**	:=
Target T02_LED Assert Color (R,G,A)	**T02_LEDC**	:=
LED 3 LATCH (Y, N)	**T03LEDL**	:=
LED3 EQUATION (SELOGIC)	**T03_LED**	:=
Target T03_LED Assert Color (R,G,A)	**T03_LEDC**	:=
LED 4 LATCH (Y, N)	**T04LEDL**	:=
LED4 EQUATION (SELOGIC)	**T04_LED**	:=
Target T04_LED Assert Color (R,G,A)	**T04_LEDC**	:=
LED 5 LATCH (Y, N)	**T05LEDL**	:=
LED5 EQUATION (SELOGIC)	**T05_LED**	:=
Target T05_LED Assert Color (R,G,A)	**T05_LEDC**	:=
LED 6 LATCH (Y, N)	**T06LEDL**	:=
LED6 EQUATION (SELOGIC)	**T06_LED**	:=
Target T06_LED Assert Color (R,G,A)	**T06_LEDC**	:=
PB01 LED Assert/Deassert Colors (AG,AO,AR,GA,GO,GR,OA,OG,OR,RA,RG,RO)	**PB01_LEDC**	:=
PB01 LED Equation (SELOGIC)	**PB01_LED**	:=
PB01B LED Assert/Deassert Colors (AG,AO,AR,GA,GO,GR,OA,OG,OR,RA,RG,RO)	**PB01BLEDC**	:=
PB01B LED Equation (SELOGIC)	**PB01BLED**	:=

PB02 LED Assert/Deassert Colors (AG,AO,AR,GA,GO,GR,OA,OG,OR,RA,RG,RO)	**PB02_LEDC**	:= ________
PB02 LED Equation (SELOGIC)	**PB02_LED**	:= ________
PB02B LED Assert/Deassert Colors (AG,AO,AR,GA,GO,GR,OA,OG,OR,RA,RG,RO)	**PB02BLEDC**	:= ________
PB02B LED Equation (SELOGIC)	**PB02BLED**	:= ________
PB03 LED Assert/Deassert Colors (AG,AO,AR,GA,GO,GR,OA,OG,OR,RA,RG,RO)	**PB03_LEDC**	:= ________
PB03 LED Equation (SELOGIC)	**PB03_LED**	:= ________
PB03B LED Assert/Deassert Colors (AG,AO,AR,GA,GO,GR,OA,OG,OR,RA,RG,RO)	**PB03_LEDC**	:= ________
PB03B LED Equation (SELOGIC)	**PB03BLED**	:= ________
PB04 LED Assert/Deassert Colors (AG,AO,AR,GA,GO,GR,OA,OG,OR,RA,RG,RO)	**PB04_LEDC**	:= ________
PB04 LED Equation (SELOGIC)	**PB04_LED**	:= ________
PB04B LED Assert/Deassert Colors (AG,AO,AR,GA,GO,GR,OA,OG,OR,RA,RG,RO)	**PB04_LEDC**	:= ________
PB04B LED Equation (SELOGIC)	**PB04BLED**	:= ________
PB05 LED Assert/Deassert Colors (AG,AO,AR,GA,GO,GR,OA,OG,OR,RA,RG,RO)	**PB05_LEDC**	:= ________
PB05 LED Equation (SELOGIC)	**PB05_LED**	:= ________
PB05B LED Assert/Deassert Colors (AG,AO,AR,GA,GO,GR,OA,OG,OR,RA,RG,RO)	**PB05BLEDC**	:= ________
PB05B LED Equation (SELOGIC)	**PB05BLED**	:= ________
PB06 LED Assert/Deassert Colors (AG,AO,AR,GA,GO,GR,OA,OG,OR,RA,RG,RO)	**PB06_LEDC**	:= ________
PB06 LED Equation (SELOGIC)	**PB06_LED**	:= ________
PB06B LED Assert/Deassert Colors (AG,AO,AR,GA,GO,GR,OA,OG,OR,RA,RG,RO)	**PB06BLEDC**	:= ________
PB06B LED Equation (SELOGIC)	**PB06BLED**	:= ________
PB07 LED Assert/Deassert Colors (AG,AO,AR,GA,GO,GR,OA,OG,OR,RA,RG,RO)	**PB07_LEDC**	:= ________
PB07 LED Equation (SELOGIC)	**PB07_LED**	:= ________
PB07B LED Assert/Deassert Colors (AG,AO,AR,GA,GO,GR,OA,OG,OR,RA,RG,RO)	**PB07BLEDC**	:= ________
PB07B LED Equation (SELOGIC)	**PB07BLED**	:= ________
PB08 LED Assert/Deassert Colors (AG,AO,AR,GA,GO,GR,OA,OG,OR,RA,RG,RO)	**PB08_LEDC**	:= ________
PB08 LED Equation (SELOGIC)	**PB08_LED**	:= ________
PB08B LED Assert/Deassert Colors (AG,AO,AR,GA,GO,GR,OA,OG,OR,RA,RG,RO)	**PB08BLEDC**	:= ________
PB08B LED Equation (SELOGIC)	**PB08BLED**	:= ________

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 as many as 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 as many as 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 as many as 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 (1, 5, 10, 15, 30, 60 min)	**SPAR**	:= __________
Signal Profile Enable (SV)	**SPEN**	:= __________

DNP3 Settings (in Port Settings)

Port 1 DNP Settings

DNP3 Communications (hidden if DNP not supported)

Enable DNP Sessions (0–5)	**EDNP**	:= __________
Device DNP Address (0–65519)	**DNPADR**	:= __________

Master 1 Settings

IP Address (zzz.yyy.xxx.www) NOTE: Set DNPIP1 to 0.0.0.0 for anonymous connections.	**DNPIP1**	:= __________
DNP TCP and UDP Port (1–65534)	**DNPNUM1**	:= __________
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**	:= __________
Analog Change Event Default Variation (1–8)	**DVARAIE1**	:= __________
Frozen Counter Default Variation (1, 2, 5, 6, 9, 10)	**DVARFC1**	:= __________
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 deadband for current (0–32767)	**ANADBA1**	:=
Analog reporting deadband for voltages (0–32767)	**ANADBV1**	:=
Analog reporting deadband for miscellaneous analogs (0–32767)	**ANADBM1**	:=
Time-set request interval, minutes (I, M, 1–32767)	**TIMERQ1**	:=
Select/operate time-out, seconds (0.0–60.0)	**STIMEO1**	:=
Seconds to communications time-out (0–3600 seconds)	**DNP_TO1**	:=
Send Data Link Heartbeat, seconds (0.0–120)	**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**	:=
Default Counter Reporting (RUNNING, FROZEN, ALL)	**DCNTRP1**	:=
Analog Input Event Reporting (MOST_RECENT, SOE)	**AI_RPT1**	:=
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 (OFF, 1–5000)	**UTIMEO1**	:=

Master 2 Settings

IP Address (zzz.yyy.xxx.www) NOTE: Set DNPIP2 to 0.0.0.0 for anonymous connections.	**DNPIP2**	:=
DNP TCP and UDP Port (1–65534)	**DNPNUM2**	:=
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**	:=
Analog Change Event Default Variation (1–8)	**DVARAIE2**	:=
Frozen Counter Default Variation (1, 2, 5, 6, 9, 10)	**DVARFC2**	:=
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 deadband for current (0–32767)	**ANADBA2**	:=
Analog reporting deadband for voltages (0–32767)	**ANADBV2**	:=
Analog reporting deadband 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**	:=
Seconds to communications time-out (0–3600 seconds)	**DNP_TO2**	:=

Send Data Link Heartbeat, seconds (0.0–120)	**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**	:=
Default Counter Reporting (RUNNING, FROZEN, ALL)	**DCNTRP2**	:=
Analog Input Event Reporting (MOST_RECENT, SOE)	**AI_RPT2**	:=
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 (OFF, 1–5000)	**UTIMEO2**	:=

Master 3 Settings

IP Address (zzz.yyy.xxx.www) NOTE: Set DNPIP3 to 0.0.0.0 for anonymous connections.	**DNPIP3**	:=
DNP TCP and UDP Port (1–65534)	**DNPNUM3**	:=
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**	:=
Analog Change Event Default Variation (1–8)	**DVARAIE3**	:=
Frozen Counter Default Variation (1, 2, 5, 6, 9, 10)	**DVARFC3**	:=
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 deadband for current (0–32767)	**ANADBA3**	:=
Analog reporting deadband for voltages (0–32767)	**ANADBV3**	:=
Analog reporting deadband 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**	:=
Seconds to communications time-out (0–3600 seconds)	**DNP_TO3**	:=
Send Data Link Heartbeat, seconds (0.0–120)	**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**	:=
Default Counter Reporting (RUNNING, FROZEN, ALL)	**DCNTRP3**	:=
Analog Input Event Reporting (MOST_RECENT, SOE)	**AI_RPT3**	:=
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 (OFF, 1–5000)	**UTIMEO3**	:= __________

Master 4 Settings

IP Address (zzz.yyy.xxx.www) NOTE: Set DNPIP4 to 0.0.0.0 for anonymous connections.	**DNPIP4**	:= __________
DNP TCP and UDP Port (1–65534)	**DNPNUM4**	:= __________
Transport Protocol (UDP, TCP)	**DNPTR4**	:= __________
UDP Response Port (REQ, 1–65534)	**DNPUDP4**	:= __________
DNP3 address of the Master to send messages to (0–65519)	**REPADR4**	:= __________
DNP3 Session Map (1–3)	**DNPMAP4**	:= __________
Analog Input Default Variation (0–6)	**DVARAI4**	:= __________
Analog Change Event Default Variation (1–8)	**DVARAIE4**	:= __________
Frozen Counter Default Variation (1, 2, 5, 6, 9, 10)	**DVARFC4**	:= __________
Class for binary event data, 0 disables (0–3)	**ECLASSB4**	:= __________
Class for counter event data, 0 disables (0–3)	**ECLASSC4**	:= __________
Class for analog event data, 0 disables (0–3)	**ECLASSA4**	:= __________
Decimal places scaling for Current data (0–3)	**DECPLA4**	:= __________
Decimal places scaling for Voltage data (0–3)	**DECPLV4**	:= __________
Decimal places scaling for Miscellaneous data (0–3)	**DECPLM4**	:= __________
Analog reporting deadband for current (0–32767)	**ANADBA4**	:= __________
Analog reporting deadband for voltages (0–32767)	**ANADBV4**	:= __________
Analog reporting deadband for miscellaneous analogs (0–32767)	**ANADBM4**	:= __________
Time-set request interval, minutes (I, M, 1–32767)	**TIMERQ4**	:= __________
Select/operate time-out, seconds (0.0–30.0)	**STIMEO4**	:= __________
Seconds to communications time-out (0–3600 seconds)	**DNP_TO4**	:= __________
Send Data Link Heartbeat, seconds (0.0–120)	**DNPINA4**	:= __________
Data link retries (0–15)	**DRETRY4**	:= __________
Data link time-out, seconds (0.0–5.0)	**DTIMEO4**	:= __________
Event message confirm time-out, seconds (1–50)	**ETIMEO4**	:= __________
Default Counter Reporting (RUNNING, FROZEN, ALL)	**DCNTRP4**	:= __________
Analog Input Event Reporting (MOST_RECENT, SOE)	**AI_RPT4**	:= __________
Enable unsolicited reporting (Y, N)	**UNSOL4**	:= __________
Enable unsolicited reporting at power up (Y, N)	**PUNSOL4**	:= __________
Number of events to transmit on (1–200)	**NUMEVE4**	:= __________
Oldest event to transmit on, seconds (0.0–99999.0)	**AGEEVE4**	:= __________
Unsolicited messages maximum retry attempts (2–10)	**URETRY4**	:= __________
Unsolicited messages offline timeout, seconds (OFF, 1–5000)	**UTIMEO4**	:= __________

Master 5 Settings

IP Address (zzz.yyy.xxx.www) NOTE: Set DNPIP5 to 0.0.0.0 for anonymous connections.	**DNPIP5**	:= __________
DNP TCP and UDP Port (1–65534)	**DNPNUM5**	:= __________
Transport Protocol (UDP, TCP)	**DNPTR5**	:= __________
UDP Response Port (REQ, 1–65534)	**DNPUDP5**	:= __________
DNP3 address of the Master to send messages to (0–65519)	**REPADR5**	:= __________
DNP3 Session Map (1–3)	**DNPMAP5**	:= __________

Analog Input Default Variation (0–6)	**DVARAI5**	:=
Analog Change Event Default Variation (1–8)	**DVARAIE5**	:=
Frozen Counter Default Variation (1, 2, 5, 6, 9, 10)	**DVARFC5**	:=
Class for binary event data, 0 disables (0–3)	**ECLASSB5**	:=
Class for counter event data, 0 disables (0–3)	**ECLASSC5**	:=
Class for analog event data, 0 disables (0–3)	**ECLASSA5**	:=
Decimal places scaling for Current data (0–3)	**DECPLA5**	:=
Decimal places scaling for Voltage data (0–3)	**DECPLV5**	:=
Decimal places scaling for Miscellaneous data (0–3)	**DECPLM5**	:=
Analog reporting deadband for current (0–32767)	**ANADBA5**	:=
Analog reporting deadband for voltages (0–32767)	**ANADBV5**	:=
Analog reporting deadband for miscellaneous analogs (0–32767)	**ANADBM5**	:=
Time-set request interval, minutes (I, M, 1–32767)	**TIMERQ5**	:=
Select/operate time-out, seconds (0.0–30.0)	**STIMEO5**	:=
Seconds to communications time-out (0–3600 seconds)	**DNP_TO5**	:=
Send Data Link Heartbeat, seconds (0.0–120)	**DNPINA5**	:=
Data link retries (0–15)	**DRETRY5**	:=
Data link time-out, seconds (0.0–5.0)	**DTIMEO5**	:=
Event message confirm time-out, seconds (1–50)	**ETIMEO5**	:=
Default Counter Reporting (RUNNING, FROZEN, ALL)	**DCNTRP5**	:=
Analog Input Event Reporting (MOST_RECENT, SOE)	**AI_RPT5**	:=
Enable unsolicited reporting (Y, N)	**UNSOL5**	:=
Enable unsolicited reporting at power up (Y, N)	**PUNSOL5**	:=
Number of events to transmit on (1–200)	**NUMEVE5**	:=
Oldest event to transmit on, seconds (0.0–99999.0)	**AGEEVE5**	:=
Unsolicited messages maximum retry attempts (2–10)	**URETRY5**	:=
Unsolicited messages offline timeout, seconds (OFF, 1–5000)	**UTIMEO5**	:=

Port 2 DNP Settings

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**	:=
Analog Change Event Default Variation (1–8)	**DVARAIE1**	:=
Counter Default Variation (1,2,5,6)	**DVARC1**	:=
Frozen Counter Default Variation (1, 2, 5, 6, 9, 10)	**DVARFC1**	:=
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 deadband for current (0–32767)	**ANADBA1**	:=
Analog reporting deadband for voltages (0–32767)	**ANADBV1**	:=
Analog reporting deadband for miscellaneous analogs (0–32767)	**ANADBM1**	:=
Time-set request interval, minutes (I, M, 1–32767)	**TIMERQ1**	:=
Select/operate time-out, seconds (0.0–60.0)	**STIMEO1**	:=

Seconds to communications time-out (0–3600 seconds)	**DNP_TO1**	:=
Send Data Link Heartbeat, seconds (0.0–120)	**DNPINA1**	:=
Event message confirm time-out, seconds (1–50)	**ETIMEO1**	:=
Default Counter Reporting (RUNNING, FROZEN, ALL)	**DCNTRPT1**	:=
Analog Input Event Reporting (MOST_RECENT, SOE)	**AI_RPT1**	:=
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 (OFF, 1–5000)	**UTIMEO1**	:=

Port 3 DNP Settings

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**	:=
Analog Change Event Default Variation (1–8)	**DVARAIE1**	:=
Counter Default Variation (1,2,5,6)	**DVARC1**	:=
Frozen Counter Default Variation (1, 2, 5, 6, 9, 10)	**DVARFC1**	:=
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 deadband for current (0–32767)	**ANADBA1**	:=
Analog reporting deadband for voltages (0–32767)	**ANADBV1**	:=
Analog reporting deadband for miscellaneous analogs (0–32767)	**ANADBM1**	:=
Time-set request interval, minutes (I, M, 1–32767)	**TIMERQ1**	:=
Select/operate time-out, seconds (0.0–60.0)	**STIMEO1**	:=
Seconds to communications time-out (0–3600 seconds)	**DNP_TO1**	:=
Send Data Link Heartbeat, seconds (0.0–120)	**DNPINA1**	:=
Event message confirm time-out, seconds (1–50)	**ETIMEO1**	:=
Default Counter Reporting (RUNNING, FROZEN, ALL)	**DCNTRPT1**	:=
Analog Input Event Reporting (MOST_RECENT, SOE)	**AI_RPT1**	:=
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 (OFF, 1–5000)	**UTIMEO1**	:=
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**	:=

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**	:= __________

Port 4 DNP Settings (If Card is Installed)

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**	:= __________
Analog Change Event Default Variation (1–8)	**DVARAIE1**	:= __________
Counter Default Variation (1,2,5,6)	**DVARC1**	:= __________
Frozen Counter Default Variation (1, 2, 5, 6, 9, 10)	**DVARFC1**	:= __________
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 deadband for current (0–32767)	**ANADBA1**	:= __________
Analog reporting deadband for voltages (0–32767)	**ANADBV1**	:= __________
Analog reporting deadband for miscellaneous analogs (0–32767)	**ANADBM1**	:= __________
Time-set request interval, minutes (I, M, 1–32767)	**TIMERQ1**	:= __________
Select/operate time-out, seconds (0.0–60.0)	**STIMEO1**	:= __________
Seconds to communications time-out (0–3600 seconds)	**DNP_TO1**	:= __________
Send Data Link Heartbeat, seconds (0.0–120)	**DNPINA1**	:= __________
Event message confirm time-out, seconds (1–50)	**ETIMEO1**	:= __________
Default Counter Reporting (RUNNING, FROZEN, ALL)	**DCNTRPT1**	:= __________
Analog Input Event Reporting (MOST_RECENT, SOE)	**AI_RPT1**	:= __________
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 (OFF, 1–5000)	**UTIMEO1**	:= __________
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**	:= __________

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**	:= ____________

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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 7.8* 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 communications distances (500 m to 4 km) with an SEL-2812.

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

Port Type	Port Interface	Usage
Port 3, 4C (Serial)	EIA-232 (Nonisolated)	Use the EIA-232 port for communications distances of ≤15 m (50 ft) in low-noise environments.
Port 4A (Serial)	EIA-485	Use the EIA-485 port for communications distances ≤1200 m (4000 ft). For maximum 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.

Device Word bits provided for Ethernet ports are shown in *Table 7.2*.

Table 7.2 Ethernet Port Device Word Bits

Device Word Bit	Description
LINKA	Dual Ethernet link status for Port A.
LINKB	Dual Ethernet link status for Port B.
LINKFAIL	Dual Ethernet active port link status failure indicator. LINKFAIL asserts if connections fail on both ports for SWITCHED and FAILOVER operating modes. LINKFAIL asserts if the connection fails on the primary port for FIXED operating mode.
PASEL	Dual Ethernet active Port A indicator.
PBSEL	Dual Ethernet active Port B indicator.

Serial (EIA-232 and EIA-485) Port

Use the EIA-232 port for communications distances as far as 15 m (49 ft) in low noise environments. Use the optional EIA-485 port for communications distances as far as 1200 m (3937 ft) maximum distance (to achieve this performance, ensure proper line termination at the receiver).

To connect a PC serial port to the device front-panel serial port and enter device commands, you need the following:

- A personal computer equipped with one available EIA-232 serial port
- A communications cable to connect the computer serial port to the device serial ports
- Terminal emulation software to control the computer serial port
- An SEL-2411 device

Some of the SEL devices available for integration or communications system robustness are as follows:

- SEL-3505, SEL-3530, SEL-3555, and SEL-3560 Real-Time Automation Controllers, SEL-2240 Axion®
- SEL-2800 series fiber-optic transceivers
- SEL-2890 Ethernet Transceiver
- SEL-3010 Event Messenger
- SEL-2505 Remote I/O Module (with SEL-2812 compatible ST fiber-optic port) for connection to device fiber-optic serial Port 2, or use SEL-2505 with EIA-232 (DB-9) serial port to connect to EIA-232 Port 3 on the device

A variety of terminal emulation programs on personal computers can communicate with the device. For the best display, use VT-100 terminal emulation or the closest variation.

The default settings for all EIA-232 serial ports are as follows:

Data Rate = 9600

Data Bits = 8

Parity = N

Stop Bits = 1

To change the port settings, use the **SET P** command or the front-panel settings. See *SET Command (Change Settings) on page 7.37* for port settings that use ASCII commands. See *Section 8: Front-Panel Operations* for details on changing settings by using the front-panel.

Hardware Flow Control

All EIA-232 serial ports support RTS/CTS hardware handshaking (hardware flow control). To enable hardware handshaking, set RTSCTS := Y. Disable hardware handshaking by setting RTSCTS := N.

- ➤ If RTSCTS := N, the device permanently asserts the RTS line.
- ➤ If RTSCTS := Y, the device deasserts RTS when it is unable to receive characters.
- ➤ If RTSCTS := Y, the device does not send characters until the CTS input is asserted.

Fiber-Optic Serial Port

Use the optional fiber-optic port (Port 2) for safety and communications distances as far as 1 km. For communications distances as far as 4 km, use an SEL-2812 transceiver on Port 3. Although Port 2 and the SEL-2812 are compatible, Port 2 is less sensitive than the SEL-2812, which limits the distance to 1 km.

Ethernet Port

Use the Ethernet port for interfacing with an Ethernet network environment. SEL-2411 Ethernet port choices include single or dual copper or fiber-optic configurations. With dual Ethernet ports, the unit has an unmanaged Ethernet switch. Redundant configurations support automatic failover switching from the primary to the backup network if the device detects a failure in the primary network. The basic concept in the Parallel Redundancy Protocol (PRP) mode of operation is that the Ethernet network and all traffic are fully duplicated with the two copies operating in parallel. The purpose of the protocol is to provide seamless recovery from any single Ethernet network failure. In addition to failover and PRP modes, the unit can operate in a “fixed connection (to netport) mode” or in a “switched mode” (as an unmanaged switch).

You should carefully design your Ethernet network to maximize reliability, minimize system administrator efforts, and provide adequate security. SEL recommends that you work with a networking professional to design your substation Ethernet network.

Several settings control how the device with the optional Ethernet card operates on an Ethernet network. These settings include deviceIP addressing information, network port failover options, and network speed.

Use the network configuration settings by using **SET P 1** command to configure the device for operation on an IP network and to set other parameters affecting the physical Ethernet network interface operation.

Figure 7.1 shows an example of a simple Ethernet network configuration and *Figure 7.2* shows an example of an Ethernet network configuration with dual redundant connections, and *Figure 7.3* shows an example of an Ethernet network configuration with ring structure.

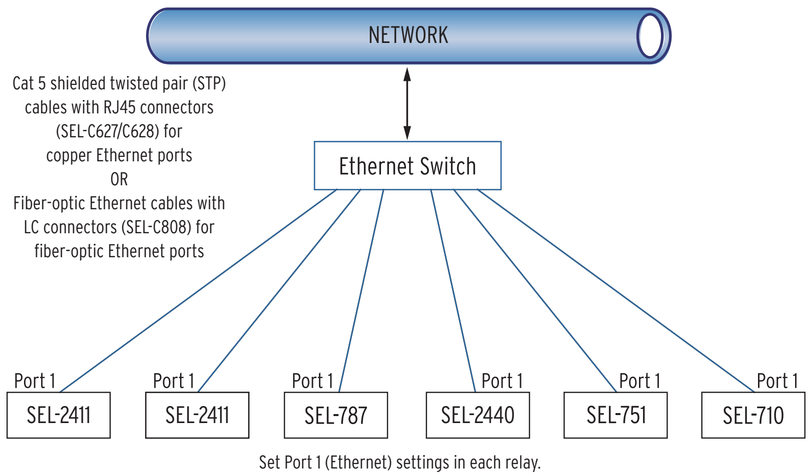

Figure 7.1 Simple Ethernet Network Configuration

Dual Network Port Operation

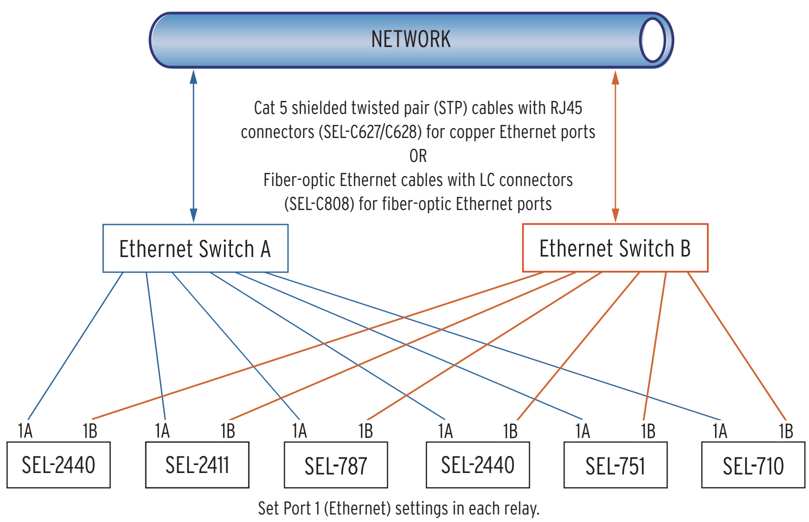

Figure 7.2 Ethernet Network Configuration With Dual Redundant Connections (Failover Mode)

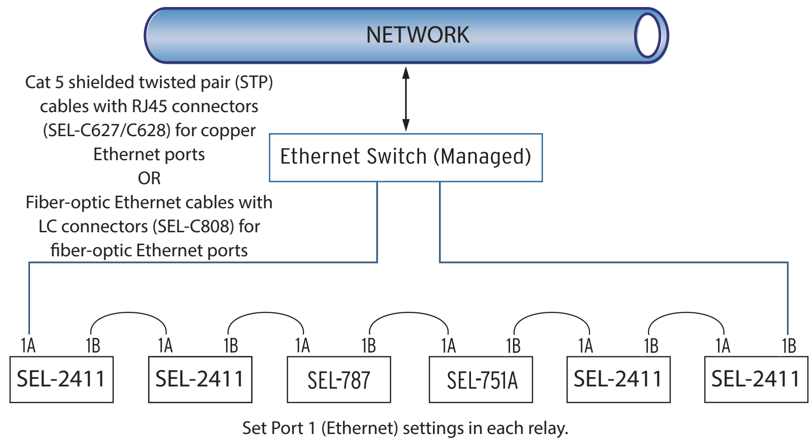

Figure 7.3 Ethernet Network Configuration With Ring Structure (Switched Mode)

The SEL-2411 dual Ethernet port option has two network ports. Network port failover mode enables the dual Ethernet port to operate as a single network adapter with a primary and standby physical interface. You can connect the two network ports to the same network or to different networks depending on your specific Ethernet network architecture.

Failover Mode

In the failover mode operation, the device determines the active port. To use failover mode, proceed with the following steps.

NOTE: If you change settings for the host port in the device and the standby network port is active, the device resets and returns to operation on the primary port.

Step 1. Set NETMODE to **FAILOVER**.

Step 2. Set FTIME to the desired network port failover time (0.10–65.00 seconds or OFF).

Step 3. Set NETPORT to the network interface you prefer.

On startup, the device communicates via NETPORT (primary port) selected. If the device detects a link failure on the primary port, it activates the standby port after the failover time, FTIME, elapses. If the link status on the primary link returns to normal before the failover time expires, the failover timer resets and uninterrupted operation continues on the primary network port.

Setting FTIME := OFF allows fast port switching (with no intentional delay). Fast port switching can occur within one processing interval (typically 100 ms) and can help with IEC 61850 GOOSE performance.

After failover, while communicating via standby port, the device checks the primary link periodically and continues checking until it detects a normal link status. The device continues to communicate via the standby port even after the primary port returns to normal. The device reevaluates the port of choice for communication upon a change of settings, at failure of the standby port, or upon reboot. The device returns to operation on the primary link under those conditions if it detects a normal link status. When the active and backup links both fail, the device alternates checking for the link status of the primary and standby ports.

Switched Mode

If you have a network configuration where you want to use the relay as an unmanaged or managed switch, set NETMODE to SWITCHED. Set ERSTP := Y to use it as a managed switch. In SWITCHED mode, both links are enabled. The relay responds to the messages it receives on either port. All the messages received on one network port that are not addressed to the relay are transmitted out of the other port without any modifications. In this mode, the relay ignores the NETPORT setting.

SWITCHED mode is often used to connect several relays to each other, creating a network of relays, then connecting at least two relays to a managed switch for redundancy. This configuration is popular because it reduces cost and reduces the number of devices in a network without sacrificing redundancy. Basically, each relay has a redundant path to the network. Refer to *Figure 7.3*.

There are compromises to be made in this configuration, however. When connecting cables between multiple switches in an Ethernet network, physical loops (rings) may occur that cause traffic storms, total bandwidth consumption, and other improper functioning. As a result, a subset of the relays in this configuration can seem unresponsive for extended periods of time.

For example, in *Figure 7.3*, imagine that a DNP master is receiving DNP UDP unsolicited messages from the relays. When a link is broken, it can sometimes take as long as 5 minutes for communications to be restored. For a similar network involving IEC 61850 GOOSE and a broken link, the restoration time can be greater than 5 seconds. The relay offers Rapid Spanning Tree Protocol (RSTP) mode to improve restoration times in such configurations. With RSTP enabled, the expected restoration time of the before-mentioned GOOSE network is around 100 ms.

RSTP protocol controls active paths in an Ethernet network to avoid loops and enable a level of redundancy. All Port 1 protocols are supported when RSTP is enabled. Refer to *Rapid Spanning Tree Protocol (RSTP) on page 7.44* for additional details.

Fixed Connection Mode

If you have a single network and want to use only one network port, or if you have both ports connected but want to force usage of only one port for various reasons, set NETMODE to **FIXED** and set NETPORT to the port you want to use. Only the selected network port operates, and the other port is disabled.

PRP Connection Mode

PRP is part of an IEC standard for high availability automation networks (IEC 62439-3). The purpose of the protocol is to provide seamless recovery from any single Ethernet network failure.

The basic concept is that the Ethernet network and all traffic are fully duplicated with the two copies operating in parallel.

Make the following settings for Port 1 to configure the device for PRP mode.

- NETMODE = PRP
- PRPTOUT = desired timeout for PRP frame entry
- PRPADDR = PRP destination MAC address LSB (least significant byte of “01-15-4E-00-01-*XX*,” converted to decimal and entered as 0–255)
- PRPINTV = desired supervision frame transmit interval

When NETMODE is not set to PRP, the following settings are hidden.

Table 7.3 PRP Settings

Setting Prompt	Setting Description	Setting Range	Setting Name := Factory Default
PRP ENTRY TIMEOUT	PRP Entry Timeout	400–10000 ms	PRPTOUT := 500
PRP DESTINATION ADDR LSB	The multicast MAC address of PRP supervision frames is 01-15-4E-00-01-*XX* where *XX* is specified by this setting in decimal notation as 0–255	0–255	PRPADDR := 0
PRP SUPERVISION TX INTERVAL	PRP Supervision TX Interval	1–10 s	PRPINTV := 2

Autonegotiation, Speed, and Duplex Mode

Single or dual copper Ethernet ports can autonegotiate to determine the link speed and duplex mode. Accomplish this by setting the NETASPD and NETBSPD (network speed) to AUTO. You can also set single or dual copper ports to specific speeds so that you can apply them in networks with older switch devices. The device fixes the single and dual fiber Ethernet ports to work at 100 Mbps and full duplex mode.

The speed and mode of an established link is dependent on the settings on both ends of the link. For all settings of network speed (AUTO, 10, or 100) on the SEL-2411 and with auto negotiation set on the other end, the devices establish a full duplex mode link at the corresponding speed. However, if the device on the other end does not support auto negotiation, or if auto negotiation is disabled, the devices establish a half duplex mode link at the set speeds. Such a mismatched state can lead to packet collisions, delays, or even packet loss. Use custom logic to set alarms when the devices fail to establish the speed and mode required for your application through the Device Word bits listed in *Table 7.4*.

Table 7.4 Device Word Bits to Monitor Network Speed and Duplex Mode

Device Word Bit	Description
SPD1[a]	Port1 Speed. Asserts for 100 Mbps and deasserts for 10 Mbps
SPD1B[b]	Port1B Speed. Asserts for 100 Mbps
SPD1A[b]	Port1A Speed. Asserts for 100 Mbps and deasserts for 10 Mbps
DUP1[a]	Port1 Duplex Mode. Asserts for full duplex and deasserts for half duplex
DUP1B[b]	Port1B Duplex Mode. Asserts for full duplex and deasserts for half duplex
DUP1A[b]	Port1A Duplex Mode. Asserts for full duplex and deasserts for half duplex

[a] The Device Word bit is available only when a single Ethernet port is available.
[b] The Device Word bit is available only when a dual Ethernet port is available.

NETPORT Selection

The NETPORT setting gives you the option of selecting the primary port of communication in failover or fixed communications modes.

TCP Keep Alive

The ETCPKA setting, along with the KAIDLE, KAINTV, and KACNT settings, can be used to verify that the computer at the remote end of a TCP connection is still available. If ETCPKA is enabled and the device does not transmit any TCP data within the interval specified by the KAIDLE setting, the device sends a keep-alive packet to the remote computer. If the device does not receive a response from the remote computer within the time specified by KAINTV, the keep-alive packet is re-transmitted as many as KACNT times. After this count is reached, the relay considers the remote device no longer available, so the device terminates the connection without waiting for the idle timer (TIDLE or FTPILE) to expire.

The device monitors MMS inactivity to identify and disconnect MMS clients that have stopped communicating. You can set it from 0 to 4,200,000 seconds via the IED Properties MMS Settings in ACSELERATOR Architect SEL-5032 Software. The MMS inactivity default value is either 120 seconds or 900 seconds, depending on the device firmware version. Setting this value to 0 disables the MMS inactivity timer. If enabled, the device starts a timer for an MMS session after it receives an MMS request from the client on that session. It resets the timer whenever it receives a new MMS request from that client. When the timer runs out, the device disconnects the MMS session, making it available for other MMS clients. This feature was implemented in addition to the TCP keep-alive timer to specifically handle MMS clients that do not disconnect properly. As there are a limited number of MMS sessions available, this ensures that misbehaving MMS clients do not take up multiple MMS sessions. Note that the MMS inactivity time-out can still disconnect an MMS session even if the device receives TCP keep-alive messages from that MMS client.

Telnet

NOTE: Telnet works with other NETMODE settings also, but NETMODE = SWITCHED is easiest to begin communication. The device hides setting NETMODE when equipped with a single Ethernet port.

Factory-default settings for the Ethernet ports disable all Ethernet protocols except Telnet and PING. Command **SET P 1** accesses settings for both Ethernet ports on the device: Port 1A and Port 1B. Use the **SET P 1** command or QuickSet to set the following settings:

- IPADDR := IP address assign by network administrator
- DEFRTR := Default router IP address assigned by network administrator
- NETMODE := SWITCHED (available with dual Ethernet ports)
- ETELNET := Y

Leave all other settings at their default values. Connect an Ethernet cable between your PC or a network switch and any Ethernet port on the device. Verify that the amber link LED illuminates on the connected device port. Many computers and most Ethernet switches support autocrossover, so nearly any Cat 5 Ethernet cable with RJ45 connectors, such as an SEL-C627 cable will work. When the computer does not support autocrossover, use a crossover cable, such as an SEL-C628 cable. If your device is equipped with dual Ethernet ports, connect to either port. Use a Telnet application or QuickSet on the host PC to communicate with the device. To terminate a Telnet session, use the **EXIT** command from any access level.

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 an SEL-C273A cable (see the cable diagrams that follow in this section or use the SEL-5801 Cable Selector software). If the unit has the fiber-optic serial option (Port 2), IRIG can be received from a master device over an SEL-2812MT.

+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 4C). Some SEL communications devices require the +5 Vdc power supply. This +5 Vdc is available on Pin 1 without the need for hardware jumpers.

Port Connector and Communications Cables

Figure 7.4 shows the front-panel EIA-232 serial port DB-9 connector pin numbering for the SEL-2411.

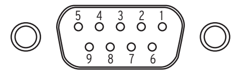

Figure 7.4 EIA-232 DB-9 Connector Pin Numbers

Table 7.5 shows the pin functions for the EIA-232 serial ports.

Table 7.5 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 7.6 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	SEL-C272A
EIA-232	DTE: 9-Pin Male D	DTE: 9-Pin Male D	Comm. Proc. with IRIG-B	SEL-C273A
EIA-232	DTE: 9-Pin Male D	DTE: 9-Pin Female D	Computer	SEL-C234A
EIA-232	DTE: 9-Pin Male D	DTE: 25-Pin Female D	Computer	SEL-C227A
EIA-232	DTE: 9-Pin Male D	DCE: 9-Pin Male	Wireless encrypting transceiver	SEL-C285
EIA-232	DTE: 9-Pin Male D	DCE: 9-Pin Female D	Serial encrypting transceiver	SEL-C245A
EIA-232	DTE: 9-Pin Male D	DCE: 25-Pin Female D	Modem	SEL-C222
EIA-485	DTE: 9-Pin Male D	8-Pin Compression	Multidrop network	SEL-C675
Ethernet	RJ45 Ethernet	RJ45 Ethernet	Copper Ethernet	SEL-C627
IRIG-B	DTE: 9-Pin Male D	BNC Female	Demodulated IRIG-B	SEL-C256
USB 2.0	DTE: 9-Pin Male D	USB Type A	EIA-232 to USB adapter	SEL-C662
USB 2.0	USB Type B	USB Type A	Computer	SEL-C664

Time-Out Indication

The SEL-2411 provides communication time-out indication for DNP and Modbus sessions. These are timers that indicate when a DNP or Modbus client stops communicating with the SEL-2411.

Set the communication time-out in seconds for serial port using PROT_TO. When the SEL-2411 does not receive a valid DNP or Modbus message on Serial Port *x* for PROTO_TO seconds, the SEL-2411 will assert the P*x*_TO Device Word bit until it receives a valid message (where *x* = 2, 3, or 4 representing Serial Ports 2, 3, or 4, respectively).

Set the TCP communication time-out for DNP sessions on Port 1 using DNP*k*_TO (where *k* = 1–5 representing DNP Sessions 1–5). When DNP*k*_TO seconds transpires without receiving a DNP message for Session *k*, the SEL-2411 will assert the DNP*k*_TO Device Word bit until it receives a valid DNP message.

Set the TCP communication time-out for Modbus sessions on Port 1 using MOD1_TO or MOD2_TO. When MOD1_TO or MOD2_TO seconds transpire without receiving any Modbus messages on Port 1, the SEL-2411 will assert the MOD1_TO or MOD2_TO Device Word bits, respectively.

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 7.7 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.
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.

Table 7.7 Serial Port Protocols (Sheet 2 of 2)

Protocol	Description
Other SEL Communications Protocols	
MIRRORED BITS®	This protocol is a direct device-to-device (peer to peer) communications protocol that allows IEDs to exchange information quickly, securely, and with minimal expense for functions such as intertripping, remote control, and remote sensing. See *Appendix G: MIRRORED BITS Communications* for details.
Event Messenger	This protocol supports transmitting messages to SEL-3010 Event Messenger. See *Table 6.14* 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 7.8* shows protocols available on the Ethernet ports.

Table 7.8 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	3	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: 7 GOOSE: 64 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*.
Industry Standard Communications Protocols		
Modbus	2	Modbus is a simple manufacturer-developed, hardware independent communications protocol. See *Appendix E: Modbus Communications*.
DNP3	5	DNP3 is an object-oriented manufacturer-developed, hardware independent communications protocol. See *Appendix D: DNP3 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 7.9*.

Table 7.9 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]
C	==>>	Access Level C commands should be used under direction of SEL only.

[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 7.10*. 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. The alarm contact closes for one second upon entry of **2AC** and if the incorrect password is entered three times for any access level.

Table 7.10 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 enter each access level. See *PASSWORD Command (View/Change Passwords) on page 7.33* 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 7.11 ANALOG Command

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

Table 7.12 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 min-
utes.
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 7.13*. This command is only available as Compressed ASCII response.

Table 7.13 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 7.14 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 7.15*. This command is only available as Compressed ASCII response.

Table 7.15 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**, **CSE**, **CPRO**, **CEV**, and **CSU**.

CEVENT Command (Compressed Event Report)

Use the **CEV** command (*Table 7.16*) 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 are 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 7.16* (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 7.16 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 7.17*.

Table 7.17 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)

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 7.18*.

NOTE: Information displayed in parenthesis is optional.

Table 7.18 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 MAT	Display SELOGIC® math variable data compressed format.	1
CME REM	Display remote analog data compressed format.	1

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

COM PTP Command

The **COM PTP** command provides a report of the PTP data sets maintained by the device as well as statistics for the measured time offsets with the parent (master) clock. The PTP data sets contain information about the state, identity, and configuration of the local, parent, and grandmaster clocks in addition to properties of the time being distributed by the grandmaster clock.

Table 7.19 COM PTP Command

Command	Description	Access Level
COM PTP	Displays the PTP data sets and offset statistics for the active PTP slave port or for the last active PTP slave port.	1
COM PTP C or **R**	Clears or resets the PTP offset statistics for all ports.	1

If the EPTP setting is set to No, and the **COM PTP** command (with or without any parameters) is sent to the relay, the relay responds with:

```
=>COM PTP <Enter>

PTP not enabled
```

If a temporary resource shortage exists, a settings change is in progress, or the PTP component is not yet initialized, and the **COM PTP** command is sent to the relay, the relay responds with:

```
=>COM PTP <Enter>

Command is not available
```

If EPTP is enabled and the **COM PTP C** or **R** command is sent to the SEL-2411, the SEL-2411 responds with:

```
=>COM PTP C <Enter>

Clear PTP offset statistics?
Are you sure? Y N
```

If you select **Y**, the relay responds with Clearing Complete. If **N** is selected, the relay responds with `Command Canceled`. If anything else is selected, the relay responds with `Command Canceled`.

If a **COM PTP C** or **R** is sent to the SEL-2411 and the PTP component is enabled but not yet initialized, the SEL-2411 responds with:

```
=>COM PTP R <Enter>

Command is not available
```

The SEL-2411 saves the date and time when the PTP offset statistics are cleared. The format of the offset clearing date matches the DATE_F Global setting. The statistic clearing date and time is the time of the last user reset via an ASCII command, the last Port 1 settings change, or the last power up. The time stamp of the most recent event is displayed.

An example response to the **COM PTP** command when PTP is available is shown in *Figure 7.5*.

```
=>>COM PTP <Enter>

SEL-2411                                  Date: 05/13/2023   Time: 10:01:41.976
Device                                     Time Source: External


PTP offset statistics previously cleared on 05/09/2019 09:32:18 (UTC)


Settings Data Set
  PTP Profile : Default
  Transport Mechanism : UDP
  Path Delay : P2P


Default Data Set
  Two Step : true
  Clock Identity : 00 30 A7 FF FE 12 32 22
  Number of Ports : 1
  Clock Quality
    Clock Class : 255
    Clock Accuracy : 254
    Offset Log Variance : 0
  Priority1 : 255
  Priority2 : 255
  Domain Number : 0
  Slave Only : true


Current Data Set
  Steps Removed : 1


Parent Data Set
  Parent Port Identity
  Clock Identity : 00 30 A7 FF FE 0B 29 91
    Port Number : 1
  Grandmaster Clock Identity : 00 30 A7 FF FE 0B 29 91
  Grandmaster Clock Quality
    Clock Class : Synchronized with PTP timescale 6
    Clock Accuracy : Within 100 ns
    Offset Log Variance : 18887
  Grandmaster Priority1 : 128
  Grandmaster Priority2 : 128


Time Properties Data Set
  Current UTC Offset : 37
  Current UTC Offset Valid : true
  Leap59 : false
  Leap61 : false
  Time Traceable : true
  Frequency Traceable : true
  PTP Timescale : true
  Time Source : GPS
  Local Time Offset
    Offset Valid : true
    Name : UTC-07:00
    Current Offset : -25237 s
    Jump Seconds : -3600 s
    Time of Next Jump : 1572771637 s


Port Data Set
  Port Identity
    Clock Identity : 00 30 A7 FF FE 12 32 22
    Port Number : 1
  Port State : SLAVE
  Log Pdelay Request Interval : 0
  Peer Mean Path Delay : 0 ns
  Announce Receipt Timeout : 4 intervals
  Path Delay Mechanism : P2P
  Failed to Receive Response : true
  Received Multiple Pdelay Responses : false
  Reason for Non-synchronization :
  Port status : A, ACTIVE

=>>
```

Figure 7.5 COM PTP Command Response When PTP Is Available

A description of each PTP data set displayed in *Figure 7.5* is provided in *Table 7.20*.

Table 7.20 PTP Data Set Descriptions (Sheet 1 of 4)

Type of Data Set	Information Field	Description
Settings	PTP Profile	This value is the same as PTPPRO.
	Transport Mechanism	This value is the same as PTPTR.
	Path Delay	This value is the same as PTHDLY.
Default	Two Step	For the default data, this is set to TRUE. A two-step clock provides time information using the combination of an event message and a subsequent general message. A one-step clock provides times information using a single event message.
	Clock Identity	This is an 8-octet number that uniquely identifies the clock on the network. It is derived from the Ethernet MAC address.
	Number of Ports	This is the number of Ethernet ports used to communicate PTP messages. It is always 1 for SEL-2411 Relays.
	Clock Quality	This contains information about clock class, accuracy, and variance for the SEL-2411.
	Priority1	This is the first priority for the SEL-2411 Relay used in the default BMCA. It is always set to 255.
	Priority2	This is the second priority for the SEL-2411 Relay used in the default BMCA. It is always set to 255.
	Domain Number	This value is the same as DOMNUM. It is the PTP domain number that the clock is part of.
	Slave Only	This is always TRUE for SEL-2411 Relays.
Current	Steps Removed	This is the number of communications paths between the SEL-2411 Relay and the grandmaster clock. A communication path is the link between a master and a slave port. Hence, links to transparent clocks do not count as separate paths. The values range from 1–65535.
Parent	Parent Port Identity	This contains the clock identity and port number of the adjacent clock to which the SEL-2411 clock is synchronized. The port number identifies the specific port on the adjacent clock from which the SEL-2411 clock is receiving PTP messages.
	Grandmaster Clock Identity	This is the clock identity of the grandmaster clock that the SEL-2411 is synchronized to.
	Grandmaster Clock Quality	This contains the class, accuracy, and variance of the grandmaster clock.
	Grandmaster Clock Class	This field displays an ASCII message based on the received clock class code described as follows:

Code (decimal)	Message
68–122, 133–170, 216–232	Profile specific value
6	Synchronized with PTP timescale
7	Holdover with PTP timescale
13	Synchronized with ARB timescale
14	Holdover with ARB timescale
52	Holdover degrade A with PTP timescale
58	Holdover degrade A with ARB timescale
187	Holdover degrade B with PTP timescale
193	Holdover degrade B with ARB timescale
248	Default
255	Slave only
All other codes	Reserved with decimal code value (xxx)

Table 7.20 PTP Data Set Descriptions (Sheet 2 of 4)

<table>
<tr><th>Type of Data Set</th><th>Information Field</th><th>Description</th></tr>
<tr><td></td><td>Grandmaster Clock Accuracy</td><td>This field displays an ASCII message based on the received clock accuracy enumeration value described as follows:
<table>
<tr><th>Value (Hex)</th><th>Message</th></tr>
<tr><td>20</td><td>Within 25 ns</td></tr>
<tr><td>21</td><td>Within 100 ns</td></tr>
<tr><td>22</td><td>Within 250 ns</td></tr>
<tr><td>23</td><td>Within 1 µs</td></tr>
<tr><td>24</td><td>Within 2.5 µs</td></tr>
<tr><td>25</td><td>Within 10 µs</td></tr>
<tr><td>26</td><td>Within 25 µs</td></tr>
<tr><td>27</td><td>Within 100 µs</td></tr>
<tr><td>28</td><td>Within 250 µs</td></tr>
<tr><td>29</td><td>Within 1 ms</td></tr>
<tr><td>2A</td><td>Within 2.5 ms</td></tr>
<tr><td>2B</td><td>Within 10 ms</td></tr>
<tr><td>2C</td><td>Within 25 ms</td></tr>
<tr><td>2D</td><td>Within 100 ms</td></tr>
<tr><td>2E</td><td>Within 250 ms</td></tr>
<tr><td>2F</td><td>Within 1 s</td></tr>
<tr><td>30</td><td>Within 10 s</td></tr>
<tr><td>31</td><td>Greater than 10 s</td></tr>
<tr><td>80–FD</td><td>Profile specific value (0xyy)</td></tr>
<tr><td>FE</td><td>Unknown</td></tr>
<tr><td>All other codes</td><td>Reserved (0xyy)</td></tr>
</table></td></tr>
<tr><td></td><td>Grandmaster Priority1</td><td>This is the priority1 value set in the grandmaster clock. If the setting ALTPRIn > 0, its value is used as the reported priority1 value for Grandmaster n. The expected value is between 0 to 255.</td></tr>
<tr><td></td><td>Grandmaster Priority2</td><td>This is the priority2 value set in the grandmaster clock. The expected value is between 0–255.</td></tr>
<tr><td></td><td>C37.238 TLV Information</td><td>This is the C37.238 TLV information received. It is valid only in the Power profile. In the case of the Default profile, this section is hidden.</td></tr>
<tr><td>Time Properties</td><td>Current UTC Offset</td><td>This is the current number of leap seconds between TAI and UTC.</td></tr>
<tr><td></td><td>Current UTC Offset Valid</td><td>This attribute is TRUE if the current UTC Offset is valid and should be used. Otherwise, it is FALSE.</td></tr>
<tr><td></td><td>Leap59</td><td>This is set to TRUE if there is an impending leap second removal, i.e., the last minute of the current day contains 59 seconds.</td></tr>
<tr><td></td><td>Leap61</td><td>This is set to TRUE if there is an impending leap second insertion, i.e., the last minute of the current day contains 61 seconds.</td></tr>
<tr><td></td><td>Time Traceable</td><td>This indicates if the time being served is traceable to UTC reference time.</td></tr>
<tr><td></td><td>Frequency Traceable</td><td>This indicates if the frequency being distributed is traceable to a primary source.</td></tr>
<tr><td></td><td>PTP Timescale</td><td>This is TRUE if the time being served uses the PTP/UTC timescale. Otherwise, it is FALSE.</td></tr>
</table>

Table 7.20 PTP Data Set Descriptions (Sheet 3 of 4)

<table>
<tr><th>Type of Data Set</th><th>Information Field</th><th>Description</th></tr>
<tr><td></td><td>Time Source</td><td>This shows the source of the time being distributed based on the value of the timeSource enumeration as show in the following table.
<table>
<tr><th>Code (decimal)</th><th>Message</th></tr>
<tr><td>10</td><td>ATOMIC_CLOCK</td></tr>
<tr><td>20</td><td>GPS</td></tr>
<tr><td>30</td><td>TERRESTRIAL_RADIO</td></tr>
<tr><td>40</td><td>PTP</td></tr>
<tr><td>50</td><td>NTP</td></tr>
<tr><td>60</td><td>HAND_SET</td></tr>
<tr><td>90</td><td>OTHER</td></tr>
<tr><td>A0</td><td>INTERNAL_OSCILLATOR</td></tr>
<tr><td>F0–FE</td><td>PROFILE SPECIFIC VALUE (0xyy)</td></tr>
<tr><td>All other codes</td><td>RESERVED (0xyy)</td></tr>
</table></td></tr>
<tr><td></td><td>Local Time Offset</td><td>This is the offset of local time from UTC and information about impending change in the offset.</td></tr>
<tr><td>Port</td><td>Port Identity</td><td>This contains the clock ID and port number of the SEL-2411 Relay on the PTP network.</td></tr>
<tr><td></td><td>Port State</td><td>This is the synchronization state of the SEL-2411 Relay: LISTENING, SLAVE, UNCALIBRATED, or FAULTY. The relay is synchronized if the state is SLAVE.</td></tr>
<tr><td></td><td>Log Delay Request Interval</td><td>If the end-to-end delay mechanism is enabled, then this is the logarithm to base 2 of the delay request intervals (in seconds) received from the master clock. If the peer-to-peer (P2P) delay mechanism is enabled, these data are hidden. Also, these data are hidden when the delay mechanism is set to OFF.</td></tr>
<tr><td></td><td>Log Pdelay Request Interval</td><td>If the peer-to-peer (P2P) delay mechanism is enabled, this is the logarithm to base 2 of the configured peer delay request intervals (PDINT). If the end-to-end delay mechanism is enabled, these data are hidden. Also, these data are hidden when the delay mechanism is set to OFF.</td></tr>
<tr><td></td><td>Peer Mean Path Delay</td><td>If the peer-to-peer (P2P) delay mechanism is enabled, this is the measured mean peer delay on the SEL-2411 Relay. If the peer-to-peer (P2P) delay mechanism is not selected (PTHDLY ≠ P2P), these data are hidden.</td></tr>
<tr><td></td><td>Announcement Receipt Timeout</td><td>This value is always 4 announce intervals.</td></tr>
<tr><td></td><td>Path Delay Mechanism</td><td>This is the same value as PTHDLY.</td></tr>
<tr><td></td><td>Failed to Receive Response</td><td>The value is TRUE if no response is received after 5 consecutive Delay or Pdelay Requests from the port. Otherwise, the value is FALSE. These data are hidden if PTHDLY = OFF.</td></tr>
<tr><td></td><td>Received Multiple Pdelay Responses</td><td>This is set to TRUE if a response is received from more than one clock to a Pdelay request from the SEL-2411. The port state will transition to FAULTY when this happens. The value is reset to FALSE when only one clock responds to Pdelay requests from the SEL-2411. These data are hidden if PTHDLY ≠ P2P.</td></tr>
</table>

Table 7.20 PTP Data Set Descriptions (Sheet 4 of 4)

<table>
<tr><th>Type of Data Set</th><th>Information Field</th><th>Description</th></tr>
<tr><td></td><td>Reason for Nonsynchronization</td><td>If the SEL-2411 Relay is failing to synchronize, this will provide one of the following reasons for the failure: incorrect domain number, clock not in the acceptable master table, or missing TLV in Announce messages. Otherwise, the string is empty.
<table>
<tr><th>#</th><th>Reason for Nonsynchronization Display Strings</th></tr>
<tr><td>1</td><td>Received Announce message for a different domain: <domain number></td></tr>
<tr><td>2</td><td>Received Announce message from an unacceptable master: <MAC or IP address></td></tr>
<tr><td>3</td><td>Required TLV is missing or incorrectly formatted by clock <clock id></td></tr>
</table>
</td></tr>
<tr><td></td><td>Port Status</td><td>This displays the Port 1A and 1B time synchronization status. If the port is not synchronized to a PTP master, NA is displayed. If a port is in the SLAVE state and it is chosen as a master, ACTIVE is displayed.
Additional port status indications are available via Relay Word bits PTPA, PTPB, PASEL, and PBSEL. When Ethernet Port 1A is active, PASEL asserts. Similarly, when Ethernet Port 1B is active, PBSEL asserts. If the operating mode of Port 1 of the relay is PRP, then PTPA asserts if PTP is enabled and the relay is receiving PTP messages on Port 1A. Similarly, in PRP mode, PTPB asserts if PTP is enabled and the relay is receiving PTP messages on Port 1B.</td></tr>
</table>

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 7.21 COMMUNICATIONS Command (Sheet 1 of 2)

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

Table 7.21 COMMUNICATIONS Command (Sheet 2 of 2)

Command	Description	Access Level
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 7.23*.

Table 7.22 CONTROL Command

Command	Description	Access Level
CON RB*nn*[a] *k*	Command to control remote bits. Replace *k* with one of the subcommands listed in *Table 7.23* to control the remote bit.	2

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

Table 7.23 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 one quarter-cycle (MOMENTARY position).	2

For example, enter the following command to set Remote bit RB32:

```
=>>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 7.24*.

Table 7.24 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 7.25*.

Table 7.25 CPROFILE Command

Command	Description	Access Level
CPR	Display analog signal profile data.	1

CSER Command (Compressed SER Report)

The **CSER** command generates the SER report in Compressed ASCII format, as shown in *Table 7.26* and *Table 7.27*.

Table 7.26 CSER Command (Compressed Sequential Events Reorder Report)

Command	Description	Access Level
CSER	Display a chronological progression of all available SER rows (as many as 512 rows). Row 1 is the most recent triggered row and Row 512 is the oldest.	1, 2
CSER *row1* **CSER *row1 row2*** **CSER *date1*** **CSER *date1 date2***	Use the **CSER** command with parameters (row or date) to display a chronological or reverse chronological subset of the SER rows, see *Table 7.53*).	1, 2

Append TERSE to any of the commands in *Table 7.26* to generate a report without labels (e.g., **CSER 5 2 TERSE** generates a report without labels from rows 5 to 2).

If the requested SER report rows do not exist, the device responds with the following:

```
"No Data Available","0668"
```

Table 7.27 CSER Command Format

Command	Description
row1	Append ***row1*** to return a chronological progression of the first *row1* rows. For example, use **SER** 5 to return the first five rows.
row1 row2	Append ***row1*** and ***row2*** to return all rows between *row1* and *row2*, beginning with *row1* and ending with *row2*. 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 **CSER 1 10** to return the first ten rows in numeric order or **CSER 10 1** to return the same items in reverse numeric order.
date1	Append ***date1*** to return all rows with this date. For example, use **CSER 1/1/2021** to return all records for January 1, 2021.
date1 date2	Append ***date1*** and ***date2*** to return all rows between *date1* and *date2*, beginning with *date2* and ending with *date1* (i.e., the newest records are listed first). 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), **CSER 1/5/2021 1/7/2021** returns all records for January 5, 6, and 7, 2021.

CSTATUS Command (Compressed Status)

The **CST** command generates a device status report in Compressed ASCII format, as shown in *Table 7.28*.

Table 7.28 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 7.29*.

Table 7.29 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 7.30*.

Table 7.30 DATE Command

Command	Description	Access Level
DAT	Display the internal clock date.	1
DAT ***date***	Set the internal clock date to *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.

ETHERNET Command

NOTE: You can upgrade units with firmware versions R316 or older to firmware versions R317 or newer, but the unit will not have the GOOSE performance improvements (i.e., a GOOSE port with a dedicated MAC address).

The **ETH** command displays the status report of both Ethernet ports, including settings and performance.

```
=>>ETH <Enter>
SEL-2411                                  Date: 11/12/2010   Time: 03:11:38
DEVICE

 MAC: 00-30-A7-D3-4F-1A
 IP ADDRESS: 192.168.0.2
 SUBNET MASK: 255.255.255.0
 DEFAULT GATEWAY: 0.0.0.0

 PRIMARY PORT:  PORT 1A
 ACTIVE PORT:   PORT 1A

             LINK   SPEED  DUPLEX   MEDIA
PORT 1A      Up     100M   Full     TX
PORT 1B      Up     100M   Full     TX

=>>
```

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 7.31*. See *HISTORY Command (Events List) on page 7.25* for details on clearing event reports.

Table 7.31 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 7.32*.

Table 7.32 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 7.33*.

Table 7.33 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 7.34*.

Table 7.34 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 *Table 7.35*.

Table 7.35 GOOSE IEDs

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. See *Table 7.36* for an explanation of the displayed codes.
Transmit Data Set 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).

Table 7.36 Warning and Error Codes for GOOSE Subscriptions

Code	Enumeration[a]	Definition	Error/Warning
–	0	No errors present.	–
HOST DISABLED	1	Optional code for when the subscribing device is disabled or becomes unresponsive after the **GOOSE** command has been issued.	Error
CONF REV MISMA	2	Configuration revision mismatch. Displayed when the value of the configuration revision number in the received GOOSE message does not match with the value of the configuration revision number present in the CID file.	Error
NEED COMMISSIO	3	Needs commissioning. Displayed when the received GOOSE message has NdsCom = true.	Error
MSG CORRUPTED	4	Message corrupted. Displayed when a received GOOSE message does not meet the proper format or is corrupted.	Error
TTL EXPIRED	5	Time-to-live expired.	Error
OUT OF SEQUENC	6	Out-of-sequence (OOS) error. This error is present when the StNum or SqNum value between received GOOSE messages is not sequential.	Warning
INVALID QUAL	7	Invalid data quality received	Warning

[a] Enumerations are used to communicate GOOSE error codes in the LGOS logical node.

IDENTIFICATION Command

Available as a compressed command only, use the **ID** command to extract device identification codes, as shown in *Table 7.37*.

Table 7.37 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 IEC 61850 is available:
	`"iedName=SEL_2411_1","05FB"`
	`"type=SEL_2411","047A"`
	`"configVersion=ICD-SEL-2411-R200-V0-Z002002-D20070730","0E52","61850ID=5FEA494D","0424"`
		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 7.38*). 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 7.38 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 7.39*. 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 7.39 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 7.40 LOOPBACK 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

NOTE: You can upgrade units with firmware versions R316 or older to firmware versions R317 or newer, but the unit will not have the GOOSE performance improvements (i.e., a GOOSE port with a dedicated MAC address).

Use the **MAC** command to display the MAC addresses of PORT 1, as shown.

```
=>>MAC <Enter>
Port 1 (IP) MAC Address: 00-30-A7-67-32-10
Port 1 (GOOSE) MAC Address: 00-30-A7-78-10-20

=>>
```

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 5) to display.

Table 7.41 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.

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 as many as 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

MET F k Fundamental Metering

Use the **MET F *k*** command to display fundamental metering data.

Command	Description	Access Level
MET F *k*	Display instantaneous metering data *k* times.	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 5.4*.

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 5.4*.

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.

NET Command

Use the **NET** command to display the state of TCP and UDP ports that are open on the SEL-2411.

Command	Description	Access Level
NET	Display TCP and UDP port states.	1

```
=>>NET <Enter>
SEL-2411                                         Date: 01/26/2000   Time: 15:41:29
DEVICE                                           Time Source: Internal

Proto   Local Address              Foreign Address              State
TCP     0.0.0.0:21                                              LISTEN
TCP     0.0.0.0:502                                             LISTEN
TCP     0.0.0.0:503                                             LISTEN
TCP     10.203.116.112:502         10.203.116.113:35206    ESTABLISHED
TCP     10.203.116.112:503         10.203.116.113:44714    ESTABLISHED
UDP     0.0.0.0:20000
UDP     0.0.0.0:34565

=>>
```

PART Command (View/Change Part Number)

Use the Part command to inspect or change the existing part number after reconfiguring the installed SELECT IO cards. This is only necessary to set the second digit of a SELECT IO card that is not automatically updated. Resetting the part number is allowed twice from Access Level 2. Changing the part number more than twice requires resetting the device to default settings.

Table 7.42 PART Command

Command	Description	Access Level
PAR	Display the current part number.	1
PAR ***2411xxxxxxxxxxx***	Set a new part number after reconfiguring installed SELECT IO cards.	2

PASSWORD Command (View/Change Passwords)

Use the **PAS** command to inspect or change existing passwords, as shown in *Table 7.43* and *Table 7.44*.

Table 7.43 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 7.44 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 7.45 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, turn off 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 2.13*) 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, turn off 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 do not 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 7.46*.

Table 7.46 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 7.47*.

Table 7.47 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 7.48*.

Table 7.48 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 7.49*.

Table 7.49 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).

RSTP Command

Use the **RSTP** command (see *Table 7.50*) to display the RSTP statistics and the present RSTP configuration when RSTP is enabled.

Table 7.50 RSTP Command

Command	Description	Access Level
RSTP	Displays the RSTP statistics and the present RSTP configuration.	1

Table 7.51 describes the information displayed in the output of the RSTP command.

Table 7.51 RSTP Command Definitions (Sheet 1 of 2)

Information Field	Description
ROOT BRIDGE	Reveals the role of the relay in the RSTP configuration. It will either display YES or NO.
BRIDGE ID	Displays the Bridge ID of the relay, which consists of the bridge priority (in decimal format) and the MAC address of the relay.
ROOT BRIDGE ID	Displays the Bridge ID of the root bridge, which consists of the bridge priority (in decimal format) and the MAC address of the root bridge.
ROOT PORT	Displays the port number (i.e., Port 1A or Port 1B) that is forwarding towards the root bridge when the relay is a designated bridge. If the relay is the root bridge, this displays NA.
TIME SINCE TOPOLOGY CHANGE	Displays the number of seconds since the last topology change occurred.
BRIDGE PRIORITY	Determines the root bridge. The bridge with the lowest value becomes the root bridge. It can be set under the Port 1 settings.
HELLO TIME	Interval in which the relay sends BPDUs. It is fixed at 2 seconds.
MAX AGE	Maximum number of hops before a BPDU is discarded. It is fixed at 40.
FORWARD DELAY	The time that the relay must spend in the listening and learning states before transitioning to forwarding. It is fixed at 21 seconds. This is only used when the relay is in STP compatibility mode.
PORT 1A PROTOCOL	Displays either STP or RSTP.
PORT 1B PROTOCOL	Displays either STP or RSTP.
PORT 1A STATE	The state of Port 1A.
PORT 1B STATE	The state of Port 1B.
PORT 1A ROLE	The role of Port 1A.
PORT 1B ROLE	The role of Port 1B.
PORT 1A PRIORITY	Determines which port the device selects as a root port when there is a tie between two ports. The port with the lower value will become the root port. It can be set under the Port 1 settings.
PORT 1B PRIORITY	Determines which port the device selects as a root port when there is a tie between two ports. The port with the lower value will become the root port. It can be set under the Port 1 settings.
PORT 1A PATH COST	Helps determine which path the device selects to a root bridge. The device selects paths with the lowest overall cost first. It is fixed at 200000.
PORT 1B PATH COST	Helps determine which path the device selects to a root bridge. The device selects paths with the lowest overall cost first. It is fixed at 200000.
PORT 1A EDGE PORT	If YES, Port 1A is an edge port. If NO, it is not.
PORT 1B EDGE PORT	If YES, Port 1B is an edge port. If NO, it is not.

Table 7.51 RSTP Command Definitions (Sheet 2 of 2)

Information Field	Description
PORT 1A BPDU COUNT	Displays the number of BPDUs received on Port 1A.
PORT 1B BPDU COUNT	Displays the number of BPDUs received on Port 1B.

Table 7.6 shows an example response to the **RSTP** command.

```
=>RSTP <Enter>

SEL-2411                                   Date: 08/26/2023   Time: 10:55:23.711
DEVICE                                     Time Source: External


RSTP Communication Statistics:

Root Bridge: NO
Bridge Id: 28672-0030A71BF353
Root Bridge Id: 20480-0030A71C931C
Root Port: 1B
Time Since Topology Change: 154111 sec
Bridge Priority: 28672;   Hello Time:  2 sec
Max Age: 40;   Forward Delay:  21 sec

PORT PROTOCOL  STATE       ROLE    PRIORITY  PATHCOST EDGE #BPDU-RCVD
 1A   RSTP   Discarding   Disabled    128    200000   False    553073
 1B   RSTP   Forwarding   Rootport    128    200000   False     77077

=>
```

Figure 7.6 RSTP Command Response

SER Command (Sequential Events Recorder Report)

Use the **SER** commands to view and manage the Sequential Events Recorder report, as shown in *Table 7.52* and *Table 7.53*.

Table 7.52 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 (as many as 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 7.53*).	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 Data Available
```

Table 7.53 SER Command Format (Sheet 1 of 2)

Parameter	Description
row1	Append *row1* to return a chronological progression of the first *row1* rows. For example, use **SER 5** to return the first five rows.
row1 row2	Append *row1* and *row2* to return all rows between *row1* and *row2*, beginning with *row1* and ending with *row2*. 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 7.53 SER Command Format (Sheet 2 of 2)

Parameter	Description
date1	Append *date1* to return all rows with this date. For example, use **SER 1/1/2005** to return all records for January 1, 2005.
date1 date2	Append *date1* and *date2* to return all rows between *date1* and *date2*, beginning with *date2* and ending with *date1* (i.e., the newest records are listed first). 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 7.54*. 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 7.54 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 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 7.55*.

Table 7.55 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 7.56*.

Table 7.56 SHOW 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 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 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 7.57*.

Table 7.57 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 7.58*.

Table 7.58 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 or **C**	Restarts 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 7.59*.

Table 7.59 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 7.60*.

Table 7.60 TARGET Command Definitions

Command	Description	Access Level
TAR	Use TARGET without parameters to display Device Word row 0.	1
TAR *n k*	Show Device Word row number *n* (0–136) 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 ... ROW	Adding ROW to the command displays the Device Word Row number at the start of each line.	1
TAR R	Reset front-panel trip/target LEDs.	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 7.61*. 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 7.61 TIME 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 7.62*.

Table 7.62 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.

Simple Network Time Protocol (SNTP)

When ESNTP is enabled (Port 1 setting ESNTP is not OFF), the relay internal clock conditionally synchronizes to the time of day served by a Network Time Protocol (NTP) server. The relay uses a simplified version of NTP called the Simple Network Time Protocol (SNTP). SNTP is not as accurate as IRIG-B. The relay can use SNTP as a less accurate primary time source, or as a backup to the higher accuracy IRIG-B time source.

SNTP as Primary or Backup Time Source

If an IRIG-B time source is connected and Device Word bit IRIGOK asserts, then the relay synchronizes the internal time-of-day clock to the incoming IRIG-B time code signal, even if SNTP is configured in the relay and an NTP server is available. If the IRIG-B source is disconnected (TIRIG deasserted) then the relay synchronizes the internal time-of-day clock to the NTP server if available. In this way, an NTP server acts as either the primary time source or as a backup time source to the more accurate IRIG-B time source.

Creating an NTP Server

Three SEL application notes available from the SEL website describe how to create an NTP server.

- AN2009-10: Using an SEL-2401, SEL-2404, or SEL-2407 to Serve NTP Via the SEL-3530 RTAC
- AN2009-38: Using SEL Satellite-Synchronized Clocks With the SEL-3332 or SEL-3354 to Output NTP
- AN2010-03: Using an SEL-2401, SEL-2404, or SEL-2407 to Create a Stratum 1 Linux NTP Server

Configuring SNTP Client in the Relay

To enable SNTP in the relay, make Port 1 setting ESNTP = UNICAST, MANYCAST, or BROADCAST. *Table 7.63* shows each setting associated with SNTP.

Table 7.63 Settings Associated With SNTP

Setting	Prompt	Range	Default	Description
ESNTP	SNTP Enable (OFF, UNICAST, MANYCAST, BROADCAST)	UNICAST, MANYCAST, BROADCAST	OFF	Selects the mode of operation of SNTP. See descriptions in *SNTP Operation Modes*.
SNTPRAT[a]	SNTP Request Update Rate (15–3600 s)	15–3600 s	60	Determines the rate at which the relay asks for updated time from the NTP server when ESNTP = UNICAST or MANYCAST. Determines the time the relay will wait for an NTP broadcast when ESNTP = BROADCAST.
SNTPTO	SNTP Timeout (5–20 s)	5–20 s	5	Determines the time the relay will wait for the NTP master to respond when ESNTP = UNICAST or MANYCAST.
SNTPPSIP	SNTP Primary Server IP Address (w.x.y.z)[b]	Valid IP Address	192.168.1.110	Selects primary NTP server when ESNTP = UNICAST, or broadcast address when ESNTP = MANYCAST or BROADCAST.
SNTPBSIP	SNTP Backup Server IP Address (w.x.y.z)[c]	Valid IP Address	192.168.1.111	Selects backup NTP server when ESNTP = UNICAST.
SNTPPOR[d]	SNTP IP Local Port Number (1–65534)	1–65534	123	Ethernet port used by SNTP. Leave at default value unless otherwise required.

[a] This setting is: hidden if ESNTP = OFF; hidden and forced to 5 if ESNTP = BROADCAST.
[b] Where: w: 0–126, 128–239, x: 0–255, y: 0–255, z: 0–255.
[c] Where: w: 0–126, 128–223, x: 0–255, y: 0–255, z: 0–255.
[d] This setting is hidden if ESNTP ≠ UNICAST.

SNTP Operation Modes

The following sections explain the setting associated with each SNTP operation mode (UNICAST, MANYCAST, and BROADCAST).

ESNTP = UNICAST

In unicast mode of operation, the SNTP client in the relay requests time updates from the primary (IP address setting SNTPPSIP) or backup (IP address setting SNTPBSIP) NTP server at a rate defined by setting SNTPRAT. If the NTP server does not respond with the period defined by the sum of setting SNTPTO and SNTPRAT, then the relay tries the other SNTP server. When the relay successfully synchronizes to the primary NTP time server, Device Word bit TSNTPP asserts. When the relay successfully synchronizes to the backup NTP time server, Device Word bit TSNTPB asserts.

ESNTP = MANYCAST

In manycast mode of operation, the relay initially sends an NTP request to the broadcast address contained in setting SNTPPSIP. The relay continues to broadcast requests at a rate defined by setting SNTPRAT. When a server replies, the relay considers that server to be the primary NTP server, switches to UNICAST mode, asserts Device Word bit TSNTPP, and thereafter requests updates from the primary server. If the NTP server stops responding for time SNTPTO, the relay deasserts TSNTPP and begins to request time from the broadcast address again until a server responds.

