# SEL-3306
## Synchrophasor Processor

## Instruction Manual

20090522

SCHWEITZER ENGINEERING LABORATORIES, INC.

*PM3306-01*

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# Preface

## Overview

The SEL-3306 Synchrophasor Processor manual includes necessary information to properly install the product.

The scope of the manual covers specifications, installation, and mechanical information, system configuration, self-monitoring, and alarming.

An overview of each manual section follows:

Preface. Describes the manual organization and conventions used to present information.

Section 1: Introduction and Specifications. Describes the basic features and functions of the SEL-3306; lists the specifications.

Section 2: Installation. Describes how to mount and wire the SEL-3306; illustrates wiring connections for various applications.

Section 3: Product Overview. Describes the communication and configuration features that are used in the SEL-3306.

Section 4: Product Application Example. Describes a system application with four SEL-3306 Synchrophasor Processors.

Section 5: Troubleshooting. Lists common operating and troubleshooting questions.

Appendix A: Firmware and Manual Versions. Details differences between firmware and manual versions. Provides a record of changes made to the manual since the initial release.

## Conventions

### Typographic Conventions

There are three ways to communicate with the SEL-3306:

- Using a command line interface in a PC terminal emulation window
- Using the front-panel menus and pushbuttons
- Using ACSELERATOR QuickSet software

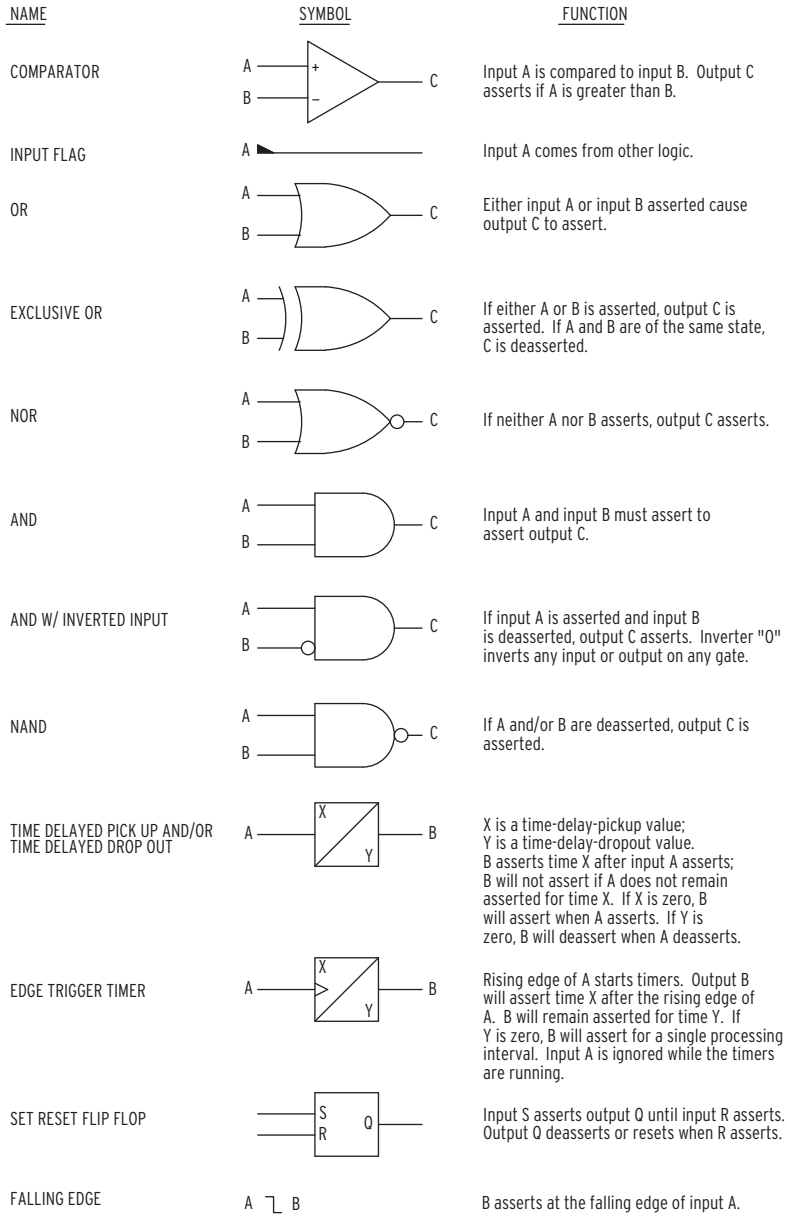
The instructions in this manual indicate these options with specific font and formatting attributes. The following table lists these conventions:

| Example | Description |
|---|---|
| **STATUS** | Commands, command options, and command variables typed at a command line interface on a PC. |
| *n*<br>**SUM *n*** | Variables determined based on an application (in bold if part of a command). |
| **<Enter>** | Single keystroke on a PC keyboard. |
| **<Ctrl+D>** | Multiple/combination keystroke on a PC keyboard. |

| Example | Description |
|---|---|
| **Start > Settings** | PC software dialog boxes and menu selections. The > character indicates submenus. |
| **ENABLE** | Relay front- or rear-panel labels and pushbuttons. |
| MAIN > METER | Relay front-panel LCD menus and relay responses visible on the PC screen. The > character indicates submenus. |

## Logic Diagrams

Logic diagrams in this manual follow the conventions and definitions shown below.



# Safety Information

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

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

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

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

## Symbols

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

| | | |
|---|---|---|
| Symbol 14 | | Caution, Risk of Danger—Consult Documentation for Additional Information |
| Symbol 6 | | Protective (Safety) Ground Conductor Terminal |
| Symbol 1 | | Direct Current |
| Symbol 2 | | Alternating Current |
| Symbol 3 | | Direct and Alternating Current |
| Symbol 5 |  | Earth (Ground) Terminal |

# SEL-3306 Cautions, Warnings, and Dangers

The following hazard statements appear in the body of this manual in English. See the following table for the English and French translation of these statements.

**Cautions, Warnings, and Dangers** (Sheet 1 of 2)

| English | French |
|---|---|
| **⚠CAUTION**<br>Equipment components are sensitive to electrostatic discharge (ESD). Undetectable permanent damage can result if you do not use proper ESD procedures. Ground yourself, your work surface, and this equipment before removing any cover from this equipment. If your facility is not equipped to work with these components, contact SEL about returning this device and related SEL equipment for service. | **⚠ATTENTION**<br>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. |
| **⚠DANGER**<br>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. | **⚠ATTENTION**<br>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. |
| **⚠CAUTION**<br>Contact with instrument terminals can cause electrical shock that can result in injury or death. | **⚠ATTENTION**<br>Tout contact avec les bornes de l'appareil peut causer un choc électrique pouvant entraîner des blessuers ou la mort. |

**Cautions, Warnings, and Dangers** (Sheet 2 of 2)

| English | French |
|---|---|
| **⚠WARNING**<br>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**<br>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**<br>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**<br>Cet appareil est expédié avec des mots de passe par défaut. A l'installation, les mots de passe par défaut devront être changés pour des mots de passe confidentiels. Dans le cas contraire, un accés non-autorisé á l'équipement peut être possible. SEL décline toute responsabilité pour tout dommage résultant de cet accés non-autorisé. |
| **⚠WARNING**<br>Use of this equipment in a manner other than specified in this manual can impair operator safety safeguards provided by this equipment. | **⚠AVERTISSEMENT**<br>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. |
| **⚠WARNING**<br>Never use standard null-modem cables with the SEL-3306. Using any non-SEL cable can cause severe power and ground problems involving Pins 1, 4, and 6 on the SEL-3306 communications ports. | **⚠AVERTISSEMENT**<br>Ne jamais utiliser de cables standards à inversion de signaux ("null-modem") avec le SEL-3306. L'utilisation d'un cable d'une autre provenance que SEL peut causer de sérieux problèmes de neutre et d'alimentation impliquant les fiches 1, 4 et 6 sur les ports de communication du SEL-3306. |
| **⚠WARNING**<br>If a modulated IRIG-B input is used, the demodulated IRIG-B output is unsuitable for synchronizing connected PMCUs. | **⚠AVERTISSEMENT**<br>Si une entrée de type IRIG-B à modulation est utilisée, la sortie correspondante de type IRIG-B démodulé ne peut être utilisée pour synchroniser les autres Unités de Commande et de Mesure de Phaseurs qui sont raccordées. |
| **⚠WARNING**<br>Do not operate device unless the device is properly grounded. | **⚠AVERTISSEMENT**<br>Ne pas mettre l'appareil en marche à moins qu'il ne soit adéquatement mis à la terre. |
| **⚠WARNING**<br>Failure to ensure proper voltage levels can cause equipment damage. | **⚠AVERTISSEMENT**<br>Des dommages peuvent survenir à l' équipement en cas de présence de niveaux de tension inadéquats. |
| **⚠WARNING**<br>It is not recommended to operate the device with the CompactFlash in the J35 slot, except for short-term configuration or maintenance conditions. | **⚠AVERTISSEMENT**<br>Il n'est pas recommandé de faire marcher l'appareil avec la mémoire CompactFlash dans la fente J35 à l'exception de configurations temporaires ou d'opérations de maintenance. |
| **⚠WARNING**<br>There is danger of explosion if the battery is incorrectly replaced. Replace only with Ray-O-Vac® no. BR2335 or equivalent recommended by manufacturer. Dispose of used batteries according to the manufacturer's instructions. | **⚠AVERTISSEMENT**<br>Il y a un danger d'explosion si la pile électrique n'est pas correctement remplacée. Utiliser exclusivement Ray-O-Vac® No. BR2335 ou un équivalent recommandé par le fabricant. Se débarrasser des piles usagées suivant les instructions du fabricant. |

# Technical Assistance

Obtain technical assistance from the following:

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

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# Section 1
# Introduction and Specifications

## Overview

The SEL-3306 is a synchrophasor data processor. The SEL-3306 reads and correlates synchrophasor data from various Phasor Measurement and Control Units (PMCUs), such as the SEL-311 series, SEL-421 and SEL-451, and metering devices such as the SEL-734. The SEL-3306 transmits the processed data over Ethernet. The SEL-3306 can process incoming data from as many as 40 PMCUs at a maximum data rate of 60 messages per second with a message size of 64 bytes. This section introduces the SEL-3306 and provides information regarding features, available models and options, applications, and specifications.

## Features

The SEL-3306 provides a mechanism for collecting and time-aligning synchrophasor data from multiple PMCUs (including other synchrophasor data processors) in multiple formats (IEEE C37.118-2006, IEEE 1344, and SEL Synchrophasor Fast Message). It can then transmit the correlated data in multiple formats (IEEE C37.118-2006 and BPA PDC Stream) for synchrophasor applications. Features include the following:

- **Communication Ports**

  **Serial and Ethernet Ports.** Fifteen serial ports and two Ethernet ports can process messages as large as 64 bytes from as many as 40 PMCUs at 60 messages per second. The console port is dedicated for terminal access supporting configuration. The console port does not support the streaming synchrophasor measurement data. The SEL-3306 uses the console port mainly to configure the network settings.

- **IRIG-B**

  **IRIG-B Time-Code Input.** A software setting configures the SEL-3306 for modulated or demodulated IRIG-B input on the IRIG IN BNC connector. The IRIG-B input updates the operating system clock.

  **IRIG-B Time-Code Output.** Demodulated IRIG-B is distributed to each serial port and the IRIG OUT BNC connector.

➤ **Synchrophasor Data Format**

**Input Data Formats.** Reads synchrophasor data through serial and Ethernet ports according to IEEE C37.118-2006, IEEE 1344, and SEL Synchrophasor Fast Message formats.

**Output Data Formats.** Correlates data through Ethernet and produces outputs according to IEEE C37.118-2006 and BPA PDC Stream format.

➤ **Security**

**Internal Firewall and Password Protection.** An internal firewall and multilevel password protection for the console port and Ethernet ports provide security.

➤ **Watchdog Timer**

A separate system watchdog microcontroller provides an extra level of system reliability. The microcontroller reboots the device if there is a software failure.

# Models and Options

## Models

This manual does not provide complete ordering information. See the latest SEL-3306 Model Option Table at www.selinc.com, under **SEL Literature** > **Ordering Information** (Model Option Tables).

## Options

The SEL-3306 has the following options:

- Power Supply Ranges
  - 24/48 Vdc
  - 48/125 Vdc or 120 Vac
  - 125/250 Vdc or 120/240 Vac
- Communication Options
  - 16 serial ports, EIA-232 (One port for console and 15 ports for synchrophasor data input).
  - Ethernet 1, 10/100BASE-T copper or 100BASE-FX fiber-optic port, jumper selectable.
  - Ethernet 2, 100BASE-FX fiber-optic port only.
- IRIG-B
  - Time-Code Input, both modulated and demodulated, IRIG-B BNC only
  - Time-Code Output, demodulated IRIG-B only, BNC and serial
- Synchrophasor Data Format
  - Input data formats

    IEEE C37.118-2006, Ethernet and serial

    IEEE 1344, Ethernet and serial

    SEL Fast Message, Ethernet and serial

- Output data formats
  IEEE C37.118-2006, Ethernet only
  BPA PDC Stream, Ethernet only

- Mounting
  - Horizontal panel
  - Horizontal 19-inch rack

# Applications

*Figure 1.1* shows a general configuration of the SEL-3306 for synchrophasor data processing application.

