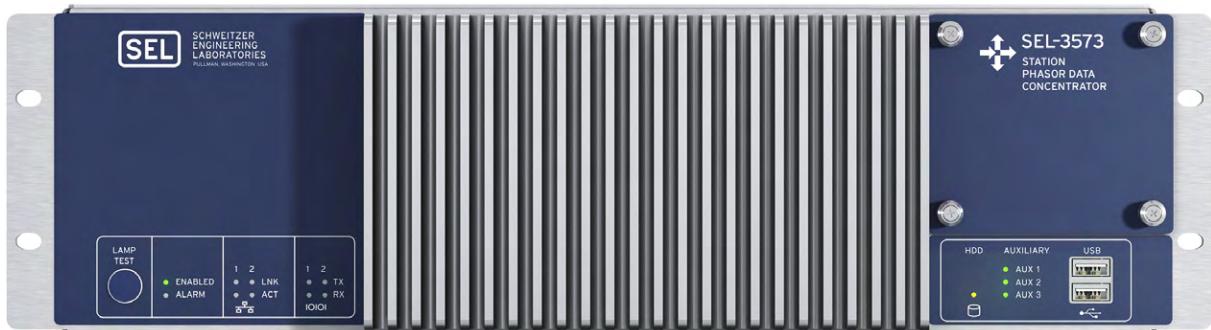


SEL-3573

Station Phasor Data Concentrator (PDC)

Instruction Manual



20221221

SEL SCHWEITZER ENGINEERING LABORATORIES



* P M 3 5 7 3 - 0 1 *

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PM3573-01

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Preface

Overview

The SEL-3573 Station Phasor Data Concentrator (PDC) allows you to use synchronized phasor measurements (synchrophasors) for real-time power system monitoring, control, archiving, and protection. The SEL-3573 acquires and time-correlates synchrophasor data from various phasor measurement units (PMUs), PDCs, synchrophasor vector processors (SVPs), and other devices that support the IEEE C37.118 (2005 and 2011 versions) Standards for Synchrophasors for Power Systems. The SEL-3573 receives synchrophasor messages by using Ethernet and EIA-232 communications. The SEL-3573 transmits time-correlated data over Ethernet to external IEEE C37.118 clients. The SEL-3573 also sends the data to an internal archiver, which saves data in a relational database.

SEL PDC Assistant software is a non-licensed settings configuration tool that is included with the SEL-3573 and is free to download from selinc.com. This Windows-based software provides you the ability to configure the SEL-3573. PDC Assistant is a user-friendly interface where you set inputs, outputs, calculations, and archives by using a real-time status display. In addition, the following features are included: logged results of unusual activity; retrieval of archives based on time and date, manually or with the archive collection service (ACS); and the management of user accounts and SEL-3573 firmware versions.

The following is a list of manual sections and overviews of section topics:

Section 1: Introduction, Features, and Specifications. Introduces and lists features of the SEL-3573 and PDC Assistant software.

Section 2: Installation. Provides information on the installation of the SEL-3573 and PDC Assistant software.

Section 3: Hardware Serviceability. Provides instructions for accessing control (DIP) switches and installing and removing expansion cards and power supplies.

Section 4: PDC Assistant. Explains in detail how to set up your system, view real-time status, collect archived synchrophasor data, create new user accounts, and view system logs.

Section 5: Troubleshooting. Provides many symptoms, causes, and debugging methods for commonly encountered issues.

Appendix A: Firmware, Software, and Manual Versions. Provides instructions for determining firmware and software version, and provides a firmware revision history and a manual revision history.

Appendix B: Firmware Upgrade Instructions. Provides instructions for upgrading firmware.

Appendix C: Detailed Diagnostic Logs. Contains a list of all diagnostic logs, details regarding the cause of the log, and instructions for resolving each log item.

Appendix D: Network Ports and Services. Provides information to help security auditors verify that the network hosts and open ports on a control network are what is expected.

Appendix E: Lightweight Directory Access Protocol (LDAP). Provides an LDAP settings form to facilitate setting up the SEL-3573.

Safety Information

CAUTION

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

Dangers, Warnings, and Cautions

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

DANGER

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

WARNING

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

CAUTION

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

Safety Symbols

The following symbols are often marked on SEL products.

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

Safety Marks

The following statements apply to this device.

General Safety Marks

⚠ CAUTION There is danger of explosion if the battery is incorrectly replaced. Replace only with Panasonic BR2330A or equivalent recommended by manufacturer. See Owner's Manual for safety instructions. The battery used in this device may present a fire or chemical burn hazard if mis-treated. Do not recharge, disassemble, heat above 100°C or incinerate. Dispose of used batteries according to the manufacturer's instructions. Keep battery out of reach of children.	⚠ ATTENTION Une pile remplacée incorrectement pose des risques d'explosion. Remplacez seulement avec un Panasonic BR2330A ou un produit équivalent recommandé par le fabricant. Voir le guide d'utilisateur pour les instructions de sécurité. La pile utilisée dans cet appareil peut présenter un risque d'incendie ou de brûlure chimique si vous en faites mauvais usage. Ne pas recharger, démonter, chauffer à plus de 100°C ou incinérer. Éliminez les vieilles piles suivant les instructions du fabricant. Gardez la pile hors de la portée des enfants.
Ambient air temperature shall not exceed 40°C (104°F) in locations where touch temperature safety is required.	La température de l'air ambiant ne doit pas dépasser 40 °C (104 °F) dans les endroits où la sécurité relative à la température de surface est requise.

Other Safety Marks

⚠ DANGER Disconnect or de-energize all external connections before opening this device. Contact with hazardous voltages and currents inside this device can cause electrical shock resulting in injury or death.	⚠ DANGER Débrancher tous les raccordements externes avant d'ouvrir cet appareil. Tout contact avec des tensions ou courants internes à l'appareil peut causer un choc électrique pouvant entraîner des blessures ou la mort.
⚠ DANGER Contact with instrument terminals can cause electrical shock that can result in injury or death.	⚠ DANGER Tout contact avec les bornes de l'appareil peut causer un choc électrique pouvant entraîner des blessures ou la mort.
⚠ WARNING Use of this equipment in a manner other than specified in this manual can impair operator safety safeguards provided by this equipment.	⚠ AVERTISSEMENT L'utilisation de cet appareil suivant des procédures différentes de celles indiquées dans ce manuel peut désarmer les dispositifs de protection d'opérateur normalement actifs sur cet équipement.
⚠ WARNING Have only qualified personnel service this equipment. If you are not qualified to service this equipment, you can injure yourself or others, or cause equipment damage.	⚠ AVERTISSEMENT Seules des personnes qualifiées peuvent travailler sur cet appareil. Si vous n'êtes pas qualifiés pour ce travail, vous pourriez vous blesser avec d'autres personnes ou endommager l'équipement.
⚠ WARNING Never use standard null-modem cables with the SEL-3573. Using any non-SEL cable can cause severe power and ground problems involving Pins 1, 4, and 6 on the SEL-3573 communications ports.	⚠ AVERTISSEMENT Ne jamais utiliser de câbles standards à inversion de signaux ("nullmodem") avec le SEL-3555. L'utilisation d'un câble 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-3555.
⚠ WARNING Do not operate device unless properly grounded.	⚠ AVERTISSEMENT Ne pas mettre en marche l'appareil sauf s'il est bien mis à la terre.
⚠ CAUTION Equipment components are sensitive to electrostatic discharge (ESD). Undetectable permanent damage can result if you do not use proper ESD procedures. Ground yourself, your work surface, and this equipment before removing any cover from this equipment. If your facility is not equipped to work with these components, contact SEL about returning this device and related SEL equipment for service.	⚠ ATTENTION Les composants de cet équipement sont sensibles aux décharges électrostatiques (DES). Des dommages permanents non-décelables peuvent résulter de l'absence de précautions contre les DES. Raccordez-vous correctement à la terre, ainsi que la surface de travail et l'appareil avant d'en retirer un panneau. Si vous n'êtes pas équipés pour travailler avec ce type de composants, contacter SEL afin de retourner l'appareil pour un service en usine.
⚠ CAUTION Looking into optical connections, fiber ends, or bulkhead connections can result in hazardous radiation exposure.	⚠ ATTENTION Regarder vers les connecteurs optiques, les extrémités des fibres ou les connecteurs de cloison peut entraîner une exposition à des rayonnements dangereux.

General Information

Environmental Conditions and Voltage Information

The following table lists important environmental and voltage information.

Condition	Range/Description
Indoor/outdoor use	Indoor
Altitude	As high as 2000 m
Relative humidity	5 to 95%
Oversupply	Category II
Pollution	Degree 2
Atmospheric pressure	80 to 110 kPa

Instructions for Cleaning and Decontamination

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

Trademarks

SEL trademarks appearing in this manual are shown in the following table.

exe-GUARD®	SYNCHROWAVE®
------------	--------------

Technical Support

⚠️WARNING

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

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

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Internet: selinc.com/support
Email: info@selinc.com

S E C T I O N 1

Introduction, Features, and Specifications

Overview

The SEL-3573 Station Phasor Data Concentrator (PDC) is a hardware device that allows you to use synchronized phasor measurements (synchrophasors) for real-time power system monitoring, control, archiving, and protection. The SEL-3573 acquires and time-correlates synchrophasor data from various phasor measurement units (PMUs), such as SEL-351, SEL-421, SEL-451, SEL-487E, SEL-487V, SEL-411L, SEL-311C, SEL-787, SEL-751, SEL-751A, SEL-735, and SEL-700G relays; SEL-651RA, SEL-651R-2, and SEL-351RS recloser controls; SEL-2431 voltage regulator controls; and from other devices that support IEEE C37.118-2005 or IEEE C37.118-2011 Standards for Synchrophasors for Power Systems.

The SEL-3573 receives synchrophasor messages through use of Ethernet communications and EIA-232. The SEL-3573 can process incoming data from as many as 120 PMUs. The maximum data rate is 240 messages per second. The SEL-3573 transmits the time-correlated data over Ethernet to as many as ten external IEEE C37.118 clients. The SEL-3573 also sends the data to the internal archiver, which saves data in a relational database.

The SEL-3573 includes the PDC Assistant software. The software runs on Microsoft Windows and provides the ability to configure the SEL-3573. The PDC Assistant is a user-friendly interface in which you can set inputs, outputs, calculations, and archives with the aid of a real-time status display. In addition, the software includes the following features:

- Logged results of unusual activity.
- Retrieval of archives based on time and date, manually or automatically.
- Management of user accounts and SEL-3573 firmware versions.

Figure 1.1 shows the internal architecture of the SEL-3573, along with connectivity of the PDC Assistant.

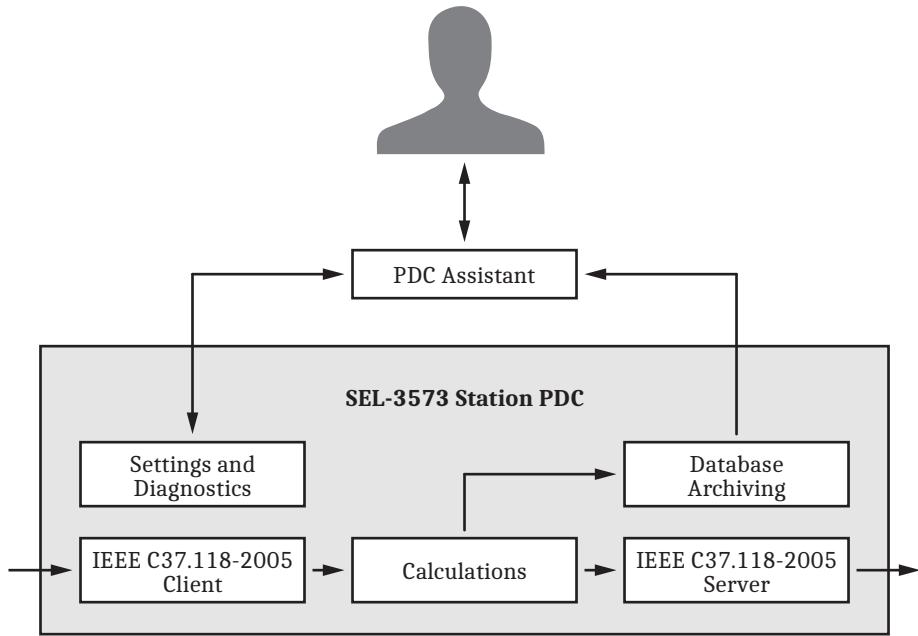


Figure 1.1 SEL-3573 Internal Architecture

Figure 1.2 shows a simple system configuration. The figure shows the SEL-3573 receiving synchrophasor data from an SEL-421 Protection, Automation, and Control System. The SEL-421 includes PMU functionality as a standard feature. The SEL-3573 processes synchrophasor data and then sends it to the SEL-5078-2 SYNCHROWAVE Central Software for visualization. In the example in *Figure 1.2*, the PDC Assistant software is running on a separate computer, but it can also run with SYNCHROWAVE Central on the same computer.

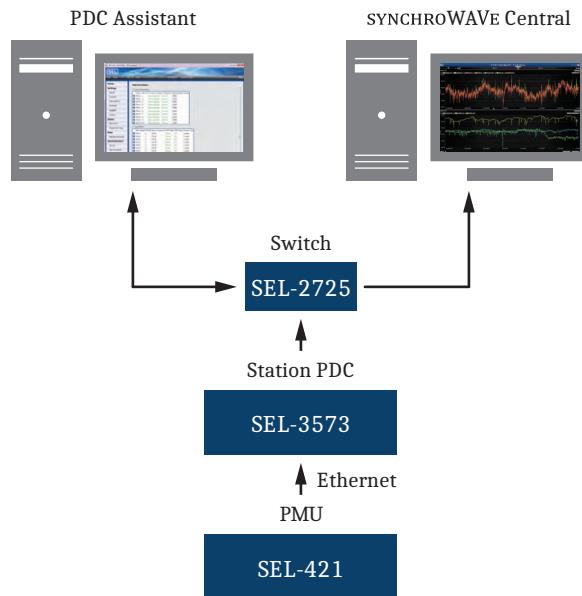


Figure 1.2 Simple System Architecture

Figure 1.3 shows a large-scale synchrophasor system, with data shared between substations, utilities, and regional coordinating centers.