ESNTP = BROADCAST

Setting SNTPPSIP = 0.0.0.0 while ESNTP = BROADCAST, the relay will listen for and synchronize to any broadcasting NTP server. If setting SNTPPSIP is set to a specific IP address while setting ESNTP = BROADCAST, then the relay will listen for and synchronize to only NTP server broadcasts from that address. When synchronized, the relay asserts Device Word bit TSNTPP. Device Word bit TNSTPP deasserts if the relay does not receive a valid broadcast within the SNTPT0 setting value after the period defined by setting SNTPRAT.

SNTP Accuracy Considerations

SNTP time synchronization accuracy is limited by the accuracy of the SNTP Server and by the networking environment. The highest degree of SNTP time synchronization can be achieved by minimizing the number of switches and routers between the SNTP Server and the relay.

When installed on a network with low burden configured with one Ethernet switch between the relay and the SNTP Server, and when using ESNTP = UNICAST or MANYCAST, the relay time-synchronization error to the SNTP server is typically less than ±5 milliseconds.

Precision Time Protocol (PTP)

Configuring PTP in the Relay

PTP implementation in the SEL-2411 is firmware-based only. If the EPTP setting is available and set to Y, then the SEL-2411 supports PTP Version 2 (PTPv2) as a slave-only clock as defined by IEEE 1588-2008 on Ports 1A and 1B. *Table 7.64* shows the settings associated with PTP.

Table 7.64 Settings Associated With PTP

Setting Prompt	Setting Range	Setting Name := Factory Default	Description
ENABLE PTP	Y, N	EPTP := N	When set to Y, the device becomes a slave PTP clock
PTP PROFILE	DEFAULT, C37.238	PTPPRO := DEFAULT	Sets the PTP profile
PTP TRANSPORT MECHANISM	UDP, LAYER2	PTPTR := UDP	Transport mechanism for PTP messages
PTP DOMAIN NUMBER	0–255	DOMNUM := 0	PTP domain number of the clock
PTP PATH DELAY MECHANISM	P2P, E2E, OFF	PTHDLY := E2E	Path delay measurement method to be used on the PTP network
PEER DELAY REQUEST INTERVAL	1, 2, 4, 8, 16, 32, 64 sec	PDINT := 1	Duration of time between transmissions of peer delay request messages
PTP NUMBER OF ACCEPTABLE MASTERS	1–5, OFF	AMNUM := OFF	Number of acceptable PTP masters
PTP ACCEPTABLE MASTER *n*[a] IP	*zzz.yyy.xxx.www*	AMIP*n* := 192.168.1.12*n*	Acceptable master IP addresses
PTP ACCEPTABLE MASTER *n*[a] MAC	*xx:xx:xx:xx:xx:xx*	AMMAC*n* := 00-30-A7-00-00-0*m*[b]	Acceptable master MAC addresses
PTP ALTERNATE PRIORITY1 FOR MASTER *n*[a]	0–255	ALTPRI*n* := 0	If the acceptable master table option is enabled and this setting value is not zero, the Priority 1 value received in the Announce message from the specified master will be replaced by this value and used in the Best Master Clock Algorithm (BCMA)
PTP VLAN IDENTIFIER	1–4094	PVLAN := 1	VLAN ID for a C37.238 Ethernet frame
PTP VLAN PRIORITY	0–7	PVLANPR := 4	VLAN priority for a C37.238 Ethernet frame

[a] n = 1–5.
[b] m = A–E.

To achieve the best accuracy (<1 ms), it is necessary to have one or more PTP master clocks and that all intervening equipment (e.g., Ethernet switches) be IEEE 1588-aware (i.e., all intervening network devices need to be transparent or boundary clocks).

In PTP, a clock that provides time to other devices, typically based on GPS input, is a master clock. The intervening switches are transparent clocks. You can connect networks together and pass time from one network to another using boundary clocks. Transparent and boundary clocks are important because they provide time correction in the PTP messages that pass through them, whereas devices that are not IEEE 1588-aware do not provide this correction. Because it is possible for a network to have multiple master clocks, PTP clocks implement algorithms to select the best available clock. The one selected for use by an end device is the grandmaster clock. You can learn more about configuring a PTP network in these application guides:

- "Using the SEL-2488 to Provide IEEE 1588 Version 2 Grandmaster Functionality in a Redundant Network Topology" (AN2015-07)
- "Using the SEL-2488 to Provide IEEE 1588 Version 2 Grandmaster Functionality to Isolated Ethernet Networks" (AN2015-06)

To configure PTP, update the Port 1 PTP settings as described in *Table 7.64*. By default, PTP is disabled in the SEL-2411. Set EPTP to Y to enable PTP and to make the other PTP settings available.

PTP implementation in the SEL-2411 supports both one-step and two-step clocks. A one-step clock provides time information using a single event message. A two-step clock provides time information using the combination of an event message and a subsequent general message.

Within PTP, there are multiple clock profiles available. A profile defines the set of PTP features available in a specific application domain. SEL-2411 devices support two profiles: Default and Power (C37.238-2011).

The Default profile has many optional features and is intended to address common applications. The Default profile supports both UDP or Layer 2 (802.3) Ethernet transport, and can use either the end-to-end (E2E) or the peer-to-peer (P2P) delay mechanism. Grandmaster clocks can send Announce, Sync, and Delay request messages over a wide range of intervals. A Default profile network can consist of boundary clocks or transparent clocks anywhere between the grandmaster and the end devices. The only performance requirement for the Default profile is that a master clock must maintain frequency accuracy to within 0.01 percent.

The Power profile has minimal optional features to facilitate interoperability and performance predictability. The Power profile is only supported on Layer 2 networks and exclusively uses the peer-to-peer delay mechanism. All messages must be sent at 1-second intervals, have 802.1Q VLAN tags, and include grandmaster ID and (maximum) inaccuracy fields in the Announce message. Transparent clocks are mandatory in a Power profile network and boundary clocks are not allowed. Select the profile by using the PTPPRO setting.

PTP defines a logical grouping of clocks in a network as a clock domain. This allows a logical separation between clocks that participate in different application domains to coexist on the same network. Domains are identified by domain numbers. The domain number for the SEL-2411 is selected using the DOMNUM setting. Set DOMNUM to match the domain number configured in the master clocks to which the SEL-2411 should synchronize.

The SEL-2411 supports transport of PTP messages over UDP or Layer 2 (Ethernet). Use the PTPTR setting to select the PTP transport mechanism. This needs to match the transport mechanism used in the master clocks. Only Layer 2 is available with the Power profile. If operating in a UDP network, PTP operates on Ports 319 or 320. Except for peer delay messages, the SEL-2411 sets the time allowed to live (TTL) value in the UDP/IP header of PTP messages to 64. This allows you to use routers across a WAN to synchronize the SEL-2411 PTP master. High-accuracy synchronization may not be achievable across the WAN, so it is left to you to determine if the accuracy meets the needs of your application.

When using the Power profile, use the VLAN identifier and priority settings, PVLAN and PVLANPR, to set the VLAN ID and priority, respectively, of the Ethernet frames. Be sure to set PVLAN unique from other VLANs used within the SEL-2411.

PTP defines two methods for calculating and correcting the communications path delay between the SEL-2411 and the master clock: end-to-end (Delay Request Response) and peer-to-peer (Peer Delay Request Response). The end-to-end mechanism calculates the total path delay between the SEL-2411 and the master clock.

The peer-to-peer mechanism calculates the total path delay in a piecemeal fashion between each device in the path. Peer-to-peer is the more accurate method and is recommended for use with the SEL-2411. Only the peer-to-peer mechanism is available for the Power profile. The SEL-2411 periodically initiates path delay calculations. Use the PTHDLY and PDINT settings to configure the path delay method and the path delay request rate. If PTHDLY is set to OFF, then the SEL-2411 will not calculate and correct for path delay.

By default, the SEL-2411 synchronizes to any clock on the network that it evaluates to be the best clock based on the BMCA. Use the settings to specify a list of master (grandmaster or boundary) clocks to which the SEL-2411 may synchronize. The SEL-2411 will not synchronize to any master clock that is not in the list. It is recommended to use this feature for additional security. The AMNUM setting selects the number of master clocks you list. The default value is OFF, which means the SEL-2411 synchronizes to any master clock on the network. If AMNUM is set to a value other than OFF, the number of allowable masters must be identified in accordance with the PTP transport chosen, i.e., MAC address for 802.3 or IP address for UDP transport.

If the PTP transport (PTPTR) is set to UDP, use the AMIP*n* settings to specify the IP addresses of the clocks to which the SEL-2411 is permitted to synchronize. If PTP transport is set to Layer 2, use the AMMAC*n* settings to specify the MAC addresses of the clocks to which the SEL-2411 is permitted to synchronize.

If the ALTPRI*n* (Alternate Priority1 for Master *n*) setting value is positive, the ALTPRI*n* value replaces the Priority1 value in the received Announce message before the SEL-2411 applies the BMCA. The ALTPRI*n* values reprioritize the master clocks locally.

Rapid Spanning Tree Protocol (RSTP)

RSTP is a protocol and is a distributed algorithm that is defined in the IEEE 802.1Q-2014 standard. Devices communicate RSTP through packets called Bridge Protocol Data Units (BPDUs) that travel between adjacent RSTP-enabled devices. These frames allow the devices to determine the root bridge in the network, as well as defines the state and role of each port of devices connected in the RSTP network.

Table 7.65 and *Table 7.66* list the various roles and states supported by the SEL-2411. Use the **RSTP** command to view the assigned state and role of a port. The device keeps a log of the states and roles in the Sequential Events Recorder (SER) report.

Table 7.65 RSTP Roles Supported in the SEL-2411

Roles	Definition
Root Port	A port with the shortest path[a] to the root bridge. All STP and RSTP capable bridges must have exactly one except the root bridge, which cannot have any.
Designated Port	The port that connects a LAN to its designated bridge.
Alternate Port	Represents the best alternative path to the root bridge. This path is different than using the root port. The alternative port moves to the forwarding state if there is a failure on the designated port for the segment.
Backup Port	Represents a redundant path to a segment where another port on the bridge already connects.
Disabled	The port is disabled during the role initialization or it is disabled due to a link or hardware failure.

[a] This is not always the shortest path. The settings in the network define the path costs, so the root port is the one with the smallest path costs to the root switch. There may be a physically shorter path, but because of the path costs of the other devices, a longer path to the root may be used.

NOTE: Exercise caution when disabling RSTP (ERSTP := N) in a relay connected in a switched network because doing so could introduce network loops.

Table 7.66 RSTP States Supported in the SEL-2411

Forwarding	Definition
Learning	A port receiving and transmitting message frames and BPDUs.
Discarding	A port receiving and transmitting BPDUs; this port does not receive or transmit message frames.
Forwarding	A port receiving BPDUs; this port does not receive or transmit message frames.

There are three RSTP settings available to set on Port 1 after RSTP is enabled. They include the bridge priority (BRDGPRI), which is used to help determine the root bridge in the network, and the port priorities (PORTAPRI and PORTBPRI) for Ports 1A and 1B, which are used to help determine the root port of the device. See *Table 7.20* for more information regarding these settings.

Example of a Simple Topology

The simplest example of a loop is a network of devices connected in a ring (*Figure 7.7*). Devices connected in a ring topology allow traffic to go from one port on one device to another port on another device in either direction around the ring, as the two green lines show in *Figure 7.7* between Devices 1 and 6.

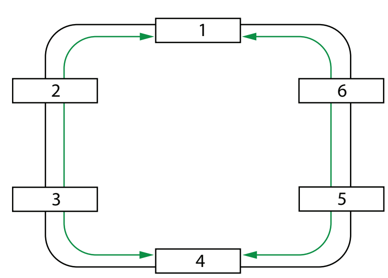

Figure 7.7 Physical Ring Without Loop Mitigation

Disabling the link between Devices 3 and 4 forces traffic to follow a single path across the network (as the green line in *Figure 7.8* shows). The process of disabling links to logically remove loops from the network is called convergence because the devices use RSTP to converge the network into a stable configuration without any loops.

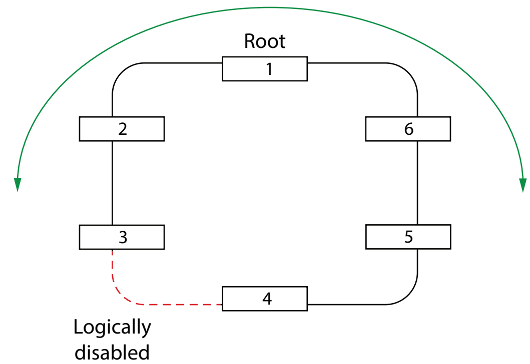

Figure 7.8 Network Convergence With Logically Disabled Link

The logically disabled connections remain physically present and can be quickly enabled by RSTP to provide an alternative path for the network traffic in the event of a physical network failure. For example, if the link between Devices 2 and 3 were to fail, traffic would be disrupted on the network, as indicated by the dashed green line in *Figure 7.9*. Devices 2 and 3 would respond by using RSTP and BPDUs to inform the other devices in the network that an event occurred. The rapid spanning tree algorithm (RSTA) in each network device would then use BPDUs over RSTP to communicate with their respective connected devices, in turn, and eventually the logically disabled link between Devices 3 and 4 would be re-enabled, as shown in *Figure 7.10*.

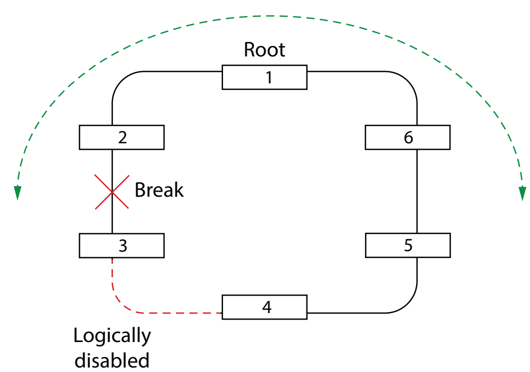

Figure 7.9 Physical Link Failure Between Devices

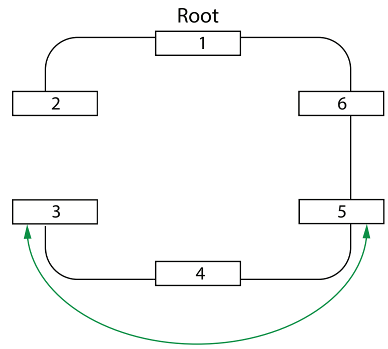

Figure 7.10 Network Convergence

As the green line in *Figure 7.10* shows, traffic can still flow between Devices 3 and 5 but now it is through a different path. The process of re-enabling disabled links to allow traffic to flow and heal the network is called reconvergence. *Figure 7.3* shows a typical network diagram using SEL-2411 in a switched network with ERSTP := Y. During this change in the network, traffic is temporarily disrupted. Refer to SEL application guide “Understanding RSTP and Choosing the Best Network Topology” (AG2017-21) at selinc.com for additional information on RSTP.

RSTP Performance Measurement

Figure 7.11 shows a convergence example involving a ring network where both SEL-2730M switches and all seven SEL devices are configured with default RSTP settings. In this example, there is a transmitting device connected to the North SEL-2730M switch and a receiving device connected to the South SEL-2730M switch.

As a result of the devices being configured with default RSTP settings, the network converges to break the loop at Relay 14. This configuration results in the port for Relay 14 to be in discarding state (indicated by “D”). In this state, traffic flows from the North SEL-2730M switch to the South SEL-2730M switch by passing through Link L1.

For this example, consider a link-down event occurring at Link L1. A linkdown event is when the cable that connects two devices is physically broken (indicated by the slash). After this link-down event, the network takes approximately 150 ms to reconverge such that the discarding port on Relay 14 transitions into a forwarding state. This allows traffic to flow from the North SEL-2730M switch to the South SEL-2730M switch by passing through all seven relays.

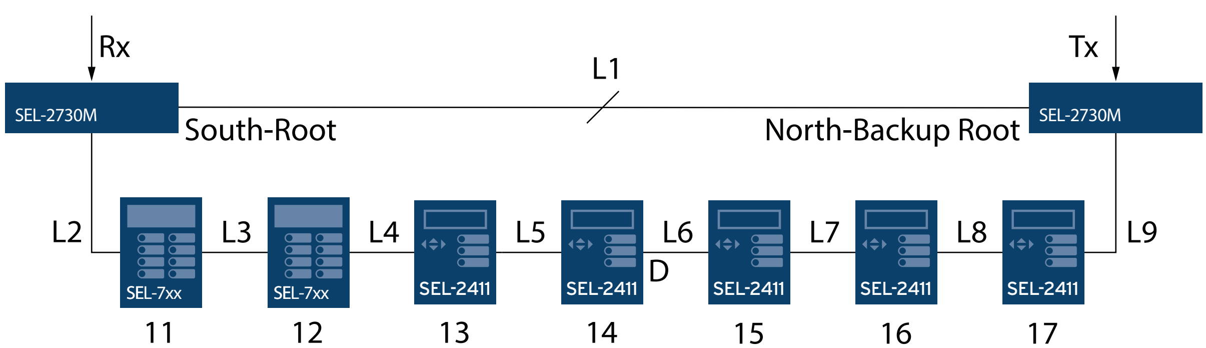

Figure 7.11 Link-Down Event at Link L1

If additional relays are added to this example network, then the reconvergence time will increase by approximately 20 ms per additional relay.

SEL-700 series and SEL-2411 devices are configured with a Max Age value of 40. This means that a network with SEL-700 series and SEL-2411 RSTP devices should be created with the understanding that the maximum number of hops from the root in the network should not exceed 40.

To understand the importance of enabling RSTP in an SEL-700 series relay ring network in comparison to leaving it disabled, refer to the SEL application guide “Maintaining Switched-Mode Relay Responsiveness in an RSTP Network” (AG2019-15).

Network Connection Using PRP Connection Mode

PRP is part of an IEC standard for high-availability automation networks (IEC 62439-3). The purpose of the protocol is to provide seamless recovery from any single Ethernet network failure. The basic concept is that the Ethernet network and all network traffic are fully duplicated with the two copies operating in parallel.

Make the following settings in Port 1 to configure the PAC for PRP mode.

- ➤ NETMODE := PRP
- ➤ PRPTOUT := desired timeout for PRP frame entry
- ➤ PRPADDR := PRP destination MAC address LSB 01-15-4E-00-01-XX
- ➤ PRPINTV := desired supervision frame transmit interval

Virtual File Interface

You can retrieve and send data as files through the device virtual file interface. Devices with embedded computers can also use the virtual file interface. When using serial ports of virtual terminal links, use the **FILE DIR** command to access the file interface.

Send and receive files using the following three protocols:

Protocol	Port Availability
FTP	Ethernet only
MMS	Ethernet only
Ymodem	Serial and Ethernet

FTP and MMS File Structure

The Ethernet FTP and the IEC 61850 MMS have a two-level file structure. Files are available at the root level and in subdirectories. *Table 7.67* shows the directories and their contents.

Table 7.67 FTP and MMS Virtual File Structure

Directory	Contents
/ (Root)	Files: CFG.TXT, CFG.XML, ERR.TXT, and SET_61850.CID, Directories: SETTINGS, REPORTS, and UPGRADE
/SETTINGS[a]	Device settings
/REPORTS	SER and signal profile reports
/EVENTS	CEV, COMTRADE, and HIS reports
/COMTRADE[b]	COMTRADE events
/HMI[c]	Touchscreen settings (SET_HMI.zds and CDP.zds) and diagnostics (HMI_ALL.zip)
/UPGRADE	Firmware and SELBOOT upgrade files

[a] Only available in the FTP file structure.
[b] The COMTRADE directory is only available in the MMS file structure.
[c] Available only in the SEL-2411 with touchscreen display.

Root Directory

CFG.TXT File (Read-Only). The CFG.TXT file contains general configuration information about the device and each settings class. External support software retrieves the CFG.TXT file to interact automatically with the device.

```
[INFO]
RELAYTYPE=SEL-2411
FID=SEL-2411-R401-V0-Z012008-D20230317
BFID=SLBT24XX-R600-V0-Z000000-D20210430
PARTNO=241121A1A6X74811640
[FRONTPANEL]
BDP=2.0.52411.60
[CLASSES]
ACV,"Analog Control Variables"
PF,"Port F Settings"
P2,"Port 2 Settings"
P3,"Port 3 Settings"
P1,"Port 1 Settings"
G,"Global Settings"
1,"Device Settings"
L,"Logic Settings"
R,"Report Settings"
F,"Front Panel Settings"
D1,"DNP Map 1 Settings"
D2,"DNP Map 2 Settings"
D3,"DNP Map 3 Settings"
```

CFG.XML (Read-Only), ERR.TXT (Read-Only) and SET_61850.CID Files.

These files are only present if the device is ordered with the IEC 61850 protocol option. The CFG.XML file describes the IED configuration such as firmware identification, settings class names, and Ethernet port information. The SET_61850.CID file contains the encrypted IEC 61850 configured IED description. ACSELERATOR Architect® SEL-5032 Software generates and then sends this file to the device. See *Appendix F: IEC 61850 Communications* for more information. The ERR.TXT file contents are based on the most recent SET_61850.CID file written to the device. If there are no errors on writing the CID file, the ERR.TXT file is empty.

Settings Directory (Available for FTP and MMS)

You can access the device settings through files in the SETTINGS directory.

Table 7.68 Settings Directory Files

File Name	Settings Description
SET_1.TXT	Device settings
SET_ACV.TXT	Analog control variables
SET_D*n*.TXT	DNP3 Map; *n* in range 1–3
SET_F.TXT	Front panel
SET_G.TXT	Global
SET_L.TXT	Logic
SET_P*n*.TXT	Port; *n* in range 1, 2, 3, 4, F
SET_R.TXT	Report
SET_ALL.TXT	All instances of all settings classes
ERR.TXT	Error log for most recently written settings file

SET_ALL.TXT File (Read-Only). The SET_ALL.TXT file contains the settings for all of the settings classes in the device. Calibration settings are included only when the file is read at Access Level C.

SET_1.TXT File (Read and Write). This is the file for the device setting class.

ERR.TXT (Read-Only). The ERR.TXT file contents are based on the most recent SET_*cn*.TXT file written to the device. If there were no errors, the file is empty. If the errors occurred, the device logs these errors in the ERR.TXT file.

The device only allows you to write to the individual SET_*cn* files, where *c* is the settings class code and *n* is the settings instance. Except for the SET_61850 CID file, changing settings with external support software involves the following steps:

Step 1. Read the CFG.TXT and the SET_ALL.TXT files from the device.

Step 2. Modify the settings for each settings class and send the corresponding SET_*cn*.TXT file to the device.

Step 3. Read the ERR.TXT file from the device. If the ERR.TXT file is empty, the device detected no errors in the SET_*cn*.TXT file and it is accepted.

Step 4. For any detected errors, fix the SET_*cn*.TXT file as indicated by the ERR.TXT file and send the SET_*cn*.TXT file to the device.

Step 5. Repeat *Step 2* to *Step 4* for each setting class that you want to modify.

Step 6. After all setting changes are complete, test and commission the device.

Reports Directory (Read-Only) (Available for FTP and MMS)

Use the REPORTS directory to retrieve files that contain the reports shown in *Table 7.69*. Note that the device provides a report file that contains the latest information each time you request the file. Each time you request a report, the device stores its corresponding command response in the designated text file.

Table 7.69 Reports Directory Files

File Name	Description	Equivalent Command Response
CPRO.TXT	Compressed ASCII Analog Signal Profile Report	CPRO
PRO.TXT	ASCII Analog Signal Profile Report	PRO
CSER.TXT	Compressed Sequence of Events	CSER
SER.TXT	Sequence of Events	SER

Events Directory (Read-Only) (Available for FTP and MMS)

The device provides history, event reports, and oscillography files in the EVENTS directory as shown in *Table 7.70*.

Event reports are available in the following formats:

- ➤ SEL Compressed ASCII
- ➤ Binary COMTRADE format (IEEE C37.111-1999)

The size of each event report file is determined by the LER setting in effect at the time the event is triggered.

Compressed SEL ASCII event report files are generated, when requested, by storing the appropriate command response shown in *Table 7.70*.

Oscillography files are generated at the time the event is triggered (see *Event Reporting on page 9.2*). Higher resolution oscillography is available with SEL Compressed ASCII 32-sample/cycle raw event reports and binary COMTRADE files.

COMTRADE event files are available to read as a batch. See *Batch File Access on page 7.53*.

Table 7.70 Event Directory Files

File Name	Description	Equivalent Command Response
CHISTORY.TXT[a]	Compressed ASCII History Report	**CHI**
HISTORY. TXT[a]	History Report	**HIS**
C4_*nnnnn*.CEV	Compressed 4-samples/cycle ASCII filtered event report; event ID number = *nnnnn*	**CEV *nnnnn***
CR_*nnnnn*.CEV	Compressed 16-samples/cycle ASCII raw event report; event ID number = *nnnnn*	**CEV R *nnnnn***
HR_*nnnnn*.CFG[b]	COMTRADE configuration file; event ID number = *nnnnn*	N/A
HR_*nnnnn*.DAT[b]	COMTRADE binary data file; event ID number = *nnnnn*	N/A
HR_*nnnnn*.HDR[b]	COMTRADE header file; event ID number = *nnnnn*	N/A

[a] Also available in the Reports directory for convenience.
[b] Also available in the COMTRADE directory for MMS only.

HR_nnnnn.* (Read-Only)

The three files HR_*nnnnn*.CFG, HR_*nnnnn*.DAT, and HR_*nnnnn*.HDR shown in *Table 7.70* are used to create an event report that conforms to the COMTRADE standard. The event is an unfiltered (raw) 16-samples/cycle event. The field, *nnnnn*, corresponds to the unique event identification number displayed by the **HIS** command. For details on event reports see *Section 9: Analyzing Events*.

COMTRADE Directory (Available Only for MMS)

When using MMS file transfer, conveniently retrieve all of the COMTRADE files from the COMTRADE directory. Note that the COMTRADE files are also available in the EVENTS directory. Refer to *Table 7.70* for all the files available in the COMTRADE directory.

HMI Directory (Read and Write)

Use the HMI directory to retrieve the diagnostic information and the setting files that apply to the touchscreen. Refer to *Table 7.67* for all the files available in the HMI directory. The HMI_ALL.zip file is not available for MMS file transfers.

Ymodem File Structure

All the files available (see *Table 7.71*) for Ymodem protocol are in the root directory. See *FILE Command (Manage Settings Files) on page 7.25* for a response to the **FIL DIR** command.

Table 7.71 Files Available for Ymodem Protocol (Sheet 1 of 2)

File Name	Description	Read Access Level	Write Access Level
CFG.TXT	See *Root Directory on page 7.49*	1, 2, C	N/A
ERR.TXT	See *Settings Directory (Available for FTP and MMS) on page 7.50*	1, 2, C	N/A
SET_ALL.TXT[a]	See *Settings Directory (Available for FTP and MMS) on page 7.50*	1, 2, C	N/A
SET_1.TXT	See *Settings Directory (Available for FTP and MMS) on page 7.50*	1, 2, C	2, C
SET_C.TXT[a]	See *Settings Directory (Available for FTP and MMS) on page 7.50*	C	C
SET_D*n*.TXT	See *Settings Directory (Available for FTP and MMS) on page 7.50*	1, 2, C	2, C
SET_F.TXT	See *Settings Directory (Available for FTP and MMS) on page 7.50*	1, 2, C	2, C
SET_G.TXT	See *Settings Directory (Available for FTP and MMS) on page 7.50*	1, 2, C	2, C
SET_L.TXT	See *Settings Directory (Available for FTP and MMS) on page 7.50*	1, 2, C	2, C
SET_P*n*.TXT	See *Settings Directory (Available for FTP and MMS) on page 7.50*	1, 2, C	2, C
SET_R.TXT	See *Settings Directory (Available for FTP and MMS) on page 7.50*	1, 2, C	2, C
C4_*nnnnn*.CEV	See *Events Directory (Read-Only) (Available for FTP and MMS) on page 7.51*	1, 2, C	N/A
CR_*nnnnn*.CEV	See *Events Directory (Read-Only) (Available for FTP and MMS) on page 7.51*	1, 2, C	N/A
HR_*nnnnn*.CFG	See *Events Directory (Read-Only) (Available for FTP and MMS) on page 7.51*	1, 2, C	N/A
HR_*nnnnn*.DAT	See *Events Directory (Read-Only) (Available for FTP and MMS) on page 7.51*	1, 2, C	N/A
HR_*nnnnn*.HDR	See *Events Directory (Read-Only) (Available for FTP and MMS) on page 7.51*	1, 2, C	N/A
CHISTORY.TXT	See *Events Directory (Read-Only) (Available for FTP and MMS) on page 7.51*	1, 2, C	N/A
HISTORY.TXT	See *Events Directory (Read-Only) (Available for FTP and MMS) on page 7.51*	1, 2, C	N/A
CSER.TXT	See *Events Directory (Read-Only) (Available for FTP and MMS) on page 7.51*	1, 2, C	N/A
SER.TXT	See *Events Directory (Read-Only) (Available for FTP and MMS) on page 7.51*	1, 2, C	N/A
CPRO.TXT	See *Events Directory (Read-Only) (Available for FTP and MMS) on page 7.51*	1, 2, C	N/A
PRO.TXT	See *Events Directory (Read-Only) (Available for FTP and MMS) on page 7.51*	1, 2, C	N/A
SET_HMI.zds	See *HMI Directory (Read and Write) on page 7.52*	1, 2, C	2, C

Table 7.71 Files Available for Ymodem Protocol (Sheet 2 of 2)

File Name	Description	Read Access Level	Write Access Level
CDP.zds	See *HMI Directory (Read and Write) on page 7.52*	1, 2, C	2, C
HMI_ALL.zip	See *HMI Directory (Read and Write) on page 7.52*	1, 2, C	N/A

[a] Calibration settings are included only when accessed at Access Level C.

UPGRADE Directory (Read and Write) (Available Only for FTP)

Use the UPGRADE directory to write firmware and SELBOOT upgrade files over FTP and read upgrade error information. See *Table 7.72* for all the files available in the UPGRADE directory. See *Appendix B: Firmware Upgrade Instructions* for firmware upgrade over FTP information.

Table 7.72 Upgrade Directory Files

File Name	Description
RELAY.ZDS	Signed firmware upgrade file
SLBT.ZDS	Signed SELBOOT upgrade file
ERR.TXT	Error log for firmware upgrades

Batch File Access

Files can be accessed as a batch by using the supported wild card character, *.

FTP and MMS Wild Card Usage

Table 7.73 shows examples using supported wild cards. Note that these wild cards may be appended to a directory path (e.g., /specified_directory/*.txt).

Table 7.73 FTP and MMS Wildcard Usage Examples

Usage	Description	Example	Note
*xyz	Lists all files and/or subdirectories in a specified directory whose name (including extension) ends with xyz.	/*.TXT	List all files with the .TXT extension
abc*	Lists all files and/or subdirectories in a specified directory whose name begins with abc.	/SETTINGS/SET*	List all settings files that start with SET.
mno	Lists all files and/or subdirectories in a specified directory whose name contains mno.	/SETTINGS/*ET_*	List all files that have ET_ in the name.

Ymodem Wild Card Usage

Event, report, and diagnostic files can also be accessed as a batch using wild cards.

Table 7.74 Ymodem Wildcard Usage Examples

Usage	Description	Example	Note
*xyz	Lists all files that end with xyz.	FILE DIR*.TXT	Lists all of the text files
abc*	Lists all files whose name begins with abc.	FILE READ SET	Retrieves all of the settings files

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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.

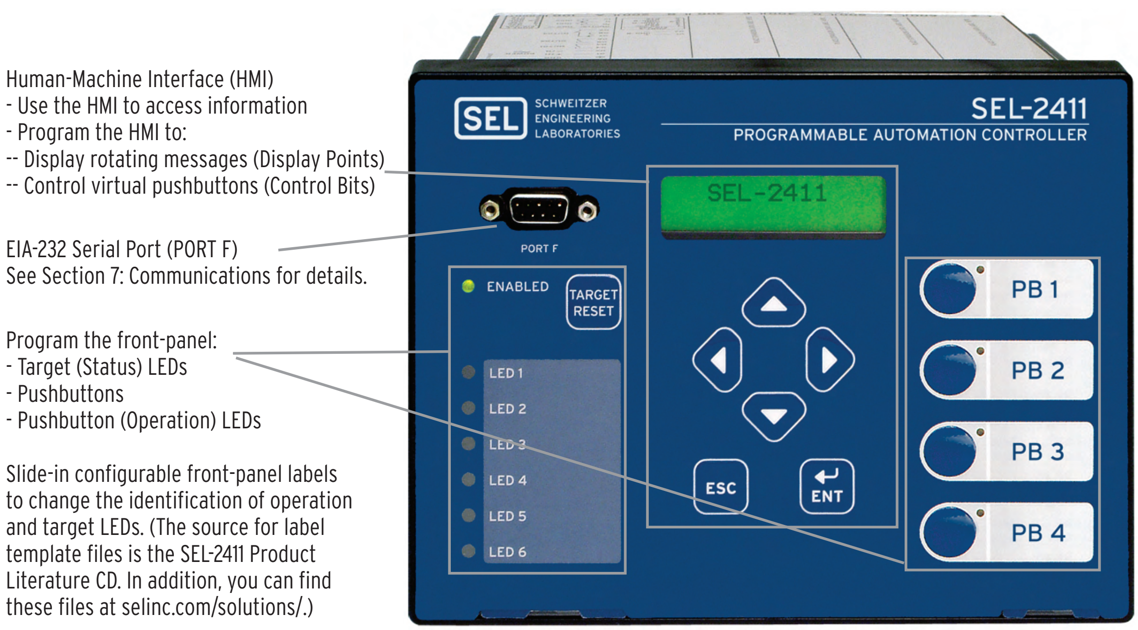


Figure 8.1 Front-Panel Overview

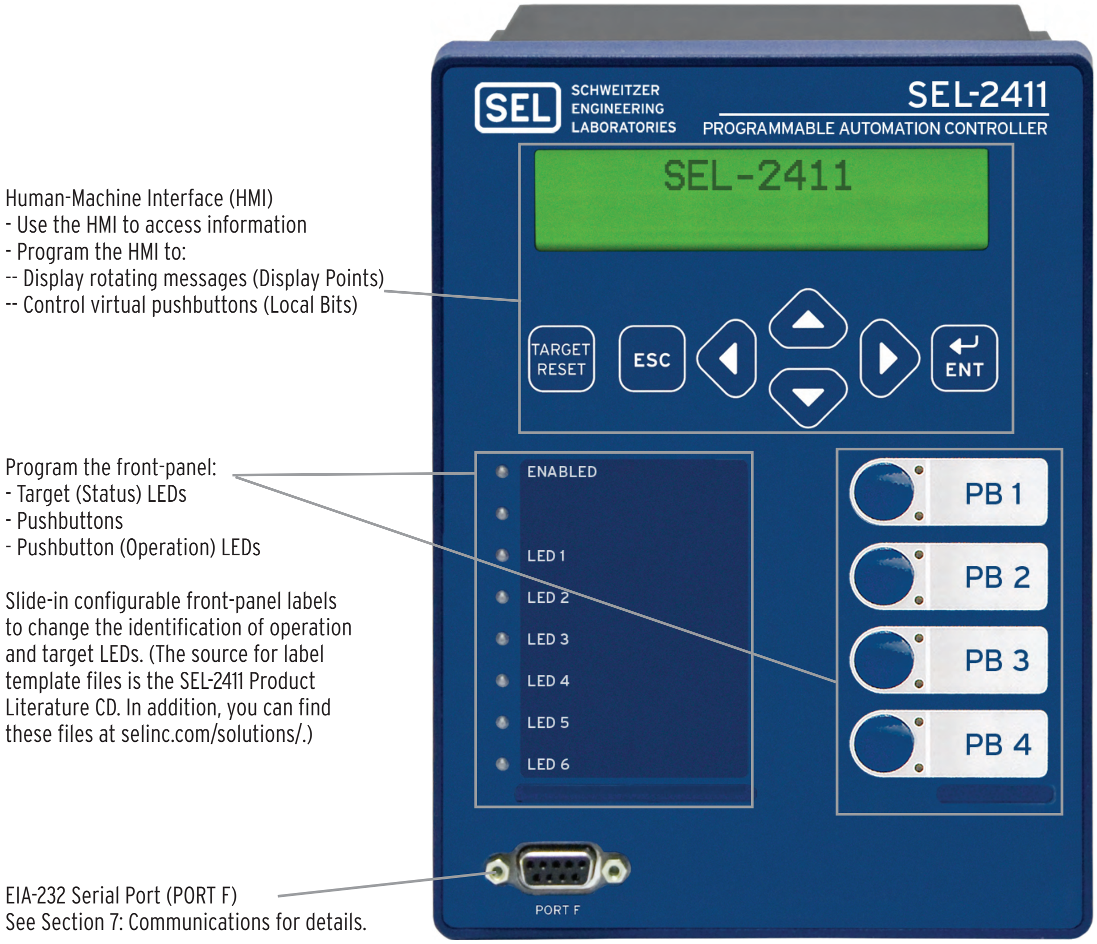


Figure 8.2 Vertical Front-Panel Overview

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 as many as 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, as shown in *Figure 8.4*.

```
FACTORY DEFAULT
    SETTINGS
```

Figure 8.3 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"

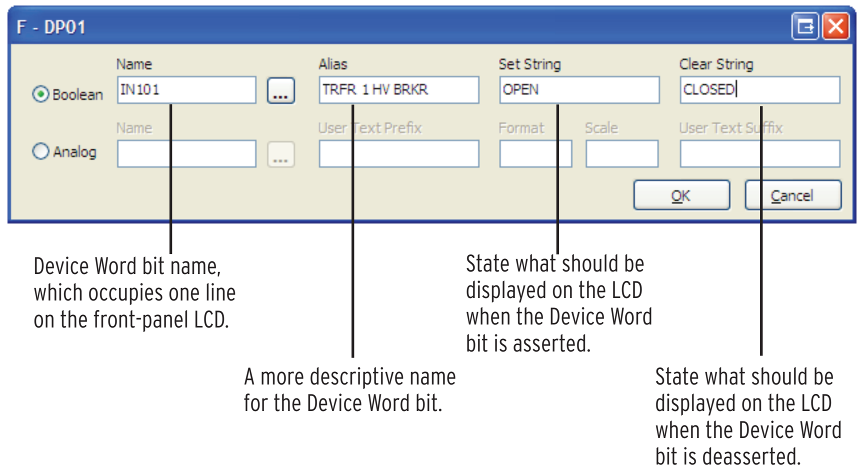


Figure 8.4 QuickSet—Settings for a Device Word Bit (Boolean)

Examples using the settings in *Table 8.1* are shown in *Figure 8.5* and *Figure 8.6*.

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 8.5 shows the display when both HV and LV breakers are open (both IN101 and IN102 deasserted). *Figure 8.6* shows the display when the HV breaker is closed, and the LV breaker is open (IN101 asserted, but IN102 still deasserted).

Figure 8.5 Front-Panel Display—Both HV and LV Breakers Open

Figure 8.6 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.

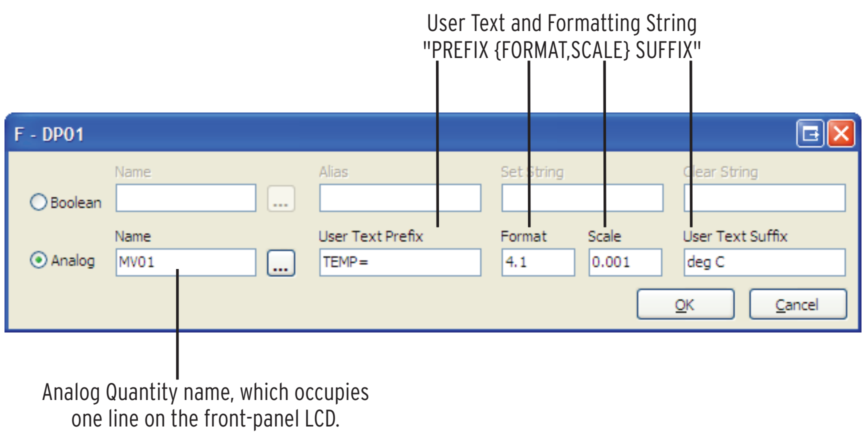


Figure 8.7 QuickSet—Settings for an Analog Quantity

Figure 8.8 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 8.9 shows the front-panel display for a setting with a Name string, a "TEMPERATURE" User Text Prefix string, and known engineering units.

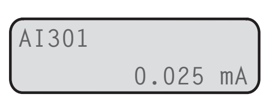


Figure 8.8 Front-Panel Display for an Analog Entry in the Name String Only

```
TEMPERATURE:
        0.024 mA
```

Figure 8.9 Analog Name and User Text and Formatting Strings

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.

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=1234000
1,{}	Empty line

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 8.10*.

```
TRFR 1 HV BRKR:=
TRFR 1 LV BRKR:=     Screen 1

HOT SPOT TEMP
        0.024 mA     Screen 2

OIL TEMPERATURE
        0.031 mA     Screen 3

WINDING TEMP
        0.037 mA     Screen 4

TRFR 1 HV BRKR:=
TRFR 1 LV BRKR:=     Screen 1
```

Figure 8.10 Rotating Display

Local Bits

Local bits are variables (LB*nn*, where *nn* means LB01–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 of 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.

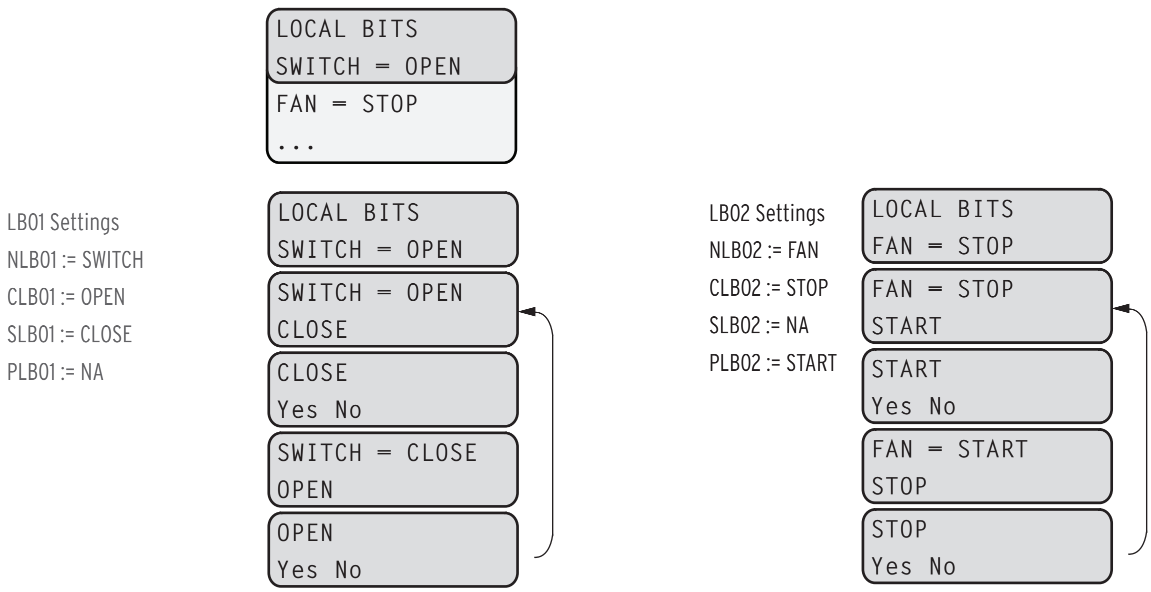


Figure 8.11 Local Bit Examples

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 LCD.

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 8.12* 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 8.12 Password Entry Screen

See *PASSWORD Command (View/Change Passwords) on page 7.33* 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 8.13*.

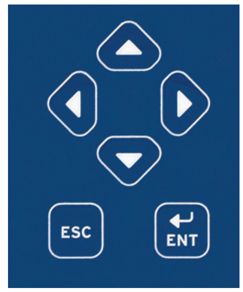


Figure 8.13 Front-Panel Navigation Pushbuttons

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	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	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 8.14 shows the `MAIN` menu screen. Using the **Up Arrow** or **Down Arrow** and **ENT** pushbuttons, you can navigate to a specific menu item in the `MAIN` menu. Each menu item is explained in detail in the following paragraphs.

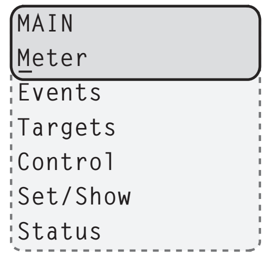


Figure 8.14 Main Menu

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 7.29* for formatting information.

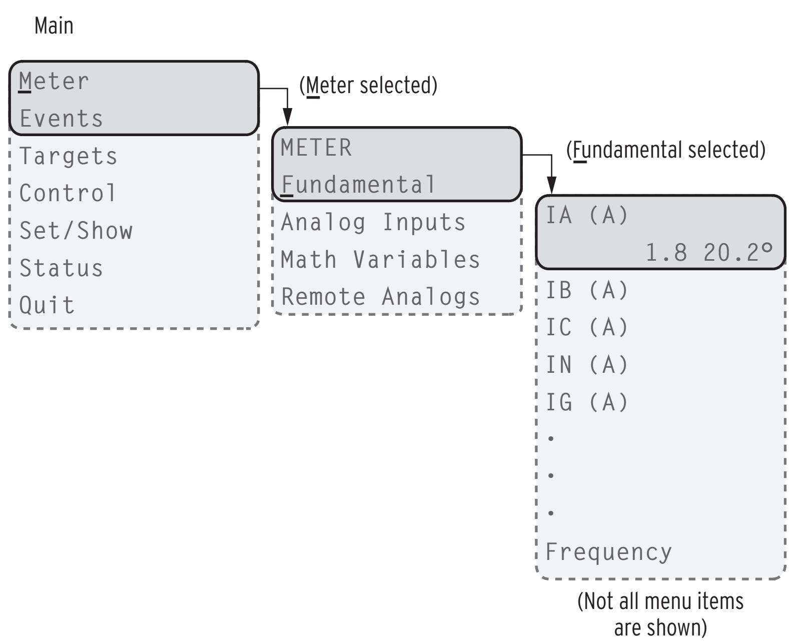


Figure 8.15 Main Menu and Meter Submenu

If the device contains no analog cards, the device displays the message shown in *Figure 8.16*.

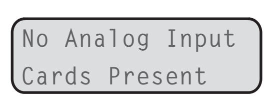


Figure 8.16 Device Response When No Analog Cards Are Installed

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 8.17 shows the **Events** menu of the SEL-2411. With this selection you can see an event summary, trigger an event, and clear existing events.

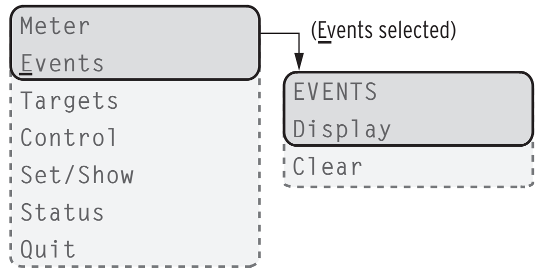


Figure 8.17 Main Menu and Events Submenu

If there are 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 8.18 shows the **Targets** menu item on the **MAIN** menu and the submenus to access the target rows (Device Word bits).

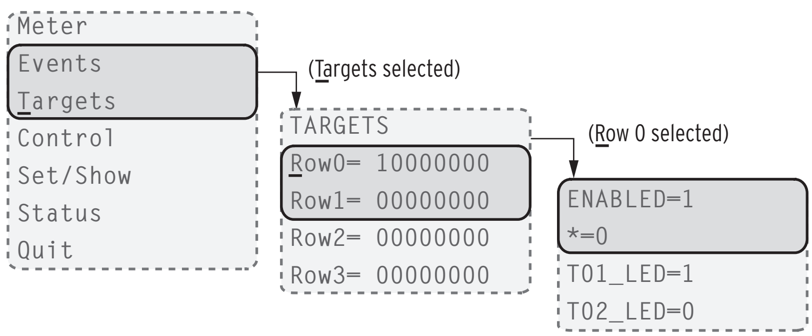


Figure 8.18 Main Menu and Target Submenu

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–RB09 and Row 3 shows RB09–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 8.19*. 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 8.19* 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 8.19*.

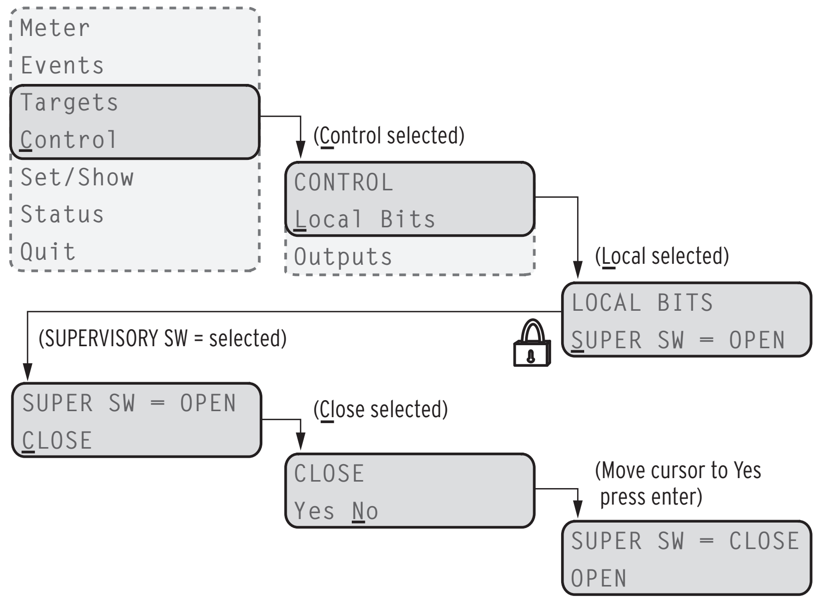


Figure 8.19 Main Menu and Control Submenu

Set/Show Menu

Figure 8.20 shows the **SET/SHO** menu of the SEL-2411.

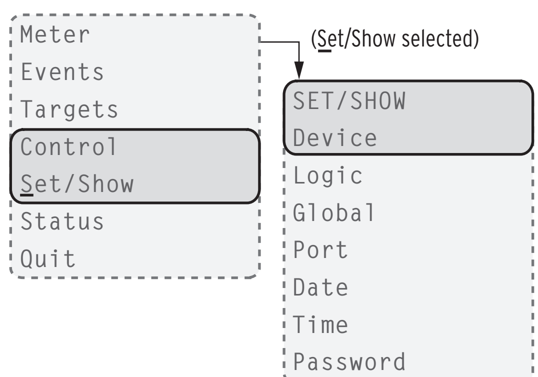


Figure 8.20 Main Menu and Set/Show Submenu

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 8.21*.

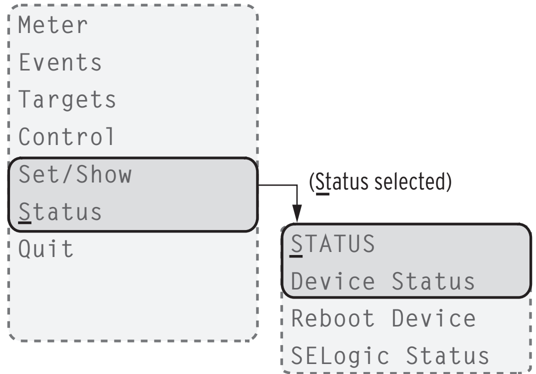


Figure 8.21 Main Menu and Status Submenu

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 horizontal SEL-2411 provides quick confirmation of device conditions via four operation and six target LEDs. The vertical SEL-2411 provides quick confirmation of device conditions via eight operation and seven target LEDs. You can use SELOGIC® control equations to program all 10/15 LEDs. Target LEDs differ from the pushbutton LEDs only in that they also include a latch function. *Figure 8.22* shows this region with factory-default text on the front-panel configurable labels.

Figure 8.22 Horizontal Factory-Default Front-Panel LEDs

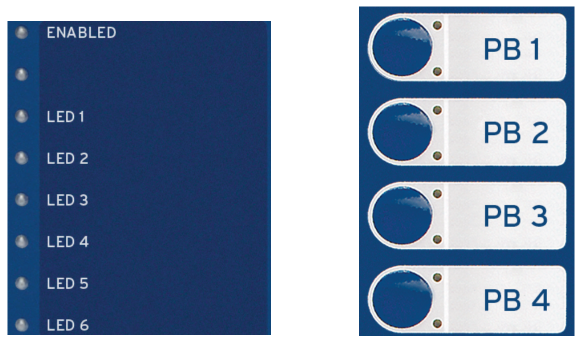


Figure 8.23 Vertical Factory-Default Front-Panel LEDs

Target LEDs

Settings T*n*_LEDL (*n* = 01–06 for horizontal, *n* = 00–06 for vertical) and T*n*_LED (*n* = 01–06 for horizontal, *n* = 00–06 for vertical) control the six/seven 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
T01_LEDC (touchscreen device only)	(R, G, A)	R

Pushbutton LEDs

Enter any of the Device Word bits (or combinations of Device Word bits) as conditions in the PB*p*_LED (*p* = 01–04 for horizontal, *p* = 01–04B for vertical, B LEDs do not use the underscore) SELOGIC control equation (SV) settings. The SEL-2411 with touchscreen option has eight pushbuttons with top and bottom tricolor LEDs. When these Device Word bits assert, the corresponding LED also asserts. *Table 8.9* shows the setting prompts, setting ranges, and default settings. Tricolor LEDs change the display of the configured color based on the logical value of the configured Device Word bit. The colors are amber (A), green (G), red (R), and off (O). The first character indicated in the color pair listed in *Table 8.9* is the asserted color, and the second is the deasserted color.

Table 8.9 Pushbutton LED Settings

Settings Prompt	Setting Range	Default Settings
PB01 LED Equation PB01_LED := [Present Setting]	(SELOGIC)	0
PB0*x*_LED (where *x* is 1–8)	(SELOGIC)	0
PB0*x*_LEDC (where *x* is 1–8 on touchscreen)	(AG, AO, AR, GA, GO, GR, OA, OG, OR, RA, RG, RO)	AO
PB0*x*BLED (where *x* is 1–8)	(SELOGIC)	0
PB0*x*BLEDC (where *x* is 1–8 on touchscreen)	(AG, AO, AR, GA, GO, GR, OA, OG, OR, RA, RG, RO)	AO

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 7.39* 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).

Touchscreen Display Front Panel

The SEL-2411 can be ordered with an optional touchscreen display (5-inch, color, 800 x 480 pixels). The touchscreen display makes device data metering, monitoring, and control quick and efficient. The touchscreen display option in the SEL-2411 features a straightforward application-driven control structure and includes intuitive and graphical screen designs.

Front-Panel Layout

The touchscreen front panel is the same as the two-line display with regard to the target LEDs, operator control pushbuttons, and the **TARGET RESET** pushbutton. Refer to *Operation and Target LEDs on page 8.12* for a detailed description of these features. In addition, the touchscreen front panel features a **HOME** pushbutton.

Touchscreen Display HMI

NOTE: The touchscreen display updates every 250 ms.

This section explains the navigation of the front-panel touchscreen and all the features it supports.

The touchscreen display allows you to:

- View and control bay screens
- Access metering and monitoring data
- Inspect targets
- View event history, summary data, and SER information
- View device status and configuration
- Control device operations
- View and edit settings
- Enable the rotating display
- Program control pushbuttons to jump to a specific screen

Figure 8.24 shows the device touchscreen display components and indicators.

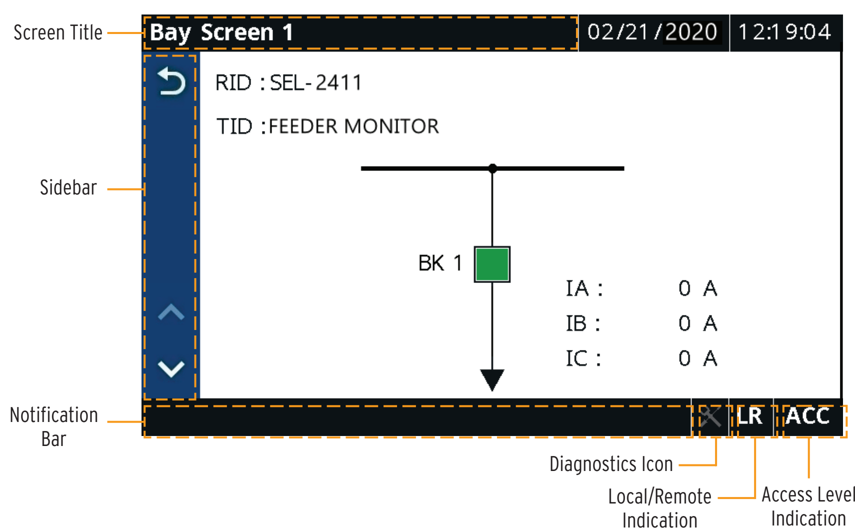
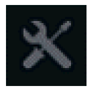


Figure 8.24 Touchscreen Display Components and Indicators

Table 8.10 Touchscreen Display Component and Indicator Descriptions

Display Components and Indicators	Function or Indication
Screen Title	Shows the display name of a screen (see *Figure 8.24*).
Sidebar	Shows the navigation icons (see *Figure 8.24*).
Notification Bar	Shows the notification messages and help text for screens (see *Figure 8.24*).
Diagnostics Icon	ON if there are any warning/diagnostic failures on the unit.
	Normal (no warnings or diagnostic failures present). Icon is OFF.
	Warning. Icon asserts in amber.
	Diagnostic failure. Icon asserts in red.
Local/Remote Indication	Indicates the status of the local/remote control. Refer to *Local/Remote Control on page 8.41* for more details.
L	When EN_LRC := Y and LOCAL := 1, device control is in local mode, i.e., SW*xx*OC and SW*xx*CC bits can be processed via the front panel only.
R	When EN_LRC := Y and LOCAL := 0, device control is in remote mode, i.e., SW*xx*OC and SW*xx*CC bits can be processed via remote sources/protocols only.
LR	When EN_LRC := N, device control is in local/remote control, i.e., SW*xx*OC and SW*xx*CC bits can be processed from both the front panel and the remote sources/protocols.
Access Level Indication	Indicates the access level that the device is on at the time. Shows ACC if the device is on Access Level 1 and 2AC if the device is on Access Level 2.

Home Pushbutton

Use the **HOME**  pushbutton to wake up the touchscreen after the inactivity timer expires and the screen goes dark. While the default mapping of the **HOME** pushbutton is the Home screen (see *Figure 8.25*), you can program the **HOME** pushbutton to jump to any screen. Refer to *Table 8.22* for a list of screens available for the **HOME** pushbutton. Use the FPHOME setting in the Touchscreen settings of QuickSet to program a specific screen.

Touchscreen Backlight

Adjustment

Touchscreen displays have an LED backlight that you can adjust to suit your viewing angle and lighting conditions. To change the backlight settings, tap the **Settings** folder and then tap the **Touchscreen** application. Use the FPBAB setting to adjust the brightness of the display.

Front-Panel Automatic Messages

The device displays automatic messages that override the present display under the conditions described in *Table 8.11*. Device failure messages have the highest priority, followed by trip and alarm. When the device has a trip or alarm condition, the trip and diagnostic messages screen will appear on the display. These messages can also be accessed by tapping the **Trip & Diag. Messages** application in the Device Info folder.

Table 8.11 Front-Panel Automatic Messages

Condition	Front-Panel Message
Device detects any failure	Displays the latest failure type (refer to *Section 10: Testing and Troubleshooting*).
Device alarm condition occurs	Displays the type of alarm (refer to *Table 10.11* for a list of the warning conditions).

Front-Panel Security

Use the **Access Level** folder on the Home screen for login/logout operations.

The SEL-2411 front panel typically operates at Access Level 1 and allows you to view device measurements and settings. Particular activities, such as editing settings and controlling output contacts, are restricted to those operators who know the Access Level 2 password.

When an activity requires Access Level 2, an authentication screen appears on the display, which requires you to enter the Access Level 2 password to proceed further. After you have correctly entered the password, you can perform other Access Level 2 operations without re-entering the password. You will have to re-enter the password if the front-panel inactivity timer, FP_TO, expires.

See *PASSWORD Command (View/Change Passwords) on page 7.33* for the list of default passwords and for more information on changing the passwords.

Front-Panel Timeout

To help prevent unauthorized access to password-protected functions, the SEL-2411 provides a front-panel timeout setting, FP_TO, in the Touchscreen application in the Settings folder. The timeout resets each time you press a front-panel pushbutton or tap the display. Once the timeout expires, the access level resets to the ACC access level. You can manually reset the access level by tapping **Logout** in the Access Level folder. The backlight of the display dims 60 minutes after the inactivity timer (1–30 min) expires.

Touchscreen

Navigating the Touchscreen Folders and Applications

Use the front-panel touchscreen and pushbuttons to access data measured and stored by the device and to perform device operations. All device information and operations are available through the touchscreen via folders, applications, and the buttons in the sidebar. *Table 8.12* describes the functions of the sidebar buttons.

Table 8.12 Sidebar Buttons

Button	Button Name	Function	Button	Button Name	Function
	Up	Pages up in applications with multiple screens; when on the first screen, this button is disabled.		Trigger Event	Triggers an event.
	Down	Pages down in applications with multiple screens; when on the last screen, this button is disabled.		Back	Returns to the preceding screen, e.g., from applications to folders.
	Left	Pages left on the home screen and in folders with multiple screens; this button is hidden if there is no screen to the left.		Pause	Stops updating the phasors.
	Right	Pages right on the home screen and in folders with multiple screens; this button is hidden if there is no screen to the right.		Play	Updates the phasor values from the device as the screen refreshes.
	Reset	Resets the accumulating quantities, such as energy, to zero.		Refresh	Reloads the data when new data are available.
	Save	Saves the edited settings to the device.		Search	Search tool (e.g., search for the status of a Device Word bit).
	Cancel Save	Cancels the setting edits.		Trash	Deletes the records from the report.

The device wakes up to the screen set in the FPHOME setting, unless the rotating display is enabled. If the rotating display is enabled and the inactivity time has expired, the device wakes up to the rotating display. Pressing the **HOME** pushbutton a second time returns you to the screen set in the FPHOME setting.

You can navigate the touchscreen by tapping the folders and applications. Tap a folder or an application to view available applications or access an application, respectively. Folders and applications are labeled according to functionality.

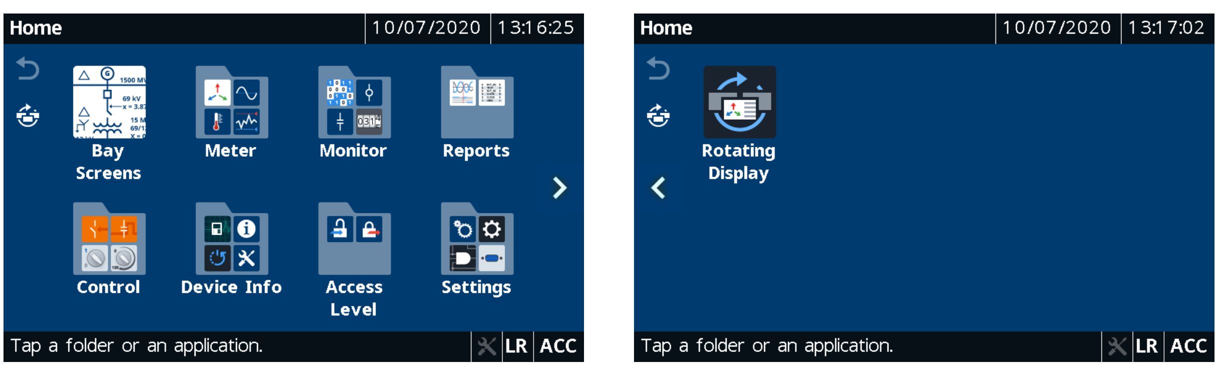


Figure 8.25 Home (Default FPHOME Setting)

Table 8.13 shows a list of folders and applications available on the Home screen.

Table 8.13 Home Folders and Applications

Screen Name	Folder or Application Name	Comments
Home	Bay Screens	Always available
	Meter	Always available
	Monitor	Always available
	Reports	Always available
	Control	Always available
	Settings	Always available
	Device Info	Always available
	Access Level	Always available
	Rotating Display	Always available

The applications shown in the folders are based on the part number. For example, if the device does not have an ac voltage or current input, the Phasor and Fundamental applications are not shown in the Meter folder.

Descriptions of the folders and applications on the Home screen follow.

Bay Screens

NOTE: Five bay screens are always rendered on the touchscreen. Any unused screens are blank.

Tap this application to navigate to as many as five customer-designed screens (Bay Screen 1 through Bay Screen 5, see *Table 8.22*). You can design these screens using ACSELERATOR Bay Screen Builder SEL-5036 Software. Refer to *Bay Control on page 8.39* for the procedure to create custom screens.

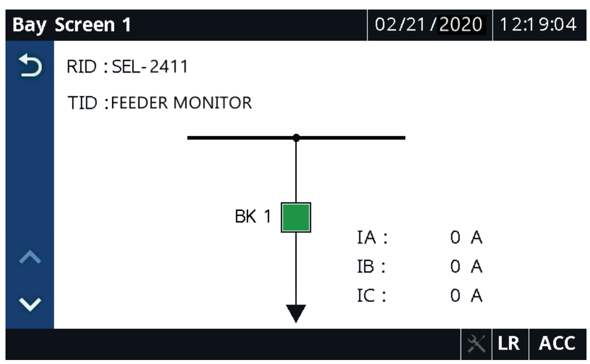


Figure 8.26 Bay Screens Application

Meter

Tapping this folder navigates you to the Meter screen, as shown in *Figure 8.27*. This screen lists all of the available metering applications. The applications on the Meter screen are part number dependent. Only those metering applications specific to your part number appear on the Meter screen. Tapping an application on the Meter screen shows you the report for that particular application.

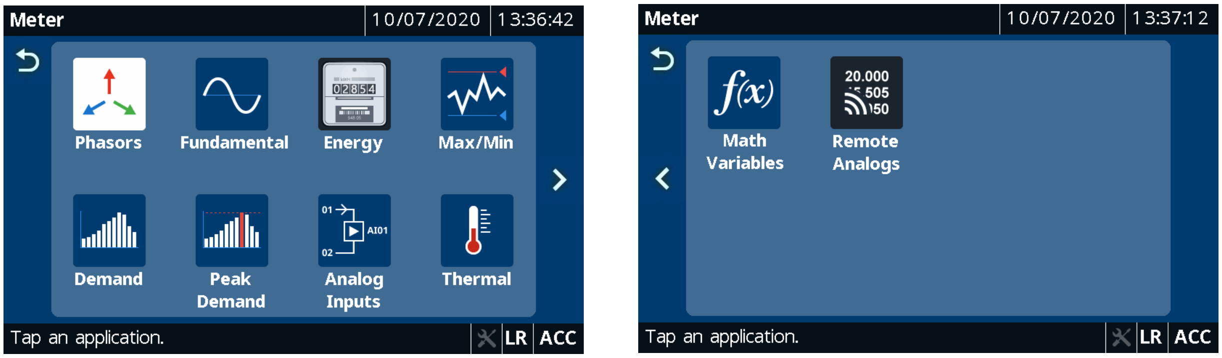


Figure 8.27 Meter Applications

Table 8.14 identifies all the applications available in the Meter folder.

Table 8.14 Meter Application Availability

Folder Name	Application Name	Comments[a]
Meter	Phasors	Shown when Slot E = 7*x* or Slot Z = 8*x*
	Fundamental	Shown when Slot E = 7V or Slot Z = 8*x*
	Energy	Shown when (Slot E = 73 or 74) or (Slot E = 7*x* and Slot Z = 8*x*)
	Max/Min	Shown when Slot E = 7*x* or Slot Z = 8*x*
	Demand	Shown when Slot E = 73 or 74 or Slot Z = 8*x*
	Peak Demand	Shown when Slot E = 73 or 74 or Slot Z = 8*x*
	Analog Inputs	Shown when (Slot C = 5*x* or 6*x*) or (Slot D = 5*x* or 6*x*) or (Slot E = 5*x* or 6*x*) or (Slot Z = 5*x* or 6*x*)
	Thermal	Shown when (Slot D = 9*x*) or (Port 2, 3, or 4 PROTO := RTD)
	Math Variables	Always available
	Remote Analogs	Always available

[a] Refer to the device part number.

Figure 8.28 and *Figure 8.29* show typical screens for phasor and fundamental metering.

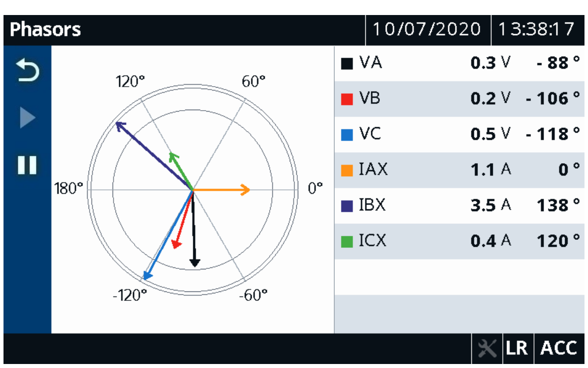


Figure 8.28 Meter Phasors

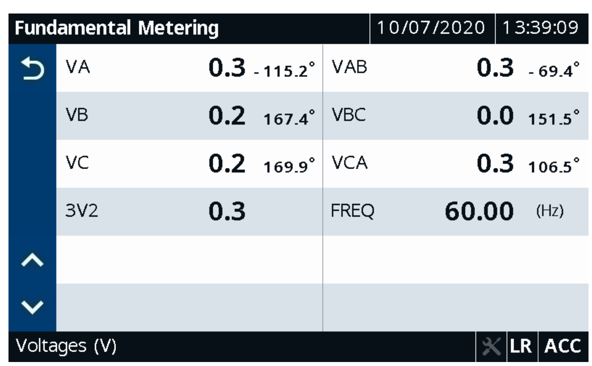


Figure 8.29 Meter Fundamental

A reset feature is provided for the Energy, Max/Min, Demand, and Peak Demand applications. Tap the **Reset** button to navigate to the reset confirmation screen. Once you confirm the reset, the data are reset to zero. *Figure 8.30* and *Figure 8.31* show typical screens for energy metering and reset confirmation.

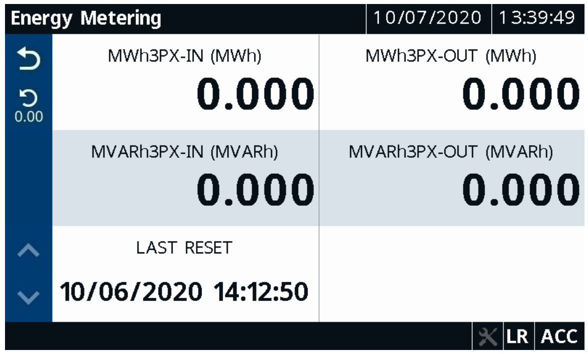


Figure 8.30 Meter Energy

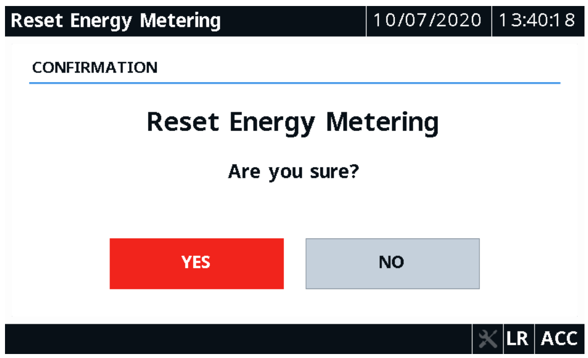


Figure 8.31 Meter Energy Reset

Monitor

Tapping this folder navigates you to the Monitor screen, as shown in *Figure 8.32*. Monitor the status of the Device Word Bits, digital outputs, digital inputs, and SELOGIC counters by using the respective applications (Device Word Bits, Digital Outputs, Digital Inputs, and SELOGIC Counters).

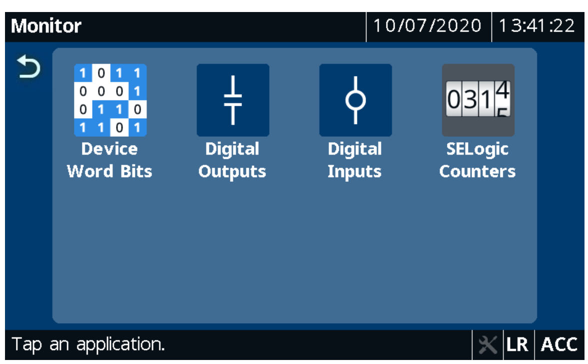


Figure 8.32 Monitor Applications

Table 8.15 identifies all the applications available in the Monitor folder.

Table 8.15 Monitor Application Availability

Folder Name	Application Name	Comments
Monitor	Device Word Bits	Always available
	Digital Outputs	Always available
	Digital Inputs	Always available
	SELOGIC Counters	Always available

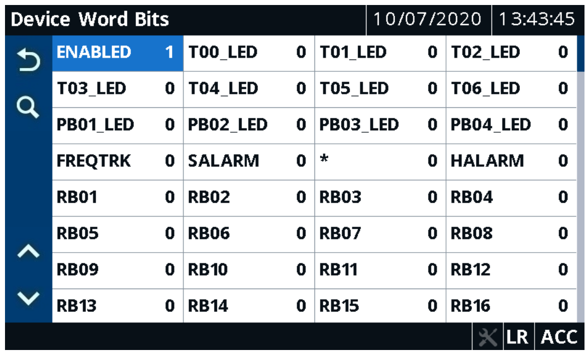


Figure 8.33 Monitor Device Word Bits

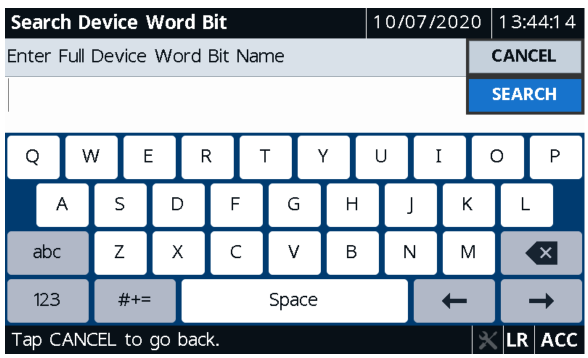


Figure 8.34 Search Device Word Bits

Use the Device Word Bits screen to monitor the status of the Device Word bits. Note that asserted Device Word bits are highlighted in blue. You can use the **SEARCH** button in the Device Word Bits application to view the status of a Device Word bit. To search for a Device Word bit, you must enter the full name of the Device Word bit in the screen Search Device Word Bit SEARCH field. *Figure 8.33* and *Figure 8.34* show typical Device Word bits monitoring screens.