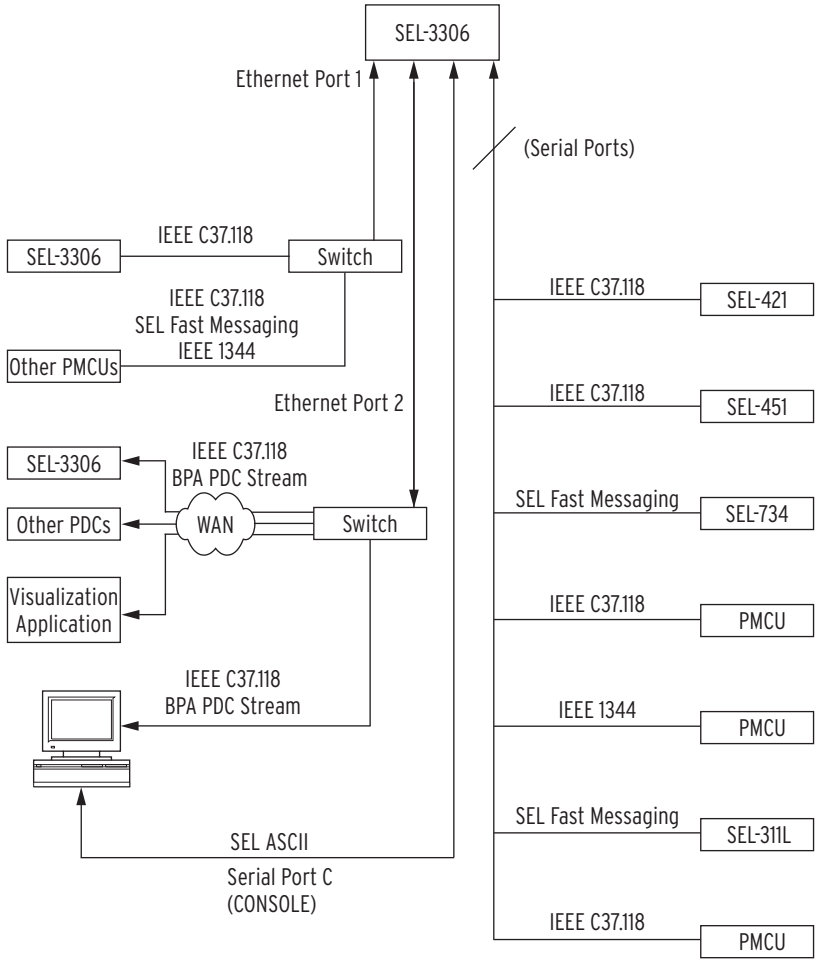


**Figure 1.1 SEL-3306 Application Overview**

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# Specifications

## General

### Operating Temperature

–40° to +75°C (–40° to +167°F)

### Storage Temperature

–40° to 85°C (–40° to +185°F)

### Terminal Connections

Rear Screw-Terminal Tightening Torque

| | |
|---|---|
| Minimum: | 0.8 Nm (7 in-lb) |
| Maximum: | 1.4 Nm (12 in-lb) |

User terminals and stranded copper wire should have a minimum temperature rating of 105°C and a minimum insulation thickness of 0.4 mm. Ring terminals are recommended.

### Operating Environment

| | |
|---|---|
| Pollution Degree: | 2 as per IEC 60950 |
| Overvoltage Category: | II as per IEC 60950 |
| Humidity: | 5 to 95% without condensing |
| Altitude: | 2000 m maximum |
| Atmospheric Pressure: | 80 to 110 kPa |
| Unit Weight: | 5 kg (11 lbs) |

### Communication Ports

| | |
|---|---|
| Serial Ports: | Sixteen serial ports |
| Console Port: | EIA-232 with DB-9 connectors |
| Serial Data Speed: | 9600 bps |
| Ports 1–15: | EIA-232 with DB-9 connectors |
| Serial Data Speed: | 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 bps |
| Ethernet Ports: | Two Ethernet ports |
| Ethernet Port 1: | 10/100BASE-T copper or 100BASE-FX fiber-optic ports |
| Ethernet Port 2: | 100BASE-FX fiber-optic port |

### IRIG-B Ports

Time-Code Input

| | |
|---|---|
| Connector: | Female BNC |
| Time-Code: | Demodulated IRIG-B TTL compatible |
| Pinout: | DB-9 port connectors<br>Pin 4 TTL-level signal<br>Pin 6 chassis ground reference<br>Female BNC |

**Note:** SEL-3306 can be configured to accept Modulated or Demodulated IRIG-B input.

Time-Code Output

| | |
|---|---|
| Connector: | 16 rear DB-9 port connectors<br>Female BNC |
| Time-Code: | Modulated IRIG-B<br>Demodulated IRIG-B TTL compatible |

**Note:** IRIG-B output available only when IRIG-B input is present.

### Synchrophasor Data Format

Input Data Formats

| | |
|---|---|
| IEEE C37.118-2006: | Ethernet and serial |
| IEEE 1344: | Ethernet and serial |
| SEL-Fast Message for Synchrophasors: | Ethernet and serial |

Output Data Formats

| | |
|---|---|
| IEEE C37.118-2006: | Ethernet only |
| BPA PDC Stream: | Ethernet only |

### Synchrophasor Input/Output Message Rates

| | |
|---|---|
| 60 Hz Nominal Data Rate: | 1, 2, 4, 5, 10, 12, 15, 20, 30, 60 messages per second |
| 50 Hz Nominal Data Rate: | 1, 2, 5, 10, 25, 50 messages per second |

### Synchrophasor Data Ports

| | |
|---|---|
| Input Data Ports: | 40 |
| Output Data Ports: | 6 |

### Synchrophasor Processing Capacity

| | |
|---|---|
| Processing Capacity: | Data from as many as 40 PMCUs |
| Processing Interval: | <34 ms |
| Typical Message Size: | 64 bytes |
| Maximum Data Rate: | 60 messages per second |

### Power Supply

125/250 Vdc or 120/230 Vac; 50/60 Hz

| | |
|---|---|
| DC Range: | 85–300 Vdc |
| AC Range: | 85–264 Vac |
| Frequency Range: | 30–120 Hz |
| Burden: | <40 W |

48/125 Vdc or 120 Vac; 50/60 Hz

| | |
|---|---|
| DC Range: | 38–140 Vdc |
| AC Range: | 85–140 Vac |
| Frequency Range: | 30–120 Hz |
| Burden: | <40 W |

24/48 Vdc

| | |
|---|---|
| DC Range: | 20–60 Vdc polarity dependent |
| Burden: | <40 W |

Main Supply Voltage

| | |
|---|---|
| Fluctuations: | as much as ±10% of nominal voltage |

## Type Tests

### Environmental

| | |
|---|---|
| Enclosure Protection Class: | IEC 60529:IP20<br>UL 50: Enclosure Type 1 |
| Cold: | IEC 60068-2-1:1990 + A1:1993 + A2:1994<br>Test Ad: 16 hours at –40°C |
| Dry Heat: | IEC 60068-2-2:1974 + A1:1993 + A2:1994<br>Test Bd: 16 hours at +75°C |
| Damp Heat, Cyclic: | IEC 60068-2-30:1980 + A1:1985<br>Test Db: (12 + 12-hour cycle), 95% r.h.<br>25° to 55°C, 6 cycles |

Vibration Resistance: IEC 60255-21-1:1988,
Endurance Class 1
Response Class 1

Shock Resistance: IEC 60255-21-2:1988,
Shock Withstand, Bump Class 1
Shock Response Class 1
IEC 60255-21-3:1993
Quake Response Class 2

Object Penetration: IEC 60529:2001 + CRGD:2003, IP30 from front of unit.

### Electromagnetic Compatibility Immunity

Electrostatic Discharge: IEC 60255-22-2:1996
IEC 61000-4-2:2001
IEEE C37.90.3-2001
Severity Level: 2, 4, 6, 8 kV contact discharge; 2, 4, 8, 15 kV air discharge

Fast Transient Burst: IEC 61000-4-4:1995 + A1:2000 + A2:2001
IEC 60255-22-4:2002
Severity Level: Class A
4 kV, 2.5 kHz on power supply;
2 kV, 5 kHz on communication lines, digital inputs, and digital outputs

Radiated Radio Interferences: IEC 61000-4-3:2002
IEC 60255-22-3:2000
Severity Level: 10 V/m
IEEE C37.90.2-2004
Severity Level: 35 V/m

Surge Withstand Capability Immunity: IEC 60255-22-1:2005
Severity Level:
Power supply and outputs
2.5 kV peak common mode
1.0 kV peak differential mode
Communications ports
1.0 kV peak common mode
IEEE C37.90.1-2002
Severity Level:
2.5 kV oscillatory;
4 kV fast transient

Surge Immunity: IEC 61000-4-5:1995 + A1:2001
IEC 60255-22-5:2002
Severity Level: 0.5 1.0 kV Line-to-Line;
0.5, 1.0, 2.0 kV Line-to-Earth

Conducted Emissions: EN 55011:1998 + A1:1999 + A2:2002
Level: Class A
IEC 60255-25:2000

Radiated Emissions: EN 55011:1998 + A1:1999 + A2:2002
Level: Class A
IEC 60255-25:2000

Voltage Fluctuations and Flicker: IEC 61000-3-3:2002

Conducted Immunity: IEC 61000-4-6:2004
IEC 60255-22-6:2001
Severity Level: 10 Vrms

Power Frequency Magnetic Field Immunity: IEC 61000-4-8:2001
1000 A/m for 3 s
100 A/m for 1 min. Level 5

### Safety

Dielectric Strength: IEC 60255-5:2000,
IEEE C37.90-1989,
3100 Vdc for 1 min. on power supply
2500 Vac on contact output
Type tested for one minute.

Impulse: IEC 60255-5:2000
IEEE Std 1613-2003
IEEE C37.90-1989
Severity Level: 0.5 Joule, 5 kV

Laser: IEC 60825-1:1993 + A1:1997 + A2:2001

## Certifications

ISO: SEL-3306 is designed and manufactured using an ISO 9001 certified quality program.

UL: UL 61010-1

CSA: CSA C22.2 No. 61010-1

CE: CE Mark
EN 61326: 1997—EMC Directive
EN 50263:1999—EMC Directive
EN 61010-1:2001—Low-Voltage Directive (Safety)
IEC 60255-6:1998—Low-Voltage Directive (Safety)

# Section 2
# Installation

## Overview

This section describes jumpers and CompactFlash® socket, unit placement and maintenance, rear-panel connections, and field serviceability. A successful installation requires an understanding of both the physical and software functions of the device.

Familiarity with synchrophasor processor configuration features and options is critical to safe and effective installation and connection. Carefully plan unit placement, cable connections, and communications during initial design.

This section contains connection drawings for Ethernet, serial port, IRIG-B, alarm contact, and power. Use these drawings in planning synchrophasor processor applications.

## Jumpers and CompactFlash Socket

The SEL-3306 contains jumpers and CompactFlash sockets that configure the processor communication hardware and emergency password reset. Access the jumpers from the main board (the top board).

### Main Board Jumpers

The jumpers on the main board perform the following functions:

- Serial port +5 Vdc or Data Carrier Detect (DCD) enable or disable (JMP2)
- Ethernet Port 1, copper or fiber-optic selection (JMP5)

*Figure 2.1* shows the location of the main board jumpers JMP2 and JMP5. *Table 2.1* shows jumper positions and whether these jumpers are accessible from the front of the device.

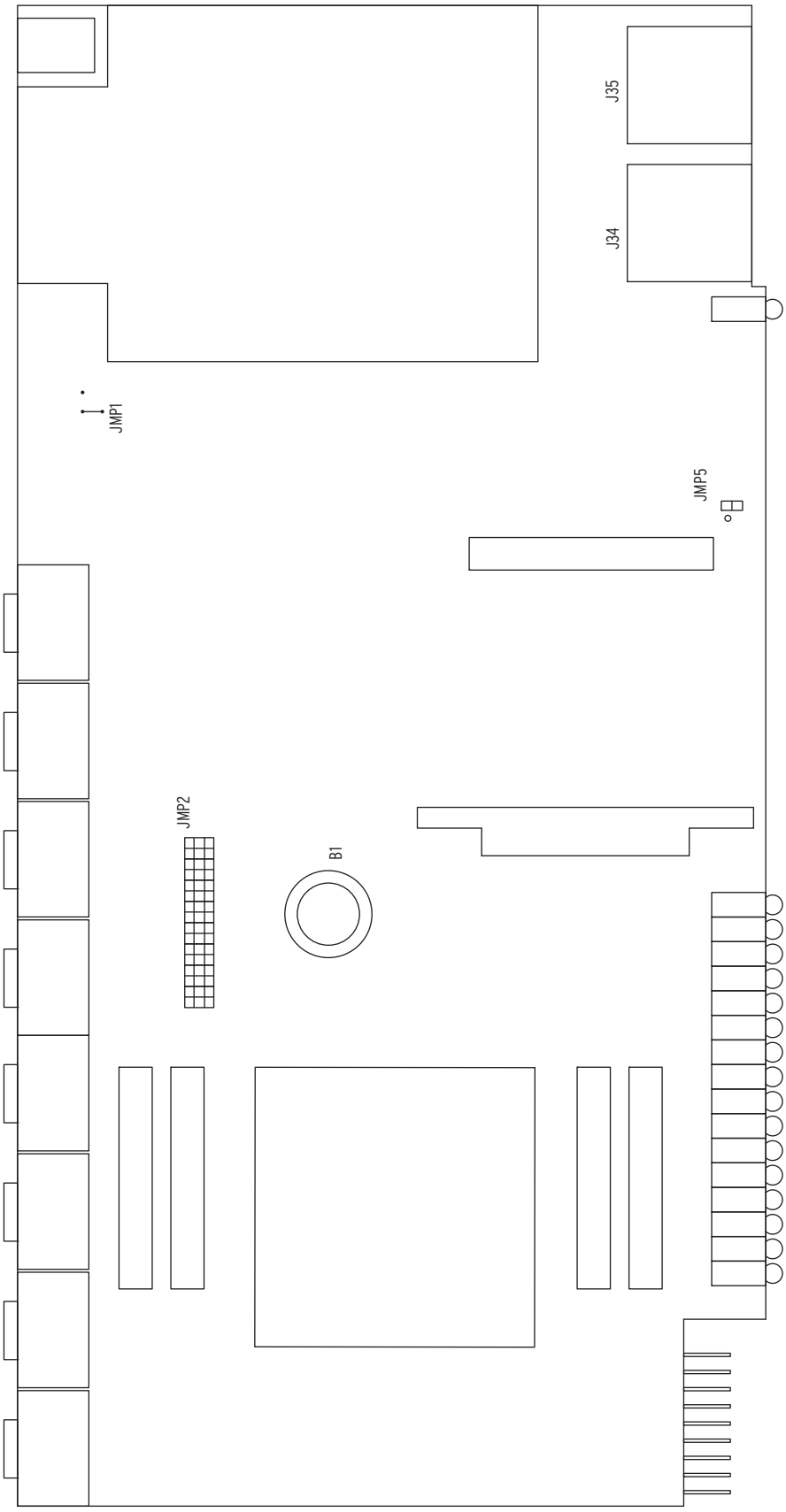



**Figure 2.1 Jumper Locations**

**Table 2.1 Main Board Jumper Positions**

| Function | Jumper Position | Access From Front |
|---|---|---|
| JMP1 | Fixed in position B | No |
| JMP2 Serial Port 1 | DCD Connection (Default)  | No |
| | No Connection  | |
| | +5 Vdc Connection  | |
| JMP5 Ethernet Port 1 Fiber-Optic Selection | 10/100BASE-T Enabled (Default)  | Yes |
| | 100BASE-FL Enabled  | |

Jumper 1 is a hard-soldered jumper that modifies the alarm contact function from normally closed to normally open.

JMP2 has a set of jumpers (1 through 16) that correspond to the **Console** port and ports **1** through **15**. JMP2 connects serial port pin 1 to a +5 Vdc source, no connection, or DCD. DCD asserts when an external modem establishes a connection to another modem through a telecommunications network.

JMP5 position determines the Ethernet Port **1** media. The **Off** position enables copper, and the **On** position enables a fiber-optic Ethernet connection. The processor reads the **Off** or **On** position during bootup. Reboot the SEL-3306 to acknowledge a change in jumper position.

SEL-3306 ships with the default jumper positions in *Table 2.1*. Set the main board jumpers to meet specific requirements.