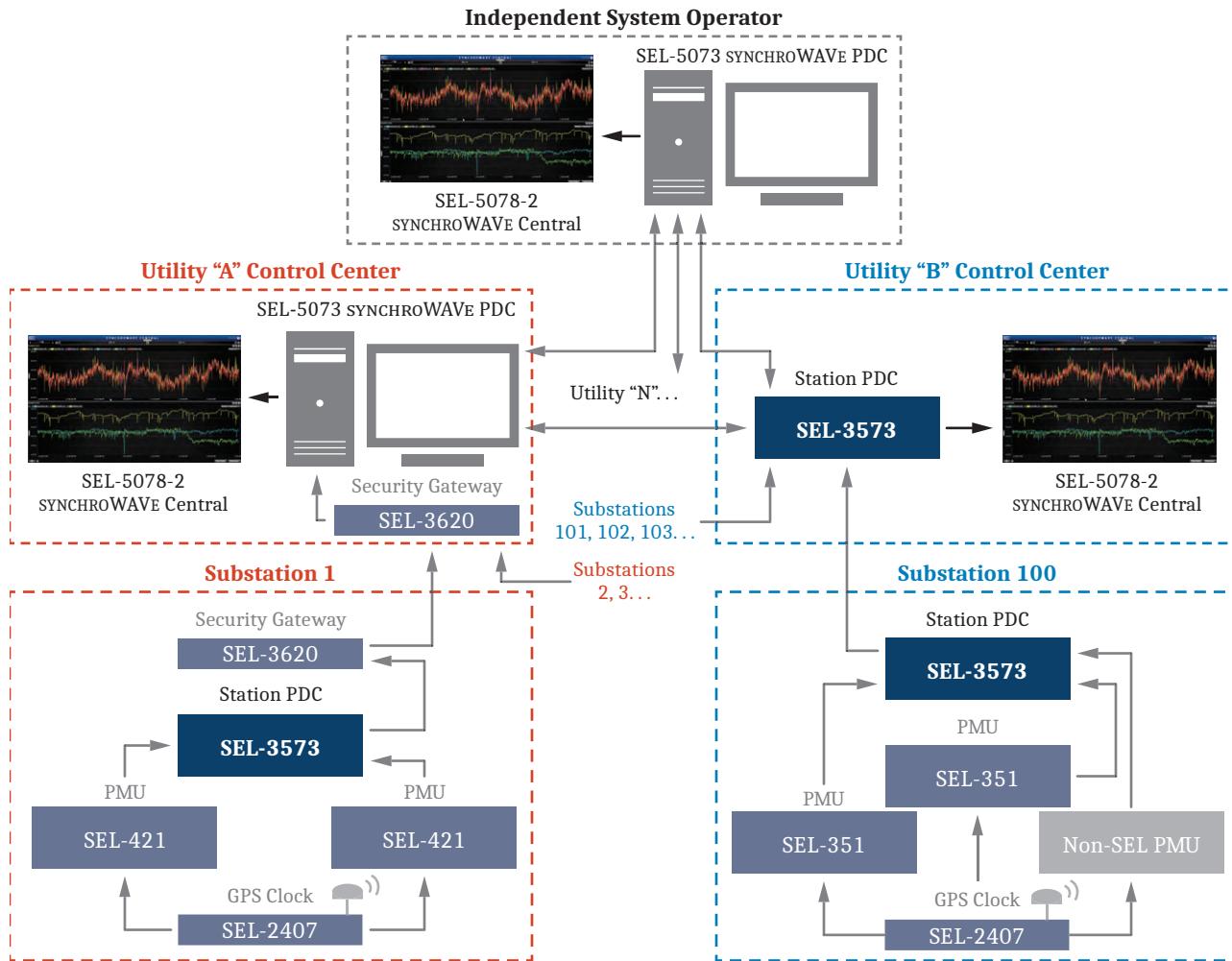


Figure 1.3 Large-Scale System Architecture With Regional Control Centers

Features

The SEL-3573 collects and time-correlates synchrophasor data from PMUs, such as those listed previously, as well as other PDCs such as the SEL-3555 Real-Time Automation Controller (RTAC), SEL-5073 SYNCHROWAVE PDCs, SEL-3573 Station PDCs, and SEL relays with real-time control (RTC) capability.

The SEL-3573 uses relative time alignment to correlate synchrophasor data. This allows for continuous operation without the necessity of a global reference such as an IRIG-B time source.

The SEL-3573 can transmit correlated data to external IEEE C37.118 clients for synchrophasor applications. The SEL-3573 includes the following features:

- **High Performance.** Connect PMUs at message rates from 1 to 240 messages per second. Configure as many as ten separate outputs.
- **Low Latency.** Latency is specified to be less than 15 ms, but it is typically less than 10 ms.

- **Easy to Configure and Commission.** Use the PDC Assistant to quickly set up or add PMUs, outputs, internal archives, and more, without interrupting existing PMUs.
- **Synchrophasor Message Inputs and Outputs.** Read inputs through Ethernet ports and EIA-232 according to IEEE C37.118-2005 or IEEE C37.118-2011. Outputs send synchrophasor data through Ethernet according to IEEE C37.118-2005. Individually configure message rates and content for outputs.
- **Archiving.** Select from the following options for capturing data: continuous or triggered archives, and pre- and post-disturbance data capture. Retrieve data in binary and ASCII COMTRADE, comma-separated value (CSV), and compressed CSV formats. The Archive Collection Service (ACS) enables the automatic collection and storage of phasor archive data on local or network drives.
- **Calculations.** You can use several calculations, including power, sequence, algebraic, scaling, dx/dt, and latency. All calculations can be saved in archives and sent to upstream PDCs.

Table 1.1 shows the performance for various configurations using 60 or 120 PMUs. All testing was performed using the following common configurations:

- Each PMU input included 12 phasors, 8 analogs, 2 digital words, status, frequency, and df/dt.
- IEEE floating-point values were used for phasors, analogs, frequency, and df/dt.
- Each test case configuration included 40 calculations.
- Each test case configuration included 10 archives, each with 800 tags, set to archive at the specified message rate.
- Each test case configuration included 10 outputs, each with 1000 tags, set to stream data at the specified message rate.

Table 1.1 Performance of Configurations With 60 or 120 PMU Inputs

Number of PMUs	Input Message Rate	Average Latency
60	30	<10 ms
60	60	<10 ms
120	30	<10 ms
120	60	<15 ms

Security

Malware Protection

SEL exe-GUARD anti-malware technology protects the SEL-3573 in two ways:

1. Only authorized tasks are allowed to run on the system.
2. Mandatory Access Control restricts privileges of programs and services to the absolute minimum required to function on the system.

There is no need for virus definition files because only whitelisted or pre-approved tasks are allowed to run on the SEL-3573. SEL Whitelist operates at the core of the SEL-3573 operating system, where it intercepts every program before it is executed. Using advanced cryptographic algorithms, Whitelist inspects a

program's binary image before it is allowed to execute, verifying its legitimacy and integrity against a known digital signature. Unauthorized changes to the system will generate corresponding diagnostic logs.

Mandatory Access Control fine-tunes the system security policy so that programs and services are constrained to the absolute minimum access privileges required to function. Defining this minimal privilege set at design time ensures firmware processes can be locked to their minimal scope of influence in the system.

User Authentication and Security Auditing

The SEL-3573 authenticates individual user- and role-based accounts, requiring strong passwords, and supports centralized user account management using LDAP. Audit logs are generated for user activity.

Models and Options

Models

Complete ordering information is not provided in this instruction manual. See the latest SEL-3573 Model Option Table (MOT) at selinc.com.

The following items are included in the SEL-3573 base model:

- Two DB-9 serial ports
- One PCI expansion card with six RJ45 serial ports
- Two rear-panel Ethernet ports
- One removable power supply
- One 30 GB industrial grade single-level cell (SLC) solid-state drive (SSD)

Options

The following options are available when ordering and configuring the SEL-3573:

- As many as 3 additional PCI expansion serial cards for a maximum of 24 RJ45 serial ports
- A redundant power supply
- Conformal coating for additional environmental protection
- 60, 120, or 250 GB industrial grade SLC SSD¹

¹ Note: The SEL-3573 can only be configured with one SSD.

Specifications

Compliance

Designed and manufactured under an ISO 9001 certified quality management system

47 CFR 15B, Class A

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

UL Recognized to U.S. and Canadian safety standards
(File E231500; NWGQ2, NWGQ8)

CE Mark

UKCA Mark

General

Operating System

SEL Linux® Krakatoa

CPU

Intel Core i7-3612QE Quad-Core

Speed: 2.1 GHz base, 3.1 GHz turbo
Cache: 4 x 256 KB L2, 6 MB L3

RAM

8 GB DDR3 ECC PC3-10600 (1333 MHz)

Chipset

Intel QM77 Express Chipset

Mass Storage

Internal Drive Bay: One 2.5" SSD
SATA II 3.0 Gb/s

Ethernet

Two Rear-Panel 1 Gbps Copper RJ45 Ports

ETH1: Intel 82579LM, 10/100/1000 Mbps
RJ45 copper
ETH2: Intel 82574L, 10/100/1000 Mbps
RJ45 copper

Serial Ports

Standard Ports: 2 EIA-232 ports, DB-9 connectors,
300 to 115,200 bps
Included SEL-3390S8 PCIe expansion card provides six additional EIA-232 ports, RJ45 connectors, 9600 to 115,200 bps

Optional SEL-3390S8 PCIe x1 Expansion Cards: As many as 18 additional EIA-232 ports, RJ45 connectors, 9600 to 115,200 bps

Note: On-board and SEL-3390S8 serial ports meet EIA/TIA-562 specifications.

Time-Code Input/Output

Available With SEL-3390S8 Expansion Card

Connector: RJ45

Time-Code: Compatible with demodulated IRIG-B TTL

Note: Output generated from either IRIG-B input or SEL-3573 clock.

Real-Time Clock/Calendar

Battery Type:	IEC No. BR2330A Lithium
Battery Life:	10 years with power 2 years without power

Power Supply

125–250 Vdc or 120–240 Vac	
Rated Voltage:	125–250 Vdc, 120–240 Vac
Operational Voltage Range:	100–300 Vdc, 85–264 Vac
Rated Frequency:	50/60 Hz
Operational Frequency Range:	45–65 Hz
Typical Burden:	50 W
Max. Burden:	300 W, 310 VA
DC Ripple:	<15% rated voltage
Peak Inrush:	20 A
Insulation:	3100 Vdc

Recommended External Overcurrent Protection

Breaker Type:	Standard
Breaker Rating:	20 A at 250 Vdc
Current Breaking Capacity:	10 kA
Grounded Neutral Systems:	Device in series with the HOT or energized conductor
DC and Isolated Systems:	Device in series with both conductors

Power Consumption (in Watts)

Component	Min.	Typical	Max.
Base System (Quad-Core CPU, 1 PSU, 8 GB RAM, 30 GB SSD, and 1 SEL-3390S8 Serial Card)	31	45	70
Additional Consumption From Optional Components			
2nd Power Supply	+10	+10	+13
SEL-3390S8 Serial Card	+4	+5	+7
Chipset Heater Consumption			
Cold startup (<5°C [41°F])	NA	NA	+90
Continuous operation (0°C [32°F])	0	+5	+10
Continuous operation (-40°C [-40°F])	0	+20	+40

Fuse Ratings

HV Power Supply Fuse:	5 A, 250 Vdc/277 Vac Time-lag T 277 Vac/1500 A break rating
Heater Fuses F2, F3:	5 A, 125 V slow blow 125 Vdc/50 A break rating

Note: Fuses are not user-serviceable.

Alarm Output Contact

Per IEC 60255-0-20:1974, using the simplified method of assessment.

Output Type:	Relay, Form C, break-before-make
Power Supply Burden:	<1 W maximum
Mechanical Life:	2,000,000 operations
Operational Voltage:	250 Vac/Vdc
Make:	30 A at 250 Vdc
Carry:	6 A continuous at 70°C
1 s Rating:	50 A

MOV Protection:	270 Vac/360 Vdc, 75 J	
Insulation Voltage:	300 Vac/Vdc	
Pickup Time:	<8 ms	
Dropout Time:	<8 ms	
Breaking Capacity (10,000 Operations):		
24 V	0.75 A	L/R = 40 ms
48 V	0.50 A	L/R = 40 ms
125 V	0.30 A	L/R = 40 ms
250 V	0.20 A	L/R = 40 ms
Cyclic Capacity (2.5 Cycles/Second):		
24 V	0.75 A	L/R = 40 ms
48 V	0.50 A	L/R = 40 ms
125 V	0.30 A	L/R = 40 ms
250 V	0.20 A	L/R = 40 ms

Terminal Connections

Compression Screw Terminal

Power Wiring

Insulation:	300 V min.
Size:	12–18 AWG

Alarm Wiring

Insulation:	300 V min.
Size:	12–18 AWG

Tightening Torque

Minimum:	0.6 Nm (5 in-lb)
Maximum:	0.8 Nm (7 in-lb)

Crimp Ferrule Recommended

Mounting Ear Tightening Torque

Minimum:	0.18 Nm (1.6 in-lb)
Maximum:	0.25 Nm (2.2 in-lb)

Grounding Screw

Ground Wiring

Insulation:	300 V min.
Size:	12 AWG, length <3 m

Tightening Torque

Minimum:	0.9 Nm (8 in-lb)
Maximum:	1.4 Nm (12 in-lb)

Ring Terminal Recommended

Serial Port

Tightening Torque

Minimum:	0.6 Nm (5 in-lb)
Maximum:	0.8 Nm (7 in-lb)

Operating Temperature Range

i7-3612QE CPU: -40° to +60°C (-40° to +140°F)

Note: Not applicable to UL applications.

Storage Temperature

-40° to +85°C (-40° to +185°F)

Relative Humidity

5 to 95% noncondensing

Maximum Altitude

2000 m

Atmospheric Pressure

80–110 kPa

Overvoltage Category

Category II

Pollution Degree

2

Insulation Class

1

Weight (Maximum)

9.072 kg (20 lb)

Product Standards

Communications Equipment in Utility Substations:	IEC 61850-3:2013 IEEE 1613-2009 Severity Level: Class 1
Industrial Environment:	IEC 61000-6-2:2005 IEC 61000-6-4:2006
Information Technology Equipment:	CISPR 22:2008 CISPR 24:2010 IEC 60950-1:2005+A1:2009 +A2:2013 UL UL 60950-1, C22.2 No. 60950-1
Measuring Relays and Protection Equipment:	IEC 60255-26:2013 IEC 60255-27:2013

Type Tests**Electromagnetic Compatibility Emissions**

Conducted and Radiated Emissions:	CISPR 11:2009+A1:2010 CISPR 22:2008 ANSI C63.4-2014 Class A
Harmonic Current:	IEC 61000-3-2:2014 Severity Level: Class A
Voltage Flicker:	IEC 61000-3-3:2013
Conducted RF:	IEC 61000-4-6:2008 Severity Level: 10 Vrms
Electrostatic Discharge:	IEC 61000-4-2:2008 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 61000-4-4:2012 Severity Level: Class A 4 kV, 5 kHz on power supply and outputs; 2 kV, 5 kHz on communications lines

Magnetic Field:	IEC 61000-4-8:2009 Severity Level: 1000 A/m for 3 s 100 A/m for 1 m
Power Supply:	IEC 61000-4-9:2001 Severity Level: 1000 A/m IEC 61000-4-10:2001 Severity Level: 100 A/m
Radiated Radio Frequency:	IEC 61000-4-11:2004 IEC 61000-4-17:1999+A1:2001 +A2:2008 IEC 61000-4-29:2000
	IEC 61000-4-3:2006+A1:2007 +A2:2010 Severity Level: 10 V/m IEEE C37.90.2-2004 Severity Level: 35 V/m

1.8 | Introduction, Features, and Specifications

Specifications

Surge Withstand Capability:	IEC 61000-4-18:2006+A1:2010 Severity Level (power supply and outputs): 2.5 kV peak common mode 1.0 kV peak differential mode Severity Level (communications ports): 1.0 kV peak common mode
Surge Immunity:	IEEE C37.90.1-2002 Severity Level: 2.5 kV oscillatory 4 kV fast transient

Environmental

Change of Temperature:	IEC 60068-2-14:2009 Severity Level: 5 cycles, 1°C per minute ramp -40°C to +60°C (i7-3612QE CPU)
Cold, Operational:	IEC 60068-2-1:2007 Severity Level: 16 hours at -40°C
Cold, Storage	IEC 60068-2-1:2007 Severity Level: 16 hours at -40°C
Damp Heat, Cyclic:	IEC 60068-2-30:2005 Severity Level: 12 + 12-hour cycle 25° to 55°C, 6 cycles, >93% r.h.
Damp Heat, Steady:	IEC 60068-2-78:2001 Severity Level: 40°C, 240 hours, >93% r.h.
Dry Heat, Operational:	IEC 60068-2-2:2007 Severity Level: 16 hours at 60°C (i7-3612QE CPU)
Dry Heat, Storage:	IEC 60068-2-2:2007 Severity Level: 16 hours at 85°C
Vibration:	IEC 60255-21-1:1988 Severity Level: Endurance Class 2 Response Class 2
	IEC 60255-21-2:1988 Severity Level: Shock Withstand, Bump Class 1 Shock Response Class 2
	IEC 60255-21-3:1993 Severity Level: Quake Response Class 2
	IEEE 1613-2009 Severity Level: V.S.4

Safety

Enclosure Protection:	IEC 60529:2001 + CRGD:2003 Severity Level: IP30
Dielectric Strength:	IEC 60255-27:2013 IEEE C37.90-2005 Severity Level: 3100 Vdc on power supply 2500 Vac on contact output 1500 Vac Ethernet ports Type tested for one minute
Impulse:	IEC 60255-27:2013 IEEE C37.90-2005 Severity Level: 5 kV power supply, contact outputs 1.5 kV Ethernet ports

S E C T I O N 2

Installation

Overview

The first steps in applying the SEL-3573 Station Phasor Data Concentrator (PDC) are installing and connecting the unit. This section describes common installation features and requirements. A successful installation requires an understanding of both the hardware and software functions.