Reports

Tapping this folder navigates you to the Reports screen, as shown in *Figure 8.35*, where you can access the Events and SER applications. Use these applications to view events and the SER report.

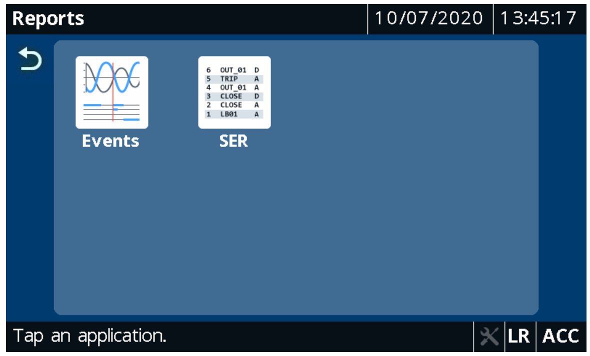


Figure 8.35 Reports Applications

Table 8.16 identifies all the applications available in the Reports folder.

Table 8.16 Reports Application Availability

Folder Name	Application Name	Comments[a]
Reports	Events	Always available
	SER	Always available

[a] Refer to the device part number.

To view the summary of a particular event record, tap the event record on the Event History screen. You can also trigger an event from the Event History screen using the **Trigger Event** button. When new records become available while viewing any of the Reports screens (Events and SER), the up and down buttons are disabled and the footer displays a message to refresh the screen. Update the screen using the **Refresh** button. Tapping the **Trash** button on the Event History and Sequential Events Recorder screens and confirming the delete action removes the records from the device. *Figure 8.36* through *Figure 8.38* show typical Event History, Event Summary, and Sequential Events Recorder screens.

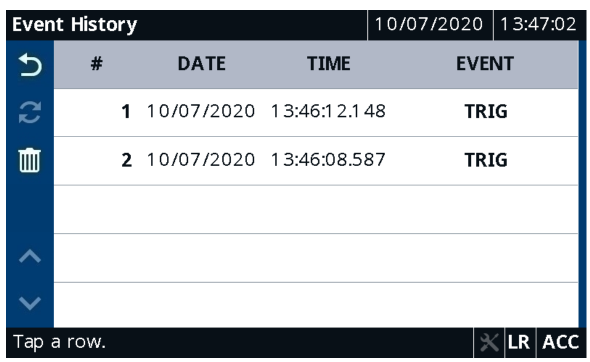


Figure 8.36 Event History

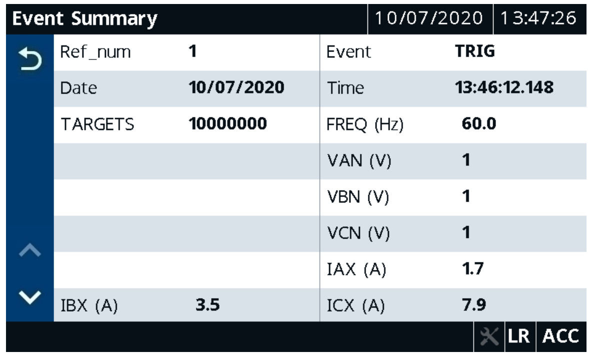


Figure 8.37 Event Summary

Figure 8.38 Sequential Events Recorder

Control

Tapping this folder navigates you to the Control screen, as shown in *Figure 8.39*. Use the Control folder applications Output Pulsing and Local Bits to perform breaker control operations, pulse contact outputs, or control the local bits.

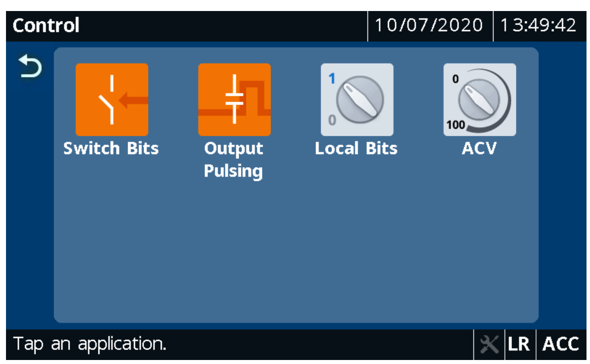


Figure 8.39 Control Applications

Table 8.17 identifies all the applications available in the Control folder.

Table 8.17 Control Application Availability

Folder Name	Application Name	Comments
Control	Switch Control	Always available
	Output Pulsing	Always available
	Local Bits	Always available
	Analog Control Variables	Always available

To perform switch control, tap the **Switch Control** application and then tap and confirm the control action. Switch control through the touchscreen is supervised by (1) the status of the LOCAL bit when EN_LRC := Y and (2) the access level (requires Access Level 2). When EN_LRC := N, supervision through the LOCAL bit is ignored, while supervision through the access level is maintained.

When local/remote supervision settings EN_LRC := Y and LOCAL := 0, the OC and CC bits are not processed from the touchscreen (i.e., switch control through the touchscreen is blocked). *Figure 8.40* shows a typical switch control screen. For the settings related to the local/remote control function, refer to *Local/ Remote Control on page 8.41*.

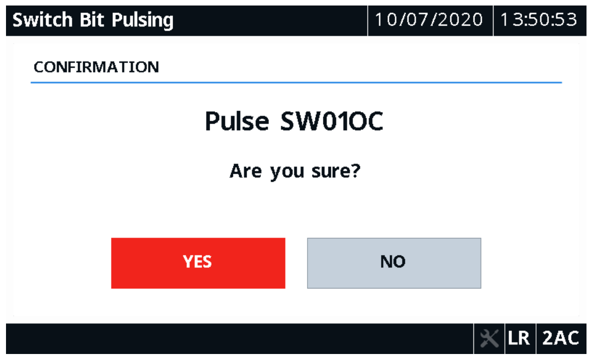


Figure 8.40 Local Bits Confirmation

To pulse a digital contact output, tap the Output Pulsing application. Navigate to the desired output contact screen, tap the desired output, and confirm the control action. The output tile will be highlighted in blue on assertion, as shown in *Figure 8.41*. A contact output cannot be pulsed if it is already asserted. Pulsing the contact output requires that you have Level 2 access.

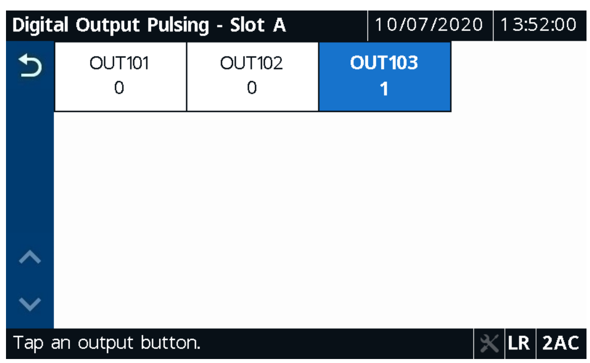


Figure 8.41 Digital Output Pulsing—Slot A

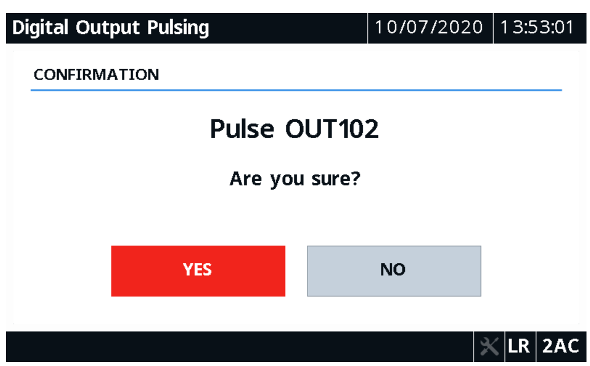


Figure 8.42 Digital Output Pulsing Confirmation

To control the local bits, tap the Local Bits application. You can control the desired local bit by tapping on the corresponding row. Depending on the state, tap and confirm the type of action you would like to perform. *Figure 8.43* through *Figure 8.45* show typical local bits control screens.

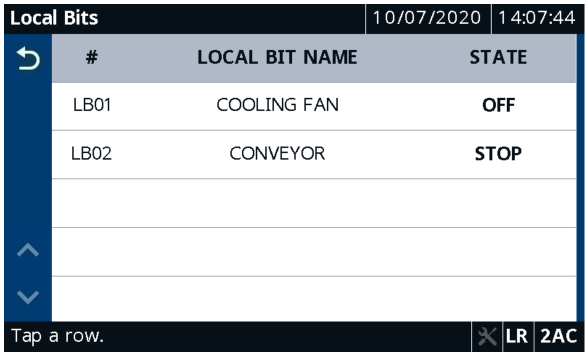


Figure 8.43 Local Bits

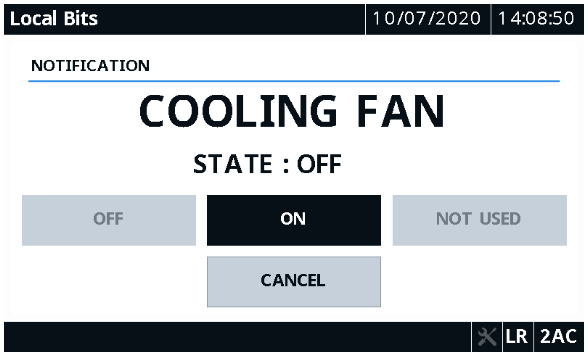


Figure 8.44 Local Bits Notification

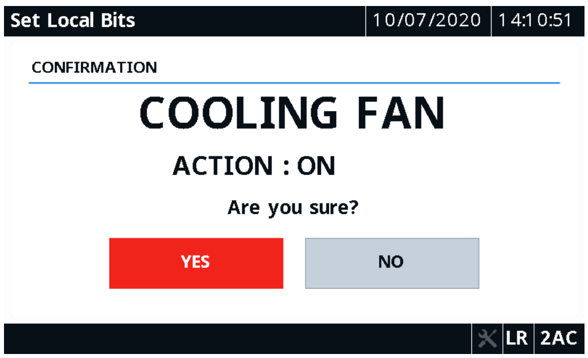


Figure 8.45 Local Bits Confirmation

Device Info

Tapping this folder navigates you to the Device Info screen where you can access specific device information applications (Status, Configuration, and Trip & Diag. Messages) and the Reboot application.

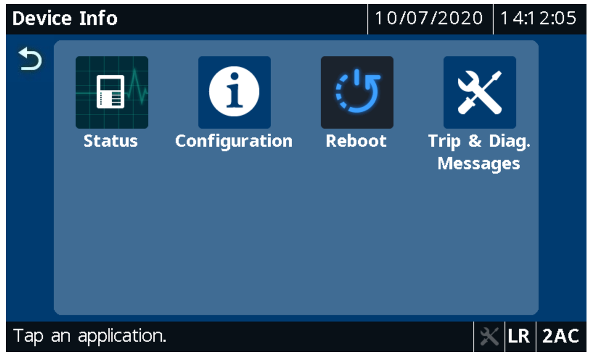


Figure 8.46 Device Info Applications

Table 8.18 identifies all the applications available in the Device Info folder.

Table 8.18 Device Info Application Availability

Folder Name	Application Name	Comments[a]
Device Info	Status	Always available
	Configuration	Always available
	Reboot	Always available
	Trip & Diag. Messages	Always available

[a] Refer to the device part number.

Tap the **Status** application to view the device status, firmware version, part number, etc., as shown in *Figure 8.47*. Use the **Configuration** application to view port information, the jumper positions, etc., as shown in *Figure 8.48*. If the device detects any new card in one of the slots, it disables and directs you to accept the change in configuration, as shown in *Figure 8.49*. *Figure 8.47* through *Figure 8.50* show typical screens for device configuration, device status, and trip and diagnostic messages.

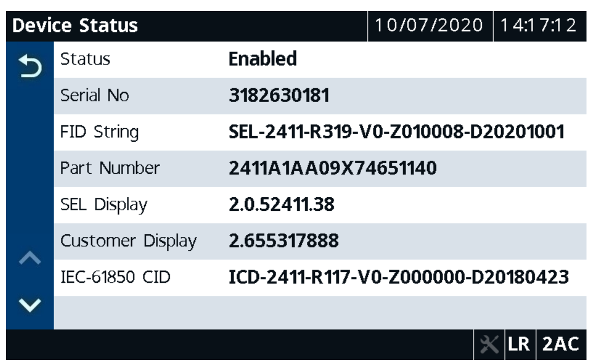


Figure 8.47 Device Status

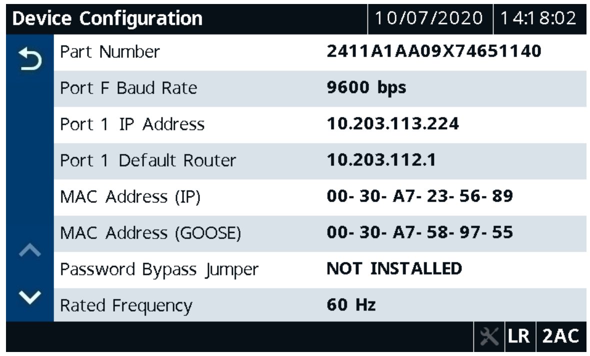


Figure 8.48 Device Configuration

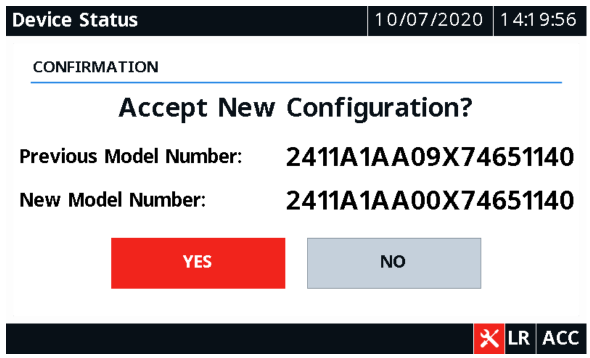


Figure 8.49 Model Number Confirmation

When a diagnostic failure, trip, or warning occurs, the device displays the diagnostic message on the screen until it is either overridden by the restart of the rotating display or the inactivity timer expires. To view the trip and diagnostic messages, tap the **Trip & Diag. Messages** application in the Device Info folder.

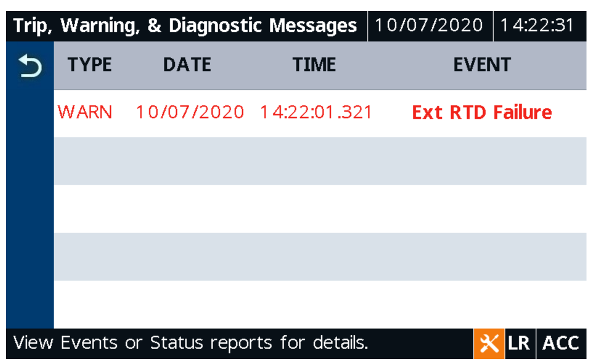


Figure 8.50 Trip and Diagnostic Messages

Access Level

Tapping this folder navigates you to the Access Level screen where you can either log in to or log out of Access Level 2.

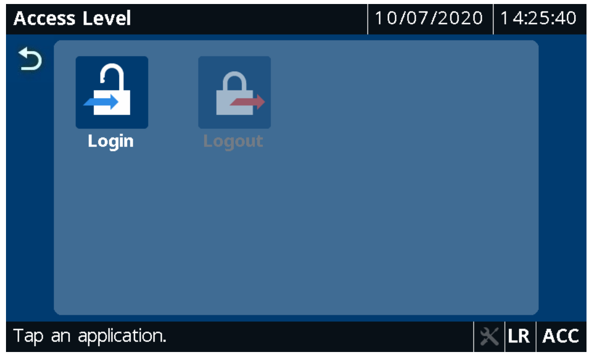


Figure 8.51 Access Level Applications

Table 8.19 identifies all of the applications available in the Access Level folder.

Table 8.19 Access Level Application Availability

Folder Name	Application Name	Comments
Access Level	Login	Always available
	Logout	Always available

Note that when a folder requires Access Level 2 and the device is at Access Level 1, the device automatically pops up the authentication screen requiring you to enter the password before performing a control operation, editing setting, etc.

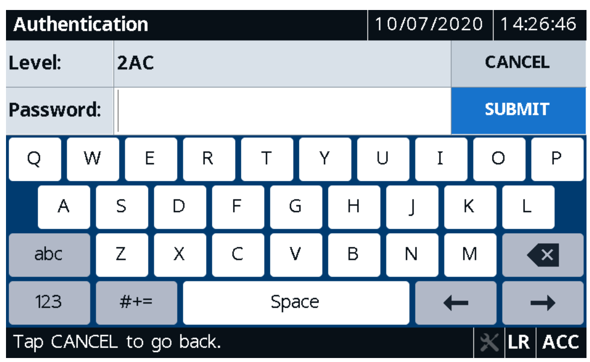


Figure 8.52 Authentication

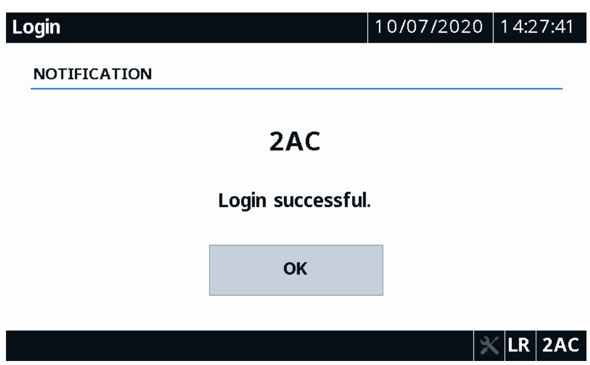


Figure 8.53 Login Confirmation

Settings

Tapping this folder navigates you to the Settings screen where you can access settings applications (Global, Touchscreen) or settings folders (Port, Group, Date and Time) through which you can set or show settings.

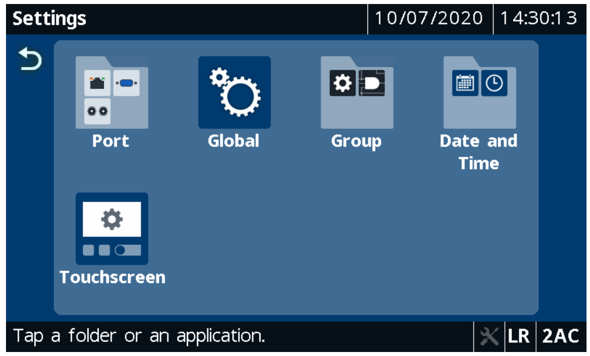


Figure 8.54 Settings Folders and Applications

Table 8.20 identifies all of the folders and applications available in the Settings folder.

Table 8.20 Settings Folder and Application Availability

Folder Name	Folder or Application Name	Comments
Settings	Port	Always available
	Global	Always available
	Group	Always available
	Date and Time	Always available
	Touchscreen	Always available

Table 8.21 identifies all the applications available in each folder (Port, Group, Date and Time) in the Settings folder.

Table 8.21 Settings Folders Port, Group, and Date and Time Application Availability

Folder Name	Application Name	Comments[a]
Port	Port F	Always available
	Port 1	Shown when Slot B ≠ *x*0*x* or *x*1*x*
	Port 2	Shown when serial fiber port is available
	Port 3	Always available
	Port 4	Shown when Slot C = A0
Group	Set	Always available
	Logic	Always available
Date and Time	Date	Always available
	Time	Always available

[a] Refer to the device part number.

Figure 8.55 and *Figure 8.56* show typical port and group settings screens.

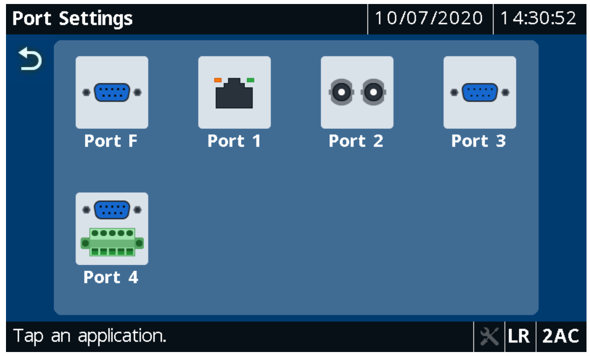


Figure 8.55 Port Settings

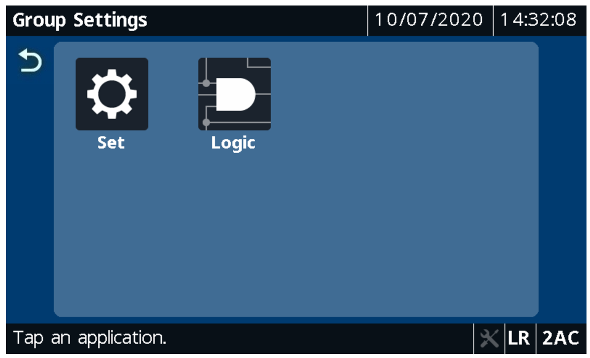


Figure 8.56 Group Settings

To edit a setting, tap on a setting row and enter the Access Level 2 password. If the access level is already at Access Level 2, the device does not prompt for password authentication. After entering the value, tap the **Save** button to save your edit, or select the **Cancel Save** button to cancel the edit (see *Table 8.12*). When editing a settings class (e.g., Set in Group Settings), you cannot navigate to another class (e.g., Logic 1) without saving or discarding the settings change made in Set.

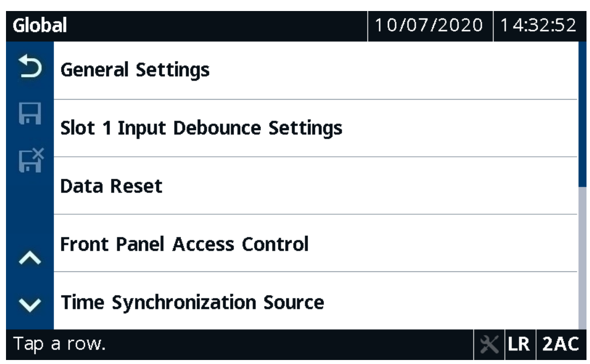


Figure 8.57 Global Settings

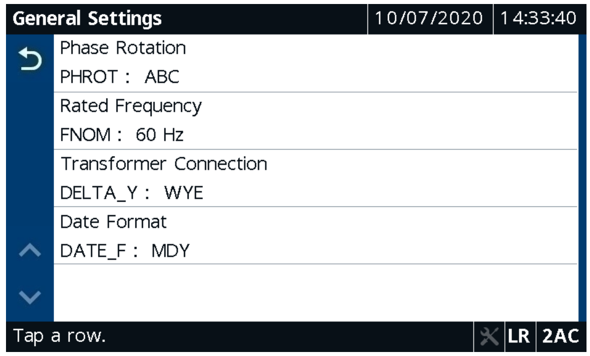


Figure 8.58 General Settings

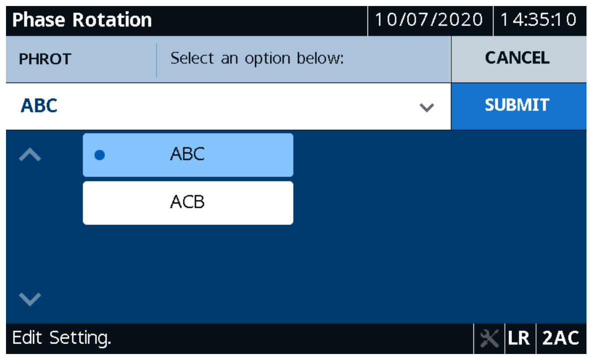


Figure 8.59 Set/Show Settings Edit

You can control the screen brightness, the screen inactivity timer settings, etc., through the Touchscreen application.

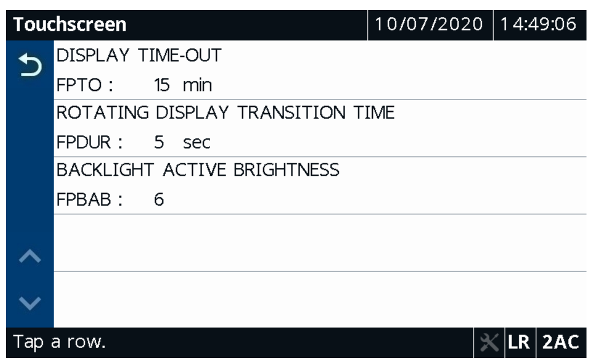


Figure 8.60 Touchscreen Settings

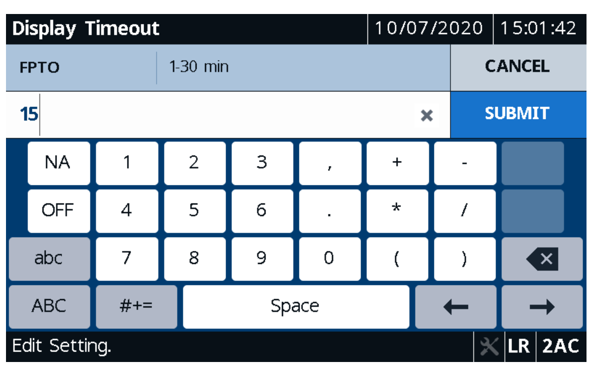


Figure 8.61 Touchscreen Settings Edit

Rotating Display

Tapping this application allows you to start the rotating display. You can pick as many as 16 screens through which the display can rotate after the inactivity timer expires. Refer to *Table 8.22* for all the available quantities on each screen.

Tapping any screen while the display is rotating takes you to that particular screen. You can perform the needed operation and use the **Back** button to return to the Home screen.

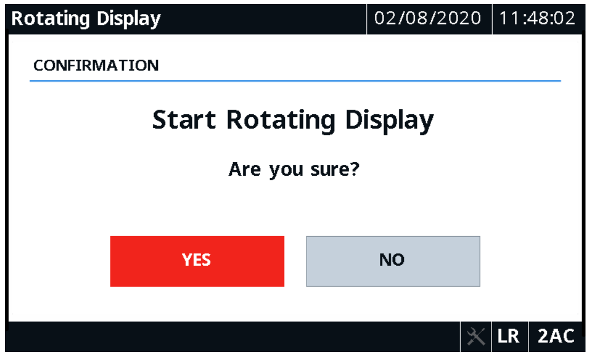


Figure 8.62 Rotating Display

Operation and Target LEDs

Programmable LEDs

The SEL-2411 provides quick confirmation of device conditions via operation and target LEDs. Refer to *Operation and Target LEDs on page 8.12* for details on programmable LEDs and their operation.

TARGET RESET Pushbutton

Refer to *TARGET RESET Pushbutton on page 8.14* for the operation of the **TARGET RESET** pushbutton, the lamp test, and other target reset options.

Front-Panel Operator Control Pushbuttons

The SEL-2411 touchscreen display features four operator-controlled pushbuttons, **PB01–PB08**, each with two programmable tricolor pushbutton LEDs, for local control, as shown in *Table 8.9*. Refer to *Operation and Target LEDs on page 8.12* for details on operator control pushbuttons and LEDs and their programming.

You can use the front-panel operator control pushbuttons to jump to a specific screen while using them for SELOGIC operations, etc. You can program the selectable operator pushbutton screen settings under the Touchscreen settings category in QuickSet and map the button to a specific screen. For example, PB04, which is used to trip a breaker by default, can be programmed to jump to a bay screen by mapping the pushbutton touchscreen setting FPPB04 to Bay Screen 1. When you press PB04, the display jumps to Bay Screen 1, where you can see a visual confirmation of the TRIP action.

Table 8.22 Screens Available for the Rotating Display, HOME Pushbutton, and Programmable Pushbuttons (Sheet 1 of 6)

Home Screen Folders and Applications	Folder and Application Names	Display Name	Quantities	Comments
Bay Screens				
		Bay Screen 1	Displays Bay Screen 1	Always available
		Bay Screen 2	Displays Bay Screen 2	Always available
		Bay Screen 3	Displays Bay Screen 3	Always available
		Bay Screen 4	Displays Bay Screen 4	Always available
		Bay Screen 5	Displays Bay Screen 5	Always available
Meter				
	Phasors			
		Phasor Screen 1	IA_MAG, IA_ANG, IB_MAG, IB_ANG, IC_MAG, IC_ANG	Shown when Slot Z = 8*x* AND Slot E != 7*x*
		Phasor Screen 2	IA_MAG, IA_ANG, IB_MAG, IB_ANG, IC_MAG, IC_ANG, VAB_MAG, VAB_ANG, VBC_MAG, VBC_ANG, VCA_MAG, VCA_ANG	Show when (Slot Z = 8*x* AND Delta_Y = DELTA) AND (Slot E = 71)
		Phasor Screen 3	IA_MAG, IA_ANG, IB_MAG, IB_ANG, IC_MAG, IC_ANG, VA_MAG, VA_ANG, VB_MAG, VB_ANG, VC_MAG, VC_ANG	Shown when (Slot Z = 8*x* AND DELTA_Y = WYE) AND (Slot E = 71)
		Phasor Screen 5	VA_MAG, VA_ANG, VB_MAG, VB_ANG, VC_MAG, VC_ANG,	Shown when (Slot Z != 8*x* AND DELTA_Y = WYE) AND (Slot E = 73 or 74)
		Phaser Screen 6	IAX_MAG, IAX_ANG, IBX_MAG, IBX_ANG, ICX_MAG, ICX_ANG, VAB_MAG, VAB_ANG, VBC_MAG, VBC_ANG, VCA_MAG, VCA_ANG	Shown when (Slot E = 73 or 74 AND DELTA_Y = DELTA) AND (Slot Z != 8*x*)
		Phasor Screen 7	IA_MAG, IA_ANG, IB_MAG, IB_ANG, IC_MAG, IC_ANG, IAX_MAG, IAX_ANG, IBX_MAG, IBX_ANG, ICX_MAG, ICX_ANG, VAB_MAG, VAB_ANG, VBC_MAG, VBC_ANG, VCA_MAG, VCA_ANG	Shown when (Slot E = 73 or 74 AND DELTA_Y = DELTA) AND (Slot Z = 8*x*)
		Phasor Screen 8	IA_MAG, IA_ANG, IB_MAG, IB_ANG, IC_MAG, IC_ANG, IAX_MAG, IAX_ANG, IBX_MAG, IBX_ANG, ICX_MAG, ICX_ANG, VA_MAG, VA_ANG, VB_MAG, VB_ANG, VC_MAG, VC_ANG	Shown when (Slot E = 73 or 74 AND DELTA_Y = WYE) AND (Slot Z = 8*x*)
		Phasor Screen 9	VA_MAG, VA_ANG, VB_MAG, VB_ANG, VC_MAG, VC_ANG	Shown when (Slot E = 71 AND DELTA_Y = WYE) AND (Slot Z != 8*x*)
		Phasor Screen 10	VAB_MAG, VAB_ANG, VBC_MAG, VBC_ANG, VCA_MAG, VCA_ANG	Shown when (Slot E = 71 AND DELTA_Y = DELTA) AND (Slot Z != 8*x*)
	Fundamental			
		Fundamental Screen 1	IA_MAG, IA_ANG, IB_MAG, IB_ANG, IC_MAG, IC_ANG, IN_MAG, IN_ANG, FREQ	Shown when Slot Z = 8*x*

Table 8.22 Screens Available for the Rotating Display, HOME Pushbutton, and Programmable Pushbuttons (Sheet 2 of 6)

Home Screen Folders and Applications	Folder and Application Names	Display Name	Quantities	Comments
		Fundamental Screen 2	IAX_MAG, IAX_ANG, IBX_MAG, IBX_ANG, ICX_MAG, ICX_ANG, IGX_MAG, IGX_ANG, 3I2X, FREQ	Show when (Slot E = 73 OR 74)
		Fundamental Screen 3	VAB_MAG, VAB_ANG, VBC_MAG, VBC_ANG, VCA_MAG, VCA_ANG, 3V2, FREQ	Show when (Slot E = 7*x*) AND (DELTA_Y = DELTA)
		Fundamental Screen 4	VA_MAG, VA_ANG, VB_MAG, VB_ANG, VC_MAG, VC_ANG, 3V2, FREQ	Show when (Slot E = 7*x*) AND (DELTA_Y = WYE)
		Fundamental Screen 5	P, Q, S, PF	Show when (Slot E = 7*x* AND Slot Z = 8*x*) AND (DELTA_Y = DELTA)
		Fundamental Screen 6	PA, PB, PC, QA, QB, QC, SA, SB, SC, PFA, PFB, PFC	Show when (Slot E = 7*x* AND Slot Z = 8*x*) AND (DELTA_Y = WYE)
		Fundamental Screen 7	PX, QX, SX, PFX	Show when (Slot E = 73 or 74) AND (DELTA_Y = DELTA)
		Fundamental Screen 8	PAX, PBX, PCX, QAX, QBX, QCX, SAX, SBX, SCX, PFAX, PFBX, PFCX	Show when (Slot E = 7*x* AND Slot Z = 8*x*) AND (DELTA_Y = WYE)
	Max/Min			
		Max/Min Screen 1	IAMX, IAMN, IBMX, IBMN, ICMX, ICMN, INMX, INMN, IGMX, IGMN, VABMX, VABMN, VAMX, VAMN, VBCMX, VBCMN, VBMX, VBMN, VCAMX, VCAMN, VCMX, VCMN, VSMX, VSMN, kW3MX, kW3MN, kVAR3MX, kVAR3MN, kVA3MX, kVA3MN, FREQMX, FREQMN	Show when (Slot E = 7*x* OR Slot Z = 8*x*)
		Max/Min Reset Screen	Reset max/min data	Show when (Slot E = 7*x* OR Slot Z = 8*x*)
	Energy			
		Energy Screen 1	MWh3P-IN (MWh), MWh3P-OUT (MWh), MVARh3P-IN (MVARh), MVARh3P-OUT (MVARh), LAST RESET	Show when (Slot E = 7*x* AND Slot Z = 8*x*)
		Energy Screen 2	MWh3PX-IN (MWh), MWh3PX-OUT (MWh), MVARh3PX-IN (MVARh), MVARh3PX-OUT (MVARh), LAST RESET	Show when (Slot E = 73 OR 74)
		Energy Reset Screen	Reset Energy data	Show when (Slot E = 73 OR 74) OR (Slot E = 7*x* AND Slot Z = 8*x*)
	Demand			
		Demand Screen 1	IAD, IBD, ICD, IND, IGD, 3I2D	Show when (Slot Z = 8*x*)
		Demand Screen 2	IAXD, IBXD, ICXD, INXD, IGXD, 3I2XD	Show when (Slot E = 73 OR 74)
		Demand Screen 3	Meter Demand LAST RESET	Show when (Slot E = 73 OR 74) OR (Slot Z = 8*x*)
		Demand Reset Screen	Reset Demand data	Show when (Slot E = 73 OR 74) OR (Slot Z = 8*x*)

Table 8.22 Screens Available for the Rotating Display, HOME Pushbutton, and Programmable Pushbuttons (Sheet 3 of 6)

Home Screen Folders and Applications	Folder and Application Names	Display Name	Quantities	Comments
	Peak Demand			
		Peak Demand Screen 1	IAPD, IBPD, ICPD, INPD, IGPD, 3I2PD	Show when (Slot Z = 8*x*)
		Peak Demand Screen 2	IAXPD, IBXPD, ICXPD, INXPD, IGXPD, 3I2XPD	Show when (Slot E = 73 OR 74)
		Peak Demand Screen 3	Meter Demand LAST RESET	Show when (Slot E = 73 OR 74) OR (Slot Z = 8*x*)
		Peak Demand Reset Screen	Reset Demand data	Show when (Slot E = 73 OR 74) OR (Slot Z = 8*x*)
	Analog Inputs			
		Analog Inputs Screen 1	AI301–AI308, AI401–AI408, AI501–AI508, AI601–AI608	Show when (Slot C, D, E, or Z = 5*x* or 6*x*)
	Thermal			
		Thermal Screen 1	INTRTD01–INTRTD10	Show when (Slot D = 90)
		Thermal Screen 2	INTEMP01–INTEMP10	Show when (Slot D = 91)
		Thermal Screen 3	EXTEMP01–EXTEMP12	Show when (PORT 2, 3, or 4 PROTO = RTD)
	Math Variables			
		Math Variables Screen 1	MV01–MV64	Show when EMV != N; shows 12 math variables per page
	Remote Analogs			
		Remote Analogs Screen 1	RA001–RA012	Always available
		Remote Analogs Screen 2	RA013–RA024	Always available
		Remote Analogs Screen 3	RA025–RA036	Always available
		Remote Analogs Screen 4	RA037–RA048	Always available
		Remote Analogs Screen 5	RA049–RA060	Always available
		Remote Analogs Screen 6	RA061–RA072	Always available
		Remote Analogs Screen 7	RA073–RA084	Always available
		Remote Analogs Screen 8	RA085–RA096	Always available
		Remote Analogs Screen 9	RA097–RA108	Always available
		Remote Analogs Screen 10	RA109–RA120	Always available
		Remote Analogs Screen 11	RA121–RA128	Always available

Table 8.22 Screens Available for the Rotating Display, HOME Pushbutton, and Programmable Pushbuttons (Sheet 4 of 6)

Home Screen Folders and Applications	Folder and Application Names	Display Name	Quantities	Comments
Monitor				
	Device Word Bits			
		Device Word Bits Screen 1	Show the status of all the Device Word bits	Shows 32 Device Word bits per page
	Digital Inputs			
		Digital Inputs Screen 1	IN101, IN102	Always available
		Digital Inputs Screen 2	IN301, IN302, IN303, IN304	Show when (Slot C = C*x*, B*x*, or 1*x*)
		Digital Inputs Screen 3	IN301, IN302, IN303, IN304, IN305, IN306, IN307, IN308	Show when (Slot C = 3*x*)
		Digital Inputs Screen 4	IN301, IN302, IN303, IN304, IN305, IN306, IN307, IN308, IN309, IN310, IN311, IN312, IN313, IN314	Show if (Slot C = D*x*)
		Digital Inputs Screen 5	IN401, IN402, IN403, IN404	Show if (Slot D = C*x*, B*x*, or 1*x*)
		Digital Inputs Screen 6	IN401, IN402, IN403, IN404, IN405, IN406, IN407, IN408	Show if (Slot D = 3*x*)
		Digital Inputs Screen 7	IN401, IN402, IN403, IN404, IN405, IN406, IN407, IN408, IN409, IN410, IN411, IN412, IN413, IN414	Show when (Slot D = D*x*)
		Digital Inputs Screen 8	IN501, IN502, IN503, IN504	Show when (Slot E = C*x*, B*x*, or 1*x*)
		Digital Inputs Screen 9	IN501, IN502, IN503, IN504, IN505, IN506, IN507, IN508	Show when (Slot E = 3*x*)
		Digital Inputs Screen 10	IN501, IN502, IN503, IN504, IN505, IN506, IN507, IN508, IN509, IN510, IN511, IN512, IN513, IN514	Show when (Slot E = D*x*)
		Digital Inputs Screen 11	IN601, IN602, IN603, IN604	Show when (Slot Z = C*x*, B*x*, or 1*x*)
		Digital Inputs Screen 12	IN601, IN602, IN603, IN604, IN605, IN606, IN607, IN608	Show when (Slot Z = 3*x*)
		Digital Inputs Screen 13	IN601, IN602, IN603, IN604, IN605, IN606, IN607, IN608, IN609, IN610, IN611, IN612, IN613, IN614	Show when (Slot Z = D*x*)
	Digital Outputs			
		Digital Outputs Screen 1	OUT101, OUT102, OUT103	Always available
		Digital Outputs Screen 2	OUT301, OUT302, OUT303, OUT304	Show when (Slot C = B*x* or 1*x*)
		Digital Outputs Screen 3	OUT301, OUT302, OUT303	Show when (Slot C = C*x*)
		Digital Outputs Screen 4	OUT301, OUT302, OUT303, OUT304, OUT305, OUT306, OUT307, OUT308	Show when (Slot C = 2*x*)
		Digital Outputs Screen 5	OUT401, OUT402, OUT403, OUT404	Show when (Slot D = B*x* or 1*x*)

Table 8.22 Screens Available for the Rotating Display, HOME Pushbutton, and Programmable Pushbuttons (Sheet 5 of 6)

Home Screen Folders and Applications	Folder and Application Names	Display Name	Quantities	Comments
		Digital Outputs Screen 6	OUT401, OUT402, OUT403	Show when (Slot D = C*x*)
		Digital Outputs Screen 7	OUT401, OUT402, OUT403, OUT404, OUT405, OUT406, OUT407, OUT408	Show when (Slot D = 2*x*)
		Digital Outputs Screen 8	OUT501, OUT502, OUT503, OUT504	Show when (Slot E = B*x* or 1*x*)
		Digital Outputs Screen 9	OUT501, OUT502, OUT503	Show when (Slot E = C*x*)
		Digital Outputs Screen 10	OUT501, OUT502, OUT503, OUT504, OUT505, OUT506, OUT507, OUT508	Show when (Slot E = 2*x*)
		Digital Outputs Screen 11	OUT601, OUT602, OUT603, OUT604	Show when (Slot Z = B*x* or 1*x*)
		Digital Outputs Screen 12	OUT601, OUT602, OUT603	Show when (Slot Z = C*x*)
		Digital Outputs Screen 13	OUT601, OUT602, OUT603, OUT604, OUT605, OUT606, OUT607, OUT608	Show when (Slot Z = 2*x*)
Reports				
	SELOGIC Counters			
		SELOGIC Counters Screen 1	SC01–SC32	Show when ESC != N
	Events			
		Event History Screen		Always available
	SER			
		SER Screen		Always available
	Device Info			
		Status Screen 1	Status, serial number, FID string, part number, SEL display, customer display, IEC 61850 CID, IEC 61850 Mode	Always available
		Status Screen 2	Diagnostic status for the device cards and power supply rails. CARD_C, CARD_D, CARD_E, CARD_Z, FPGA, GPSB, HMI, RAM, ROM, CR_RAM, NON_VOL, CLOCK, RTD, CID_FILE, +0.9V CHK (V), +1.2V CHK (V), +1.5V CHK (V), +1.8V CHK (V), +2.5V CHK (V), +3.3V CHK (V), +3.75V CHK (V), +5.0V CHK (V), –1.25V CHK (V), –5.0V CHK (V), BATT CHK (V)	Always available
		Status Screen 3	OFFSETS: IA, IB, IC, IN, VA, VB, VC	Show when (Slot E = 7*x*) OR (Slot Z = 8*x*)

Table 8.22 Screens Available for the Rotating Display, HOME Pushbutton, and Programmable Pushbuttons (Sheet 6 of 6)

Home Screen Folders and Applications	Folder and Application Names	Display Name	Quantities	Comments
	Trip and Diagnostic			
		Trip and Diagnostics Screen	Diagnostic failures, trip event types, and warnings	Always available
	Configuration			
		Configuration Screen	Part number, Port F protocol, Port F baud rate, Port 1 IP address, Port 1 default router, MAC address (IP), MAC address (GOOSE), breaker control jumper, rated frequency, phase rotating, nominal phase CT rating, nominal/neutral CT rating, PT connection, date format	

Bay Control

The SEL-2411 with the touchscreen display option provides you with the ability to design bay configuration screens to meet your system needs. The bay configuration can be displayed as a single-line diagram (SLD) on the touchscreen. You can create as many as five bay screens with three monitor-only breakers and as many as five controllable two-position disconnects. ANSI and IEC symbols, along with analog and digital labels, are available for you to create detailed single-line diagrams of the bay to indicate the status of the breaker and disconnects, bus voltages, and power flow through the breaker. In addition to single-line diagrams, you can design the screens to show the status of various device elements via Device Word bits or to show analog quantities for commissioning or day-to-day operations. These screens can be designed with the help of ACSELERATOR Bay Screen Builder SEL-5036 Software in conjunction with ACSELERATOR QuickSet SEL-5030 Software. Note that the bay screen related settings can only be set via QuickSet (setting via an ASCII terminal is not supported).

This section covers all aspects of the SEL-2411 bay control.

- *Circuit Breaker Symbol Settings and Status Logic on page 8.39*
- *Disconnect Control Settings on page 8.40*
- *Local/Remote Control on page 8.41*
- *Two-Position Disconnect Control Via Touchscreen on page 8.42*
- *Bay Screens Design Using QuickSet and Bay Screen Builder on page 8.43*
- *Bay Control Screen Example on page 8.49*

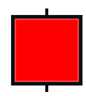
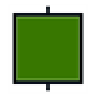
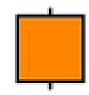
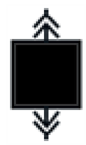
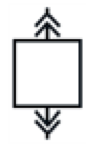
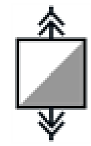
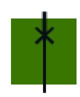
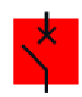
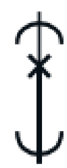
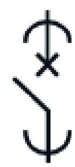
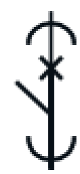
Circuit Breaker Symbol Settings and Status Logic

The SEL-2411 supports as many as three monitor-only circuit breakers. You can map Device Word bits to the Open, Close, and Alarm status in Bay Control settings in QuickSet to display the status of the breaker on the bay screen.

Use SELOGIC control equations to create dual-point status of the breaker with breaker alarm indication. Refer to *Table 8.26* for the Bay Control breaker settings. Refer to *Bay Control Screen Example on page 8.49* for example settings.

Table 8.23 provides typical ANSI and IEC breaker symbols that are supported by Bay Screen Builder. Column 1 identifies the standard (ANSI/IEC) and the type of breaker. Columns 3, 4, and 5 identify closed, open, and alarm states of the breaker image, respectively. Bay Screen Builder allows you to set the breaker color sequence property (identified in Column 2) for each of these states. Select the breaker color sequence based on your system convention. For a complete list of ANSI and IEC circuit breaker symbols available to use with the bay screens, refer to the *ACSELERATOR Bay Screen Builder SEL-5036 Software Instruction Manual*, available in the **Help > Contents** menu of Bay Screen Builder.

Table 8.23 Circuit Breaker Symbols

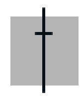
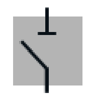
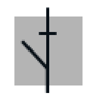
Type	Breaker Color Sequence	State 1 (Closed)	State 2 (Open)	State 3 (Alarm)
ANSI Breaker	Red, Green, Amber			
ANSI Truck Operated Breaker	Black, White, Grey			
IEC Breaker	Green, Red, Amber			
IEC Truck Operated Breaker	Transparent			

Disconnect Control Settings

The SEL-2411 supports as many as five two-position disconnect switches that can be controlled and monitored via the bay screen or control screen application. Map Device Word bits to the Open, Close, and Alarm status in Bay Control settings in QuickSet to control the switch appearance on the bay screen. SW*xx*CC and SW*xx*OC (where *xx* is 01 to 05) are the Switch Open Contact and Switch Close Contact Device Word bits for use in SELOGIC control equations.

Table 8.24 provides typical ANSI and IEC disconnect symbols that are available to use in bay screen design. Column 1 identifies the standard (ANSI/IEC) and the type of disconnect. Column 2 identifies the interior color property of the disconnect. Columns 3, 4, and 5 identify closed, open, and alarm states of the disconnect. For a complete list of ANSI and IEC disconnect symbols available to use with the bay screens, refer to the *ACSELERATOR Bay Screen Builder SEL-5036 Software Instruction Manual*.

Table 8.24 Two-Position Disconnect Symbols

Type	Interior Color	State 1 (Closed)	State 2 (Open)	State 3 (Alarm)
ANSI and IEC Disconnect	Gray			
ANSI and IEC Motor-Operated Disconnect	Transparent			

Local/Remote Control

The SEL-2411 supports local/remote two-position disconnect control functionality through supervision of the OC and CC two-position disconnect control Device Word bits. The supervision of these two-position disconnect control Device Word bits is enabled or disabled by the global setting EN_LRC (see *Table 8.25*). To enable local/remote supervision of the breaker control Device Word bits, set EN_LRC := Y.

When EN_LRC := Y, the LOCAL SELOGIC control equation is available.

Table 8.25 Local/Remote Control Settings

Setting Prompt	Setting Range	Setting Name := Factory Default
ENABLE LOC REM CON	Y, N	EN_LRC := N
LOCAL CONTROL[a]	SELOGIC	LOCAL := 0

[a] This setting is hidden when EN_LRC := N.

The device controls the status of the LOCAL Device Word bit based on the EN_LRC setting.

- When EN_LRC := Y and LOCAL := 1, the device processes the open and close commands from the front panel (two-line display or touchscreen). The commands from remote sources/protocols (DNP3, IEC 61850, etc.) are blocked.
- When EN_LRC := Y and LOCAL := 0, the device processes the open and close commands from remote sources/protocols (DNP3, IEC 61850, etc.). The commands from the front panel are blocked (two-line display or touchscreen).
- When EN_LRC := N, the device processes the open and close commands from both the front panel (two-line display or touchscreen) and remote sources/protocols (DNP3, IEC 61850, etc.).

Enable local/remote control for proper supervision of breaker/disconnect control and operator safety. Map the LOCAL SELOGIC control equation to the status of the local/remote switch on the panel, if available. Alternatively, program one of the front-panel pushbuttons and an LED in conjunction with a SELOGIC latch to mimic the local/remote switch and map it to the LOCAL SELOGIC control equation.

When EN_LRC := Y, the status of local/remote control is indicated on the footer of the touchscreen as “L” for local (LOCAL = 1) and “R” for remote (LOCAL = 0). If you do not intend to use the built-in local/remote function, and prefer to create your own control function using SELOGIC and remote bits, set EN_LRC := N. When EN_LRC := N, “LR,” as shown in *Figure 8.63*, indicates that OC and CC bits are processed from both the touchscreen and remote sources/protocols. Local/remote indication is only available on the SEL-2411 touchscreen display model.

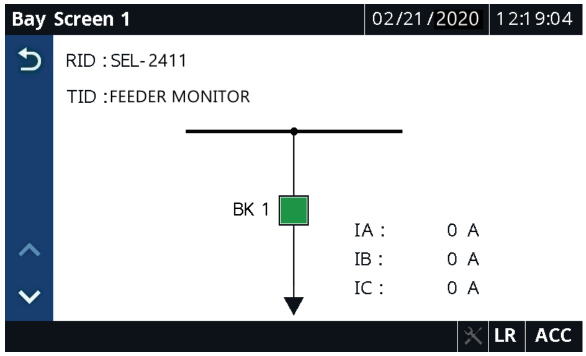


Figure 8.63 Local/Remote Control Mode Indication

Two-Position Disconnect Control Via Touchscreen

The SEL-2411 touchscreen enables you to control the two-position disconnect switch via two applications: Bay Screen or Control Switch Bit. The Bay Screens application is available on the Home screen. Switch control via the Bay Screens application requires you to design a bay control single-line diagram. *Figure 8.64* shows a sample single-line diagram with a controllable two-position disconnect switch and a motor. For more details on how to design this screen, refer to *Bay Control Screen Example on page 8.49*.

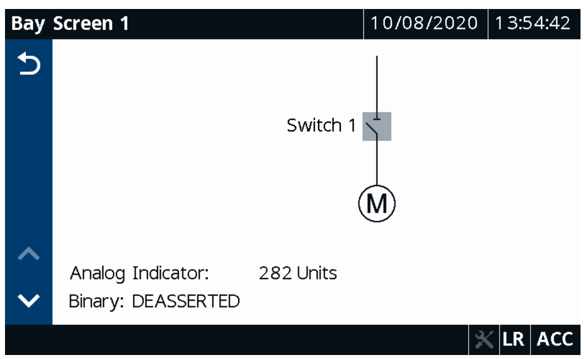


Figure 8.64 Bay Screens Application Display With a Single-Line Diagram

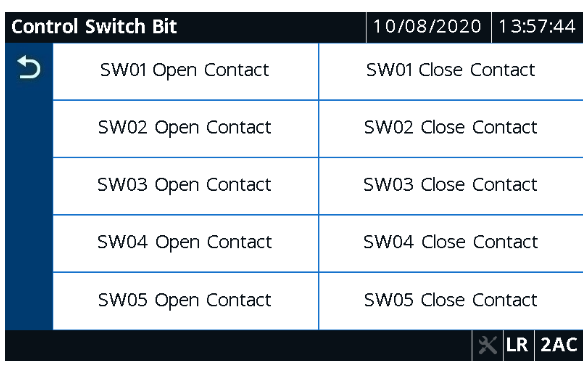


Figure 8.65 Bay Screen Two-Position Disconnect Control Application

You can also control the two-position disconnect via the Control Switch Bit application, which is available in the Control folder. This application is built-in and is always available for you to perform switch control. *Figure 8.66* shows the two-position disconnect control application display.

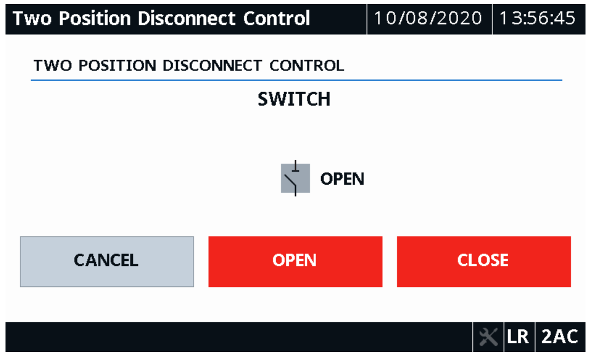


Figure 8.66 Breaker Control Application

The Bay Screens and Control Switch Bit applications will only pulse the Open Contact and Close Contact if the following conditions are satisfied.

1. EN_LRC := Y and Device Word bit LOCAL is asserted. If EN_LRC := N, then this check is ignored.
2. You are at Access Level 2. The device prompts for the Access Level 2 password if you are not at Access Level 2.

When the conditions are satisfied, the application pulses the SW*xx*OC or SW*xx*CC bit, respectively, depending on your selection for breaker open or close.

Bay Screens Design Using QuickSet and Bay Screen Builder

QuickSet and Bay Screen Builder provide user-friendly interfaces to set the touchscreen settings. The touchscreen settings are not available for setting via ASCII terminal, unlike the other device settings. The touchscreen settings are only available if the device part number is configured with eight pushbuttons and the touchscreen display under the Front-Panel Options dropdown menu is as shown in *Figure 8.67*. *Figure 8.68* shows the Touchscreen settings in QuickSet.

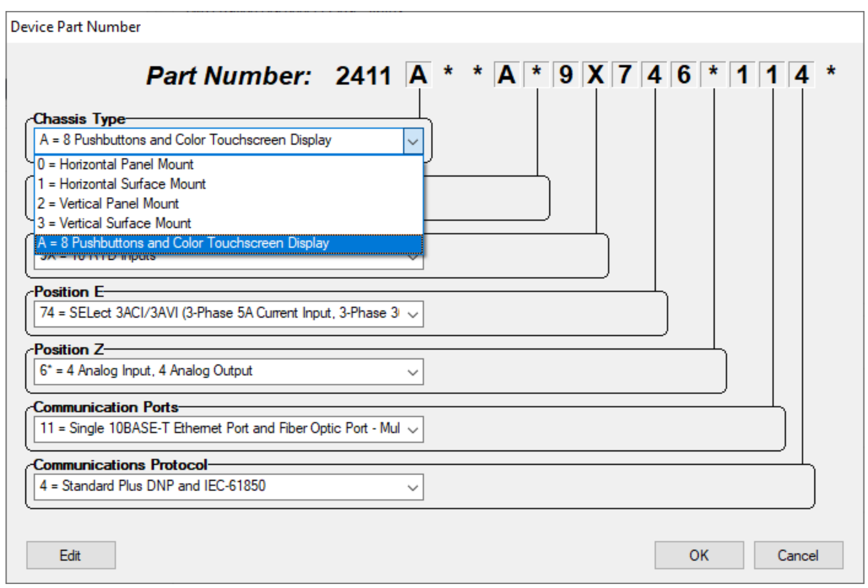


Figure 8.67 QuickSet Front-Panel Options

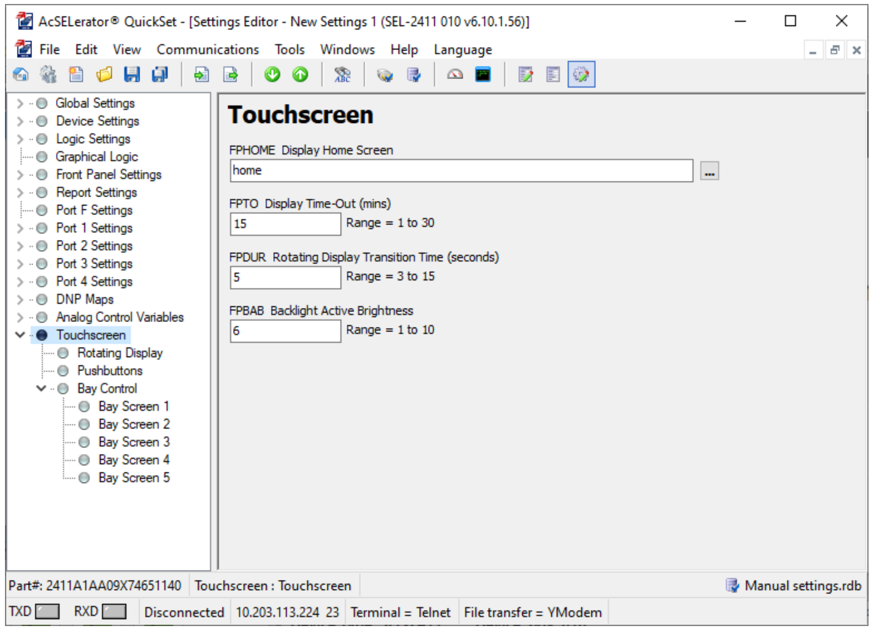


Figure 8.68 QuickSet Touchscreen Settings

NOTE: The settings in Table 8.26 are populated under each of the custom screens (sld1–sld5) based on the dynamic symbols you choose.

Table 8.26 Touchscreen Settings (Sheet 1 of 2)

Setting Prompt	Setting Range	Setting Name := Factory Default
Display Settings		
Display Home Screen	See *Table 8.22*	FPHOME := HOME
Display Time-Out	1–30 min	FP_TO := 15
Rotating Display Transition Time	3–15 sec	FPDUR := 5
Backlight Active Brightness	1–10	FPBAB := 6
Rotating Display Screen Settings (kk = 01–16)		
Rotating Display 01	See *Table 8.22*	FPRD01 := Bay Screen 1
Rotating Display *kk*	See *Table 8.22*	FPRD*kk* :=
Pushbutton Settings (nn = 01–04 or 01–08 depending on the ordering option selected)		
Pushbutton *nn* HMI Screen	OFF, See *Table 8.22*	FPPB*nn* := OFF
Bay Control Breaker Settings		
Breaker Trip Type	3	(customer named) := 3
Breaker Mode	MONITOR	(customer named) := MONITOR
Breaker Close Status	Device Word Bit	(customer named) := NA
Breaker Open Status	Device Word Bit	(customer named) := NA
Breaker Alarm Status	Device Word Bit	(customer named) := NA
Bay Control Two-Position Disconnect Settings (m = 1–8)		
Two-Position Disconnect Close Status	Device Word Bit	(customer named) := NA
Two-Position Disconnect Open Status	Device Word Bit	(customer named) := NA

Table 8.26 Touchscreen Settings (Sheet 2 of 2)

Setting Prompt	Setting Range	Setting Name := Factory Default
Two-Position Disconnect Alarm Status	Device Word Bit	(customer named) := NA
Bay Control Analog Label Settings (qq = 01–32)		
Analog Quantity	Analog Quantity	(customer named) := NA
Bay Control Digital Label Settings (qq = 01–32)		
Device Word Bit	Device Word Bit Name	(customer named) := NA

Display Settings

Use these settings to configure the touchscreen. Pressing the **HOME** pushbutton on the front panel takes you to the screen configured as part of the FPHOME setting. By default, FPHOME is set to the Home screen, which displays the Home screen folders and applications. You can set FPHOME to any screen that you like to view when the **HOME** pushbutton is pressed (see *Table 8.22* for the list of available screens).

To help prevent unauthorized access to password-protected functions, the SEL-2411 provides a front-panel timeout setting, FP_TO. The timeout resets each time you press a front-panel pushbutton or the screen detects a touch. When the timeout expires, the access level resets to Access Level 1 and switches to the rotating display if at least one screen is configured as part of the rotating display settings, FPRD*kk* (*kk* = 01–16), if not, the display switches to the Home screen. The rotating display transition time setting FPDUR defines the duration that each screen is displayed on the rotating display. Set FPDUR to a transition time most suitable to your application.

Use the FPBAB setting to control the backlight active brightness.

Rotating Display Settings

The SEL-2411 allows you to configure as many as 16 screens for the rotating display. Configure the settings FPRD*kk* (*kk* = 01–16) to the screens most suitable to your application. Refer to *Table 8.22* for the list of screens available as part of the FPRD*kk* settings.

Pushbutton Settings

The pushbutton settings FPPB*nn* (*nn* = 01–04 or 01–08) allow you to quickly navigate to a specific screen by pressing the programmed pushbutton. Refer to *Table 8.22* for the list of screens available for the FPPB*nn* settings. Note that a given pushbutton can be configured to navigate to a specific screen but can also be used in SELOGIC (e.g., PB01 Device Word bit). The device does not prevent you from configuring a pushbutton for two purposes. Make sure to set dual-purpose pushbuttons with care to ensure safe operation.

Bay Control Breaker Settings

Bay control breaker monitoring settings are available when the bay screen contains a breaker symbol. When QuickSet detects a breaker symbol, it will populate the associated bay screen settings page with Open, Close, and Alarm status settings grouped under the breaker name defined by “Display Text” in Bay Screen Builder. Place Device Word bits in these status settings to control the breaker appearance on the bay screen.

Bay Control Disconnect Settings

Two-position disconnect switch settings are available when the bay screen contains one or more disconnect switch symbols. When QuickSet detects one or more disconnect symbols, it will populate the associated bay screen settings page with Open, Close, and Alarm status settings grouped under the two-position disconnect name defined by "Display Text" in Bay Screen Builder. In control mode, the two-position disconnect HMI Close/Open commands are SW*xx*CC and SW*xx*OC (*xx* is the instance number of the switch).

For example, if the two-position disconnect named "Motor 1 SW" is touched on the bay screen, the Switch Control Screen will prompt for the Open or Close command. If the Open button is selected, SW01OC will pulse for one processing cycle (4 ms). Conversely, if Close is selected, SW01CC will pulse for one processing cycle. The switch designation is 01 because it was the first switch placed on the bay screen diagram. In SELOGIC, if Latch 1 settings are SET01 := SW01CC and RST01 := SW01OC, selecting the "Motor 1 SW" Close command will set LT01 and Open will reset LT01.

Bay Control Analog Label Settings

NOTE: Thermal metering analog quantities must have the leading string "string_" before the analog quantity (e.g., INTRTD01 = STRING_INTRTD01, EXTRTD01 = STRING_EXTRTD01, INTEMP01 = STRING_INTEMP01

Analog label settings are available when QuickSet detects an analog label as part of the bay screen diagram. Configure the analog label with any device analog quantity on the associated bay screen settings page.

Bay Control Digital Label Settings

Digital label settings are available when QuickSet detects a digital label as part of the bay screen diagram. Configure the digital label with any Device Word bit on the associated bay screen settings page.

Bay Screen Builder Software

NOTE: Refer to the Product Literature CD for a list of UTF-8 characters that can be rendered on the bay screen in Bay Screen Builder.

The Bay Screen Builder Software provides an intuitive and powerful interface to design bay screens to meet your application needs. This instruction manual provides only a brief overview of the Bay Screen Builder Software. For more details, refer to the *ACSELERATOR Bay Screen Builder SEL-5036 Software Instruction Manual* available from the **Help** > **Contents** menu in Bay Screen Builder or at selinc.com.

Several of the settings identified in *Table 8.26* are available for you to set depending on the symbols chosen for your single-line diagram. *Figure 8.69* shows the layout of Bay Screen Builder and identifies different menus, panes, and information.

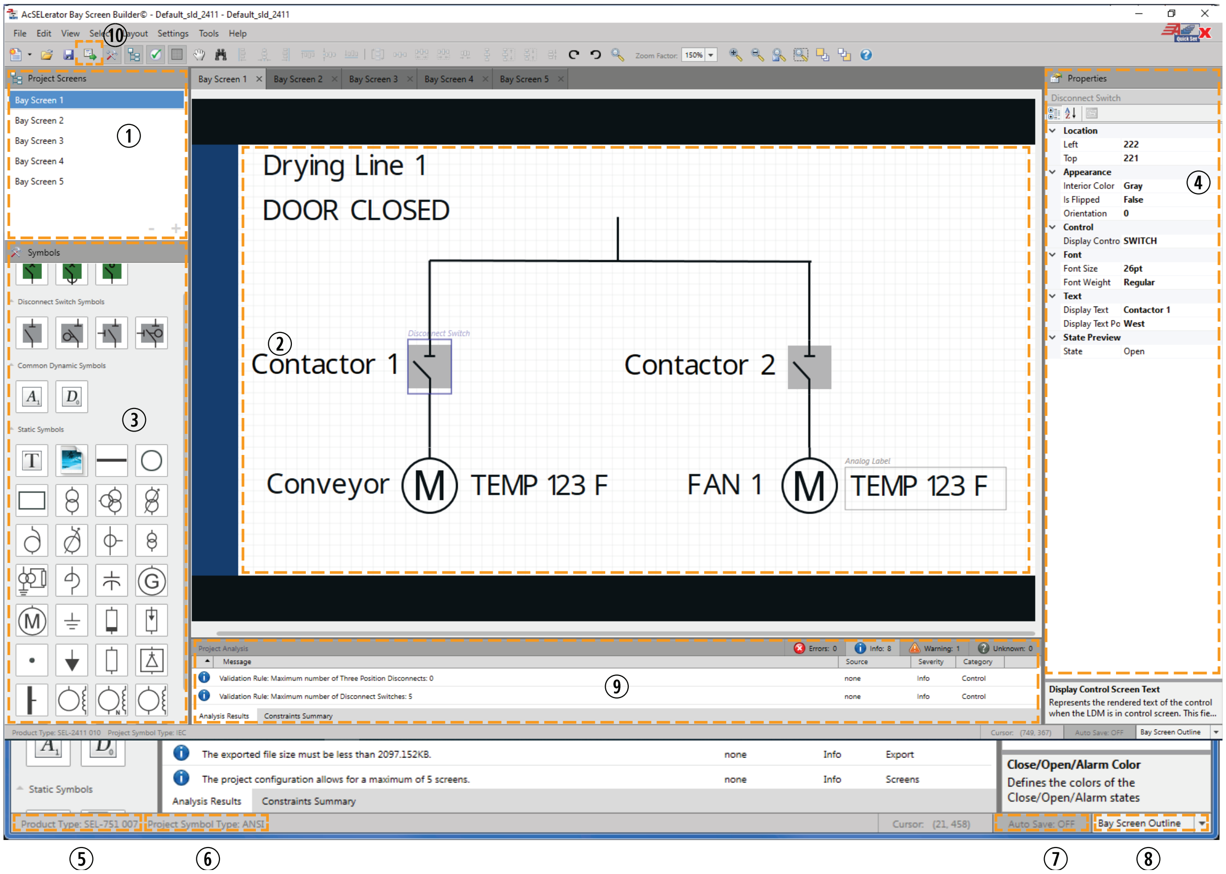


Figure 8.69 Layout of Bay Screen Builder

Descriptions of the different menus, panes, and information in Bay Screen Builder are as follows:

① **Project Screens Pane:** Displays the names of the screens (as many as 5) present in a project. Select a screen name to open the screen, and double-click or right-click a screen name to access additional options for that screen.

② **Screen Area:** Displays the selected project screen and its symbols. Create a single-line diagram or a metering or status screen by dragging and dropping symbols from the Symbols pane.

③ **Symbols Pane:** Displays the symbols available for selection. Bay Screen Builder supports several static and a limited number of dynamic ANSI and IEC symbols. Note that for a given project, you can only use either ANSI *or* IEC symbols, not both. While there are no constraints on the number of static symbols, Bay Screen Builder limits the number of dynamic symbols. The following table provides the number of breakers, disconnects, analog labels, and digital labels supported in a given project.

Symbols	Number of Supported Symbols per Project
Breakers	3
Two-Position Disconnects	5
Analog Labels	32
Digital Labels	32

④ **Properties Pane:** Displays the properties of a selected symbol. Edit the symbol properties as needed for your application. For instance, the breaker color sequence property identified in *Table 8.23* can be set via the appearance property of the breaker symbol. Bay Screen Builder supports UTF-8 character encoding. Refer to the Product Literature CD for a complete list of UTF-8 characters that can be rendered on the touchscreen display.

⑤ **Product Type:** Displays the name of the QuickSet driver version of the product associated with the selected project (e.g., SEL-2411 010, as shown in *Figure 8.69*). Select the product type in Bay Screen Builder when you create a new project independent of QuickSet. View Product Type though **Settings** > **Project Settings**. If a project is edited via QuickSet, Bay Screen Builder inherits the product type from the QuickSet settings file. You can export the project file with a different QuickSet driver version using **File** > **Export Package As**.

⑥ **Project Symbol Type:** Displays the symbol type (IEC or ANSI) associated with the selected project as shown in *Figure 8.69*. Select the symbol type when you create a new project. If a project is edited via QuickSet, the ANSI symbol type is selected by default.

⑦ **Auto Save:** Provides a shortcut for changing the auto save setting for the application. Enable **Auto Save** to allow Bay Screen Builder to automatically save your project periodically. Your auto save setting preference is saved when you exit the application and is applied the next time you launch Bay Screen Builder. You can also set **Auto Save** through **Settings** > **Application Settings** > **File Handling**.

⑧ **Bay Screen Outline:** Displays the dropdown list of symbols on the presently open screen. Select a symbol from the list to make it active. The bay screen outline provides an alternate way to select the symbols and is most useful in cases where symbols are crowded or stacked.

⑨ **Project Analysis Pane:** Displays troubleshooting information/messages about the project (Errors, Info, Warning, Unknown). The project analysis pane supports two tabs: Analysis Results and Constraints Summary, as shown in *Figure 8.68* and *Figure 8.69*, respectively.

The **Analysis Results** tab displays details about the error, information, warning, and unknown messages for the project. You can use these messages for troubleshooting. Select a message type button to view the messages for that category. For example, select the **Errors** button to view the error messages for the project. Select a column header to sort by the information in that column (see *Figure 8.70*).

The **Constraints Summary** tab provides information about the rules that apply to the present project. All conditions listed under Symbol Constraints must be satisfied for a project to be valid. You can only publish a valid project, but you can save a project with errors (see *Figure 8.71*).

⑩ **Publish Package** button will publish the bay screen back into QuickSet for uploading to the SEL-2411.

Figure 8.70 Project Analysis Pane: Analysis Results Tab

NOTE: The Constraints Summary tab shows the usage and limits of dynamic symbols for an entire project (all screens). Although not constrained, it is recommended that you limit the dynamic symbols to 32 symbols per screen for faster screen updates.

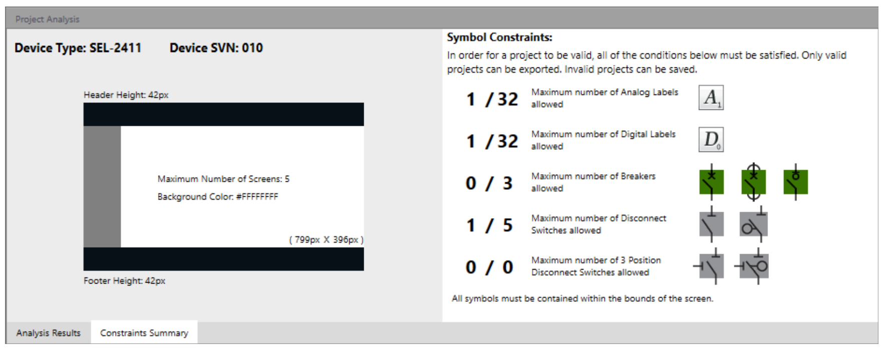


Figure 8.71 Project Analysis Pane: Constraints Summary Tab

You can adjust the size of the panes in the application. If you reconfigure the size of any of these panes, the new size is saved when you exit the application and applies the next time you launch Bay Screen Builder.

Bay Control Screen Example

Specific components of bay screens are covered in Bay Screens Design Using QuickSet and Bay Screen Builder. This section provides a summarized application example for building a bay control screen. Refer to the *ACSELERATOR Bay Screen Builder SEL-5036 Software Instruction Manual*, available from the **Help** > **Contents** menu in Bay Screen Builder or at selinc.com, for more specific details regarding bay screen creation and symbol properties.

The SEL-2411 supports as many as five custom screens. Edit the predefined bay screen (Bay Screen 1) and the blank screens (Bay Screen 2, Bay Screen 3, Bay Screen 4, and Bay Screen 5) (see *Figure 8.72*) by using QuickSet.