Perform the following steps to configure the JMP2 jumper to change the serial port function.

Step 1. De-energize the SEL-3306 by disconnecting or removing power.

Be sure that the power source is tagged properly to avoid accidental reenergization.

Step 2. Remove all connections from the rear of the SEL-3306.

Step 3. Remove the SEL-3306 from the panel or 19-inch rack.

Step 4. Remove the front panel.

Step 5. Remove the top cover.

Step 6. Locate the jumpers JMP2 on the main board as shown in *Figure 2.1*.

Configure the main board JMP2 jumper according to the options given in *Table 2.1*. Note that the **Console** port and Port **1** through Port **15** are mapped to the JMP2 jumpers labeled 1 through 16.

Step 7. After reconfiguring, replace the top cover.

Step 8. Replace the front panel.

Step 9. Reinstall the SEL-3306 into the panel or 19-inch rack.

Step 10. Replace the cable connections in the rear of the SEL-3306.

Step 11. Reapply power to the SEL-3306.

Perform the following steps to configure the JMP5 jumper to change the Ethernet port function.

Step 1. De-energize the SEL-3306 by disconnecting or removing power.

Be sure that the power source is tagged properly to avoid accidental reenergization.

Step 2. Remove all connections from the rear of the SEL-3306.

Step 3. Remove the SEL-3306 from the panel or 19-inch rack.

Step 4. Remove the front panel.

Step 5. Locate the jumper JMP5 on the main board as shown in *Figure 2.1*.

Configure the main board JMP5 jumper according to the options in *Table 2.1*.

Step 6. Replace the front panel.

Step 7. Reinstall the SEL-3306 into the panel or 19-inch rack.

Step 8. Replace the cable connections in the rear of the SEL-3306.

Step 9. Reapply power to the SEL-3306.

## CompactFlash Socket

The CompactFlash socket J35 is provided for emergency password override. Booting the device with the CompactFlash card in the J35 slot disables all authentication protection, allowing unrestricted access to the device.

**⚠WARNING**
It is not recommended to operate the device with the CompactFlash in the J35 slot, except for short-term configuration or maintenance conditions.

Perform the following steps to configure the device for emergency password override:

Step 1. De-energize the SEL-3306 by disconnecting or removing power.

Be sure that the power source is tagged properly to avoid accidental reenergization.

Step 2. Remove all connections from the rear of the SEL-3306.

Step 3. Remove the front panel.

Step 4. Locate the CompactFlash slots at J34 and J35 on the main board as shown in *Figure 2.1*.

Step 5. Remove the CompactFlash at slot J34 by slightly pressing down on the card and pulling straight out.

Step 6. Carefully slide the card into the J35 slot, aligning the pins into the connectors on the card. Gently press the card into the slot until no copper on the pins is visible.

Step 7. Replace the front panel.

Step 8. Replace the cable connections in the rear of the SEL-3306.

Step 9. Reapply power to the SEL-3306.

# Unit Placement and Maintenance

Proper placement and maintenance of the SEL-3306 helps ensure years of trouble-free operation. Use the following guidelines for proper installation of the SEL-3306.

## Physical Location

Mount the SEL-3306 in a sheltered indoor environment (a building or an enclosed cabinet) that does not exceed the temperature and humidity ratings for the unit (see *Specifications on page 1.5*). The unit is rated to Overvoltage Category II and Pollution Degree 2 according to IEC 60950. This rating allows mounting of the unit indoors or in an outdoor (extended) enclosure where the unit is protected against exposure to direct sunlight, precipitation, and full wind pressure. Temperature and humidity are not controlled.

## Unit Mounting

Panel and rack mount options are available. *Figure 2.2* shows dimensions and panel cutout size for both options.

## Cleaning

Use care when cleaning the SEL-3306. Use a mild soap or detergent solution and a damp cloth to clean the unit chassis. Allow the unit to air dry, or wipe dry with a soft, dry cloth. Do not use abrasive materials or polishing compounds on any unit surface. Be careful cleaning the front and rear panels because a permanent plastic sheet covers each panel; do not use harsh chemical solvents such as xylene or acetone on these surfaces.

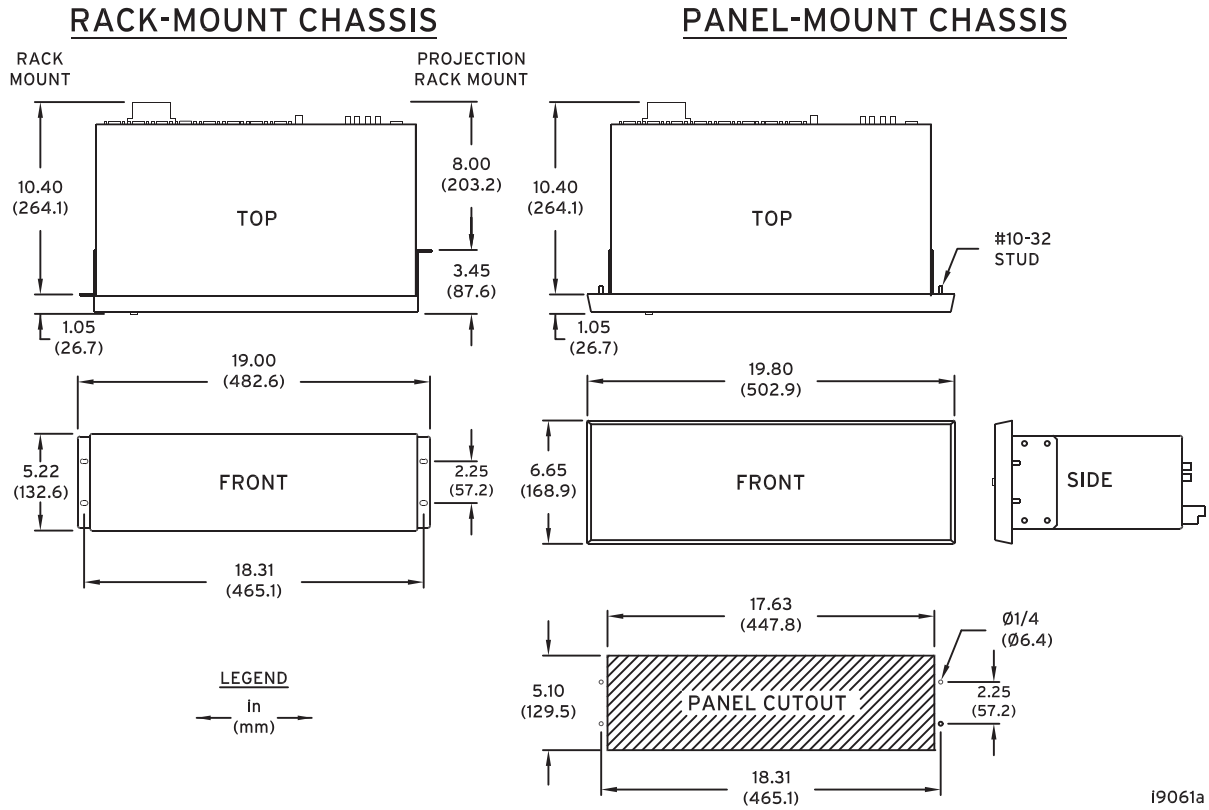



**Figure 2.2 Dimensions Diagram**

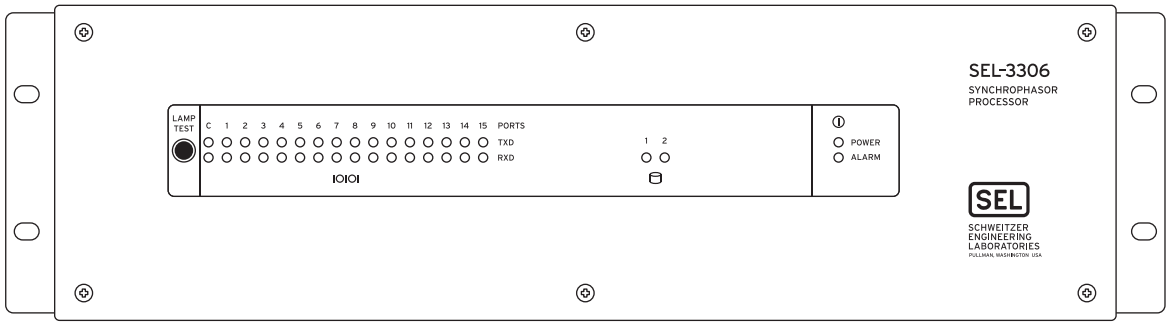



**Figure 2.3 Front Rack-Mount Diagram**

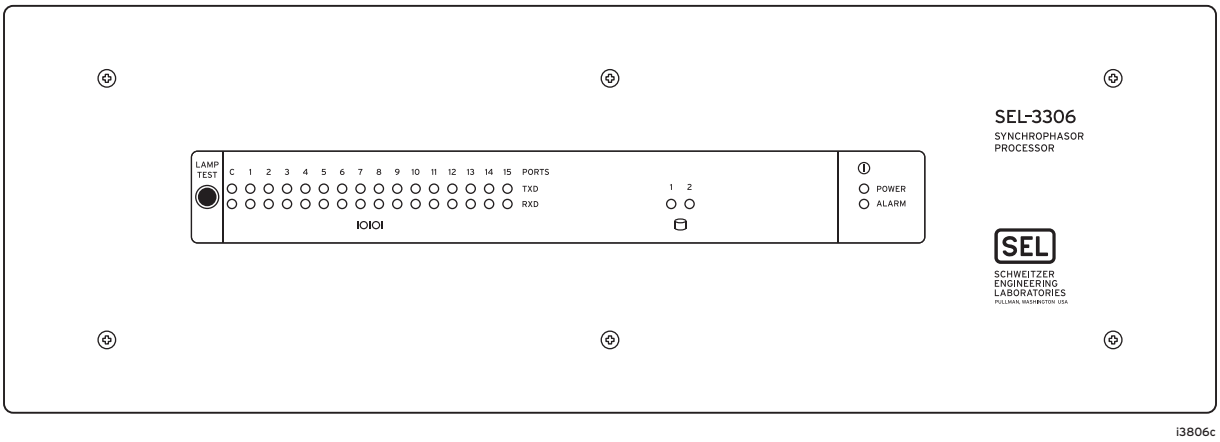



**Figure 2.4 Front Panel-Mount Diagram**

# Rear-Panel Connections

The physical layout of the connectors on the rear panel of an SEL-3306 is shown in *Figure 2.5*.

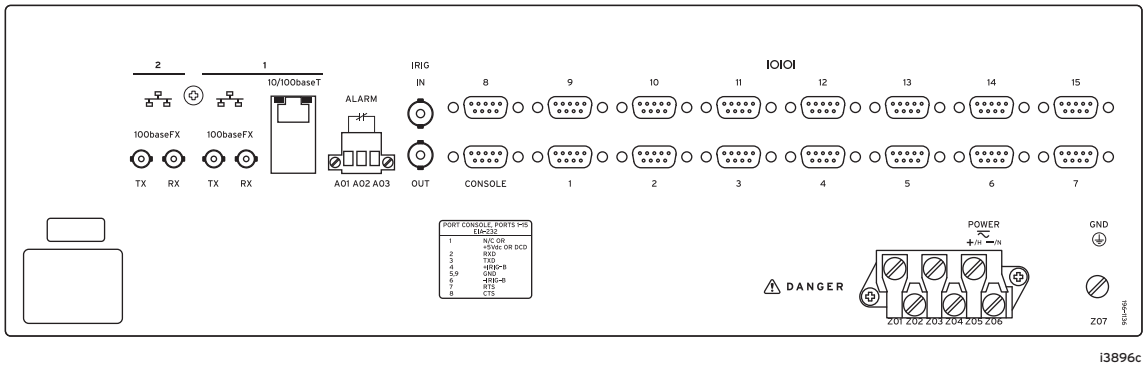



**Figure 2.5 Rear-Panel Diagram**

## Ethernet Connection

Use the Ethernet connection to send correlated synchrophasor data to other synchrophasor data processors and for synchrophasor applications. Also use the Ethernet port to read synchrophasor data from other PMCUs and the SEL-3306. Refer to *Figure 1.1* for application overview.

The SEL-3306 is equipped with dual Ethernet. Ethernet Port 1 is jumper selectable between copper 10/100BASE-T or fiber-optic 100BASE-FX (see *Figure 2.1* and *Table 2.1*). The Ethernet Port 1 copper and fiber interface cannot be used at the same time. Ethernet Port 2 is 100BASE-FX only.

The LEDs on the Ethernet Port 1 jack apply to both copper and fiber connections. The left LED illuminates orange for a 10 Mbps connection and green for a 100 Mbps connection. The LED on the right flashes yellow during data transfer.

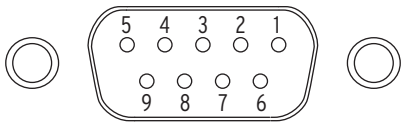
The dual Ethernet function of the SEL-3306 is the same as for a standard dual Ethernet PC-AT compatible computer.

## Serial Port Communications

Sixteen serial ports (**Console**, **1**–**15**) are available on the SEL-3306, as shown in *Figure 2.5*.

**Console** port is dedicated for interfacing with the SEL-3306. The port has a fixed data rate of 9600 baud (8, 1, N, HW flow control). Ports **1** through **15** have settable data rates. Use these ports to read synchrophasor data from different protective devices (SEL-311, SEL-421, or SEL-451), metering devices (SEL-734), and other PMCUs.

The serial ports function as standard EIA-232 ports. See *Figure 2.6* for EIA-232 DB-9 female connector pin numbers. See *Table 2.2* for EIA-232 serial port pin functions.




Female chassis connector, as viewed from the outside panel.

**Figure 2.6 EIA-232 DB-9 Connector Pin Numbers**

The communications circuits have internal surge protection.

**Table 2.2 Serial Port Connector Pin Definition**

| Pin | Signal Name | Description |
|---|---|---|
| 1 | N/C or +5 Vdc or DCD[a] | Modem power |
| 2 | RXD | Receive data |
| 3 | TXD | Transmit data |
| 4 | +IRIG-B | Time-code signal positive |
| 5 | GND | Chassis ground |
| 6 | -IRIG-B (GND) | Time-code signal negative |
| 7 | RTS | Request to send |
| 8 | CTS | Clear to send |
| 9 | GND | Chassis ground |

[a] Jumper configurable

**NOTE:** The SEL-3306 serial ports (Console, 1–15) transmit IRIG-B. Do not connect to another device with a serial port that transmits IRIG-B.

The following figures show common serial cable configurations. Refer to SEL-5801 Cable Selector Software for the most recent cable configurations. *Figure 2.7* shows the C235 serial cable for interfacing SEL-3306 (through the console port) with a local computer. *Figure 2.8* shows the C272A serial cable

for connecting to PMCUs that do not require RTS/CTS information. Use cables C273A and C276 in *Figure 2.8* and *Figure 2.9* to connect to PMCUs that require RTS/CTS information.