To install and connect the SEL-3573 safely and effectively, you must be familiar with the device configuration features and options. Carefully plan unit placement, cable connections, and communications during initial design.

This section contains connection drawings for Ethernet ports, DB-9 and RJ45 serial ports, IRIG-B, and power inputs. You can use these drawings as a starting point for planning your particular application.

Unit Placement and Maintenance

Proper placement of the SEL-3573 helps ensure that you receive years of trouble-free operation. Use the following guidelines for proper installation of the SEL-3573.

Physical Location

Mount the SEL-3573 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 1.6*). The unit is rated Installation/Overvoltage Category II and Pollution Degree 2. 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, but where temperature and humidity are not controlled.

Unit Mounting

Panel-mount and 19-inch rack-mount options are available. The dimension diagrams in *Figure 2.1* show dimensions and the panel cutout size for the unit. The finned aluminum front- and rear-panel heatsinks provide efficient passive cooling to the ambient air around the SEL-3573. No fans or forced air ventilation are required, but a minimum of 2.5 cm (1 inch) clearance around the heatsinks is recommended.

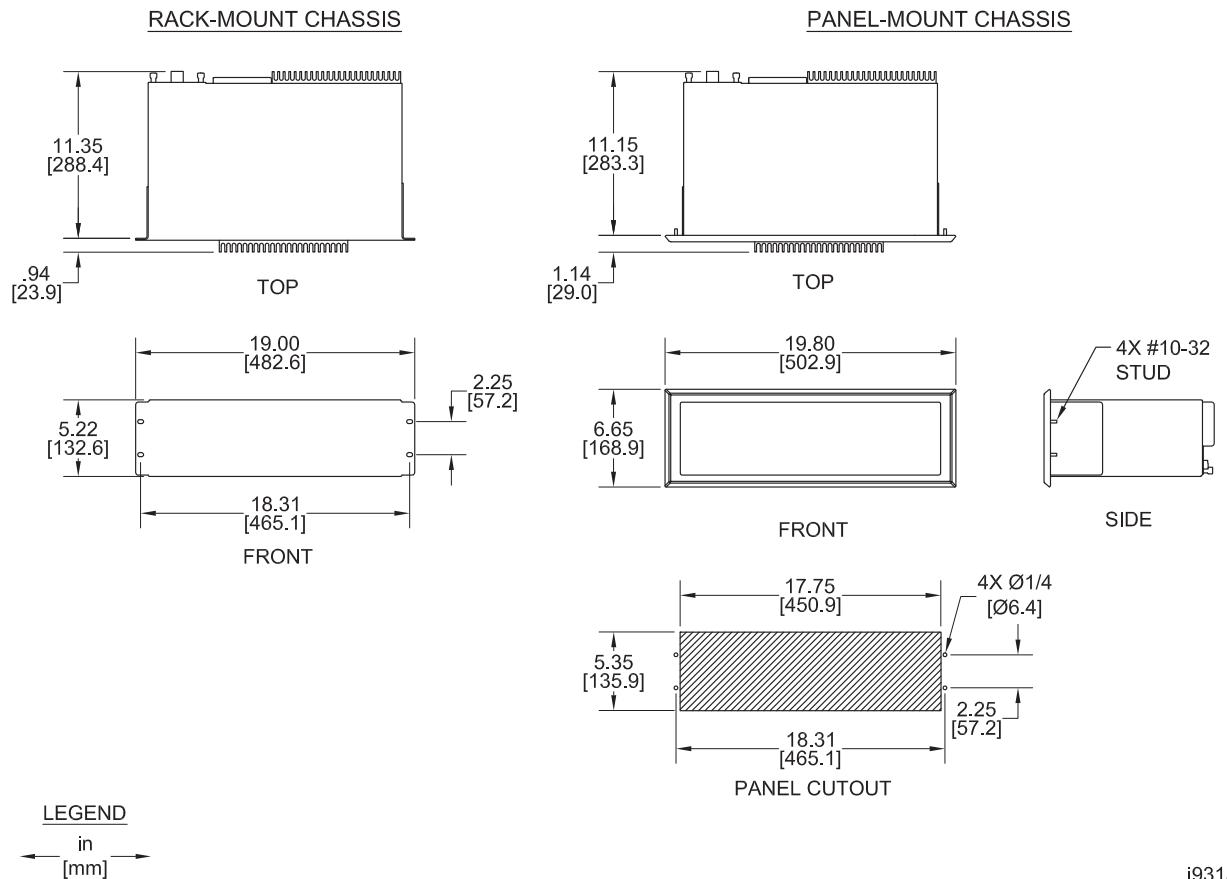


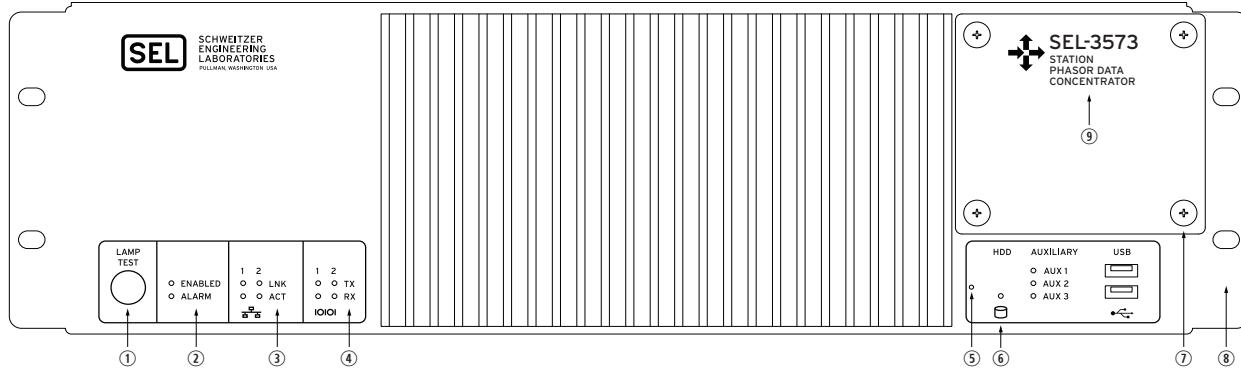
Figure 2.1 Dimension Diagram

Cleaning

Use care when cleaning the SEL-3573. 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. A permanent plastic overlay covers the front panel; do not use harsh chemical solvents such as xylene or acetone when cleaning the surface.

Front Panel

Figure 2.2 and Figure 2.3 show the physical layout of the front panel of the SEL-3573.



- ① **LAMP TEST** Button. Press and hold to test the front-panel LEDs.
- ② **ENABLED** and **ALARM** LEDs. The **ENABLED** LED indicates operational status. Green indicates normal operation, and red indicates that the system is stopped, booting, or that an alarm condition has occurred. The **ALARM** LED indicates that a non-optimal system condition exists. The **ALARM** LED illuminates red whenever the alarm contact operates.
- ③ **LINK** and **ACT** LEDs. Indicate link status and network activity for each Ethernet port.
- ④ **TX** and **RX** LEDs. The Transmit (TX) and Receive (RX) LEDs indicate activity on serial ports.
- ⑤ **Pinhole Button**. Provides reset and power functions; requires a pin to prevent accidental use.
- ⑥ **HDD** LED. Indicates SATA drive activity.
- ⑦ **Removable Drive Bay Panel**. Allows access to the solid-state drive (SSD) and control (DIP) switches.
- ⑧ **Device Enclosure**. The rugged enclosure withstands EMI, RFI, shock, and vibration.
- ⑨ **Device Label**. The high contrast, white-on-blue lettering is highly legible even in dark areas.

Figure 2.2 Front-Panel Diagram (Rack Mount)

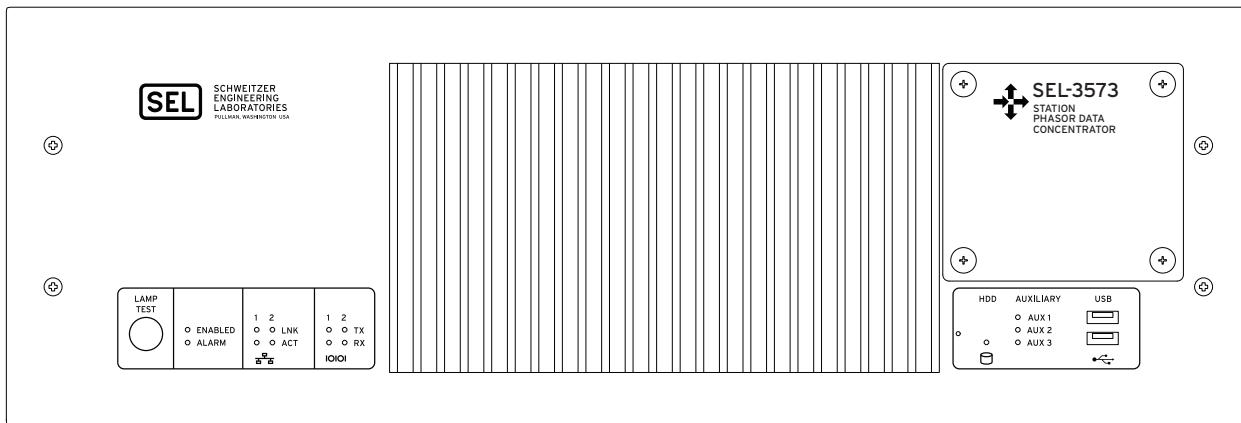


Figure 2.3 Front-Panel Diagram (Panel Mount)

Lamp Test Button

Press the **LAMP TEST** button to illuminate all LEDs. Press and hold the **LAMP TEST** button to cycle through the LED test pattern.

Status Indicators

The **ENABLED** LED displays operational status; green indicates normal operation, and red indicates that the system is starting up, has halted, or is in an error condition.

The **ALARM** LED illuminates red when the alarm contact operates, indicating a nonoptimal system condition. For details regarding alarm contact function, see *Alarm Contact on page 2.7*.

Ethernet LEDs (**LNK** and **ACT**) indicate network status and network activity for built-in Ethernet ports.

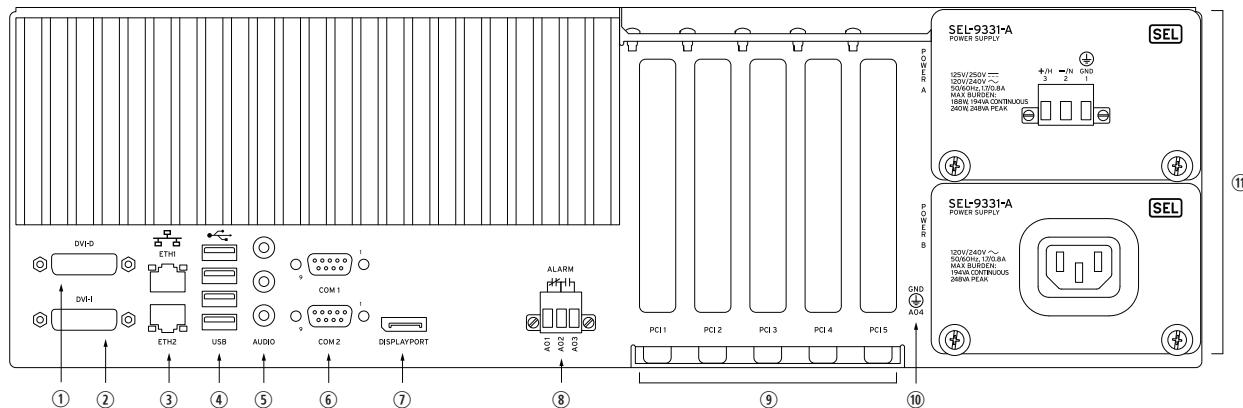
Serial LEDs (**TX** and **RX**) indicate activity on serial ports.

The **HDD** LED indicates SATA drive activity. The blink rate of the LED indicates the level of SATA drive activity, with greater blinking frequency indicating more SATA drive activity.

Auxiliary LEDs labeled **AUX 1**, **AUX 2**, and **AUX 3** are not used by the SEL-3573.

Rear Panel

Figure 2.4 shows the physical layout of the rear panel of the SEL-3573.



- ① **DVI-D Port.** Not used by the SEL-3573 at this time.
- ② **DVI-I Port.** Not used by the SEL-3573 at this time.
- ③ **ETH1 and ETH2 Ports.** Onboard independent Gigabit Ethernet interfaces.
- ④ **USB Ports.** Not used by the SEL-3573 at this time.
- ⑤ **AUDIO Ports.** Not used by the SEL-3573 at this time.
- ⑥ **COM1 and COM2 Ports.** Standard EIA-232 serial ports with configurable +5 Vdc power on Pin 1.

- ⑦ **DISPLAYPORT Port.** Not used by the SEL-3573 at this time.
- ⑧ **ALARM Contact.** The Form C contact output can be wired either normally closed or normally open.
- ⑨ **PCI Expansion Slots.** Use SEL rugged PCI Express expansion cards for additional serial inputs.
- ⑩ **Earth Ground (GND) Terminal Screw.** The earth ground connection for the SEL-3573.
- ⑪ **Power Supply Modules.** The rated input voltage is marked on the chassis near the terminals.