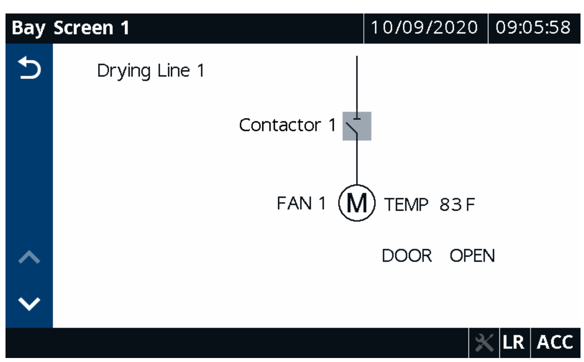


Figure 8.72 Example Bay Screen Diagram

These steps can be executed with out access to an SEL-2411 touchscreen. Only the final step, uploading the custom bay screen, requires an SEL-2411 touchscreen.

To use the QuickSet and Bay Screen Builder to create bay screens for the SEL-2411, your device part number must support the touchscreen. **Note:** This example also requires the 10 RTD card and a 4 Digital Input/4 Digital Output card.

Step 1. Create an SEL-2411 settings file configured for the touch screen display, the 10RTD card, and the 4 Digital Input /4 Digital Output card for this example (Part Number = 2411A1A009X74151140) (see *Figure 8.73*).

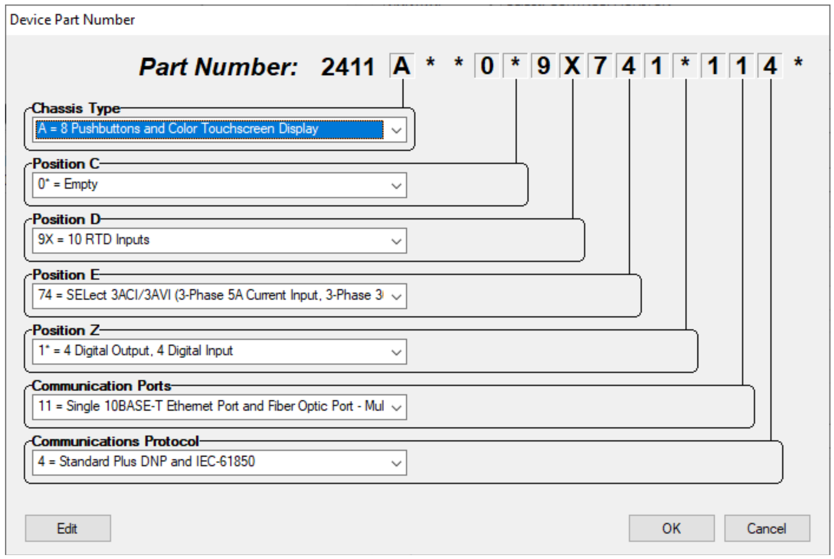


Figure 8.73 Device Part Number Touchscreen Configuration Option

Step 2. Select **OK.**

Step 3. Expand the Touchscreen settings class.

Step 4. Select **Bay Control**.

QuickSet displays project management buttons and a project preview that includes a small-scale view of five project (one default bay screen and a four blank bay screens) and an enlarged view of the bay screen currently selected (see *Figure 8.74*).

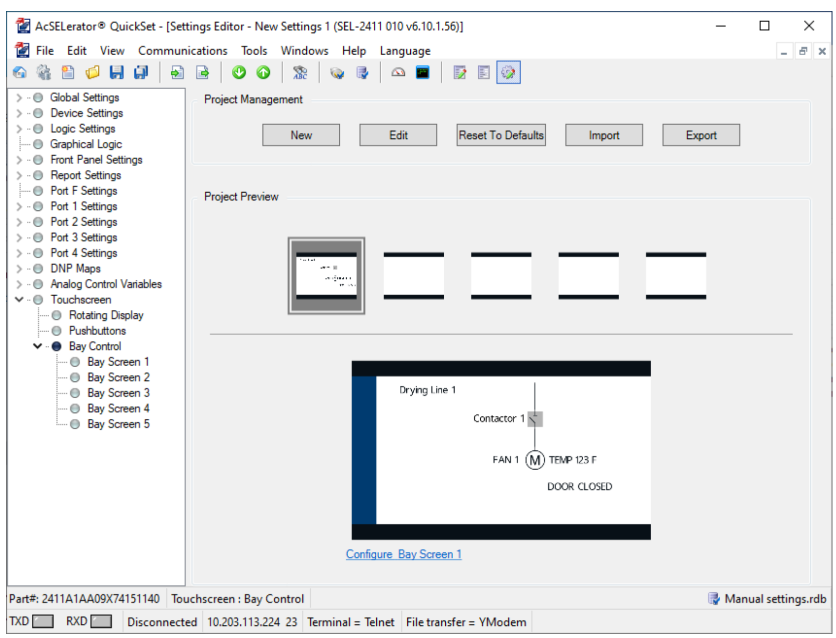


Figure 8.74 QuickSet Bay Control Project Management and Project Preview Display

Build Custom diagrams in Bay Screen Builder

Use Bay Screen Builder to create a custom display screen to load on the SEL-2411 through QuickSet. To create the custom screen seen in *Figure 8.72*, perform the following steps.

Step 1. Select a Blank diagram and select **Edit**, as shown in *Figure 8.75*, to launch the Bay Screen Builder software.

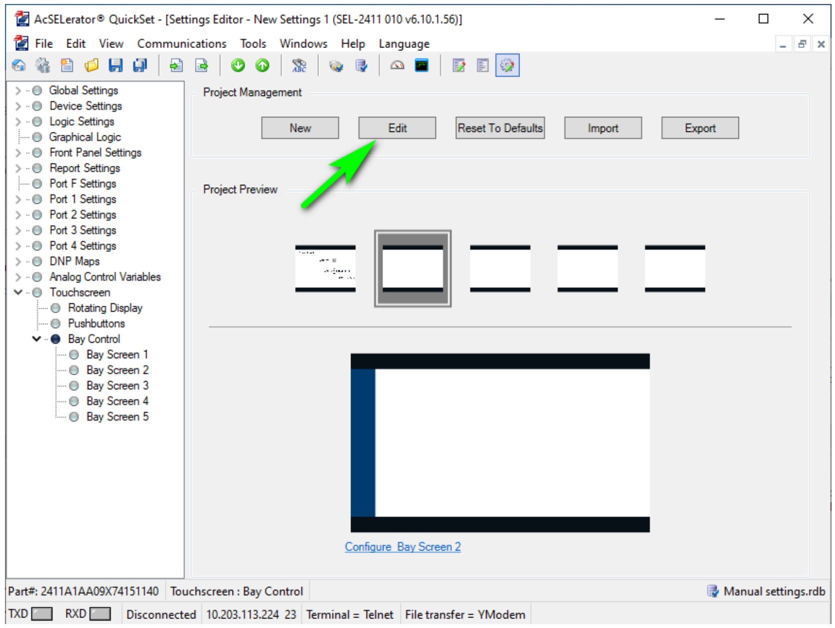


Figure 8.75 Open Diagram in Bay Screen Builder

Step 2. Drag-and-drop the symbols required for your diagram and arrange them, as seen in *Figure 8.72*. The required symbols are highlighted with orange boxes in *Figure 8.76*. The symbols required are as follows: two text boxes, two lines, one motor, one analog label, one digital label, and a two-position disconnect switch.

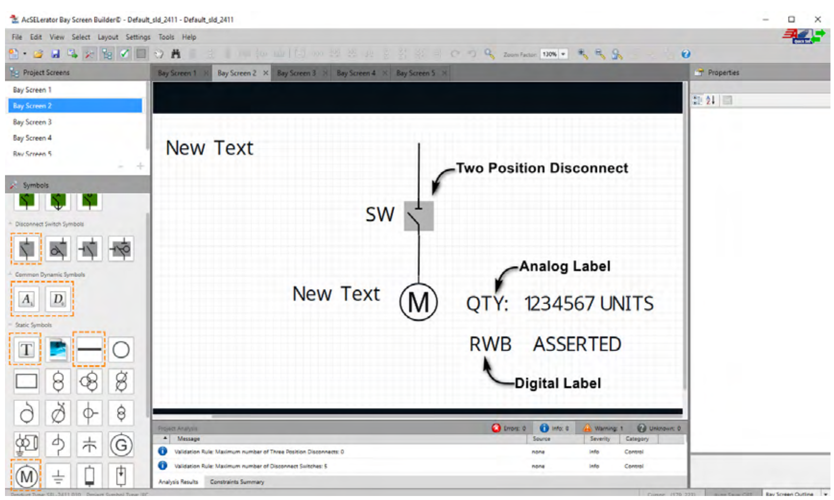


Figure 8.76 Required Drag-and-Drop Symbols

Step 3. To update the text labels, double-click them to display the text editor box.

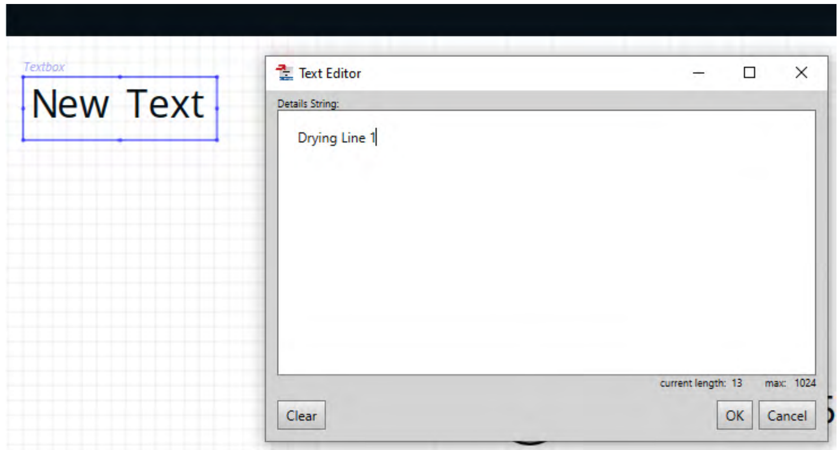


Figure 8.77 Text Editor

Step 4. Name the two-position disconnect by changing the **Display Text** indicated in *Figure 8.78*. This is the identifier used to configure the Open, Close, and Alarm input settings in QuickSet.

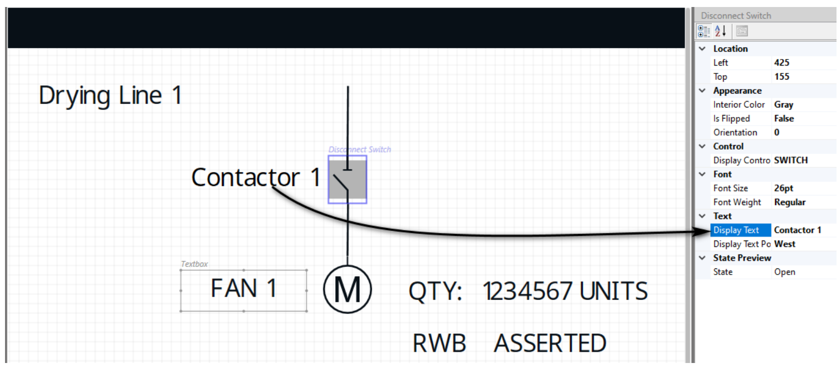


Figure 8.78 Edit Disconnect Switch

Step 5. Name the analog label by modifying the Pre Text value. Value Text is the displayed measurement. Place the maximum number of characters you want to display in Preview Text. Enter the units in Post Text (see *Figure 8.79*).

NOTE: Enter a width of 10 in the text width boxes to coerce the width to the minimum width required for the text.

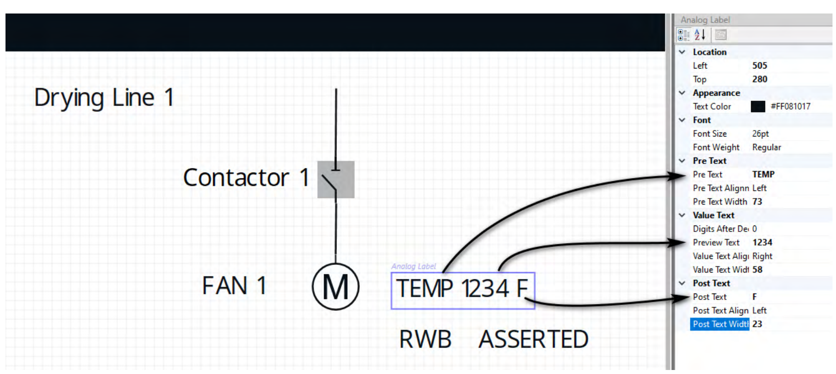


Figure 8.79 Edit Analog Label Properties

Step 6. Name the Digital label by modifying the Pre Text indicated in *Figure 8.80*. Asserted Text under Displayed Text will display when the associated Device Word bit evaluates to a logical TRUE, where as a Deasserted displays in the case of a logical FALSE.

NOTE: Enter a width of 10 in the text width boxes to coerce the width to the minimum width required for the text.

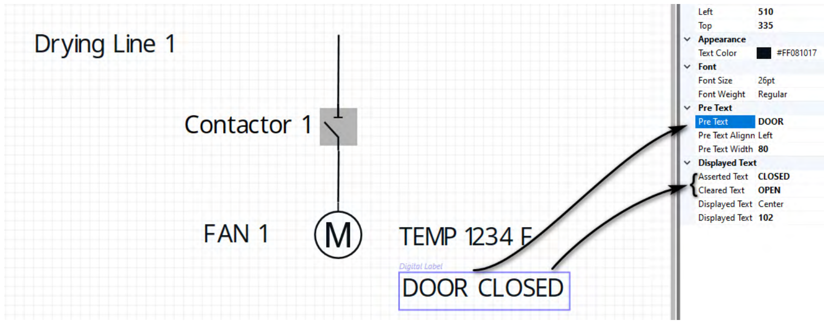


Figure 8.80 Edit Digital Label Properties

Step 7. To load the custom diagram in to QuickSet, select **Publish Package** indicated by the orange box next to the save icon in *Figure 8.81*.

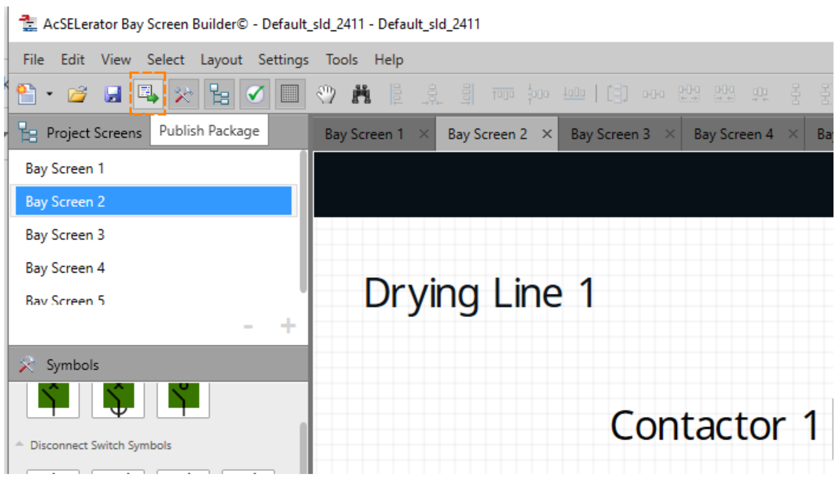


Figure 8.81 Publish Package Button

Edit Settings in QuickSet

Step 1. Select the Bay Screen settings under the Bay Control class (see *Figure 8.82*).

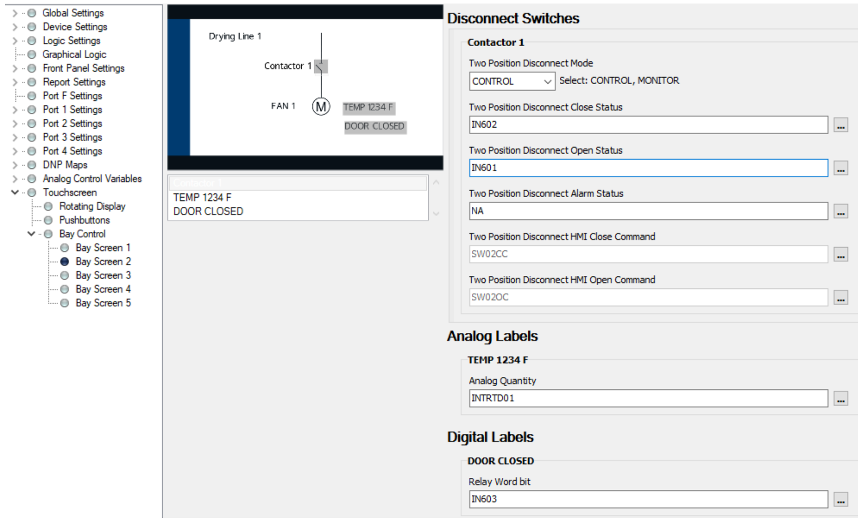


Figure 8.82 Configure Labels in QuickSet

In this example the two-position disconnect Open position status is connected to IN601 and the close status is connected to IN402. The open contact is OUT401 and the close contact is OUT602. The door switch status is connected to IN603. The Temperature sensor is RTD 1. Configure the settings shown in *Figure 8.82* as follows:

> Contactor 1
> Two Position Disconnect Mode := **CONTROL**
> Two Position Disconnect Close Status := **IN602**
> Two Position Disconnect Open Status := **IN601**
>
> Analog Labels
> TEMP := **INTRTD01**
>
> Digital Labels
> DOOR := **IN603**

The Two Position Disconnect HMI Close Command and Two Position Disconnect HMI OPEN Command Device Word bits are SW02CC and SW02OC in this example. This is because there was already a switch on Bay Screen 1 with the name SW01OC/CC.

Step 2. Under the Logic Settings Class configure OUT601 := SW02OC and OUT602 := SW02CC.

Step 3. Send Active Settings to the SEL-2411.

Note: SW*xx*OC and SW*xx*CC (*xx* = 01–05) pulse for one processing cycle or approximately 4 ms. If that assertion time is not long enough for your application, consider using SELOGIC timers to stretch the pulse with a delayed dropout:

> SV01 := SW02OC
> SV01PU := 0
> SV01DO := 0.500
> SV02 := SW02CC
> SV02PU := 0
> SV02DO := 0.500
> OUT601 := SV01T
> OUT602 := SV02T;

These settings will cause OUT601 and OUT602 to assert for 500 ms when SW02OC or SW02CC are pulsed.

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). The SEL-2411 offers four types of event reports: standard ASCII (EVE) reports, Compressed ASCII (CEV) reports, binary COMTRADE reports, and Sequential Event Recorder (SER) 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: Device Word Bits*)

- ➤ 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.
CEV R *n*	Displays Compressed ASCII event reports with raw (unfiltered) data.

See the *CEVENT Command (Compressed Event Report) on page 7.15* 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 as many as 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-stamped 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.44* 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 as many as 15 elements (as many as 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 7.40* 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 QuickSet. 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 7.25* 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** or **CEV** 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

```
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 (Continued)

Retrieving Event Reports Via Ethernet File Transfer

Event reports are available as read-only files that can be retrieved using Ethernet File Transfer Protocol (FTP) or Manufacturing Message Specification (MMS). MMS is only available in models that support IEC 61850 and only when IEC 61850 and MMS file transfer are enabled (E61850 := Y, EMMSFS := Y).

The Ethernet file server EVENTS folder contains three categories of files for each event stored in the relay:

- ➤ Compressed, 4 sample/cycle, filtered event, equivalent to issuing a **CEV** command. These files are named C4.*nnnnn*.cev, where *nnnnn* is the unique event identifier.
- ➤ Compressed, 16 sample/cycle, unfiltered event, equivalent to issuing a **CEV R** command. These files are named CR.*nnnnn*.cev, where *nnnnn* is the unique event identifier.
- ➤ 16 sample/cycle, unfiltered event, with 3 files per event according to the COMTRADE standards. These files are named HR.*nnnnn*.cfg, HR.*nnnnn*.hdr, and HR.*nnnnn*.dat, where *nnnnn* is the unique event identifier.

The date and time displayed for events are from the time of event trigger. The times are UTC.

The EVENTS folder also contains the event history with unique event identification number (equivalent to the **HIS** command) and the compressed event history (equivalent to the **CHIS** command). See *HISTORY Command (Events List) on page 7.25*. The event files can also be retrieved with the **FIL** command. See *FILE Command (Manage Settings Files) on page 7.25* and *CHISTORY Command (Compressed History) on page 7.15* for additional information.

CEVENT

The relay provides a Compressed ASCII event report for SCADA and other automation applications. QuickSet uses Compressed ASCII commands to gather event report data. If you want to view the Compressed ASCII event report data, use a terminal to issue ASCII command **CEV**. A sample of the report appears in *Figure 9.2*; this is a comma-delimited ASCII file. The relay appends a four-digit hex checksum at the end of the line in the Compressed ASCII report.

Items included in the Compressed ASCII event report are similar to the event report, although the relay reports the items in a special order. CEV files (and COMTRADE files) include all Device Word bits (see *Appendix H: Device Word Bits*).

```
==>CEV <Enter>
"FID","CEV_VER","03DD"
"FID=SEL-2411-X015-V0-Z011008-D20230201","2.0.1","0A32"
"MONTH","DAY","YEAR","HOUR","MIN","SEC","MSEC","0ACA"
2,10,2023,17,38,50,933,"0465"
```

Report Header

```
"NUM_CH_A","NUM_CH_D","FREQ","NFREQ","SAM/CYC_A","SAM/CYC_D","NUM_OF_CYC","PRIM_VAL","CTR_IA","CTR_IB","CT
    R_IC","CTR_IN","CTR
X_IA","CTRX_IB","CTRX_IC","PTR_VA","PTR_VB","PTR_VC","EVENT","IA(A)","IB(A)","IC(A)","IAX(A)","IBX(A)","IC
    X(A)","IN(A)","VA(V
)","VB(V)","VC(V)","40CC"
```

Summary Labels

```
10,1304,60.0,60,4,4,15,"YES",250.00,250.00,250.00,250.00,250.00,250.00,250.00,35.00,35.00,35.00,"TR
IG",2.2,0.7,1.6,0.06,2.5,2.5,7.1,0.000,0.783,1.565,"1CDE"
```

Summary Data

```
"IA(A)","IB(A)","IC(A)","IN(A)","IAX(A)","IBX(A)","ICX(A)","VA(V)","VB(V)","VC(V)","TRIG","PB01_LED
    PB02_LED PB03_LED PB04_LE
D FREQTRK SALARM * HALARM RB01 RB02 RB03 RB04 RB05 RB06 RB07 RB08 RB09 RB10 RB11 RB12 RB13 RB14 RB15 RB16
    RB17 RB18 RB19 RB20
 RB21 RB22 RB23 RB24 RB25 RB26 RB27 RB28 RB29 RB30 RB31 RB32 LB01 LB02 LB03 LB04 LB05 LB06 LB07 LB08 LB09
    LB10 LB11 LB12 LB13
 LB14 LB15 LB16 LB17 LB18 LB19 LB20 LB21 LB22 LB23 LB24 LB25 LB26 LB27 LB28 LB29 LB30 LB31 LB32 SV01 SV02
    SV03 SV04 SV05 SV06
 SV07 SV08 SV01T SV02T SV03T SV04T SV05T SV06T SV07T SV08T SV09 SV10 SV11 SV12 SV13 SV14 SV15 SV16 SV09T
    SV10T SV11T SV12T SV
13T SV14T SV15T SV16T SV17 SV18 SV19 SV20 SV21 SV22 SV23 SV24 SV17T SV18T SV19T SV20T SV21T SV22T SV23T
    SV24T SV25 SV26 SV27
SV28 SV29 SV30 SV31 SV32 SV25T SV26T SV27T SV28T SV29T SV30T SV31T SV32T SV33 SV34 SV35 SV36 SV37 SV38 SV39
    SV40 SV33T SV34T
SV35T SV36T SV37T SV38T SV39T SV40T SV41 SV42 SV43 SV44 SV45 SV46 SV47 SV48 SV41T SV42T SV43T SV44T SV45T
    SV46T SV47T SV48T S
V49 SV50 SV51 SV52 SV53 SV54 SV55 SV56 SV49T SV50T SV51T SV52T SV53T SV54T SV55T SV56T SV57 SV58 SV59 SV60
    SV61 SV62 SV63 SV6
4 SV57T SV58T SV59T SV60T SV61T SV62T SV63T SV64T SET01 SET02 SET03 SET04 SET05 SET06 SET07 SET08 RST01
    RST02 RST03 RST04 RST
05 RST06 RST07 RST08 SET09 SET10 SET11 SET12 SET13 SET14 SET15 SET16 RST09 RST10 RST11 RST12 RST13 RST14
    RST15 RST16 SET17 SE
T18 SET19 SET20 SET21 SET22 SET23 SET24 RST17 RST18 RST19 RST20 RST21 RST22 RST23 RST24 SET25 SET26 SET27
    SET28 SET29 SET30 S
ET31 SET32 RST25 RST26 RST27 RST28 RST29 RST30 RST31 RST32 LT01 LT02 LT03 LT04 LT05 LT06 LT07 LT08 LT09 LT10
    LT11 LT12 LT13 L
T14 LT15 LT16 LT17 LT18 LT19 LT20 LT21 LT22 LT23 LT24 LT25 LT26 LT27 LT28 LT29 LT30 LT31 LT32 SC01QU SC02QU
    SC03QU SC04QU SC0
5QU SC06QU SC07QU SC08QU SC01QD SC02QD SC03QD SC04QD SC05QD SC06QD SC07QD SC08QD SC09QU SC10QU SC11QU SC12QU
    SC13QU SC14QU SC
15QU SC16QU SC09QD SC10QD SC11QD SC12QD SC13QD SC14QD SC15QD SC16QD SC17QU SC18QU SC19QU SC20QU SC21QU
    SC22QU SC23QU SC24QU S
C17QD SC18QD SC19QD SC20QD SC21QD SC22QD SC23QD SC24QD SC25QU SC26QU SC27QU SC28QU SC29QU SC30QU SC31QU
    SC32QU SC25QD SC26QD
SC27QD SC28QD SC29QD SC30QD SC31QD SC32QD RSTENRGY DSABLSET RSTTRGT ER TRGTR SPEN MATHSTRT MATHTSK RELAY_EN
    RSTMXMN RSTDEM RS
TPKDM MATHERR ERTDIN ERTDFLT * IN101 IN102 * * * * * WARNING IN301 IN302 IN303 IN304 * * * * * * * * * * *
    * * * * * * * * *
* * * * * * * * OUT101 OUT102 OUT103 * * * * * OUT301 OUT302 OUT303 OUT304 * * * * * * * * * * * * * * * *
    * * * * * * * * *
* * * AILW1 AILW2 AILAL * AIHW1 AIHW2 AIHAL * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
    * * * * * * * * *
 * * * * * * * * * * * * * * * * * * * * * * * * AI401LW1 AI401LW2 AI401LAL * AI401HW1 AI401HW2 AI401HAL *
    AI402LW1 AI402LW2
AI402LAL * AI402HW1 AI402HW2 AI402HAL * AI403LW1 AI403LW2 AI403LAL * AI403HW1 AI403HW2 AI403HAL * AI404LW1
    AI404LW2 AI404LAL
* AI404HW1 AI404HW2 AI404HAL * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
    * * * * * * * * *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
    * * * * * * * * *
 * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * LINKA
    LINKB LINKFAIL PAS
EL PBSEL * * * IN101E IN102E * * * * * * IN301E IN302E IN303E IN304E * * * * * * * * * * * * * * * * * * *
    * * * * * * * * *
```

Column Labels

Figure 9.2 Sample Compressed ASCII Event Report

```
RMB8A RMB7A RMB6A RMB5A RMB4A RMB3A RMB2A RMB1A TMB8A TMB7A TMB6A TMB5A TMB4A TMB3A TMB2A TMB1A RMB8B RMB7B
    RMB6B RMB5B RMB4B
 RMB3B RMB2B RMB1B TMB8B TMB7B TMB6B TMB5B TMB4B TMB3B TMB2B TMB1B LBOKB CBADB RBADB ROKB LBOKA CBADA RBADA
    ROKA PB01 PB02 PB
03 PB04 PB05 PB06 PB07 PB08 PB01_PUL PB02_PUL PB03_PUL PB04_PUL PB05_PUL PB06_PUL PB07_PUL PB08_PUL VB001
    VB002 VB003 VB004 V
B005 VB006 VB007 VB008 VB009 VB010 VB011 VB012 VB013 VB014 VB015 VB016 VB017 VB018 VB019 VB020 VB021 VB022
    VB023 VB024 VB025
VB026 VB027 VB028 VB029 VB030 VB031 VB032 VB033 VB034 VB035 VB036 VB037 VB038 VB039 VB040 VB041 VB042 VB043
    VB044 VB045 VB046
 VB047 VB048 VB049 VB050 VB051 VB052 VB053 VB054 VB055 VB056 VB057 VB058 VB059 VB060 VB061 VB062 VB063 VB064
    VB065 VB066 VB06
7 VB068 VB069 VB070 VB071 VB072 VB073 VB074 VB075 VB076 VB077 VB078 VB079 VB080 VB081 VB082 VB083 VB084
    VB085 VB086 VB087 VB0
88 VB089 VB090 VB091 VB092 VB093 VB094 VB095 VB096 VB097 VB098 VB099 VB100 VB101 VB102 VB103 VB104 VB105
    VB106 VB107 VB108 VB
109 VB110 VB111 VB112 VB113 VB114 VB115 VB116 VB117 VB118 VB119 VB120 VB121 VB122 VB123 VB124 VB125 VB126
    VB127 VB128 PB01BLE
D PB02BLED PB03BLED PB04BLED PB05BLED PB06BLED PB07BLED PB08BLED * * * * DST * * * TSNTPB TSNTPP * * * * *
    * IRIGOK * * TDNP3
 * * * * PB05_LED PB06_LED PB07_LED PB08_LED * * * * IAHW1 IAHW2 IAHAL * IBHW1 IBHW2 IBHAL * ICHW1 ICHW2
    ICHAL * INHW1 INHW2
INHAL * IAXHW1 IAXHW2 IAXHAL * IBXHW1 IBXHW2 IBXHAL * ICXHW1 ICXHW2 ICXHAL * * * * * VAHW1 VAHW2 VAHAL *
    VBHW1 VBHW2 VBHAL *
VCHW1 VCHW2 VCHAL * * * * * VALW1 VALW2 VALAL * VBLW1 VBLW2 VBLAL * VCLW1 VCLW2 VCLAL SW05CC SW04CC SW03CC
    SW02CC SW01CC VABH
W1 VABHW2 VABHAL * VBCHW1 VBCHW2 VBCHAL * VCAHW1 VCAHW2 VCAHAL SW05OC SW04OC SW03OC SW02OC SW01OC VABLW1
    VABLW2 VABLAL * VBCL
W1 VBCLW2 VBCLAL * VCALW1 VCALW2 VCALAL TESTDB SC850TM SC850BM EN_LRC LOCAL ACV01RST ACV02RST ACV03RST
    ACV04RST ACV05RST ACV0
6RST ACV07RST ACV08RST ACV09RST ACV10RST ACV11RST ACV12RST ACV13RST ACV14RST ACV15RST ACV16RST ACV17RST
    ACV18RST ACV19RST ACV
20RST ACV21RST ACV22RST ACV23RST ACV24RST ACV25RST ACV26RST ACV27RST ACV28RST ACV29RST ACV30RST ACV31RST
    ACV32RST DNP1_TO DNP
2_TO DNP3_TO DNP4_TO DNP5_TO P2_TO P3_TO P4_TO MOD1_TO MOD2_TO * * SC850SM LPHDSIM * * SC850LS LOCSTA MLTLEV
    * * * * * * * * SP
D1B SPD1A * DUP1B DUP1A * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
    * * * * * * * * *
 * * * * * * * * * * * * * ETEMP01F ETEMP02F ETEMP03F ETEMP04F ETEMP05F ETEMP06F ETEMP07F ETEMP08F ETEMP09F
    ETEMP10F ETEMP1
1F ETEMP12F * * * * * * * * * * * * TP_FAIL TP_CHTR TPOS_MIN TPOS_MAX UEX_TPOS TPALMRST LTC_RSE LTC_LWR * *
    * * UEX_POS1 UEX_
POS2 UEX_POS3 UEX_POS4 RSE_CTRL LWR_CTRL PAR_OP RSE_850 LWR_850 PAROP850 * * * * * * * * * * EACC E2AC * *
    * * * * * * * * *
* * * * * * * * * * * * * * * * * * * *","7170"
```

Column Labels

```
0.3,0.0,0.0,0.0,0.0,0.0,-2.5,0,0,0,
    ,"A000000000000000000000000000000000000000000000000000000000000000000000000000FF000000000
00048000000000000E0000000000000000000000000000000000000000000000000000000000000000000000000009000000000000
    0000000000000000000
00000000000000000000000000000000000000000000000000000000000000000000FFC00012000000000000000000000000000000
    00000000","44E6"
-1.5,0.3,-0.5,-0.2,0.0,0.0,0.0,-1,0,1,
    ,"A000000000000000000000000000000000000000000000000000000000000000000000000000FF000000
00000048000000000000E000000000000000000000000000000000000000000000000000000000000000000000000000900000000
    0000000000000000000
00000000000000000000000000000000000000000000000000000000000000000000000FFC00012000000000000000000000000000
    00000000000","4575"
-0.5,-1.0,-1.5,-0.1,-2.5,0.0,-2.5,0,-1,-1,
    ,"A000000000000000000000000000000000000000000000000000000000000000000000000000FF00
0000000000480000000000000E000000000000000000000000000000000000000000000000000000000000000000000000000900000
    0000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000FFC00012000000000000000000000000
    000000000000000","4
634"
0.0,0.0,0.3,0.0,-2.5,0.0,-2.5,-1,0,0,
    ,"A000000000000000000000000000000000000000000000000000000000000000000000000000FF0000000
0000048000000000000E00000000000000000000000000000000000000000000000000000000000000000000000000090000000000
    0000000000000000000
0000000000000000000000000000000000000000000000000000000000000000000000FFC000120000000000000000000000000000
    0000000000","4548"
```

Event Data (Cycle 1)
The block shown represents four quarter cycles of data.

```
.
.
.
0.0,-1.0,0.3,-0.2,0.0,0.0,0.0,-1,0,-1,
    ,"A000000000000000000000000000000000000000000000000000000000000000000000000000FF000000
00000048000000000000E000000000000000000000000000000000000000000000000000000000000000000000000000900000000
    0000000000000000000
00000000000000000000000000000000000000000000000000000000000000000000000FFC00012000000000000000000000000000
    00000000000","456B"
0.0,0.0,0.3,-0.1,0.0,0.0,1.7,0,0,0,
    ,"A000000000000000000000000000000000000000000000000000000000000000000000000000FF000000000
00048000000000000E0000000000000000000000000000000000000000000000000000000000000000000000000009000000000000
    0000000000000000000
```

Figure 9.2 Sample Compressed ASCII Event Report (Continued)

```
0000000000000000000000000000000000000000000000000000000000000000000000000000000FFC00012000000000000000000000000000000
      00000000","44E8"
-0.5,0.0,-1.0,0.0,-2.5,0.0,1.7,0,0,0,
      ,"A00000000000000000000000000000000000000000000000000000000000000000000000000000000000FF0000000
0000004800000000000E00000000000000000000000000000000000000000000000000000000000000000000000000000000000090000000000
      0000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000000FFC000120000000000000000000000000000
      0000000000","454B"
0.3,0.0,-1.5,0.0,-2.5,-2.5,-5.0,0,-1,-1,
      ,"A00000000000000000000000000000000000000000000000000000000000000000000000000000000000FF0000
00000000048000000000000E000000000000000000000000000000000000000000000000000000000000000000000000000000000000090000000
      0000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000000000FFC000120000000000000000000000000
      0000000000000","45D
B"
0.0,-1.0,0.0,-0.1,0.0,-2.5,-2.5,-1,-1,0,
      ,"A00000000000000000000000000000000000000000000000000000000000000000000000000000000000FF0000
00000000048000000000000E000000000000000000000000000000000000000000000000000000000000000000000000000000000000090000000
      0000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000000000FFC000120000000000000000000000000
      0000000000000","45C
F"
-1.0,-0.5,0.3,0.0,0.0,0.0,-5.0,0,-
      1,0,">","A00000000000000000000000000000000000000000000000000000000000000000000000000000000000FF0000
00000000048000000000000E000000000000000000000000000000000000000000000000000000000000000000000000000000000000090000000
      0000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000000000FFC000120000000000000000000000000
      0000000000000","45D
4"
.
.
.
000000000","45B0
"
1.3,-1.5,0.0,0.0,-2.5,0.0,-2.5,-1,0,-2,
      ,"A00000000000000000000000000000000000000000000000000000000000000000000000000000000000FF00000
0000000048000000000000E0000000000000000000000000000000000000000000000000000000000000000000000000000000000000900000000
      0000000000000000000
00000000000000000000000000000000000000000000000000000000000000000000000000000000000FFC0001200000000000000000000000000
      000000000000","45AB
"
-0.5,0.0,0.3,0.0,0.0,0.0,1.7,0,-1,0,
      ,"A00000000000000000000000000000000000000000000000000000000000000000000000000000000000FF00000000
000004800000000000E00000000000000000000000000000000000000000000000000000000000000000000000000000000000000900000000000
      0000000000000000000
00000000000000000000000000000000000000000000000000000000000000000000000000000000FFC00012000000000000000000000000000000
      000000000","451A"
-1.5,0.0,0.0,-0.2,0.0,0.0,-2.5,0,-1,0,
      ,"A00000000000000000000000000000000000000000000000000000000000000000000000000000000000FF000000
00000004800000000000E000000000000000000000000000000000000000000000000000000000000000000000000000000000000009000000000
      0000000000000000000
0000000000000000000000000000000000000000000000000000000000000000000000000000000000FFC000120000000000000000000000000000
      00000000000","4573"
0.3,-0.5,0.0,-0.1,0.0,0.0,-2.5,0,-1,0,
      ,"A00000000000000000000000000000000000000000000000000000000000000000000000000000000000FF000000
00000004800000000000E000000000000000000000000000000000000000000000000000000000000000000000000000000000000009000000000
      0000000000000000000
0000000000000000000000000000000000000000000000000000000000000000000000000000000000FFC000120000000000000000000000000000
      00000000000","4574"
-0.5,0.3,0.3,0.1,-2.5,0.0,0.0,-1,-1,0,
      ,"A00000000000000000000000000000000000000000000000000000000000000000000000000000000000FF000000
00000004800000000000E000000000000000000000000000000000000000000000000000000000000000000000000000000000000009000000000
      0000000000000000000
0000000000000000000000000000000000000000000000000000000000000000000000000000000000FFC000120000000000000000000000000000
      00000000000","4578"
-2.0,-0.5,-1.5,0.0,-2.5,0.0,-2.5,0,0,-1,
      ,"A00000000000000000000000000000000000000000000000000000000000000000000000000000000000FF0000
00000000048000000000000E000000000000000000000000000000000000000000000000000000000000000000000000000000000000090000000
      0000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000000000FFC000120000000000000000000000000
      0000000000000","45D
9"
0.8,-0.5,-0.5,-0.1,0.0,-2.5,6.7,0,-1,-1,
      ,"A00000000000000000000000000000000000000000000000000000000000000000000000000000000000FF0000
00000000048000000000000E000000000000000000000000000000000000000000000000000000000000000000000000000000000000090000000
      0000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000000000FFC000120000000000000000000000000
      0000000000000","45E
6"
0.8,0.3,0.0,-0.1,0.0,-2.5,-2.5,0,0,0,
      ,"A00000000000000000000000000000000000000000000000000000000000000000000000000000000000FF0000000
0000004800000000000E00000000000000000000000000000000000000000000000000000000000000000000000000000000000090000000000
      0000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000000FFC000120000000000000000000000000000
      0000000000","4550"
```

Event Data
The quarter cycle with the ">" symbol represents the trigger row for the event.

Figure 9.2 Sample Compressed ASCII Event Report (Continued)

```
-1.5,-0.5,0.3,0.0,0.0,0.0,-7.5,-1,0,0,
    ,"A000000000000000000000000000000000000000000000000000000000000000000000000000FF000000
0000004800000000000000E00000000000000000000000000000000000000000000000000000000000000000000000090000000000
    0000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000FFC000120000000000000000000000000000
    00000000000","457E"
-0.5,0.0,0.0,0.0,0.0,0.0,4.2,0,-1,0,
    ,"A000000000000000000000000000000000000000000000000000000000000000000000000000FF00000000
00004800000000000000E000000000000000000000000000000000000000000000000000000000000000000000000900000000000000
    0000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000FFC0001200000000000000000000000000000
    000000000","4515"
0.0,-0.5,-0.5,-0.2,0.0,0.0,0.0,0,0,0,
    ,"A000000000000000000000000000000000000000000000000000000000000000000000000000FF0000000
00000480000000000000E0000000000000000000000000000000000000000000000000000000000000000000000009000000000000
    0000000000000000000
0000000000000000000000000000000000000000000000000000000000000000000000FFC00012000000000000000000000000000
    0000000000","4542"

0.0,-1.5,-1.0,0.1,0.0,0.0,-2.5,0,0,-1,
    ,"A000000000000000000000000000000000000000000000000000000000000000000000000000FF000000
0000004800000000000000E00000000000000000000000000000000000000000000000000000000000000000000000090000000000
    0000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000FFC000120000000000000000000000000000
    00000000000","4573"
0.0,0.3,-0.5,-0.1,-2.5,0.0,-5.0,-1,-1,0,
    ,"A000000000000000000000000000000000000000000000000000000000000000000000000000FF0000
000000004800000000000000E0000000000000000000000000000000000000000000000000000000000000000000000009000000000
    0000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000FFC0001200000000000000000000000000
    0000000000000","45D
.
.
.
-0.5,0.3,-0.5,-0.2,-2.5,0.0,4.2,0,0,1,
    ,"A000000000000000000000000000000000000000000000000000000000000000000000000000FF000000
0000004800000000000000E00000000000000000000000000000000000000000000000000000000000000000000000090000000000
    0000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000FFC000120000000000000000000000000000
    00000000000","4580"
-1.5,0.0,0.0,-0.2,-2.5,0.0,0.0,0,-1,-1,
    ,"A000000000000000000000000000000000000000000000000000000000000000000000000000FF00000
00000004800000000000000E000000000000000000000000000000000000000000000000000000000000000000000000900000000000
    0000000000000000000
0000000000000000000000000000000000000000000000000000000000000000000000000FFC00012000000000000000000000000000
    000000000000","45A1
"
"SETTINGS","02E1"
"
PARTNO=241121A1A6X74811640
```


General Settings

```
Global

General Settings
PHROT    := ABC          FNOM     := 60          DELTA_Y  := WYE
DATE_F   := MDY
```

Slot 1 Input Debounce Settings

```
Slot 1 Input Debounce Settings
IN101D   := 10           IN102D   := 10
```

Slot 3 Input Debounce Settings

```
Slot 3 Input Debounce Settings
IN301D   := 10           IN302D   := 10          IN303D   := 10
IN304D   := 10
```

Data Reset

```
Data Reset

RSTTRGT  := 0
RSTENRGY := 0
RSTMXMN  := 0
RSTDEM   := 0
RSTPKDM  := 0
```

Front-Panel Access Control

```
Front Panel Access Control
DSABLSET := 0
```

Time Synchronization Source

```
Time Synchronization Source
TIME_SRC := IRIG1
```

Figure 9.2 Sample Compressed ASCII Event Report (Continued)

```
Event Messenger
MPTR1    := OFF
MPAQ1    := NONE
MPTX1    :=
MPTR2    := OFF
MPAQ2    := NONE
MPTX2    :=
MPTR3    := OFF
MPAQ3    := NONE
MPTX3    :=
MPTR4    := OFF
MPAQ4    := NONE
MPTX4    :=
MPTR5    := OFF
MPAQ5    := NONE
MPTX5    :=
```

Event Messenger

```
Time and Date Management Settings
UTC_OFF  := 0.00          DST_BEGM := NA
```

Time and Date Management Settings

```
Control Configuration
EN_LRC   := N
```

Control Configuration

```
IEC 61850 Mode/Behavior Configuration
SC850BM  := 0
SC850TM  := 0
```

IEC 61850 Mode/Behavior Configuration

```
IEC 61850 Simulation Configuration
SC850SM  := 0
```

IEC 61850 Simulation Configuration

```
Port Access Control Settings
EACC     := 0
E2AC     := 0
```

Port Access Control Settings

```
Device

ID Settings
DID      := SEL-2411
TID      := DEVICE
```

ID Settings

```
Transformer Settings
CTR      := 250           CTRN     := 250           CTRX     := 250
PTR      := 35.00
```

Transformer Settings

```
Demand Settings
EDEM     := THM           DMTC     := 5
```

Demand Settings

```
Phase Overcurrent Threshold
IAHW1    := OFF           IAHW2    := OFF           IAHAL    := OFF
IBHW1    := OFF           IBHW2    := OFF           IBHAL    := OFF
ICHW1    := OFF           ICHW2    := OFF           ICHAL    := OFF
```

Phase Overcurrent Threshold

```
Neutral Overcurrent Threshold
INHW1    := OFF           INHW2    := OFF           INHAL    := OFF
```

Neutral Overcurrent Threshold

```
Auxilliary Phase Overcurrent Threshold
IAXHW1   := OFF           IAXHW2   := OFF           IAXHAL   := OFF
IBXHW1   := OFF           IBXHW2   := OFF           IBXHAL   := OFF
ICXHW1   := OFF           ICXHW2   := OFF           ICXHAL   := OFF
```

Auxilliary Phase Overcurrent Threshold

```
Phase Undervoltage Threshold
VALW1    := OFF           VALW2    := OFF           VALAL    := OFF
VBLW1    := OFF           VBLW2    := OFF           VBLAL    := OFF
VCLW1    := OFF           VCLW2    := OFF           VCLAL    := OFF
```

Phase Undervoltage Threshold

```
Phase Overvoltage Threshold
VAHW1    := OFF           VAHW2    := OFF           VAHAL    := OFF
VBHW1    := OFF           VBHW2    := OFF           VBHAL    := OFF
VCHW1    := OFF           VCHW2    := OFF           VCHAL    := OFF
```

Phase Overvoltage Threshold

```
AI 401 Settings
AI401NAM := AI401         AI401TYP := I             AI401L   := 4.000
AI401H   := 20.000
AI401EU  := mA
AI401EL  := 4.000         AI401EH  := 20.000        AI401LW1 := OFF
AI401LW2 := OFF           AI401LAL := OFF           AI401HW1 := OFF
AI401HW2 := OFF           AI401HAL := OFF
```

AI 401 Settings

```
AI 402 Settings
AI402NAM := AI402         AI402TYP := I             AI402L   := 4.000
AI402H   := 20.000
AI402EU  := mA
AI402EL  := 4.000         AI402EH  := 20.000        AI402LW1 := OFF
AI402LW2 := OFF           AI402LAL := OFF           AI402HW1 := OFF
AI402HW2 := OFF           AI402HAL := OFF
```

AI 402 Settings

Figure 9.2 Sample Compressed ASCII Event Report (Continued)

```
AI 403 Settings
AI403NAM := AI403         AI403TYP := I             AI403L   := 4.000
AI403H   := 20.000
AI403EU  := mA
AI403EL  := 4.000         AI403EH  := 20.000        AI403LW1 := OFF
AI403LW2 := OFF           AI403LAL := OFF           AI403HW1 := OFF
AI403HW2 := OFF           AI403HAL := OFF
```

AI 403 Settings

```
AI 404 Settings
AI404NAM := AI404         AI404TYP := I             AI404L   := 4.000
AI404H   := 20.000
AI404EU  := mA
AI404EL  := 4.000         AI404EH  := 20.000        AI404LW1 := OFF
AI404LW2 := OFF           AI404LAL := OFF           AI404HW1 := OFF
AI404HW2 := OFF           AI404HAL := OFF
```

AI 404 Settings

```
AO 401 Settings
AO401AQ  := OFF
```

AO 401 Settings

```
AO 402 Settings
AO402AQ  := OFF
```

AO 402 Settings

```
AO 403 Settings
AO403AQ  := OFF
```

AO 403 Settings

```
AO 404 Settings
AO404AQ  := OFF
```

AO 404 Settings

```
Load Tap Changer Settings

Load Tap Changer Control
EN_LTCC  := N
```

Load Tap Changer Settings

```
Load Tap Position and Control Monitoring Settings
ETPM_MDE := OFF
```

Load Tap Position and Control Monitoring Settings

```
Logic

SELogic Enables
ELAT     := N             ESV      := N             ESC      := 8
EMV      := N             EACV     := N             ERAFAST  := N
```

SELOGIC Enables Settings

```
SELogic Counter Settings
(Note: If setting SCnnCD is set to NA, the entire counter nn is disabled)
SC01NV   := N             SC01PV   := 1
SC01R    := NA
SC01LD   := NA
SC01CU   := NA
SC01CD   := NA
SC02NV   := N             SC02PV   := 1
SC02R    := NA
SC02LD   := NA
SC02CU   := NA
SC02CD   := NA
SC03NV   := N             SC03PV   := 1
SC03R    := NA
SC03LD   := NA
SC03CU   := NA
SC03CD   := NA
SC04NV   := N             SC04PV   := 1
SC04R    := NA
SC04LD   := NA
SC04CU   := NA
SC04CD   := NA
SC05NV   := N             SC05PV   := 1
SC05R    := NA
SC05LD   := NA
SC05CU   := NA
SC05CD   := NA
SC06NV   := N             SC06PV   := 1
SC06R    := NA
SC06LD   := NA
SC06CU   := NA
SC06CD   := NA
SC07NV   := N             SC07PV   := 1
SC07R    := NA
SC07LD   := NA
SC07CU   := NA
SC07CD   := NA
SC08NV   := N             SC08PV   := 1
SC08R    := NA
SC08LD   := NA
SC08CU   := NA
SC08CD   := NA
```

SELOGIC Counter Settings

Figure 9.2 Sample Compressed ASCII Event Report (Continued)

Output SELogic Equations OUT101 := 1 OUT102 := 1 OUT103 := 1	Output SELOGIC Control Equations
Slot 3 Output SELogic Equations OUT301 := 0 OUT302 := 0 OUT303 := 0 OUT304 := 0 ","60EF"	Slot 3 Output SELOGIC Control Equations
=>>	

Figure 9.2 Sample Compressed ASCII Event Report (Continued)

The order of the labels in the digital portion of the Column Labels field matches the order of the HEX-ASCII Device Word. Each numeral in the HEX-ASCII Device Word reflects the status of four Device Word bits from the Digital Column Labels field of the Compressed ASCII event report. The HEX-ASCII Device Word from the trigger cycle from *Figure 9.2*, follows.

```
A000000000000000000000000000000000000000000000000000000000000000000000000000FF000000000
000048000000000000E000000000000000000000000000000000000000000000000000000000000000000000
    00000090000000000000000000000000000000
00000000000000000000000000000000000000000000000000000000000000000000FFC0001200000000000
    000000000000000000000000000
```

In this HEX-ASCII Device Word, the first numeral in the HEX-ASCII Device Word is an A. In binary, this is 1010. Mapping the labels to the digital Column Labels yields the following:

PB01_LED	PB02_LED	PB03_LED	PB04_LED
1	0	1	0

The PB01_LED and PB03_LED elements picked up at the first sample of the trigger cycle row (see *Figure 9.2*).

Viewing Compressed Event (CEV) Reports

The CEV can be viewed in the following ways:

- ➤ QuickSet via SYNCHROWAVE Event
- ➤ SYNCHROWAVE Event

To view the saved events using QuickSet, select **Tools > Events** to view an event with SYNCHROWAVE Event and select the event you want to view (QuickSet remembers the location where you stored the previous event record). You can view multiple events by selecting **Local Event > Add New Event** in the SYNCHROWAVE Event software.

As shown in *Figure 9.3*, all the analog and digital data can be viewed with SYNCHROWAVE Event or QuickSet via SYNCHROWAVE Event. The Export Event feature allows you to export the CEV report in COMTRADE format. The Export Data feature also allows you to export the CEV report in comma-separated values (CSV) format.

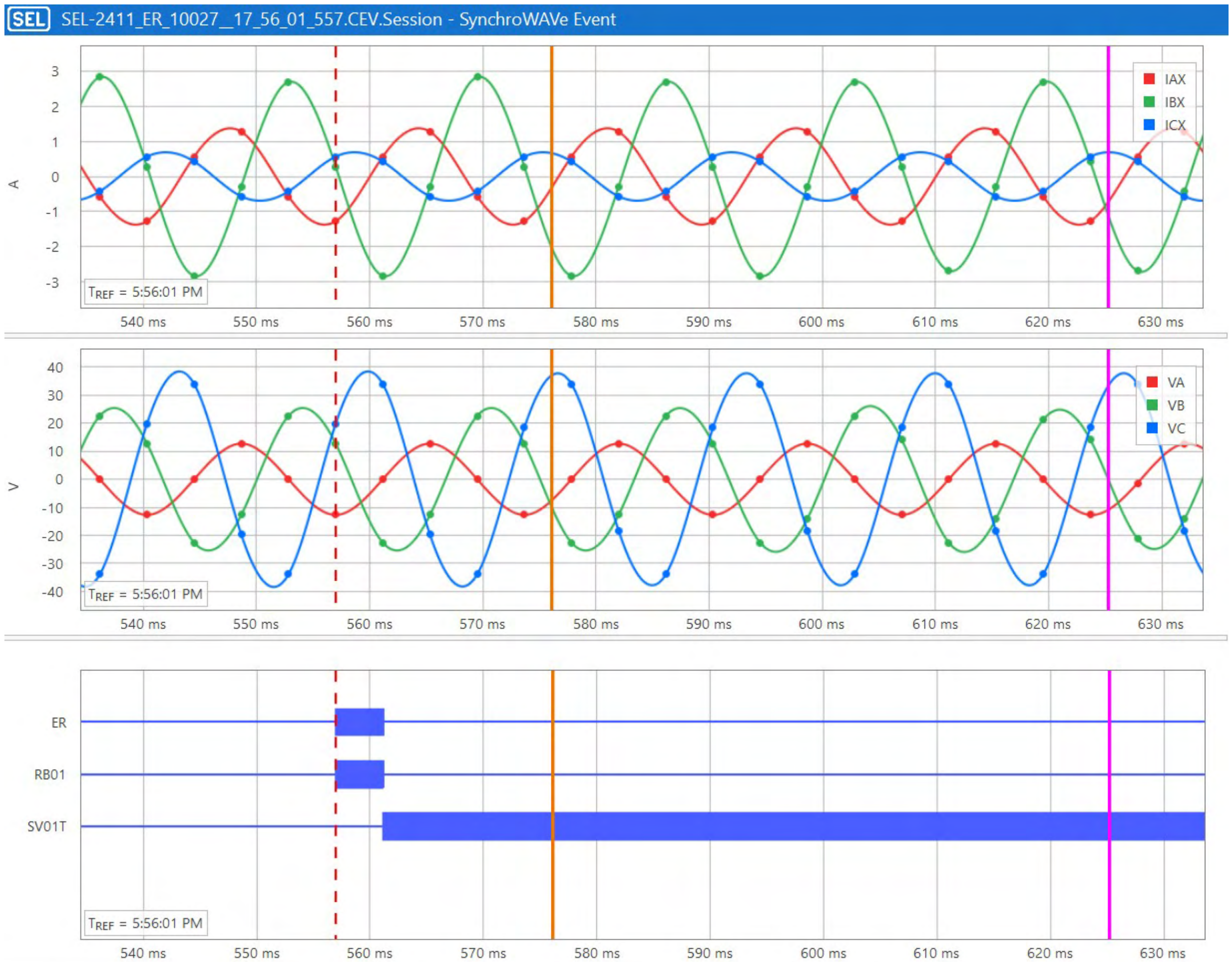


Figure 9.3 Sample CEV Report Viewed With SYNCHROWAVE Event

With SYNCHROWAVE Event, you have six options for converting CEV reports to COMTRADE.

- COMTRADE 1999 ASCII
- COMTRADE 1999 Binary
- COMTRADE 2013 ASCII
- COMTRADE 2013 Binary
- COMTRADE 2013 Binary32
- COMTRADE 2013 Float32

COMTRADE File Format Event Reports

NOTE: COMTRADE event reports are sampled at 16 samples per cycle, which are equivalent to CEV R event reports.

NOTE: COMTRADE events can be extracted using the **FILE** command (see Section 7: Communications), Ethernet File Transfer Protocol (FTP), or IEC 61850 Manufacturing Message Specification (MMS). To transfer files using MMS, set EMMSFS to **Y**.

The SEL-2411 stores raw data oscillography in binary format and uses COMTRADE file types to output these data:

- .HDR—header file
- .CFG—configuration file
- .DAT—high-resolution raw data file

The .HDR file contains summary information about the event in ASCII format. The .CFG file is an ASCII configuration file that describes the layout of the .DAT file. The .DAT file is in binary format and contains the values for each input channel for each sample in the record. These data conform to the IEEE C37.111-1999 COMTRADE standard.

.HDR File

The .HDR file contains the event summary and relay settings information that appears in the event report for the data capture. The settings portion is in a comma-delimited format as illustrated in *Figure 9.4*.

```
FID,"SEL-2411-X016-V0-Z011009-D20230213"
Event_Report_Type,"UVR"
Part_Number,"241121A1A6X74811640"
Serial_Number,"1112345678"

[Summary]
Time_Source,"Internal"
Event_Logs,"7"
Event_Number,"10010"
Event_Date,"13/02/2023"
Event_Time,"14:08:07.212100"
Event,"ER"
Freq,"60.04"
Targets,"10010000"
IA (A),"1.5366"
IB (A),"0.0000"
IC (A),"1.8028"
IN (A),"0.1198"
IG (A),"2.7588"
VA (A),"318.8098"
VB (A),"319.4856"
VC (A),"319.2050"
VG (A),"1.8848"
```

Event Summary Information

```
Global Settings

PHROT   := ABC
FNOM    := 60
DELTA_Y := WYE
DATE_F  := MDY
IN101D  := 10           IN102D  := 10
IN301D  := 10           IN302D  := 10           IN303D  := 10
IN304D  := 10
RSTTRGT := 0
RSTENRGY:= 0
RSTMXMN := 0
RSTDEM  := 0
RSTPKDM := 0

DSABLSET:= 0

TIME_SRC:= IRIG1

MPTR1  :=OFF MPAQ1  :=NONE MPTX1  :=
MPTR2  :=OFF MPAQ2  :=NONE MPTX2  :=
MPTR3  :=OFF MPAQ3  :=NONE MPTX3  :=
MPTR4  :=OFF MPAQ4  :=NONE MPTX4  :=
MPTR5   :=OFF MPAQ5   :=NONE MPTX5   :=
UTC_OFF := 0.00         DST_BEGM:= NA
EN_LRC  := N
SC850BM := 0
SC850TM := 0
SC850SM := 0

EACC    := 0
E2AC    := 0
```

Global Settings

Figure 9.4 Sample COMTRADE .HDR Header File

```
Device Settings

DID     := SEL-2411
TID     := DEVICE

CTR     := 250
CTRN    := 250
CTRX    := 250
PTR     := 35.00
EDEM    := THM            DMTC    := 5
IAHW1   := OFF            IAHW2   := OFF            IAHAL   := OFF
IBHW1   := OFF            IBHW2   := OFF            IBHAL   := OFF
ICHW1   := OFF            ICHW2   := OFF            ICHAL   := OFF
INHW1   := OFF            INHW2   := OFF            INHAL   := OFF
IAXHW1  := OFF            IAXHW2  := OFF            IAXHAL  := OFF
IBXHW1  := OFF            IBXHW2  := OFF            IBXHAL  := OFF
ICXHW1  := OFF            ICXHW2  := OFF            ICXHAL  := OFF
VALW1   := OFF            VALW2   := OFF            VALAL   := OFF
VBLW1   := OFF            VBLW2   := OFF            VBLAL   := OFF
VCLW1   := OFF            VCLW2   := OFF            VCLAL   := OFF
VAHW1   := OFF            VAHW2   := OFF            VAHAL   := OFF
VBHW1   := OFF            VBHW2   := OFF            VBHAL   := OFF
VCHW1   := OFF            VCHW2   := OFF            VCHAL   := OFF
AI401NAM:=AI401    AI401TYP:= I              AI401L  := 4.000
AI401H  := 20.000         AI401EU := mA              AI401EL := 4.000
AI401EH := 20.000         AI401LW1:= OFF            AI401LW2:= OFF
AI401LAL:= OFF            AI401HW1:= OFF            AI401HW2:= OFF
AI401HAL:= OFF
AI402NAM:=AI402    AI402TYP:= I              AI402L  := 4.000
AI402H  := 20.000         AI402EU := mA              AI402EL := 4.000
AI402EH := 20.000         AI402LW1:= OFF            AI402LW2:= OFF
AI402LAL:= OFF            AI402HW1:= OFF            AI402HW2:= OFF
AI402HAL:= OFF
AI403NAM:=AI403    AI403TYP:= I              AI403L  := 4.000
AI403H  := 20.000         AI403EU := mA              AI403EL := 4.000
AI403EH := 20.000         AI403LW1:= OFF            AI403LW2:= OFF
AI403LAL:= OFF            AI403HW1:= OFF            AI403HW2:= OFF
AI403HAL:= OFF
AI404NAM:=AI404    AI404TYP:= I              AI404L  := 4.000
AI404H  := 20.000         AI404EU := mA              AI404EL := 4.000
AI404EH := 20.000         AI404LW1:= OFF            AI404LW2:= OFF
AI404LAL:= OFF            AI404HW1:= OFF            AI404HW2:= OFF
AI404HAL:= OFF
AO401AQ :=OFF
AO402AQ :=OFF
AO403AQ :=OFF
AO404AQ :=OFF
EN_LTCC := N              ETPM_MDE:= OFF            EN_LTCC := N              ETPM_MDE:= OFF
```

Device Settings