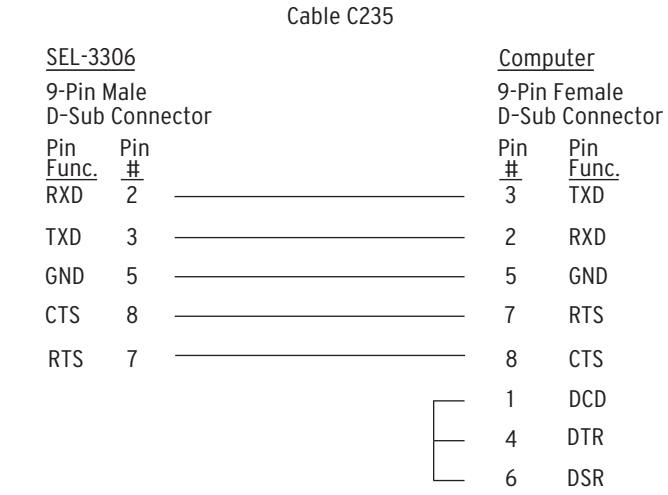



**Figure 2.7 SEL Cable C235**

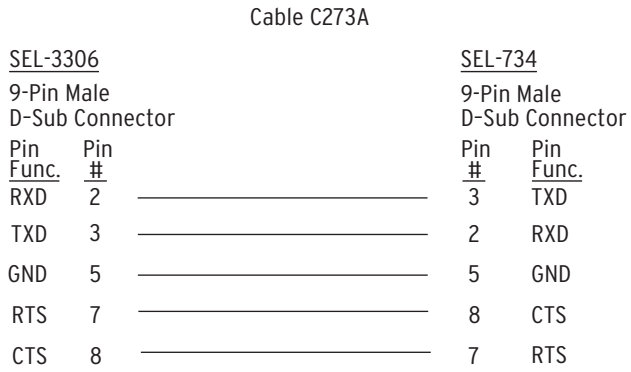



**Figure 2.8 SEL Cable C282**

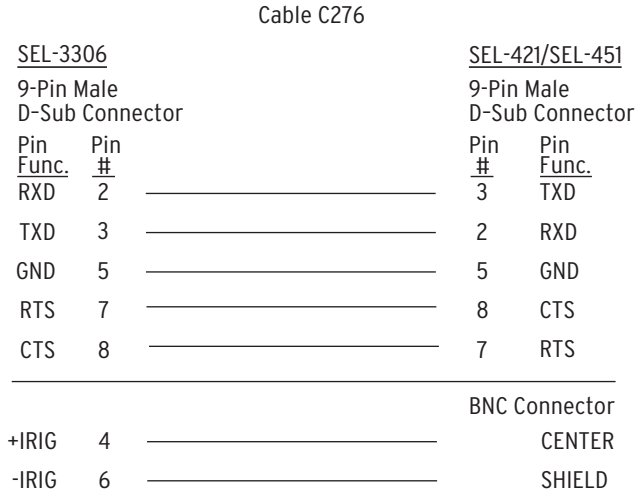



**Figure 2.9 SEL Cable C276**

**WARNING**
Never use standard null-modem cables with the SEL-3306. Using any non-SEL cable can cause severe power and ground problems involving Pins 1, 4, and 6 on the SEL-3306 communications ports.

The following list provides additional rules and practices necessary for successful communication with EIA-232 serial communications devices and cables:

- Keep communications cables as short as possible to minimize communications circuit interference and to minimize the magnitude of hazardous ground potential differences that can develop during abnormal power system conditions.
- EIA-232 communications cables should never exceed 50 feet. Always use shielded cables for communications circuits longer than 10 feet.
- Modems or fiber-optic lines are necessary for communication over long distances and to provide isolation from ground potential differences between device locations. Refer to the SEL-2800 series of fiber-optic transceivers.
- Route communications cables away from power and control circuits. Switching spikes and surges in power and control circuits can cause noise in inadequately separated communications circuits.

## IRIG-B Connections

The SEL-3306 accepts modulated (B122) or demodulated (B002) IRIG-B on the BNC IRIG-B input connector. Demodulated IRIG-B is distributed through the BNC IRIG-B output connector and on Pins 4 and 6 of the serial ports.

**NOTE:** IRIG-B input is not available on any serial communication ports.

IRIG-B can be distributed through serial ports and a BNC connector. IRIG propagation delay though SEL-3306 serial outputs is about 350 ns. IRIG propagation delay through BNC output is about 300 ns. The distributed IRIG-B can be used for time synchronization of connected PMCUs. To distribute IRIG-B to PMCUs sending C37.118-2006 synchrophasor data, use an IRIG-B input that has IEEE C37.118-2006 compliant control bit information.

**WARNING**
If a modulated IRIG-B input is used, the demodulated IRIG-B output is unsuitable for synchronizing connected PMCUs.

Use the IRIG-B input to update day-of-the-year and time-of-day but not year. Update the year manually. See *DATE on page 3.2* to change the year. The SEL-3306 stores the year for the set date in nonvolatile memory. Once the date is set properly, the SEL-3306 maintains the proper year even if power cycles off and on.

## Alarm Contact Connection

**WARNING**
Do not operate device unless the device is properly grounded.

The SEL-3306 includes an alarm output contact connected to terminals **A01** and **A03**. Terminal **A02** is not used. By default, the alarm contact is closed for an alarm condition and open for normal operation. To invert the alarm output contact to close under normal conditions (i.e., Form A), contact your local SEL representative for assistance.

The SEL-3306 monitors its critical subsystems and latches or pulses the alarm contact during failure or warning conditions. See *Section 5: Troubleshooting* for a discussion of these failures. The **ALARM** LED on the front panel illuminates whenever the alarm contact asserts. Ratings for the contact are 30 A make, 6 A continuous, and 0.5 A or less break (depending on circuit voltage). The alarm contact has a maximum safety rating of 250 Vac/330 Vdc.

## Ground Connection

Connect the grounding terminal (**#Z07**) labeled **GND** on the rear panel to a rack frame ground or main station ground for proper safety and performance. Use 14 AWG (2.5 $mm^2$) wire shorter than 6.6 feet (2 m) for this connection. This terminal connects directly to the internal chassis ground of the SEL-3306.

## Power Connection

**⚠WARNING**
Failure to ensure proper voltage levels can cause equipment damage.

**⚠WARNING**
Do not operate device unless properly grounded.

Connect the power terminals on the rear panel (**Z05(+/H)** and **Z06(-/N)**) to a proper power source that matches the power supply rating listed on the serial number sticker on the rear panel as shown in *Figure 2.10*. Ensure that the connected voltage is within the specified range. Refer to *Section 1: Introduction and Specifications* for power supply specification.

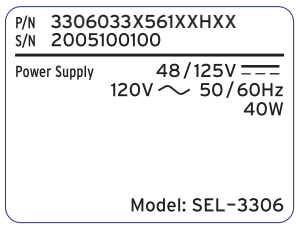



**Figure 2.10 Serial Number Sticker**

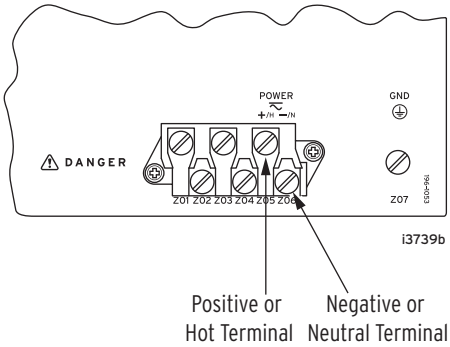



**Figure 2.11 Power Connections**

The power terminals are isolated from the chassis ground. Use 14 AWG (2.5 $mm^2$) to 16 AWG (1.5 $mm^2$) wire to connect to the power terminals.

Place an external switch, circuit breaker, or other overcurrent protection device in the power leads. The overcurrent protection device must interrupt both the hot and neutral power leads if dc powered. The maximum current rating for the overcurrent protection device must be no greater than 20 A. Be sure to locate this device within 9.8 feet (3.0 m) of the SEL-3306. Disconnect devices must comply with IEC 60947-1 and IEC 60947-3.1.

Operational power is internally fused on the power supply. See *Field Serviceability on page 2.10* for the fuse replacement procedure. An internal fuse failure indicates possible circuit board or electronic failure that can cause sporadic or incorrect device operation.

# Field Serviceability

The SEL-3306 is designed to provide years of trouble-free and maintenance-free operation. Should you need to maintain the device, consult this section for information on field-serviceable items. SEL recommends contacting your local SEL representative before performing any of the service items in this section. By contacting SEL, you provide SEL feedback necessary for determining if a common failure mode is developing. SEL can also provide any recent suggestions or clarifications to the following procedures.

## Fuse Replacement

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

**⚠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.

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

Step 1. De-energize the SEL-3306 by disconnecting or removing power.

Be sure that the power source is tagged properly to avoid accidental reenergization.

Step 2. Remove all connections from the rear of the SEL-3306.

Step 3. Remove the SEL-3306 from the panel or 19-inch rack.

Step 4. Remove the front panel.

Step 5. Remove the top cover.

Step 6. Remove the side and rear screw connections (see *Figure 2.12*) between the heatsink and the case.

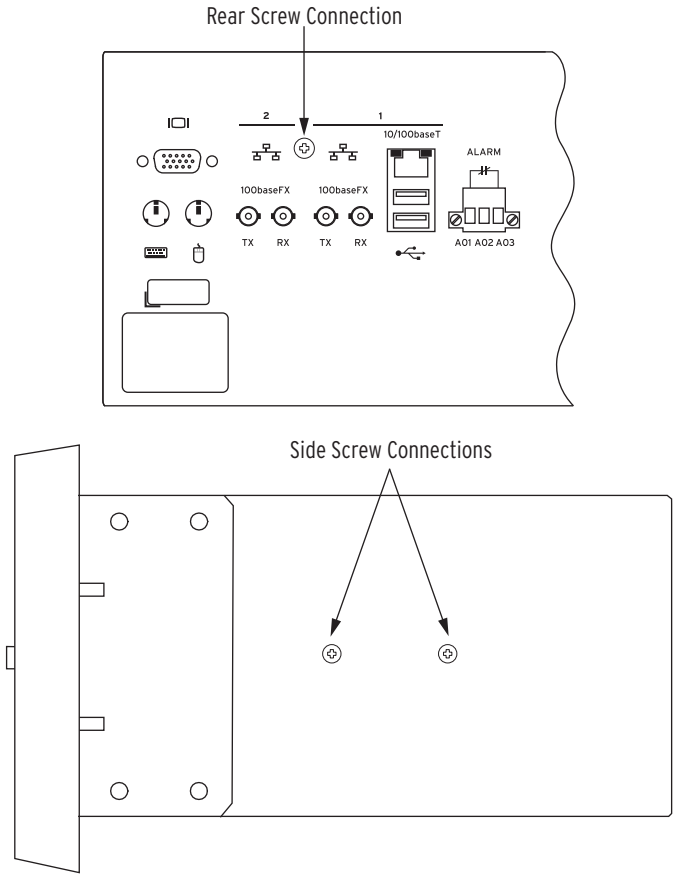



**Figure 2.12 Screw Connections**

Step 7. Gently slide out the top tray.

Step 8. Locate the power supply mounted on the bottom of the chassis.

Step 9. Locate the fuse F1 on the power supply as shown in *Figure 2.13*.

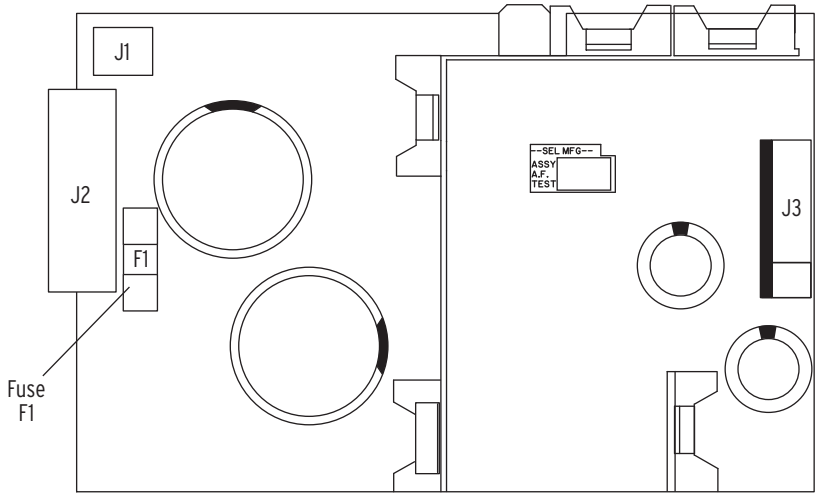



**Figure 2.13 PS30 Power Supply Fuse Location**

Step 10. Replace the fuse with fuse types listed in *Table 2.3*.

**Table 2.3 Fuse Requirements for the SEL-3306 Power Supply**

| Nominal Power Supply Voltage Rating | Fuse F1 | Fuse Description |
|---|---|---|
| 24/48 V | T6.3A H250V | 5 x 20 mm, time-lag, 6.3 A, high break capacity, 250 V |
| 48/125 V<br>120 V<br>50/60 Hz | T3.15A H250V | 5 x 20 mm, time-lag, 3.15 A, high break capacity, 250 V |
| 125/250 V<br>120/230 V<br>50/60 Hz | T3.15A H250V | 5 x 20 mm, time-lag, 3.15 A, high break capacity, 250 V |

Step 11. Gently slide in the top tray.

Step 12. Replace the side and rear screws.

Step 13. Connect the power supply cable.

Step 14. Replace the top cover.

Step 15. Replace the front panel.

Step 16. Replace the device into the panel or 19-inch rack.

Step 17. Replace all connections on the rear of the device.

Step 18. Reapply power to the SEL-3306.

## Lithium Battery Replacement

**⚠CAUTION**
There is danger of explosion if the battery is incorrectly replaced. Replace only with a 3 V lithium coin cell Ray-O-Vac® no. BR2335 or equivalent recommended by manufacturer. Dispose of used batteries according to the manufacturer's instructions.

A lithium battery powers the clock (supplying date and time) if the external power source is lost or removed. At room temperature, the battery will operate nominally for two years at rated load with no external source present. When an external source powers the SEL-3306, the battery discharges at a low rate and can operate longer than 10 years.

The battery cannot be recharged. To replace the lithium battery, perform the following steps.

Step 1. De-energize the device by disconnecting or removing power.

Be sure that the power source is tagged properly to avoid accidental reenergization.

Step 2. Remove all connections from the rear of the SEL-3306.

Step 3. Remove the SEL-3306 from the panel or 19-inch rack.

Step 4. Remove the front panel.

Step 5. Remove the top cover.

Step 6. Locate the battery B1 as shown in *Figure 2.1*.

Step 7. Remove the battery from underneath the retaining clip.

Properly dispose of the battery.