Figure 2.4 Rear-Panel Diagram

Ethernet

The SEL-3573 is equipped with two built-in, high-speed Gigabit Ethernet 10/100/1000BASE-T (**ETH1** and **ETH2**) copper ports for connecting to two independent networks. Both Ethernet ports can be used concurrently and have unique SEL-programmed MAC addresses. Default IP addresses for the Ethernet ports are as follows:

- **ETH1:** 192.168.1.2
- **ETH2:** Disabled by default

The left LED on each rear Ethernet port illuminates orange for a 10 Mbps connection, green for a 100 Mbps connection, and yellow for a 1000 Mbps connection. The right LED flashes green during data transfer.

PCI Expansion

The SEL-3573 includes one SEL-3390S8 Serial Adapter Card in Slot 2. Three expansion slots (Slots 3, 4, and 5) are available for additional SEL-3390S8 serial cards. Slot 1 is not used by the SEL-3573.

To install additional SEL-3390S8 serial cards, first unplug the power source. Unscrew the top panel and remove the blanker plate to access the required expansion slot.

Serial

The SEL-3573 comes with two nonisolated DB-9 serial ports and one SEL-3390S8 PCIe serial expansion card (you have the option to order an additional three SEL-3390S8 cards, for a total of four). Each SEL-3390S8 card supports six RJ45 serial ports. The SEL-3573 supports EIA-232 signaling for serial communication. See *Table 2.1* and *Table 2.2* for the pinout of the SEL-3573 serial ports. See the *SEL-3390S8 Instruction Manual* for further information on expansion card serial ports. *Table 2.4* shows recommendations for cables for serial and Ethernet ports.

Table 2.1 EIA-232 Serial Port Connector Pin Definition

Pin	Ports 1-2
1	DCD or +5 Vdc ^a
2	RXD
3	TXD
4	DTR
5	GND
6	DSR
7	RTS
8	CTS
9	RI

^a Software configurable.

Table 2.2 SEL-3390S8 RJ45 Port Pin Definition

Pin	EIA-232 Mode Default Function	Alternate Function
1	Data Set Ready (DSR in)	-IRIG-B Output ^a
2	Data Carrier Detect (DCD in)	+5 Vdc Port Power
3	Data Terminal Ready (DTR out)	+IRIG-B Output ^a
4	Signal Ground (GND)	Port Power Ground ^b
5	Receive Data (RXD in)	
6	Transmit Data (TXD out)	
7	Clear to Send (CTS in)	
8	Request to Send (RTS out)	

^a Configurable as an IRIG-B input.^b When using +5 Vdc Port Power, Pin 4 functions as both Signal Ground and Port Power Ground.

A common serial cable configuration is shown in *Table 2.3*. Refer to the SEL-5801 Cable Selector Software (free software download from selinc.com) for the most recent cable configurations. Please refer to the individual device manual and SEL-5801 Cable Selector Software prior to selecting a proper cable.

Table 2.3 SEL-C282 Cable Configuration Example

SEL-3573 9-Pin Male D-Sub Connector		SEL-300/400/500/700 Series Relays (Except SEL-321) 9-Pin Male D-Sub Connector	
Pin Func.	Pin No.	Pin No.	Pin Func.
RXD	2	3	TXD
TXD	3	2	RXD
GND	5	5	GND
RTS	7	8	CTS
CTS	8	7	RTS

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

- Keep the length of communications cables as short as possible to minimize communications circuit interference and the magnitude of hazardous ground potential differences that can develop during abnormal power system conditions.
- Ensure that the length of EIA-232 communications cables are not longer than 15.2 m (50.0 ft), and always use shielded cables for communications circuit lengths longer than 3.0 m (9.8 ft).
- Always use modems or fiber optics for communication over long distances; this practice helps provide isolation from ground potential differences between device locations.
- Always route communications cables away from power and control circuits. Switching spikes and surges in power and control circuits can cause noise in the communications circuits if not adequately separated.
- Use the lowest data rate that provides adequate data transfer speed. Lower-speed communication is less susceptible to interference and will transmit greater distances over the same medium than communication at higher speeds.

Serial Port Enumeration

Each serial port on the SEL-3573 corresponds to a static port number that you select during settings configuration with PDC Assistant. *Figure 2.5* displays the port numbering sequence.

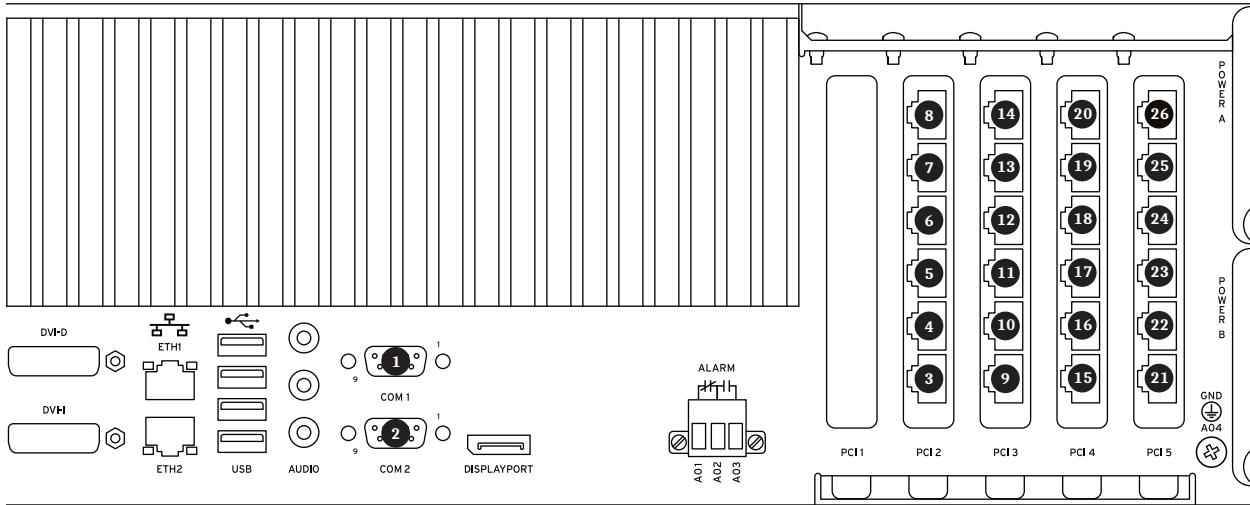


Figure 2.5 Serial Port Enumeration

IRIG-B Connection

You can configure Port 1 of each serial expansion card to accept a demodulated IRIG-B000 or IRIG-B002 signal. See *IRIG-B* on page 2.12 for additional information on configuring SEL-3390S8 serial cards for IRIG-B input.

Grounding

Connect the grounding terminal (see label ⑩ in *Figure 2.4*) labeled **GND** on the rear panel to a rack frame ground or main station ground for proper safety and performance. Use 12 AWG (4 mm²) or heavier wire, less than 3.0 m (9.8 ft) in length, for this connection. This terminal connects directly to the internal chassis ground of the SEL-3573.

Alarm Contact

The SEL-3573 provides a Form C, dry alarm contact that closes under any of the following conditions:

- CPU usage is too high
- Temperature is too high or low
- The SEL-3573 is not running after being turned on
- The SEL-3573 failed an internal diagnostic
- Less than the user-set amount of the available space for archiving remains on the internal drive
- The password jumper is installed

The alarm contact will close for one second under the following conditions:

- A connection to the SEL-3573 is attempted from PDC Assistant after exceeding the allowed number of unsuccessful login attempts
- Settings are sent to the SEL-3573 from PDC Assistant

The SEL-3573 automatically restarts upon a device failure. The device does not restart if the archive is full. See *Archives on page 4.32* for more details on the archiving function and disk space guidelines.

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.

Recommended Communications Cables

Table 2.4 lists the recommended SEL communications cables for use with the SEL-3573.

Table 2.4 Recommended Communications Cables

Port	Port Interface	Cables
COM1 and COM2 (serial)	EIA-232 (nonisolated)	SEL-C235 and SEL-C282
PCI expansion serial ports	EIA-232 (nonisolated)	SEL-C605A and SEL-C659
	RJ45 IRIG-B output	SEL-C972 and SEL-C659
PCI expansion serial port 1	RJ45 IRIG-B input	SEL-C972

Commissioning the SEL-3573

For the initial connection to the SEL-3573, you need the following:

- A computer with a wired Ethernet port
- An uncommissioned SEL-3573
- One RJ45 Ethernet cable

Physical Network

NOTE: The SEL-3573 is capable of autocrossover. This means that neither a hub nor a crossover cable is required.

Connect the SEL-3573 to your computer as shown in *Figure 2.6*. Using a standard RJ45 Ethernet cable, connect the Ethernet port of your computer directly to the **ETH1** port of the SEL-3573. The uncommissioned SEL-3573 only has the **ETH1** port enabled. By default, the IP address on this port is **192.168.1.2**.

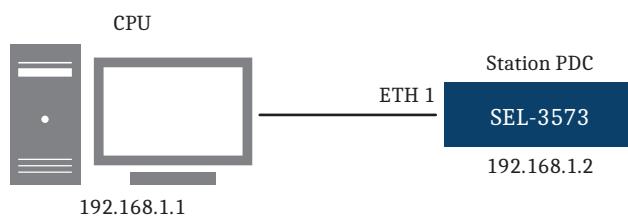


Figure 2.6 Commissioning the SEL-3573

Configuring Microsoft Windows Networking

NOTE: Depending on your company's computer use policies and your user privileges, you may need the assistance of your IT department to configure networking on your workstation.

Confirm that your computer is configured to communicate on the **192.168.1.x/255.255.255.0** subnet.

- Step 1. Start the Microsoft Windows Command Terminal. The Command Terminal is in the **Accessories** folder of the Windows Start menu. Alternately, you can access the Command Terminal by enter **cmd** by using the Run tool in the Windows Start menu.

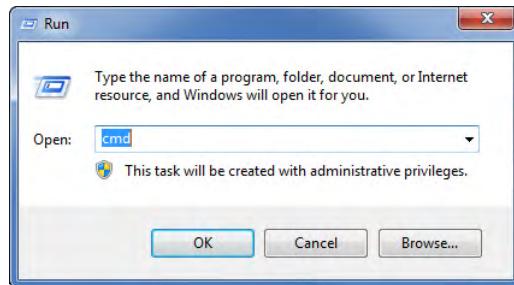


Figure 2.7 Open Terminal With Run Command

- Step 2. In the command terminal, type **ipconfig <Enter>** as shown in *Figure 2.8*. This will show you the IP address and subnet mask for which your Ethernet connection is configured. The IP address must match **192.168.1.1** and the subnet mask must match **255.255.255.0**.



Figure 2.8 Windows IP Configuration

NOTE: Any IP address in the 192.168.1.x/255.255.255.0 subnet is acceptable except for 192.168.1.2, which is taken by the SEL-3573.

- Step 3. If you need to configure your computer to communicate on the **192.168.1.0/255.255.255.0** subnet, and open Microsoft Windows **Network Connections** by typing **ncpa.cpl** in the Windows Run dialog box, as shown in *Figure 2.9*. Clicking **OK** opens the **Network Connections** window, which contains a list of the network devices available on your computer.

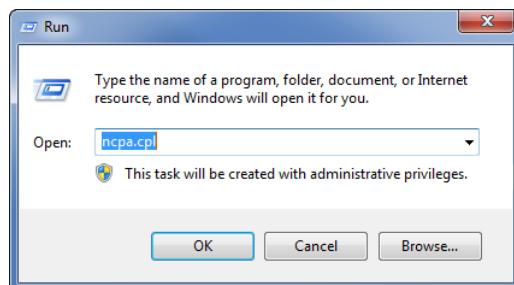


Figure 2.9 Open Network Connections With Run Command

Step 4. Right-click the connection you will be using to communicate with the SEL-3573 and select the **Properties** option. This connection may be labeled **Local Area Connection**.

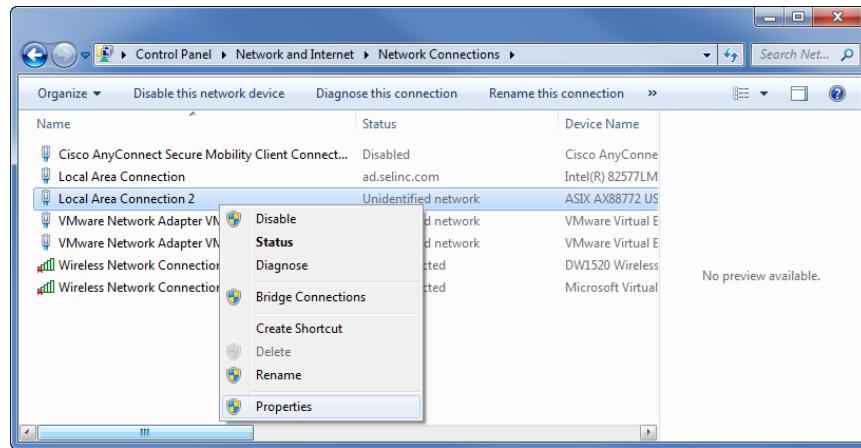


Figure 2.10 Open Connection Properties

Step 5. In the **This connection uses the following items** box, select **Internet Protocol (TCP/IP)** from the list. Click the **Properties** button.

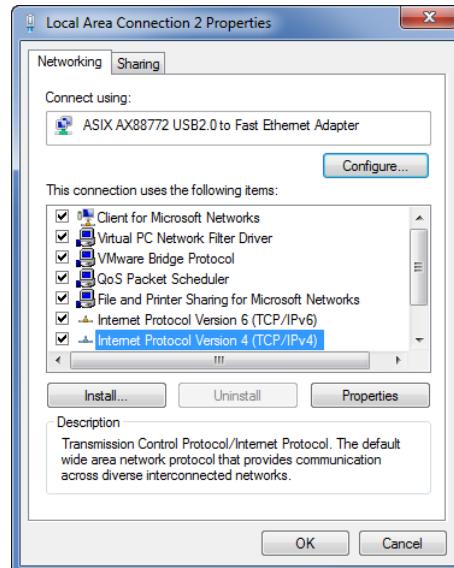


Figure 2.11 Local Area Connection Properties

- Step 6. Select the radio button **Use the following IP address**. Enter **192.168.1.1** for the IP address and **255.255.255.0** for the subnet mask, as *Figure 2.12* shows. Click **OK**.

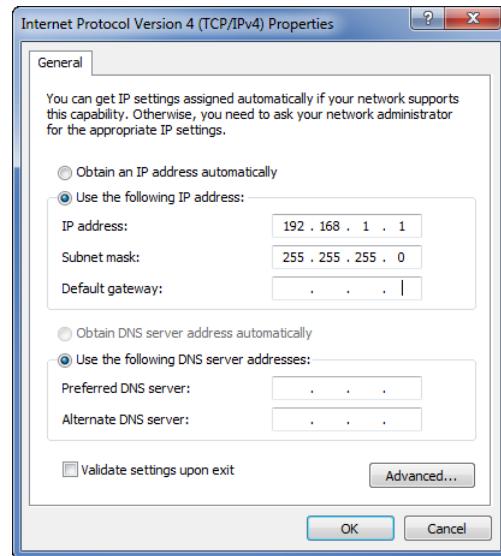


Figure 2.12 Internet Protocol (TCP/IP) Properties

- Step 7. Click **OK** in the **Local Area Connection Properties** dialog box. The new settings do not take effect until this is complete.