```
Report Settings

ESERDEL := N

SER1    := RB01 SV01 SV01T OUT301
SER2    := NA
SER3    := NA
SER4    := NA

EALIAS  := N

ER      := RB01
LER     := 15             PRE     := 5

FMR1NAM := FMR1
FMR1    :=NA
FMR2NAM := FMR2
FMR2    :=NA
FMR3NAM := FMR3
FMR3    :=NA
FMR4NAM := FMR4
FMR4    :=NA
```

Report Settings

Figure 9.4 Sample COMTRADE .HDR Header File (Continued)

<pre>RA01TYPE:= I
RA02TYPE:= I
RA03TYPE:= I
RA04TYPE:= I
RA05TYPE:= I
RA06TYPE:= I
RA07TYPE:= I
RA08TYPE:= I
RA09TYPE:= I
RA10TYPE:= I
RA11TYPE:= I
RA12TYPE:= I
RA13TYPE:= I
RA14TYPE:= I
RA15TYPE:= I
RA16TYPE:= I
RA17TYPE:= I
RA18TYPE:= I
RA19TYPE:= I
RA20TYPE:= I
RA21TYPE:= I
RA22TYPE:= I
RA23TYPE:= I
RA24TYPE:= I
RA25TYPE:= I
RA26TYPE:= I
RA27TYPE:= I
RA28TYPE:= I
RA29TYPE:= I
RA30TYPE:= I
RA31TYPE:= I
RA32TYPE:= I
 	
SPLIST1 := NA
SPLIST2 := NA
SPAR   := 5
SPEN   := 1</pre>
	Report Settings

<pre>Logic Settings
 	
ELAT   := N   ESV   := 1   ESC   := 8
EMV   := N   EACV   := N   ERAFAST := N
 	
SV01   := RB01
 	
SV01PU :=0.000   SV01DO :=1.5
 	
SC01NV := N   SC01PV := 1
SC01R   := NA
SC01LD := NA
SC01CU := NA
SC01CD := NA
SC02NV := N   SC02PV := 1
SC02R   := NA
SC02LD := NA
SC02CU := NA
SC02CD := NA
SC03NV := N   SC03PV := 1
SC03R   := NA
SC03LD := NA
SC03CU := NA
SC03CD := NA
SC04NV := N   SC04PV := 1
SC04R   := NA
SC04LD := NA
SC04CU := NA
SC04CD := NA
SC05NV := N   SC05PV := 1
SC05R   := NA
SC05LD := NA
SC05CU := NA
SC05CD := NA
SC06NV := N   SC06PV := 1
SC06R   := NA
SC06LD := NA
SC06CU := NA
SC06CD := NA
SC07NV := N   SC07PV := 1
SC07R   := NA
SC07LD := NA
SC07CU := NA
SC07CD := NA
SC08NV := N   SC08PV := 1</pre>
	Logic Settings

Figure 9.4 Sample COMTRADE .HDR Header File (Continued)

SC08R := NA SC08LD := NA SC08CU := NA SC08CD := NAOUT101 := 1 OUT102 := 1 OUT103 := 1 OUT301 := SV01T OUT302 := 0 OUT303 := 0 OUT304 := 0	Logic Settings
SAM/CYC_A = 16 SAM/CYC_D = 4	Analog, Digital, and Input Samples per Cycle Data

Figure 9.4 Sample COMTRADE .HDR Header File (Continued)

.CFG File

The .CFG file contains data that is used to reconstruct the input signals to the relay and the status of Device Word bits during the event report (see *Figure 9.5*). A <CR><LF> follows each line. If control inputs or control outputs are unavailable because of board loading and configuration, the relay does not report these inputs and outputs in the analog and digital sections of the .CFG file.

<RID Setting>,FID=SEL-2411-Rxxx-Vx-Zxxxxxx-Dxxxxxxxx,1999	COMTRADE Standard
#T,#A,#D	Total Channels, Analog, Digital
1,IA,A,,A,0.235702,0.0,0,-32767,32767,250.0,1.0,P 2,IB,B,,A,0.235702,0.0,0,-32767,32767,250.0,1.0,P 3,IC,C,,A,0.235702,0.0,0,-32767,32767,250.0,1.0,P 4,IN,,,A,0.025254,0.0,0,-32767,32767,250.0,1.0,P 5,VA,A,,V,0.494975,0.0,0,-32767,32767,35.0,1.0,P 6,VB,B,,V,0.494975,0.0,0,-32767,32767,35.0,1.0,P 7,VC,C,,V,0.494975,0.0,0,-32767,32767,35.0,1.0,P 8,IAX,A,,A,1.178511,0.0,0,-32767,32767,250.0,1.0,P 9,IBX,B,,A,1.178511,0.0,0,-32767,32767,250.0,1.0,P 10,ICX,C,,A,1.178511,0.0,0,-32767,32767,250.0,1.0,P 11,FREQ,,,Hz,0.01,0.0,0,0,12000,1.0,1.0,P	Analog Channel Data [a]Scale_factor is the value used to convert the equivalent channel analog data in the DAT file to primary units (A or kV peak-to-peak)
1,dwb_label[b,c],,,0 2,dwb_label[b,c],,,0 . . . nnnn[d],dwb_label[b,c],,,0	Digital (Status) Channel Data [b]dwb_label is replaced with Device Word bit labels as seen in Table H.1 [c]Place holders denoted by asterisk (*), are labeled as UNUSEDxxx (where xxx is the number of the associated label) [d]nnnn = number of the last Relay Word bit
<NFREQ> 0 0,<# of samples>	
dd/mm/yyyy,hh:mm:ss.ssssss	First Data Point
dd/mm/yyyy,hh:mm:ss.ssssss	Trigger Point
BINARY <time stamp multiplication factor>	

Figure 9.5 Sample COMTRADE .CFG Configuration File Data

The configuration file has the following format:

- Device ID, firmware ID, COMTRADE standard year
- Number and type of channels
- Channel name units and conversion factors
- Digital Device Word bit names
- System frequency
- Sample rate and number of samples
- Date and time of first data point
- Date and time of trigger point

- Data file type
- Time stamp multiplication factor

.DAT File

The .DAT file follows the COMTRADE binary standard. The format of the binary data files is sample number, time stamp, data value for each analog channel, and digital channel status data for each sample in the file. There are no data separators in the binary file, and the file contains no carriage return/ line feed characters. The sequential position of the data in the binary file determines the data translation. Refer to the IEEE Standard *Common Format for Transient Data Exchange (COMTRADE) for Power Systems*, IEEE C37.111–1999 for more information. Many software applications can read binary COMTRADE files, including SYNCHROWAVE Event and QuickSet. View the COMTRADE Event Files viewed similar to the .CEV files as explained in *Viewing Compressed Event (CEV) Reports on page 9.16*.

Retrieving COMTRADE Event Files

COMTRADE files are available as read-only files that can be retrieved using the **FILE** command and Ymodem file transfer, Ethernet FTP, or MMS. MMS file transfer is only available in models that support IEC 61850 and only when IEC 61850 is enabled (E61850 := Y) and MMS file services is enabled (EMMSFS := Y). See *FILE Command (Manage Settings Files) on page 7.25* and *MMS on page F.6* for additional information.

Sequential Events Recorder (SER) Report

The SEL-2411 SER report gives you detailed information on device element state changes over an extended period of time. The SER captures and time-stamps 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 as many as 512 state changes of as many as 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 time-stamp accuracy is ±1 millisecond 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 an automatic deletion and reinsertion function to prevent overfilling of the SER buffer with chattering information. Each processing interval, the relay checks the Device Word bits in the four SER reports for any changes of state.

The relay adds a record to the SER report when it detects a change of state. This contains the Device Word bit(s), new state, time stamp, and checksum. When the relay detects oscillating SER items, it automatically deletes these oscillating items from the SER recording. *Table 9.3* shows the auto-removal settings.

Table 9.3 Auto-Removal Settings

Settings Prompt	Setting Range	Factory Default
Auto-Removal Enable	Y, N	ESERDEL := N
Number of Counts	2–20 counts	SRDLCNT := 5
Removal Time	0.1–90.0 seconds	SRDLTIM := 1.0

To use the automatic deletion and reinsertion function, proceed with the following steps:

Step 1. Set Report setting ESERDEL (Enable SER Delete) to **Y** to enable this function.

Step 2. Select values that mask the chattering SER elements for the setting SRDLCNT (SER Delete Count) and the setting SRDLTIM (SER Delete Time).

Setting SRDLTIM declares a time interval during which the relay qualifies an input by comparing the changes of state of each input against the SRDLCNT setting. When an input changes state more than SRDLCNT times in an SRDLTIM interval, the relay automatically removes these Device Word bits from the SER recording. Once deleted from the recording, the SER report ignores the inputs for the next nine intervals. At the ninth interval, the chatter criteria are again checked and, if the point does not exceed the criteria, it is automatically reinserted into the recording at the start of the tenth interval. You can enable or disable the autodeletion function via the SER settings. Any autodeletion notice entry is lost during changes of settings. The deleted items can be viewed in the SER Delete Report (command **SER D**—refer to *Section 7: Communications* for additional information).

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. As many as 96 Device Word bits can be selected as triggers and as many as 20 of these can be assigned aliases.

Define the alias by using the following format, where each field can consist of as many as 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 9.6 shows the data contained in the SER report.

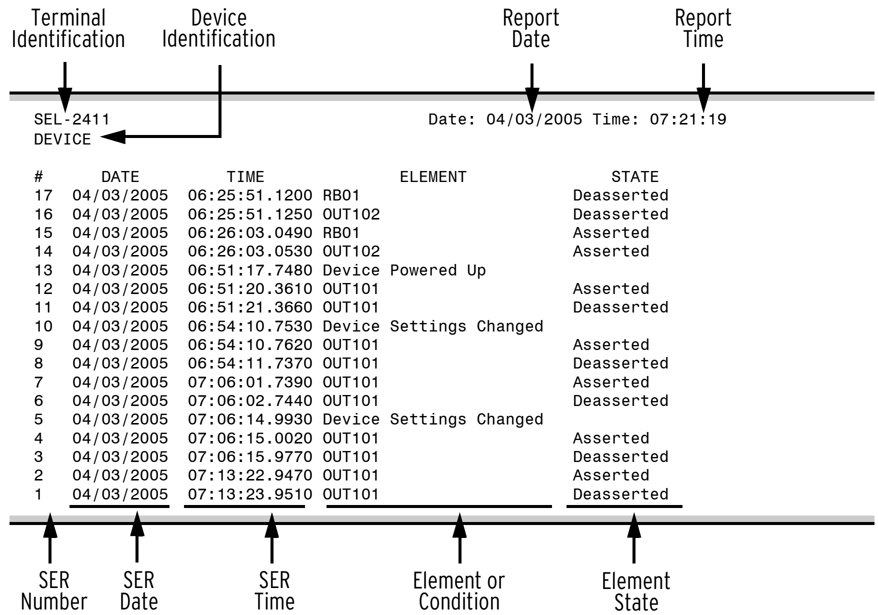


Figure 9.6 Sample SER Report

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 9.6*). 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 7.36* for more information.

Section 10
Testing and Troubleshooting

Overview

Device testing is typically divided into the two following 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 *Troubleshooting* section 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 7.31*. 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 7.31*.

SER Command

The device provides a Sequential Events Recorder (SER) event report that time-stamps 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 7.52* shows the **SER** commands to view and manage the SER 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 7.60*. 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.

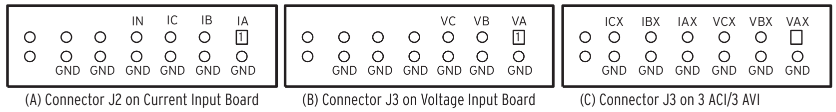


Figure 10.1 Low-Level Test Interfaces

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 (Sheet 1 of 2)

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

Table 10.4 Scale Factors for an ACI/AVI Card (Sheet 2 of 2)

Channel Label	Circuit Board and Connector	SEL-5401 Channel No.	Nominal Input	Output	Scale Factors
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).

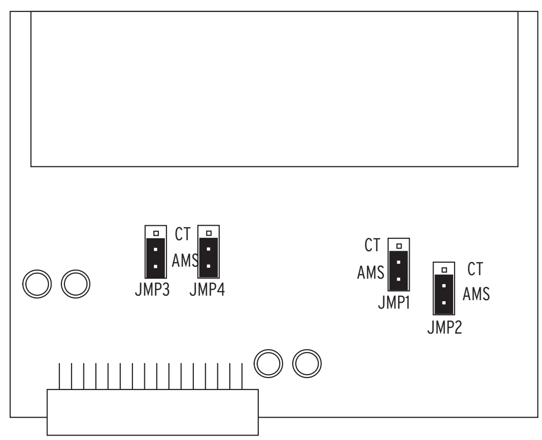


Figure 10.2 Jumpers on Current Card to Change to Low-Level Injection

Step 4. Locate connector J2 and connect low-level signal connector (e.g., ribbon cable connector of SEL-RTS Test System).

NOTE: The 14-pin connectors of the SEL-RTS ribbon cable SEL-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 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. 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-C234A cable 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.

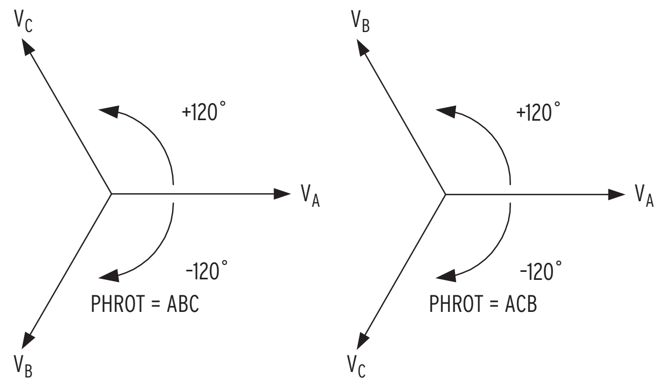
If you set the device to accept phase-to-ground voltages (DELTA_Y = wye), set the voltage phase angles as shown in *Figure 10.3*.

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.

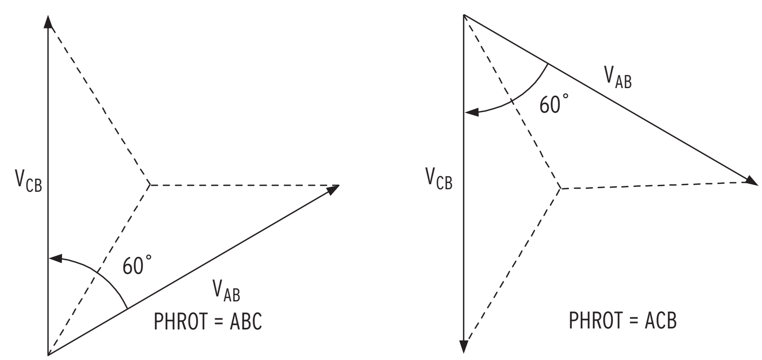
Step 14. Use the front-panel **METER > Fundamental** or serial port **METER F** command to verify that the device is measuring the magnitude and phase angle of both voltage and current correctly, taking into account the device PTR and CTR settings and the fact that the quantities are displayed in primary 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 steps show tests for current, voltage, phase angle, and power measurements.

Step 1. Connect the current source to the device, as shown in *Figure 10.5*.

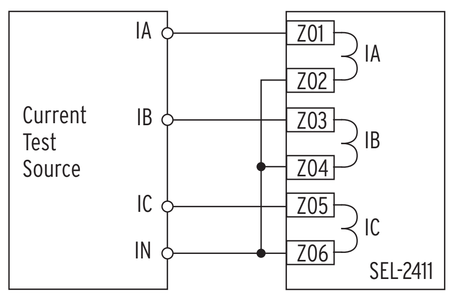


Figure 10.5 Current Source Connections

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)
$0.2 \bullet I_{NOM}$				
$0.9 \bullet I_{NOM}$				
$1.6 \bullet I_{NOM}$				

[a] I_{NOM} = rated secondary amperes (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.

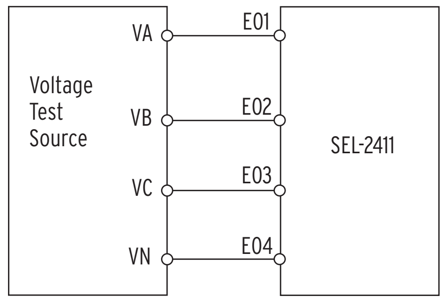


Figure 10.6 Wye Voltage Source Connections

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

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
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.

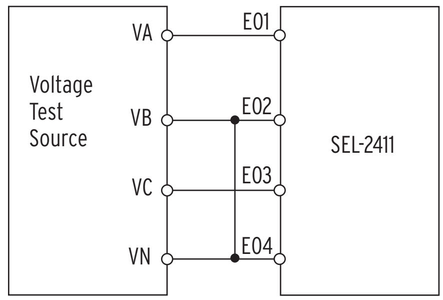


Figure 10.7 Delta Voltage Source Connections

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
Main Board FPGA (run time)	Fail on lack of data acquisition interrupts or on detection of a CRC error in the FPGA code	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)	Checksum is computed on the entire code base in non-volatile memory	NA	NA	NA	
Data Flash (power up)	Checksum is computed on Critical (Settings and SELOGIC) 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`
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	

Table 10.11 Device Self-Tests (Sheet 2 of 3)

Self-Test	Description	Automation Disabled on Failure	Alarm Status	Status Command	Front-Panel Message
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[a] OK/ FAILOVER/ FAIL	Status Fail
+0.675 V Warn	Monitor +0.675 V power supply 0.641 to 0.709 V	No	Pulse, 5 sec	+0.675 V OK/WARN	
+0.675 V Fail	Monitor +0.675 V power supply 0.608 to 0.743 V	Yes	Latched	+0.675 V OK/FAIL	Status Fail +0.675 V Fail-ure
+1.1 V Warn	Monitor +1.1 V power supply 1.045 to 1.155 V	No	Pulse, 5 sec	+1.1 V OK/WARN	
+1.1 V Fail	Monitor +1.1 V power supply 0.99 to 1.21 V	Yes	Latched	+1.1 V OK/FAIL	Status Fail +1.1 V Failure
+1.8 V Warn	Monitor +1.8 V power supply 1.71 to 1.89 V	No	Pulse, 5 sec	+1.8 V OK/WARN	
+1.8 V Fail	Monitor +1.8 V power supply 1.62 to 1.98 V	Yes	Latched	+1.8 V OK/FAIL	Status Fail +1.8 V Failure
+1.0 V Warn	Monitor +1.0 V power supply 0.95 to 1.05 V	No	Pulse, 5 sec	+1.0 V OK/WARN	
+1.0 V Fail	Monitor +1.0 V power supply 0.9 to 1.1 V	Yes	Latched	+1.0 V OK/FAIL	Status Fail +1.0 V Failure
+1.35 V Warn	Monitor +1.35 V power supply 1.283 to 1.418 V	No	Pulse, 5 sec	+1.35 V OK/WARN	
+1.35 V Fail	Monitor +1.35 V power supply 1.215 to 1.485 V	Yes	Latched	+1.35 V OK/FAIL	Status Fail +1.35 V Failure
+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
+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/O Card Failure`
Exception Vector	CPU Error	Yes	Latched	NA	`Vector nn Disabled`

[a] CID only appears when the IEC 61850 option is installed and enabled.

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 or 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.

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Appendix A
Firmware and Manual Versions

Firmware

Determining the Firmware Version

To determine the firmware version, view the status report by using the serial port **STATUS** command or the front panel. The status report displays the Firmware Identification (FID) number.

The firmware version will be either a standard release or a point release. A standard release adds new functionality to the firmware beyond the specifications of the existing version. A point release is reserved for modifying firmware functionality to conform to the specifications of the existing version.

A standard release is identified by a change in the R-number of the device FID number.

Existing firmware:

FID=SEL-2411-**R100**-V0-Z001001-Dxxxxxxxx

Standard release firmware:

FID=SEL-2411-**R101**-V0-Z001001-Dxxxxxxxx

A point release is identified by a change in the V-number of the device FID number.

Existing firmware:

FID=SEL-2411-R100-**V0**-Z001001-Dxxxxxxxx

Point release firmware:

FID=SEL-2411-R100-**V1**-Z001001-Dxxxxxxxx

The date code is after the D. For example, the following is firmware version number R100, date code December 2, 2005.

FID=SEL-2411-R100-V0-Z001001-**D20051202**

Revision History

Table A.2 lists the firmware versions for R400 series firmware (see *Table A.3*, *Table A.4*, and *Table A.6* for R300, R200, and R100 series firmware, respectively), revision descriptions, and corresponding instruction manual date codes. The most recent firmware version is listed first.

Starting with revisions published after March 1, 2022, changes that address security vulnerabilities are marked with “[Cybersecurity]”. Other improvements to cybersecurity functionality that should be evaluated for potential cybersecurity importance are marked with “[Cybersecurity Enhancement]”.

Table A.1 Firmware Revision History for R500 Series Firmware (Sheet 1 of 3)

Firmware Identification (FID) Number	Summary of Revisions	Manual Date Code
SEL-2411-R502-V0-Z102101-D20250228	➤ [Cybersecurity] Resolved an issue where the MMS server did not lock the user out after three failed password attempts within one minute. ➤ Updated IEC 61850 protocol implementation to IEC 61850 Edition 2.1 ➤ Improved processing of pulsed remote bits by adding support for pulse configuration attributes cmdQual, onDur, offDur, and numPls according to IEC 61850-7-3. ➤ Extended LPHD logical node to include IEC 61850 library version (SelLibId). ➤ Added support for indexed unbuffered and buffered MMS reports. ➤ Added support for the sAddr attribute to replace the esel:datasrc attribute in ICD files to improve compatibility with third-party system configuration tools. ➤ Added support to allow the relay to accept GOOSE data with questionable or invalid validity. ➤ Added support for deadband configuration, including the dbRef, dbAngRef, zeroDbRef, and zeroDb attributes, according to IEC 61850-7-3 Edition 2.1. ➤ Added support for attributes valImport and valKind according to IEC 61850-6 for compatibility with third-party system configuration tools. ➤ Added support for display points screens on the touchscreen display. ➤ Increased the number of circuit breakers supported on a bay screen to 8. ➤ Improved support for IEC 61850 Edition 1 MMS clients. ➤ Resolved an issue with the reporting of the quality data attribute in IEC 61850 OFF mode. ➤ Enhanced the relay firmware to retain the IP address, subnet mask, and default router settings after an **R_S** command is issued. ➤ Resolved an issue where a two-line display, when display points are set to remote bits or virtual bits without assert and deassert strings, may not indicate the correct state. ➤ Resolved an issue with the processing of multicast and broadcast messages in failover mode.	20250228
SEL-2411-R501-V1-Z101100-D20240319	Includes all the functions of SEL-2411-R501-V0-Z101100-D20231208 with the following addition: ➤ [Cybersecurity] Resolved an issue introduced in R500-V0 where changing the global VSCALE setting on units with a low energy analog 3ACI/3AVI card may disable the device. ➤ Improved the performance of the device in switched mode during a network storm. ➤ Resolved an issue introduced in R501-V0 where the device may publish GOOSE messages before the Ethernet link is up. ➤ Resolved an issue introduced in R500-V0 where the device may require a power cycle to enable after a successful firmware upgrade. ➤ Resolved an issue introduced in R500-V0 where changing the TIMERQ setting on the touchscreen display may disable the device. ➤ Resolved an issue introduced in R500-V0 where changing the pickup or dropout settings for SELOGIC variable/timers on the touchscreen display may disable the device.	20240319
SEL-2411-R501-V0-Z101100-D20231208	➤ [Cybersecurity] Resolved an issue introduced in R500-V0 where excessive Ethernet traffic on devices with dual Ethernet ports in switched mode (NETMODE = SWITCHED) could temporarily inhibit MIRRORED BITS data processing. ➤ [Cybersecurity] Resolved an issue introduced in R500-V0 where excessive Ethernet traffic on devices with dual Ethernet ports in switched mode (NETMODE = SWITCHED) could temporarily disable the front panel.	20231208

Table A.1 Firmware Revision History for R500 Series Firmware (Sheet 2 of 3)

Firmware Identification (FID) Number	Summary of Revisions	Manual Date Code
	➤ [Cybersecurity] Resolved an issue introduced in R500-V0 where a Port 1 settings change may disable Ethernet communications after the Ethernet port has failed over to the secondary port. ➤ Added support for IEEE 1588-2008 firmware-based Precision Time Protocol (PTP) for time synchronization. ➤ Added support for IEEE 802.1Q-2014 Rapid Spanning Tree Protocol (RSTP) for models with the dual Ethernet port option. ➤ Added Device Word bits to indicate a pending addition or subtraction of a leap second from an external time source. ➤ Added support for logging of IEC 61850 Mode/Behavior status changes due to power cycles, diagnostic restarts, or settings changes to the Sequential Events Recorder reports. ➤ Increased the maximum number of GOOSE subscriptions to 64. ➤ Increased the number of default unbuffered and buffered MMS reports to 12. ➤ Modified the DNPIP setting to disallow address of 0.0.0.0 in UDP mode. ➤ Removed support for setting identical device IP and DNP Master IP addresses. ➤ Resolved an issue introduced in R314-V0 where the device may report raw compressed event data from LEA 3ACI/3AVI cards incorrectly. ➤ Resolved an issue introduced in R318-V0 where the front-panel and communications ports may disable after collecting thousands of event and report files from the device. ➤ Resolved an issue introduced in R500-V0 where the two-line LCD may incorrectly display the Target Row 0 Device Word bit values. ➤ Resolved an issue introduced in R500-V0 where the device may not negotiate full duplex communications mode when NETASPD or NETBSPD are set to 10 or 100 Mbps. ➤ Resolved an issue introduced in R500-V0 that may cause the internal clock time for an unsynchronized device to advance several seconds after a power cycle. ➤ Resolved an issue introduced in R500-V0 where the device may report erroneous TTL expired and OOS errors after receiving concurrent state changes from multiple GOOSE messages. ➤ Resolved an issue introduced in R500-V0 where the device may reject valid IP addresses for SNTPPSIP or SNTPBSIP settings.	
SEL-2411-R500-V3-Z100100-D20240130	Includes all the functions of SEL-2411-R500-V2-Z100100-D20231229 with the following addition: ➤ [Cybersecurity] Resolved an issue introduced in R500-V0 where changing the global VSCALE setting on units with a low energy analog 3ACI/3AVI card may disable the device. ➤ Resolved an issue introduced in R500-V0 where changing the TIMERQ setting on the touchscreen display may disable the device. ➤ Resolved an issue introduced in R500-V0 where changing the pickup or dropout settings for SELOGIC variable/timers on the touchscreen display may disable the device. ➤ Resolved an issue introduced in R500-V0 where the device may reject some valid IP addresses for SNTPPSIP or SNTPBSIP settings.	20240130

Table A.1 Firmware Revision History for R500 Series Firmware (Sheet 3 of 3)

Firmware Identification (FID) Number	Summary of Revisions	Manual Date Code
SEL-2411-R500-V2-Z100100-D20231229	Includes all the functions of SEL-2411-R500-V1-Z100100-D20230927 with the following addition: ➤ Resolved an issue introduced in R318-V0 where the front-panel and communications ports may disable after collecting thousands of event and report files from the device.	20231229
SEL-2411-R500-V1-Z100100-D20230927	Includes all the functions of SEL-2411-R500-V0-Z100100-D20230609 with the following addition: ➤ [Cybersecurity] Resolved an issue introduced in R500-V0 that may cause the device to disable when Report settings are modified. ➤ Resolved an issue introduced in R500-V0 that may prevent DNP3 communications over fiber-optic serial ports.	20230927
SEL-2411-R500-V0-Z100100-D20230609	➤ Added firmware support for a new processor component. Previous firmware versions cannot be upgraded to R500. ➤ Removed GOOSE-dedicated MAC address. ➤ Removed support for half-duplex mode. ➤ Resolved an issue introduced in R400 that may prevent setting IPADDR, SUBNETM, or DEFRTR from the 2-line LCD. ➤ Resolved an issue introduced in R400 where the 2-line LCD may incorrectly display the Load Tap Changer settings. ➤ Resolved an issue introduced in R401-V0 that may prevent configuring the maximum number of GOOSE messages. ➤ Resolved an issue introduced in R401-V0 where the touchscreen may not display SER data.	20230609

Table A.2 Firmware Revision History for R400 Series Firmware (Sheet 1 of 3)

Firmware Identification (FID) Number	Summary of Revisions	Manual Date Code
SEL-2411-R401-V2-Z012008-D20231229	Includes all the functions of SEL-2411-R401-V1-Z012008-D20230630 with the following additions: ➤ Resolved an issue introduced in R318-V0 where the front-panel and communications ports may disable after collecting thousands of event and report files from the device.	20231229
SEL-2411-R401-V1-Z012008-D20230630	Includes all the functions of SEL-2411-R401-V0-Z012008-D20230331 with the following additions: ➤ Resolved an issue introduced in R401-V0 that may prevent configuring the maximum number of GOOSE messages. ➤ Resolved an issue introduced in R401-V0 where the touchscreen may not display SER data. ➤ Resolved an issue introduced in R401-V0 where a nonvolatile failure may occur after a firmware upgrade. ➤ Resolved an issue introduced in R400-V0 that may cause the device to lose settings after a firmware upgrade over an Ethernet network. ➤ Resolved an issue introduced in R400-V0 that may prevent setting IPADDR, SUBNETM, or DEFRTR from the two-line LCD. ➤ Resolved an issue introduced in R400-V0 where the two-line LCD may incorrectly display the Load Tap Changer settings.	20230721
SEL-2411-R401-V0-Z012008-D20230331	➤ Added support for the Select Before Operate with Normal Security control model for IEC 61850 controllable data objects. ➤ Added support for IEEE C37.111-1999 COMTRADE event reports.	20230331

Table A.2 Firmware Revision History for R400 Series Firmware (Sheet 2 of 3)

Firmware Identification (FID) Number	Summary of Revisions	Manual Date Code
	➤ Added multilevel and station level supervision for IEC 61850 Local/ Remote control. ➤ Added Device Word bits to indicate speed and duplex mode for established Ethernet links. ➤ Resolved an issue where the device may not properly close a DNP TCP connection after the connection timeout has expired.	
SEL-2411-R400-V0-Z011008-D20220218	➤ [Cybersecurity] Added support for zipped and digitally signed (.zds) firmware files. These files require the SELBOOT firmware version to be upgraded to R600 first. Firmware files with the .s19 and .z19 extensions cannot be sent to relays with SELBOOT firmware R600. ➤ [Cybersecurity] Added the ability to upgrade relay firmware remotely over an Ethernet network. ➤ [Cybersecurity] Added EACC, E2AC, and EPAC settings to support port access control using SELOGIC control equations. ➤ Added support for load tap changer control using SELOGIC variables RSE_CTRL, LWR_CTRL, and PAR_OP. ➤ Added support for load tap position and control monitoring. ➤ Added TAP_POS to the Modbus register map. ➤ Added Modbus command code for resetting the load tap control monitor alarms. ➤ Added temperature measurement fault Device Word bits ITEMP01F–ITEMP10F and ETEMP01F–ETEMP12F. ➤ Added support for Local/Remote control using SELOGIC variables EN_LRC and LOCAL. ➤ Added support for IEC 61850 Local/Remote control at local (bay) level feature as defined in the IEC61850-7-4 standard. ➤ Added SELOGIC variable SC850SM to support IEC 61850 Simulation mode. ➤ Added event reference numbers for CEV event records. ➤ Added the ability to trigger event reports from the Event History application on the touchscreen display. ➤ Added ability to refresh event history screen on the touchscreen display. ➤ Added clarifying SEL ASCII message in response to an invalid **EVE** command. ➤ Enhanced touchscreen display by removing unnecessary navigation buttons on the Switch bits control screens. ➤ Enhanced the temperature metering display to hide unused temperature inputs. ➤ Enhanced RTD temperature measurements (INTEMP01 to INTEMP10 and INTRTD01 to INTRTD10) to provide 0.1°C resolution. ➤ Resolved an issue where the **CAS** command response did not include sufficient CEV header information for communication with an SEL RTAC. ➤ Resolved an issue where the device may not update testdb overrides of Virtual Bits over IEC 61850 communications. ➤ Resolved an issue where the touchscreen display may not update properly after an **SER C** command.	20220218

Table A.2 Firmware Revision History for R400 Series Firmware (Sheet 3 of 3)

Firmware Identification (FID) Number	Summary of Revisions	Manual Date Code
	➤ Resolved an issue where the touchscreen display may not update properly after an **HIS C** command. ➤ Resolved an issue where the device may not correctly update Remote Analogs in the analog processing interval. ➤ Resolved an issue where SER alias settings would not allow for blank spaces.	

Table A.3 Firmware Revision History for R300 Series Firmware (Sheet 1 of 3)

Firmware Identification (FID) Number	Summary of Revisions	Manual Date Code
SEL-2411-R320-V2-Z010008-D20231229	Includes all the functions of SEL-2411-R320-V1-Z010008-D20211210 with the following addition: ➤ Resolved an issue introduced in R318-V0 where the front-panel and communications ports may disable after collecting thousands of event and report files from the device.	20231229
SEL-2411-R320-V1-Z010008-D20211210	Includes all the functions of SEL-2411-R320-V0-Z010008-D20201230 with the following addition: ➤ Revised the firmware to allow replacement of the field-programmable gate array (FPGA) part.	20211210
SEL-2411-R320-V0-Z010008-D20201230	➤ Added support for the SEL-2411 Temperature Monitor Digital Data Logger. ➤ Enhanced thermocouple temperature processing to provide faster measurements immediately after power up.	20201230
SEL-2411-R319-V0-Z010008-D20201029	➤ Added support for the front-panel 5-inch touchscreen display. ➤ Added support for 1-minute load profile data. ➤ Enhanced the device reset command to warn that the MAC address will be set to the default value. ➤ Resolved an issue that could cause the device to disable after installing a serial communication card in Slot C. ➤ Resolved an issue introduced in R318 where changing any port settings after the unsolicited message offline timeout is set to OFF would cause the device to stop responding to **SET** or **SHOW** commands, requiring the user to issue a **STA C** command to resolve the issue.	20201029
SEL-2411-R318-V1-Z009008-D20201028	Includes all the functions of SEL-2411-R318-V0-Z009008-D20200611 with the following addition: ➤ Resolved an issue introduced in R318-V0 that may cause the DNP server to stop communicating after approximately 25 days.	20201028
SEL-2411-R318-V0-Z009008-D20200611	➤ Added support for the 14 DI card. ➤ Added support for IEC 61850 mode/behavior. ➤ Added support for MMS file transfer. ➤ Added communication time-out indication for DNP and Modbus. ➤ Added **NET** command. ➤ Added analog control variables. ➤ Added run-time configurable timers and more variables/timers. ➤ Added support for analog input event buffers for DNP. ➤ Enhanced Time Source status to allow for reporting SNTP and DNP time sources.	20200611

Table A.3 Firmware Revision History for R300 Series Firmware (Sheet 2 of 3)

Firmware Identification (FID) Number	Summary of Revisions	Manual Date Code
	➤ Resolved an issue where a counter's active low and active high outputs would not assert after a restart until the counter value changed at least once. ➤ Improved timer accuracy and expanded setting ranges for variables/timers. ➤ Resolved an issue where dc offset errors may be present in unfiltered event reports from ac current and voltage measurements.	
SEL-2411-R317-V1-Z008007-D20190315	Includes all the functions of SEL-2411-R317-V0-Z008007-D20180131 with the following additions: ➤ Improved backward compatibility with certain MMS clients. ➤ Enhanced device self-diagnostics to prevent false clock warnings.	20190315
SEL-2411-R317-V0-Z008007-D20180131	➤ Added support for IEC 61850 Edition 2. ➤ Added a dedicated MAC address to improve GOOSE processing performance. **Note**: You can upgrade units with firmware versions R316 or older to firmware versions R317 or newer, but the unit will not have the GOOSE performance improvements (i.e., a GOOSE port with a dedicated MAC address).	20180330
SEL-2411-R316-V1-Z008007-D20180801	Includes all the functions of SEL-2411-R316-V0-Z008007-D20161205 with the following addition: ➤ Resolved an issue introduced in R316-V0 that could prevent receipt of new Goose messages after a heavy storm of Goose messages.	20180801
SEL-2411-R316-V0-Z008007-D20161205	➤ Added Parallel Redundancy Protocol (PRP). ➤ Added fast analog processing option for remote analogs (ERAFAST). ➤ Optimized MIRRORED BITS processing for faster performance. ➤ Modified the behavior of STSET to assert after a setting download.	20161205
SEL-2411-R315-V2-Z007007-D20160507	➤ Resolved an issue that could cause a nonvolatile memory failure to be detected if nonvolatile storage of Math Variables or Counters was enabled shortly after the initial out-of-box application of power. This would occur only once on a unit and clear after entry of a **STATUS C** command.	20160507
SEL-2411-R315-V1-Z007007-D20150707	➤ Resolved an issue that caused SELOGIC timers to drop out after a temporary dropout of the input that was less than the timer's dropout time setting.	20150707
SEL-2411-R315-V0-Z007007-D20150112	➤ Resolved an issue introduced in R314 that prevented SERs from being retrieved in an ASCII terminal. ➤ Resolved an issue introduced in R314 that affected units with the old FPGA which could cause the HMI buttons and display to be inoperative after a warm restart.	20150112
SEL-2411-R314-V0-Z007007-D20141027	➤ Revised firmware for new FPGA. R314 firmware is compatible with older R3XX hardware. Units built after this release are not compatible with firmware older than R314. ➤ Added support for multiple anonymous DNP sessions. ➤ Revised firmware to support DC analog inputs with event reports on 8V LEA inputs. ➤ Enhanced device self-diagnostics to prevent false clock, 15V, and battery warnings. ➤ Resolved an issue on port F setting transfers using YMODEM that prevented ACSELERATOR QuickSet from knowing the transfer completed. ➤ Added default setting for DNP frozen counters. ➤ Added DAYM and MONTH analog time quantities.	20141027
SEL-2411-R313-V0-Z006006-D20131217	➤ Resolved handling of unrecognized Ethertype frames that can cause Ethernet to stop responding.	20131217

Table A.3 Firmware Revision History for R300 Series Firmware (Sheet 3 of 3)

Firmware Identification (FID) Number	Summary of Revisions	Manual Date Code
SEL-2411-R312-V0-Z006006-D20130503	➤ Resolved an issue introduced in R311 with the initial Gratuitous ARP that prevented the relay from initializing when the Ethernet port is disabled.	20130503
SEL-2411-R311-V0-Z006006-D20130418	➤ Resolved an Ethernet Failover Switching issue for dual Ethernet models. ➤ Resolved an issue with the initial Gratuitous ARP request not being sent for as long as five minutes after startup.	20130418
SEL-2411-R310-V0-Z006006-D20120718	➤ Added support for nonvolatile storage of Counters and Math Variables. ➤ Added support for Fast Analog Logic Blocks. ➤ Added support for SNTP time synchronization. ➤ Added support for a second Modbus session. ➤ Added support for Telnet settings transfer through Ymodem.	20120718
SEL-2411-R309-V0-Z005005-D20120523	➤ Resolved an issue which could cause intermittent GPSB or CARD failures on cold startup.	20120523
SEL-2411-R308-V0-Z005005-D20110902	➤ Resolved an issue that could cause intermittent GPSB failures on startup in vertical chassis units. ➤ Updated for IEC 61850 KEMA Certification. ➤ Made the SEL-2411 series Flash driver more robust to prevent unintended writes or erasures.	20110902
SEL-2411-R306-V0-Z005005-D20110211	➤ Resolved an issue introduced in R305 when frequency tracking from a current source that can cause incorrect meter reporting.	20110211
SEL-2411-R305-V0-Z005005-D20101222	➤ Added support for storage of Designer Templates. ➤ Increased maximum number of DNP sessions to 5.	20101222
	➤ Added support for secondary PB LEDs and extra target LED in vertical units. ➤ Increased frequency tracking accuracy. ➤ Enhanced device self-diagnostic capabilities.	
SEL-2411-R304-V0-Z004004-D20100702	➤ Resolved a firmware upgrade issue where the IED, under certain settings conditions, fails to upgrade settings.	20100702
SEL-2411-R303-V0-Z004004-D20100325	➤ Updated the DNP library and added additional Object Variations. ➤ Resolved an issue with DNP over Port 2 fiber. ➤ Changed device functionality to restart when an exception occurs.	20100325
SEL-2411-R302-V0-Z004004-D20100115	➤ Added support for Universal Temperature Input card (this includes type J, K, T, and E thermocouples). ➤ Added DNP Frozen Counters. ➤ Added protocol enables for FTP, Telnet, and Modbus. ➤ Resolved an occasional IEC 61850 communications problem 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.4 Firmware Revision History for R200 Series Firmware

Firmware Identification (FID) Number	Summary of Revisions	Manual Date Code
SEL-2411-R210-V1-Z003003-D20150805	➤ Resolved an issue that caused SELOGIC timers to drop out after a temporary dropout of the input that was less than the timer's dropout time setting.	20151020
SEL-2411-R210-V0-Z003003-D20131004	➤ Resolved an Ethernet Failover Switching issue for dual Ethernet models. ➤ Resolved an issue with the initial Gratuitous ARP request not being sent for as long as five minutes after startup.	20131004
SEL-2411-R209-V0-Z003003-D20100122	➤ Increased metering accuracies with system calibration. ➤ Resolved TCP socket issue to prevent possible vectors.	20100122
SEL-2411-R208-V0-Z003003-D20090724	➤ Resolved an issue with 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 selinc.com/support/security-notifications/ for details).	20090302
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 selinc.com/support/security-notifications/ 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. ➤ Updated 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	➤ Resolved operating MMS controls may cause operation failure. ➤ Resolved 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. ➤ Previous versions cannot be upgraded to R200.	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.5* for compatibilities between Architect, ICD/CID file, and Ethernet port firmware versions.

Table A.5 Architect CID File Compatibility

Architect Software Version	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.6 Firmware Revision History for R100 Series Firmware

Firmware Identification (FID) Number	Summary of Revisions	Manual Date Code
SEL-2411-R104-V1-Z001001-D20150911	➤ Resolved an issue that caused SELOGIC timers to drop out after a temporary dropout of the input that was less than the timer's dropout time setting.	20151020
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	➤ Improved SEL-2411 XON/XOFF handshaking with SEL-2032 during autoconfiguration. ➤ Improved MIRRORED BITS communications using Pulsar modems. ➤ Resolved potential for a device to disable 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 autoconfiguration. ➤ Improved SEL-2411 Fast SER state change condition with SEL-2032 during power up.	20070725
SEL-2411-R101-V0-Z001001-D20060223	➤ Added check for SELECT 4 AI/4 AO.	20060223
SEL-2411-R100-V0-Z001001-D20051202	➤ Initial version.	20051202

SELBOOT Firmware Version and Relay Firmware Compatibility

The SELBOOT version and the compatible relay firmware versions are listed in *Table A.7*. Older versions are not listed for simplicity. SELBOOT firmware versions, R600 and higher, ensure that the relay firmware upgrade file is digitally signed by SEL using a secure hash algorithm and that the file has been provided by SEL and that its contents have not been altered.

Firmware version R400-V0 or higher requires that the SELBOOT firmware be upgraded to R600.

Table A.7 SELBOOT Firmware Revision History

Boot Firmware Identification Number	SEL-2411 Firmware Versions Supported	Date Code
SLBTIND-R101-V0-Z000000-D20230609	R500 and higher	20230609
SLBT24XX-R600-V0-Z000000-D20210430	R400 to R401	20210430
BOOTLDR-R501-V0-Z000000-D20140224	R315 to R320	20140224
BOOTLDR-R500-V0-Z000000-D20090925	R300 to R320	20090925
BOOTLDR-R400-V0-Z000000-D20081007	R204 to R210	20081007

SEL Display Package Versions

The SEL-2411 with the touchscreen display option has display packages for the SEL display and default custom display. *Table A.8* lists the display package version, a description of the modifications, and the instruction manual date code that corresponds to the display package versions. The most recent firmware version is listed first. The version number of this firmware is accessible through the Device Info folder.

Table A.8 SEL Display Package Revision History

SEL Display Package Version	Summary of Revisions	Manual Date Code
2.0.52411.58	➤ Added support for new hardware component suppliers. ➤ Modified the color touchscreen backlight brightness for more consistent dimming while in standby mode. ➤ Improved the performance of the touchscreen display in rotating display mode. ➤ Resolved an issue where the backlight could flicker during start-up.	20211210
2.0.52411.43	➤ Added support for SEL-2411TM.	20201230
2.0.52411.38	➤ Initial version.	20201029

SEL Display Package and SEL-2411 Firmware Compatibility

The display package and the compatible SEL-2411 firmware versions are listed in *Table A.9*. The version number of the display package is accessible through the Device Info folder. Display packages may be compatible with more than one SEL-2411 firmware version.

Table A.9 SEL Display Package Compatibility With SEL-2411 Firmware

SEL Display Package Version	SEL-2411 Firmware Versions Supported	Manual Date Code
2.0.52411.58	R320-V1	20211210
2.0.52411.43	R320	20201230
2.0.52411.38	R319	20201029

ICD File

To find the ICD revision number (configVersion) in your device,

- ➤ Issue the SEL ASCII command, ID.
- ➤ On units with the touchscreen display, view the Device Status screen.

The configVersion appears in the following format in the responses.

configVersion = ICD-2411-R201-V0-Z310004-D20140321

The ICD revision number follows the R (e.g., 202) and the date code follows the D (e.g., 20140321). This revision number is not related to the relay firmware revision number. The ICD file version is used to create the CID file that is loaded in the relay.

See *Table A.10* for the ICD file revision history.

Table A.10 ICD File Revision History (Sheet 1 of 2)

configVersion	Summary of Revisions	Minimum Relay Firmware	ClassFileVersion
ICD-2411-R122-V0-Z502010-D20250228	➤ Initial ICD file release with Edition 2.1 support and compatibility. ➤ Updated ClassFileVersion to 010. ➤ Added support for pulse configuration attributes cmdQual, onDur, offDur, and numPls according to IEC 61850-7-3. ➤ Added support for deadband data attributes dbRef, dbAngRef, zeroDbRef, and zeroDb according to IEC 61850-7-3 Edition 2.1. ➤ Added support for attributes valImport and valKind according to IEC 61850-6 for compatibility with third-party system configuration tools. ➤ Extended LPHD logical node to include IEC 61850 library version (SelLibId). ➤ Added support for sAddr attribute to replace esel:datasrc attribute in ICD files to improve compatibility with third-party system configuration tools. ➤ Removed maximum and minimum metering quantities from MDST1 and MDST2 logical nodes and moved them into newly created MSTA1 and MSTA2 logical nodes. ➤ Conformance-related changes.	R502	010
ICD-2411-R121-V1-Z501009-D20240319	➤ Minor changes for DNV IEC Ed 2 Certification. ➤ Added a display of selected mod/beh and control model type in the description. ➤ Changed the behavior of internal controls such as Mod and Sim to always be Direct Control with Normal security. ➤ Added capability for pos control in the CSWI logical node to use the selected control model type. ➤ Added "Sel" prefix to some data attributes in the LTMS logical node. ➤ Removed bufreport and unbufreport services from <Clientservices> that incorrectly indicated that the device was an MMS client. ➤ Added minVal and maxVal attributes to BSC control models.	R501	009
ICD-2411-R121-V0-Z501009-D20231011	➤ Added support for 64 incoming GOOSE message subscriptions. ➤ Increased the number of default unbuffered and buffered MMS reports to 12.	R501	009
ICD-2411-R120-V1-Z401009-D20230609	➤ Added minor changes for IEC61850 standard conformance.	R401	009

Table A.10 ICD File Revision History (Sheet 2 of 2)

configVersion	Summary of Revisions	Minimum Relay Firmware	ClassFileVersion
ICD-2411-R120-V0-Z401009-D20230120	➤ Added support for the Select Before Operate with Normal Security control model. ➤ Added support for the PRBGGIO logical node for pulsing remote bits. ➤ Added support for multilevel and station level supervision for IEC 61850 Local/Remote control. ➤ Added support for No Operation by allowing NOOP as data source for IEC 61850 data objects.	R401	009
ICD-2411-R119-V2-Z400006-D20230609	➤ Added persisent Data atrribute to all CDCs.	R400	006
ICD-2411-R119-V1-Z000000-D20221007	➤ Resolved an issue introduced in R119-V0 where the ICD file may not pass a schema check.	R400	006
ICD-2411-R119-V0-Z000000-D20220218	➤ Added system logical nodes LGOS, LTIM, LTMS, and LCCH. ➤ Added the device main board version numbers to the IEC 61850 LPHD logical node. ➤ Added the IEC 61850 LTRK logical node for service tracking. ➤ Added the ATCC logical node for the LTC control. ➤ Added Overcurrent, Undervoltage, and Overvoltage binary values in POCGGIO26, NOCGGIO27, XPOCGGIO28, PUVGGIO29, PPUVGGIO30, PPOVGGIO31, and POVGGIO32 logical nodes. ➤ Added support for the IEC 61850 Functional Naming Feature.	R400	006
ICD-2411-R118-V0-Z000000-D20200505	➤ Added support for ACVs in the ACVGGIO1–ACVGGIO2 logical nodes. ➤ Added support for IEC 61850 Test Mode control in LLN0 logical node. ➤ Added support for additional MVs and DIs. ➤ Added support for switch bits in CSWI1–CSWI5 logical nodes.	R318	006
ICD-2411-R117-V0-Z000000-D20180423	➤ Added support for IEC 61850 Ed 2. ➤ Certified by KEMA for IEC 61850 conformance.	R317	006
ICD-2411-R115-V0-Z000000-D20120718	➤ Added Conformance enhancements.	R310	004
ICD-2411-R114-V0-Z000000-D20110107	➤ Added support for four more push button LEDs in PLEDGGIO7 logical node.	R305	003
ICD-2411-R112-V0-Z000000-D20090416	➤ Added support for Universal Temperature Card in UTCMTHI1 logical node.	R301	003
ICD-2411-R111-V0-Z000000-D20090107	➤ Support SPC controls.	R206	003
ICD-2411-R107-V0-Z000000-D20080519	➤ Added Demand Metering Logical Node. ➤ Support SBOES Controls and SEL Architect selectable ctlModel.	R202	002
ICD-2411-R201-V0-Z002002-D20080108	➤ Initial release of the SEL-2411 ICD file for firmware R200 or higher.	R200	002

Instruction Manual

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

Table A.11 lists the instruction manual versions and revision descriptions. The most recent instruction manual version is listed first.

Table A.11 Instruction Manual Revision History (Sheet 1 of 15)

Date Code	Summary of Revisions
20250228	Preface ➤ Updated *Safety Marks*. ➤ Updated *Laser/LED Emitter*. Section 1 ➤ Updated *Specifications*. Section 2 ➤ Updated *Field Serviceability*. Section 7 ➤ Updated *Table 7.8: Ethernet Protocols*. ➤ Updated *SER Command (Sequential Events Recorder Report)*. ➤ Updated *Table 7.60: Settings Associated With SNTP*. Appendix A ➤ [Cybersecurity] Updated for firmware version R502-V0. ➤ Updated for ICD version R122. Appendix E ➤ Updated *Table E.15: Modbus Register Map*. Appendix F ➤ Updated for IEC 61850 Edition 2.1.
20241120	Preface ➤ Updated *Product Compliance Label for Hazardous Locations Approval*.
20240319	Appendix A ➤ [Cybersecurity] Updated for firmware version R501-V1. ➤ Updated release notes for ICD version R121-V1.
20240130	Section 1 ➤ Corrected note on front-panel display temperature range in *Specifications*. Appendix A ➤ [Cybersecurity] Updated for firmware version R500-V3. ➤ Added an R500-V0 release note in firmware version R501-V0. ➤ Updated for ICD version R121-V1. Appendix F ➤ Updated *Table F.23: Logical Device: CFG (Configuration)*.
20231229	Appendix A ➤ Updated for firmware versions R320-V2, R401-V2, and R500-V2. ➤ Updated the R318-V0 release note in firmware version R501-V0. Appendix H ➤ Updated *Table H.1: SEL-2411 Device Word Bits* and *Table H.2: Device Word Bit Definitions*.

Table A.11 Instruction Manual Revision History (Sheet 2 of 15)

Date Code	Summary of Revisions
20231208	Section 1 ➤ Updated *Communications Protocol* in *Features*. ➤ Updated *Specifications*. Section 2 ➤ Updated *Power Connections* in *Rear-Panel Connections*. ➤ Added *Figure 2.10: Slot A Euro Connector*. ➤ Added *I/O Connections* in *Rear-Panel Connections*. Setting Sheets ➤ Updated *Port 1 (Ethernet Port in Slot B)* in *Port Settings (SET P Command)*. ➤ Updated *Master 1 Settings*, *Master 2 Settings*, *Master 3 Settings*, *Master 4 Settings*, and *Master 5 Settings* in *DNP3 Settings (in Port Settings)*. Section 7 ➤ Added *Figure 7.3: Ethernet Network Configuration With Ring Structure (Switched Mode)*. ➤ Added *Precision Time Protocol (PTP)* and *Rapid Spanning Tree Protocol (RSTP)*. ➤ Added *COM PTP Command* and *RSTP Command* in *ASCII Commands*. Section 8 ➤ Updated *Front-Panel Security* and *Front-Panel Timeout* in *Touchscreen Display Front Panel*. ➤ Updated *Table 8.26: Touchscreen Settings*. ➤ Updated *Display Settings* in *Bay Screens Design Using QuickSet and Bay Screen Builder*. Appendix A ➤ [Cybersecurity] Updated for firmware version R501-V0. ➤ [Cybersecurity] Added the [Cybersecurity] label to and revised one entry in firmware version R500-V1. ➤ Updated for ICD version R121-V0. Appendix E ➤ Updated *Table E.13: Device Outputs* and *Table E.16: Modbus Register Map*. Appendix F ➤ Updated *Reports* in *IEC 61850 Operation*. Appendix J ➤ Updated *Table J.1: IP Port Numbers*. Glossary ➤ Updated *TC*.
20230927	Appendix A ➤ Updated for firmware version R500-V1.
20230721	Section 2 ➤ Updated *Communications Card (EIA-232/EIA-485)* in *Card Configuration*. Section 5 ➤ Updated *Tap Position Alarms* in *Load Tap Position and Control Monitoring*. Appendix A ➤ Updated Summary of Revisions for R500-V0. ➤ Updated for firmware version R401-V1. Appendix J ➤ Removed Port 319/320 from *Table J.1: IP Port Numbers*.
20230609	Section 1 ➤ Updated *Specifications*. Section 2 ➤ Updated *Communications Ports*. ➤ Updated *Figure 2.5: Pins for Password Jumper and SELboot Jumper*.

Table A.11 Instruction Manual Revision History (Sheet 3 of 15)

Date Code	Summary of Revisions
	SEL-2411 Settings Sheets ➤ Updated *DNP3 Settings (in Port Settings)*. Section 7 ➤ Removed Ethernet networks with ring structure because of no support for spanning tree protocol. Section 9 ➤ Updated *Retrieving COMTRADE Event Files*. Section 10 ➤ Updated *Table 10.11: Device Self-Tests*. Appendix A ➤ Updated for firmware version R500-V0. ➤ Updated for SELBOOT firmware version R101-V0. ➤ Updated for ICD versions R120-V1 and R119-V2.
20230331	Section 1 ➤ Updated *Specifications*. Section 3 ➤ Updated *Table 3.2: SEL Software Solutions*. ➤ Updated *Connection Parameters* and *Event Analysis*. Section 6 ➤ Updated *Table 6.23: Local/Remote Control Settings*. ➤ Added *Multilevel Local/Remote Control*. SEL-2411 Settings Sheets ➤ Updated *Control Configuration*. Section 7 ➤ Added *Virtual File Interface*. Section 9 ➤ Updated *Overview*. ➤ Updated *Table 9.1: Compressed ASCII Event Commands*. ➤ Added *Retrieving Event Reports Via Ethernet File Transfer*. ➤ Updated *CEVENT, Viewing Compressed Event (CEV) Reports*, and *COMTRADE File Format Event Reports.* Appendix A ➤ Updated for firmware version R401-V0. ➤ Updated for ICD version R120-V0. Appendix F ➤ Updated *Features* and *IEC 61850 Operation*. ➤ Updated *Table F.27: Logical Device: CON (Control)*. Appendix H ➤ Updated *Table H.1: SEL-2411 Device Word Bits* and *Table H.2: Device Word Bit Definitions*. Appendix J ➤ Added appendix. Glossary ➤ Added *COMTRADE* and *PRP*.
20230310	Preface ➤ Updated *Hazardous Locations Approval*. ➤ Updated *Product Compliance Label for Hazardous Locations Approval.*
20221221	Section 1 ➤ Added UKCA Mark to *Specifications*.

Table A.11 Instruction Manual Revision History (Sheet 4 of 15)

Date Code	Summary of Revisions
202201007	Appendix A ➤ Updated for ICD version R119-V1.
20220520	Section 2 ➤ Updated *Power Connections*. Section 5 ➤ Updated *Math Variable Metering*.
20220218	Section 5 ➤ Updated *Table 5.5: Energy Meter Values*. ➤ Added *Load Tap Position and Control Monitoring*. Section 6 ➤ Added *Local/Remote Control*. ➤ Added *Test/Blocked Mode Control*. ➤ Added *Simulation Mode Control*. ➤ Added *Port Access Control*. Settings Sheets ➤ Added *Load Tap Changer Settings*. ➤ Added *Time and Date Management Settings*. ➤ Added *Control Configuration*. ➤ Added *IEC 61850 Mode/Behavior Configuration*. ➤ Added *IEC 61850 Simulation Configuration*. ➤ Added *Port Access Control Settings*. ➤ Added EPAC and EETHFWU settings to *Port Settings*. Section 7 ➤ Added *CSER Command (Compressed SER Report)*. Appendix A ➤ Updated for firmware version R400. ➤ Added *SELBOOT Firmware Version and Relay Firmware Compatibility*. ➤ Added *ICD File*. Appendix B ➤ Updated entire appendix. Appendix D ➤ Updated *Device Profile*. ➤ Updated *Table D.7: DNP3 Reference Data Map*. Appendix E ➤ Updated *Table E.16: Modbus Register Map*. Appendix F ➤ Added *IEC 61850 Operation*. ➤ Added *IEC 61850 Simulation Mode*. ➤ Added *Common Logical Nodes*. ➤ Updated *Table F.27: Logical Device: ANN (Annunciation)*. Appendix H ➤ Updated *Table H.1: SEL-2411 Device Word Bits*. ➤ Updated *Table H.2: Device Word Bit Definitions*. Appendix I ➤ Updated *Table I.1: Available Analog Quantities*.

Table A.11 Instruction Manual Revision History (Sheet 5 of 15)

Date Code	Summary of Revisions
20211210	Appendix A ➤ Updated for firmware version R320-V1. ➤ Added *Table A.5: SEL Display Package Revision History* and *Table A.6: SEL Display Package Compatibility With SEL-2411 Firmware*.
20210831	Section 1 ➤ Updated *Type Tests* in *Specifications*.
20210820	Appendix E ➤ Updated *Table E.5: SEL-2411 Inputs*. ➤ Updated *Table E.16: Modbus Register Map*.
20210702	Section 1 ➤ Updated *Dielectric Strength and Impulse Tests* in *Specifications*.
20201230	Section 1 ➤ Updated *Universal Temperature Input Card* in *Specifications*. Section 2 ➤ Updated *Thermocouple Inputs*. Appendix A ➤ Updated for firmware version R320.
20201029	Section 1 ➤ Updated *Specifications*. Section 5 ➤ Updated steps under *Analog Input Field Calibration Process*. ➤ Added note under *Digital Input Configuration*. Setting Sheets ➤ Updated *LED Settings*. Section 8 ➤ Updated throughout for touchscreen models. ➤ Added *Bay Control*. Appendix A ➤ Updated for firmware version R319.
20201028	Appendix A ➤ Updated for firmware version R318-V1.
20200611	Section 1 ➤ Updated *Specifications*. Section 2 ➤ Added *Digital Input Card (14 DI)*. Section 4 ➤ Updated *Variables/Timers*. ➤ Added *Run-Time Configurable Timers*. ➤ Added *Analog Control Variables*. ➤ Updated *Table 4.5: Counter Input/Output Description*. Section 6 ➤ Updated *Table 6.16: Rear-Panel Terminal Number and Software Reference Number Correlation*. ➤ Updated *Table 6.17: General Global Settings*. ➤ Added *Time and Date Management Settings*.

Table A.11 Instruction Manual Revision History (Sheet 6 of 15)

Date Code	Summary of Revisions
	Settings Sheets ➤ Updated *Logic Settings (SET L Command)*. ➤ Updated *Global Settings (SET G Command)*. ➤ Updated *Port Settings (SET P Command)*. ➤ Updated *DNP3 Settings (SET DNP Command)*. Section 7 ➤ Added *Communication Time-Out Indication*. ➤ Added *NET Command*. Appendix A ➤ Updated for firmware version R318. Appendix D ➤ Updated *Table D.7: DNP3 Reference Data Map*. Appendix E ➤ Updated *Modbus Register Map*. Appendix F ➤ Added *IEC 61850 Mode/Behavior*. ➤ Updated *Table F.12: Logical Device: ANN (Annunciation)*. ➤ Updated *Table F.13: Logical Device: CON (Control)*. Appendix H ➤ Updated *Table H.1: SEL-2411 Device Word Bits*. ➤ Updated *Table H.2: SEL-2411 Device Word Bit Definitions*. Appendix I ➤ Updated *Table I.1: Available Analog Quantities*.
20191115	Preface ➤ Updated *Safety Marks* and *General Information* for current certifications. Section 1 ➤ Updated *Specifications*. Section 2 ➤ Updated *Device Placement* for ATEX compliance.
20190315	Section 7 ➤ Updated *Communications* and *Simple Network Time Protocol (SNTP)*. Appendix A ➤ Updated for firmware version R317-V1.
20180801	Appendix A ➤ Updated for firmware version R316-V1.
20180601	Section 1 ➤ Updated *Specifications*.
20180330	Section 7 ➤ Updated *MAC Command*. Section 9 ➤ Updated *Chatter Filtering*. Appendix A ➤ Updated for firmware version R317-V0.

Table A.11 Instruction Manual Revision History (Sheet 7 of 15)

Date Code	Summary of Revisions
20161205	Section 1 ➤ Updated *Specifications*. Section 5 ➤ Updated for the addition of ERAFAST for remote analog processing. Section 6 ➤ Updated settings for the addition of PRP and fast remote analog processing. Section 5 ➤ Updated communication for the addition of PRP. Section 7 ➤ Added *Network Connection Using PRP Connection Mode*. Appendix A ➤ Updated for firmware version R316-V0.
20160507	Appendix A ➤ Updated for firmware version R315-V2.
20160325	Preface ➤ Updated *Safety Information*. Section 1 ➤ Updated *Specifications*. Appendix A ➤ Updated point release information. Appendix B ➤ Updated point release information.
20160304	Section 1 ➤ Updated *Specifications*.
20151020	Appendix A ➤ Updated for firmware version R210-V1 and R104-V1.
20150714	Appendix A ➤ Added details on description of firmware point releases. Appendix B ➤ Added examples to show the difference between firmware standard releases and firmware point releases.
20150707	Preface ➤ Updated *Safety Marks*. Appendix A ➤ Updated for firmware version R315-V1.
20150624	Section 1 ➤ Updated *Specifications*.
20150126	Preface ➤ Updated *Safety Information*. Section 1 ➤ Changed *Certifications* to *Compliance* and moved to the beginning of *Specifications*.
20150112	Appendix A ➤ Updated for firmware version R315.

Table A.11 Instruction Manual Revision History (Sheet 8 of 15)

Date Code	Summary of Revisions
20141027	Section 2 ➤ Added note to *Table 2.7: Current/Voltage Car (3 ACI/3 AVI) Terminal Designation*. Settings Sheets ➤ Added *Auxiliary DC Voltage Inputs* settings. ➤ Added VSCALE setting. ➤ Changed T_OUT setting value to 0–30 minutes. ➤ Added DVARFC*n* settings. ➤ Added DNPNUM*n* settings. Appendix A ➤ Updated for firmware version R314. Appendix E ➤ Added *Table E.4: 02 Read Input Status Command*. Appendix I ➤ Added MONTH and DAYM to *Table I.1: Available Analog Quantities*.
20131217	Settings Sheets ➤ Added note to IP Address settings in *DNP3 Settings (SET DNP Command)*. Appendix A ➤ Updated for firmware version R313. Appendix D ➤ Added *Ethernet Operation* and *Table D.2: DNP-IP Specific Settings*. Appendix I ➤ Updated Date/Time Quantities in *Table I.1: Available Analog Quantities*.
20131004	Appendix A ➤ Updated for firmware version R210.
20130503	Section 1 ➤ Updated *Specifications*. Appendix A ➤ Updated for firmware version R312.
20130418	Section 1 ➤ Updated *Table 1.2: Optional Accessories*. Section 3 ➤ Updated ACSELERATOR QuickSet information in *QuickSet*. Appendix A ➤ Updated for firmware version R311.
20120907	Preface ➤ Added product label example in *Product Labels*. Section 1 ➤ Updated *Specifications*.

Table A.11 Instruction Manual Revision History (Sheet 9 of 15)

Date Code	Summary of Revisions
20120718	Section 1 ➤ Added Time-Code Input (SNTP) in *Specifications*. ➤ Added frequency accuracy in *Specifications*. ➤ Added Fast Analog Alarm Pickup in *Specifications*. ➤ Updated DC Transducer (Analog) Inputs in *Specifications*. ➤ Added AC Current Input Neutral in *Specifications*. Section 4 ➤ Added *Fast Analog Logic*. Section 6 ➤ Added nonvolatile settings to Math Variable SELOGIC Equations in *Setting Sheets*. ➤ Added Fast Analog Logic settings in *Setting Sheets*. ➤ Added SNTP settings in *Setting Sheets*. Section 7 ➤ Added *Simple Network Time Protocol (SNTP)*. Appendix A ➤ Updated for firmware version R310. Appendix B ➤ Added cautionary notes to save settings and SERs before modifying firmware. Appendix D ➤ Updated *Table D. 5 DNP Object List*. Appendix E ➤ Updated *Table E.15 Modbus Register Map*. Appendix H ➤ Updated *Table H.1 SEL-2411 Device Word Bits*. ➤ Updated *Table H.2 Device Word Bit Definitions*.
20120523	Appendix A ➤ Updated for firmware version R309.
20120301	Section 1 ➤ Added Hazardous Locations Operating Temperature Range and updated UL certifications in *Specifications*.
20110902	Section 1 ➤ Expanded RTD measurement specifications. ➤ Added timer accuracy specifications. Section 2 ➤ Added AI jumper settings to 4AI/4AO card configuration. Section 4 ➤ Clarified use of R_TRIG and F_TRIG with individual Device Word bits. Appendix A ➤ Updated for firmware version R308.
20110211	Appendix A ➤ Updated for firmware version R306.

Table A.11 Instruction Manual Revision History (Sheet 10 of 15)

Date Code	Summary of Revisions
20101222	Section 1 ➤ Expanded *Table 1.2: Optional Accessories*. ➤ Added clarification on analog processing in *Specifications*. ➤ Increased maximum number of DNP sessions to 5. Section 2 ➤ Added 8DO Form B card option. ➤ Added 8DO Six Form A / 2 Form B and Six Form B / 2 Form A card options. ➤ Added *Figure 2.5: Pins for Password Jumper and SELBOOT Jumper* for firmware versions R300 and higher. ➤ Added *Figure 2.11: Communications Ports*, *Figure 2.12 Digital Inputs*, and *Figure 2.13: Digital Outputs*. Section 3 ➤ Added *ACSELERATOR QuickSet Graphical Logic Editor* and *ACSELERATOR QuickSet Designer Template Storage*. Section 4 ➤ Moved latch storage to battery-backed RTC SRAM. Section 6 ➤ Added *Table 6.2: Ethernet Port Device Word Bits*. ➤ Added description of Alarm Contact behavior for Access Levels and Setting Change. ➤ Added setting sheets for DNP sessions 4 and 5. ➤ Added T00_LED and PB01BLED–PB04BLED to setting sheets. Section 7 ➤ Added description of **ETH** command. Section 8 ➤ Added LED description and programming for vertical SEL-2411s. Section 10 ➤ Added to description of FPGA Self-Tests. Appendix A ➤ Updated for firmware version R305. Appendix D ➤ Updated DNP object 32 default value. ➤ Added detail to RTD/TC part number and DNP default map. ➤ Added *Table D.8: R303 or Later Example Object 12 Trip/Close or Code Selection Operation*. ➤ Added T00_LED and PB01BLED–PB04BLED to DNP Map. Appendix E ➤ Added T00_LED and PB01BLED–PB04BLED to Modbus Map. Appendix F ➤ Added T00_LED and PB01BLED–PB04BLED to IEC 61850 Logical Nodes. Appendix H ➤ Added FREQTRK, T00_LED, and PB01BLED–PB04BLED to Device Word Bits. ➤ Expanded explanation of ERTDFLT and IRTDFLT Device Word Bits.
20100702	Appendix A ➤ Updated for firmware revision R304.
20100512	Section 1 ➤ Added vertical surface-mount kit to *Table 1.2: Optional Accessories.* Section 2 ➤ Added Form B description to *Digital Output (8 DO)*.

Table A.11 Instruction Manual Revision History (Sheet 11 of 15)

Date Code	Summary of Revisions
20100325	Appendix A ➤ Updated for firmware revision R303. Appendix D ➤ Updated *Table D.5: SEL-2411 DNP Object List*.
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 Controller 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. 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 ➤ Updated 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*.

Table A.11 Instruction Manual Revision History (Sheet 12 of 15)

Date Code	Summary of Revisions
	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*.
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*.

Table A.11 Instruction Manual Revision History (Sheet 13 of 15)

Date Code	Summary of Revisions
	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.
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)*.

Table A.11 Instruction Manual Revision History (Sheet 14 of 15)

Date Code	Summary of Revisions
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.
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*.

Table A.11 Instruction Manual Revision History (Sheet 15 of 15)

Date Code	Summary of Revisions
20060607	Preface ➤ Updated *Class 1 LED Product Compliance Label and Location*. Section 1 ➤ Updated *Contact Protection* in *Specifications*. ➤ Added UL/CSA information. Section 2 ➤ Updated AWG specifications in *Power Connections*. Appendix E ➤ Updated Note under *Reference Data Map*. Command Summary ➤ Added **SET DNP** and **SHO DNP** commands.
20060404	Appendix E ➤ Clarified DNP binary event time stamping.
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.

Appendix B
Firmware Upgrade Instructions

Overview

These instructions guide you through the process of upgrading firmware in the device. The firmware upgrade will be either a standard release or a point release. A standard release adds new functionality to the firmware beyond the specifications of the existing version. A point release is reserved for modifying firmware functionality to conform to the specifications of the existing version.

A standard release is identified by a change in the R-number of the device firmware identification (FID) number.

Existing firmware:

FID=SEL-2411-**R100**-V0-Z001001-Dxxxxxxxx

Standard release firmware:

FID=SEL-2411-**R101**-V0-Z001001-Dxxxxxxxx

A point release is identified by a change in the V-number of the device FID string.

Existing firmware:

FID=SEL-2411-R100-**V0**-Z001001-Dxxxxxxxx

Point release firmware:

FID=SEL-2411-R100-**V1**-Z001001-Dxxxxxxxx

The release date is after the D. For example, the following is firmware version number R100, release date December 10, 2003.

FID=SEL-72411-R100-V0-Z001001-**D20031210**

SEL occasionally offers firmware upgrades to improve the performance of your device. The SEL-2411 stores firmware in flash memory. Therefore, changing physical components for the firmware upgrade is unnecessary. Upgrade the device firmware by downloading a file from a personal computer to the device via the Ethernet port through FTP or via Telnet. You can also use the front-panel serial port through ACSELERATOR QuickSet SEL-5030 Software or a terminal emulator, as outlined in the following sections. For devices with the IEC 61850 option, verify the IEC 61850 protocol after the upgrade (see *IEC 61850 CID File Upgrade Instructions on page B.11*).

Table B.1 details the available firmware upgrade methods. Available methods depend on your existing firmware and the firmware version to which you are upgrading.

Table B.1 Firmware Upgrade Methods

Existing Firmware	Upgrade Version	SELBOOT Upgrade Required?	Firmware Upgrade Methods Supported	
			Serial	Ethernet
R1*xx*	R1*xx*	No	Terminal emulator QuickSet	
R1*xx*	R2*xx*	---	Cannot be upgraded	
R2*xx*	R2*xx*	No	Terminal emulator QuickSet	---
R2*xx*	R3*xx*	---	Cannot be upgraded	
R3*xx*	R3*xx*	No	Terminal emulator QuickSet	---
R3*xx*	R4*xx*	Yes[a]	Terminal emulator	---
R4*xx*	R4*xx*	No	Terminal emulator QuickSet	FTP Terminal emulator

[a] When upgrading from firmware versions R3xx to R4xx or higher, first perform the Special Instructions for Upgrading to R400 Series Firmware on page B.3 and then follow Upgrade the Firmware Via Terminal Emulator Using the FILE Command Over Telnet on page B.10 instructions to upgrade your device firmware.

Required Equipment

Gather the following equipment before starting this firmware upgrade:

- PC
- Terminal emulation software that supports Xmodem/CRC or 1 k Xmodem/CRC protocol
- Serial communications cable (SEL-C234A or equivalent, or a null-modem cable) or Ethernet cable
- Disk containing the firmware upgrade file (e.g., SEL2411-R*xxx*-V*x*.s19, SEL2411-R*xxx*-V*x*.z19, or SEL2411-R*xxx*-v*x*.zds)
- QuickSet software

Digitally Signed Firmware Files

NOTE: The device pulses the SALARM bit and writes an entry to the device SER log whenever a firmware upgrade is attempted over Ethernet. Monitoring the SALARM bit and reviewing the SER log can help identify possible unauthorized firmware upgrade attempts.

The SEL-2411 supports digitally signed firmware files for firmware versions R400 and higher. These firmware files are compressed to reduce file transfer times and are digitally signed by SEL using a secure hash algorithm. The signature ensures that the file has been provided by SEL and that its contents have not been altered. Once the firmware is uploaded to the device, the signature of the firmware is verified with a public key that is stored on the device from the factory. If the device cannot verify the signature, it rejects the file. The name of the digitally signed firmware file is of the form SEL2411-R*xxx*-V*x*.zds, where R*xxx*-V*x* is the firmware revision number, 2411 indicates the device type, and .zds is the file extension reserved for digitally signed files. Firmware files with the .s19 or .z19 extension are not available for firmware versions R400 and higher.

Ethernet Firmware Upgrades

You can upgrade firmware over an Ethernet connection by sending the .zds firmware upgrade files via File Transfer Protocol (FTP) or Telnet protocols to a device running SELBOOT version R600 or newer and a device firmware version identified in *Table B.1*. FTP and Telnet are plain text protocols and do not inherently support message encryption (e.g., device passwords, etc.). Because of this, SEL strongly recommends you use a security gateway between your device and your network that provides encrypted communications along with SEL Software Defined Networking (SDN) technology to harden your network cybersecurity.

Special Instructions for Upgrading to R400 Series Firmware

NOTE: Make sure that the device and SELBOOT firmware revisions are compatible. Refer to Appendix A: Firmware and Manual Versions in this manual. If needed, upgrade the SELBOOT firmware prior to upgrading the device firmware.

The SELBOOT firmware in devices shipped with firmware versions R320-V1 or earlier must be upgraded before you can use digitally signed firmware files that have versions R400 or later. The SELBOOT firmware can be upgraded from version R50*x* to version R600 by uploading a special SELBOOT Loader firmware to the device.

The following instructions assume you have a working knowledge of your PC terminal emulation software.

Step 1. If the device is in service, open the device control circuits.

Step 2. Connect the PC to the front-panel serial port and enter Access Level 2.

Step 3. Save the present device settings.

NOTE: To save the calibration settings, perform **SHO C** from the terminal by logging into Access Level C using the Access Level C password. The factory-default password for Access Level C is CLARKE.

Use the following steps to save and restore the settings:

a. To display the settings files issue the following command at the ASCII prompt: **FILE DIR**

b. Record all the settings for possible re-entry after the firmware upgrade.

For example, to save the Device Settings, issue **FILE READ SET_1.txt** command. Then, receive the file to the PC via YMODEM transfer.

We recommend that you save all data, including events, stored in the device before the upgrade.

Step 4. Change the data rate of the communications software to 9600 bps and press **<Enter>**.

NOTE: Change the data rate of the device serial port to 9600 before issuing the **L_D** command to start the upgrade process.

Step 5. Enter current SELBOOT.

a. Issue the **L_D** command.

b. Type **Y <Enter>** at the following prompt:

```
Disable device to receive firmware (Y/N)?
```

c. Type **Y <Enter>** at the following prompt:

```
Are you sure (Y,N)?
```

The device sends the !> prompt.

Step 6. Issue the **REC** command to receive the new firmware.

Step 7. Type **Y** to confirm that the existing SELBOOT and device firmware can be erased.

Step 8. Press any key (e.g., **<Enter>**) when the device sends a prompt.

Step 9. Send the special SELBOOT Loader firmware (e.g., slbtldr_r60024*xx*.s19) to the device. The special SELBOOT Loader firmware erases the existing SELBOOT and device firmware and loads SELBOOT firmware version SLBT24XX-R600-V0-Z000000-D20210430.

The file transfer typically takes less than 5 minutes at 9600 bps, depending on the product. After the transfer is complete, the device reboots and displays the SELBOOT !> prompt.

After the SELBOOT upgrade is complete, upgrade your device firmware by using a terminal emulator (see *Upgrade the Firmware Using a Terminal Emulator on page B.4*). It is not necessary to save the device settings and other data again during the firmware upgrade process if you saved them before upgrading SELBOOT. Proceed to *Step 5* in *Upgrade the Firmware Using a Terminal Emulator on page B.4*.

Figure B.1 shows the entire special SELBOOT upgrade process.

```
==>>l_d
Disable device to receive firmware (Y,N)? y
Are you sure (Y,N)? y
Device Disabled

BFID=BOOTLDR-R501-V0-Z000000-D20140224
!>bau 9600
!>rec
This command uploads new firmware.
When new firmware is uploaded successfully, IED will erase old firmware,
load new firmware and reboot.

Are you sure you want to erase the existing firmware(Y,N)?
Press any key to begin transfer and then start transfer at the terminal.C
Erasing firmware.
Erase successful.
Writing new firmware.
Upload completed successfully. Attempting a restart.
!>
```

Figure B.1 Special SELBOOT Upgrade Process

Upgrade the Firmware Using a Terminal Emulator

NOTE: Make sure that the device and SELBOOT firmware revisions are compatible. Refer to Appendix A: Firmware and Manual Versions in this manual. If needed, upgrade the SELBOOT firmware prior to upgrading the device firmware.

NOTE: To save the calibration settings, perform **SHO C** from the terminal by logging into Access Level C using the Access Level C password. The factory-default password for Access Level C is CLARKE.

The following instructions assume you have a working knowledge of your PC terminal emulation software.

Step 1. If the device is in service, open the device control circuits.

Step 2. Connect the PC to the front-panel serial or Ethernet port and enter Access Level 2.

Step 3. Save the present device settings.

Use the following steps to save and restore the settings:

a. To display the settings files, issue the following commands at the ASCII prompt: **FILE DIR**

b. Record all the settings for possible reentry after the firmware upgrade.

For example, to save the Device Settings, issue **FILE READ SET_1.txt** command. Then, receive the file to the PC via YMODEM transfer.

We recommend that you save all stored data in the device, including events, before the upgrade.

Step 4. Enter SELBOOT to upgrade firmware.

a. Issue the **L_D** command.

b. Type **Y <Enter>** at the following prompt:

`Disable device to receive firmware (Y/N)?`

c. Type **Y <Enter>** at the following prompt:

`Are you sure (Y,N)?`

The device sends the !> prompt.

If you are using an Ethernet port, proceed to *Step 6*.

NOTE: Change the data rate of the device serial port to 9600 before issuing the **L_D** command to start the upgrade process.

Step 5. Change the data rate, if necessary.

a. Type **BAU 115200 <Enter>**.

This changes the data rate of the communications port to 115200 bps.

b. Change the data rate of the PC to 115200 bps to match the device.

Step 6. Issue the **REC** command to receive the new firmware.

Step 7. Type **Y** to confirm that the existing firmware can be erased.

Step 8. Press any key (e.g., **<Enter>**) when the device sends a prompt.

NOTE: To send a file using the Xmodem protocol via the ACSELERATOR QuickSet terminal, after Step 8, right-click in the terminal and select **Send File > Xmodem.**

Step 9. Start the file transfer.

Use the Xmodem protocol to send the file that contains the new firmware (e.g., SEL-2411-R*xxx*-V*x*.s19, SEL-2411-R*xxx*-V*x*.z19, or SEL-2411-R*xxx*-V*x*.zds). Firmware files for firmware versions R1*xx*, R2*xx*, and R3*xx* have .s19 or .z19 extensions. Firmware files for firmware versions R400 or higher have .zds extensions. Firmware files with .s19 or .z19 extensions are not available for firmware versions R400 and higher.

The file transfer typically takes less than 6 minutes at 115200 bps. After the transfer is complete, the device reboots and returns to Access Level 0.

Figure B.2 shows the entire upgrade process.