Step 8. Install a new battery with the positive (+) side up.

Step 9. Replace the top cover.

Step 10. Replace the front panel.

Step 11. Reinstall the SEL-3306 into the panel or 19-inch rack.

Step 12. Replace the cable connections in the rear of the SEL-3306.

Step 13. Reapply power to the SEL-3306.

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# Section 3
# Product Overview

## Overview

This section provides an overview of communication interfaces for configuring the SEL-3306. *Access Control and Security on page 3.4* explains security features that prevent unauthorized access. *Startup Procedure on page 3.5* provides a step-by-step commissioning procedure.

## Console Port

The console port provides a serial communication interface with the SEL-3306 for configuring the network settings, for displaying self-test status report information, and for setting date and time. **Console** is dedicated as the console port. The console port is set at a fixed data rate of 9600 (eight bits per byte, no parity, one stop bit, and no flow control).

Issue ASCII commands as needed to change product configuration or to view the status report.

The console port has three access levels (0, 1, 2). Each level has corresponding commands and includes the commands of any lower access level. See *Access Control and Security on page 3.4* for more details on console port access levels and passwords.

The following tables list commands, command descriptions, and command availability.

### Console Port Commands

#### HELP

Use the **HELP** (**HEL**) command to display a list of commands available at the present access level. Use **HEL** with the parameter *command* (e.g., **HEL ACC**) to obtain a detailed description of the command.

**Table 3.1 HELP Commands**

| Command | Description | Access Level |
|---|---|---|
| HEL | Display a list of commands | 1, 2 |

#### QUIT

Use the **QUIT** (**QUI**) command to go to Access Level 0. See *Access Control and Security on page 3.4* for more details on Access Level 0 and this command.

**Table 3.2 QUIT Command**

| Command | Description | Access Level |
|---|---|---|
| QUI | Go to Access Level 0 | 0, 1, 2 |

## ACCESS

Use the **ACCESS (ACC)** command to go to Access Level 1. See *Access Control and Security on page 3.4* for more details on Access Level 1 and this command.

**Table 3.3 ACCESS Command**

| Command | Description | Access Level |
|---|---|---|
| ACC | Go to Access Level 1 | 0, 1, 2 |

## 2ACCESS

Use the **2ACCESS (2AC)** command to go to Access Level 2. See *Access Control and Security on page 3.4* for more details on Access Level 2 and this command.

**Table 3.4 2ACCESS Command**

| Command | Description | Access Level |
|---|---|---|
| 2AC | Go to Access Level 2 | 1, 2 |

## PASSWORD

**⚠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.

Use the **PASSWORD (PAS)** command to change the password of the present access level to a new password. All passwords are case sensitive. See *Startup Procedure on page 3.5* for more details on changing passwords. See *Access Control and Security on page 3.4* for more details on password protection for the console port.

**Table 3.5 PASSWORD Commands**

| Command | Description | Access Level |
|---|---|---|
| PAS | Change passwords | 1, 2 |

## DATE

Use the **DATE (DAT)** command to display the date of the internal clock. Use the **SET DATE (SET DAT)** command to change the date.

If you enter an invalid date or date with invalid format, the SEL-3306 responds `Invalid Date`. The SEL-3306 overwrites the entered date (except year) if you connect IRIG to the SEL-3306. Regardless of whether IRIG is updating the internal clock, use the **SET DAT** command to change the year of the internal clock.

**Table 3.6 DATE Commands**

| Command | Description | Access Level |
|---|---|---|
| DAT | Display the internal clock date | 1, 2 |
| SET DAT | Change the internal clock date | 2 |

## TIME

Use the **TIME (TIM)** command to display the time of the internal clock. Use the **SET TIME (SET TIM)** command to change the time. If you enter an invalid time, the SEL-3306 responds `Invalid Time`. The SEL-3306 overwrites the entered time if an IRIG source is updating the internal clock.

**Table 3.7 TIME Commands**

| Command | Description | Access Level |
|---|---|---|
| TIM | Display the internal clock time | 1, 2 |
| SET TIM | Change the internal clock time | 2 |

## SHOW

Use the **SHOW (SHO)** command to display SEL-3306 setting labels and present values.

**Table 3.8 SHOW Command**

| Command | Description | Access Level |
|---|---|---|
| SHO | Show settings | 1, 2 |

## SET

Use the **SET** command to configure SEL-3306 network settings. See *Section 4* for more details on the settings and corresponding descriptions.

**Table 3.9 SET Command**

| Command | Description | Access Level |
|---|---|---|
| SET | Change setting configuration | 2 |

When you change settings, the SEL-3306 displays the setting label, prompt and present value. *Table 3.10* lists the possible keyboard operations from a settings prompt.

**Table 3.10 Possible Keyboard Operations**

| Press Key(s) | Response |
|---|---|
| <Enter> | Accept setting and move to next setting |
| value <Enter> | Enter the given value and move to the next setting if valid |

The SEL-3306 checks each setting to ensure that it is within the allowed range. If the setting is not within the allowed range, the relay generates an appropriate error message and prompts you again for the setting.

When you have entered all settings, the SEL-3306 displays the new settings and prompts you for approval. Answer **Y <Enter>** to enable the new settings. Upon successful completion of the **SET** command session, the SEL-3306 becomes disabled for about 10 seconds while it saves the setting values in nonvolatile memory.

### STATUS

Use the **STATUS (STA)** command to display the SEL-3306 self-test status report. See *Section 5: Troubleshooting* for more details. Use **STA** with parameter C to clear the status report. Clearing the status report initiates a reboot of the SEL-3306. See *Status Report on page 5.1* for details.

**Table 3.11 STATUS Commands**

| Command | Description | Access Level |
|---|---|---|
| STA | Display the self-test status report information | 1, 2 |
| STA C | Clear the status report information and reboot the SEL-3306 | 2 |

# Access Control and Security

Controlled access levels and multilevel passwords for the console port prevent unauthorized access. The SEL-3306 comes with default passwords. It is extremely important that you change the factory default passwords. Setting unique passwords for the product access levels increases security. This subsection provides information on access control and security for the console port.

The console port has three access levels: 0, 1 and 2. *Figure 3.1* shows the general access level structure for the console port.

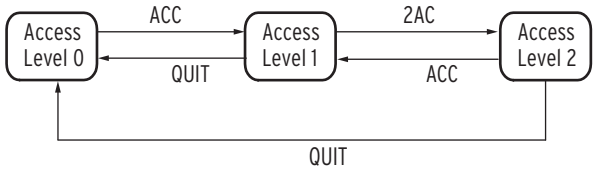


**Figure 3.1 Console Port Access Level Structure**

**⚠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.

Access Level 0 provides very limited access. Access Level 1 provides access only for viewing settings. Access Level 2 provides full access for viewing and modifying settings. Each access level has an associated prompt that indicates the active level. Moving from lower to higher security levels is sequential and requires correct passwords. *Figure 3.1* lists the access levels, prompts, ASCII commands, and corresponding factory default passwords.

**Table 3.12 Console Port Access Levels, Prompts, ASCII Commands, and Passwords**

| Access Level | Prompt | ASCII Command | Factory Default Password |
|---|---|---|---|
| 0 | = | QUIt | (none) |
| 1 | => | ACCess | Nevada-3306 |
| 2 | =>> | 2ACess | Sierra-3306 |

You must first enter a correct password to move from Access Level 0 to Access Level 1. To enter Access Level 2, you must enter a correct password from Access Level 1. For example, to go to the Access Level 2 from Access Level 1, type **2AC <Enter>**. At the `Password: ?` prompt, type your Access Level 2 password.

If you are unable to enter the correct password after the third failed attempt, the SEL-3306 displays on a communications terminal screen the following error message: `Bad password. Console is now locked.` In addition, you cannot make further access level entry attempts for 30 seconds.

Passwords can contain as few as 6 characters and as many as 16 characters. The SEL-3306 treats upper- and lowercase letters as different characters. Strong passwords consist of at least the allowed number of characters, with at least one special character, number 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.

**Table 3.13 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<br>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 | ! " # $ % & ' ( ) * + , - . / : ; < = > ? @ [ \ ] ^ _ ` { \| } ~ |

See *Startup Procedure on page 3.5* for details on changing passwords.

Use the **QUI** command from any access level to return to Access Level 0.

When the console session times out, the access level resets to Access Level 0.

# Startup Procedure

This subsection provides a step-by-step procedure for SEL-3306 commissioning, which includes initial checkout and console port password change.

## Initial Checkout

Perform the following steps for initial checkout.

Step 1. Visually inspect the SEL-3306 for any loose or damaged parts.

Step 2. Use the information provided in *Unit Placement and Maintenance on page 2.5* to properly mount the SEL-3306.

Step 3. Use an SEL-C234A cable or equivalent to connect a computer equipped with terminal emulation software to the console port (**Console**) of the SEL-3306.

Step 4. Connect any PMCUs sending synchrophasor data through serial cable to SEL-3306 serial ports. See *Section 2* for details.

Step 5. Use a BNC cable to connect any GPS clock with IRIG-B output to the SEL-3306 **IRIG IN** input. See *Section 2* for more details on the IRIG-B connection.

Step 6. Connect and apply power to the SEL-3306. Wait five minutes for the device to boot.

Step 7. Press and hold the **LAMP TEST** button and confirm that all LEDs illuminate.

Step 8. Set the computer terminal emulation software to operate at the following settings:

- 9600 bits per second (sometimes called baud)
- 8 data bits

- 1 stop bit
- no parity
- hardware flow control

Step 9. Press **<Enter>**.

Step 10. Verify that the SEL-3306 returns the = prompt.

Completion of this procedure should have successfully established console port communication.

## Console Port Password Change

**⚠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.

Perform the following steps to change access level passwords on the console port.

Step 1. Type **ACC** and press **<Enter>** at the = prompt to go to Access Level 1.

If you have not yet changed the password, enter the factory default password (**Nevada-3306**) and press **<Enter>**. The password is case sensitive. The SEL-3306 returns the => prompt.

Step 2. Type **2AC** and press **<Enter>** at the => prompt to change to Access Level 2.

If you have not yet changed the password, enter the factory default password (**Sierra-3306**) and press **<Enter>**. The SEL-3306 returns the =>> prompt.

Step 3. Type **PAS** and press **<Enter>** at the =>> prompt to change the Access Level 2 password from the default.

Step 4. Verify that the SEL-3306 returns the prompt `Old Password: ?`. Enter the Access Level 2 password (**Sierra-3306**) and press **<Enter>**.

Step 5. Verify that the SEL-3306 returns the prompt `New Password: ?`.

Step 6. Enter the new password (for example, **ot7S#Er**) and press **<Enter>**.

See *Access Control and Security on page 3.4* for more details on using strong passwords. Verify that the SEL-3306 returns the prompt `Verify New Password: ?`.

Step 7. Enter the new password (for example, **ot7S#Er**) again and press **<Enter>**.

If the new passwords do not match, the SEL-3306 issues a `New passwords do not match` response. Otherwise, the SEL-3306 issues a `Password for Level 2 changed` response.

Step 8. Similarly, use the **PAS** command at Access Level 1 to change the Access Level 1 password.

# Network Configuration Settings

The console port is used mainly to configure network configuration settings for Ethernet Port 1 and 2 during product installation. See *Ethernet Connection on page 2.6* for more details regarding the Ethernet port and connections. *Table 3.14* shows the network configuration settings and default values that you can modify or display at the console port through the use of the **SET** or **SHO** commands.

**Table 3.14 Network Configuration settings**

| Label | Prompt | Default Value |
|---|---|---|
| 01ETHEN | Enable network interface 01 | Y |
| 01ETDHCP[a] | Enable DHCP on network interface 01 | Y |
| 01ETIPAD[a,b] | Network interface 01 IP address | 0.0.0.0 |
| 01ETSNMK[a,b] | Network interface 01 subnet mask | 0.0.0.0 |
| 01ETGTWY[a,b] | Network interface 01 gateway | 0.0.0.0 |
| 02ETHEN | Enable network interface 02 | Y |
| 02ETDHCP[c] | Enable DHCP on network interface 02 | Y |
| 02ETIPAD[c,d] | Network interface 02 IP address | 0.0.0.0 |
| 02ETSNMK[c,d] | Network interface 02 subnet mask | 0.0.0.0 |
| 02ETGTWY[c,d] | Network interface 02 gateway | 0.0.0.0 |
| ETDNS[e] | Domain Name Server address DNS | 0.0.0.0 |
| ETDOMA[e] | Network domain name | NA |
| ETHOST[e] | Network hostname | NA |

[a] Setting is hidden when 01ETHEN = N.
[b] Setting shows only when 01ETDHCP = N.
[c] Setting is hidden when 02ETHEN = N.
[d] Setting shows only when 02ETDHCP = N.
[e] Setting is hidden when 01ETHEN = N and 02ETHEN = N.

The SEL-3306 default network configuration settings assume that the two Ethernet ports are enabled, that the network has a DHCP server, and that there is at least one DNS server. The DHCP (Dynamic Host Configuration Protocol) server dynamically assigns IP configuration (i.e., IP address, Subnet Mask, and Gateway address) to the Ethernet port. The DNS (Domain Name System) server translates domain and host names into IP addresses. Use the 01ETHEN and 02ETHEN settings to enable Ethernet Ports 1 and 2. If you have a DHCP server in the network, use the 01ETDHCP and 02ETDHCP settings to enable the DHCP server to provide IP configuration automatically. Contact your network administrator for the network configuration.

The following is an example of how to configure SEL-3306 network settings for a utility *xyz*. Ethernet Port 1 on SEL-3306 is connected to the utility network, which has a DHCP server. Ethernet Port 2 on SEL-3306 is connected to a different network that has no DHCP server. The utility *xyz* has a registered domain name *xyz.com* and a DNS server.

Step 1. Gain access to Access Level 2 on the console port.

Step 2. Each Ethernet port has a unique MAC address. MAC addresses for Ethernet ports can be found by using the **STA** command.

Step 3. Provide the MAC addresses to the network administrator for reserving static IP configuration for the SEL-3306 Ethernet ports.

Step 4. Use the **SET** command to enter the new settings.

**Table 3.15 New Settings**

| Prompt | Action |
|---|---|
| Enable network interface 01 | **Y <Enter>** |
| Enable DHCP on network interface 01 | **Y <Enter>** |
| Enable network interface 02 | **Y <Enter>** |
| Enable DHCP on network interface 02 | **Y <Enter>** |
| Network interface 02 IP address | **123.123.123.123 <Enter>** |
| Network interface 02 subnet mask | **255.255.0.0 <Enter>** |
| Network interface 02 gateway | **231.211.212.1 <Enter>** |
| Domain Name Server address DNS | **1.1.1.1 <Enter>** |
| Network domain name | **XYZ.COM <Enter>** |
| Network hostname | **HOSTNAME <Enter>** |
| Are you sure you want to change settings? | **Y <Enter>** |

Step 5. Connect SEL-3306 Ethernet ports to the network.