Initial Connection

The SEL-3573 default IP address, **192.168.1.2**, is assigned to the **ETH1** port. The SEL-3573 uses port number **26272** for PDC Assistant access. To initially connect to the SEL-3573, open PDC Assistant (see *Installation on page 4.8*) and click **Connect**.

In the **Connections** dialog, enter **192.168.1.2** for **Server**, enter **26272** for **Port**, and leave the **User Name** and **Password** blank, as *Figure 2.13* shows. Connecting without a username and password is only allowed for the initial connection to the PDC or if the password jumper is installed.

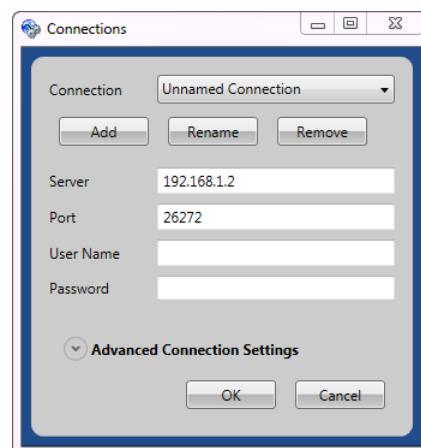


Figure 2.13 Connection Dialog Box

Upon connection, PDC Assistant prompts you for an administrator account name and password, as *Figure 2.14* shows. Enter an account name and password to use when configuring the SEL-3573 and click **OK**.

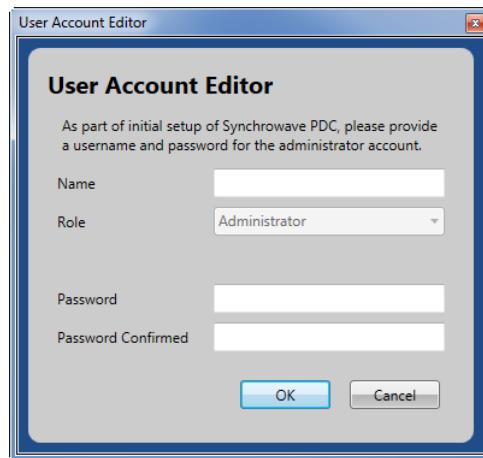


Figure 2.14 Initial Account Setup

The next step in commissioning is to set up the network settings for each Ethernet port on the device. Refer to *Network* on page 4.62 to complete this process.

IRIG-B

SEL-3573 IRIG-B In/Out Capabilities

- Receives and distributes IRIG-B time via the SEL-3390S8 serial expansion PCI cards. Synchronizes the SEL-3573 system clock to a GPS clock by configuring the SEL-3390S8 serial cards as described in *Configuring an IRIG-B Input on the SEL-3573* on page 2.13.
- Accepts demodulated IRIG-B000 or IRIG-B002 with either even or odd parity and demodulated IRIG-B000 outputs with even parity.
- Generates IRIG-B directly from the SEL-3573 system clock if no IRIG-B source is detected. In this case, the SEL-3573 assigns a time quality of FAULT to the distributed IRIG-B.
- Allows daisy-chaining of SEL-3390S8 serial cards for simultaneous IRIG-B distribution to as many as 23 PMUs (assuming one port is used for IRIG-B input).
- Limits the through-box delay of distributed IRIG-B time to 500 ns.
- Allows any installed SEL-3390S8 serial card to be used for IRIG-B input or output.

SEL-3573 IRIG-B Synchronization Considerations

NOTE: The SEL-3573 does not require system time synchronization for basic operation. The SEL-3573 system clock is used for data archiving, latency calculation, and log time-stamping. Basic time alignment functions operate without the necessity of a GPS time source.

The SEL-3573 data archiving function requires that the SEL-3573 system time be within 30 minutes of the time stamps associated with the data being archived. PDC Assistant provides a means for synchronizing SEL-3573 internal time to the local computer time (see *Device* on page 4.57), which is typically within 30 minutes of the GPS time values that the PMUs receive. In this case, however, the natural drift of SEL-3573 internal time could cause shifting of this time outside of the 30-minute synchronization requirement.

Consequently, SEL recommends that for station archiving applications, the SEL-3573 be synchronized to a GPS time source through an SEL-3390S8 card. This ensures synchronization of the SEL-3573 internal time to GPS time.

Configuring an IRIG-B Input on the SEL-3573

Each SEL-3390S8 serial card can accept an IRIG-B input signal on Port 1. By default, this port is configured for IRIG-B output. To configure this port for IRIG-B input, use the following steps. See *Section 3: Hardware Serviceability* for more information on removing PCI expansion cards.

- Step 1. Remove power from the SEL-3573 if already turned on.
- Step 2. Unscrew and remove the top panel of the SEL-3573 chassis.
- Step 3. Unscrew the SEL-3390S8 serial card from the SEL-3573 chassis and remove.
- Step 4. Locate the Port 1 IRIG-B In/Out Jumper (see *Figure 2.15*) and apply the jumper to the **IRIG IN** position (note that this is labeled on the circuit board itself).

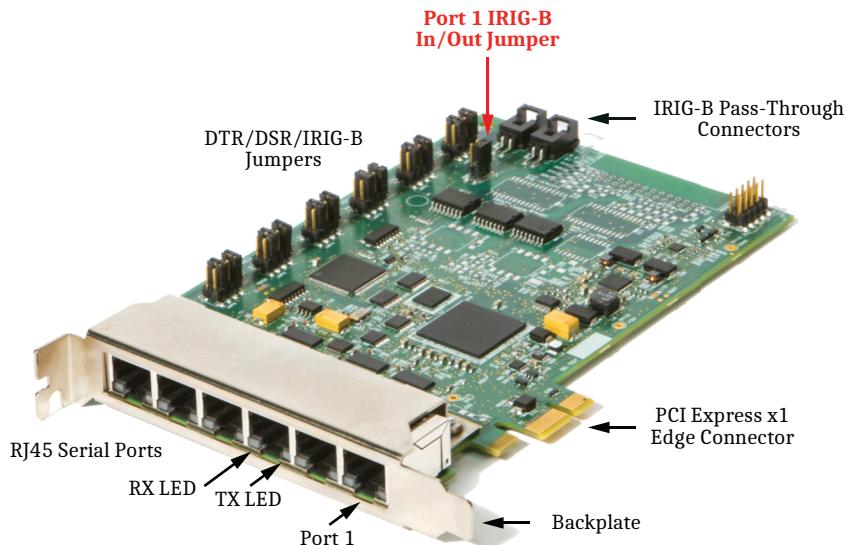


Figure 2.15 SEL-3390S8 IRIG-B In/Out Jumper

- Step 5. Reinstall the SEL-3390S8 card and secure the chassis top panel.

You can now connect the SEL-3573 directly to an IRIG-B time source by using a BNC-to-RJ45 cable, such as the SEL-C972.

Configuring IRIG-B Output on the SEL-3573

By default, each SEL-3390S8 card supports IRIG-B output on all ports. If the SEL-3573 is not synchronized to an external time source, it will distribute IRIG-B by using the SEL-3573 system clock as a time source. SEL recommends synchronizing the SEL-3573 to an external time source if distributing IRIG-B. Follow the steps in *Configuring an IRIG-B Input on the SEL-3573* on page 2.13 to enable IRIG-B input on Port 1 of one SEL-3390S8 serial card.

You can use the remaining five ports on the SEL-3390S8 card to distribute the IRIG-B signal. Once the SEL-3390S8 card is receiving IRIG-B on Port 1, connect one or more of the remaining five ports to one or more PMUs by using a BNC-to-RJ45 cable, such as the SEL-C972.

To synchronize more than five PMUs to the IRIG-B time source, use the following steps to daisy-chain multiple SEL-3390S8 serial cards for IRIG-B distribution (as many as 23 ports total).

- Step 1. Remove power from the SEL-3573, if already turned on.
- Step 2. Unscrew and remove the top panel of the SEL-3573 chassis.
- Step 3. Use SEL-C5865 jumper cables to connect the IRIG-B pass-through cables of each SEL-3390S8 card.

The output of one card must connect to the input of the adjacent card. Note that when daisy-chained, only one SEL-3390S8 should be configured to accept an IRIG-B input on one port. See *Figure 2.16*.

Generate IRIG-B Output From External Source

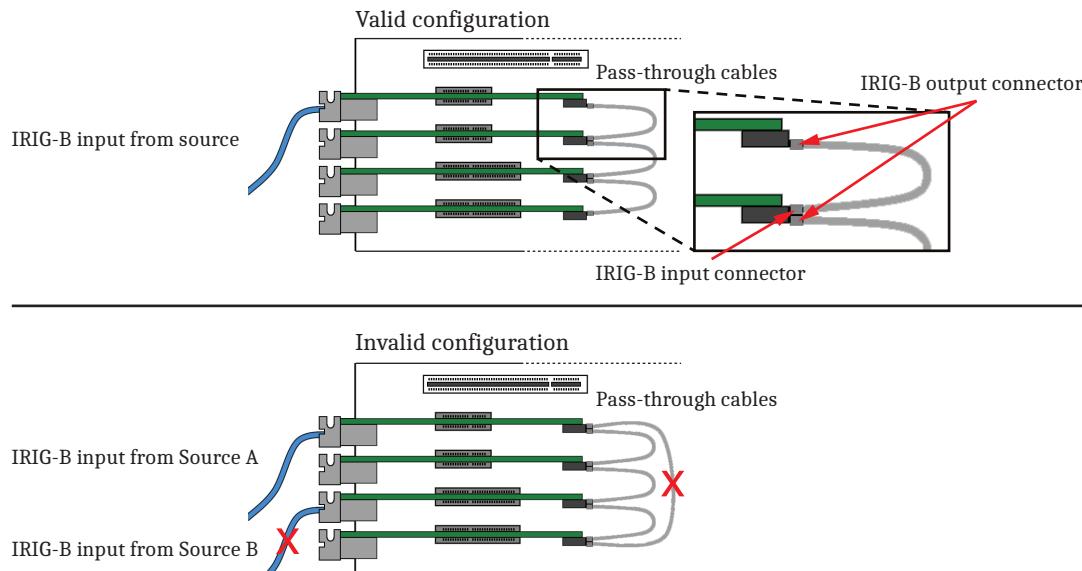
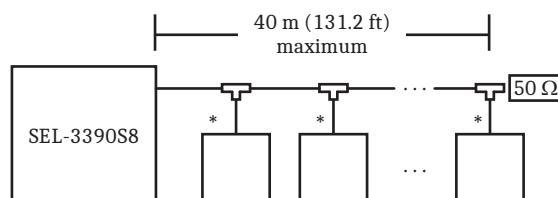


Figure 2.16 Valid and Invalid IRIG-B Distribution Configurations

SEL-3390S8 Drive Capabilities

Each SEL-3390S8 uses one IRIG-B drive circuit for IRIG-B outputs. Each SEL-3390S8 output can distribute IRIG-B to as many as 20 PMUs when connected to the SEL-3390S8 port, as *Figure 2.17* shows. For additional details, refer to the *SEL-3390S8 Instruction Manual*.



*Keep this connection as short as possible.

Figure 2.17 Multiple Device Connections

S E C T I O N 3

Hardware Serviceability

Overview

The SEL-3573 Station Phasor Data Concentrator (PDC) has unique hardware, which sets its deployment and servicing apart from other devices. This section details the individual hardware components that make up the core of the SEL-3573, its expansion capabilities, and the technical specifications and requirements of the various components.

Main Board

⚠ CAUTION

There is danger of explosion if the battery is incorrectly replaced. Replace only with Panasonic BR2330A or equivalent recommended by manufacturer. See Owner's Manual for safety instructions. The battery used in this device may present a fire or chemical burn hazard if mistreated. Do not recharge, disassemble, heat above 100°C or incinerate. Dispose of used batteries according to the manufacturer's instructions. Keep battery out of reach of children.

Figure 3.1 shows the location of the real-time clock and BIOS battery and the control (DIP) switches on the SEL-3573 main board.

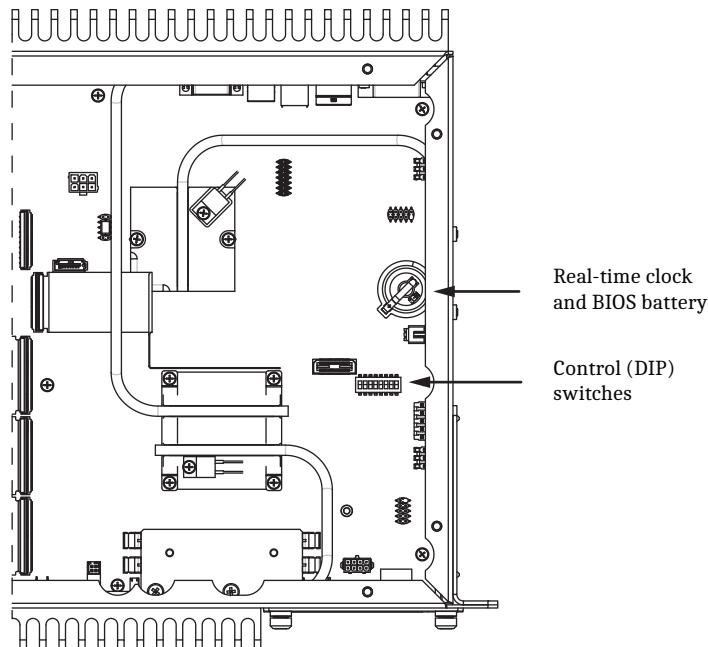


Figure 3.1 Main Board Diagram

Top Panel Removal and Installation

⚠ 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 access the main board and PCI expansion slots, you must first remove the top panel from the SEL-3573. To do so, remove the screws as shown in *Figure 3.2*.

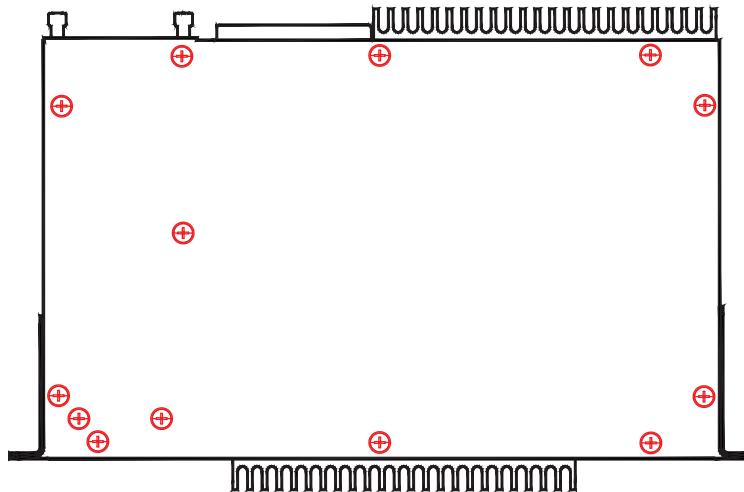


Figure 3.2 Top Panel Removal

Control (DIP) Switches

Figure 3.3 shows the control (DIP) switches and their functions on the SEL-3573 main board. The switches can be accessed from the top of the unit by removing the top panel (see *Top Panel Removal and Installation*) or by removing the drive bay door from the front of the unit (see *SATA Drives Removal and Installation on page 3.4*) and all installed SATA drives.