```
==>>l_d
Disable device to receive firmware (Y,N)? y
Are you sure (Y,N)? y
Device Disabled
In SELBoot from L_D
Validating Firmware. Standby...
Firmware validated.
!>bau 115200
!>rec
This command uploads new firmware.
When new firmware is uploaded successfully, IED will erase old firmware,
load new firmware and reboot.
Are you sure you want to erase the existing firmware (Y/N)?
Press any key to begin transfer and then start transfer at the terminal.
OKC
Validating firmware. Please stand by.
Erasing firmware.
Erase successful.
Writing new firmware.
Upload completed successfully. Attempting a restart.
Starting Application
```

Figure B.2 Firmware File Transfer Process

Step 10. The device front-panel **ENABLED LED** illuminates if the device settings are retained through the download.

If **ENABLED LED** is illuminated, proceed to *Step 11*.

If **ENABLED LED** is not illuminated or the front panel displays `STATUS FAIL Non_Vol Failure`, use the following procedure to restore the factory-default settings:

a. Set the communications software settings to 9600 bps, 8 data bits, and 1 stop bit.

b. Enter Access Level 2 by issuing the **2AC** command.

c. Issue the **R_S** command to restore the factory-default settings.

The device then reboots with the factory-default settings.

d. Enter Access Level 2.

e. Issue the **STATUS** command.

If the device is enabled, go to *Step f*.

If the STATUS report shows option card `FAIL` and `Relay Disabled` and the message:

```
Confirm Hardware Config
Accept & Reboot (Y/N)?
```

Enter **Y**. This saves the device calibration settings.

The device reboots and comes up enabled.

f. Restore device settings back to the settings saved in *Step 3*.

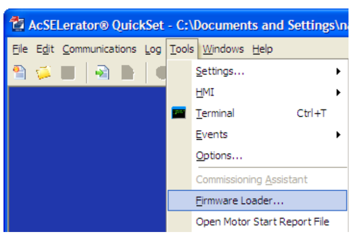
Step 11. Change the data rate of the PC to match that of the device prior to *Step 4*, and enter Access Level 2.

Step 12. Issue the **STATUS** command; verify all device self-test results are OK.

Step 13. Configure the SEL communications processor port to restore port settings to re-establish previous connections.

Upgrade the Firmware Using QuickSet

Select **Tools > Firmware Loader** from the ACSELERATOR QuickSet® SEL-5030 Software 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:

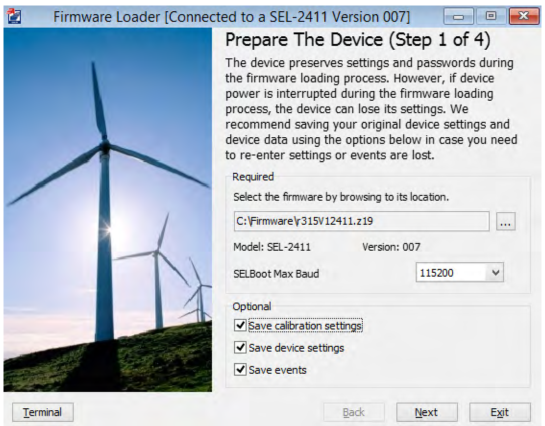
- ➤ The device is unsupported by QuickSet.
- ➤ The device is not connected to the computer with a communications cable.
- ➤ The connected port does not support SELBOOT.
- ➤ The device is disabled.

Step 1: Prepare Device

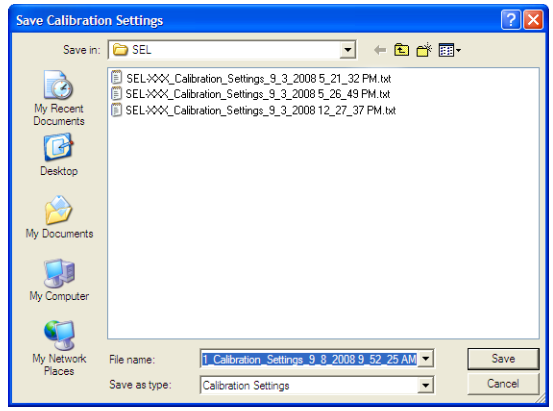
a) Select the firmware to be loaded using the browse control and select whether you want to save calibration settings, device settings, and event report files. Select **Next** to continue the wizard.

NOTE: If you are downgrading firmware, be certain to save device settings as they can be lost during a downgrade. Additionally, you may need to use the PART command to restore some MOT fields after a downgrade.

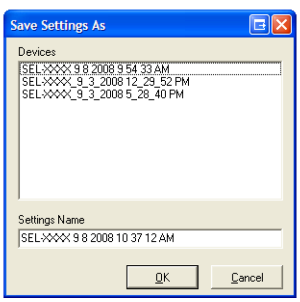
NOTE: Be certain to save SERs before upgrading or downgrading firmware as they can be lost during the process.



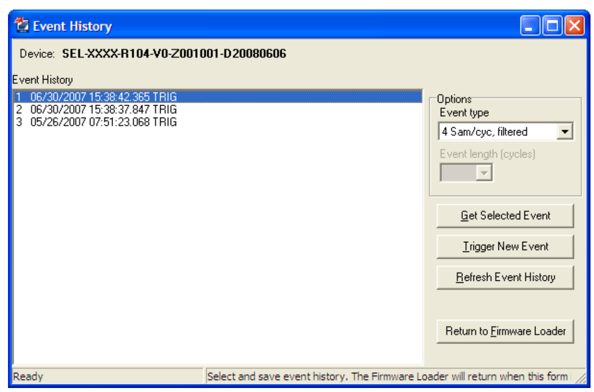
b) Select a file name and path to save the settings or accept the defaults as shown. Select **Save**.



c) After the device settings are downloaded, select a file name and path to save the settings or accept the default, as shown.

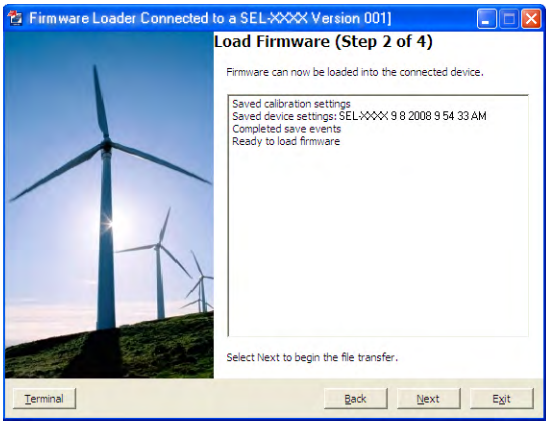


d) Select events and select **Get Selected Event** to save any events. After saving all events, select **Return to Firmware Loader**.

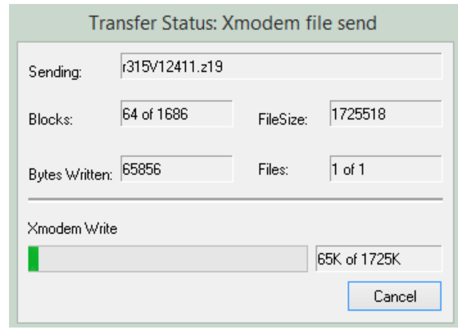


Step 2: Transfer Firmware

Select **Next** to begin the firmware transfer.

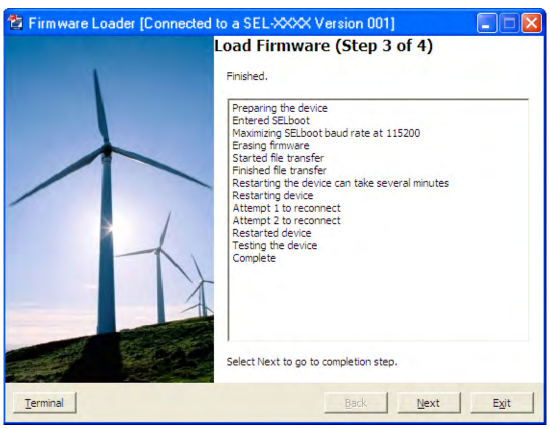


The **Transfer Status: Xmodem file send** window shows the transfer progress of the firmware file. Selecting **Cancel** will stop the transfer.



Step 3: Prepare Device

During this step, the device will be put in SELBOOT. The transfer speed will be maximized and the firmware transfer will begin.



Step 4: Verify Device

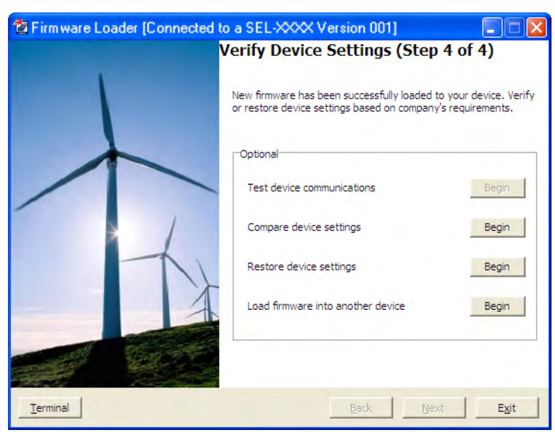
Four verification options are provided and when enabled these options perform as follows.

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.



Upgrade the Firmware Using File Transfer Protocol

NOTE: Make sure that the device and SELBOOT firmware revisions are compatible. Refer to Firmware, ICD, and Manual Versions in this manual. If needed, upgrade the SELBOOT firmware prior to upgrading the device firmware.

NOTE: The device pulses SALARM bit and writes an entry to the device SER log whenever a firmware upgrade is attempted over Ethernet. Monitoring the SALARM bit and reviewing the SER log can help identify possible unauthorized firmware upgrade attempts.

NOTE: To save the calibration settings, perform **SHO C** from the terminal by logging into Access Level C using the Access Level C password. The factory-default password for Access Level C is CLARKE.

NOTE: File name RELAY.zds is not case sensitive.

To upgrade firmware using FTP, the firmware in your device must be R400 or higher. The firmware is designated with a .zds extension.

To upgrade device firmware using FTP, set the Port 1 setting **EETHFWU:= Y**. If EETHFWU is set to N, you cannot upgrade the firmware over Ethernet.

The following instructions assume you have a working knowledge of the Windows command prompt.

Step 1. Ensure that the device is not in service.

Step 2. Connect the PC to the Ethernet port and enter Access Level 2.

Step 3. Save the present device settings.

Use the following steps to save and restore the settings:

a. Issue the following commands at the ASCII prompt:
   SHO, **SHO L**, **SHO G**, **SHO P**, **SHO F**, **SHO R**, **SHO C**, etc.

b. Record all the settings for possible re-entry after the firmware upgrade.
   We recommend that you save all stored data in the device, including events, before the upgrade.

Step 4. Rename the SEL-2411-R*xxx*-V*x*.zds file as **RELAY.zds**.

Step 5. Create an FTP session to connect to the device using the device IP address.

Step 6. Enter your FTP username and password.

Step 7. Issue the **CD UPGRADE** command to switch the present device directory to the UPGRADE directory.

Step 8. Issue the **PUT RELAY.ZDS** command to place the RELAY.zds file in the UPGRADE directory and to send the file to the device.

When the download is complete, the device reboots and comes up enabled. During this upgrade process, you will lose the FTP connection, and you must reestablish the FTP connection after the upgrade is complete. Then navigate to the device UPGRADE directory and review the ERR.txt file for any error messages. If the firmware upgraded properly, no errors occurred during the upgrade process and the file will contain `Firmware upgrade succeeded. Date: MM/DD/YYYY Time: HH:MM:SS.sss`.

```
Microsoft Windows [Version 10.0.19042.985]
(c) Microsoft Corporation. All rights reserved.

Z:\>ftp
ftp> open 10.203.116.73
Connected to 10.203.116.73.
220 SEL-2411 FTP SERVER:
550 NOOP requested action not taken.
User (10.203.116.73:(none)): FTPUSER
331 User name okay, need password.
Password:
230 User logged in, proceed.
ftp> cd UPGRADE
250 CWD  requested file action okay, completed.
ftp> CWD
Invalid command.
ftp> PWD
257 "/UPGRADE" is current directory.
ftp> PUT RELAY.zds
200 PORT Command okay.
150 File status okay; about to open data connection.
Connection closed by remote host.
ftp>
```

Figure B.3 Firmware Upgrade Via FTP

Upgrade the Firmware Via Terminal Emulator Using the FILE Command Over Telnet

To upgrade firmware using the **FILE** command over Telnet, the firmware in your device must be R400 or higher. The firmware is designated with a .zds extension.

NOTE: Make sure that the device and SELboot firmware revisions are compatible. Refer to Appendix A: Firmware and Manual Versions. If needed, upgrade the SELboot firmware prior to upgrading the device firmware.

To upgrade device firmware using the **FILE** command over Ethernet, set the Port 1 setting:

EETHFWU := Y. If EETHFWU is set to N, you cannot upgrade the firmware over Ethernet.

The following procedure assumes that you have a working knowledge of the software being used to upgrade the firmware via **FILE** command.

Step 1. Ensure that the device is not in service.

Step 2. Connect the PC to the Ethernet port and enter Access Level 2.

Step 3. Save the present device settings.

Use the following steps to save and restore the settings:

a. Issue the following commands at the ASCII prompt:

SHO, **SHO L**, **SHO G**, **SHO P**, **SHO F**, **SHO R**, **SHO C**, etc.

b. Record all the settings for possible re-entry after the firmware upgrade.

We recommend that you save all stored data in the device, including events, before the upgrade.

NOTE: The device pulses SALARM bit and writes an entry to the device SER log whenever a firmware upgrade is attempted over Ethernet. Monitoring the SALARM bit and reviewing the SER log can help identify possible unauthorized firmware upgrade attempts.

NOTE: To save the calibration settings, perform SHO C from the terminal by logging into Access Level C using the Access Level C password. The factory-default password for Access Level C is CLARKE.

Step 4. Rename the SEL-2411-R*xxx*-V*x*.zds file as RELAY.zds.

Step 5. Save the RELAY.zds file to a directory.

Step 6. Update the active directory to be the directory where the RELAY.zds file is saved.

NOTE: File name RELAY.zds is not case sensitive,

Step 7. Issue the **FILE WRITE RELAY.ZDS** command to the device.

Step 8. Send the RELAY.zds file to the device via Ymodem transfer. When the upgrade is complete, the device reboots and comes up enabled.

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 Architect software upgrade that supports your required CID file version.

b. Run 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, 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.

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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*.

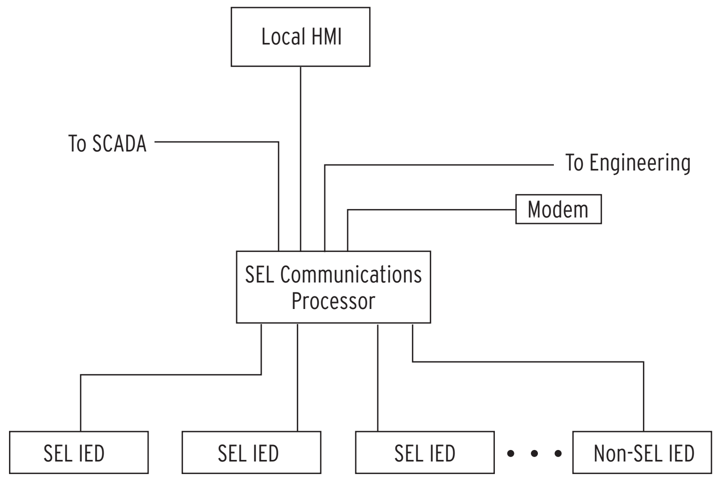

Figure C.1 SEL Communications Processor Star Integration Network

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.

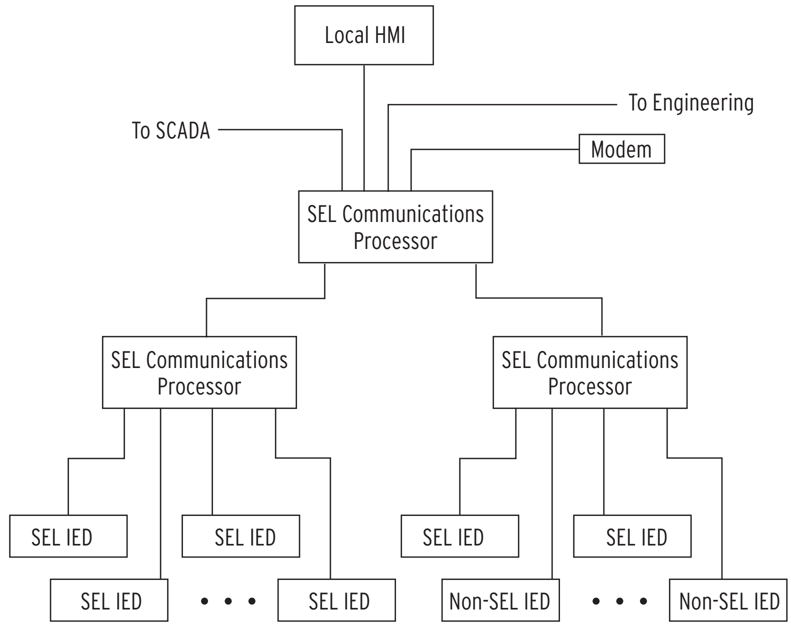

Figure C.2 Multitiered SEL Communications Processor Architecture

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 Outstation	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

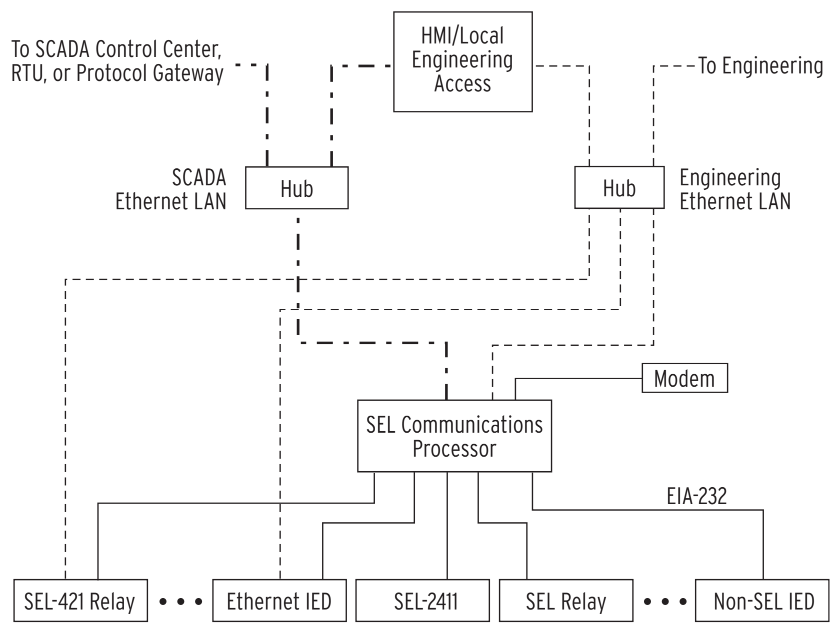

Figure C.3 Enhancing Multidrop Networks With SEL Communications Processors

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*.

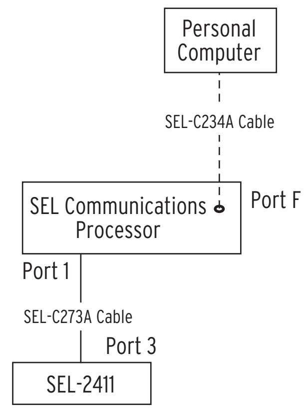

Figure C.4 Example SEL Device and SEL Communications Processor Configuration

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 are 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 are stored in the SEL communications processor (06 is the User regions port number where the data are 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, specify 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.

Ethernet Operation

The DNP-IP response is identical to the serial response, but it requires the communications-specific settings shown in *Table D.2*.

Table D.2 DNP-IP Specific Settings

Setting	Definition	Range	Default Value
EDNP	Enable DNP-IP sessions. Set this value to 0 to disable DNP-IP in the SEL-2411.	0–5	0
DNPNUM*n*	DNP TCP and UDP port. Identifies the TCP and UDP port between the master and the SEL-2411. DNPNUM must be unique for each anonymous DNP session.	1–65534 excluding 20, 21, 502, and the TPORT setting.	2000
DNPIP*n*	Master IP Address. Set DNPIP = 0.0.0.0 to accept requests from any DNP-IP address.	zzz.yyy.xxx.www	192.168.0.3
DNPTR*n*	Transport Protocol. Selects between TCP and UDP protocols.	TCP, UDP	TCP
DNPUDP*n*	UDP Response Port. Selects the port to which the SEL-2411 responds. If DNPUDP = REQ, the SEL-2411 responds to the port number from the master's UDP request.	REQ, 1–65534	2000

If the UNSOL setting is set to Y, the SEL-2411 transmits unsolicited data when either of the following are true:

- ➤ Initialization is complete and DNPTR = UDP, or
- ➤ The master has established a session, if DNPTR = TCP.

DNP3 in the SEL-2411

The PAC is a DNP3 Level 2 Outstation device. See *DNP3 Communications* for additional documentation describing DNP3.

Data Access

Table D.3 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.

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 5. All settings with the same numerical suffix comprise the complete DNP3 session configuration.

NOTE: Firmware versions R500 and later limit the range of DNPINA*n* to 0–120 seconds to ensure proper closing of unresponsive TCP connections. Versions R400-V0 and earlier allowed a range of 0–7200 seconds.

Table D.3 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. 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. If UTIMEO*n* is set to OFF, the retry interval will be 10 * ETIMEO*n*.

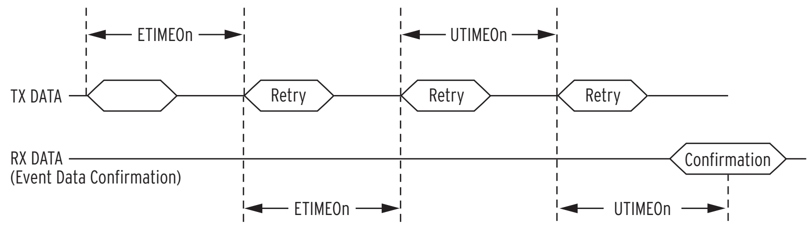

Figure D.1 Application Confirmation Timing With URETRYn = 2

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*.

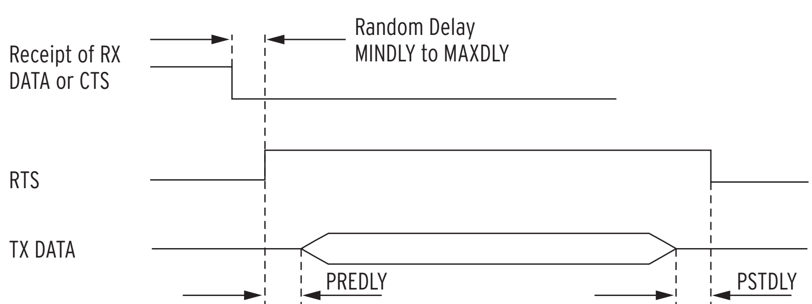

Figure D.2 Message Transmission Timing

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, change-of-value, 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. To record analog values and corresponding timestamps in the event buffer, set AI_RPT*n* to SOE. Use DVARAIE*n* to set the default variation for analog event data.

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.4*.

Table D.4 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 deadbands. Deadbands are applied to the scaled value. 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 as many as five unique DNP3 masters. Each map is initially populated with default data points, as described in *Default Data Map on page D.12*.

Device Profile

The DNP3 Device Profile document, available on the supplied DVD or as a download from the SEL website, contains the standard device profile information for the device. This information is also available in XML format. Refer to this document for complete information on DNP3 Protocol support in the device.

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. If any device attributes are modified, it is necessary to issue the **STA C** command prior to those changes being reflected in any DNP query for device attributes.

Table D.5 SEL-2411 DNP Object List (Sheet 1 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]
0	242	Device Attributes—Device manufacturer's software version	1	0	129	0, 17
0	243	Device Attributes—Device manufacturer's hardware version	1	0	129	0, 17
0	246	Device Attributes—User assigned ID code/number	1	0	129	0, 17
0	248	Device Attributes—Device serial number	1	0	129	0, 17
0	250	Device Attributes—Device manufacturer's product name and model	1	0	129	0, 17
0	252	Device Attributes—Device manufacturer's name	1	0	129	0, 17
0	254	Device Attributes—Non-specific all attributes request	1	0, 6		
0	255	Device Attributes—List of attribute variations	1	0, 6	129	0, 17
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—Not Supported				
12	3	Pattern Mask—Not Supported				
20	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		
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

Table D.5 SEL-2411 DNP Object List (Sheet 2 of 4)

Obj.	Var.	Description	Request[a]		Response[b]	
			Funct. Codes[c]	Qual. Codes[d]	Funct. Codes[c]	Qual. Codes[d]
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	
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				

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]
31	7	Short Floating Point Frozen Analog Input				
31	8	Long Floating Point Frozen Analog Input				
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	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[e]	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				

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]
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		
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 start;14 warm start; 23 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.

Reference Data Map

NOTE: STFAIL, STWARN and STSET are available via DNP3 communications only. STSET asserts concurrent to Relay settings change in the SER. After a warm_reset, STSET deasserts after the first Class 0 poll.

NOTE: Deadband changes via Object 34 are not stored in nonvolatile memory. Make sure to reissue the Object 34 deadbands after a warm (**STA C**) or cold start (power cycle).

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.

The SEL-2411 scales analog values by the indicated settings or fixed scaling indicated in the description. Analog deadbands 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 PB04BLED	Device Word Elements, Row 1 to Row 123 (see *Table H.1*)	
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, 21, 22, 23	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–INTEMP10)—Slot **D** only	f
30, 32, 34	MV*xx*	Math Variables (MV01 to MV64)	
30, 32, 34	ACV*xx*	Analog Control Variables (ACV01 to ACV32)	

Table D.6 DNP3 Reference Data Map[a] (Sheet 2 of 4)

Object	Labels	Description	
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	P*x*	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
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	MWHI	Real 3-Phase Energy In (from load to source)	b
30, 32, 34	MVARHI	Reactive 3-Phase Energy In (from load to source)	b
30, 32, 34	MWHO	Real 3-Phase Energy Out (from source to load)	b

Table D.6 DNP3 Reference Data Map[a] (Sheet 3 of 4)

Object	Labels	Description	
30, 32, 34	MVARHO	Reactive 3-Phase Energy Out (from source to load)	b
30, 32, 34	MWHXI	Auxiliary Real 3-Phase Energy In (from load to source)	c
30, 32, 34	MVARHXI	Auxiliary Reactive 3-Phase Energy In (from load to source)	c
30, 32, 34	MWHXO	Auxiliary Real 3-Phase Energy Out (from source to load)	c
30, 32, 34	MVARHXO	Auxiliary Reactive 3-Phase Energy Out (from source to load)	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
Analog Outputs			
40, 41	RA*xxx*	Remote Analogs (RA001 to RA032)	
40, 41	RA*xxx*	Remote Analogs (RA033 to RA064)	

Table D.6 DNP3 Reference Data Map[a] (Sheet 4 of 4)

Object	Labels	Description	
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 Z and E 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 installed 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: Deadband changes via Object 34 are stored in nonvolatile memory. Make sure to reissue the Object 34 deadbands 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 does not differentiate between the RTD and RTD/TC cards. If an RTD/TC card is installed, you must change *9X* to *91* manually in the part number field for Slot D. This can be performed from Access Level 2 with the **PART** command. After changing the part number to 91, INTEMP01–INTEMP10 are 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. *Table D.8* demonstrates how you can use this functionality for both paired and non-paired points with firmware revision R303 or later. *Table D.9* demonstrates how you can use this functionality for both paired and non-paired points on a PAC with R302 or previous firmware. Pulse operations for remote bits provide a pulse with duration of one protection-processing interval.

Table D.8 R303 or Later Example Object 12 Trip/Close or Code Selection Operation

Control Points	Trip/Close		Code Selection Operation		
	Close/PULSE_ON	Trip/PULSE_ON	Null/LATCH_ON	Null/LATCH_OFF	Null/PULSE_ON
RB01:RB02	PULSE ON RB02	PULSE ON RB01	NOT_SUPPORTED	NOT_SUPPORTED	NOT_SUPPORTED
RB03	PULSE ON RB03	PULSE ON RB03	SET RB03	CLEAR RB03	PULSE ON RB03

Table D.9 R302 or Previous 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

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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.16*). 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 zeros 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.

Table E.4 02h Read Input Status Command

Bytes	Field
Requests from the master must have the following format:	
1 byte	Slave Address
1 byte	Function Code (02h)
2 bytes	Address of the first bit
2 bytes	Numbers of bits to read
2 bytes	CRC-16
A successful response from the slave will have the following format:	
1 byte	Slave Address
1 byte	Function Code (02h)
1 byte	Bytes of data (*n*)
n bytes	Data
2 bytes	CRC-16

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 zeros to make an even byte.

NOTE: Refer to : for individual elements.

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.5* 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.6*.

Table E.5 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 = T00_LED 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	
16–1163	10–48B	02h	Device Element Status Row 2–163[a]	

[a] Returns 0 if associated hardware is not installed.

Table E.6 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.16*.

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 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.16*. 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.8*.

Table E.8 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.9*, the command response is identical to the command request.

Table E.9 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 68–99) causes the remote bit to be cleared at the end of the pulse.

Table E.9 05h 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.10*.

Table E.10 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.16* 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.11*.

Table E.11 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 (as many as 100 per operation). For six-digit addressing, add 400001 to the standard database addresses.

The device responds to errors in the query as shown in *Table E.12*.

Table E.12 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.16*), 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.16*).

Controlling Output Contacts and Remote Bits Using Modbus

The SEL-2411 Modbus Register Map (*Table E.16*) 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.13*. 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.13* defines the command codes in decimal and hex and their functions and associated parameter(s).

Table E.13 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
45	2D	Reset Tap Alarms	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—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.14 SEL-2411 Modbus Command Region (Sheet 1 of 2)

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

Table E.14 SEL-2411 Modbus Command Region (Sheet 2 of 2)

Parameter 2 for Command Code 39	Parameter 2 for Command Code 40
0100 0000 0000 0000—RB15	0100 0000 0000 0000—RB31
1000 0000 0000 0000—RB16	1000 0000 0000 0000—RB32

Table E.15 shows the Modbus Command Region.

Table E.15 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.17* to convert the units of the received data into the appropriate scale for further processing or display.

Modbus Register Map

Table E.16 Modbus Register Map (Sheet 1 of 20)

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	

Table E.16 Modbus Register Map (Sheet 2 of 20)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
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	
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		0.675V Status 0-OK, 1-Warn, 2-Fail	
179	B3	03h, 04h	0	0	1		0.675VD Status 0-OK, 1-Warn, 2-Fail	
180	B4	03h, 04h	0	0	1		1.0V Status 0-OK, 1-Warn, 2-Fail	
181	B5	03h, 04h	0	0	1		1.1V Status 0-OK, 1-Warn, 2-Fail	
182	B6	03h, 04h	0	0	1		1.35V Status 0-OK, 1-Warn, 2-Fail	
183	B7	03h, 04h	0	0	1		3.3V Status 0-OK, 1-Warn, 2-Fail	
184	B8	03h, 04h	0	0	1		5.0V Status 0-OK, 1-Warn, 2-Fail	
185	B9	03h, 04h	0	0	1		3.75V Status 0-OK, 1-Warn, 2-Fail	
186	BA	03h, 04h	0	0	1		–1.25V Status 0-OK, 1-Warn, 2-Fail	

Table E.16 Modbus Register Map (Sheet 3 of 20)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
187	BB	03h, 04h	0	0	1		–5.0V Status 0-OK, 1-Warn, 2-Fail	
188	BC	03h, 04h	0	0	1		1.8V Status 0-OK, 1-Warn, 2-Fail	
189–199	BD–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
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

Table E.16 Modbus Register Map (Sheet 4 of 20)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
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
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

Table E.16 Modbus Register Map (Sheet 5 of 20)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
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	
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 PowerX^c—UW	kVAR
345	159	03h, 04h				0	Phase C Reactive PowerX^c—LW	kVAR
346	15A	03h, 04h	13	–200000000	200000000	0	Phase C Apparent PowerX^c—UW	kVA
347	15B	03h, 04h				0	Phase C Apparent PowerX^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 PowerX^c—UW	kVA
354	162	03h, 04h				0	3 Phase Apparent PowerX^c—LW	kVA
355	163	03h, 04h	8	–100	100	0	3 Phase PowerX^c Factor	

Table E.16 Modbus Register Map (Sheet 6 of 20)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
356	164	03h, 04h	13	–200000000	200000000	0	3 Phase Real Power Delta 2 Voltage 2 Current Method—UW	kW
357	165	03h, 04h				0	3 Phase Real Power Delta 2 Voltage 2 Current Method—LW	kW
358	166	03h, 04h	13	–200000000	200000000	0	3 Phase Reactive Power Delta 2 Voltage 2 Current Method—UW	kVAR
359	167	03h, 04h				0	3 Phase Reactive Power Delta 2 Voltage 2 Current Method—LW	kVAR
360	168	03h, 04h	13	–200000000	200000000	0	3 Phase Apparent Power Delta 2 Voltage 2 Current Method—UW	kVA
361	169	03h, 04h				0	3 Phase Apparent Power Delta2 Voltage 2 Current Method—LW	kVA
362	16A	03h, 04h	8	-100	100	0	Power Factor Delta 2 Voltage 2 Current Method	
363	16B	03h, 04h	13	–200000000	200000000	0	3 Phase Real PowerX Delta 2 Voltage 2 Current Method—UW	kW
364	16C	03h, 04h				0	3 Phase Real PowerX Delta 2 Voltage 2 Current Method—LW	kW
365	16D	03h, 04h	13	–200000000	200000000	0	3 Phase Reactive PowerX Delta 2 Voltage 2 Current Method—UW	kVAR
366	16E	03h, 04h				0	3 Phase Reactive PowerX Delta 2 Voltage 2 Current Method—LW	kVAR
367	16F	03h, 04h	13	–200000000	200000000	0	3 Phase Apparent PowerX Delta 2 Voltage 2 Current Method—UW	kVA
368	170	03h, 04h				0	3 Phase Apparent PowerX Delta2 Voltage 2 Current Method—LW	kVA
369	171	03h, 04h	8	–100	100	0	Power FactorX Delta 2 Voltage 2 Current Method	
370–379	172–17B	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	

Table E.16 Modbus Register Map (Sheet 7 of 20)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
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
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

Table E.16 Modbus Register Map (Sheet 8 of 20)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
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
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

Table E.16 Modbus Register Map (Sheet 9 of 20)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
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
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

Table E.16 Modbus Register Map (Sheet 10 of 20)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
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
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	

Table E.16 Modbus Register Map (Sheet 11 of 20)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
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	6	–32768	32767	0	INTRTD01	deg C
651	28B	03h, 04h	6	–32768	32767	0	INTRTD02	deg C
652	28C	03h, 04h	6	–32768	32767	0	INTRTD03	deg C
653	28D	03h, 04h	6	–32768	32767	0	INTRTD04	deg C
654	28E	03h, 04h	6	–32768	32767	0	INTRTD05	deg C
655	28F	03h, 04h	6	–32768	32767	0	INTRTD06	deg C
656	290	03h, 04h	6	–32768	32767	0	INTRTD07	deg C
657	291	03h, 04h	6	–32768	32767	0	INTRTD08	deg C
658	292	03h, 04h	6	–32768	32767	0	INTRTD09	deg C
659	293	03h, 04h	6	–32768	32767	0	INTRTD10	deg C
660	294	03h, 04h	6	–32768	32767	0	EXTRTD01	deg C
661	295	03h, 04h	6	–32768	32767	0	EXTRTD02	deg C
662	296	03h, 04h	6	–32768	32767	0	EXTRTD03	deg C
663	297	03h, 04h	6	–32768	32767	0	EXTRTD04	deg C
664	298	03h, 04h	6	–32768	32767	0	EXTRTD05	deg C
665	299	03h, 04h	6	–32768	32767	0	EXTRTD06	deg C
666	29A	03h, 04h	6	–32768	32767	0	EXTRTD07	deg C
667	29B	03h, 04h	6	–32768	32767	0	EXTRTD08	deg C
668	29C	03h, 04h	6	–32768	32767	0	EXTRTD09	deg C
669	29D	03h, 04h	6	–32768	32767	0	EXTRTD10	deg C
670	29E	03h, 04h	6	–32768	32767	0	EXTRTD011	deg C
671	29F	03h, 04h	6	–32768	32767	0	EXTRTD12	deg C
672	2A0	03h, 04h	7	–32768	32767	0	INTEMP01	deg C
673	2A1	03h, 04h	7	–32768	32767	0	INTEMP02	deg C
674	2A2	03h, 04h	7	–32768	32767	0	INTEMP03	deg C
675	2A3	03h, 04h	7	–32768	32767	0	INTEMP04	deg C
676	2A4	03h, 04h	7	–32768	32767	0	INTEMP05	deg C
677	2A5	03h, 04h	7	–32768	32767	0	INTEMP06	deg C
678	2A6	03h, 04h	7	–32768	32767	0	INTEMP07	deg C
679	2A7	03h, 04h	7	–32768	32767	0	INTEMP08	deg C
680	2A8	03h, 04h	7	–32768	32767	0	INTEMP09	deg C
681	2A9	03h, 04h	7	–32768	32767	0	INTEMP10	deg C
682–699	2AA–2BB	03h, 04h	5	8000	8000	8000	Reserved = 8000 Hex	

Table E.16 Modbus Register Map (Sheet 12 of 20)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
Math Variables								
700–827	2BC–33B	03h, 04h	15	–1677721599	+1677721599	0	MV01 [0: UW], [1: LW] to MV64 [0: UW], [1: LW]	
828–949	33C–3B5	03h, 04h	5	8000	8000	8000	Reserved = 8000 Hex	
Device Date/Time								
950	3B6	03h, 04h, 06h, 10h	1	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 = T00_LED Bit 15 = Enabled	
1001–1163	3E9–48B	03h, 04h	11	0	65281		Row 1–163	
1164–1189	48C–4A5	03h, 04h	5	8000	8000	8000	Reserved = 8000 Hex	
Modbus Communications Counters								
1190	4A6	03h, 04h	1	0	65535	0	Number of Message Received	
1191	4A7	03h, 04h	1	0	65535	0	Number of Messages to Other devices	
1192	4A8	03h, 04h	1	0	65535	0	Invalid Address	
1193	4A9	03h, 04h	1	0	65535	0	Bad CRC	
1194	4AA	03h, 04h	1	0	65535	0	UART Error	
1195	4AB	03h, 04h	1	0	65535	0	Illegal Function	
1196	4AC	03h, 04h	1	0	65535	0	Illegal Register	
1197	4AD	03h, 04h	1	0	65535	0	Illegal Write	
1198	4AE	03h, 04h	1	0	65535	0	Bad Packet Format	
1199	4AF	03h, 04h	1	0	65535	0	Bad Packet Length	
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]	

Table E.16 Modbus Register Map (Sheet 13 of 20)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
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
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

Table E.16 Modbus Register Map (Sheet 14 of 20)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
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
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

Table E.16 Modbus Register Map (Sheet 15 of 20)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
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
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	

Table E.16 Modbus Register Map (Sheet 16 of 20)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
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
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	9D4	03h, 04h	1	0	16777215	0	SC01 – Upper Word	
2517	9D5					0	SC01 – Lower Word	
2518	9D6	03h, 04h	1	0	16777215	0	SC02 – Upper Word	
2519	9D7					0	SC02 – Lower Word	
2520	9D8	03h, 04h	1	0	16777215	0	SC03 – Upper Word	
2521	9D9					0	SC03 – Lower Word	
2522	9DA	03h, 04h	1	0	16777215	0	SC04 – Upper Word	
2523	9DB					0	SC04 – Lower Word	
2524	9DC	03h, 04h	1	0	16777215	0	SC05 – Upper Word	
2525	9DD					0	SC05 – Lower Word	

Table E.16 Modbus Register Map (Sheet 17 of 20)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
2526	9DE	03h, 04h	1	0	16777215	0	SC06 – Upper Word	
2527	9DF					0	SC06 – Lower Word	
2528	9E0	03h, 04h	1	0	16777215	0	SC07 – Upper Word	
2529	9E1					0	SC07 – Lower Word	
2530	9E2	03h, 04h	1	0	16777215	0	SC08 – Upper Word	
2531	9E3					0	SC08 – Lower Word	
2532	9E4	03h, 04h	1	0	16777215	0	SC09 -– Upper Word	
2533	9E5					0	SC09 – Lower Word	
2534	9E6	03h, 04h	1	0	16777215	0	SC10 – Upper Word	
2535	9E7					0	SC10 – Lower Word	
2536	9E8	03h, 04h	1	0	16777215	0	SC11 – Upper Word	
2537	9E9					0	SC11 – Lower Word	
2538	9EA	03h, 04h	1	0	16777215	0	SC12 – Upper Word	
2539	9EB					0	SC12 – Lower Word	
2540	9EC	03h, 04h	1	0	16777215	0	SC13 – Upper Word	
2541	9ED					0	SC13 – Lower Word	
2542	9EE	03h, 04h	1	0	16777215	0	SC14 – Upper Word	
2543	9EF					0	SC14 – Lower Word	
2544	9F0	03h, 04h	1	0	16777215	0	SC15 – Upper Word	
2545	9F1					0	SC15 – Lower Word	
2546	9F2	03h, 04h	1	0	16777215	0	SC16 – Upper Word	
2547	9F3					0	SC16 – Lower Word	
2548	9F4	03h, 04h	1	0	16777215	0	SC17 – Upper Word	
2549	9F5					0	SC17 – Lower Word	
2550	9F6	03h, 04h	1	0	16777215	0	SC18 – Upper Word	
2551	9F7					0	SC18 – Lower Word	
2552	9F8	03h, 04h	1	0	16777215	0	SC19 – Upper Word	
2553	9F9					0	SC19 – Lower Word	
2554	9FA	03h, 04h	1	0	16777215	0	SC20 – Upper Word	
2555	9FB					0	SC20 – Lower Word	
2556	9FC	03h, 04h	1	0	16777215	0	SC21 – Upper Word	
2557	9FD					0	SC21 – Lower Word	
2558	9FE	03h, 04h	1	0	16777215	0	SC22 – Upper Word	
2559	9FF					0	SC22 – Lower Word	
2560	A00	03h, 04h	1	0	16777215	0	SC23 – Upper Word	
2561	A01					0	SC23 – Lower Word	
2562	A02	03h, 04h	1	0	16777215	0	SC24 – Upper Word	
2563	A03					0	SC24 – Lower Word	
2564	A04	03h, 04h	1	0	16777215	0	SC25 – Upper Word	
2565	A05					0	SC25 – Lower Word	
2566	A06	03h, 04h	1	0	16777215	0	SC26 – Upper Word	
2567	A07					0	SC26 – Lower Word	
2568	A08	03h, 04h	1	0	16777215	0	SC27 – Upper Word	
2569	A09					0	SC27 – Lower Word	
2570	A0A	03h, 04h	1	0	16777215	0	SC28 – Upper Word	
2571	A0B					0	SC28 – Lower Word	

Table E.16 Modbus Register Map (Sheet 18 of 20)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
2572	A0C	03h, 04h	1	0	16777215	0	SC29 – Upper Word	
2573	A0D					0	SC29 – Lower Word	
2574	A0E	03h, 04h	1	0	16777215	0	SC30 – Upper Word	
2575	A0F					0	SC30 – Lower Word	
2576	A10	03h, 04h	1	0	16777215	0	SC31 – Upper Word	
2577	A11					0	SC31 – Lower Word	
2578	A12	03h, 04h	1	0	16777215	0	SC32 – Upper Word	
2579	A13					0	SC32 – Lower Word	
2580–2643	A14–A53	03h, 04h	5	8000	8000	8000	Reserved = 8000 Hex	
Analog Control Variables								
2644	A54	03h, 04h, 06h, 10h	15	–1677721599	1677721599	0	ACV01 – Upper Word	
2645	A55	03h, 04h, 06h, 10h				0	ACV01 – Lower Word	
2646	A56	03h, 04h, 06h, 10h	15	–1677721599	1677721599	0	ACV02 – Upper Word	
2647	A57	03h, 04h, 06h, 10h				0	ACV02 – Lower Word	
2648	A58	03h, 04h, 06h, 10h	15	–1677721599	1677721599	0	ACV03 – Upper Word	
2649	A59	03h, 04h, 06h, 10h				0	ACV03 – Lower Word	
2650	A5A	03h, 04h, 06h, 10h	15	–1677721599	1677721599	0	ACV04 – Upper Word	
2651	A5B	03h, 04h, 06h, 10h				0	ACV04 – Lower Word	
2652	A5C	03h, 04h, 06h, 10h	15	–1677721599	1677721599	0	ACV05 – Upper Word	
2653	A5D	03h, 04h, 06h, 10h				0	ACV05 – Lower Word	
2654	A5E	03h, 04h, 06h, 10h	15	–1677721599	1677721599	0	ACV06 – Upper Word	
2655	A5F	03h, 04h, 06h, 10h				0	ACV06 – Lower Word	
2656	A60	03h, 04h, 06h, 10h	15	–1677721599	1677721599	0	ACV07 – Upper Word	
2657	A61	03h, 04h, 06h, 10h				0	ACV07 – Lower Word	
2658	A62	03h, 04h, 06h, 10h	15	–1677721599	1677721599	0	ACV08 – Upper Word	
2659	A63	03h, 04h, 06h, 10h				0	ACV08 – Lower Word	
2660	A64	03h, 04h, 06h, 10h	15	–1677721599	1677721599	0	ACV09 – Upper Word	
2661	A65	03h, 04h, 06h, 10h				0	ACV09 – Lower Word	
2662	A66	03h, 04h, 06h, 10h	15	–1677721599	1677721599	0	ACV10 – Upper Word	
2663	A67	03h, 04h, 06h, 10h				0	ACV10 – Lower Word	

Table E.16 Modbus Register Map (Sheet 19 of 20)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
2664	A68	03h, 04h, 06h, 10h	15	–1677721599	1677721599	0	ACV11 – Upper Word	
2665	A69	03h, 04h, 06h, 10h				0	ACV11 – Lower Word	
2666	A6A	03h, 04h, 06h, 10h	15	–1677721599	1677721599	0	ACV12 – Upper Word	
2667	A6B	03h, 04h, 06h, 10h				0	ACV12 – Lower Word	
2668	A6C	03h, 04h, 06h, 10h	15	–1677721599	1677721599	0	ACV13 – Upper Word	
2669	A6D	03h, 04h, 06h, 10h				0	ACV13 – Lower Word	
2670	A6E	03h, 04h, 06h, 10h	15	–1677721599	1677721599	0	ACV14 – Upper Word	
2671	A6F	03h, 04h, 06h, 10h				0	ACV14 – Lower Word	
2672	A70	03h, 04h, 06h, 10h	15	–1677721599	1677721599	0	ACV15 – Upper Word	
2673	A71	03h, 04h, 06h, 10h				0	ACV15 – Lower Word	
2674	A72	03h, 04h, 06h, 10h	15	–1677721599	1677721599	0	ACV16 – Upper Word	
2675	A73	03h, 04h, 06h, 10h				0	ACV16 – Lower Word	
2676	A74	03h, 04h, 06h, 10h	15	–1677721599	1677721599	0	ACV17 – Upper Word	
2677	A75	03h, 04h, 06h, 10h				0	ACV17 – Lower Word	
2678	A76	03h, 04h, 06h, 10h	15	–1677721599	1677721599	0	ACV18 – Upper Word	
2679	A77	03h, 04h, 06h, 10h				0	ACV18 – Lower Word	
2680	A78	03h, 04h, 06h, 10h	15	–1677721599	1677721599	0	ACV19 – Upper Word	
2681	A79	03h, 04h, 06h, 10h				0	ACV19 – Lower Word	
2682	A7A	03h, 04h, 06h, 10h	15	–1677721599	1677721599	0	ACV20 – Upper Word	
2683	A7B	03h, 04h, 06h, 10h				0	ACV20 – Lower Word	
2684	A7C	03h, 04h, 06h, 10h	15	–1677721599	1677721599	0	ACV21 – Upper Word	
2685	A7D	03h, 04h, 06h, 10h				0	ACV21 – Lower Word	
2686	A7E	03h, 04h, 06h, 10h	15	–1677721599	1677721599	0	ACV22 – Upper Word	
2687	A7F	03h, 04h, 06h, 10h				0	ACV22 – Lower Word	
2688	A80	03h, 04h, 06h, 10h	15	–1677721599	1677721599	0	ACV23 – Upper Word	
2689	A81	03h, 04h, 06h, 10h				0	ACV23 – Lower Word	

Table E.16 Modbus Register Map (Sheet 20 of 20)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
2690	A82	03h, 04h, 06h, 10h	15	–1677721599	1677721599	0	ACV24 – Upper Word	
2691	A83	03h, 04h, 06h, 10h				0	ACV24 – Lower Word	
2692	A84	03h, 04h, 06h, 10h	15	–1677721599	1677721599	0	ACV25 – Upper Word	
2693	A85	03h, 04h, 06h, 10h				0	ACV25 – Lower Word	
2694	A86	03h, 04h, 06h, 10h	15	–1677721599	1677721599	0	ACV26 – Upper Word	
2695	A87	03h, 04h, 06h, 10h				0	ACV26 – Lower Word	
2696	A88	03h, 04h, 06h, 10h	15	–1677721599	1677721599	0	ACV27 – Upper Word	
2697	A89	03h, 04h, 06h, 10h				0	ACV27 – Lower Word	
2698	A8A	03h, 04h, 06h, 10h	15	–1677721599	1677721599	0	ACV28 – Upper Word	
2699	A8B	03h, 04h, 06h, 10h				0	ACV28 – Lower Word	
2700	A8C	03h, 04h, 06h, 10h	15	–1677721599	1677721599	0	ACV29 – Upper Word	
2701	A8D	03h, 04h, 06h, 10h				0	ACV29 – Lower Word	
2702	A8E	03h, 04h, 06h, 10h	15	–1677721599	1677721599	0	ACV30 – Upper Word	
2703	A8F	03h, 04h, 06h, 10h				0	ACV30 – Lower Word	
2704	A90	03h, 04h, 06h, 10h	15	–1677721599	1677721599	0	ACV31 – Upper Word	
2705	A91	03h, 04h, 06h, 10h				0	ACV31 – Lower Word	
2706	A92	03h, 04h, 06h, 10h	15	–1677721599	1677721599	0	ACV32 – Upper Word	
2707	A93	03h, 04h, 06h, 10h				0	ACV32 – Lower Word	
2708–2771	A14–F9F	03h, 04h	5	8000	8000	8000	Reserved = 8000 Hex	
2772	AD4	03h, 04h	6	–32768	32767	0	TAP_POS – Measured Tap Position	
2773–3999	AD5–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.17 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.16.

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Appendix F
IEC 61850 Communications

Features

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.

The SEL-2411 device supports the following features through use of Ethernet and IEC 61850:

SCADA. Connect as many as seven simultaneous IEC 61850 Manufacturing Message Specification (MMS) client sessions. The device supports as many as 12 buffered and seven unbuffered report control blocks. See *Table F.33* and *Table F.31* for details on the logical nodes associated with these bits. This information is useful for issuing controls with an MMS browser. Controls support the Normal and Enhanced Security control models for Direct and Select Before Operate operations.

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 four control models as defined in the standard. Remote Bits (RB01–RB32), Virtual Bits (VB001–VB128), analog control variables (ACV01–ACV32), 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 Architect to transfer the Substation Configuration Language (SCL) Configured IED Description (CID) files 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.

Introduction to IEC 61850

In the early 1990s, the Electric Power Research Institute (EPRI) and the Institute of Electrical and Electronics Engineers, Inc. (IEEE) began to define a Utility Communications Architecture (UCA). They initially focused on inter-control center and substation-to-control center communications and produced the Inter-Control Center Communications Protocol (ICCP) specification. This specification, later adopted by the IEC as 60870-6 TASE.2, became the standard protocol for real-time exchange of data between databases.

In 1994, EPRI and IEEE began work on UCA 2.0 for Field Devices (simply referred to as UCA2). In 1997, they combined efforts with Technical Committee 57 of the IEC to create a common international standard. Their joint efforts created the current IEC 61850 standard.

The IEC 61850 standard, a superset of UCA2, contains most of the UCA2 specification, plus additional functionality. The standard describes client/server and peer-to-peer communications, substation design and configuration, testing, and project standards.

The IEC 61850 standard consists of the parts listed in *Table F.1*. The original parts were first published between 2001 and 2004, and are often referred to as IEC 61850 Edition 1 (Ed1). Selected parts of the standard were updated again between 2018 and 2020. The revised versions are collectively known as Edition 2 Amendment 1 (Ed 2.1), published in 2020, and include modifications to the following core parts:

- IEC 61850-6
- IEC 61850-7-1
- IEC 61850-7-2, 7-3, 7-4
- IEC 61850-8-1
- IEC 61850-9-2, IEC 61869-9
- IEC 61850-10

It is possible and even likely, that an installation can have a mixture of devices that conform to different editions. The standard generally supports backward compatibility, i.e., Ed2 devices can send and receive messages to and from Ed1 devices. However, there are important considerations to be made when adding Ed2 or Ed2.1 devices to an existing Ed1 system. Please refer to *Potential Client and Automation Application Issues With Ed2 and 2.1 Upgrades on page F.60* for more information.

Table F.1 IEC 61850 Document Set

IEC 61850 Sections	Definitions
IEC 61850-1	Introduction and overview
IEC 61850-2	Glossary
IEC 61850-3	General requirements
IEC 61850-4	System and project management
IEC 61850-5	Communication requirements
IEC 61850-6	Configuration description language for substation IEDs
IEC 61850-7-1	Basic communication structure for substations and feeder equipment—Principles and models
IEC 61850-7-2	Basic communication structure for substations and feeder equipment—Abstract communication service interface (ACSI)
IEC 61850-7-3	Basic communication structure for substations and feeder equipment—Common data classes
IEC 61850-7-4	Basic communication structure for substations and feeder equipment—Compatible logical node (LN) classes and data classes
IEC 61850-8-1	SCSM—Mapping to Manufacturing Messaging Specification (MMS) (ISO/IEC 9506-1 and ISO/IEC 9506-2 over ISO/IEC 8802-3)
IEC 61850-9-1	SCSM—Sampled values over serial multidrop point-to-point link
IEC 61850-9-2	SCSM—Sampled values over ISO/IEC 8802-3
IEC 61850-10	Conformance testing

The IEC 61850 document set, available directly from the IEC at www.iec.ch, contains information necessary for successful implementation of this protocol. SEL strongly recommends that anyone involved with the design, installation, configuration, or maintenance of IEC 61850 systems be familiar with the appropriate sections of this standard.

IEC 61850 Operation

IEC 61850 and Ethernet networking model options are available when ordering a new relay and may also be available as field upgrades to relays equipped with the Ethernet card. In addition to IEC 61850, the Ethernet card provides support protocols and data exchange, including FTP and Telnet, to SEL devices. Access the relay Port 1 settings to configure all of the Ethernet settings, including IEC 61850 network settings.

The relay supports IEC 61850 services, including transport of logical node objects, over TCP/IP. The relay can coordinate a maximum of seven concurrent IEC 61850 MMS sessions.

Object Models

The IEC 61850 standard relies heavily on the Abstract Communication Service Interface (ACSI) models to define a set of services and the responses to those services. In terms of network behavior, abstract modeling enables all IEDs to act identically. These abstract models are used to create objects (data items) and services that exist independently of any underlying protocols. These objects are in conformance with the common data class (CDC) specification IEC 61850-7-3, which describes the type and structure of each element within a logical node. CDCs for status, measurements, controllable analogs and statuses, and settings all have unique CDC attributes. Each CDC attribute belongs to a set of functional constraints that groups the attributes into specific categories such as status (ST) and description (DC). Functional constraints, CDCs, and CDC attributes are used as building blocks for defining logical nodes. *Table F.2* shows the CDCs supported in the SEL-2411.

Table F.2 Relay Common Data Classes (Sheet 1 of 2)

CDC Name	Description
Status Information	
SPS	Single point status
DPS	Double point status
INS	Integer status
ENS	Enumerated status
ACT	Protection activation information
ACD	Directional protection activation information
BCR	Binary counter reading
VSS	Visible string status
Measurand Information	
MV	Measured value
CMV	Complex measured value
SAV	Sampled value
WYE	Phase-to-ground/neutral-related measured values of a three-phase system.

Table F.2 Relay Common Data Classes (Sheet 2 of 2)

CDC Name	Description
DEL	Phase-to-phase-related measured values of a three-phase system
SEQ	Sequence
Status Settings	
SPG	Single point setting
ING	Integer status setting
ENG	Enumerated status setting
ORG	Object reference setting
TSG	Time setting group
CUG	Currency setting group
VSG	Visible string setting
Analog Settings	
ASG	Analog setting
CURVE	Setting curve
Description Information	
DPL	Device name plate
LPL	Logical node name plate
Controls	
SPC	Controllable single point
DPC	Controllable double point
ENC	Controllable enumerated status
INC	Controllable integer status
BSC	Binary controlled step position information
ISC	Integer controlled step position information
APC	Controllable analog process value
BAC	Binary controlled analog process value

The standard describes elements of the power system by using semantic representations. A physical device contains one or more logical devices, which contain many logical nodes. A logical node represents a group of data (controls, status, measurements, etc.) associated with a particular function. For example, the MMXU logical node (polyphase measurement unit) contains nonrevenue-grade measurement data and other points associated with three-phase metering. Each IED may contain many functions such as protection, metering, and control. Multiple logical nodes represent the functions in multifunction devices.

IEC 61850 devices are capable of self-description. Clients can request and display a list and description of the data available in an IEC 61850 server device. Simply run an MMS browser to query devices on an IEC 61850 network and discover what data are available. Self-description also shows extensions to both standard and custom data models. Instead of having to look up data in a profile stored in its database, an IEC 61850 client can query an IEC 61850 device and receive a description of all logical devices, logical nodes, and available data.

Unlike other SCADA protocols that present data as a list of addresses or indices, IEC 61850 presents data with descriptors in a composite notation made up of components. *Table F.3* shows how the A-Phase current magnitude expressed as MMXUAphsA$cVal.mag.f is broken down into its component parts.

Table F.3 Example IEC 61850 Descriptor Components

Component		Description
MMXU	Logical Node	Polyphase measurement unit
A	Data Object	Phase-to-ground amperes
PhsA	Subdata Object	A-Phase
cVal	Data Attribute	Complex value
mag	Subdata Object	Magnitude
f	Data type	Float32

Data Mapping

Device data are mapped to IEC 61850 LN according to rules defined by SEL. Refer to IEC 61850-5:2013(E) and IEC 61850-7-4:2010(E) for the mandatory content and usage of these LNs. The relay logical nodes are grouped under Logical Devices for organization based on function. See *Table F.4* for descriptions of the logical devices in a relay. See *Logical Nodes on page F.38* for a description of the LNs that make up these logical devices.

Table F.4 Relay Logical Devices

Logical Device	Description
CFG	Configuration elements—data sets and report control blocks
MET	Metering or Measurement elements—currents, voltages, power, etc.
CON	Control elements—remote bits
ANN	Annunciator elements—alarms, status values

Functional Naming

NOTE: Functional naming is not supported by all MMS clients and GOOSE subscribers. Verify support for this feature before configuring functional names in a publishing IED. Earlier SEL-2411 firmware that does not support functional naming can subscribe to GOOSE publications from IEDs that use functional naming.

Substation design typically starts with a one-line diagram and progresses down to the assignment of functions to IEDs. In this top-down approach, the functions are identified and named independently from the IEDs to which they are assigned. Because a logical device is a grouping of logical nodes that perform a certain high-level function at a substation, the associated name often indicates the assigned function. The functional naming feature allows users to name a logical device based on the function it provides independent of the name of the IED to which the function is assigned. The alternative is product naming, which prepends the IED name to the logical device instance to create the logical device name. The functional name is used on the communications interface for all references to data in the logical device.

The SEL-2411 supports functional naming of logical devices. You can add functional names in Architect for supported Edition 2 relays. To enable it in Architect, navigate to **Edit > Project Settings** and select the **Enable functional name editing on Server Model tab of supporting IEDs** check box, as shown in *Figure F.1*.

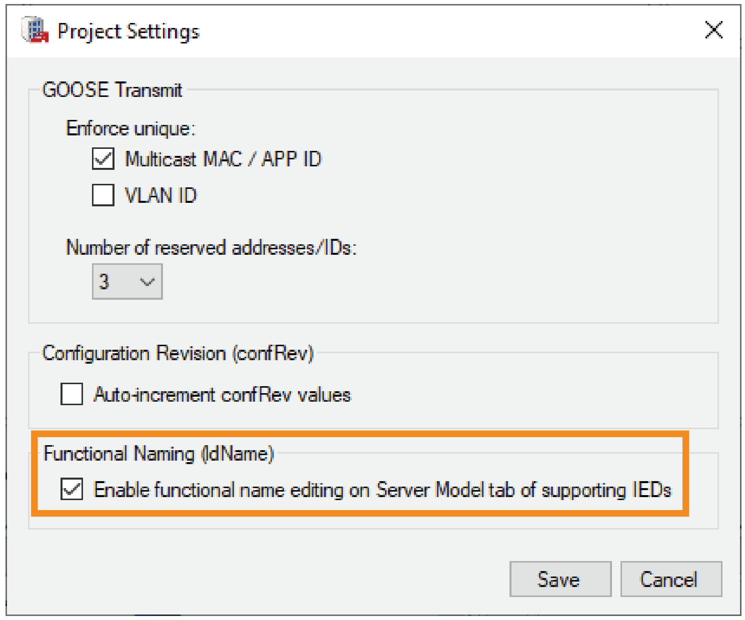


Figure F.1 Enabling Functional Naming in Architect

To provide functional names to the logical devices, navigate to the Server Model tab for the IED. Because datasets and control blocks are in the CFG logical device, any functional name given to the CFG logical device instance is used in dataset references, control block references, and in published GOOSE messages, as shown in *Figure F.2*. The IED Server Model also allows the user to change the default logical node prefix and instance values.

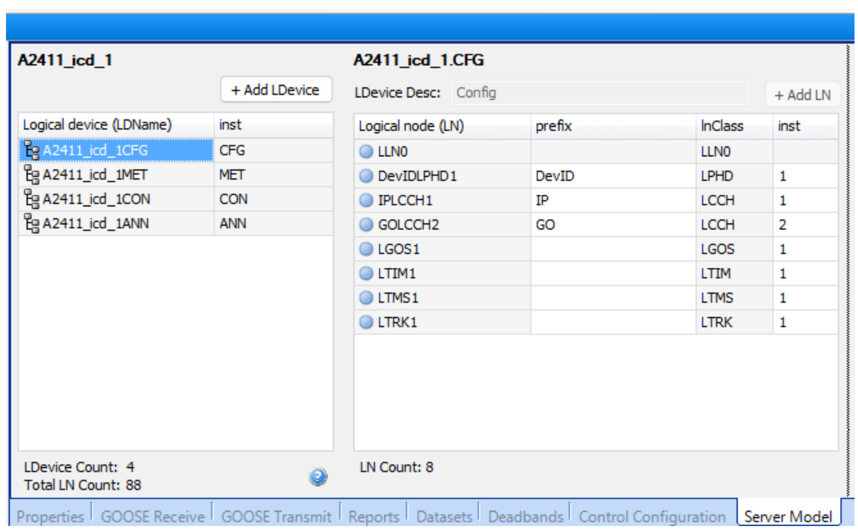


Figure F.2 Server Model View in Architect

MMS

MMS provides services for the application-layer transfer of real-time data within a substation LAN. MMS was developed as a network-independent data exchange protocol for industrial networks in the 1980s and standardized as ISO 9506.

In theory, you can map IEC 61850 to any protocol. However, it can become unwieldy and quite complicated to map objects and services to a protocol that only provides access to simple data points via registers or index numbers. MMS supports complex named objects and flexible services that enable mapping to IEC 61850 in a straightforward manner. This was why the UCA users group used

MMS for UCA from the start, and why the IEC chose to keep it for IEC 61850. MMS associations are discussed within IEC61850-8-1, clause 10 of the edition 1 standard.

If MMS authentication is enabled, the device will authenticate each MMS association by requiring the client to provide the password authentication parameter with a value that is equal to the Access Level 2 password of the relay.

➤ If the correct password authentication parameter value is not received, the device will return a not authenticated error code. If a user attempts to log into the relay with three consecutive invalid login attempts within a 1-minute period, the relay will disable login requests for 30 seconds and pulse the SALARM Device Word bit.

➤ If the correct password authentication parameter value is received, the device will provide a successful association response. The device will allow access to all supported MMS services for that association.

Service Tracking

The IEC 61850 standard defines many services to be provided by an IED (server). These services include control services, reporting services, logging services, and group switch control services. IEC 61850 Edition 2 defines the service tracking feature to allow these services to be reported or logged, whether they succeed or fail.

The SEL-2411 supports the service tracking feature for control commands, report control block edits, and group switch selection. You can report these services.

Tracking of these services is enabled by data objects in the service tracking logical node LTRK. *Table F.5* lists the service tracking data objects. Their data attributes mirror those in the service request or in the control block that was the target of the service request.

Table F.5 Service Tracking Data Objects

Data Object	CDC	Description
SpcTrk	CTS	Tracks control service requests targeted at a controllable single-point object
DpcTrk	CTS	Tracks control service requests targeted at a controllable double-point object
EncTrk	CTS	Tracks control service requests targeted at a controllable enumerated status object
UrcbTrk	UTS	Tracks unbuffered report control block edits
BrcbTrk	BTS	Tracks buffered report control block edits
APCFTrk	CTS	Tracks control service requests targeted at a controllable analog process value object
BSCTrk	CTS	Tracks control service requests targeted at a controllable binary step position object

Refer to *Table F.28* for information regarding the available attributes in each tracking data object.

Each tracking data object includes the data attributes objRef, serviceType, and errorCode. The attribute objRef provides the reference to the control object or control block instance that was the target of the service request. The attribute serviceType provides an enumerated value for the specific service requested or executed. *Table F.6* defines the service type enumerations.

Table F.6 IEC 61850 Service Type Enumeration

Service Type	Service Name	Description
16	SelectActiveSG	Active settings group switch request
24	SetBRCBValues	Write request on one or more of the following buffered report control block attributes: RptID, RptEna, OptFlds, BufTm, TrgOps, IntgPd, PurgeBuf, EntryID, or GI
26	SetURCBValues	Write request on one or more of the following unbuffered report control block attributes: RptID, RptEna, OptFlds, BufTm, TrgOps, IntgPd, Resv, or GI
43	Select	Select control request for CDCs with SBO with Normal Security control model
44	SelectWithValue	Select control request for CDCs with SBO with Normal Security control model
45	Cancel	Cancel control request
46	Operate	Operate control request
47	CommandTermination	Control processing completed on a control object configured with enhanced security control model
54	InternalChange	Report control block has been automatically disabled, i.e., RptEna is set to False after a loss of association with the client

The attribute errorCode provides the error code that indicates whether the service was successful or unsuccessful. The codes are listed in *Table F.7* together with the corresponding ACSI errors.

Table F.7 IEC 61850 ACSI Service Error

Error Code	ACSI Error
0	no-error
1	instance-not-available
3	access-violation
5	parameter-value-inappropriate
6	parameter-value-inconsistent
7	class-not-supported
8	instance-locked-by-other-client
10	type-conflict
11	failed-due-to-communications-constraint
12	failed-due-to-server-constraint

When creating datasets to track the services through information reporting, it is important to include the tracking data objects as a whole object (FCD—functionally constrained data), and not as individual data attributes (FCDA—functional constrained data attribute). Only the objRef attribute has a trigger option (dupd—data update) and can trigger a report. The dupd trigger option must also be enabled in the report control block that is reporting changes in the tracking data objects.

File Services

The Ethernet file system allows reading or writing data as files. The file system supports FTP and MMS file transfer. The file system provides:

- ➤ A means for the device to transfer data as files.
- ➤ A hierarchal file structure for the device data.

The relay supports MMS file transfer with or without authentication. Note that the MMS File Transfer service will still be supported even if the relay contains an invalid CID file. The service is intended to support:

- Settings file download and upload
- CID file download and upload
- Event report retrieval

MMS File Services are enabled or disabled via Port 1 settings, EMMSFS. Permissions for the Access Level 2 apply to MMS File Services requests. All files and directories that are available at the Access Level 2 via any supported file transfer mechanism (FTP, file read/write, etc.) are also available for transfer via MMS File Services.

See *Virtual File Interface on page 7.48* for details on the files available for MMS file services.

SCL Files

Substation Configuration Language (SCL) is an XML-based configuration language used to support the exchange of database configuration data between different tools, which may come from different manufacturers. There are four types of SCL files:

- IED Capability Description file (.ICD)
- System Specification Description (.SSD) file
- Substation Configuration Description file (.SCD)
- Configured IED Description file (.CID)

The ICD file describes the capabilities of an IED, including information on LN and GOOSE support. The SSD file describes the single-line diagram of the substation and the required LNs. The SCD file contains information on all IEDs, communications configuration data, and a substation description. The CID file, of which there may be several, describes a single instantiated IED within the project, and includes address information.

Data Sets

IEC 61850 data sets are lists of references to DataObject attributes for the purpose of efficient observation and transmission of data. Architect ICD files come with predefined data sets that can be used to transfer data via GOOSE messages, SV messages, or MMS reports.

- GOOSE: You can use predefined or edited data sets, or create new data sets for outgoing GOOSE transmission.
- SV: Four predefined data sets are provided. Each data set includes three phase currents and the neutral current as well as three phase voltages and the neutral voltage.
- Reports: Fourteen predefined data sets (BRDSet01–BRDSet07 and URDSet01–URDSet07) correspond to the default seven buffered and seven unbuffered reports. Note that you cannot change the number (14) of each type of report (buffered or unbuffered) within Architect. However, you can alter the data attributes that a data set contains or even create new data sets, and so define what data an IEC 61850 client receives with a report.

Reports

IEC 61850 provides two classes of reporting services, unbuffered and buffered, that a client can use to receive event data from a server. The unbuffered report service provides event data on a best-effort basis only while the client is connected. In contrast, the buffered report service keeps an internal buffer of events, which ensures clients can receive a sequence of events report even after reconnecting following a lost connection. The relay supports unbuffered and buffered report control blocks in the report model as defined in IEC 61850-8-1:2020.

IEC 61850 servers can deliver the same event data to multiple clients. IEC 61850 Ed1 proposed two different approaches that a server could use to accomplish this: association-based (non-indexed) reports and indexed reports. As of Ed2.1, SEL devices support both methods. The device supports as many as 24 report control blocks (12 each of buffered and unbuffered reports). Reports can either be configured as association-based reports or indexed reports. You cannot configure a mix of association-based reports and indexed reports, and the IED will reject such a configuration. SEL devices with ClassFileVersion 009 or earlier support only association-based reports. Devices that are ClassFileVersion 010 or later support association-based reports as well as indexed reports.

ICD files with ClassFileVersion 009 or earlier only support dynamic report reservations. Writing to ResvTms of the buffered report control block (BRCB) or Resv of the unbuffered report control block (URCB) causes the client to dynamically obtain a reservation. ICD files with ClassFileVersion 010 and later support both preconfigured report reservations and dynamic reservations. The SEL-2411 does not support report reservations; however, other SEL relays with Ed2.1 do support this feature.

Reports are serviced at a 2 Hz rate. The client can set the IntgPd to any value with a resolution of 1 ms. However, the integrity report is only sent when the period of time has expired. The report service rate of 2 Hz results in a report being sent within 500 ms of expiration of the IntgPd. The new IntgPd begins at the time that the current report is serviced.

When configuring buffered and unbuffered reports that contain only analog values, a data change report is only triggered when there is a change in the magnitude value in excess of the deadband setting. When you configure unbuffered and buffered reports that contain a combination of digital and analog values, any digital value change triggers a data change report, which contains the current value of the analogs contained in the report at the time of the trigger.

Unbuffered Reports

By using Architect, you can define if the URCB should be association-based or indexed. You can allocate data within each report data set to present different data attributes for each report. For unbuffered reports, connected clients may edit the report parameters shown in *Table F.8*.

Table F.8 Unbuffered Report Control Block Client Access (Sheet 1 of 2)

RCB Attribute	User Changeable (Report Disabled)[a]	User Changeable (Report Enabled)	Default Values
RptID	YES		URep01–URep07
RptEna	YES	YES	FALSE
Resv	YES		Resv = FALSE if no URCB instances are preconfigured for a client. Resv = TRUE for all URCB instances if one or more preconfigured clients are specified by the SCL.
OptFlds	YES		seqNum
			timeStamp
			dataSet
			reasonCode
BufTm	YES		250
TrgOps	YES		dchg
			qchg

Table F.8 Unbuffered Report Control Block Client Access (Sheet 2 of 2)

RCB Attribute	User Changeable (Report Disabled)[a]	User Changeable (Report Enabled)	Default Values
			period
IntgPd	YES		0
GI		YES[b]	FALSE
Owner			If the ReportControl has a single preconfigured client and its IP address can be found in the SCL, the IP address of the client is used as the default value for Owner; otherwise, the default value is NULL.

[a] The report must be actively reserved by setting Resv to 1 before the attribute values can be changed.

[b] Exhibits a pulse behavior. Write a one to issue the command. Once command is accepted will return to zero. Always read as zero.

Association-Based (Non-Indexed) URCBs

In association-based URCBs, the relay provides a unique URCB instance for each client association. Each client sees a different instance, although all instances have the same URCB name. This results in multiple client associations for that URCB. Once enabled, each client has independent access to an instance of that URCB. The server automatically ensures that a URCB instance is available to each client. SEL first offered association-based URCB support in the IEC 61850 Ed1 release of the relay.

The relay supports seven association-based URCBs and seven simultaneous clients, resulting in a total of 49 URCB instances, since each client views a different instance.

For example, if an association-based URCB is named UrcbA, seven clients can get independent access to UrcbA.

Indexed URCBs

In indexed URCBs, the server provides multiple URCB instances with all instances visible to all clients. Because all clients can see all instances, each instance must have a unique name. So, the report name is appended with a two-digit number *nn*, where *nn* ranges from 01 to the maximum number of instances supported for that control block. This allows a client to view all instances of a report control block, unlike association-based reports, where each client can only view the instance to which it is connected. Clients can reserve an instance by using the URCB Resv attribute. To prevent conflicts between clients, Ed2 introduced the concept of preconfigured reservations.

The relay added support for as many as 49 indexed URCB instances as part of the IEC 61850 Ed2.1 release of the relay.

Each report control block has seven instances available to connect to when a URCB is configured as indexed. For example, if UrcbA is configured as indexed, a client can connect to any one of the instances named UrcbA*xx*, where *xx* = 01–07.

Buffered Reports

By using Architect, you can define if the BRCB should be association-based or indexed. You can allocate data within each report data set to present different data attributes for each report. For buffered reports, connected clients may edit the report parameters shown in *Table F.9*.

Table F.9 Buffered Report Control Block Client Access

RCB Attribute	User Changeable (Report Disabled)[a]	User Changeable (Report Enabled)	Default Values
RptID	YES		BRep01–BRep07
RptEna	YES	YES	FALSE
OptFlds	YES		seqNum
			timeStamp
			dataSet
			reasonCode
			entryID
BufTm	YES		500
TrgOps	YES		dchg
			qchg
			period
IntgPd	YES		0
GI	YES[b, c]	YES[a]	0
PurgeBuf	YES[b]		FALSE
EntryId	YES		0
ResvTms	YES		–1 if the BRCB instance is preconfigured for a specific client in the SCL.
			0 if the BRCB instance is not reserved.
			60 if the report has been reserved with a write value of 0.
Owner			NULL if the BRCB instance is not preconfigured,
			or the IP address of the client in the SCL if it is preconfigured or dynamically assigned.

[a] The report must be actively reserved by setting ResvTms > 0 before the attribute values can be changed.

[b] Exhibits a pulse behavior. Write a one to issue the command. Once command is accepted will return to zero. Always read as zero.

[c] When disabled, a GI will be processed and the report buffered if a buffer has been previously established. Buffered reports begin buffering at startup.

ResvTms is an indication of the report reservation time for buffered reports. Clients must actively reserve the BRCB by setting ResvTms to a value greater than 0 before the report can be enabled. This is applicable to pre-configured SCL clients as well. A successful write to ResvTms results in the Owner attribute being updated to the IP address of the client that performed the write operation. When the MMS client disables the BRCB by setting RptEna to False and actively unreserves it by setting ResvTms to 0, the report is immediately available for write operations. After the ResvTms duration elapses, ResvTms reverts to 0 for dynamic associations, indicating the control block is available to other clients.

Association-Based (Non-Indexed) BRCBs

When a BRCB is configured as association-based or non-indexed, only one client can enable the BRCB at a time, which results in a client association for that BRCB. Once enabled, the associated client has exclusive access to the BRCB until the connection is closed or the BRCB is unreserved. Once enabled by a client, all unassociated clients have read-only access to the BRCB. SEL first offered association-based BRCB support in the 61850 Ed1 release of the relay. For example, if an association-based BRCB is named BrcbA, a client can connect to the report with name BrcbA.

Indexed BRCBs

In indexed BRCBs, the server provides multiple BRCB instances with all instances visible to all clients. The report name is appended with a two-digit number *nn*, where *nn* ranges from 01 to the maximum number of instances supported for that control block. This allows a client to view all instances of a report control block. Clients can reserve an instance by using the BRCB ResvTms attribute.

The relay supports seven indexed BRCB instances as part of its IEC 61850 Ed2.1 release of the relay. Only one instance of the report control block is available to connect to when a BRCB is configured as indexed. For example, if BrcbA is configured as indexed in Architect, a client will connect to the report with name BrcbA01.

Deadband Configuration and Functionality

Analog values of the MV, CMV, APC, and BAC CDCs defined in IEC 61850-7-3 have associated deadbands that determine when the analog values should be updated. The MV and CMV analog objects contain attributes that reflect the instantaneous value of the magnitude (instMag) and the value of the magnitude (mag), which is updated based on the deadband calculation.

Deadband calculations in Ed1 and Ed2 use a percent multiplier and the maximum range. The percent multiplier, a number between 0 and 100,000, is multiplied by 0.001 percent to determine the percentage of the maximum range to use as a deadband. Architect handles these calculations in the background, enabling users to configure the deadbands using nominal values. *Figure F.3* displays the view from the Deadband tab in Architect for both Ed1 and Ed2 implementations.

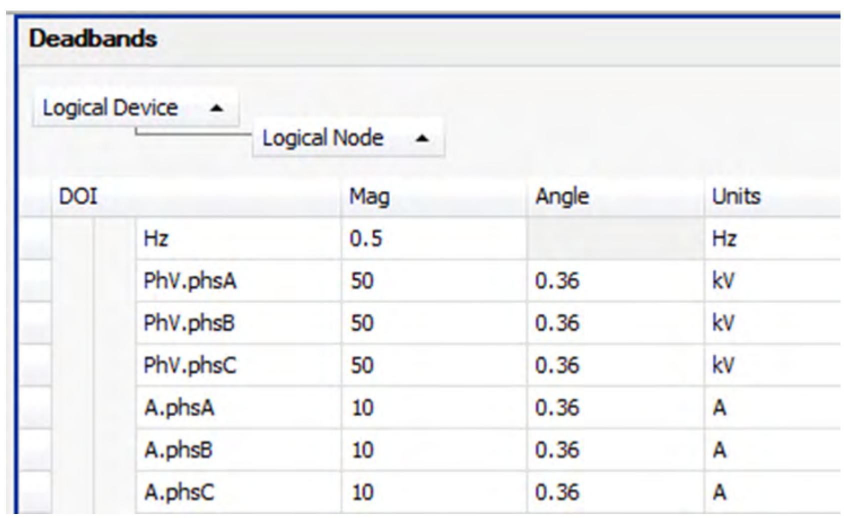


Figure F.3 Deadband Configuration View for Ed1 and Ed2

Ed2.1 introduced deadband-related attributes, dbRef, dbAngRef, zeroDb, and zeroDbRef, to explicitly expose the deadband behavior. The attribute dbRef may have a value of 0, which means the value db is used as the percentage of the last transmitted value in units of 0.001 percent. This is appropriate for currents and voltages. If the dbRef value is less than 0, it means the db represents the percentage of the dbRef in units of 0.001 percent and is appropriate for values with constant or small-changing values, for example frequency. The zeroDb attribute is the configuration parameter used to calculate the range around zero where the deadbanded value mag is forced to zero. The value of zeroDb represents the percentage of zeroDdRef in units of 0.001 percent.

For ICD files with ClassFileVersion 010 or higher, use Architect to view and configure the deadbands for analog values. The configuration values for the parameters shown in *Figure F.4* are editable, and Architect displays the resulting deadband value.

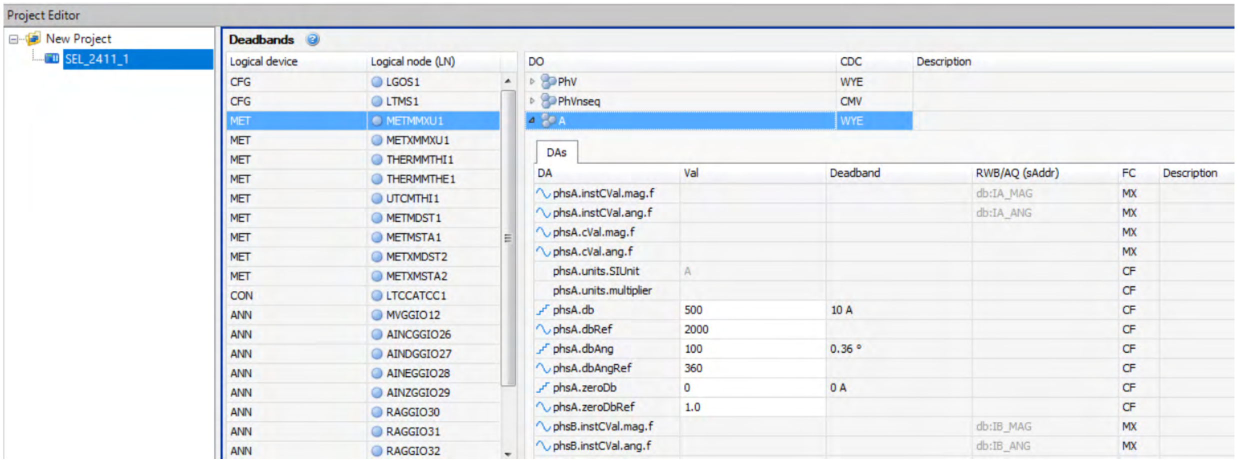


Figure F.4 Deadband Configuration View for Ed2.1

Supplemental Software Support

Examine the data structure and values of the supported IEC 61850 LNs with an MMS browser such as MMS Object Explorer and AX-S4 61850 from Sisco, Inc.

The settings needed to browse the relay with an MMS browser are shown below.

Table F.10

OSI-PSEL (Presentation Selector)	00000001
OSI-SSEL (Session Selector)	0001
OSI-TSEL (Transport Selector)	0001

Time Stamps and Quality

In addition to the various data values, the two attributes quality and t (time stamp) are available at any time. The time stamp is determined when data or quality change is detected. A change in the quality attribute can also be used to issue an internal event.

The time stamp is applied to all data and quality attributes (Boolean, Bstrings, Analogs, etc.) in the same fashion when a data or quality change is detected. However, there is a difference in how the change is detected between the different attribute types. For points in a data set that are also listed in the SER, the change is detected by the SER process. For all other Booleans or Bstrings, the change is detected via the scanner, which compares the last state against the previous state to detect the change. For analogs, the scanner looks at the amount of change relative to the deadband configured for the point to indicate a change and apply the time stamp. In all cases, these timestamps are used for the reporting model.

LN data attributes listed in the SER will have SER timestamps of 1 ms accuracy for data change events. All other LN data attributes are scanned on a 1/2-second interval for data change and have 1/2-second time stamp accuracy.

The relay uses GOOSE quality attributes to indicate the quality of the data in its transmitted GOOSE messages. Under normal conditions, all attributes are zero, indicating good quality data. *Figure F.5* shows the GOOSE quality attributes available to devices that subscribe to GOOSE messages from relay data sets that contain them. Internal status indicators provide the information necessary for the device to set these attributes. For example, if the device becomes disabled, as shown via status indications (e.g., an internal self-test failure), the relay will set the Validity attribute to INVALID and the Failure attribute to TRUE. Note that the relay does not set any of the other quality attributes. These attributes will always indicate FALSE (0). See the Architect help for additional information on GOOSE Quality attributes.

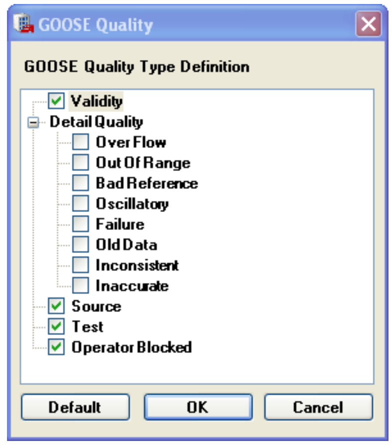


Figure F.5 GOOSE Quality

Control

IEC 61850 Controls

An IEC 61850 server may allow a client to manipulate data related to its outputs, external devices, or internal functions. This is accomplished by the IEC 61850 control model, which provides services to execute control commands. The control models are defined in IEC 61850-7-2 and the mapping to the MMS application protocol is defined in IEC 61850-8-1. The former describes control functionality while the latter maps the IEC 61850 control primitives to MMS.

The SEL-2411 supports four different control models:

- Status Only
- Direct With Normal Security
- Direct With Enhanced Security
- SBO With Normal Security
- SBO With Enhanced Security

One control model is selected during initial IED configuration in Architect and is applied throughout the CID file. This control model applies to all controls in the IED. For CID files created from an ICD file ClassFileVersion 10 or higher, the Architect tool allows modification of the control model on a per-control basis if a control model different than the one selected during initial IED configuration is required.

Firmware that supports Ed2.1 and ClassFileVersion 10 or higher supports pulsing the SPC and DPC control models as defined in IEC 61850-7-3 by configuring pulseConfig attributes cmdQual, onDur, offDur, and numPls.

Direct Control Models

The "Direct" control models provide the simplest means to initiate actions on the server. In these models, the client issues a control request via MMS, the server validates the request. Once validated, the server attempts to act upon the request. Note that if multiple clients are trying to perform control actions, the server will do nothing to prevent this.

SBO Control Model

The SBO control model supports the Select and SelectWithValue Service and can be used to prevent multiple clients from performing simultaneous control actions. In this mode, a client has to "reserve" the control object by sending a "select" control command. Once an object is selected, only the client that made the selection is allowed to perform control actions on it. If that client does not send a valid operate request for the object by the time the select time-out runs out, the object becomes available for selection again. The relay will support as many as ten pending control object selections at any time.

NOTE: When an IED is configured with the SBO (with Normal or Enhanced Security) control models, the sboTimeout attribute of the controllable CDCs in the CID file is set to ten seconds. This time-out is not configurable via Architect.

The attribute stSeld (selected status) of the controllable CDC is set to TRUE when a client successfully selects the control object. The attribute is reset to FALSE when either the control (operate) command is successfully executed, an error occurs, or no operate command is received within the select time-out period. The stSeld attribute may trigger a report just like any data attribute with trigger option.

Security in Control Models

"Security" in the control model context refers to additional supervision of the status value by the control object. The "enhanced security" models report additional error information on failed operations to the requesting client unlike the models with "normal security." Enhanced security control models provide a command termination report indicating if the control actually reached the new state as commanded within a configurable time-out period.

NOTE: The maximum time required for a control operation to be completed should be less than the configured time-out period to avoid erroneous command termination reports indicating failure.

The time-out period between the execution of a control and the generation of a command termination report indicating failure has a default value of 1 s and is configurable via the CID file. This time-out is not configurable via Architect.

Optional Control Configurations

SEL-2411 devices that have Ed2.1 and CFV of 10 or higher support the pulse configuration option specified in Clause 6.7 of IEC 61850-7-3. In devices that are not Ed2.1, some control models are available that will pulse a control for one processing interval.

Controls that can be configured for pulse operations, such as the SPCSO data objects in the RBGGIO logical nodes, contain a pulseConfig constructed data attribute type.

The cmdQual data attribute of an SPC or DPC control defines whether the control will be persistent or pulsed.

➤ cmdQual defines whether the control is persistent or pulsed. If cCmdQual = 0 (pulse), the control object pulses when the command is written to, according to the onDur, offDur and numPls attributes. If cmdQual = 1 (persistent), the control object asserts if ctlVal is true or deassert if ctlVal is false.

Figure F.6 shows an example of how onDur, offDur and numPls are used when the control is pulsed:

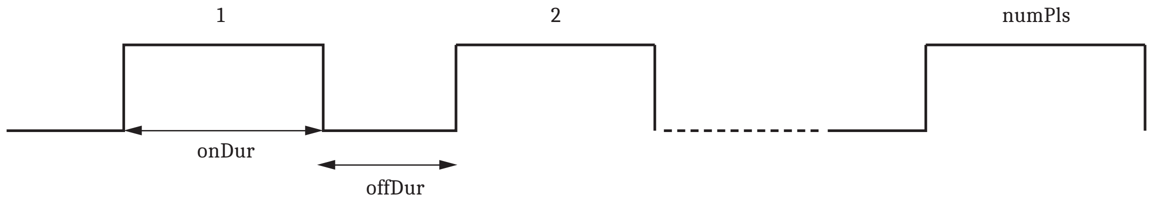


Figure F.6 Pulse Behavior in Control Operations

➤ If cmdQual = 0 (pulse), onDur = 0, and offDur = 0, the control object pulses for one processing interval.

Use Architect to configure a control to pulse by selecting a controllable data object (such as a remote bit), selecting the Control Configuration tab, and setting the pulseConfig.cmdQual to pulse (see *Figure F.7*). Setting pulseConfig.cmdQual allows changes to the onDur, offDur, and numPls attributes.

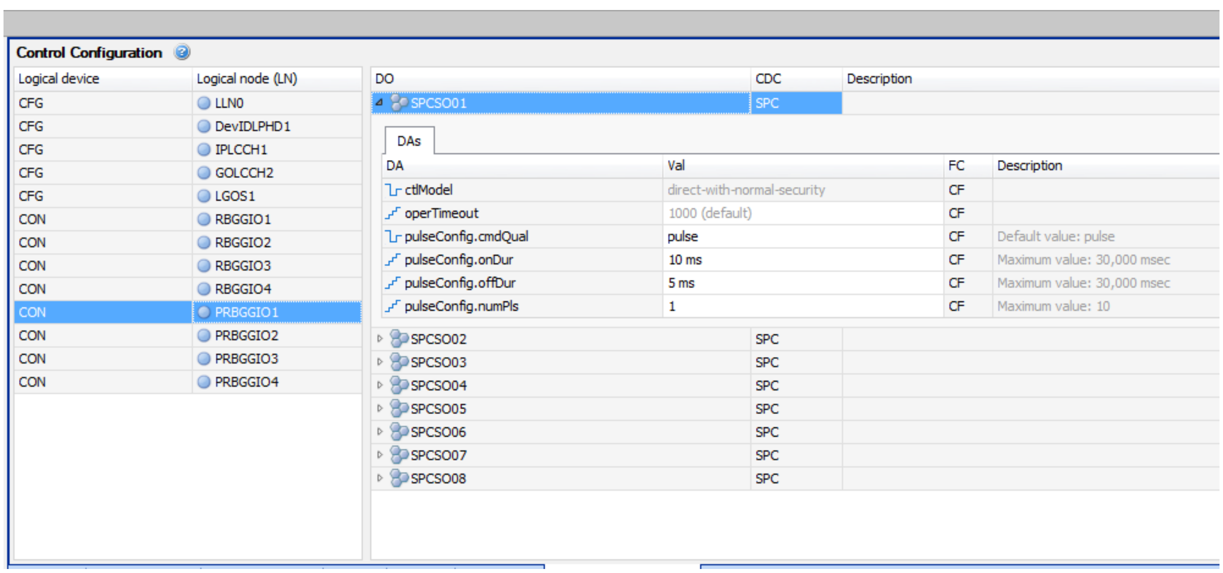


Figure F.7 Configuration of Pulse Control Operations

Local/Remote Control Authority

Control commands at a substation originate from one of three levels: remote (network control center), station, or bay. Under certain operational conditions (e.g., during maintenance), you may need to block control commands from one or more of these levels. The local/remote control feature allows you to enable or disable control authority at any of the three levels. The level at which a control command originates is determined by the value of the origin.orCat (originator category) attribute in the command. *Table F.11* describes the different orCat values defined in IEC 61850-7-2.

Table F.11 Originator Categories (Sheet 1 of 2)

Originator Category	Value
Not-supported	0
Bay-control	1
Station-control	2

Table F.11 Originator Categories (Sheet 2 of 2)

Originator Category	Value
Remote-control	3
Automatic-bay	4
Automatic-station	5
Automatic-remote	6
Maintenance	7
Process	8

SEL-2411 devices support the local/remote control feature defined in IEC 61850-7-4. The feature is supported at the IED level and logical node level with identical and configurable attributes in the LLN0 logical node of each logical device and in CSWI logical nodes. *Table F.12* describes the attributes and their data sources in various logical nodes.

Table F.12 Control Authority Attributes

Logical Node	Attribute	Data Source	Description
LLN0	Loc.stVal	LOC	Control authority of the IED at local (bay) level
	LocSta.stVal	LOCSTA	Control authority of the IED at station level
	MltLev.setVal	MLTLEV	Multi-level control authority
CSWI	Loc.stVal	LOC	Control authority of the switch controller at local (bay) level
	LocSta.stVal	LOCSTA	Control authority of the switch controller at station level

You can control the Relay Word bits LOCAL, LOCSTA, and MLTLEV through SELOGIC control equations. LOCSTA is set to True when the SELOGIC control equation SC850LS asserts and is set to False when SC850LS deasserts. LOCSTA can also be controlled through MMS, but if LOCSTA is set to True through SELOGIC control equations, it cannot be set to False through MMS. By default, all three attributes are set to False, so only remote commands are allowed.

The IED-level local/remote behavior can be changed by changing the value of the LOCAL Relay Word Bit through a SELOGIC control equation.

Using the Loc, LocSta, and MltLev LLNO stVal attributes, you can enable or disable control authority at any of the three switching levels, as shown in *Table F.13*.

Table F.13 Control Authority Settings

LLNO			orCat Value		
Loc.stVal	LocSta.stVal	MltLev.setVal	Bay (1 or 4)	Station (2 or 5)	Remote (3 or 6)
F	F	F	NA	NA	AA
F	F	T	AA	AA	AA
F	T	F	NA	AA	NA
T	X	X	AA	NA	NA
F	T	T	AA	AA	NA

Control Requests

IEC 61850 control services are implemented by reading and writing to pseudo-variables in the relay in response to MMS requests. Similar to how client requests are generated and mapped to MMS read or write service requests, server actions are also mapped to internal commands, read and write actions and MMS information report messages. In the case of an unsuccessful control request, the relay will send the appropriate response PDU indicating that there was a problem and an MMS information report that contains more detailed information about the problem that occurred.

To control CDCs with SBO with Enhanced Security models, the client must select and write the entire SBOw, Oper, or Cancel structure to the relay. See *Figure F.8* for the attributes of the CON Logical Device and ST and CO functional constraints (FC) of LN RBGGIO1 used for controls of RB01 through RB08.

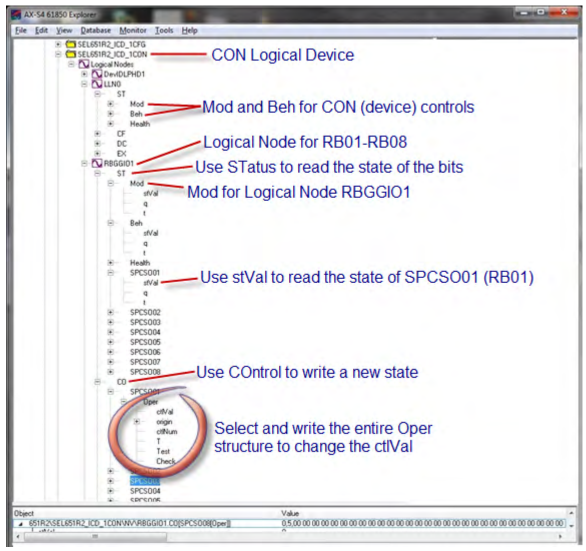


Figure F.8 MMS Client View of the CON Logical Device With SBO With Enhanced Security CDC

To control CDCs with SBO with Normal Security models, the client must read the SBO structure to select and then write the entire Oper, or Cancel structure to the relay. See *Figure F.9* for the attributes of the CON Logical Device and ST and CO functional constraints (FC) of LN RBGGIO1 used for controls of RB01 through RB08.

Figure F.9 MMS Client View of a CON Logical Device With SBO With Normal Security CDC

Control Error Messages

If a control request results in an error condition, the relay will respond with an AddCause value in an MMS information report. See Clause 20.5.2.9 of IEC 61850-7-2 for additional information on the AddCause values.

The SEL-2411 supports the AddCause values in *Table F.14* as part of the LastApplError information report.

Table F.14 AddCause Descriptions (Sheet 1 of 2)

AddCause Enumeration	AddCause Description	Error Condition
0	Unknown	No other AddCause value defined within this section applies.
2	Blocked-by-switching-hierarchy	Logical node is set to local mode, i.e., Loc.stVal = true.
3	Select-failed	Originator category not allowed to issue control commands or SelectWithValue operation fails.
4	Invalid-position	For controls with enhanced security, an AddCause of "Invalid-position" (4) will be sent if the control status changes to an unexpected value. If no control status change is detected after the operate time-out period, an AddCause of "Time-limit-over" (16) will be sent.
5	Position-reached	Control status is already at the desired state.
6	Parameter-change-in-execution	Control object is already selected by the client, and 1. Logical node is set to local mode i.e., Loc.stVal = true, or 2. Originator category not allowed to issue control commands.
8	Blocked-by-mode	Mode of logical device or node is not ON.
10	Block-by-interlocking	Selection of switch device failed due to interlock check.
12	Command-already-in-execution	Execution of a previous control is not completed.

Table F.14 AddCause Descriptions (Sheet 2 of 2)

AddCause Enumeration	AddCause Description	Error Condition
13	Blocked-by-health	Health of logical device or node is not OK.
16	Time-limit-over	CommandTermination gives a negative response. (The control failed to reach its intended state prior to time-out.)
18	Object-not-selected	Control action is rejected because control object was not selected.
19	Object-already-selected	Select action is not executed because the addressed object is already selected
20	No-access-authority	Control action is blocked due to lack of access authority.
26	Inconsistent-parameters	The parameters between successive control services are not consistent. For example, the ctlNum of Select and Operate service are different.
27	Locked-by-other-client	Another client has already reserved the object.

Any AddCause value not specified above is not supported. Control CDC data attributes, which are associated with unsupported AddCause values and are not part of a control structure, will be accepted but ignored. For example, the attribute CmdBlk.stVal, which is associated with the AddCause value “blocked-by-command” and is not part of a SBOw, Oper, or Cancel structure, will be ignored.

For CDCs with SBO with Normal Security, according to Clause 20.5.2 of IEC 61850-8-1-2011, the relay indicates a negative response for the Select service by returning a Null string.

GOOSE

The Generic Object Oriented Substation Event (GOOSE) object within IEC 61850 is for high-speed control messaging. IEC 61850 GOOSE automatically broadcasts messages containing status, controls, and measured values onto the network for use by other devices. IEC 61850 GOOSE sends the message several times, increasing the likelihood that other devices receive the messages.

IEC 61850 GOOSE objects can quickly and conveniently transfer status, controls, and measured values between peers on an IEC 61850 network. Configure SEL devices to respond to GOOSE messages from other network devices with Architect. Also, configure outgoing GOOSE messages for SEL devices in Architect. See the Architect help for more information.

Each IEC 61850 GOOSE sender includes a text identification string (GOOSE Control Block Reference) in each outgoing message and an Ethernet multicast group address. Devices that receive GOOSE messages use the text identification and multicast group to identify and filter incoming GOOSE messages.

Virtual bits (VB001–VB128) are control inputs that you can map to values from incoming GOOSE messages by using the Architect software. See the VB*nnn* bits in *Table F.31* for details on which logical nodes and names are used for these bits. This information can be useful when searching through device data with MMS browsers. If you intend to use any relay Virtual bits for controls, you must create SELOGIC equations to define these operations. The relay is capable of receiving and sending analog values via peer-to-peer GOOSE messages. Remote analogs (RA001–RA128) are analog inputs that you can map to values from incoming GOOSE messages. Remote analog outputs (RA01–RA128) can be used to transmit analog values via GOOSE messages. You must create SELOGIC control equations to assign internal relay values to RA points to transmit them via GOOSE.

GOOSE Processing

SEL devices support GOOSE processing as defined by IEC 61850-7-1:2011(E), IEC 61850-7-2:2010(E), and IEC 61850-8-1:2011(E) via the installed Ethernet port.

Outgoing GOOSE messages are processed in accordance with the following constraints.

- The user can define as many as eight data sets for outgoing GOOSE messages consisting of any data attribute (DA) from any logical node. A single DA can be mapped to one or more outgoing GOOSE data sets, or one or more times within the same outgoing GOOSE data set. A user can also map a single GOOSE data set to multiple GOOSE control blocks. The number of unique Boolean variables is limited to a combined total of 512 digital bits across all eight outgoing messages.
- High-speed GOOSE messaging (as defined under GOOSE Performance) is available for GOOSE messages that contain either all Boolean data or a combination of Boolean data and remote analog output (RA01–RA128) data.
- The relay will transmit all configured GOOSE immediately upon successful initialization. If a GOOSE message is not retriggered, then following the initial transmission, the relay shall retransmit that GOOSE based on the Min. Time and Max. Time configured for that GOOSE message. The first transmission shall occur immediately upon triggering of an element within the GOOSE data set. The second transmission shall occur Min. Time later. The third shall occur Min. Time after the second. The fourth shall occur twice Min. Time after the third. All subsequent transmissions shall occur at the Max Time interval. For example, a message with a Min. Time of 4 ms and Max. Time of 1000 ms, will be transmitted upon triggering, then retransmitted at intervals of 4 ms, 4 ms, 8 ms, and then at 1000 ms indefinitely or until another change triggers a new GOOSE message (See IEC 61850-8-1, Sec. 18.1).
- Each outgoing GOOSE includes communications parameters (VLAN, Priority, and Multicast Address) and is transmitted entirely in a single network frame.
- The relay will maintain the configuration of outgoing GOOSE through a power cycle and device reset.

Incoming GOOSE messages are processed in accordance with the following constraints.

- The user can configure the relay to subscribe to as many as 16 incoming GOOSE messages.
- Control bits in the relay get data from incoming GOOSE messages which are mapped to Virtual Bits (VB*nnn*). Virtual bits are volatile and are reset to zero when a new CID file is loaded, the device is restarted, or they are overwritten by data from a subscribed GOOSE message.

NOTE: Options marked with * are configurable via tools such as Architect. The relay, by default, checks against this parameter.

Any GOOSE message that fails these checks shall be rejected. You can find the default quality check in the quality mask in Architect. See Figure F.11 for an example.

The relay recognizes incoming GOOSE messages as valid based on the following content:

- Source broadcast MAC address
- Data Set Reference*
- Application ID*
- GOOSE Control Reference*

- Configuration Revision*
- Needs Commissioning*
- Quality Test*

- Every received and validated GOOSE message that indicates a data change, by an incremented status number, is evaluated as follows:
  - Data within the received GOOSE data set that are mapped to host data bits are identified.
  - Mapped bits are compared against a local version of the available host data bits.
  - If the state of the received bits is different than the local version:
    - Update the local version with the new state for that bit.
    - Pass the new state for the bit to the relay.
- Rejection of all DA contained in an incoming GOOSE based on the presence of the following error indications created by inspection of the received GOOSE:
  - Configuration Mismatch: The configuration number of the incoming GOOSE changes.
  - Needs Commissioning: This Boolean parameter of the incoming GOOSE is true.
  - Decode Error: The format of the incoming GOOSE is not as configured.
- Reject DAs with quality indicating test if subscriber is in On or On-Blocked mode.
- Upon transition of a device or logical node from On to test, previously processed incoming GOOSE messages will be re-evaluated for test data and processed.
- The relay will discard incoming GOOSE under the following conditions:
  - After a permanent (latching) self-test failure
  - When EGSE is set to No
- Upon a transition of Mod/Beh, the received GOOSE messages are evaluated to determine if they will be processed according to IEC 61850-7-4 Appendix A.

Link-layer priority tagging and virtual LAN is supported as described in Annex C of IEC 61850-8-1:2011.

GOOSE Performance

For outgoing high-speed data (as identified under GOOSE Processing), transmission of GOOSE begins within 2 ms of transition of digital data within the relay. Note that you can include RAO points in outgoing GOOSE for high-speed transmission. Only the transition of a digital point will trigger the transmission within 2 ms. For all other data contained in outgoing GOOSE, transmission of GOOSE begins within 500 ms of transition of data within the relay. For incoming GOOSE data with an included change of state, the corresponding mapped virtual bit states update within two processing intervals.

IEC 61850 Simulation Mode

The SEL-2411 controllers can be configured to operate in simulation mode. In this mode, the SEL-2411 continues to process normal GOOSE messages until a simulated GOOSE message is received for a subscription. Once a simulated GOOSE message is received, only simulated GOOSE messages are processed for that subscription. The simulated mode only terminates when the Device Word bit LPHDSIM is returned to FALSE. When the device is not in the simulation mode, only normal GOOSE messages are processed for all subscriptions.

A user can place the SEL-2411 in IEC 61850 simulation mode by setting CFG.DevIDLPHD1.Sim.stVal to TRUE via MMS messaging.

Alternatively, you can use SELOGIC variable SC850SM to enable the simulation mode. A rising edge of SC850SM enables the simulation mode and asserts LPHDSIM, and a falling edge of SC850SM disables it and deasserts LPHDSIM. When you use SC850SM to enter simulation mode, the relay rejects MMS attempts to enter or exit simulation mode until SC850SM deasserts.

IEC 61850 Mode/Behavior

NOTE: IEC 61850 Mode/Behavior is only available in IEDs with IEC 61850 Edition 2 support.

The IEC 61850-7-4:2010 standard defines behaviors of different modes to facilitate testing. The SEL-2411 supports the following modes:

- On
- Blocked
- Test
- Test/Blocked
- Off

IEC 61850 Behavior is jointly determined by the logical device mode and its logical node mode according to the IEC 61850 standard. For the SEL-2411, the selected IEC 61850 Mode/Behavior applies to the entire IED, including all its logical devices and all logical nodes. The behavior of the IED is always the same as the selected mode.

Table F.15 describes the available services based on the mode/behavior of the IED.

Table F.15 IEC 61850 Services Available Based on Mode/Behavior

Mode	MMS	GOOSE Publication and Subscription
On	Available	Available
Blocked	Available	Available
Test	Available	Available
Test/Blocked	Available	Available
Off	No services[a]	Publication[b]

[a] All MMS control requests to change the mode with Test = false will be processed.
[b] GOOSE and SV publication in mode Off are disabled if EOFFMTX = N.

The analog quantity I850MOD is an enumerated number that corresponds to mode and behavior as shown in *Table F.16*.

Table F.16 Analog Quantity I850MOD Status Based on the Selected IEC 61850 Mode/Behavior

I850MOD	IEC 61850 Mode/Behavior
1	On
2	Blocked
3	Test
4	Test/Blocked
5	Off
0	Not Supported

Mode/Behavior Control

Enable Mode/Behavior Control

IEC 61850 Mode/Behavior, by default, is disabled on SEL-2411 devices. To enable IEC 61850 Mode/Behavior, you must set Port 1 setting E61850 to **Y**. To enable IEC 61850 Mode/Behavior control, you must set port setting E850MBC to **Y** and the CID file setting controllableModeSupported to **True**. You can set the controllableModeSupported setting by selecting **Enable control of IEC 61850 Mode/Behavior** when adding an IED into an Architect project, as shown in *Figure F.10*.

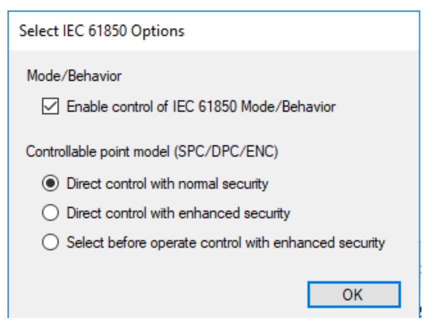


Figure F.10 Set controllableModeSupported = True

Enhanced Secure Mode Control

Relay setting E850MBC and CID file setting controllableModeSupported provide security to prevent accidental switching into an unplanned IEC 61850 Mode/Behavior during normal operations. For example, following IED testing, a technician can disable unplanned switching of IEC 61850 Mode/Behavior by setting E850MBC to N after switching the relay back to On mode.

Change Mode Via MMS or SELogic

If IEC 61850 Mode/Behavior is set as controllable, you can control the IEC 61850 Mode/Behavior via MMS writes to the LLN0 logical node mode data object (Mod.ctlVal) in logical device CFG. Note that Mod.ctVal in other logical devices does not accept MMS writes.

Table F.17

Write Values to Mod.ctVal in Logical Device CFG	Selected IEC 61850 Mode/Behavior
1	On
2	Blocked
3	Test
4	Test/Blocked
5	Off

You can also control IEC 61850 Mode/Behavior through the use of SET G global settings SC850TM and SC850BM SELOGIC variables. These variables control Test Mode and Blocked Mode, respectively.

NOTE: The variables SC850TM and SC850BM are not protection settings.

Table F.18

SC850TM	SC850BM	Selected IEC 61850 Mode/Behavior
0	0	See Note[a]
1	0	Test
0	1	Blocked
1	1	Test/Blocked
See Note[b]	See Note[b]	Off

[a] **Note:** The SELOGIC controls have higher priority than MMS clients in controlling the Test mode and Blocked mode. When SC850TM and SC850BM both evaluate to 0 (false), IEC 61850 Mode/Behavior control is available to MMS clients. If either SC850TM or SC850BM evaluates to 1 (true), SELOGIC determines the IEC 61850 Mode/Behavior of the IED regardless of MMS control values.

[b] **Note:** You cannot control Off mode by using SC850TM and SC850BM. When an MMS client causes the IED to be in Off mode, the SELOGIC controls are disabled and SC850TM and SC850BM are not evaluated.

EXAMPLE F.1 Change Mode Via SELOGIC

In this example, pushbuttons PB1 and PB2 control SC850TM. Pushbuttons PB3 and PB4 control SC850BM. If you press PB1, the relay enters Test mode. If you press PB3, the relay transitions from Test mode into Test/Blocked mode. Press PB2 and PB4 to reset Test mode and Blocked mode, respectively.

NOTE: Extraneous settings omitted in SHO L and SHO G.