Step 6. Issue a **SHO** command again at the =>> prompt and press **<Enter>**.

Step 7. SEL-3306 responds as follows:

```
=>>SHO <Enter>

Network Configuration
01ETHEN  : Y
01ETDHCP : Y
02ETHEN  : Y
02ETDHCP : N
02ETIPAD : 123.123.123.123
02ETSNMK : 255.255.0.0
02ETGTWY : 231.211.212.1
  ETDNS  : 1.1.1.1
  ETDOMA : XYZ.COM
  ETHOST : HOSTNAME
```

# Section 4
# Product Application Example

## Overview

This section provides a practical example of synchrophasor measurement acquisition, concentration, and application.

It describes the configuration requirements for a system with three substations that provide synchrophasor data at two different message rates: 60 messages per second and one message per second. Each of the stations has one SEL-3306 Synchrophasor Processor. The synchrophasor processors provide data to upper-tier applications. The section ends with a visualization example that uses SYNCHROWAVE® wide-area visualization software to show phasor and frequency data from different PMCUs in the system.

## System Configuration

The synchrophasor data acquisition, processing, and application system that includes PMCUs and PDCs for three substations is shown in *Figure 4.1*.

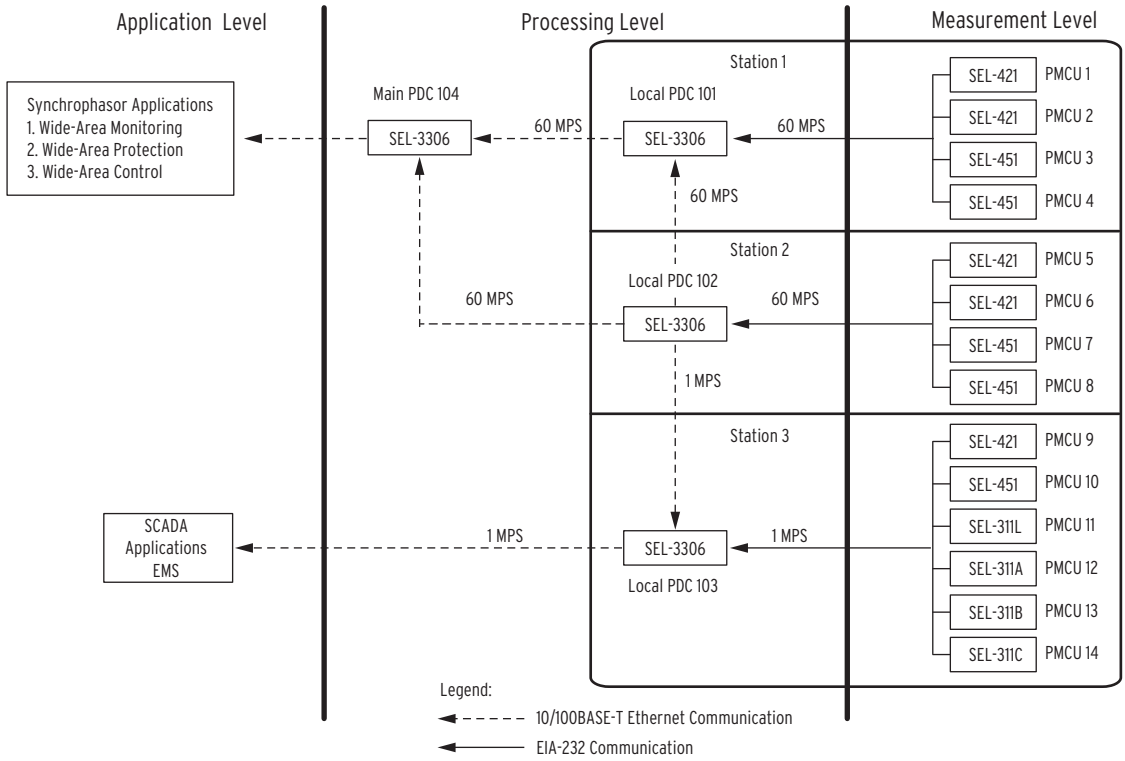


**Figure 4.1 Synchrophasor Data Acquisition, Processing, and Application System for Three Substations**

The system can be divided into three sections:

1. Synchronized measurement section, where phasor measurement and control units measure and time-stamp power system signals such as voltages, currents, and frequencies and send these signals to synchrophasor processors.
2. Data processing section, where the synchrophasor processors correlate synchrophasor data from many PMCUs according to time stamp and send these organized data to different locations at the necessary transmission speed.
3. Application section, where the use of visualization software tools integrated to the energy management system, etc. provides display of correlated information from different points of the system.

The data are measured in three power stations (Stations 1, 2, and 3). PDC 101 (Station 1) and PDC 102 (Station 2) send the synchrophasor data to PDC 104 at sixty messages per second. PDC 102 also sends the synchrophasor data to PDC 103 (Station 3) at one message per second.

The data from Station 2 are also routed through PDC 101 to get to PDC 104.

The data from PDC 104 synchrophasor processor are used for wide-area monitoring, control, and protection. PDC 103 sends one data message per second to SCADA and to the System State Estimator.

## Station 1

Station 1 consists of two SEL-421 (PMCU 1 and PMCU 2) and two SEL-451 (PMCU 3 and PMCU 4) phasor measurement and control units along with the SEL-3306 Synchrophasor Processor (Local PDC 101). All PMCUs in the station send the synchrophasor data at the speed of 60 messages per second and according to C37.118-2006 standard protocol. *Figure 4.2* and *Figure 4.3* show the settings related to PMCU 1.

```
MFRMT   := C37.118
MRATE   := 60
PMSTN   := "PMCU 1"
PMID    := 1
```

**Figure 4.2 PMCU 1 Synchrophasor Measurement Settings**

```
PROTO   := PMU
SPEED   := 57600
STOPBIT := 1
RTSCTS  := Y
PARITY  := N
```

**Figure 4.3 PMCU 1 Serial Port Communication Settings**

# SEL-3306 PDC 101 Configuration

## General Configuration

**Station Name.** The station name can contain as many as 16 ASCII printable characters. This name identifies the substation in which the SEL-3306 Synchrophasor Processor is located.

**ID Number.** Possible ID numbers range from 1 to 65534 and should be unique for each PDC/PMCU in the system.

**Header Frame.** The header frame can contain as many as 256 ASCII printable characters.

**Nominal System Frequency.** This is the nominal frequency of the system.

**Input Message Rate Per Second.** The input synchrophasor message rate must be the same for all the PMCUs connected to the synchrophasor processor. The SEL-3306 supports up to 1, 2, 4, 5, 10, 12, 15, 20, 30, or 60 messages per second for a 60 Hz nominal frequency system, and 1, 2, 5, 10, 25, or 50 messages per second for a 50 Hz nominal frequency system.

**Maximum Message Waiting Period.** This is the maximum time that the SEL-3306 has to wait for time alignment of the input synchrophasor data from different PMCUs. The period begins with the arrival of the first message of a particular time stamp at the PDC. This time accounts for the maximum combined measurement and communication delays. Measurement delay is the time during which the PMCU develops a synchrophasor (includes filtering or group delay). Note that different PMCUs have different measurement delays. The communication delay is the time for synchrophasor data to travel from the PMU to the SEL-3306. Note that communication delays vary for different PMCUs depending on medium (serial or Ethernet), PMCU location, the amount of congestion on the network (if Ethernet), baud rate (if serial), etc. In our example, all the PMCUs are connected serially and are of the same type (SEL-400 series). A maximum waiting period of 300 milliseconds would be sufficient in this case. The longest delay comes from the Ethernet link connecting PDC 101 with PDC 102.

**Port Time-Out.** The time-out applies to the console interface (Access Level 1 and above). If there is no activity (no ASCII characters transmitted or received) within the time specified by the time-out setting, the access level changes to Level 0. The time-out can be disabled or range from 1 to 30 minutes. When the time-out is disabled, the console session never times out.

**IRIG Signal Type.** The SEL-3306 can accept modulated or demodulated IRIG-B. In this example, the SEL-2407 Satellite-Synchronized Clock provides a demodulated IRIG-B signal.

**Table 4.1 SEL-3306 PDC 101 General Data Configuration**

| Description | Value |
|---|---|
| Station Name | MARS PDC 101 |
| ID Number | 101 |
| Header Frame | Not used |
| Nominal System Frequency | 60 Hz |
| Input Message Rate per Second | 60 messages per second |
| Maximum Message Waiting Period | 300 milliseconds |
| Port Time-Out | 10 minutes |
| IRIG-B Signal Type | Demodulated |

## Serial Port Configuration

SEL-3306 configuration must be such that the PMCUs connected to the SEL-3306 serial ports can send synchrophasor data and receive commands. As many as 15 PMCUs can be connected to SEL-3306 serial ports and support synchrophasor data in such different formats as IEEE 1344, IEEE C37.118-2006, and SEL Fast Message (FM).

Serial Ports 1, 2, 3, and 4 of the SEL-3306 PDC 101 are enabled and configured to receive data from PMCU 1, PMCU 2, PMCU 3, and PMCU 4, respectively.

**PMU Message Format.** This is the same as the synchrophasor data format that the connected PMCU or PDC sends.

**PMU/PDC ID Number.** This must be the same as the ID number of the connected PMCU or PDC. In our example, PMCU 1 connects to Serial Port 1 of PDC 101. The ID number ranges from 1 to 65534 when the connected PMCU message format is C37.118-2006 or FM. The ID number ranges from 0 to 18446744073709551615 for decimal or 0x0000000000000000 to 0xFFFFFFFFFFFFFFFF for hexadecimal format, when the connected PMU message format is 1344.

**Voltage Angle and Current Angle Compensation Factors.** These values compensate for the steady-state phase errors (introduced by phase-shifting transformers, DY transformers, instrument transformers, wiring characteristics, etc.) in the synchrophasor data. Note that the SEL-300 and SEL-400 series PMCUs have these corrections as part of their settings.

**Data Speed.** This value must match the baud rate of the input synchrophasor data the SEL-3306 receives.

**Table 4.2 SEL-3306 PDC 101 Serial Port 1 Configuration**

| Description | Value |
|---|---|
| PMU Message Format | C37.118-2006 |
| PMU/PDC ID Number | 1 |
| Voltage Angle and Current Angle Compensation Factor | 0 degrees |
| Data Speed | 57600 |

Configuration of Serial Ports 2, 3, and 4 of PDC 101 uses different PMU/PDC ID numbers, but is otherwise similar to Port 1 configuration.

## Ethernet Port Configuration

SEL-3306 configuration must be such that the PMCUs connected to SEL-3306 Ethernet ports can send synchrophasor data and/or receive commands. The SEL-3306 can receive input synchrophasor data via UDP, TCP, or Telnet. The PMCUs can issue commands via TCP or Telnet. As many as 40 PMCUs can be connected to an SEL-3306 Ethernet port. The SEL-3306 can support synchrophasor data in such different formats as IEEE1344, IEEE C37.118-2006, and SEL FM over Ethernet.

**PMU Message Format.** This is the same format as the synchrophasor data format that the connected PMCU or PDC sends.

**PMU/PDC ID Number.** This ID number must be the same as the ID number of the connected PMU/DC. In our example, PDC 102 connects to Ethernet Port 1 of the PDC 101. The ID number ranges from 1 to 65534 when the connected PMCU message format is C37.118-2006 or FM. The ID number ranges from 0 to 18446744073709551615 for decimal or 0x0000000000000000 to 0xFFFFFFFFFFFFFFFF for hexadecimal format when the connected PMCU message format is 1344.

**Voltage Angle and Current Angle Compensation Factors.** These values correct the steady-state phase errors (introduced by phase-shifting transformers, DY transformers, instrument transformers, wiring characteristics, etc.) in the synchrophasor data. Note that the SEL-400 series PMCUs have these corrections as part of their settings.

**PMU IP Address.** This must be the same as the IP address of the connected PMCU or PDC.

**PMU Transmit Data Protocol.** It is through a connection with this protocol that the SEL-3306 receives synchrophasor data (UDP or TCP). PDC 102 uses UDP to send data.

**Telnet.** You can enable Telnet only for TCP connections.

**PMU Ethernet Data Port Number.** This number specifies a data port on which the SEL-3306 uses a UDP connection to receive synchrophasor data. Each Ethernet port should have a unique number.

**PMU Ethernet Command Port Number.** This number specifies a port on which the SEL-3306 will receive synchrophasor data and send commands if the port uses a TCP connection to transmit data. This number specifies a port on which the SEL-3306 will send commands if the data port uses a UDP connection.

**Table 4.3 SEL-3306 PDC 101 Ethernet Port 1 Configuration**

| Description | Value |
|---|---|
| PMU Message Format | C37.118-2006 |
| PMU/PDC ID Number | 102 |
| Voltage Angle and Current Angle Compensation Factors | 0 degrees |
| PMU IP Address | 100.100.100.102<br>(IP address of PCD 102) |
| PMU Transmit Data Protocol | UDP |
| Ethernet Data Port Number | 20001 |
| PMU Ethernet Command Port Number | 20002 |

## Output Configuration

Use PDC Output Configuration to configure the SEL-3306 to send aligned synchrophasor data to a synchrophasor application (such as SYNCHROWAVE, PDCStreamReader, etc.) or a synchrophasor processor (SEL-3306 or other PDC). The SEL-3306 can transmit as many as six synchrophasor data streams through its two physical Ethernet ports. The output data stream can be either an IEEE C37.118-2006 or a BPA PDC Stream.

**Output Message Format.** The output message format configures the output synchrophasor data format (C37.118-2006 or BPA PDC stream) on the enabled port.

**Output Phasor Format.** The output phasor format specifies the phasor format in the synchrophasor data output. This phasor format can be polar or rectangular. Note that for the BPA format, the phasor format is always rectangular and that a setting option is unavailable.

**Destination IP Address.** The destination IP address is an IP address to which the SEL-3306 sends the output data stream. The IP address can be a PC address where an application such as SYNCHROWAVE or PDCStreamReader is running, or it can be the IP address of a synchrophasor processor (SEL-3306 or other PDC). The IP address of PDC 104 is 100.100.100.104.

**Output Data Port Number.** The output data port number specifies a port number for sending output synchrophasor data through the use of the UDP protocol.

**Output Command Port Number.** The output command port number specifies a port number for receiving commands using TCP protocol. This number should be unique for each enabled output port.

**Output Message Rate.** The output message rate specifies the output synchrophasor message rate on the selected output in number of messages per second.

You can configure each output data port for different output message rates, but the output message rate should be evenly divisible into the input data rate. For example, if the input message rate, MRATE, is 30 messages per second, you can configure the output message rate for different output ports as 1, 2, 5, 6, 10, 15, or 30.

**Output Message in PMU Frames.** The output message in PMU frames specifies the amount of data a particular port will send. The maximum value is 40 PMU frames.