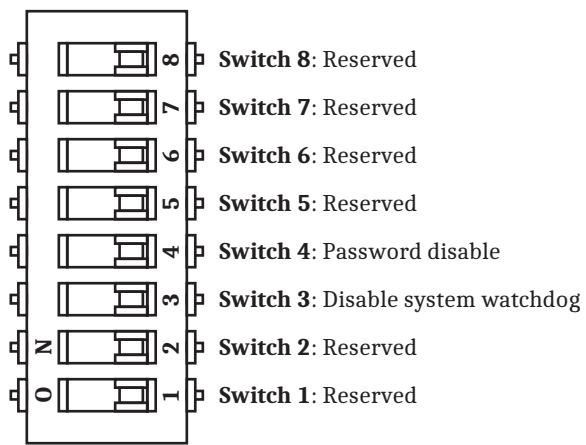


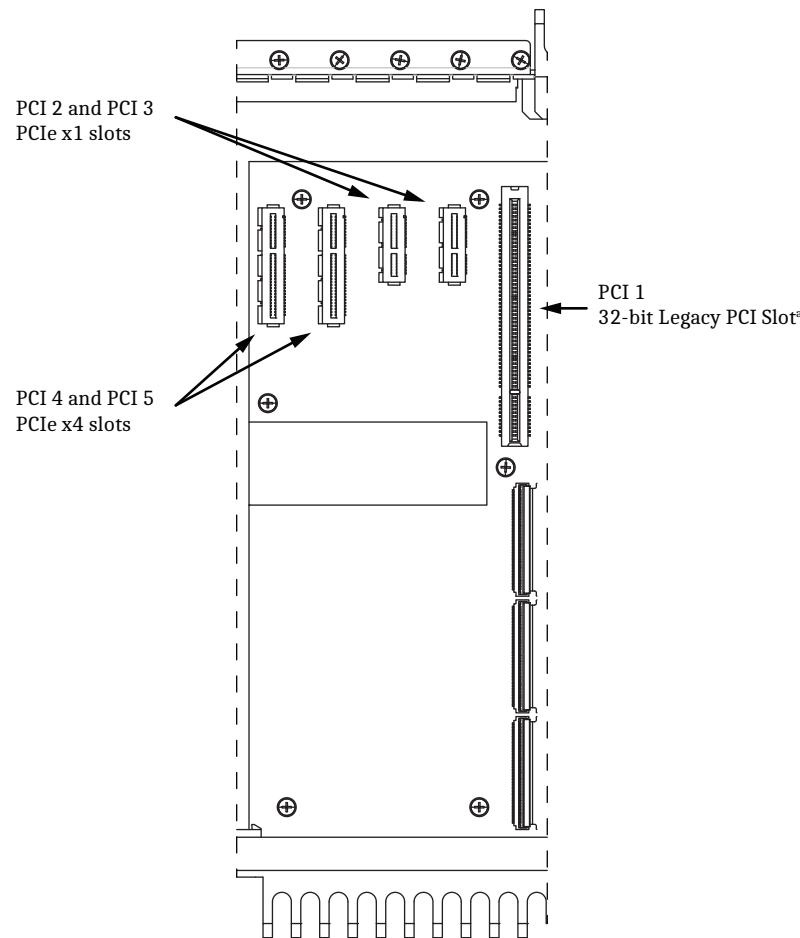
Figure 3.3 Main Board Control (DIP) Switches

Real-Time Clock and BIOS Battery

The SEL-3573 contains a button cell battery that is used to maintain BIOS defaults and clock status when an external power source is disconnected.

PCI Expansion Slots

Figure 3.4 shows the expansion slot locations and their functionality. Typical consumer-rated expansion cards do not meet SEL environmental standards. The SEL-3573 drivers, therefore, are designed to work only with SEL expansion cards. The SEL-3573 supports only SEL-3390S8 Serial Adapter cards at this time. The SEL-3390S8 is compatible with both PCI Express x1 and x4 slots. One SEL-3390S8 card is included in the base SEL-3573 configuration. Additional SEL-3390S8 cards can be added. Please see *Removal and Installation*.



^a Not used in the SEL-3573.

Figure 3.4 PCI Expansion Slots

Removal and Installation

When installing or removing expansion cards, ensure that the system is turned off and all power supplies are disconnected. Each expansion card in the SEL-3573 is secured to the chassis by a screw at the rear panel. Once installed, the foam pads on the expansion board and top panel hold the cards securely in place and to resist shock and vibration.

Power Supplies

The SEL-3573 allows for dual, redundant power supply configurations to maximize availability in critical service situations. The SEL-3573 supports different power sources of varying voltage levels, allowing you to wire your system to primary and backup power sources with seamless transition during a service outage. See *Specifications on page 1.6* for available power supply configurations.

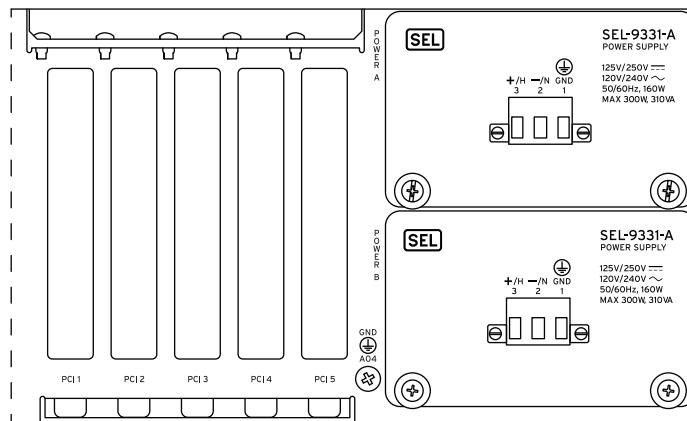


Figure 3.5 Power Supply Installation

Removal and Installation

The SEL-3573 power supplies include two thumbscrews that secure them to the SEL-3573 chassis. To remove a power supply, disconnect its power source, unscrew the thumbscrews until they spin freely, and then pull the power supply out until it is free of the chassis. The installation process follows the removal steps in reverse.

Load-Sharing Configuration

If two power supplies are present in the SEL-3573, they will always attempt to share the load equally. In the event that one supply fails or loses its input source, the remaining power supply provides all the power to the unit.

SATA Drives

The SEL-3573 SATA drive comes preformatted and programmed for the SEL-3573 unit. Do not attempt to use additional SATA drives in your SEL-3573.

Removal and Installation

The drive bay is secured by a cover with four thumbscrews. Unscrew each of the thumbscrews until they spin freely and the drive bay cover comes off. The included SATA drive is attached to a sled plate with four screws. The sled fits into a slot in the drive bay itself, allowing for easy insertion and removal of the drive.

S E C T I O N 4

PDC Assistant

Overview

NOTE: Throughout this section of the manual, the SEL-3573, SEL-3373, and SEL-5073 are referred to collectively as "the PDC."

This section describes the SEL Phasor Data Concentrator (PDC) Assistant software application. Use PDC Assistant to configure the SEL-5073 SYNCHROWAVE PDC, the SEL-3573 Station PDC, or the SEL-3373 Station PDC; retrieve archived data; view the PDC real-time status; view PDC logs; set up user accounts; and update the PDC firmware and maintain the PDC.

Figure 4.1 shows the initial screen when you launch PDC Assistant. From the PDC Assistant **Home** view, you can create new settings files, open existing files, read settings from a PDC, or manage local PDC services.

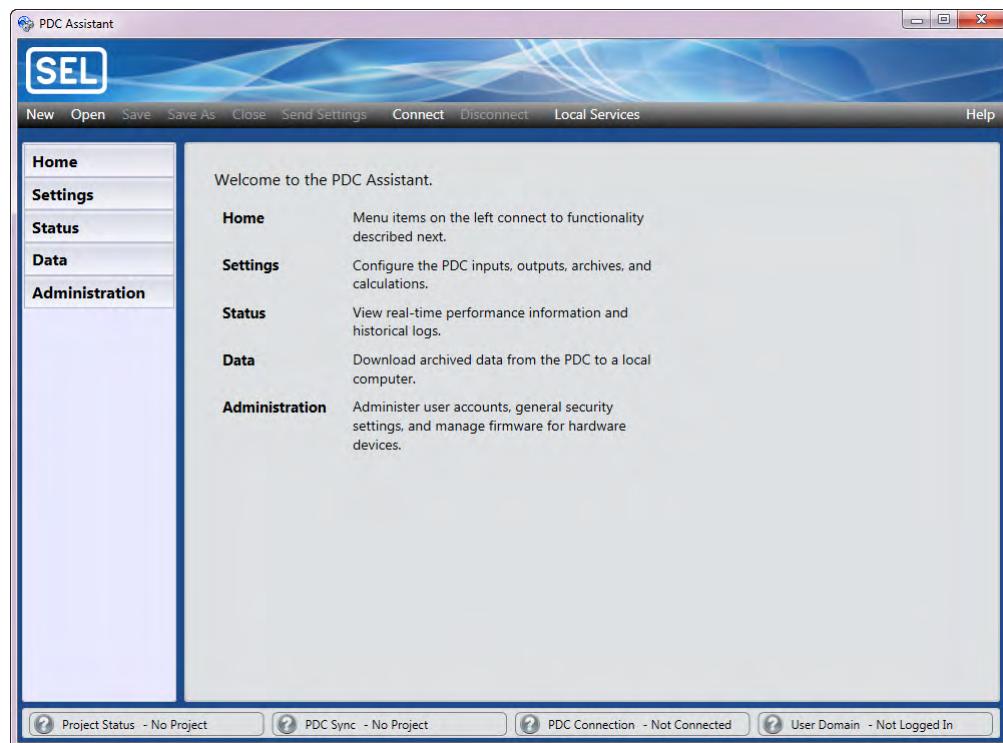


Figure 4.1 PDC Assistant Home Page

Project Files

The PDC configuration information is stored in a project file. When saving a project file, you have two available options:

- Store the project file on a computer by using the **Save** or **Save As** button.
In this case, the file is available for future edits with PDC Assistant.
- Store the project file on the PDC by using the **Send Settings** or **Connect** button.
In this case, the file is used by the PDC as its internal source of configuration information.

PDC Assistant caches a local project file when you make changes to settings, but these changes are not saved to a computer or the PDC. Changes to a document are not permanent until saved. Files can be retrieved from a computer or from the PDC storage.

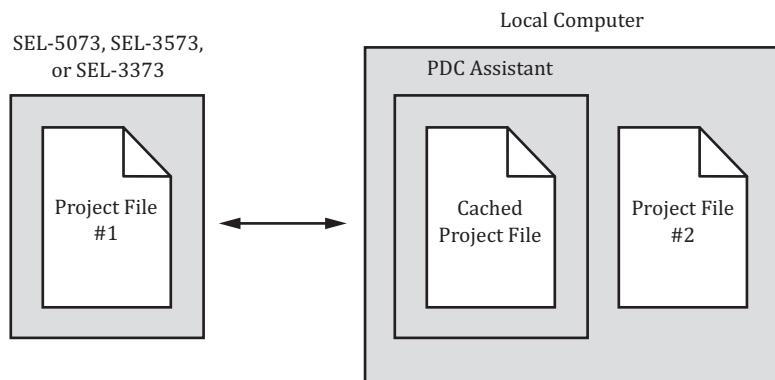


Figure 4.2 Storage Locations for Project Files

Online and Offline Modes

It is possible to create a PDC configuration while PDC Assistant is not connected to the PDC. This allows PDC settings to be created on a local computer and then later applied to the PDC. Access to real-time status, diagnostic logs, retrieving archives, and user account administration is not available while offline. For these tasks, you must establish an active connection with the PDC. See *Status Bar on page 4.7* for assistance with confirming online and offline status.

File and Connection Management Menu Bar

Figure 4.3 shows the file and connection management menu bar. Use it for managing project files and connecting to the PDC.



Figure 4.3 File and Connection Management Menu Bar

New

Use this button to start a new project file. When adding a new project file, the settings version dialog box displays, as *Figure 4.4* shows.

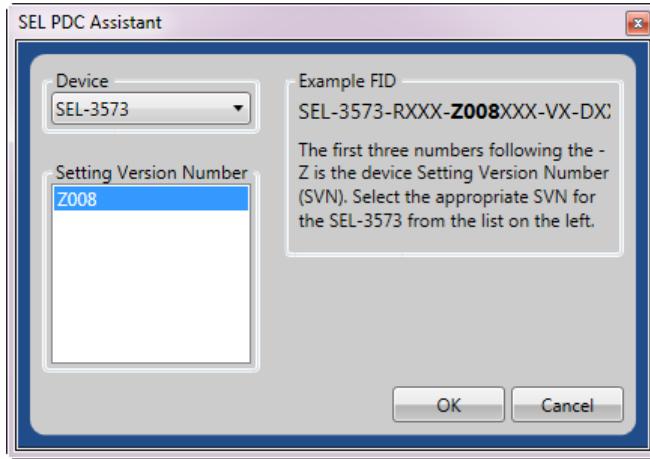


Figure 4.4 Device Setting Version Number

Select the device type: SEL-3573, SEL-3373, or SEL-5073. The Settings Version Number (SVN) corresponds with the version of PDC you are using. *Table 4.1* shows the mapping between SVN, PDC version, and the PDC Assistant version in which the given SVN was introduced.

Table 4.1 Settings Version Map

SVN	SEL-3573	SEL-3373	SEL-5073	PDC Assistant ^a
Z001	NA	NA	R100	1.1.0.0
Z002	NA	R100	NA	1.2.0.0
Z003	NA	R101	R101	1.3.0.0
Z004	NA	R108	R108	1.4.0.0
Z005	NA	R110	R110	1.5.0.0
Z006	NA	R111	R111	1.7.0.0
Z007	NA	R112, R113, R114, R115	R112, R113	1.9.0.0
Z008	NA	NA	R115, R116	2.0.0.0
Z008	NA	R116	NA	2.1.0.0
Z008	R117	NA	NA	2.2.0.0
Z008	R117-V2	R116-V6	NA	2.3.0.0
Z008	NA	R116-V7	R116-V1	2.5.0.0
Z008	NA	NA	R116-V2	2.5.1.0
Z009	R117-V3	NA	NA	2.5.0.0
Z009	R117-V3	NA	NA	2.5.1.0

^a Each PDC Assistant version provides backward compatibility with all previous SVN settings.

Open

Use the **Open** button to open an existing project file from a local computer.

Save and Save As

Use the **Save** or **Save As** button to save settings to a local computer project file. **Save** updates the current file, while **Save As** allows you to save the current project to a new file.

An asterisk appears in the PDC Assistant window title bar when the project file contains unsaved settings, as *Figure 4.5* shows.