```
=>>SHO G <Enter>

Global

IEC 61850 Mode/Behavior Configuration
SC850BM  := LT01
SC850TM  := LT02

=>>
=>>SHO L <Enter>

Logic

Latch Bit Set/Reset SELogic Equations
SET01    := PB01
RST01    := PB02
SET02    := PB03
RST02    := PB04

=>>
```

You can read the current IEC 61850 Mode/Behavior through an MMS client or by using the **STA** commands.

Incoming Messages Processing

IEC 61850 incoming data processing is jointly determined by quality validity, test, and operatorBlocked. SEL-2411, by default, checks if the quality operatorBlocked = False; if not, the relays treat the messages as invalid. You can disable the default check by changing the quality mask of GOOSE subscriptions. *Figure F.11* illustrates the default quality check for GOOSE subscription on the SEL-2411.

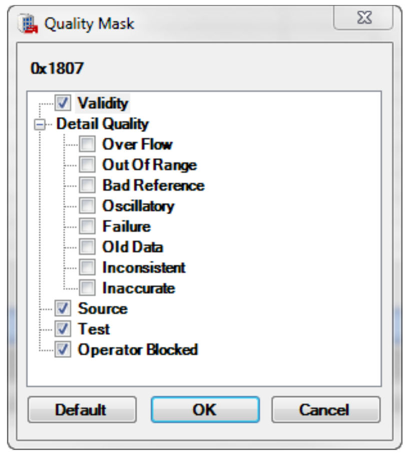


Figure F.11 Default Quality Check on GOOSE Subscription if Quality Is Present

Relay Operation for Different IEC 61850 Modes/Behaviors

Mode: On

In On mode, the relay operates as normal; it reports IEC 61850 Mode/Behavior status as On and processes all inputs and outputs as normal. If the quality of the subscribed GOOSE messages satisfies the GOOSE processing, the relay processes the received GOOSE messages as valid.

NOTE: An IEC 61850 IED determines the processing of GOOSE messages based on the received quality of the GOOSE data and its current mode. If a GOOSE message does not contain quality information, the relay always processes it as valid. To use the IEC 61850 Mode/Behavior, SEL recommends including quality attributes in GOOSE messages.

Table F.19 IEC 61850 Incoming Message Handling in On Mode

IEC 61850 Messages	Incoming Message With Quality Test Bit Set to False (0)	Incoming Message With Quality Test Bit Set to True (1)
MMS	Processed	Processed as invalid
GOOSE	Processed	Processed as invalid

Table F.20 IEC 61850 Outgoing Message Handling in On Mode

IEC 61850 Messages	Outgoing Message Quality Test Bit Status
MMS	False
GOOSE	False

Figure F.12 illustrates the mode/behavior.

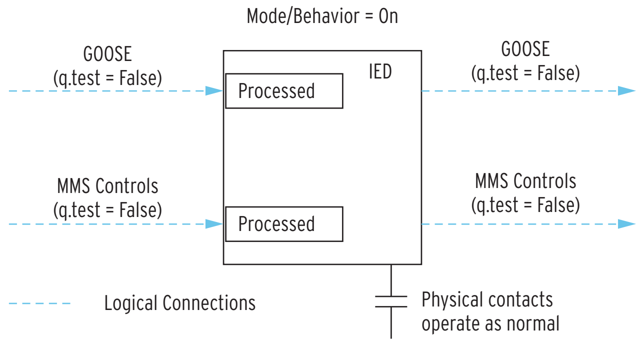


Figure F.12 Relay Operations in On Mode

Mode: Blocked

The relay operates in Blocked mode similarly to how it operates in On mode, except that it does not operate any physical contact outputs in this mode. It does continue to operate control bits such as remote bits and output contact bits.

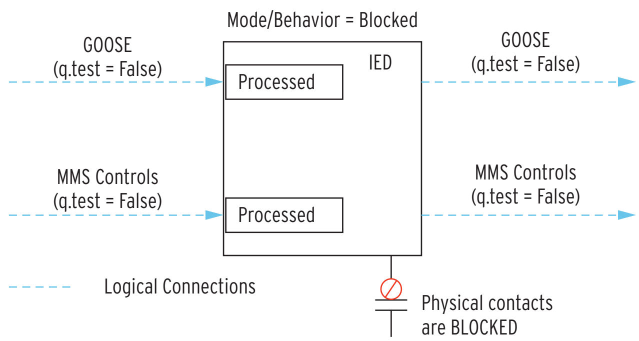


Figure F.13 Relay Operations in Blocked Mode

Mode: Test

In Test mode, the relay processes valid incoming test signals or normal messages and operates physical contact outputs if triggered. In this mode/behavior, outgoing MMS and GOOSE messages have the quality test bit set to True if the quality test bit is present. If the quality of the subscribed GOOSE messages satisfies the user-defined quality type definition (regardless of whether the quality test bit is set to True or False), the relay processes the received GOOSE messages as valid.

NOTE: An IEC 61850 IED determines the processing of GOOSE messages based on the received quality of the GOOSE data and its current mode. If a GOOSE message does not contain quality information, the relay always processes it as valid. To use the IEC 61850 Mode/Behavior, SEL recommends including quality attributes in GOOSE messages.

Table F.21 IEC 61850 Incoming Message Handling in Test Mode

IEC 61850 Messages	Incoming Message With Quality Test Bit Set to False (0)	Incoming Message With Quality Test Bit Set to True (1)
MMS	Not Processed	Processed
GOOSE	Processed	Processed

Table F.22 IEC 61850 Outgoing Message Handling in Test Mode

IEC 61850 Messages	Outgoing Message Quality Test Bit Status
MMS	True
GOOSE	True

Figure F.14 illustrates the mode/behavior.

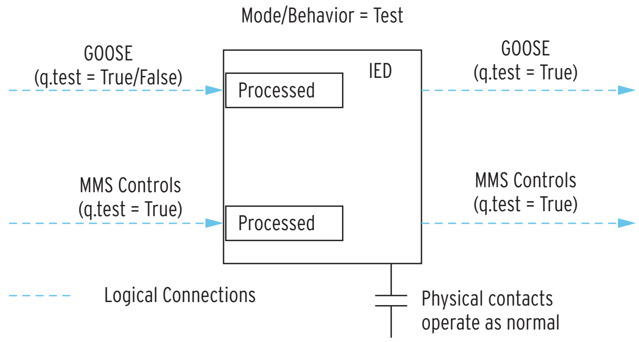


Figure F.14 Relay Operations in Test Mode

Mode: Test/Blocked

In Test/Blocked mode the relay processes valid incoming test signals or normal messages but blocks any physical contact outputs from operating. In this mode/behavior, outgoing MMS and GOOSE messages have the quality test bit set to True if the quality test bit is present. If the quality of the subscribed GOOSE messages satisfies the user-defined quality type definition (regardless of whether the quality test bit is set to True or False), the relay processes the received GOOSE messages as valid.

NOTE: An IEC 61850 IED determines the processing of GOOSE messages based on the received quality of the GOOSE data and its current mode. If a GOOSE message does not contain quality information, the relay always processes it as valid. To use the IEC 61850 Mode/Behavior, SEL recommends including quality attributes in GOOSE messages.

Figure F.15 illustrates the mode/behavior.

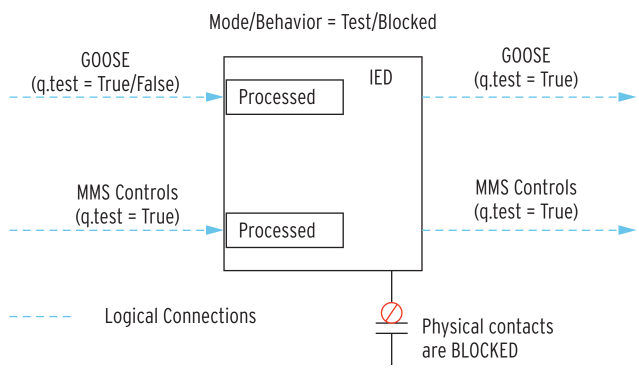


Figure F.15 Relay Operations in Test/Blocked Mode

Mode: Off

In Off mode, the relay no longer processes incoming GOOSE messages. The relay processes MMS control requests to change the IEC 61850 Mode/Behavior if the quality Test bit is set to False. The relay is in a disabled state, and it no longer trips any physical contact outputs.

In this mode, the relay is in a disabled state. Device Word bit EN is set to False. The device processes MMS control requests to change the active mode of IEC 61850 Mode/Behavior if the quality Test bit of the control is set to False.

If EOFFMTX is set to True, the relay continues to transmit GOOSE messages with the quality test bit set to False (0) and the validity set to Invalid (01) if the quality is present in the messages. If EOFFMTX is set to False, the relay does not transmit GOOSE messages in this mode. The relay also does not process any incoming GOOSE messages.

Table F.23 IEC 61850 Incoming Message Handling in Off Mode

IEC 61850 Messages	Incoming Message With Quality Test Bit Set to False (0)	Incoming Message With Quality Test Bit Set to True (1)
MMS	Relay Only Processes Messages to Control the Mode	Not Processed
GOOSE	Not Processed	Not Processed

Table F.24 IEC 61850 Outgoing Message Handling in Off Mode

IEC 61850 Messages	Outgoing Message Quality Validity Bit
MMS	Invalid
GOOSE	Invalid

Figure F.16 illustrates the IEC 61850 Mode/Behavior.

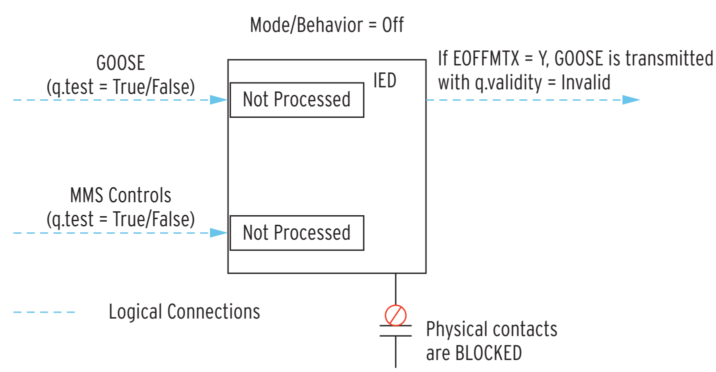


Figure F.16 Relay Operations in Off Mode

IEC 61850 Configuration

Settings

Table F.25 lists IEC 61850 settings. These settings are only available if your device includes the optional IEC 61850 protocol.

Table F.25 IEC 61850 Settings

Label	Description	Range	Default
E61850	IEC 61850 interface enable	Y, N	N
EGSE	Outgoing IEC 61850 generic substation event (GSE) message enable	Y, N	N
EMMSFS	Enable MMS File Services	Y, N	N
E850MBC	Enable IEC 61850 Mode/Behavior control	Y, N	N
EOFFMTX	Enable GOOSE in Off mode	Y, N	N

Architect

The Architect software enables protection and integration engineers to design and commission IEC 61850 substations containing SEL IEDs.

Engineers can use 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

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.

Common Logical Nodes

Each logical device (LD) has a set of common data objects at the top-level LN0. These represent the current state of the device, as well as some informational data. These data objects are Mod (Mode), Beh (Behavior), Health, and NamPlt. See the following brief descriptions of each object.

Mode/Behavior

In the SEL-2411, the top-level LN0 within each LD includes the following enumerations for **Mod.stVal** and **Beh.stVal**.

Table F.26 Mod.stVal and Beh.stVal Enumerations

Mod.stVal Enumeration	Beh.stVal Enumeration	Description
1	1	On
2	2	Blocked
3	3	Test
4	4	Test/Blocked
5	5	Off
0	0	IEC 61850 Mode/Behavior disabled

The top-level logical node of each LD also includes the following Mod and Beh attributes:

- **Mod.q** and **Beh.q** represents quality
- **Mod.t** and **Beh.t** represents time stamps

See *Change Mode Via MMS or SELOGIC on page F.25* for instructions on changing the Mode/Behavior.

Health

In the SEL-2411, the top-level LN0 within each LD includes the following enumerations for **Health.stVal**.

Table F.27 Health.stVal Enumerations

Health.stVal Enumeration	Health.stVal Enumeration	Description
1	Ok	ENABLED Device Word bit = 1
3	Alarm	ENABLED Device Word bit = 0

The logical nodes also include the following Health attributes:

- **Health.q** represents quality
- **Health.t** represents time stamps

NamPlt

The top-level LN0 of each LD includes the following NamPlt attributes:

- **NamPlt.vendor** has a string value set to SEL
- **NamPlt.swRev** contains the relay FID string value
- **NamPlt.d** contains the LD description

LPHD

The LPHD logical node in the CFG logical device contains information about the physical device, such as the physical device nameplate information. SEL extended this logical node to include an object that provides an identifier for the version of the IEC 61850 component firmware in the device. This object, LPHD.SelLibID, contains a checksum derived from the IEC 61850 library version, and is the same value across different devices with the same underlying code. This value is also available in the 61850ID field of the **ID** command.