**Output Messages.** The output messages determine which of the messages the PDC receives are included in the particular Ethernet output. In this example, data the PDC receives on Serial Ports 1, 2, 3, and 4 (four PMCUs) and on Ethernet Port 1 (messages from the four PMCUs of Station 2) must be sent on Ethernet Output 1.

**Table 4.4 SEL-3306 PDC 101 Output 1 Configuration**

| Description | Value |
|---|---|
| Output Message Format | C37.118-2006 |
| Output Phasor Format | Polar |
| Destination IP Address | 100.100.100.104 |
| Output Data Port Number | 10001 |
| Output Command Port Number | 10002 |
| Output Message Rate | 60 messages per second |
| Output Message in PMCU Frames | 8 |
| Output Messages | Serial Port 1, 2, 3, and 4<br>plus 4 PMCUs from Ethernet Port 1 |

## Station 2

Station 2 consists of two SEL-421 relays (PMCU 5 and PMCU 6) and two SEL-451 (PMCU 7 and PMCU 8) phasor measurement and control units along with the SEL-3306 Synchrophasor Processor (Local PDC 102). All PMCUs in the station are set to send the synchrophasor data at a speed of 60 times per second and according to standard C37.118-2006 protocol.

All Station 2 PMCUs communicate with the local PDC (PDC 102) through serial connections. The synchrophasor measurement settings of the PMCUs are similar to the settings of PMCUs in Station 1 but have different station names and ID numbers (the ID number should be unique for each PMCU in the system).

## SEL-3306 PDC 102 Configuration

### General Data Configuration

**Table 4.5 SEL-3306 PDC 102 General Data Configuration**

| Description | Value |
|---|---|
| Station Name | PLUTO PDC 102 |
| ID Number | 102 |
| Header Frame | Not used |
| Frequency | 60 Hz |
| Input Synchrophasor Data Rate | 60 messages per second |
| Maximum Message Waiting Period | 50 milliseconds |
| Port Time-Out | 10 minutes |
| IRIG-B Signal Type | Demodulated |

### Serial Port Configuration

Serial Ports 1, 2, 3, and 4 of the SEL-3306 PDC 102 are enabled and configured to receive data from PMCU 5, PMCU 6, PMCU 7, and PMCU 8, respectively.

**Table 4.6 SEL-3306 PDC 102 Serial Port 1 Configuration**

| Description | Value |
|---|---|
| PMU Message Format | C37.118-2006 |
| PMU/PDC ID Number | 5 |
| Voltage Angle and Current Angle Compensation Factors | 0 degrees |
| Data Speed | 57600 |
| Input Synchrophasor Data Rate | 60 messages per second |
| Maximum Message Waiting Period | 50 milliseconds |
| Port Time-Out | 10 minutes |
| IRIG-B Signal Type | Demodulated |

Other serial ports of the PDC 102 are configured similarly but have different PCU/PDC ID numbers.

### Ethernet Port Configuration

None of the Ethernet input ports of the SEL-3306 PDC 102 are enabled.

## Output Configuration

Ethernet Output 1 of the SEL-3306 PDC 102 is enabled and configured to send data to PDC 101, Ethernet Output 2 is enabled and configured to send data to PDC 103, and Ethernet Output 3 is enabled and configured to send data to PDC 104.

**Table 4.7 SEL-3306 PDC 102 Output 1 Configuration**

| Description | Value |
|---|---|
| Output Message Format | C37.118-2006 |
| Output Phasor Format | Polar |
| Destination IP Address | 100.100.100.101<br>(IP address of PDC 101) |
| Output Data Port Number | 20001 |
| Output Command Port Number | 20002 |
| Output Message Rate | 60 messages per second |
| Output Message in PMU Frames | 4 |
| Output Messages | Serial Port 1, 2, 3, and 4 |

With this configuration (*Table 4.7*), the output synchrophasor data on this port consist of the data frames Serial Ports 1, 2, 3, and 4 receive from all four Station 2 PMCUs.

**Table 4.8 SEL-3306 PDC 102 Output 2 Configuration**

| Description | Value |
|---|---|
| Output Message Format | C37.118-2006 |
| Output Phasor Format | Polar |
| Destination IP Address | 100.100.100.103<br>(IP address of PDC 103) |
| Output Data Port Number | 20011 |
| Output Command Port Number | 20012 |
| Output Message Rate | 1 per second |
| Output Message in PMU Frames | 4 |
| Output Messages | Serial Port 1, 2, 3, and 4 |

With this configuration (*Table 4.8*), the output synchrophasor data on this port consist of the data frames Serial Ports 1, 2, 3, and 4 receive. Output 2 sends one data message per second. This reduction was necessary because the SEL-3306 in Station 3 has a one message per second rate.

**Table 4.9 SEL-3306 PDC 102 Output 3 Configuration** (Sheet 1 of 2)

| Description | Value |
|---|---|
| Output Message Format | C37.118-2006 |
| Output Phasor Format | Polar |
| Destination IP Address | 100.100.100.104<br>(IP address of PDC 104) |
| Output Data Port Number | 20021 |
| Output Command Port Number | 20022 |

**Table 4.9 SEL-3306 PDC 102 Output 3 Configuration** (Sheet 2 of 2)

| Description | Value |
|---|---|
| Output Message Rate | 60 messages per second |
| Output Message in PMU Frames | 4 |
| Output Messages | Serial Port 1, 2, 3, and 4 |

With this configuration (*Table 4.9*), the output synchrophasor data on this port consist of the data frames received on Serial Ports **1**, **2**, **3**, and **4**. Output **3** sends data at 60 messages per second.

## Station 3

Station 3 consists of one SEL-421 (PMCU 9), one SEL-451 (PMCU 10), and four SEL-300 series phasor measurement and control units along with the SEL-3306 Synchrophasor Processor (Local PDC 103). The maximum transmission rate of the SEL-300 series PMCUs is 1 message per second, and all PMCUs in the station are set to send the synchrophasor data at the speed of 1 message per second. PMCU 9 and PMCU 10 send data according to the standard C37.118-2006 protocol, and all other PMCUs send data through the use of the SEL Fast Message protocol.

All PMCUs communicate with the Local PDC 103 through serial connections. The synchrophasor measurement settings of PMCU 9 and 10 are similar to the settings of PMCUs in Station 1 but have different station names, message rates, and ID numbers.

The baud rate of SEL-300 series PMCUs is set to its maximum value of 38400 bps.

### SEL-3306 PDC 103 Configuration

#### General Data Configuration

**Table 4.10 SEL-3306 PDC 103 General Data Configuration**

| Description | Value |
|---|---|
| Station Name | VENUS PDC 103 |
| ID Number | 103 |
| Header Frame | Not used |
| Nominal System Frequency | 60 Hz |
| Input Message Rate per Second | 1 message per second |
| Maximum Message Waiting Period | 400 milliseconds |
| Port Time-Out | 10 minutes |
| IRIG-B Signal Type | Demodulated |

#### Serial Port Configuration

Serial Ports **1**, **2**, **3**, **4**, **5**, and **6** of the SEL-3306 PDC 103 are enabled and configured to receive data from PMCU 9, PMCU 10, PMCU 11, PMCU 12, PMCU 13, and PMCU 14, respectively.

**Table 4.11 SEL-3306 PDC 103 Serial Port 1 Configuration** (Sheet 1 of 2)

| Description | Value |
|---|---|
| PMU Message Format | C37.118-2006 |
| PMU/PDC ID Number | 9 |

**Table 4.11 SEL-3306 PDC 103 Serial Port 1 Configuration** (Sheet 2 of 2)

| Description | Value |
|---|---|
| Voltage Angle and Current Angle Compensation Factors | 0 degrees |
| Data Speed | 57600 |

Serial Port 2 of PDC 103 is configured similarly but has different PMU/PDC ID numbers.

**Table 4.12 SEL-3306 PDC 103 Serial Port 3 Configuration**

| Description | Value |
|---|---|
| PMU Message Format | FM |
| PMU/PDC ID Number | 11 |
| Voltage Angle and Current Angle Compensation Factors | 0 degrees |
| Data Speed | 38400 |

Serial Ports 4, 5, and 6 of PDC 103 are configured similarly but have different PMU/PDC ID numbers.

## Ethernet Port 1 Configuration

Ethernet Port 1 of the SEL-3306 PDC 103 is enabled and configured to receive data from PDC 102.

**Table 4.13 SEL-3306 PDC 103 Ethernet Port Configuration**

| Description | Value |
|---|---|
| PMU Message Format | C37.118-2006 |
| PMU/PDC ID Number | 102 |
| Voltage Angle and Current Angle Compensation Factors | 0 degrees |
| PMU IP Address | 100.100.100.102 |
| PMU Data Transmit Protocol | UDP |
| PMU Ethernet Data Port Number | 20011 |
| PMU Ethernet Command Port Number | 20012 |

## Output Configuration

Ethernet Output 1 of the SEL-3306 PDC 103 is enabled and configured to send data to SCADA.

**Table 4.14 SEL-3306 PDC 103 Output 1 Configuration** (Sheet 1 of 2)

| Description | Value |
|---|---|
| Output Message Format | C37.118-2006 |
| Output Phasor Format | polar |
| Destination IP Address | 100.100.100.105<br>(IP address of SCADA device) |
| Output Data Port Number | 30001 |
| Output Command Port Number | 30002 |

**Table 4.14 SEL-3306 PDC 103 Output 1 Configuration** (Sheet 2 of 2)

| Description | Value |
|---|---|
| Output Message Rate | 1 message per second |
| Output Message in PMCU Frames | 10 |
| Output Messages | Serial Port 1, 2, 3, 4, 5, 6,<br>plus 4 PMCUs from Ethernet Port 1 |

With this configuration (*Table 4.14*), the output synchrophasor data on this port consist of the data frames Serial Ports 1, 2, 3, 4, 5, and 6 received from all six Station 3 PMCUs and the data Ethernet Port 1 received from four Station 2 PMCUs.

# Main PDC

## SEL-3306 PDC 104 Configuration

### General Data Configuration

**Table 4.15 SEL-3306 PDC 104 Configuration**

| Description | Value |
|---|---|
| Station Name | SUN PDC 104 |
| ID Number | 104 |
| Header Frame | Not used |
| Frequency | 60 Hz |
| Input Synchrophasor Data Rate | 60 messages per second |
| Maximum Message Waiting Period | 200 milliseconds |
| Port Time-Out | 10 minutes |
| IRIG-B Signal Type | Demodulated |

### Serial Port Configuration

None of the serial ports are enabled.

### Ethernet Port Configuration

Ethernet Port 1 of the SEL-3306 PDC 104 is enabled and configured to receive data from PDC 101. Ethernet Port 2 is enabled and configured to receive data from PDC 102.

**Table 4.16 SEL-3306 PDC 104 Ethernet Port 1 Configuration**

| Description | Value |
|---|---|
| PMU Message Format | C37.118-2006 |
| PMU/PDC ID Number | 101 |
| Voltage Angle and Current Angle Compensation Factors | 0 degrees |
| PMU IP Address | 100.100.100.101 |
| PMU Data Transmit Protocol | UDP |
| PMU Ethernet Data Port Number | 10001 |
| PMU Ethernet Command Port Number | 10002 |

**Table 4.17 SEL-3306 PDC 104 Ethernet Port 2 Configuration**

| Description | Value |
|---|---|
| PMU Message Format | C37.118-2006 |
| PMU/PDC ID Number | 102 |
| Voltage Angle and Current Angle Compensation Factors | 0 degrees |
| PMU IP Address | 100.100.100.102 |
| PMU Data Transmit Protocol | UDP |
| PMU Ethernet Data Port Number | 10021 |
| PMU Ethernet Command Port Number | 10222 |

## Output Configuration

Ethernet Output 1 of the SEL-3306 PDC 104 is enabled and configured to send data to a main computer.

**Table 4.18 SEL-3306 PDC 104 Ethernet Output 1 Configuration**

| Description | Value |
|---|---|
| Output Message Format | C37.118-2006 |
| Output Phasor Format | Polar |
| Destination IP Address | 100.100.100.106<br>(IP address of main computer) |
| Output Data Port Number | 40001 |
| Output Command Port Number | 40002 |
| Output Message Rate | 60 messages per second |
| Output Message in PMCU Frames | 12 |
| Output Messages | 8 PMCUs from Ethernet Port 1<br>and 4 PMCUs from Ethernet Port 2 |

With this configuration (*Table 4.18*), the output synchrophasor data on this port consist of data from Ethernet Port 1 (four PMCUs from Station 1 and four PMCUs from Station 2) and the data received from Ethernet Port 2 (four PMCUs from Station 2). During normal operation, the data from Station 2 are duplicated.

# System Real-Time Measurement Visualization

SEL SYNCHROWAVE software can display frequency, phasor magnitude and angles, and analog and digital data in real time. *Figure 4.4* shows frequencies measured at Station 1, 2, and 3 for a period of 30 minutes.

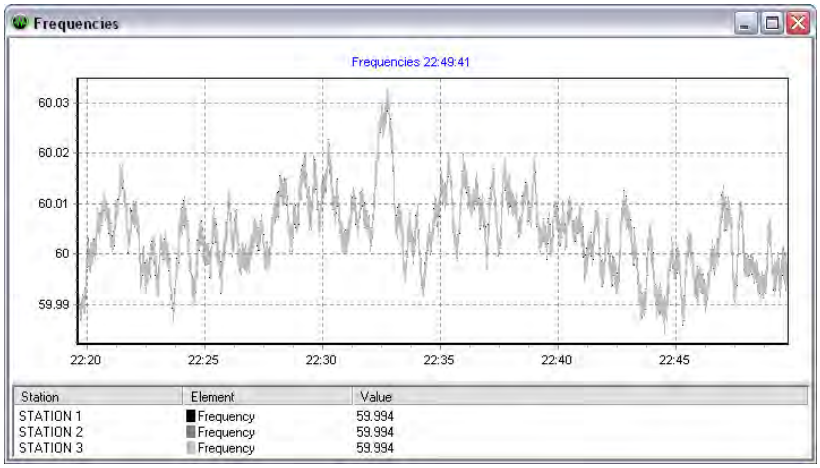


**Figure 4.4 Frequency Measured in Station 1 (PMCU 1), in Station 2 (PMCU 5), and in Station 3 (PMCU 9)**

*Figure 4.5* shows positive-sequence voltages measured at Station 1, 2, and 3.