Figure 4.5 Unsaved Settings Indicator

When the current project contains unsaved settings, terminating PDC Assistant or opening a new project opens a confirmation prompt, as shown in *Figure 4.6*.

- Select **Save to File** to save the cached configuration data to a file on a local computer (File #2 in *Figure 4.2*).
- Select **Discard** to continue with the present operation and reject any changes to the cached project file in PDC Assistant.
- Select **Cancel** to cancel opening or closing of a new project file.

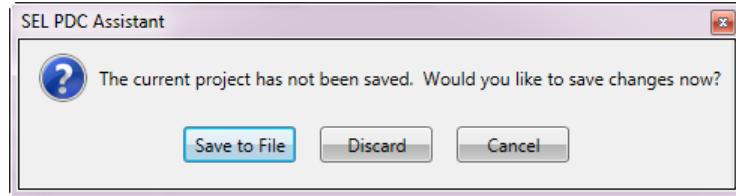


Figure 4.6 Menu for Terminating PDC Assistant

Close

Use the **Close** button to close a project file.

Send Settings

Use the **Send Settings** button to send modified settings to the PDC while in online mode. See *Status Bar on page 4.7* for assistance in confirming settings synchronization and online and offline statuses.

The real-time status, diagnostic logs, retrieving archives, and user account information are not available offline. Furthermore, changes in these functions through PDC Assistant are applied immediately to the connected PDC. Therefore, there is no Send Settings functionality associated with them.

Upon clicking **Send Settings**, a message displays to remind you that changes to the network settings may disrupt the ability of PDC Assistant to connect to the PDC. See *Network on page 4.62* for additional information on network settings.

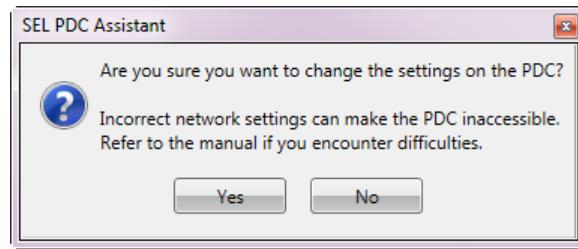


Figure 4.7 Send Network Settings Warning

If the modified settings include changes to the network settings, PDC Assistant will automatically disconnect from the PDC after applying the settings change.

Connect

Use the **Connect** button to connect to the PDC.

The connection dialog box, shown in *Figure 4.8*, requires a user name and password. Enter the IP address of the PDC in the **Server** field. In the **Port** field, enter the port value selected during installation if using an SEL-5073, or **26272** if using an SEL-3573 or SEL-3373.

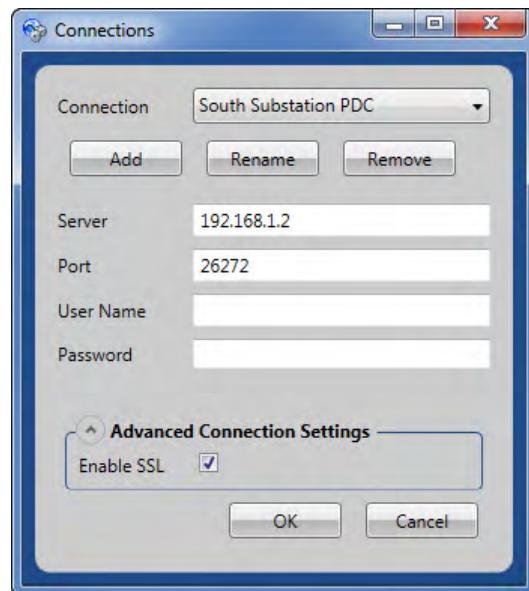


Figure 4.8 Connections Dialog Box Login Information

By default, PDC Assistant encrypts all communication with the PDC. See *Section 5: Troubleshooting* for additional information.

Entering valid user credentials in the **Connections** window and clicking **OK**, as shown in *Figure 4.8*, causes one of the following three outcomes:

1. If PDC Assistant displays the Home view (as shown in *Figure 4.1*), or if PDC Assistant contains cached settings that match the settings on the PDC, then the project file presently stored in the PDC automatically opens.
2. If PDC Assistant contains a modified version of the project settings on the PDC, a network settings warning prompt appears, as shown in *Figure 4.9*.

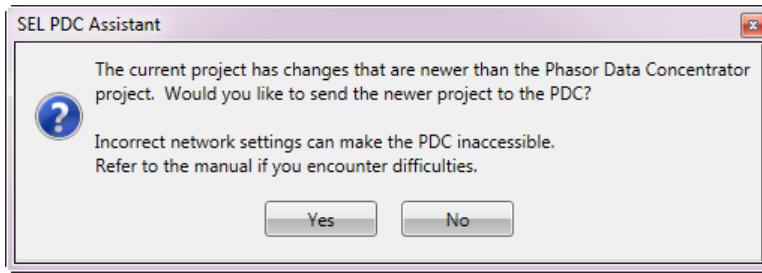


Figure 4.9 Go Online Data Change Message

- Selecting **Yes** causes PDC Assistant to go online and applies the modified project settings to the PDC (i.e., PDC Assistant is online and the cached settings are applied to Project File #1).
- Selecting **No** causes PDC Assistant to go online without applying the modified project settings to the PDC. The *Status Bar* on page 4.7 indicates that local settings are not synchronized with the settings stored in the PDC (i.e., PDC Assistant is online but the cached settings do not match those in the project file on the PDC).
- If PDC Assistant contains a different project than the project currently on the PDC, an overwrite warning prompt appears, as shown in *Figure 4.10*.

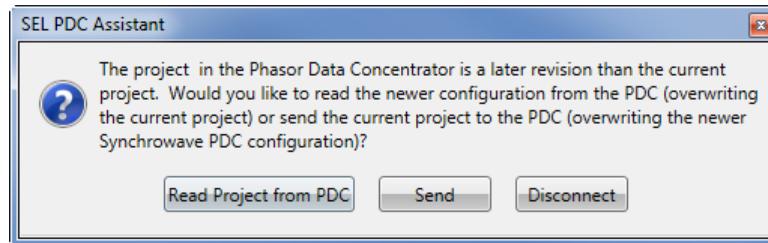


Figure 4.10 Overwrite Warning and Project File Selection Prompt

- Select **Read Project from PDC** to reject the present cached project file in PDC Assistant and instead use the project file that is presently stored in the PDC. In this case, all existing settings changes that have been made in PDC Assistant are rejected and the settings information is read from the PDC.
- Select **Send** to send the present cached project file to the PDC. This overwrites the existing project file in the PDC.
- Select **Disconnect** to cancel the operation. This option prevents any changes to either the project file in the PDC or the present cached project file in PDC Assistant.

Disconnect

Use this button to disconnect from the PDC. This allows you to use a different project file than the one stored in the PDC.

Local Services

Local services are only available if the SEL-5073 or Archive Collection Service (ACS) is installed on the same computer as PDC Assistant. The **Local Services** menu bar selection allows you to start and stop the SEL-5073 service or the ACS, or to launch the Microsoft Service Manager.

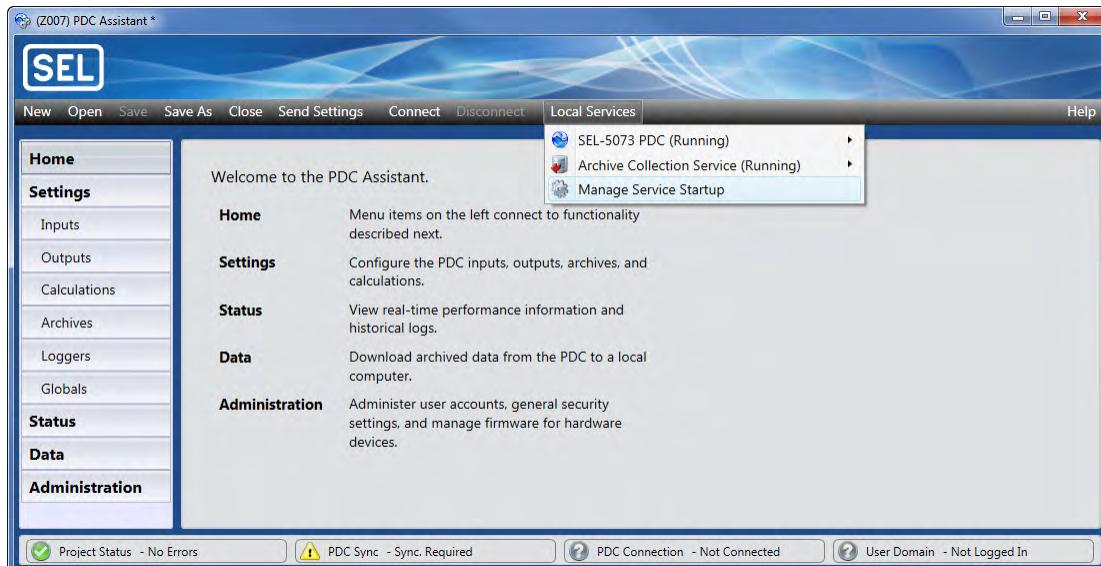


Figure 4.11 Local Services Menu

The **Local Services** options are defined as follows:

- **SEL-5073 PDC:** Allows you to start or stop the SEL-5073 service. The present status of the service is displayed in parentheses next to the heading (**Stopped** or **Running**).
- **Archive Collection Service:** Allows the user to start, stop, or configure the ACS. Refer to *Archive Collection Service on page 4.38* for details. The present status of the service is displayed in parentheses next to the heading (**Stopped** or **Running**).
- **Manage Service Startup:** Allows you to launch the Microsoft Service Manager. Once you initiate the Service Manager, you can start, stop, or edit all services on the machine.

Status Bar

The Status bar includes four status elements: Project Status, PDC Sync, PDC Connection, and User Domain.



Figure 4.12 Status Bar Indications

Each status element may display the following indications.

Project Status

-  No project is defined.
-  Active project with no errors.
-  Current project has settings errors.

PDC Sync

-  Unable to determine if local settings are synchronized with the PDC.
-  Local settings are synchronized with the PDC.
-  Local settings have been modified and may be different than those stored in the PDC.

PDC Connection

-  Disconnected from the PDC.
-  Active connection to the PDC.
-  The PDC service is not running.

User Domain

-  User authentication is performed remotely via LDAP.
-  User authentication is performed by the PDC.

Installation

System Requirements

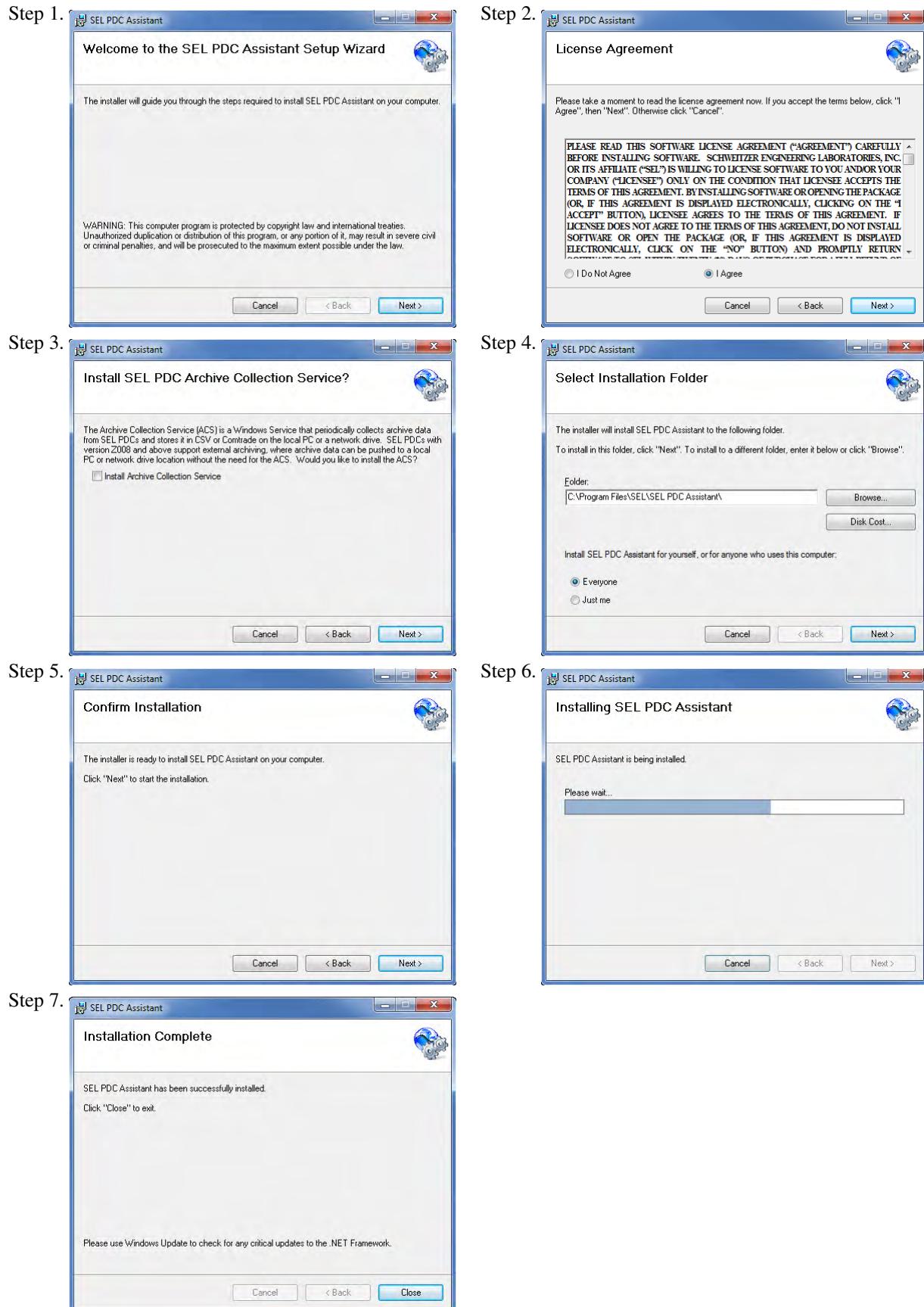
NOTE: The system disk must be partitioned as an NTFS drive.

PDC Assistant can be installed on the following operating systems:

- Windows XP SP3
- Windows Server 2008 32/64-Bit SP2
- Windows Server 2008 R2 SP1 (64-Bit)
- Windows Vista 32/64-Bit
- Windows 7 SP1 32/64-Bit
- Windows 8 32/64-Bit
- Windows Server 2012 R2
- Windows 10 32/64-Bit

Installation

Use the PDC Assistant Install File to begin installation of the PDC Assistant software. Follow the instructions sequence shown in *Figure 4.13*.