```
==>>ID <Enter>
"FID=SEL-2411-R502-V0-Z102101-D20250228","08D4"
"BFID=SLBTIND-R101-V0-Z000000-D20230609","0944"
"CID=9618","0255"
"DEVID=SEL-2414","03F5"
"DEVCODE=64","0311"
"PARTNO=241121A0X0X0X0X0840","06D9"
"SERIALNO=000000000000000","05DA"
"CONFIG=000000","0383"
"iedName=A2411_010_ver15_icd_2","098B"
"type=SEL_2411","047A"
"configVersion=ICD-2411-R122-V0-Z502010-D20250131","0D43"
"61850ID=2B6EB876","0414"
```

Standard Logical Nodes

Table F.28 lists the logical nodes that the SEL-2411 supports in the CFG, logical device, and the data attributes within.

Table F.28 Logical Device: CFG (Configuration) (Sheet 1 of 6)

Logical Node	Attribute	Data Source	Comment
Functional Constraint = CO			
DevIDLPHD1	Sim.Oper.ctlVal	LPHDSIM	IEC 61850 logical node for physical device simulation
GOLCCH2	RsStat.Oper.ctlVal	GORST[a]	Reset statistics for GOOSE traffic
IPLCCH1	RsStat.Oper.ctlVal	IPRST[a]	Reset statistics for general IP traffic (excluding GOOSE, SV, and 87L traffic)
LLN0	Mod.Oper.ctlVal[b]	I60MOD[c]	IEC 61850 mode/behavior control
LGOS*n*[d]	RsStat.Oper.ctlVal	GRST*n*[e]	Reset GOOSE statistics for Message *n*
Functional Constraint = DC			
DevIDLPHD1	PhyNam.hwRev	HWREV[f]	Hardware version of the relay mainboard
DevIDLPHD1	PhyNam.model	PARNUM	Relay part number string
DevIDLPHD1	PhyNam.serNum	SERNUM	Relay serial number string
DevIDLPHD1	SelLibId.val	61850ID	IEC 61850 Library Version Checksum contained in **ID** command.
LLN0	NamPlt.swRev	FID	Relay FID string
Functional Constraint = ST			
DevIDLPHD1	Sim.stVal	LPHDSIM	IEC 61850 logical node for physical device simulation
DevIDLPHD1	PhyHealth.stVal	EN?3:1[g]	Relay Enabled
GOLCCH2	ChLiv.stVal	GOCH[a]	Status of primary GOOSE channel

Table F.28 Logical Device: CFG (Configuration) (Sheet 2 of 6)

Logical Node	Attribute	Data Source	Comment
GOLCCH2	RedChLiv.stVal	GORCH[a]	Status of redundant GOOSE channel
GOLCCH2	RxCnt.actVal	GORX[a]	Number of frames received over the primary GOOSE channel
GOLCCH2	RedRxCnt.actVal	GORRX[a]	Number of frames received over the redundant GOOSE channel
GOLCCH2	TxCnt.actVal	GOTX[a]	Number of frames transmitted on both primary and redundant GOOSE channels
GOLCCH2	FerCh.stVal[h]	GOFER[a]	Frame error rate on the primary GOOSE channel
GOLCCH2	RedFerCh.stVal[h]	GORFER[a]	Frame error rate on the redundant GOOSE channel
GOLCCH2	RsStat.stVal	GORST[a]	Status of statistics reset for GOOSE traffic
IPLCCH1	ChLiv.stVal	IPCH[a]	Status of primary IP channel
IPLCCH1	RedChLiv.stVal	IPRCH[a]	Status of redundant IP channel
IPLCCH1	RxCnt.actVal	IPRX[a]	Number of frames received over the primary IP channel
IPLCCH1	RedRxCnt.actVal	IPRRX[a]	Number of frames received over the redundant IP channel
IPLCCH1	TxCnt.actVal	IPTX[a]	Number of frames transmitted on both primary and redundant IP channels
IPLCCH1	FerCh.stVal[h]	IPFER[a]	Frame error rate on the primary IP channel
IPLCCH1	RedFerCh.stVal[h]	IPRFER[a]	Frame error rate on the redundant IP channel
IPLCCH1	RsStat.stVal	IPRST[a]	Status of statistics reset for general IP traffic (excludes GOOSE, SV, and 87L traffic)
LLN0	Mod.stVal	I60MOD[c]	IEC 61850 mode/behavior status
LLN0	Health.stVal	EN?3:1[g]	Relay Enabled
LLN0	Loc.stVal	LOCAL	Control authority at local (bay) level
LGOS*n*[d]	NdsCom.stVal	GNCM*n*[e]	Subscription needs commissioning for GOOSE Message *n*. True if ConfRevNum does not match RxConfRevNum
LGOS*n*[d]	St.stVal	GST*n*[e]	Status of the subscription (True = active, False = not active) for GOOSE Message *n*
LGOS*n*[d]	SimSt.stVal	GSIM*n*[e]	Status showing that simulation messages are received and accepted for GOOSE Message *n*
LGOS*n*[d]	LastStNum.stVal	GLST*n*[e]	Last state number received (StNum) for GOOSE Message *n*
LGOS*n*[d]	LastSqNum.stVal	GLSQ*n*[e]	Last sequence number received (SqNum) for GOOSE Message *n*
LGOS*n*[d]	LastTal.stVal	GTAL*n*[e]	Last time-allowed-to-live received (TTL) for GOOSE Message *n*
LGOS*n*[d]	ConfRevNum.stVal	–[i]	Expected configuration revision number for GOOSE Message *n*
LGOS*n*[d]	RxConfRevNum.stVal	GCNF*n*[e]	Received configuration revision number for GOOSE Message *n*
LGOS*n*[d]	ErrSt.stVal[j]	GERR*n*[e]	Error status of the subscription for GOOSE Message *n*
LGOS*n*[d]	OosCnt.stVal	GOOS*n*[e]	Number of out-of-sequence (OOS) errors for GOOSE Message *n*
LGOS*n*[d]	TalCnt.stVal	GTLC*n*[e]	Number of time-allowed-to-live violations for GOOSE Message *n*
LGOS*n*[d]	DecErrCnt.stVal	GDER*n*[e]	Number of messages that failed decoding for GOOSE Message *n*
LGOS*n*[d]	BufOvflCnt.stVal	GBFO*n*[e]	Number of messages lost because of buffer overflow for GOOSE Message *n*
LGOS*n*[d]	MsgLosCnt.stVal	GMSL*n*[e]	Number of messages lost due to OOS errors (estimated) for GOOSE Message *n*
LGOS*n*[d]	MaxMsgLos.stVal	GMXM*n*[e]	Maximum number of sequential messages lost because of OOS error (estimated) for GOOSE Message *n*
LGOS*n*[d]	RsStat.stVal	GRST*n*[e]	Status of statistics reset for GOOSE messages
LTIM	TmDT.stVal	TMDT[a]	Indicates daylight-saving time is currently in effect at the IED location

Table F.28 Logical Device: CFG (Configuration) (Sheet 3 of 6)

Logical Node	Attribute	Data Source	Comment
LTMS	TmAcc.stVal	TSACC[a]	Number of significant bits in the FractionOfSecond (an attribute of Time-Stamp) 18: 4 µs accuracy (2^{-18}) 10: 1 ms accuracy (2^{-10}) 7: 10 ms accuracy (2^{-7}) 31: Unknown accuracy
LTMS	TmSrc.stVal	TSSRC[a]	Time-source identity If TmSrcTyp is SNTP, TmSrc indicates the IP address of the SNTP server For all other values of TmSrcTyp, TmSrc is set to "NA"
LTMS	TmSrcTyp.stVal	TSTYPE[a]	Type of the clock source as defined by Relay Word bits TSNTP and TIRIG 1: Unknown 2: SNTP 4: IRIG-B
LTMS	TmSyn.stVal	TSSYN[a]	Traceability of the reference time to which the IED is synchronized 2: GlobalAreaClock—TmSrcTyp is IRIG-B with IRIGC = C37.118 or TmSrcTyp is SNTP 1: LocalAreaClock—TmSrcTyp is IRIG-B with IRIGC ≠ C37.118 0: InternalClock—TmSrcTyp is unknown
LTMS	TmSynLkd.stVal	TSSYNLK[a]	Status of clock synchronization: 1: Locked 2: Unlocked for 0–10 seconds 3 Unlocked for 10–100 seconds 4: Unlocked for 100–1000 seconds 5: Unlocked for more than 1000 seconds
Functional Constraint = MX			
LGOS*n*[d]	TotDwnTm.instMag.f	GDWT*n*[e]	Total downtime in seconds for GOOSE Message *n*
LGOS*n*[d]	MaxDwnTm.instMag.f	GMXD*n*[e]	Maximum continuous downtime in seconds for GOOSE Message *n*
LSVS*n*[k]	NetwDly.instMag.f	SNET*n*[e]	Network delay in milliseconds for SV Stream *n*
LSVS*n*[k]	TotDwnTm.instMag.f	SDWT*n*[e]	Total downtime in seconds for SV Stream *n*
LSVS*n*[k]	MaxDwnTm.instMag.f	SMXD*n*[e]	Maximum continuous downtime in seconds for SV Stream *n*
LTMS	SelTmTosPer.instMag.f	TSPER[a]	Duration, in milliseconds, between two consecutive top-of-second points on the synchronized time; TmTosPer is set to 0 for time sources other than high-accuracy IRIG-B
Functional Constraint = SP			
GOLCCH2	NetMod.setVal	NETMODE	Port 5 network operating mode setting (1: Fixed, 2: Failover, 3: Switched, 4: PRP)
IPLCCH1	NetMod.setVal	NETMODE	Port 5 network operating mode setting (1: Fixed, 2: Failover, 3: Switched, 4: PRP)
LGOS*n*[d]	GoCBRef.setSrcRef	–[i]	Configured GOOSE control block reference for GOOSE Message *n*
LGOS*n*[d]	DatSet.setSrcRef	–[i]	Configured data set reference for GOOSE Message *n*
LGOS*n*[d]	GoID.setVal	–[i]	Configured ID for GOOSE Message *n*
LGOS*n*[d]	Addr.setVal	–[i]	Configured multicast MAC address for GOOSE Message *n*
LGOS*n*[d]	VlanID.setVal	–[i]	Configured VLAN ID for GOOSE Message *n*
LGOS*n*[d]	VlanPri.setVal	–[i]	Configured VLAN priority for GOOSE Message *n*
LGOS*n*[d]	AppID.setVal	–[i]	Configured APPID for GOOSE Message *n*
LTIM	TmOfsTmm.setVal	TMOFFS[a]	Offset of local time from UTC in minutes
LTIM	TmUseDT.setVal	TMUSEDT[a]	Set to True if daylight-saving time is enabled

Table F.28 Logical Device: CFG (Configuration) (Sheet 4 of 6)

Logical Node	Attribute	Data Source	Comment
LTIM	TmChgDT.setTm	TMCHGDT[a]	Local time of next change to daylight-saving time
LTIM	TmChgST.setTm	TMCHGST[a]	Local time of next change to standard time
Functional Constraint = SR			
LTRK1	SpcTrk.objRef	_[l]	ACSI reference to the SPC object targeted in the request
LTRK1	SpcTrk.serviceType	_[l, m]	Type of service requested or executed
LTRK1	SpcTrk.errorCode	_[l, n]	ACSI service error status
LTRK1	SpcTrk.ctlVal	_[l]	Control value in the request
LTRK1	SpcTrk.ctlNum	_[l]	Control number in the request
LTRK1	SpcTrk.origin.orCat	_[l]	Originator category value in the request
LTRK1	SpcTrk.origin.orIdent	_[l]	Originator identity value in the request
LTRK1	SpcTrk.T	_[l]	Time-stamp value in the request
LTRK1	SpcTrk.Test	_[l]	Test value in the request
LTRK1	SpcTrk.Check	_[l]	Check condition value in the request
LTRK1	SpcTrk.respAddCause	_[l]	AddCause value returned in the response
LTRK1	DpcTrk.objRef	_[l]	ACSI reference of the DPC object targeted in the request
LTRK1	DpcTrk.serviceType	_[l, m]	Type of service requested or executed
LTRK1	DpcTrk.errorCode	_[l, n]	ACSI service error status
LTRK1	DpcTrk.ctlVal	_[l]	Control value in the request
LTRK1	DpcTrk.ctlNum	_[l]	Control number in the request
LTRK1	DpcTrk.origin.orCat	_[l]	Originator category value in the request
LTRK1	DpcTrk.origin.orIdent	_[l]	Originator identity value in the request
LTRK1	DpcTrk.T	_[l]	Time-stamp value in the request
LTRK1	DpcTrk.Test	_[l]	Test value in the request
LTRK1	DpcTrk.Check	_[l]	Check condition value in the request
LTRK1	DpcTrk.respAddCause	_[l]	AddCause value returned in the response
LTRK1	EncTrk.objRef	_[l]	ACSI reference of the ENC object targeted in the request
LTRK1	EncTrk.serviceType	_[l, m]	Type of service requested or executed
LTRK1	EncTrk.errorCode	_[l, n]	ACSI service error status
LTRK1	EncTrk.ctlVal	_[l]	Control value in the request
LTRK1	EncTrk.ctlNum	_[l]	Control number in the request
LTRK1	EncTrk.origin.orCat	_[l]	Originator category value in the request
LTRK1	EncTrk.origin.orIdent	_[l]	Originator identity value in the request
LTRK1	EncTrk.T	_[l]	Time-stamp value in the request
LTRK1	EncTrk.Test	_[l]	Test value in the request
LTRK1	EncTrk.Check	_[l]	Check condition value in the request
LTRK1	EncTrk.respAddCause	_[l]	AddCause value returned in the response
LTRK1	BrcbTrk.objRef	_[l]	ACSI reference of the BRCB object targeted in the request
LTRK1	BrcbTrk.serviceType	_[l, m]	Type of service requested or executed
LTRK1	BrcbTrk.errorCode	_[l, n]	ACSI service error status
LTRK1	BrcbTrk.rptID	_[l]	RptID attribute value in the request or target BRCB object
LTRK1	BrcbTrk.rptEna	_[l]	RptEna attribute value in the request or target BRCB object

Table F.28 Logical Device: CFG (Configuration) (Sheet 5 of 6)

Logical Node	Attribute	Data Source	Comment
LTRK1	BrcbTrk.datSet	_[l]	DatSet attribute value in the target BRCB object
LTRK1	BrcbTrk.confRev	_[l]	ConfRev attribute value in the target BRCB object
LTRK1	BrcbTrk.optFlds	_[l]	OptFlds attribute value in the request or target BRCB object
LTRK1	BrcbTrk.bufTm	_[l]	BufTm attribute value in the request or target BRCB object
LTRK1	BrcbTrk.sqNum	_[l]	SqNum attribute value in the target BRCB object
LTRK1	BrcbTrk.trgOps	_[l]	TrgOps attribute value in the request or target BRCB object
LTRK1	BrcbTrk.intgPd	_[l]	IntgPd attribute value in the request or target BRCB object
LTRK1	BrcbTrk.gi	_[l]	GI attribute value in the request or target BRCB object
LTRK1	BrcbTrk.purgeBuf	_[l]	PurgeBuf attribute value in the request or target BRCB object
LTRK1	BrcbTrk.entryID	_[l]	EntryID attribute value in the request or target BRCB object
LTRK1	BrcbTrk.timeOfEntry	_[l]	TimeOfEntry attribute value in the target BRCB object
LTRK1	UrcbTrk.objRef	_[l]	ACSI reference of the URCB object targeted in the request
LTRK1	UrcbTrk.serviceType	_[l, m]	Type of service requested or executed
LTRK1	UrcbTrk.errorCode	_[l, n]	ACSI service error status
LTRK1	UrcbTrk.rptID	_[l]	RptID attribute value in the request or target URCB object
LTRK1	UrcbTrk.rptEna	_[l]	RptEna attribute value in the request or target URCB object
LTRK1	UrcbTrk.resv	_[l]	Resv attribute value in the request or target URCB object
LTRK1	UrcbTrk.datSet	_[l]	DatSet attribute value in the target URCB object
LTRK1	UrcbTrk.confRev	_[l]	ConfRev attribute value in the target URCB object
LTRK1	UrcbTrk.optFlds	_[l]	OptFlds attribute value in the request or target URCB object
LTRK1	UrcbTrk.bufTm	_[l]	BufTm attribute value in the request or target URCB object
LTRK1	UrcbTrk.sqNum	_[l]	SqNum attribute value in the target URCB object
LTRK1	UrcbTrk.trgOps	_[l]	TrgOps attribute value in the request or target URCB object
LTRK1	UrcbTrk.intgPd	_[l]	IntgPd attribute value in the request or target URCB object
LTRK1	UrcbTrk.gi	_[l]	GI attribute value in the request or target URCB object
LTRK1	APCFTrk.objRef	_[l]	ACSI reference of the APCF object targeted in the request
LTRK1	APCFTrk.serviceType	_[l, m]	Type of service requested or executed
LTRK1	APCFTrk.errorCode	_[l, n]	ACSI service error status
LTRK1	APCFTrk.rptID	_[l]	RptID attribute value in the request or target APCF object
LTRK1	APCFTrk.rptEna	_[l]	RptEna attribute value in the request or target APCF object
LTRK1	APCFTrk.resv	_[l]	Resv attribute value in the request or target APCF object
LTRK1	APCFTrk.datSet	_[l]	DatSet attribute value in the target APCF object
LTRK1	APCFTrk.confRev	_[l]	ConfRev attribute value in the target APCF object
LTRK1	APCFTrk.optFlds	_[l]	OptFlds attribute value in the request or target APCF object
LTRK1	APCFTrk.bufTm	_[l]	BufTm attribute value in the request or target APCF object
LTRK1	APCFTrk.sqNum	_[l]	SqNum attribute value in the target APCF object
LTRK1	APCFTrk.trgOps	_[l]	TrgOps attribute value in the request or target APCF object
LTRK1	APCFTrk.intgPd	_[l]	IntgPd attribute value in the request or target APCF object
LTRK1	APCFTrk.gi	_[l]	GI attribute value in the request or target APCF object
LTRK1	BSCTrk.objRef	_[l]	ACSI reference of the BSC object targeted in the request
LTRK1	BSCTrk.serviceType	_[l, m]	Type of service requested or executed

Table F.28 Logical Device: CFG (Configuration) (Sheet 6 of 6)

Logical Node	Attribute	Data Source	Comment
LTRK1	BSCTrk.errorCode	_[l, n]	ACSI service error status
LTRK1	BSCTrk.rptID	_[l]	RptID attribute value in the request or target BSC object
LTRK1	BSCTrk.rptEna	_[l]	RptEna attribute value in the request or target BSC object
LTRK1	BSCTrk.resv	_[l]	Resv attribute value in the request or target BSC object
LTRK1	BSCTrk.datSet	_[l]	DatSet attribute value in the target BSC object
LTRK1	BSCTrk.confRev	_[l]	ConfRev attribute value in the target BSC object
LTRK1	BSCTrk.optFlds	_[l]	OptFlds attribute value in the request or target BSC object
LTRK1	BSCTrk.bufTm	_[l]	BufTm attribute value in the request or target BSC object
LTRK1	BSCTrk.sqNum	_[l]	SqNum attribute value in the target BSC object
LTRK1	BSCTrk.trgOps	_[l]	TrgOps attribute value in the request or target BSC object
LTRK1	BSCFTrk.intgPd	_[l]	IntgPd attribute value in the request or target BSC object
LTRK1	BSCFTrk.gi	_[l]	GI attribute value in the request or target BSC object

[a] Internal data source and not available to the user.
[b] MMS controls to Mod.Oper are only accepted if IEC 61850 Mode/Behavior is enabled on the relay. Refer to IEC 61850 Mode/Behavior on page F.24 for more details.
[c] I60MOD is an internal data source derived from the I850MOD analog quantity and is not available to the user.
[d] Where n = 1–64, corresponding to the first 64 GOOSE message subscriptions.
[e] Internal data source not available to the user.
[f] HWREV is an internal data source and is not available to the user.
[g] If enabled, value = 1. If disabled, value = 3.
[h] When NETMODE = PRP the value indicates the number of duplicate frames not received for every 1000 PRP tagged frames received.
[i] Data source defined in the IEC 61850 Configured IED Description (CID) file.
[j] See Table 7.36 for a description of each enumeration.
[k] Where n = 1–7, corresponding to each of the seven possible SV subscriptions.
[l] The value depends on the ACSI service type requested, the target object, and the error status.
[m] Refer toTable F.6 IEC 61850 service type enumeration.
[n] Refer to Table F.7 IEC 61850 ACSI service error.

Logical Node Extensions

The following logical nodes (LNs) and data classes were created in this device as extensions to the IEC 61850 standard, in accordance with IEC 61850 guidelines.

Table F.29 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.30 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.30 Thermal Metering Data

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
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.33 through *Table F.31* show the 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.

For additional details regarding implemented Logical Nodes, see the Model Implementation Conformance Statement (MICS) for this device. The MICS lists implemented logical nodes, newly created logical nodes, and SEL-extended local nodes (with their data objects). The MICS also lists new and/or extended Enumeration types.

The MICS for this device can be found at selinc.com.

Table F.31 shows the LNs associated with annunciation element defined as Logical Device ANN.

Table F.31 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)
MVGGIO35	AnIn33.mag to AnIn64.mag	Math Variables (MV33 to MV64)
AINCGGIO26	AnIn01.mag to AnIn08.mag	Analog Inputs (AI301 to AI308)—Slot C
AINDGGIO27	AnIn01.mag to AnIn08.mag	Analog Inputs (AI401 to AI408)—Slot D
AINEGGIO28	AnIn01.mag to AnIn08.mag	Analog Inputs (AI501 to AI508)—Slot E
AINZGGIO29	AnIn01.mag to AnIn08.mag	Analog Inputs (AI601 to AI608)—Slot Z
RAGGIO30	Ra001.instMag to Ra032.instMag	Remote Analogs (RA001 to RA032)
RAGGIO31	Ra033.instMag to Ra064.instMag	Remote Analogs (RA033 to RA064)
RAGGIO32	Ra065.instMag to Ra096.instMag	Remote Analogs (RA065 to RA096)
RAGGIO33	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 Ind64.stVal	SELogic® Variables (SV01 to SV64)
SVTGGIO4	Ind01.stVal to Ind64.stVal	SELogic Variable Timers (SV01T to SV64T)
LTGGIO5	Ind01.stVal to Ind32.stVal	Latch Bits (LT01 to LT32)
TLEDGGIO6	Ind01.stVal to Ind08.stVal	Target LEDs (ENABLED, TLED_00 to TLED_06)
PLEDGGIO7	Ind01.stVal	Pushbutton LED (PB01_LED)
PLEDGGIO7	Ind02.stVal	Pushbutton LED (PB02_LED)
PLEDGGIO7	Ind03.stVal	Pushbutton LED (PB03_LED)
PLEDGGIO7	Ind04.stVal	Pushbutton LED (PB04_LED)
PLEDGGIO7	Ind05.stVal	Pushbutton LED (PB01BLED)
PLEDGGIO7	Ind06.stVal	Pushbutton LED (PB02BLED)
PLEDGGIO7	Ind07.stVal	Pushbutton LED (PB03BLED)
PLEDGGIO7	Ind08.stVal	Pushbutton LED (PB04BLED)
PLEDGGIO7	Ind09.stVal	Pushbutton LED (PB05_LED)
PLEDGGIO7	Ind10.stVal	Pushbutton LED (PB06_LED)
PLEDGGIO7	Ind11.stVal	Pushbutton LED (PB07_LED)
PLEDGGIO7	Ind12.stVal	Pushbutton LED (PB08_LED)
PLEDGGIO7	Ind13.stVal	Pushbutton LED (PB05BLED)
PLEDGGIO7	Ind14.stVal	Pushbutton LED (PB06BLED)
PLEDGGIO7	Ind15.stVal	Pushbutton LED (PB07BLED)
PLEDGGIO7	Ind16.stVal	Pushbutton LED (PB08BLED)
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)

Table F.31 Logical Device: ANN (Annunciation) (Sheet 2 of 2)

Logical Nodes	Status or Measurand	Device Word Bits or Analog Quantities
INCGGIO13	Ind01.stVal to Ind14.stVal	Digital Inputs (IN301 to IN314)—Slot C
INCEGGIO14	Ind01.stVal to Ind14.stVal	Edge Trigger Operator (IN301E to IN314E)—Slot C
OUTCGGIO15	Ind01.stVal to Ind08.stVal	Digital Outputs (OUT301 to OUT308)—Slot C
INDGGIO16	Ind01.stVal to Ind14.stVal	Digital Inputs (IN401 to IN414)—Slot D
INDEGGIO17	Ind01.stVal to Ind14.stVal	Edge Trigger Operator (IN401E to IN414E)—Slot D
OUTDGGIO18	Ind01.stVal to Ind08.stVal	Digital Outputs (OUT401 to OUT408)—Slot D
INEGGIO19	Ind01.stVal to Ind14.stVal	Digital Inputs (IN501 to IN514)—Slot E
INEEGGIO20	Ind01.stVal to Ind14.stVal	Edge Trigger Operator (IN501E to IN514E)—Slot E
OUTEGGIO21	Ind01.stVal to Ind08.stVal	Digital Outputs (OUT501 to OUT508)—Slot E
INZGGIO22	Ind01.stVal to Ind14.stVal	Digital Inputs (IN601 to IN614)—Slot Z
INZEGGIO23	Ind01.stVal to Ind14.stVal	Edge Trigger Operator (IN601E to IN614E)—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)
POCGGIO26	IAHW1.stVal to ICHAL.stVal	Phase Overcurrent warnings and alarms
NOCGGIO27	INHW1.stVal to INHAL.stVal	Neutral Overcurrent warnings and alarm
XPOCGGIO28	IAXHW1.stVal to ICXHAL.stVAl	Auxiliary Phase Overcurrent warnings and alarms
PUVGGIO29	VALW1.stVal to VCLAL.stVal	Phase Undervoltage warnings and alarms
PPUVGGIO30	VABLW1.stVal to VCALAL.stVal	Phase-to-Phase Undervoltage warnings and alarms
PPOVGGIO31	VABHW1.stVal to VCAHAL.stVal	Phase-to-Phase Overvoltage warnings and alarms
POVGGIO32	VAHW1.stVal to VCHAL.stVal	Phase Overvoltage warnings and alarms
AINCGGIO33	AI301LW1.stVal to AI308LAL.stVal	Slot C Analog Inputs Low warnings and alarms
AINDGGIO34	AI401LW1.stVal to AI408LAL.stVal	Slot D Analog Inputs Low warnings and alarms
AINEGGIO35	AI501LW1.stVal to AI508LAL.stVal	Slot E Analog Inputs Low warnings and alarms
AINZGGIO36	AI601LW1.stVal to AI608LAL.stVal	Slot Z Analog Inputs Low warnings and alarms
AINCGGIO37	AI301HW1.stVal to AI308HAL.stVal	Slot C Analog Inputs High warnings and alarms
AINDGGIO38	AI401HW1.stVal to AI408HAL.stVal	Slot D Analog Inputs High warnings and alarms
AINEGGIO39	AI501HW1.stVal to AI508HAL.stVal	Slot E Analog Inputs High warnings and alarms
AINZGGIO40	AI601HW1.stVal to AI608HAL.stVal	Slot Z Analog Inputs High warnings and alarms
ETHGGIO41	LINKA.stVal to LINKFAIL.stVAl	Port 1 (Ethernet) Link A and Link B status

Table F.32 shows the LNs associated with control elements defined as Logical Device CON.

Table F.32 Logical Device: CON (Control) (Sheet 1 of 3)

Logical Nodes	Status and Control	Device Word Bits
RBGGIO1	**Status** SPCSO01.stVal to SPCSO08.stVal **Control** SPCSO01.Oper.ctlVal to SPCSO08.Oper.ctlVal	Remote Bits (RB01 to RB08)
RBGGIO2	**Status** SPCSO09.stVal to SPCSO16.stVal **Control** SPCSO09.Oper.ctlVal to SPCSO16.Oper.ctlVal	Remote Bits (RB09 to RB16)

Table F.32 Logical Device: CON (Control) (Sheet 2 of 3)

Logical Nodes	Status and Control	Device Word Bits
RBGGIO3	**Status** SPCSO17.stVal to SPCSO24.stVal **Control** SPCSO17.Oper.ctlVal to SPCSO24.Oper.ctlVal	Remote Bits (RB17 to RB24)
RBGGIO4	**Status** SPCSO25.stVal to SPCSO32.stVal **Control** SPCSO25.Oper.ctlVal to SPCSO32.Oper.ctlVal	Remote Bits (RB25 to RB32)
PRBGGIO1	**Status** SPCSO01.stVal to SPCSO08.stVal **Control** SPCSO01.Oper.ctlVal to SPCSO08.Oper.ctlVal	Pulse Remote Bits (RB01:RB01 to RB08:RB08)[a]
PRBGGIO2	**Status** SPCSO09.stVal to SPCSO16.stVal **Control** SPCSO09.Oper.ctlVal to SPCSO16.Oper.ctlVal	Pulse Remote Bits (RB09:RB09 to RB16:RB16)[a]
PRBGGIO3	**Status** SPCSO17.stVal to SPCSO24.stVal **Control** SPCSO17.Oper.ctlVal to SPCSO24.Oper.ctlVal	Pulse Remote Bits (RB17:RB17 to RB24:RB24)[a]
PRBGGIO4	**Status** SPCSO25.stVal to SPCSO32.stVal **Control** SPCSO25.Oper.ctlVal to SPCSO32.Oper.ctlVal	Pulse Remote Bits (RB25:RB25 to RB32:RB32)[a]
ACVGGIO1	**Status** AnOut01.mxVal.f to AnOut16.mxVal.f **Control** AnOut01.Oper.ctlVal.f to AnOut16.Oper.ctlVal.f	Analog Control Variables (ACV01 to ACV16)
ACVGGIO2	**Status** AnOut17.mxVal.f to AnOut32.mxVal.f **Control** AnOut17.Oper.ctlVal.f to AnOut32.Oper.ctlVal.f	Analog Control Variables (ACV17 to ACV32)
CSWI1	**Status** CSWI1.pos.stval **Control** CSWI1.pos.ctlval	SW01CC:SW01OC
CSWI2	**Status** CSWI2.pos.stval **Control** CSWI2.pos.ctlval	SW02CC:SW02OC
CSWI3	**Status** CSWI3.pos.stval **Control** CSWI3.pos.ctlval	SW03CC:SW03OC
CSWI4	**Status** CSWI4.pos.stval **Control** CSWI4.pos.ctlval	SW04CC:SW04OC
CSWI5	**Status** CSWI5.pos.stval **Control** CSWI5.pos.ctlval	SW05CC:SW05OC

Table F.32 Logical Device: CON (Control) (Sheet 3 of 3)

Logical Nodes	Status and Control	Device Word Bits
ATCC1	**Status**	
	ATCC1.Loc.stval	LOCAL
	ATCC1.HiTapPos.stVal	TP_MAX
	ATCC1.LoTapPos.stVal	TP_MIN
	ATCC1.TapOpR.stVal	RSE_CTRL
	ATCC1.TapOpL.stVal	LWR_CTRL
	ATCC1.EndPosR.stVal	TPOS_MAX
	ATCC1.EndPosL.stVal	TPOS_MIN
	ATCC1.TapChg.valWTr.posVal	TAP_POS
	ATCC1.ParOp.stVal	PAR_OP
	Control	
	ATCC1.TapChg.oper.ctlVal	RSE_850:LWR_850
	ATCC1.ParOp.stVal	PAROP850
	Measurand	
	ATCC1.CtlV.instMag.f	LIN_VOLT
	Configuration	
	ATCC1.TapChg.persistent	---

[a] The first remote bit in the pulse remote bit pair asserts for one processing cycle when a 1 is written to the ctlVal, and the second remote bit asserts for one processing cycle when a 0 is written to the ctlVal. Additionally, the first or second bit can be assigned the value of NOOP if no operation is desired. For example, if the pair is defined as RB01:NOOP, RB01 asserts for one processing cycle when a 1 is written to the ctlVal and no operation is executed when a 0 is written to the ctlVal.

Table F.33 shows the LNs associated with measuring elements defined as Logical Device MET.

Table F.33 Logical Device: MET (Metering) (Sheet 1 of 5)

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
METXMMXU1	A.phsA.instCVal.mag	Instantaneous, Current Magnitude, Phase A	e
METXMMXU1	A.phsB.instCVal.mag	Instantaneous, Current Magnitude, Phase B	e

Table F.33 Logical Device: MET (Metering) (Sheet 2 of 5)

Logical Nodes	Measurand	Comment	
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

Table F.33 Logical Device: MET (Metering) (Sheet 3 of 5)

Logical Nodes	Measurand	Comment	
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
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

Table F.33 Logical Device: MET (Metering) (Sheet 4 of 5)

Logical Nodes	Measurand	Comment	
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			
METMSTA1	MaxHz	Maximum Frequency	d, e
METMSTA1	MaxA.phsA.instMag	Maximum, Current, A-phase	d
METMSTA1	MaxA.phsB.instMag	Maximum, Current, B-phase	d
METMSTA1	MaxA.phsC.instMag	Maximum, Current, C-phase	d
METMSTA1	MaxA.neut.instMag	Maximum, Current, Neutral	d
METMSTA1	MaxA.res.instMag	Maximum, Current, Residual	d
METMSTA1	MaxA.SeqA.instMag	Maximum, Current, Negative Sequence	d
METXMSTA2	MaxA.phsA.instMag	Maximum, Current, AX-phase	e
METXMSTA2	MaxA.phsB.instMag	Maximum, Current, BX-phase	e
METXMSTA2	MaxA.phsC.instMag	Maximum, Current, CX-phase	e
METXMSTA2	MaxA.res.instMag	Maximum, Current, Residual X	e
METXMSTA2	MaxA.SeqA.instMag	Maximum, Current, Negative Sequence X	e
METMSTA1	MaxPhV.phA.instMag	Maximum, Voltage, A-phase-to-neutral	e, f
METMSTA1	MaxPhV.phB.instMag	Maximum, Voltage, B-phase-to-neutral	e, f
METMSTA1	MaxPhV.phC.instMag	Maximum, Voltage, C-phase-to-neutral	e, f
METMSTA1	MaxP2PV.phAB.instMag	Maximum, Voltage, A-to-B-phase	e, f
METMSTA1	MaxP2PV.phBC.instMag	Maximum, Voltage, B-to-C-phase	e, f
METMSTA1	MaxP2PV.phCA.instMag	Maximum, Voltage, C-to-A-phase	e, f
METMSTA1	MaxVA	Maximum, Apparent Power	g
METMSTA1	MaxW	Maximum, Real Power	g
METMSTA1	MaxVAr	Maximum, Reactive Power	g
METXMSTA2	MaxVA	Maximum, Apparent Power X	e
METXMSTA2	MaxW	Maximum, Real Power X	e
METXMSTA2	MaxVAr	Maximum, Reactive Power X	e
Minimum Metering			
METMSTA1	MinHz	Minimum Frequency	d, e
METMSTA1	MinA.phsA.instMag	Minimum, Current, A-phase	d
METMSTA1	MinA.phsB.instMag	Minimum, Current, B-phase	d
METMSTA1	MinA.phsC.instMag	Minimum, Current, C-phase	d

Table F.33 Logical Device: MET (Metering) (Sheet 5 of 5)

Logical Nodes	Measurand	Comment	
METMSTA1	MinA.neut.instMag	Minimum, Current, Neutral	d
METMSTA1	MinA.res.instMag	Minimum, Current, Residual	d
METMSTA1	MinA.SeqA.instMag	Minimum, Current, Negative Sequence	d
METXMSTA2	MinA.phsA.instMag	Minimum, Current, AX-phase	e
METXMSTA2	MinA.phsB.instMag	Minimum, Current, BX-phase	e
METXMSTA2	MinA.phsC.instMag	Minimum, Current, CX-phase	e
METXMSTA2	MinA.res.instMag	Minimum, Current, Residual X	e
METXMSTA2	MinA.SeqA.instMag	Minimum, Current, Negative Sequence X	e
METMSTA1	MinPhV.phA.instMag	Minimum, Voltage, A-phase-to-neutral	e, f
METMSTA1	MinPhV.phB.instMag	Minimum, Voltage, B-phase-to-neutral	e, f
METMSTA1	MinPhV.phC.instMag	Minimum, Voltage, C-phase-to-neutral	e, f
METMSTA1	MinP2PV.phAB.instMag	Minimum, Voltage, A-to-B-phase	e, f
METMSTA1	MinP2PV.phBC.instMag	Minimum, Voltage, B-to-C-phase	e, f
METMSTA1	MinP2PV.phCA.instMag	Minimum, Voltage, C-to-A-phase	e, f
METMSTA1	MinVA	Minimum, Apparent Power	g
METMSTA1	MinW	Minimum, Real Power	g
METMSTA1	MinVAr	Minimum, Reactive Power	g
METXMSTA2	MinVA	Minimum, Apparent Power X	e
METXMSTA2	MinW	Minimum, Real Power X	e
METXMSTA2	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.

SEL Nameplate Data

The CID file contains information that describes the physical device attributes according to IEC 61850 standards. The LN0 logical node of each logical device contains the Nameplate DOI (instantiated data object) with the following data.

Table F.34 SEL Nameplate Data

Data Attribute	Value
vendor	“SEL”
swRev	Contents of FID string from **ID** command
d	Description of LD
configRev	Always 0
1dNs	IEC 61850-7-4:2007B

Architect Flexible Server Model (FSM)

Architect provides an interface to build custom ICD files for Ed2.1 devices that have ICD files ClassFileVersion 010 or later. SEL devices have a default ICD file available in Architect, but you may need to add IEC 61850 optional objects to the default logical nodes or add additional logical nodes based on your application.

You may need to customize the SCL server model of a device to model functions configured in SELogic control equations, and make them available through MMS or GOOSE. Various functions, such as automatic tap changer control, gas alarm for GIS, etc., can be configured in SELogic programming but require specific customization to implement in IEC 61850.

For example, the SIML logical node models insulation medium supervision (liquid). Transformers or tap changers use oil as an insulator, and sensors or measuring devices may be wired into relay contact inputs. Because the connection of these sensors into a device are application-specific, they are not included in the default ICD file. The FSM provides an interface to add and customize the SIML logical node.

Begin by adding a device to the Project Editor in Architect and selecting an existing ICD file, (ClassFileVersion 010 or later). Select the **Server Model** tab to view the logical devices, logical nodes, and data objects that exist in the default ICD file. Although logical nodes can be added to an existing logical device, SEL recommends adding a new logical device for customized logical nodes. If SEL releases new logical nodes or features in the future, the merge operation between default and customized files is less prone to inadvertent removal of the customized logical nodes.

The default ICD file in this example contains five logical devices: CFG, MET, CON, and ANN. To add a logical device, select the **+ Add LDevice** button in the logical device pane. Provide an instance name for the new logical device. The new logical device is named XFMR, as shown in *Figure F.17*.

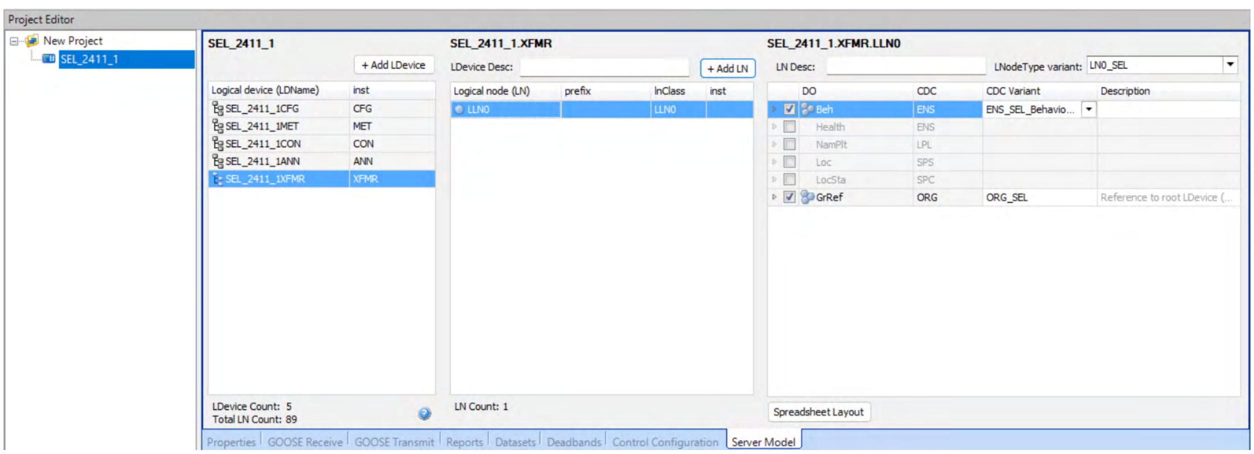


Figure F.17 Server Model View in Architect

Every logical device contains an LLN0 or common logical node that provides common information. To add another logical node, either right-click in the logical node pane or select the **+ Add LN** button. This opens a pop-up window that contains a list of logical nodes that are present in the Architect Library. There may be more than one variant of each logical node, where each variant may have different data objects included. In this case, only one SIML logical node is added to this file (see *Figure F.18*).

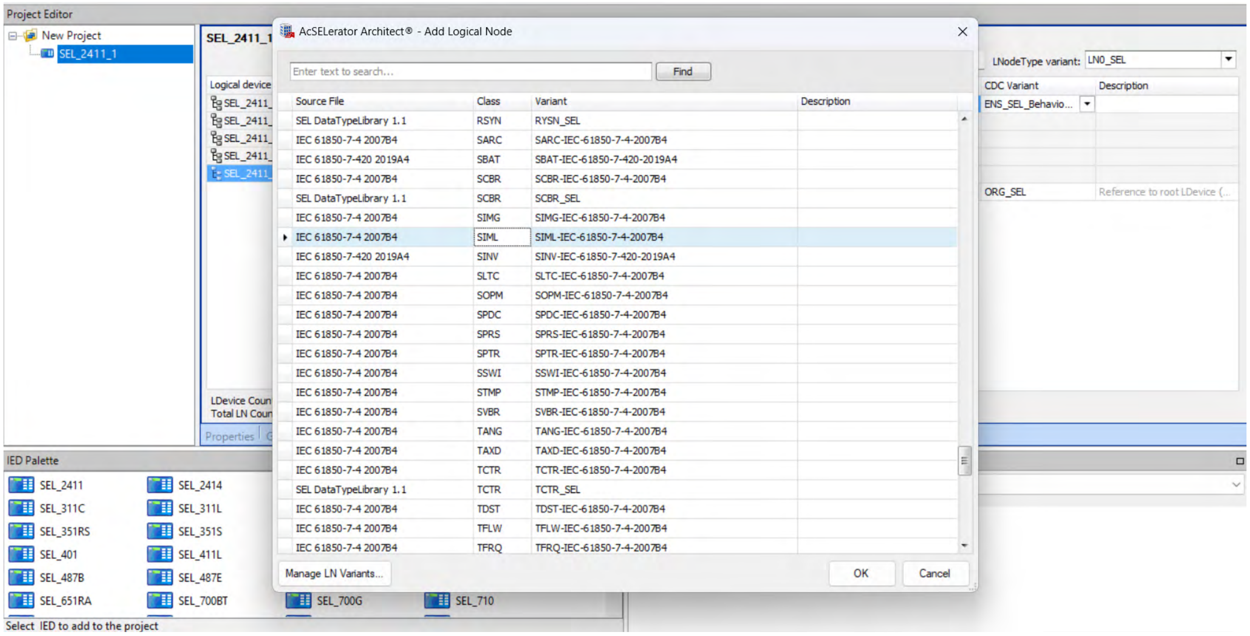


Figure F.18 Add a Logical Node From the Architect Library

Once the logical node is added to the logical device, select the logical node, which will display the data objects available in the data object pane (see *Figure F.19*). Add the TmpAlm and GasInsAlm objects by selecting the box to the left of the attribute name. Each object conforms to a particular CDC defined for that object in the IEC 61850 standard. In this example, both TmpAlm and GasInsAlm are single point status (SPS) data objects. *Table F.2* lists the CDCs supported by the SEL-2440.

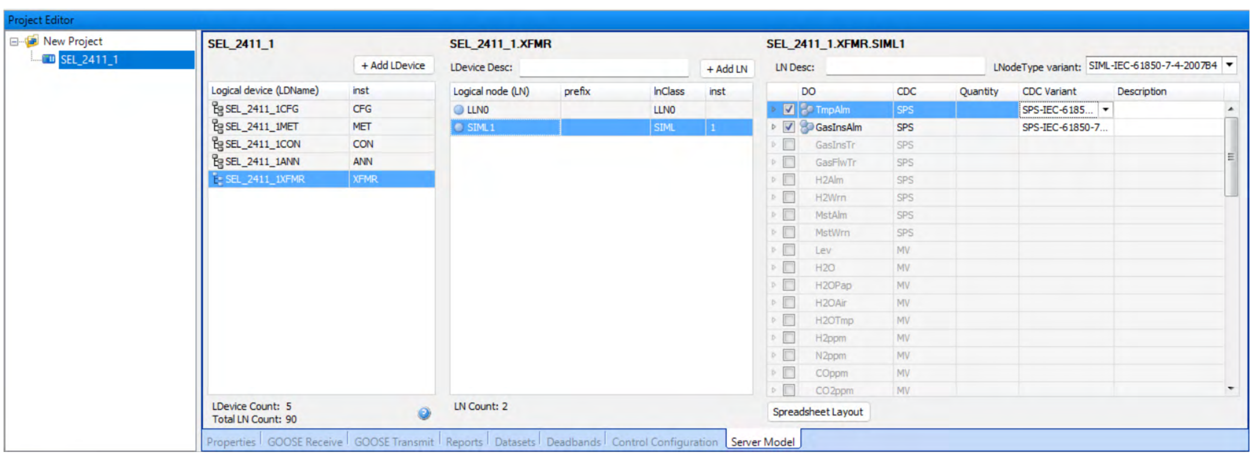


Figure F.19 Add Data Objects to a Logical Node

Each object contains a list of attributes. TmpAlm, when expanded, lists the associated attributes. In this example, the temperature alarm is wired to Input 6 on I/O Card 2, which is represented by Relay Word bit IN206. The association between TmpAlm.stVal (status value) and IN206 must be made by entering the Relay Word bit name following the db prompt in the RWB/AQ column, as shown in *Figure F.20*.

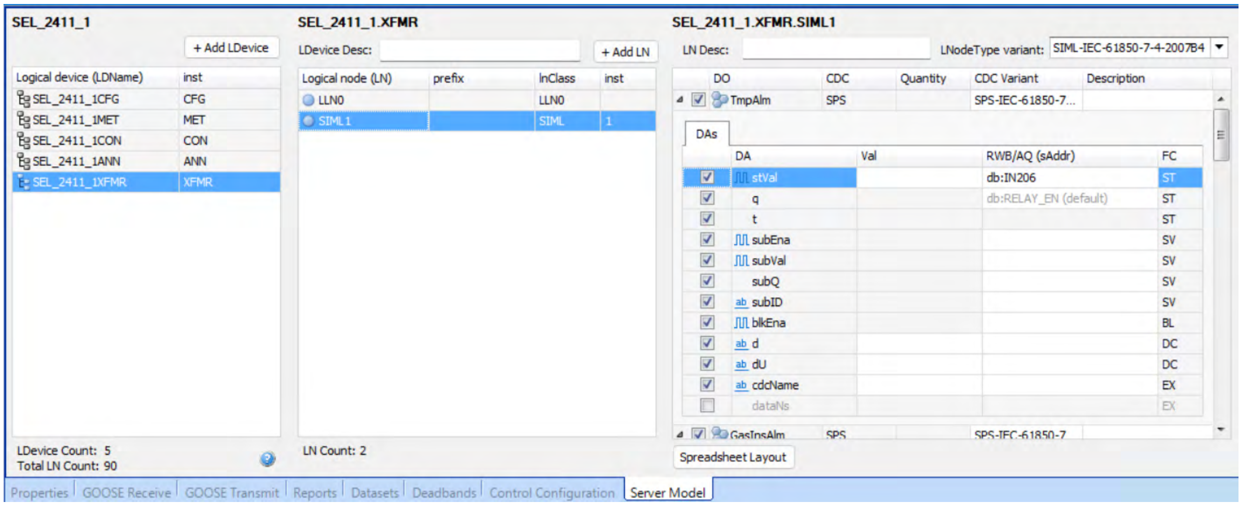
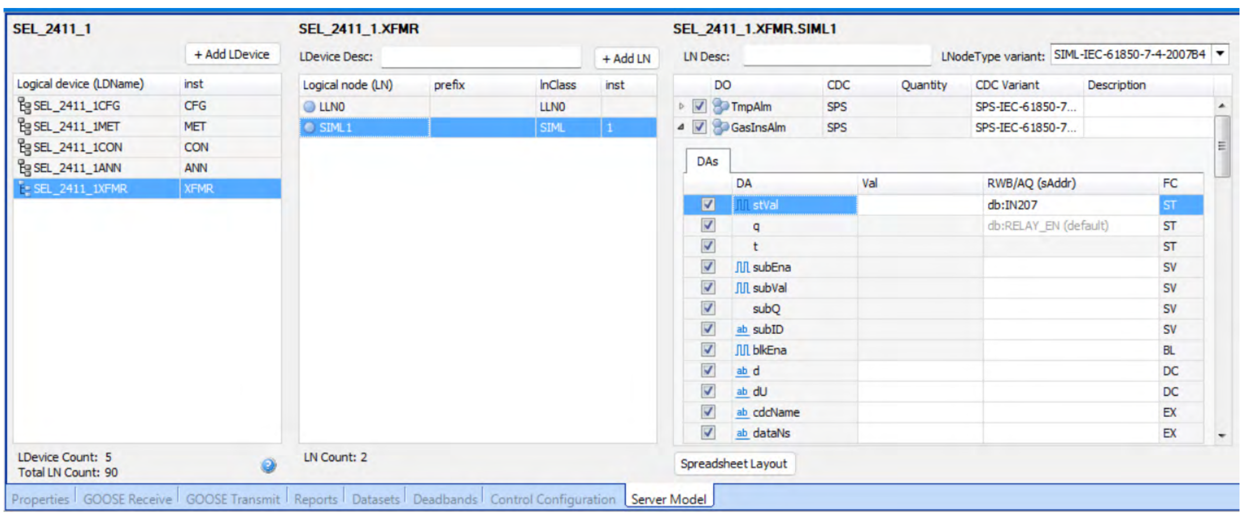


Figure F.20 Associate a Data Attributes Value to a Relay Variable

Follow the same procedure to configure the Gas Insulation Alarm (GasInsAlm.stVal), which in this example is wired to Input 7 on I/O Card 2 and is represented by Relay Word bit IN207.



If desired, other logical nodes can be added to the new XFMR logical device. Save the configuration of the project and device. The new logical node objects and attributes are available for adding to data sets that may be sent in a GOOSE message or added to a report, as shown in *Figure F.21*.

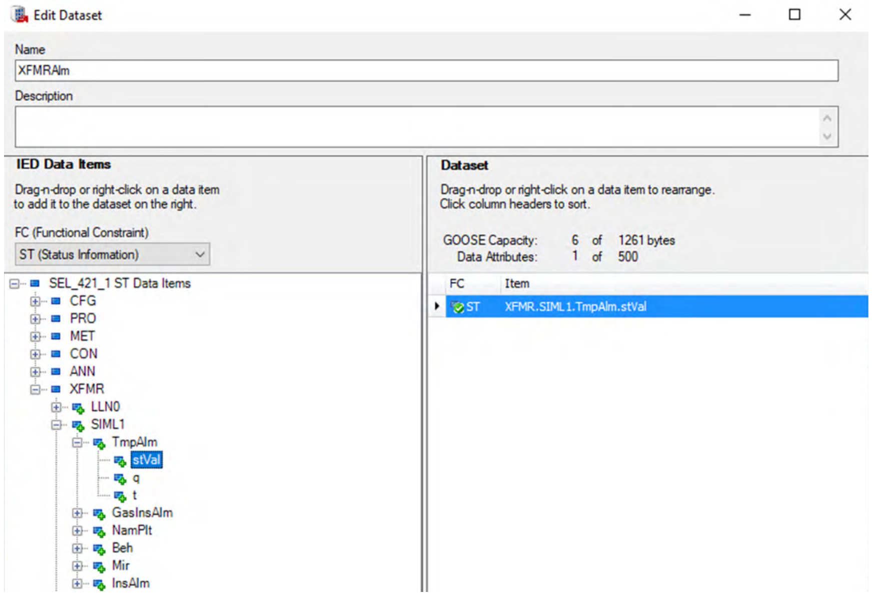


Figure F.21 Data Set Mapping From an FSM Created Attribute

Protocol Implementation Conformance Statement

The following tables are as shown in the IEC 61850 standard, Part 8-1, Section 24. Because the standard explicitly dictates which services and functions must be implemented to achieve conformance, only the optional services and functions are listed.

Table F.35 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.36 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.37* 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.37 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		
output		
takeControl		
relinquishControl		
defineSemaphore		
deleteSemaphore		
reportPoolSemaphoreStatus		
reportSemaphoreStatus		
initiateDownloadSequence		
downloadSegment		
terminateDownloadSequence		
initiateUploadSequence		
uploadSegment		
terminateUploadSequence		
requestDomainDownload		
requestDomainUpload		
loadDomainContent		
storeDomainContent		
deleteDomain		
getDomainAttributes		Y
createProgramInvocation		

Table F.37 MMS Service Supported Conformance (Sheet 2 of 3)

MMS Service Supported CBB	Client-CR Supported	Server-CR Supported
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		
fileDirectory		
unsolicitedStatus		
informationReport		Y
eventNotification		
attachToEventCondition		
attachToSemaphore		
conclude		Y
cancel		Y

Table F.37 MMS Service Supported Conformance (Sheet 3 of 3)

MMS Service Supported CBB	Client-CR Supported	Server-CR Supported
getDataExchangeAttributes		
exchangeData		
defineAccessControlList		
getAccessControlListAttributes		
reportAccessControlledObjects		
deleteAccessControlList		
alterAccessControl		
ReconfigureProgramInvocation		

Table F.38 lists specific settings for the MMS parameter Conformance Building Block (CBB).

Table F.38 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.39 Alternate Access Selection Conformance Statement

Alternate Access Selection	Client-CR Supported	Server-CR Supported
accessSelection		Y
component index indexRange allElements		Y
alternateAccess		Y
selectAccess		Y
component index indexRange allElements		Y

Table F.40 VariableAccessSpecification Conformance Statement

VariableAccessSpecification	Client-CR Supported	Server-CR Supported
listOfVariable		Y
variableSpecification alternateAccess		Y Y
variableListName		Y

Table F.41 VariableSpecification Conformance Statement

VariableSpecification	Client-CR Supported	Server-CR Supported
name		Y
address		
variableDescription		
scatteredAccessDescription		
invalidated		

Table F.42 Read Conformance Statement

Read	Client-CR Supported	Server-CR Supported
Request		
specificationWithResult variableAccessSpecification		
Response		
variableAccessSpecification listOfAccessResult		Y Y

Table F.43 GetVariableAccessAttributes Conformance Statement

GetVariableAccessAttributes	Client-CR Supported	Server-CR Supported
Request		
name address		
Response		
mmsDeletable address typeSpecification		

Table F.44 DefineNamedVariableList Conformance Statement

DefineNamedVariableList	Client-CR Supported	Server-CR Supported
Request		
variableListName listOfVariable variableSpecification alternateAccess		
Response		

Table F.45 GetNamedVariableListAttributes Conformance Statement

GetNamedVariableListAttributes	Client-CR Supported	Server-CR Supported
Request		
ObjectName		
Response		
mmsDeletable listOfVariable variableSpecification		Y Y Y
alternateAccess		Y

Table F.46 DeleteNamedVariableList Statement

DeleteNamedVariableList	Client-CR Supported	Server-CR Supported
Request		
Scope listOfVariableListName domainName		
Response		
numberMatched numberDeleted		
DeleteNamedVariableList-Error		

GOOSE Services Conformance Statement

Table F.47 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.48 ACSI Basic Conformance Statement

		Client/Subscriber	Server/Publisher	SEL-2411 Support
Client-Server Roles				
B11	Server side (of Two-Party Application-Association)	-	c1[a]	YES
B12	Client side (of Two-Party Application-Association)	c1[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
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.49 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

Table F.49 ACSI Models Conformance Statement (Sheet 2 of 2)

		Client/Subscriber	Server/Publisher	SEL-2411 Support
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				
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]	
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.50 ACSI Services Conformance Statement (Sheet 1 of 4)

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

Table F.50 ACSI Services Conformance Statement (Sheet 2 of 4)

Services		AA: TP/MC	Client/ Subscriber	Service/ Publisher	SEL-2411 Support
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
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]	

Table F.50 ACSI Services Conformance Statement (Sheet 3 of 4)

Services		AA: TP/MC	Client/ Subscriber	Service/ Publisher	SEL-2411 Support
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.50 ACSI Services Conformance Statement (Sheet 4 of 4)

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).

Potential Client and Automation Application Issues With Ed2 and 2.1 Upgrades

The following are issues that IEC 61850 Ed1-based client or automation applications may experience with IEC 61850 Ed2 ICD and firmware changes. However, such issues may be resolved by reconfiguring the client or automation application or worked around by restoring the Ed1 configuration (CID file). None of these should prevent a client application from dynamically discovering the data in the IED as long as the application adheres to the specification of the standard. Note that upgrading to Ed2 firmware will not break existing Ed1 configurations (CID files) in the field nor require loading an Ed2 version of the CID file.

In some cases, updating Ed1 client applications or server devices in an existing IEC 61850 system may not be feasible. While Ed2 or Ed2.1 devices are generally backward-compatible, it might be preferable to use an Ed1 ICD file in a device that supports Ed2 or 2.1. Architect provides a selection option to allow an Ed2.1 device to communicate with an Ed1 client.

Ed2 introduced the concept of simulated information for testing. Ed1 subscribers cannot interpret the Simulation bit in a GOOSE or Sampled Values APDU, which could lead to a misoperation. Therefore, caution and thorough testing are essential in mixed edition systems.

Unexpected Error Messages

Some MMS and control errors have been changed in Ed2. Hence, the firmware now issues only the Ed2-compliant errors. Clients or automation applications that rely on the Ed1-compliant errors will not function correctly. You can resolve this by reconfiguring the client or automation application to accept Ed2-compliant error messages.

Missing or Unknown Data Objects and Attributes

Ed2 has changed some data object and attribute names, as well as the data types of some attributes. Ed2 also prohibits the use of proprietary CDCs. See *Common Logical Nodes on page F.31* and *Table F.31* through *Table F.33* to determine the Ed2 names. This may cause the failure of clients or automation applications that rely on the Ed1 names. A workaround is to use the Ed1 version of the CID file, if available, to configure the IED. You can also resolve this by reconfiguring the client or automation application to accept the Ed2 names.

Unable to Find Operate Time-Out

A proprietary method was used to specify the operate time-out of control objects in the CID files. A client or automation application that relies on this proprietary method will fail to find the operate time-out in the CID file. A workaround is to use the Ed1 CID file to configure the IED. You can also resolve this by reconfiguring the client or automation application to accept the Ed2 control object operate time-outs.

Unexpected Control Block Data Attribute Type

The string type data attributes in control blocks (RptID, DatSet, etc.) have been changed from a maximum length of 65 to 129 characters, i.e., VisString65 to VisString129. Some clients and automation applications might see this as an error when the type is reported in the MMS GetVariableAccessAttributes response. You can resolve this by reconfiguring the client or automation application.

Unexpected Reports

Ed2 requires report buffering to start when the device is turned on, unlike in the Ed1 implementation where report buffering started after the first report enable. If a client or automation application relies on the Ed1 behavior, it might fail or indicate an error if the IED sends buffered reports immediately after the first enable. You can resolve this by reconfiguring the client or automation application.

Failure to Reselect a Control Object Before the Time-Out

In Ed1, if a client reselected a control object before the select-before-operate time-out expired, the reselection would succeed and cause the selected time-out to restart. According to Ed2, this reselection is supposed to fail. Ed1-based clients or automation applications that rely on successful reselection might operate incorrectly. You can resolve this by reconfiguring the client or automation application.

Test Control Commands Fail Immediately

In Ed1, if the test attribute was set in a control command structure, the relay would accept the command but perform no action on the target control object. With enhanced control models, the IED eventually reported an operate timeout error after the operate time-out expired. However, in Ed2, any such test commands fail immediately with an error indicating that the command is blocked because the IED is not in the appropriate mode. Clients or automation applications that depend on the Ed1 behavior might fail. You can resolve this by reconfiguring the client or automation application.

No Reports

Ed2 specifies that no reports are to be generated for a deadbanded attribute if the deadband is set to 0. Previously in Ed1, a deadband of 0 caused the relay to generate reports for any change in the instantaneous value. Ed1-based clients or automation applications might not operate correctly because of the lack of reports. You can resolve this by reconfiguring the client or automation application.

Known Interoperability Issues Between Ed2 A1 and Ed2

For unbuffered and buffered reporting, the client reserves the RCB first before changing the configuration and enabling it. Otherwise, if not reserved, the server refuses the configuration and enable request.SEL recommends that the you update each client system to Ed2.1 when an Ed2.1 server device is used.

Changes to Data Modeling in Ed2.1

Some logical nodes and data objects have been extended and updated in Ed2.1. The logical nodes and objects present in the default ICD files for SEL devices may have changed for Ed2.1. *Table F.28* and *Table F.31* through *Table F.33* list the objects included in the default ICD files. Optional objects and attributes not included in the default ICD files may not be listed.

The name space for data modeling in Ed2.1 has been changed from IEC 61850-7-4:2007A to IEC 61850-7-4:2007B.

Changes Related to Communication Services in Ed2.1

The changes for communication services in Ed2.1 include the following:

- Unbuffered Reporting
  - Clients must always set Resv = TRUE, even when the URCB is preassigned, before the report can be enabled.
  - When a URCB instance is pre-assigned to a specific client, Resv = TRUE.
  - Server will refuse configuration and RptEna = T if the client did not reserve a report.
- GOOSE Publish
  - Definition of maxTime has been updated.
- Time Sync
  - IEC 618580-9-3 PTP is optional (SNTP stays mandatory).

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 per power system cycle (automatic pacing mode)
19200	4 times per power system cycle (automatic pacing mode)
38400	4 times per 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 the 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 an 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 an 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 *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 downtime 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 7.21* 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 per power system cycle	n/a
19200	4 times per power system cycle	n/a
9600	4 times per power system cycle	2 times per 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.

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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 7.39*).

Use any Device Word bit (except Row 0) in SELOGIC® control equations (see *:*) and the Sequential Events Recorder (SER) trigger list settings (see *:*).

Table H.1 SEL-2411 Device Word Bits (Sheet 1 of 4)

Bit/ Row	Device Word Bits							
	7	6	5	4	3	2	1	0
TAR 0	ENABLED	T00_LED[a]	T01_LED	T02_LED	T03_LED	T04_LED	T05_LED	T06_LED
1	PB01_LED	PB02_LED	PB03_LED	PB04_LED	FREQTRK	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
21	SV41T	SV42T	SV43T	SV44T	SV45T	SV46T	SV47T	SV48T

Table H.1 SEL-2411 Device Word Bits (Sheet 2 of 4)

Bit/Row	Device Word Bits							
	7	6	5	4	3	2	1	0
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	RSTENRGY	DSABLSET	RSTTRGT	ER	TRGTR	SPEN	MATHSTRT	MATHTSK
47	RELAY_EN	RSTMXMN	RSTDEM	RSTPKDM	MATHERR	ERTDIN	ERTDFLT	IRTDFLT[b]
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	*
72	AI406LW1	AI406LW2	AI406LAL	*	AI406HW1	AI406HW2	AI406HAL	*

Table H.1 SEL-2411 Device Word Bits (Sheet 3 of 4)

Bit/ Row	Device Word Bits							
	7	6	5	4	3	2	1	0
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	LINKA	LINKB	LINKFAIL	PASEL	PBSEL	*	*	*
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	PB05[c]	PB06[c]	PB07[c]	PB08[c]
103	PB01_PUL	PB02_PUL	PB03_PUL	PB04_PUL	PB05_PUL[c]	PB06_PUL[c]	PB07_PUL[c]	PB08_PUL[c]
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
120	PB01BLED[a]	PB02BLED[a]	PB03BLED[a]	PB04BLED[a]	PB05BLED[c]	PB06BLED[c]	PB07BLED[c]	PB08BLED[c]
121	*	*	*	*	DST	*	LPSEC	LPSECP
122	TSNTPB	TSNTPP	*	*	*	*	*	*
123	IRIGOK	*	*	TDNP3	*	*	*	*

Table H.1 SEL-2411 Device Word Bits (Sheet 4 of 4)

Bit/ Row	Device Word Bits							
	7	6	5	4	3	2	1	0
124	PB05_LED[c]	PB06_LED[c]	PB07_LED[c]	PB08_LED[c]	*	*	*	*
125	IAHW1	IAHW2	IAHAL	*	IBHW1	IBHW2	IBHAL	*
126	ICHW1	ICHW2	ICHAL	*	INHW1	INHW2	INHAL	*
127	IAXHW1	IAXHW2	IAXHAL	*	IBXHW1	IBXHW2	IBXHAL	*
128	ICXHW1	ICXHW2	ICXHAL	*	*	*	*	*
129	VAHW1	VAHW2	VAHAL	*	VBHW1	VBHW2	VBHAL	*
130	VCHW1	VCHW2	VCHAL	*	*	*	*	*
131	VALW1	VALW2	VALAL	*	VBLW1	VBLW2	VBLAL	*
132	VCLW1	VCLW2	VCLAL	*	*	*	*	*
133	VABHW1	VABHW2	VABHAL	*	VBCHW1	VBCHW2	VBCHAL	*
134	VCAHW1	VCAHW2	VCAHAL	*	*	*	*	*
135	VABLW1	VABLW2	VABLAL	*	VBCLW1	VBCLW2	VBCLAL	*
136	VCALW1	VCALW2	VCALAL	TESTDB	SC850TM	SC850BM	ENLRC	LOCAL
137	ACV01RST	ACV02RST	ACV03RST	ACV04RST	ACV05RST	ACV06RST	ACV07RST	ACV08RST
138	ACV09RST	ACV10RST	ACV11RST	ACV12RST	ACV13RST	ACV14RST	ACV15RST	ACV16RST
139	ACV17RST	ACV18RST	ACV19RST	ACV20RST	ACV21RST	ACV22RST	ACV23RST	ACV24RST
140	ACV25RST	ACV26RST	ACV27RST	ACV28RST	ACV29RST	ACV30RST	ACV31RST	ACV32RST
141	DNP1_TO	DNP2_TO	DNP3_TO	DNP4_TO	DNP5_TO	P2_TO	P3_TO	P4_TO
142	MOD1_TO	MOD2_TO	*	*	SC850SM	LPHDSIM	*	*
143	SC850LS	LOCSTA	MLTLEV	*	*	*	*	*
144	*	SPD1	SPD1B	SPD1A	DUP1	DUP1B	DUP1A	*
145	IN309	IN310	IN311	IN312	IN313	IN314	*	*
146	IN409	IN410	IN411	IN412	IN413	IN414	*	*
147	IN509	IN510	IN511	IN512	IN513	IN514	*	*
148	IN609	IN610	IN611	IN612	IN613	IN614	*	*
149	IN309E	IN310E	IN311E	IN312E	IN313E	IN314E	*	*
150	IN409E	IN410E	IN411E	IN412E	IN413E	IN414E	*	*
151	IN509E	IN510E	IN511E	IN512E	IN513E	IN514E	*	*
152	IN609E	IN610E	IN611E	IN612E	IN613E	IN614E	*	*
153	ETEMP01F	ETEMP02F	ETEMP03F	ETEMP04F	ETEMP05F	ETEMP06F	ETEMP07F	ETEMP08F
154	ETEMP09F	ETEMP10F	ETEMP11F	ETEMP12F	ITEMP01F	ITEMP02F	ITEMP03F	ITEMP04F
155	ITEMP05F	ITEMP06F	ITEMP07F	ITEMP08F	ITEMP09F	ITEMP10F	*	*
156	TP_FAIL	TP_CHTR	TPOS_MIN	TPOS_MAX	UEX_TPOS	TPALMRST	LTC_RSE	LTC_LWR
157	*	*	*	*	UEX_POS1	UEX_POS2	UEX_POS3	UEX_POS4
158	RSE_CTRL	LWR_CTRL	PAR_OP	RSE_850	LWR_850	PAROP850	*	*
159	PTP_TIM	PTP_OK	PTPSYNC	PTPA	PTPB	*	*	*
160	EACC	E2AC	*	*	*	*	*	*

[a] PB01BLED–PB04BLED and T00_LED apply only to Vertical SEL-2411 controllers.
[b] IRTDFLT also applies to internal general purpose RTD/TC card.
[c] These Device Word bits are available for units with the five-inch touchscreen display.

Definitions

Table H.2 Device Word Bit Definitions (Sheet 1 of 13)

Row	Bit	Definition
0	ENABLED	Device Enabled
	T00_LED	SELOGIC Equation: Drives LED T00 (only available in vertical SEL-2411s)
	T01_LED	SELOGIC Equation: Drives LED T01
	T02_LED	SELOGIC Equation: Drives LED T02
	T03_LED	SELOGIC Equation: Drives LED T03
	T04_LED	SELOGIC Equation: Drives LED T04
	T05_LED	SELOGIC Equation: Drives LED T05
	T06_LED	SELOGIC Equation: Drives LED T06
1	PB01_LED	SELOGIC Equation: Drives LED PB01
	PB02_LED	SELOGIC Equation: Drives LED PB02
	PB03_LED	SELOGIC Equation: Drives LED PB03
	PB04_LED	SELOGIC Equation: Drives LED PB04
	FREQTRK	Frequency tracking status bit
	SALARM	Software Alarms: invalid password, changing access levels, settings changes
	IRIGOK	IRIG-B Time Synchronism-Check Input Data are valid
	HALARM	Diagnostics Failure
2	RB01–RB08	Remote Bits RB01–RB08
3	RB09–RB16	Remote Bits RB09–RB16
4	RB17–RB24	Remote Bits RB17–RB24
5	RB25–RB32	Remote Bits RB25–RB32
6	LB01–LB08	Local Bits LB01–LB08
7	LB09–LB16	Local Bits LB09–LB16
8	LB17–LB24	Local Bits LB17–LB24
9	LB25–LB32	Local Bits LB25–LB32
10	SV01–SV08	SELOGIC variables SV01–SV08
11	SV01T–SV08T	SELOGIC variables SV01T–SV08T with settable pickup and dropout time delay
12	SV09–SV16	SELOGIC variables SV09–SV16
13	SV09T–SV16T	SELOGIC variables SV09T–SV16T with settable pickup and dropout time delay
14	SV17–SV24	SELOGIC variables SV17–SV24
15	SV17T–SV24T	SELOGIC variables SV17T–SV24T with settable pickup and dropout time delay
16	SV25–SV32	SELOGIC variables SV25–SV32
17	SV25T–SV32	SELOGIC variables SV25T–SV32T with settable pickup and dropout time delay
18	SV33–SV40	SELOGIC variables SV33–SV40
19	SV33T–SV40T	SELOGIC variables SV33T–SV40T with settable pickup and dropout time delay
20	SV41–SV48	SELOGIC variables SV41–SV48
21	SV41T–SV48T	SELOGIC variables SV41T–SV48T with settable pickup and dropout time delay
22	SV49–SV56	SELOGIC variables SV49–SV56
23	SV49T–SV56T	SELOGIC variables SV49T–SV56T with settable pickup and dropout time delay

Table H.2 Device Word Bit Definitions (Sheet 2 of 13)

Row	Bit	Definition
24	SV57–SV64	SELOGIC variables SV57–SV64
25	SV57T–SV64T	SELOGIC variables SV57T–SV64T with settable pickup and dropout time delay
26	SET01–SET08	SELOGIC Set latch bit variables SET01–SET08
27	RST01–RST08	SELOGIC Reset latch bit variables RST01–RST08
28	SET09–SET16	SELOGIC Set latch bit variables SET09–SET16
29	RST09–RST16	SELOGIC Reset latch bit variables RST09–RST16
30	SET17–SET24	SELOGIC Set latch bit variables SET17–SET24
31	RST17–RST24	SELOGIC Reset latch bit variables RST17–RST24
32	SET25–SET32	SELOGIC Set latch bit variables SET25–SET32
33	RST25–RST32	SELOGIC Reset latch bit variables RST25–RST32
34	LT01–LT08	Latch bit variables LT01–LT08
35	LT09–LT16	Latch bit variables LT09–LT16
36	LT17–LT25	Latch bit variables LT17–LT24
37	LT25–LT32	Latch bit variables LT25–LT32
38	SC01QU–SC08QU	SELOGIC Counters 01–08 asserted when counter = preset value
39	SC01QD–SC08QD	SELOGIC Counters 01–08 asserted when counter = 0
40	SC09QU–SC16QU	SELOGIC Counters 09–16 asserted when counter = preset value
41	SC09QD–SC17QU	SELOGIC Counters 09–16 asserted when counter = 0
42	SC17QU–SC24QU	SELOGIC Counters 17–24 asserted when counter = preset value
43	SC17QD–SC24QD	SELOGIC Counters 17–24 asserted when counter = 0
44	SC25QU–SC32QU	SELOGIC Counters 25–32 asserted when counter = preset value
45	SC25QD–SC32QD	SELOGIC Counters 25–32 asserted when counter = 0
46	RSTENRGY	SELOGIC Equation: Reset Energy Metering Values.
	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).
	MATHSTRT	One processing interval pulse when SELMath starts.
	MATHTSK	Asserts when SELMath is running.
47	RELAY_EN	61850 Data Quality Bit
	RSTMXMN	SELOGIC Equation: Reset Min/Max Metering Values.
	RSTDEM	SELOGIC Equation: Reset Demand Metering Values
	RSTPKDM	SELOGIC Equation: Reset Peak Demand Metering Values.
	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 including open-circuit or shorted RTDs or communication loss of the SEL-2600.
	IRTDFLT	Asserts on if any failure on any internal RTD card or internal general purpose RTD/TC card including open-circuit or shorted RTDs.
48	IN101	Digital input slot 1 input 101
	IN102	Digital input slot 1 input 102

Table H.2 Device Word Bit Definitions (Sheet 3 of 13)

Row	Bit	Definition
	*	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
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 AI*xxx*LW1 = 1, then AILW1 = 1.
	AILW2	Analog inputs Low Warning, Level 2. If any AI*xxx*LW2 = 1, then AILW2 = 1.
	AILAL	Analog inputs Low Alarm Limit. If any AI*xxx*LAL = 1, then AILAL = 1.
	*	Reserved
	AIHW1	Analog inputs High Warning, Level 1. If any AI*xxx*HW1 = 1, then AIHW1 = 1.
	AIHW2	Analog inputs High Warning, Level 2. If any AI*xxx*HW2 = 1, then AIHW2 = 1.
	AIHAL	Analog inputs High Alarm Limit. If any AI*xxx*HAL = 1, then AIHAL = 1.
	*	Reserved
59–90		Analog inputs 301-608 Warnings/Alarms (where *xxx* = 301–608)
	AI*xxx*LW1	Low Warning, Level 1
	AI*xxx*LW2	Low Warning, Level 2
	AI*xxx*LAL	Low Alarm Limit
	*	Reserved
	AI*xxx*HW1	High Warning, Level 1
	AI*xxx*HW2	High Warning, Level 2
	AI*xxx*HAL	High Alarm Limit
	*	Reserved
91	LINKA	Dual Ethernet link status for Port A.
	LINKB	Dual Ethernet link status for Port B.

Table H.2 Device Word Bit Definitions (Sheet 4 of 13)

Row	Bit	Definition
	LINKFAIL	Dual Ethernet active port link status failure indicator.
	PASEL	Dual Ethernet active Port A indicator.
	PBSEL	Dual Ethernet active Port B indicator.
	*	*
	*	*
	*	*
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–RMB8A
98	TMB8A–TMB1A	Channel A transmit MIRRORED BITS TMB1A–TMB8A
99	RMB8B–RMB1B	Channel B receive MIRRORED BITS RMB1B–RMB8B
100	TMB8B–TMB1B	Channel B transmit MIRRORED BITS TMB1B–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
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
	PB05	Front-panel pushbutton 5 bit
	PB06	Front-panel pushbutton 6 bit
	PB07	Front-panel pushbutton 7 bit
	PB08	Front-panel pushbutton 8 bit
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)

Table H.2 Device Word Bit Definitions (Sheet 5 of 13)

Row	Bit	Definition
	PB04_PUL	Front-panel pushbutton 4 pulse bit (asserted for one processing interval when PB04 is pressed)
	PB05_PUL	Front-panel pushbutton 5 pulse bit (asserted for one processing interval when PB05 is pressed)
	PB06_PUL	Front-panel pushbutton 6 pulse bit (asserted for one processing interval when PB06 is pressed)
	PB07_PUL	Front-panel pushbutton 7 pulse bit (asserted for one processing interval when PB07 is pressed)
	PB08_PUL	Front-panel pushbutton 8 pulse bit (asserted for one processing interval when PB08 is pressed)
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
120	PB01BLED PB02BLED PB03BLED PB04BLED PB05BLED PB06BLED PB07BLED PB08BLED	SELOGIC Equation: Drives LED PB01B (only available in vertical SEL-2411) SELOGIC Equation: Drives LED PB02B (only available in vertical SEL-2411) SELOGIC Equation: Drives LED PB03B (only available in vertical SEL-2411) SELOGIC Equation: Drives LED PB04B (only available in vertical SEL-2411) SELOGIC Equation: Drives LED PB05B (only available in vertical SEL-2411) SELOGIC Equation: Drives LED PB06B (only available in vertical SEL-2411) SELOGIC Equation: Drives LED PB07B (only available in vertical SEL-2411) SELOGIC Equation: Drives LED PB08B (only available in vertical SEL-2411)
121	*	Reserved
	*	Reserved
	*	Reserved
	*	Reserved
	DST	Daylight Savings Time
	*	Reserved
	LPSEC	Direction of upcoming Leap second. While LPSECP is asserted, add leap second if LPSEC = 0, and delete leap second if LPSEC = 1.
	LPSECP	Leap second pending
122	TSNTPB	SNTP Secondary Server is active.
	TSNTPP	SNTP Primary Server is active.
	*	Reserved
	*	Reserved
	*	Reserved

Table H.2 Device Word Bit Definitions (Sheet 6 of 13)

Row	Bit	Definition
	*	Reserved
	*	Reserved
	*	Reserved
123	IRIGOK	IRIG-B Time Sync Input Data are valid.
	*	Reserved
	*	Reserved
	TDNP3	Time Source is DNP Master
	*	Reserved
	*	Reserved
	*	Reserved
	*	Reserved
124	PB05_LED	SELOGIC Equation: Drives LED PB05
	PB06_LED	SELOGIC Equation: Drives LED PB06
	PB07_LED	SELOGIC Equation: Drives LED PB07
	PB08_LED	SELOGIC Equation: Drives LED PB08
	*	Reserved
	*	Reserved
	*	Reserved
	*	Reserved
125	IAHW1	IA Overcurrent Warning, Level 1
	IAHW2	IA Overcurrent Warning, Level 2
	IAHAL	IA Overcurrent Alarm
	*	Reserved
	IBHW1	IB Overcurrent Warning, Level 1
	IBHW2	IB Overcurrent Warning, Level 2
	IBHAL	IB Overcurrent Alarm
	*	Reserved
126	ICHW1	IC Overcurrent Warning, Level 1
	ICHW2	IC Overcurrent Warning, Level 2
	ICHAL	IC Overcurrent Alarm
	*	Reserved
	INHW1	IN Overcurrent Warning, Level 1
	INHW2	IN Overcurrent Warning, Level 2
	INHAL	IN Overcurrent Alarm
	*	Reserved
127	IAXHW1	IAX Overcurrent Warning, Level 1
	IAXHW2	IAX Overcurrent Warning, Level 2
	IAXHAL	IAX Overcurrent Alarm
	*	Reserved
	IBXHW1	IBX Overcurrent Warning, Level 1
	IBXHW2	IBX Overcurrent Warning, Level 2

Table H.2 Device Word Bit Definitions (Sheet 7 of 13)

Row	Bit	Definition
	IBXHAL	IBX Overcurrent Alarm
	*	Reserved
128	ICXHW1	ICX Overcurrent Warning, Level 1
	ICXHW2	ICX Overcurrent Warning, Level 2
	ICXHAL	ICX Overcurrent Alarm
	*	Reserved
	*	Reserved
	*	Reserved
	*	Reserved
	*	Reserved
129	VAHW1	VA Overvoltage Warning, Level 1
	VAHW2	VA Overvoltage Warning, Level 2
	VAHAL	VA Overvoltage Alarm
	*	Reserved
	VBHW1	VB Overvoltage Warning, Level 1
	VBHW2	VB Overvoltage Warning, Level 2
	VBHAL	VB Overvoltage Alarm
	*	Reserved
130	VCHW1	VC Overvoltage Warning, Level 1
	VCHW2	VC Overvoltage Warning, Level 2
	VCHAL	VC Overvoltage Alarm
	*	Reserved
	*	Reserved
	*	Reserved
	*	Reserved
	*	Reserved
131	VALW1	VA Undervoltage Warning, Level 1
	VALW2	VA Undervoltage Warning, Level 2
	VALAL	VA Undervoltage Alarm
	*	Reserved
	VBLW1	VB Undervoltage Warning, Level 1
	VBLW2	VB Undervoltage Warning, Level 2
	VBLAL	VB Undervoltage Alarm
	*	Reserved
132	VCLW1	VC Undervoltage Warning, Level 1
	VCLW2	VC Undervoltage Warning, Level 2
	VCLAL	VC Undervoltage Alarm
	*	Reserved
	*	Reserved
	*	Reserved
	*	Reserved

Table H.2 Device Word Bit Definitions (Sheet 8 of 13)

Row	Bit	Definition
	*	Reserved
133	VABHW1	VAB Overvoltage Warning, Level 1
	VABHW2	VAB Overvoltage Warning, Level 2
	VABHAL	VAB Overvoltage Alarm
	*	Reserved
	VBCHW1	VBC Overvoltage Warning, Level 1
	VBCHW2	VBC Overvoltage Warning, Level 2
	VBCHAL	VBC Overvoltage Alarm
	*	Reserved
134	VCAHW1	VCA Overvoltage Warning, Level 1
	VCAHW2	VCA Overvoltage Warning, Level 2
	VCAHAL	VCA Overvoltage Alarm
	*	Reserved
	*	Reserved
	*	Reserved
	*	Reserved
	*	Reserved
135	VABLW1	VAB Undervoltage Warning, Level 1
	VABLW1	VAB Undervoltage Warning, Level 2
	VABLAL	VAB Undervoltage Alarm
	*	Reserved
	VBCLW1	VBC Undervoltage Warning, Level 1
	VBCLW2	VBC Undervoltage Warning, Level 2
	VBCLAL	VBC Undervoltage Alarm
	*	Reserved
136	VCALW1	VCA Undervoltage Warning, Level 1
	VCALW2	VCA Undervoltage Warning, Level 2
	VCALAL	VCA Undervoltage Alarm
	TESTDB	TEST DB override is active
	SC850TM	IEC 61850 Test Mode Control Equation
	SC850BM	IEC 61850 Blocked Mode Control Equation
	ENLRC	Enable Local/Remote Mode
	LOCAL	SELOGIC Control Equation
137	ACV01RST	Analog Control Variable Reset 1–8
	ACV02RST	
	ACV03RST	
	ACV04RST	
	ACV05RST	
	ACV06RST	
	ACV07RST	
	ACV08RST	

Table H.2 Device Word Bit Definitions (Sheet 9 of 13)

Row	Bit	Definition
138	ACV09RST	Analog Control Variable Reset 9–16
	ACV10RST	
	ACV11RST	
	ACV12RST	
	ACV13RST	
	ACV14RST	
	ACV15RST	
	ACV16RST	
139	ACV17RST	Analog Control Variable Reset 17–24
	ACV18RST	
	ACV19RST	
	ACV20RST	
	ACV21RST	
	ACV22RST	
	ACV23RST	
	ACV24RST	
140	ACV25RST	Analog Control Variable Reset 25–32
	ACV26RST	
	ACV27RST	
	ACV28RST	
	ACV29RST	
	ACV30RST	
	ACV31RST	
	ACV32RST	
141	DNP1_TO	Port 1 DNP Session 1 time out
	DNP2_TO	Port 1 DNP Session 2 time out
	DNP3_TO	Port 1 DNP Session 3 time out
	DNP4_TO	Port 1 DNP Session 4 time out
	DNP5_TO	Port 1 DNP Session 5 time out
	P2_TO	Indication of Port 2 time out for DNP or MODBUS
	P3_TO	Indication of Port 3 time out for DNP or MODBUS
	P4_TO	Indication of Port 4 time out for DNP or MODBUS
142	MOD1_TO	Port 1 Modbus Session 1 time out
	MOD2_TO	Port 1 Modbus Session 2 time out
	*	Reserved
	*	Reserved
	SC850SM	SELOGIC control for processing simulated GOOSE messages only
	LPHDSIM	Indication of whether device is in Simulation Mode
	*	Reserved
	*	Reserved
143	SC850LS	SELOGIC control for station level authority

Table H.2 Device Word Bit Definitions (Sheet 10 of 13)

Row	Bit	Definition
	LOCSTA	Indication of set control authority at station level
	MLTLEV	SELOGIC control for multilevel authority
	*	Reserved
	*	Reserved
	*	Reserved
	*	Reserved
	*	Reserved
144	*	Reserved
	SPD1	Port 1 Speed. Asserts for 100 Mbps and deasserts for 10 Mbps.
	SPD1B	Port 1B Speed. Asserts for 100 Mbps and deasserts for 10 Mbps.
	SPB1A	Port 1A Speed. Asserts for 100 Mbps and deasserts for 10 Mbps.
	DUP1	Port 1 Duplex Mode. Asserts for full duplex and deasserts for half duplex.
	DUP1B	Port 1B Duplex Mode. Asserts for full duplex and deasserts for half duplex.
	DUP1A	Port 1A Duplex Mode. Asserts for full duplex and deasserts for half duplex.
	*	Reserved
145	IN309	Extended Digital Inputs Slot 3
	IN310	
	IN311	
	IN312	
	IN313	
	IN314	
	*	
	*	
146	IN409	Extended Digital Inputs Slot 4
	IN410	
	IN411	
	IN412	
	IN413	
	IN414	
	*	
	*	
147	IN509	Extended Digital Inputs Slot 5
	IN510	
	IN511	
	IN512	
	IN513	
	IN514	
	*	
	*	

Table H.2 Device Word Bit Definitions (Sheet 11 of 13)

Row	Bit	Definition
148	IN609	Extended Digital Inputs Slot 6
	IN610	
	IN611	
	IN612	
	IN613	
	IN614	
	*	
	*	
149	IN309E	Extended Edge Digital Inputs Slot 3
	IN310E	
	IN311E	
	IN312E	
	IN313E	
	IN314E	
	*	
	*	
150	IN409E	Extended Edge Digital Inputs Slot 4
	IN410E	
	IN411E	
	IN412E	
	IN413E	
	IN414E	
	*	
	*	
151	IN509E	Extended Edge Digital Inputs Slot 5
	IN510E	
	IN511E	
	IN512E	
	IN513E	
	IN514E	
	*	
	*	
152	IN609E	Extended Edge Digital Inputs Slot 6
	IN610E	
	IN611E	
	IN612E	
	IN613E	
	IN614E	
	*	
	*	
153	ETEMP01F	Fault on EXTRTD01

Table H.2 Device Word Bit Definitions (Sheet 12 of 13)

Row	Bit	Definition
	ETEMP02F	Fault on EXTRTD02
	ETEMP03F	Fault on EXTRTD03
	ETEMP04F	Fault on EXTRTD04
	ETEMP05F	Fault on EXTRTD05
	ETEMP06F	Fault on EXTRTD06
	ETEMP07F	Fault on EXTRTD07
	ETEMP08F	Fault on EXTRTD08
154	ETEMP09F	Fault on EXTRTD09
	ETEMP10F	Fault on EXTRTD10
	ETEMP11F	Fault on EXTRTD11
	ETEMP12F	Fault on EXTRTD12
	ITEMP01F	Fault on INTRTD01 or INTEMP01
	ITEMP02F	Fault on INTRTD02 or INTEMP02
	ITEMP03F	Fault on INTRTD03 or INTEMP03
	ITEMP04F	Fault on INTRTD04 or INTEMP04
155	ITEMP05F	Fault on INTRTD05 or INTEMP05
	ITEMP06F	Fault on INTRTD06 or INTEMP06
	ITEMP07F	Fault on INTRTD07 or INTEMP07
	ITEMP08F	Fault on INTRTD08 or INTEMP08
	ITEMP09F	Fault on INTRTD09 or INTEMP09
	ITEMP10F	Fault on INTRTD10 or INTEMP10
	*	Reserved
	*	Reserved
156	TP_FAIL	Tap Position Monitor Failure
	TP_CHTR	Tap Position Input chatter present for at least TPFB_TIM
	TPOS_MIN	Tap Position equal to TP_MIN
	TPOS_MAX	Tap Position equal to TP_MAX
	UEX_TPOS	Unexpected Tap Position
	TPALMRST	Tap Position Monitor Reset
	LTC_RSE	LTC Rise Input
	LTC_LWR	LTC Lower Input
157	*	Reserved
	*	Reserved
	*	Reserved
	*	Reserved
	UEX_POS1	Tap Position change without LTC_RSE or LTC_LWR Control issued
	UEX_POS2	Tap Position change greater than one
	UEX_POS3	Tap Position change in an unexpected direction
	UEX_POS4	Tap Position detected is greater than the TP_MAX setting
158	RSE_CTRL	SELOGIC Equation: Load Tap Changer Raise Control Logic
	LWR_CTRL	SELOGIC Equation: Load Tap Changer Lower Control Logic

Table H.2 Device Word Bit Definitions (Sheet 13 of 13)

Row	Bit	Definition
	PAR_OP	SELOGIC Equation: Load Tap Changer Parallel or Independent Operation Control Logic
	RSE_850	Raise command as per TapChg enumeration from IEC 61850
	LWR_850	Lower command as per TapChg enumeration from IEC 61850
	PAROP850	Parallel operation control from IEC 61850
	*	Reserved
	*	Reserved
159	PTP_TIM	Valid PTP time source is detected
	PTP_OK	PTP time is within the 4 ms local offset
	PTPSYNC	The device is using PTP time to do time sync
	PTPA	PTP is enabled in PRP mode and the relay is receiving PTP messages on Port 1A
	PTPB	PTP is enabled in PRP mode and the relay is receiving PTP messages on Port 1B
	*	Reserved
	*	Reserved
	*	Reserved
160	EACC	Enable ACC Port Access Control
	E2AC	Enable 2AC Port Access Control
	*	Reserved
	*	Reserved
	*	Reserved
	*	Reserved
	*	Reserved
	*	Reserved

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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 3)

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–MV64	Math Variables	
ACV01–ACV32	Analog Control 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)	
MONTH	Month number (1–12)	
DAYM	Day of Month (1–31)	
DAYW	Day of Week number (1–7)	
HOUR	Hour number (0–23)	
MIN	Minutes number (0–59)	
MINSM	Minutes since Midnight	
SEC	Seconds number (0–59)	
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

Table I.1 Available Analog Quantities (Sheet 2 of 3)

Analog Quantity	Description	
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
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

Table I.1 Available Analog Quantities (Sheet 3 of 3)

Analog Quantity	Description	
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
Load Tap Position and Control Monitoring Quantities		
TAP_POS	LTC Monitor TAP Position	h

[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.
[h] Valid data only when ETPM_MDE is not set to OFF.

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Appendix J
Cybersecurity Features

The SEL-2411 provides a number of features to help meet cybersecurity design requirements.

Access Control

The SEL-2411 has a number of mechanisms for managing electronic access. These include ways to limit access, provide user authentication, and monitor electronic and physical access.

Physical Port Controls

Each physical serial port and the Ethernet port can be individually disabled using the EPORT setting. By default, all of the ports are enabled. It is good security practice to disable unused ports.

IP Ports

When using Ethernet, there are a number of IP ports available within the SEL-2411. Many of these IP port numbers are user-configurable. All IP ports can be disabled. *Table J.1* describes each of these.

Table J.1 IP Port Numbers

IP Port Default	Port Selection Setting	Network Protocol	Default Port State	Port Enable Setting	Purpose
21	--	TCP	Enabled	EFTP	FTP protocol access for file transfer of settings and reports
23	TPORT	TCP	Enabled	ETELNET	Telnet access for general engineering terminal access
102	--	TCP	Disabled	E61850	IEC 61850 MMS for SCADA functionality
123	SNTPPORT	UDP	Disabled	ESNTP	SNTP time synchronization
319/320	--	UDP	Disabled	EPTP[a]	PTP time synchronization
502	MODNUM1/ MODNUM2	TCP	Disabled	EMOD	MODBUS for SCADA functionality
20000	DNPNUM	TCP/UDP	Disabled	EDNP	DNP for SCADA functionality

[a] When PTPPRO = DEFAULT and PTPTR = UDP.

Authentication and Authorization

The device supports four levels of access, as described in *Access Levels on page 7.12*. Refer to this section to learn how each level is accessed and how to change passwords. It is good security practice to change the default passwords of each access level and to use a unique password for each level.

The MAXACC setting limits the level of access for each port. This permits you to operate under the principle of “least privilege”, restricting ports to the levels necessary for the functions performed on those ports.

The device supports strong passwords with as many as 12 characters, using any printable character, allowing users to select complex passwords if they so choose. SEL recommends that passwords have a minimum of 8 characters and include at least one of each of the following: lowercase letter, uppercase letter, number, and special character.

Ethernet protocols Telnet and FTP require proper passwords to gain access to level-protected functions. Ethernet protocol MMS requires a password to gain access if MMS Authentication is enabled via the CID file. See *Section 7: Communications* for more information on access restrictions for the Ethernet protocols.

Monitoring and Logging

The device provides Deice Word bits that are useful for monitoring relay access:

- SALARM—Pulses for approximately one second whenever a user gains access to Level 2, when an incorrect password is entered, or when a setting is changed.
- PASEL, PBSEL—Assert while the Ethernet port(s) is active.
- LINK1, LINKA, LINKB—Assert while the link is active on the Ethernet port(s). Loss of a link can be an indication that an Ethernet cable has been disconnected.
- LINKFAIL—Asserts if link is lost on the active IP port (Ports 1A or 1B).

NOTE: Refer to *Access Commands (ACCESS and 2ACCESS) on page 7.12* for more information on when SALARM is pulsed for access level changes and unsuccessful password entry attempts.

These bits can be mapped for SCADA monitoring via DNP3, IEC 61850, Modbus, or SEL Fast Message. They also may be added to the SER for later analysis or assigned to output contacts for alarm purposes.

The device SER is a useful tool for capturing a variety of device events. In addition to capturing state changes of user selected Device Word bits, it captures all power-ups and settings changes. See *SER Command (Sequential Events Recorder Report) on page 7.36* for more information about SER.

Configuration Management

Many users are concerned about managing the configuration of their relays. The device provides mechanisms to help users manage device configuration.

All settings changes are logged to the SER log. Analysis of this log indicates if any unauthorized settings changes occurred. The SALARM Device Word bit also indicates changes in the relay configuration by pulsing for approximately one second when any of the following occur:

- Settings are changed or saved
- A password changes

See *Self-Test on page 10.11* for more information regarding the Device Word bit SALARM.

Malware Protection

The SEL-2411 has inherent and contiguous monitoring for malware. For a full description of this, see selinc.com/mitigating_malware/.

Firmware Hash Verification

This device supports digitally signed firmware upgrades. SEL uses the SHA-256 secure hash algorithm to compress and digitally sign firmware upgrade files. The signature ensures that the file has been provided by SEL and that its contents have not been altered. When the file is uploaded to the relay, the signature is verified using a public key stored on the relay. If the relay cannot verify the signature, it rejects the file. See *Appendix B: Firmware Upgrade Instructions* for more information on firmware upgrades.

Operating System/ Firmware

SEL-2411 devices are embedded devices that do not allow additional software to be installed. The devices include a self-test that continually checks running code against the known good baseline version of code in nonvolatile memory. This process is outlined in more detail in the document titled The SEL Process for Mitigating Malware Risk to Embedded Devices located at selinc.com/mitigating_malware/. The devices run in an embedded environment for which there is no commercial anti-virus software available.

Software/Firmware Verification

The devices have the ability to install firmware upgrades in the field. Authenticity and integrity of firmware upgrades can be verified by using the *Firmware Hash* page at selinc.com/products/firmware/.

Physical Access Security

Physical security of cybersecurity assets is a common concern. Typically, relays are installed within a control enclosure that provides physical security. Other times, they are installed in boxes within the switchyard. The relay provides some tools that may be useful for managing physical security, especially when the unit is installed in the switchyard.

You can monitor physical ingress by wiring a door sensor to one of the relay contact inputs. This input can then be mapped for SCADA monitoring or added to the SER log so that you can detect when physical access to the relay occurs.

It is also possible to wire an electronic latch to a relay contact output. You could then map this input for SCADA control.

Vulnerability Notification Process

Security Vulnerability Process

SEL provides security disclosure alerts to customers, and SEL instruction manuals document all releases. SEL security vulnerability disclosures are described in The SEL Process for Disclosing Security Vulnerabilities at selinc.com.

Emailed Security Notification

You can sign up to receive email notifications when SEL releases security vulnerability notices and service bulletins at selinc.com/support/securitynotifications/.

Settings Erasure

NOTE: Do not erase the settings when sending the device to the factory for service. SEL needs to be able to see how the relay was configured to properly diagnose many problems.

It is often desirable to erase the settings from the relay when it is removed from service. You can completely erase all the configuration settings from the device using this procedure:

Step 1. Go to Access Level C. See *Access Levels on page 7.12*.

Step 2. Execute the **R_S** command.

Step 3. Allow the relay to restart.

Once this procedure is complete, all internal instances of user settings and passwords will be erased. Do not do this when sending in the relay for service at the factory. SEL needs to see how the relay was configured to properly diagnose many problems.

Glossary

A	Abbreviation for amps or amperes; units of electrical current magnitude.
ACSELERATOR Architect® SEL-5032	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-amperes (VA), kilovolt-amperes (kVA), or megavolt-amperes (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.
COMTRADE	Abbreviation for Common Format for Transient Data Exchange. The SEL-2411 supports the IEEE Standard Common Format for Transient Data Exchange (COMTRADE) for Power Systems, IEEE C37.111-1999.
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-232. Formerly known as RS-232.

EIA-485 Electrical standard for multidrop serial data communications interfaces, based on the standard EIA-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), kilovolt-watts (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.

PRP Parallel Redundancy Protocol provides seamless recovery from any single Ethernet network failure in a dual redundant Ethernet network, in accordance with IEC 62439-3.

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 Thermocouple. A TC is made of two different metals that produce a voltage related to a temperature difference. The SEL-2411 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 QuickSet software device driver version when creating or editing device settings files.

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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.
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.
CSER	Display compressed SER report.

Serial Port Command	Command Description
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 MV	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.
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.
NET	Display TCP and UDP port states.
PAR	Display the current part number.
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 *date2* to *date1*, inclusive, starting with *date2*.
SER *row1*	Display a chronological progression of the first *row1* rows.

Serial Port Command	Command Description
SER ***row1 row2***	Display SER records *row2* to *row1*, starting with *row2*.
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 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* = 0–136). 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.
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 five minutes.
LOO B	Enable loopback on MIRRORED BITS Channel B for the next five minutes.
PAR ***2411xxxxxxxxxxxxxxx***	Enter/change the part number.
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 one second.
SET	Enter/change Device settings.
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.

Serial Port Command	Command Description
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
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CAS	Return the Compressed ASCII configuration message.
DNA	Display ASCII names of Device Word bits reported in Fast Meter.
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QUI	Go to Access Level 0.
SNS	Display SER settings in Compressed ASCII format.
Access Level 1 Commands	
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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.
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.
CSER	Display compressed SER report.

Serial Port Command	Command Description
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 MV	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.
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.
NET	Display TCP and UDP port states.
PAR	Display the current part number.
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 *date2* to *date1*, inclusive, starting with *date2*.
SER *row1*	Display a chronological progression of the first *row1* rows.

Serial Port Command	Command Description
SER *row1 row2*	Display SER records *row2* to *row1*, starting with *row2*.
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 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* = 0–136). 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.
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 five minutes.
LOO B	Enable loopback on MIRRORED BITS Channel B for the next five minutes.
PAR *2411xxxxxxxxxxxxxxx*	Enter/change the part number.
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 one second.
SET	Enter/change Device settings.
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.

Serial Port Command	Command Description
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.