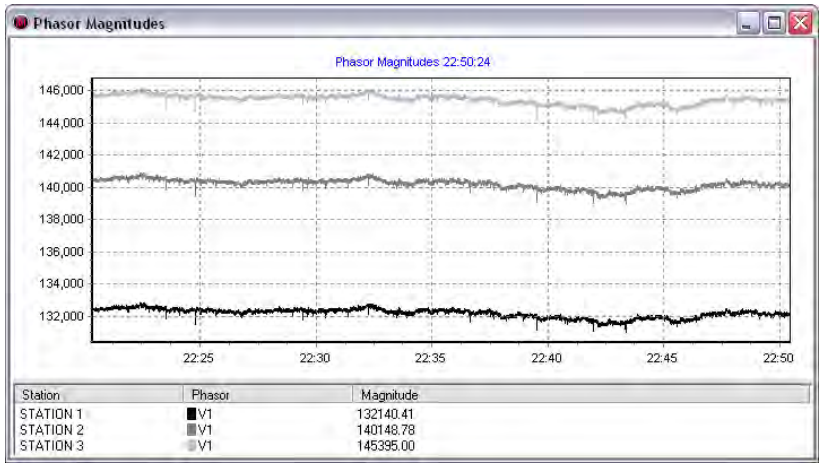


**Figure 4.5 Positive-Sequence Voltage Measured in Station 1 (PMCU 1), in Station 2 (PMCU 5), and in Station 3 (PMCU 9)**

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# Section 5
# Troubleshooting

## Overview

The SEL-3306 runs continuous self-tests to detect out-of-tolerance conditions. While these tests run at the same time as PDC logic, there is no degradation of SEL-3306 performance.

Please refer to the SEL website (www.selinc.com) for up-to-date troubleshooting information.

## Status Report

The PDC reports out-of-tolerance conditions as a status warning or a status failure. For conditions that do not compromise operation, yet are beyond expected limits, the processor issues a status warning and continues to operate. The processor signals a status warning by pulsing the alarm output for one second. A severe out-of-tolerance condition causes the processor to declare a status failure. During status failure, the SEL-3306 continues operation but displays a status byte in the data frame that indicates data invalidity. For a status failure, the processor latches the alarm output. When the processor is disabled, the **ALARM** front-panel red LED illuminates.

```
=>>STATUS


SEL 3306 Status Report

Date/Time: Mon Jan  7 11:42:28 UTC 2008
        Station Name: xxxvStation A
              PDC ID: 1
                 FID: SEL-3306-RXXX-VX-ZXXXXXX-DXXXXXXXX
         Time Source: External
         IRIG Status: Ok
          PDC Status: Enabled
          RAM Status: Ok
          ROM Status: Ok
 Critical RAM Status: Ok
 System Memory Usage: 35%
  Overcurrent Status: Ok
    Autoconfiguration: Warn
       Current Uptime: 0 hr
            CPU Usage:  2%
             CPU Temp: 50


Network Interface 01:                                          MAC address
          Link encap:Ethernet  HWaddr 00:30:A7:00:1F:1D
          inet addr:10.10.10.12  Bcast:10.10.10.255  Mask:255.255.255.0
          UP BROADCAST NOTRAILERS RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:34643 errors:0 dropped:0 overruns:0 frame:0
          TX packets:22758 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:27859591 (26.5 Mb)  TX bytes:3556256 (3.3 Mb)
```

```
Network Interface 02:                                                MAC address
          Link encap:Ethernet  HWaddr 00:30:A7:00:1F:1E
          inet addr:10.10.10.13  Bcast:10.10.10.255  Mask:255.255.255.0
          UP BROADCAST NOTRAILERS RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:34643 errors:0 dropped:0 overruns:0 frame:0
          TX packets:22758 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:27859591 (26.5 Mb)  TX bytes:3556256 (3.3 Mb)



DATE       TIME          LOCATION                    MESSAGE
=============================================================================
01/07/2008 11:41:39.759  AUTOCONFIG Warn - Auto Configuration Warning
01/07/2008 11:41:39.960  AUTOCONFIG Warn - Auto Configuration Warning
01/07/2008 11:41:39.990  AUTOCONFIG Warn - Auto Configuration Warning
01/07/2008 11:41:39.997  AUTOCONFIG Warn - Auto Configuration Warning
01/07/2008 11:41:40.026  AUTOCONFIG Warn - Auto Configuration Warning
01/07/2008 11:41:40.065  AUTOCONFIG Warn - Auto Configuration Warning
01/07/2008 11:41:40.100  AUTOCONFIG Warn - Auto Configuration Warning
01/07/2008 11:41:40.125  AUTOCONFIG Warn - Auto Configuration Warning
```

**Figure 5.1 Sample STATUS Screen**

The processor displays:

- SEL-3306 Date and Time
- Station name
- Station ID
- Firmware ID

See *Firmware on page A.1*. Additionally, the processor displays the following:

- Time Source
- Status Data
- Network 1 Settings
- Network 2 Settings

# Troubleshooting Procedures

*Table 5.1* lists troubleshooting procedures for common problems. The table lists each symptom, possible causes, and corresponding diagnoses/solutions.

**Table 5.1 Troubleshooting Procedures**

| Possible Cause | Diagnosis/Solution |
|---|---|
| **Dark Front Panel** | |
| Power is off. | Verify that substation battery power is operational. |
| Input power is not present. | Verify that power is present at the rear-panel terminal strip. |
| Blown power supply fuse. | Replace the fuse. |
| **LED Alarm On** | |
| Self-test failure. | Contact the SEL factory or your Technical Service Center. |
| **Alarm Output Asserts** | |
| Power is off. | Restore power. |
| Blown power supply fuse. | Replace the fuse. |
| Power supply failure. | LED alarm is on. |
| **System Does Not Respond to Commands** | |
| Communications device is not connected to the system. | Connect a communications device. |
| Incorrect data speed (baud rate) or other communications parameters. | Configure your terminal port parameters to the particular relay port settings. |
| Incorrect communications cables. | Use SEL communications cables, or cables you build according to SEL specifications. |
| Communications cabling error. | Check cable connections. |
| Handshake line conflict; system is attempting to transmit information, but cannot do so. | Check communications cabling. Use SEL communications cables, or cables you build according to SEL specifications. |
| System is in the XOFF state, halting communications. | Type **<Ctrl+Q>** to put the system in the XON state. |
| **Terminal Displays Meaningless Characters** | |
| Data speed (baud rate) is set incorrectly. | Check the terminal parameters configuration. |
| Terminal emulation is not optimal. | Try other terminal types, including VT-100 and VT-52 terminal emulations. |

# Factory Assistance

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

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# Appendix A
# Firmware and Manual Versions

## Firmware

### Determining the Firmware Version in Your SEL-3306

To find the firmware revision number in your SEL-3306, use the serial port **STATUS** command or the front panel to view the status report. The firmware revision number is after the R, and the release date is after the D. For example, the following is firmware revision number Rxxx, release date Dxxxxxxxx.

FID=SEL-3306-Rxxx-V0-Z001001-Dxxxxxxxx

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

**Table A.1 Firmware Revision History**

| Firmware Identification (FID) Number | Description of Changes | Manual Date Code |
|---|---|---|
| SEL-3306-R101-V0-Z001001-D20090522 | ➤ Added UDP_S and TCP output protocol. | 20090522 |
| SEL-3306-R100-V0-Z001001-D20060524 | ➤ Original firmware release. | 20060524 |

## Instruction Manual

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

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

**Table A.2 Instruction Manual Revision History**

| Revision Date | Summary of Revisions |
|---|---|
| 20090522 | Updated for firmware version R101. |
| 20060524 | Initial Release. |

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# Appendix B
# Firmware Upgrade Instructions

## Overview

NOTE: SEL recommends that you upgrade all firmware to the latest versions provided on the upgrade CD.

From time to time, SEL issues firmware upgrades for this synchrophasor processor. The instructions that follow explain how you can install new firmware in your SEL-3306 Synchrophasor Processor.

You will need the following items before beginning the firmware upgrade process:

- Personal computer (PC)
- Terminal emulation software
- Serial communications cable (SEL Cable C234A or equivalent)
- Disk containing the firmware upgrade file
- Firmware Upgrade Instructions (these instructions)

## Upgrade Procedure

Step 1. Download the MD5 checksum and rXXX3306.upg file:
   a. Insert the SEL-3306 Firmware Upgrade CD-ROM.
   b. Right click on the MD5 checksum link.
   c. Select **Save Target As**.
   d. Save file to desired location.
   e. Repeat steps a–d for the *.upg file.

Step 2. If the SEL-3306 is in use, follow your company practices for removing the SEL-3306 from service.

Step 3. Remove power from the SEL-3306.

Step 4. Insert the CompactFlash® Card into the master slot.

Step 5. Restore power to the SEL-3306.

Step 6. Establish serial port communications.
   a. Enter the serial port communications parameters (9600 bps, 8 data bits, no parity, 1 stop bit, no flow control).
   b. Click **OK**.

Step 7. Type **ACC <Enter>** at the Access Level 0 = prompt.

Step 8. Type the default Access Level 1 password (Nevada-3306) and press **<Enter>**.

You will see the Access Level 1 => prompt.

Step 9. Type **2AC <Enter>**.

Step 10. Type the default Access Level 2 password (Sierra-3306) and press **<Enter>**.

You will see the Access Level 2 =>> prompt.

Step 11. Start the web interface:

a. Type **WEB START <Enter>**.

b. Type **Yes <Enter>** to confirm.

Step 12. Reboot the SEL-3306:

a. Type **STATUS CLEAR <Enter>**.

b. Type **Yes <Enter>** to confirm.

Step 13. Type **ACC <Enter>** at the Access Level 0 = prompt.

Step 14. Type **STATUS <Enter>** to get the SEL-3306 IP address.

NOTE: You can use the following commands to stop the display as the **STATUS** command prints out information so that you can get the IP address.

Stop Scroll: **CTRL + S**

Continue Scroll: **CTRL + Q**

Step 15. Open a web browser window such as Internet® Explorer® or Firefox®.

The browser must be able to run Java.

Step 16. Type the SEL-3306 IP address in the web browser address bar.

Step 17. Log in to the SEL-3306 with the username and password shown below:

**Username:** administrator
**Password:** Nevada-3306

Step 18. From the **Menu** bar, choose **Administration**.

Step 19. From the **Administration** drop down menu, choose **Upgrades**.

Step 20. Type the default Access Level 2 password (Sierra-3306) and press **<Enter>**.

You will see the Access Level 2 =>> prompt.

Step 21. Type the **Admin** password (Ford-3306) and press **<Enter>**.

Step 22. On the **Warning** message box that appears, choose **Yes**.

Step 23. Type the MD5 checksum in the **Input** message box.

Step 24. Click the **Browse** button on the web interface.

Step 25. Locate and select the **rXXX3306.upg** file downloaded in *Step 1*.

Step 26. In the **Open Dialog** message box, click the **Open** button.

Step 27. In the **Web Interface** window, click the **Upload** button.

It may take a few minutes for the system to update.

When the serial interface returns, the update is complete. After the update is complete, the web interface will be disabled and will need to be restarted.

# Factory Assistance

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

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# Glossary

**10/100BASE-T** 10BASE-T is a variant of Ethernet that allows devices to be connected via twisted-pair cable. 100BASE-T incorporates any of several Fast Ethernet standards (under IEEE 802.3) or planned standards for twisted-pair cables. Fast Ethernet is a version of Ethernet capable of 100 Mbps, instead of the 10 Mbps data transfer speed for standard Ethernet.

**100BASE-FX** Fast Ethernet over optical fiber. Fast Ethernet is a version of Ethernet capable of 100 Mbps, instead of the 10 Mbps data transfer speed for standard Ethernet.

**3U** The designation of the vertical height of a device in rack units. One rack unit, U, is approximately 1.75 inches or 44.45 mm.

**A** Abbreviation for amps or amperes; unit of electrical current.

**ac** Abbreviation for alternating current.

**ASCII** Abbreviation for American Standard Code for Information Interchange. Defines a standard set of text characters. The SEL-3306 uses ASCII text characters to communicate through the use of serial ports.

**Baud** A unit of speed in data transmission equal to 1 bit per second (1 bps).

**BIOS** Basic Input/Output System. System software that provides the most basic interface to peripheral devices and controls the first stage of the boot process, including operating system installation.

**Burden** Percentage of time during which the CPU is working.

**CompactFlash®** A registered trademark of SanDisk® corporation. A type of nonvolatile relay memory used for storing large blocks of nonvolatile data.

**CPU** Central processing unit.

**CTS** Clear to send.

**dc** Abbreviation for direct current.

**Dry Contact** An initially available contact that is neither connected to nor energized by voltage (such voltage is usually supplied externally).

**DTR** Data Terminal Ready. A wire in an EIA-232 connection that tells data communications equipment (typically a modem) that the computer or terminal is ready to transmit and receive data.

**EIA-232** Electrical definition for point-to-point serial data communications interfaces based on the standard EIA/TIA-232. Formerly known as RS-232.

**EMI** Electromagnetic Interference.

**ESD** Electrostatic discharge. The sudden transfer of charge between objects at different potentials caused by direct contact or induced by an electrostatic field.

**Ethernet** A network physical and data link layer defined by IEEE 802.2 and IEEE 802.3.

**ETX** End of Text.

**Firmware** The nonvolatile program stored in the relay that defines relay operation.

**GND** Ground.

**GPS** Global Positioning System. Source of position and high-accuracy time information.

**GUI** Graphical user interface.

**HMI** Human machine interface.

**IEEE Floating-Point** A 32-bit representation of a real number in accordance with IEEE 754-1985.

**IRIG-B** A time-code input that the unit can use to set the internal unit clock.

**LCD** Liquid Crystal Display.

**LED** Light-Emitting Diode.

**MAC Address** The hardware address of a device connected to a shared network medium.

**MOV** Metal-Oxide Varistor.

**Network Time Server** A device that provides system-wide time synchronization for distributed computer network/client server applications.

**PC** Personal Computer.

**PDC** Phasor Data Concentrator. A data concentrator used in phasor measurement systems.

**Phasor** A complex equivalent of a simple cosine wave quantity such that the complex modulus is the cosine wave amplitude and the complex angle (in polar form) is the cosine wave phase angle.

**PMCU** Phasor Measurement and Control Unit. A PMU with additional features allowing further controlling/protection/automation functions.

**PMU** Phasor Measurement Unit. A generic device in this standard that produces synchronized phasors from voltage and/or current inputs and synchronizing signal.

**Protocol** A language for communication between devices.

**RAM** Random-Access Memory.

**RFI** Radio-Frequency Interference.

**RTS** Request to Send.

**RXD** Received data.

**SCADA** Supervisory Control and Data Acquisition.

**SOC** Second Of Century, as measured from the epoch (00:00:00 January 1, 1970).

**Synchronism** The state where connected alternating-current systems, machines, or a combination operate at the same frequency and where the phase angle displacements between voltages in these systems and machines either remain constant or vary about a steady and stable average value.

**Synchronized Phasor** A phasor calculated from data samples that uses a standard time signal as the reference for the measurement. In this case, the phasors from remote sites have a defined common phase relationship. Syn: synchrophasor.

**TXD** Transmitted data.

**UTC** Coordinated Universal Time calculated by BIH in Paris, France. It is distributed by various media, including the GPS system.

**V** Abbreviation for volts; unit of electromotive force.

**W** Abbreviation for watts; unit of electrical power.

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# Index

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

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