**Figure 4.13 PDC Assistant Software Installation**

Settings

Settings navigation menu items are organized into the following ten categories:

- **Inputs:** Add a PMU, a PDC, or a sub PMU. The sub PMU is a PMU that has previously been concentrated with other PMUs in a PDC. For each input, tags define data names. When defining inputs, tags can be loaded from PDC Assistant device definition files, created in the tag editor, or populated automatically by using the **Query Tags** button or the automatic Sub PMU menu item.
- **Outputs:** Each output combines a set of time-aligned PMU data into a concentrated data packet. The tag editor included with the output settings enables you to combine individual PMU data values into a single output.
- **Calculations:** The PDC includes an engine for high-speed calculations. The results are available as tags, which can be used in outputs or archives.
- **Archives:** A real-time database stores triggered or continuous archives. The archive settings provide you the ability to configure how data are stored and to select individual tags for storage.
- **Loggers:** Select the severity level, syslog output, and storage amount for the PDC log capture.
- **Globals:** These settings are for general PDC configuration.
- **Network** (SEL-3573 and SEL-3373 only): Assign local Ethernet interface IP and primary gateway IP addresses.
- **General Security:** Use these settings to manage access rules for connections between PDC Assistant and the PDC.
- **Light Weight Directory Access Protocol (LDAP):** Configure the PDC to interface with a centralized authentication server.
- **Certificates** (SEL-3573 and SEL-3373 only): Add encryption certificates for LDAP authentication.

After changing any settings value, the settings must be re-sent to the PDC in order for the new values to take effect. The PDC Sync field is marked with a green check when the settings in the PDC Assistant view are sent to the PDC.

Inputs

Selecting the inputs option for PDC Assistant displays the screen shown in *Figure 4.16*. Add inputs by selecting from the options in the Inputs menu bar, shown in *Figure 4.14*.



Figure 4.14 Inputs Menu Bar

Each option is defined as follows:

- **Add PMU:** Adds a new PMU in the left column of the device hierarchy region.
- **Add PDC:** Adds a new PDC in the left column of the device hierarchy region.

- **Add Sub PMU:** Adds a new PMU under the currently selected PDC. Use this option to configure a system with multiple PMUs included in a PDC. Do this by using **Manually** or **Automatically**.
Automatically queries the available PMUs and enters the name, ID, and tags available. This requires that the PDC input is communicating successfully with the PDC. Verify this on the Real-Time Status page.
- **Copy/Paste:** Copies and pastes PMUs and PDCs that have been created or imported.
In order to simplify the configuring of a PDC input coming from an SEL-3573, SEL-3373, or SEL-5073 and going to a cascaded PDC, PDC Assistant supports copying the output configuration from the upstream project and pasting it into the input configuration of the downstream project. During the paste operation, PDC Assistant maps the appropriate settings from the output to an input (of type PDC).
- **Import:** This feature allows you to import .pdex files exported from PDC Assistant. Outputs created in PDC Assistant can be exported to a .pdex file, where the file can then be imported as an input PDC or PMU.
- **Delete:** Removes an input PDC or PMU.

The following settings for each PMU are defined in the settings pane:

- **Enabled:** Select this check box to enable the input.
For security purposes, inputs that are not enabled will reject all inbound connection attempts.
- **Station Name:** Enter the station name for the incoming PMU.
This must match the station name of the external PMU settings.
- **Station Name Alias:** Allows you to change the station name of the PMU in the PDC and the PDC output.
- **PMU ID:** Enter the ID for the incoming PMU.
This must match the ID of the external PMU settings.
- **PMU ID Alias:** Allows you to change the ID of the PMU in the PDC and the PDC output.
- **Data Rate:** Select the data rate of received data from the external PMU.
- **Physical Layer:** Select Ethernet or Serial.

For an Ethernet connection, the SEL-3573, SEL-3373, and SEL-5073 support TCP, UDP, UDP_T, UDP_U, and UDP_S transport protocols. The IP address setting is the address of the remote server. The command port is the TCP port on the remote server that will receive commands, and the data and configuration port is the UDP port on the PDC that will receive data and configuration frames. For UDP_S, the port setting refers to the port number on the PDC to which IEEE C37.118 data are sent. For UDP_T and UDP_U, a command port on the remote server and data port on the PDC are required.

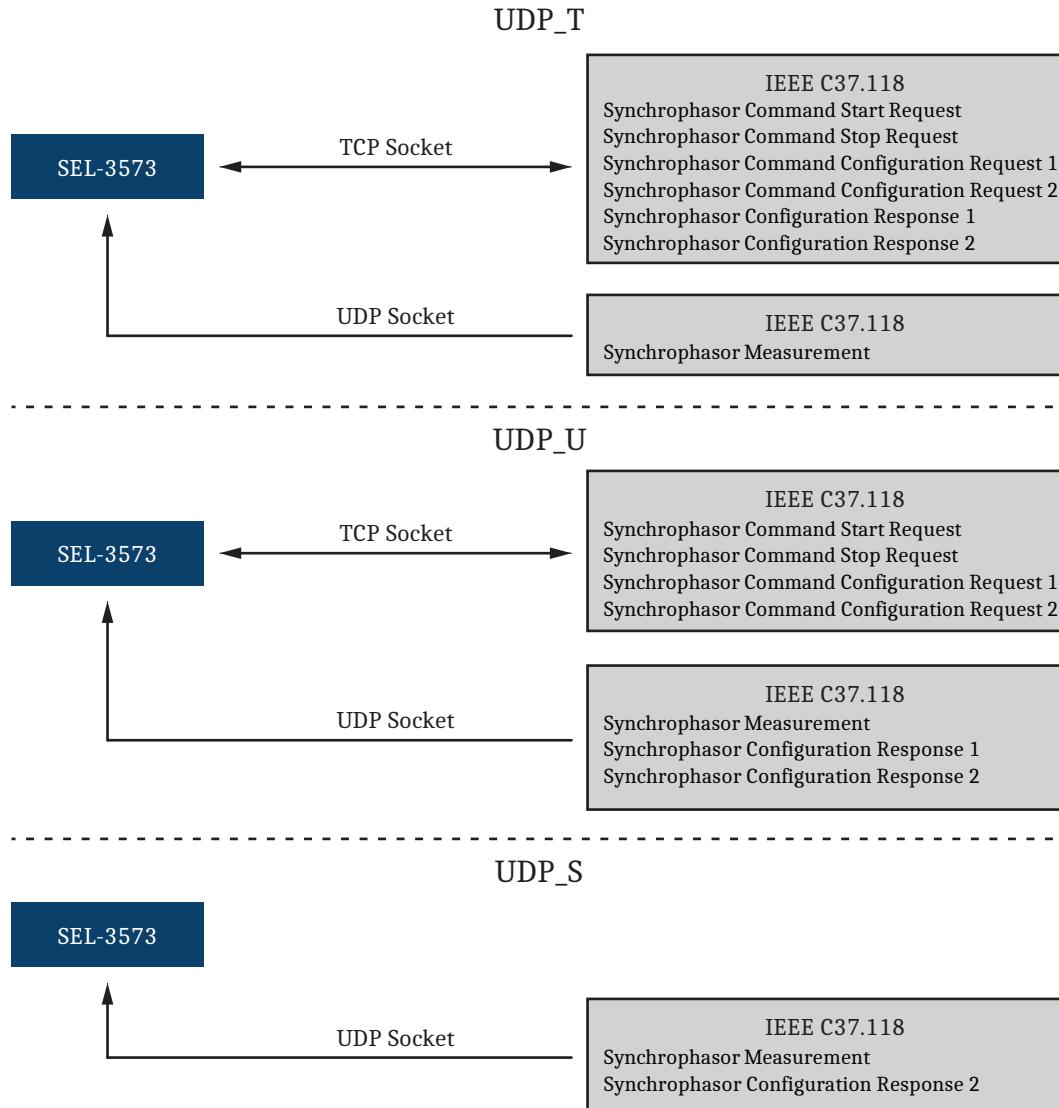


Figure 4.15 Supported Protocols

This following is general guidance on using the various protocols:

- Use TCP to ensure that all data are received (e.g., for archiving). TCP uses handshaking that allows data to be retransmitted if lost in transit. TCP should not be used in high latency (>5 s) situations because disconnects and drops may occur.
- Use UDP, UDP_T, or UDP_S for applications where it is acceptable if some data are lost (e.g., visualization). UDP_S is used in applications where users want to ignore all incoming communications (e.g., on the output of a substation PDC). UDP_S also enables the use of IP multicast.
- Use UDP_T or UDP_U in applications where you want TCP handshaking for the commands, and where you want minimal latency added to the data stream.

For a serial connection, you can specify the data rate, parity, stop bits, and flow control.

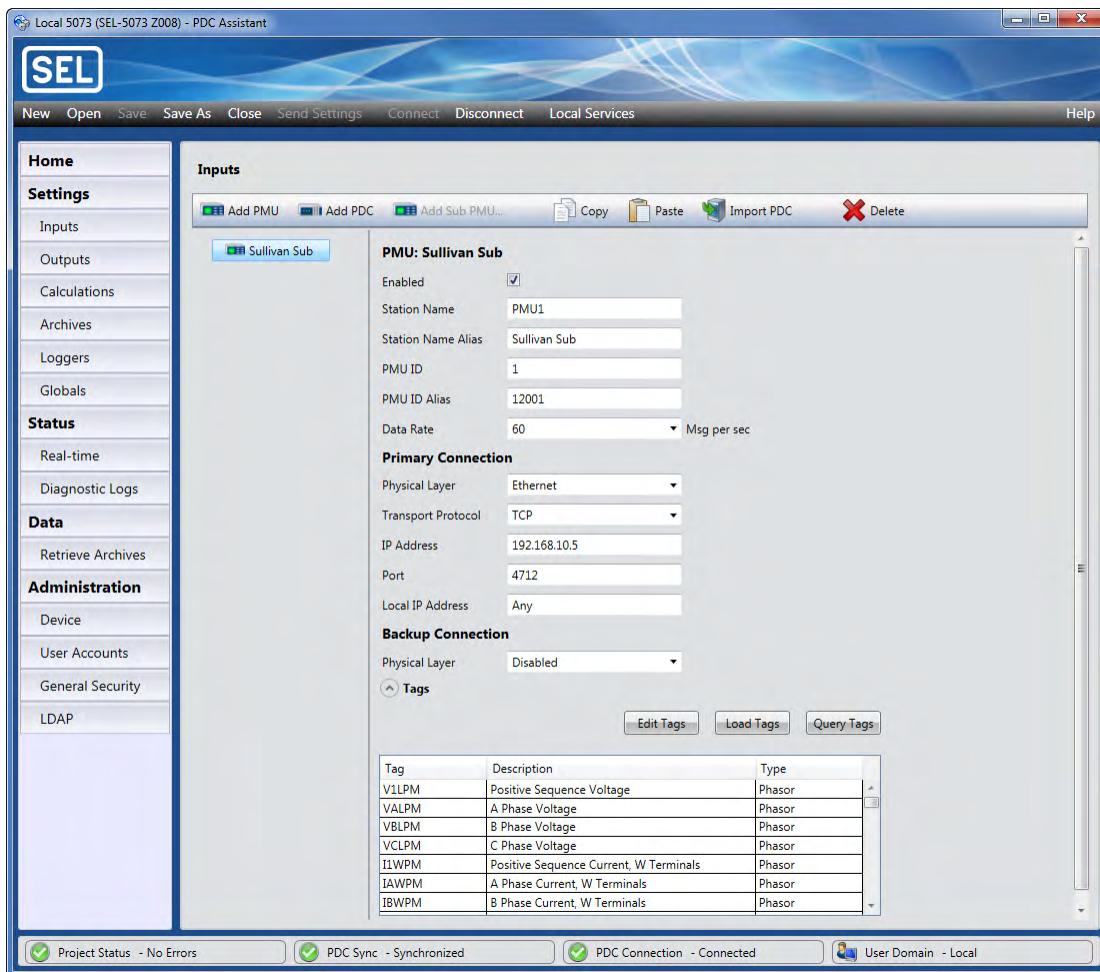


Figure 4.16 Input Settings Screen: Add PMU

Under Ethernet Configuration, the following settings apply:

- **Transport Protocol:** Select **UDP_T**, **UDP_U**, **UDP_S**, **UDP**, or **TCP**.
- **IP Address:** Enter the IP address of the external device to which the PDC will connect.
- **Port:** Specify the port the communication will use. When the transport protocol is set to **UDP**, **UDP_T**, or **UDP_U**, the following settings appear:
 - **Command Port:** Specify the port the PDC will use for communicating commands.
 - **Data Port:** Specify the port the PDC will use for communicating data.
- **Local IP Address:** The IP Address must be an address of one of the interfaces configured on the device (see *Network* on page 4.62). This address is used for all communication to and from this input. Use **Any** to allow the PDC to automatically choose the address to use, or enter the desired IP address. When you are using IP multicasting with **UDP_S**, you cannot use the **Any** setting.

PDC Input Redundancy

The SEL-3573, SEL 3373, and SEL-5073 support redundant inputs and output to increase the availability of streaming synchrophasor data for downstream applications. This allows you to set up redundant PMUs and PDCs to improve data availability in cases where one of the inputs is affected by a network outage, a clock failure, or status irregularities such as invalid data or time quality.



Figure 4.17 System Architecture Showing Redundant PMUs to Improve Data Availability

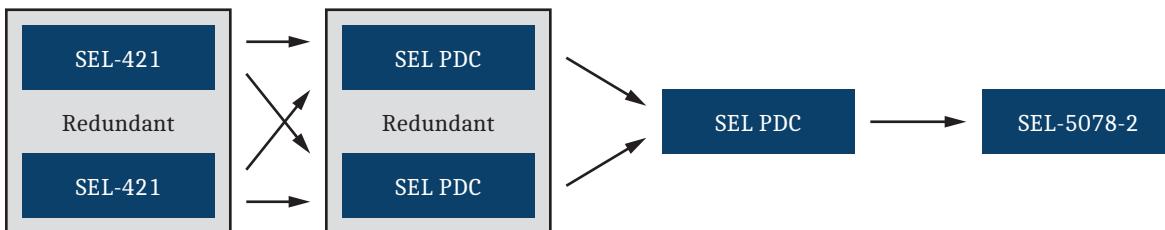


Figure 4.18 System Architecture Showing Redundant PMUs and PDCs to Improve Data Availability

Configure input redundancy by using the **Inputs** selection located below the **Settings** tab.

By configuring the **Backup Connection**, you can enable redundant inputs. Note that the default setting for the **Backup Connection** is **Disabled**. Redundant inputs require that the data stream be identical for both servers, including the same station name, ID code, and data set.

Configuring the Backup Connection

Settings for the **Backup Connection** are identical to the **Primary Connection**, however, there is an additional setting **Fail-Over Period** that allows you to specify the waiting time before failover to the backup input. You can set the **Fail-Over Period** from 1 to 5000 ms. Additionally, you can configure a different physical layer (serial or Ethernet) and a different transport protocol for the backup connection.

The PDC always uses the primary connection unless the quality of the primary connection is less than the backup connection. The PDC uses the following information from the IEEE C37.118 message stream to evaluate each data stream and select the one with the best quality:

- Time Quality bits that are part of the FRACSEC field in the data frame
- PMU Data Valid bit (Bit 15 of the STAT field in the data frame)
- PMU Error bit (Bit 14 of the STAT field in the data frame)
- PMU Sync bit (Bit 13 of the STAT field in the data frame)
- Unlocked Time bits (Bits 5 and 4 of the STAT field in the data frame)

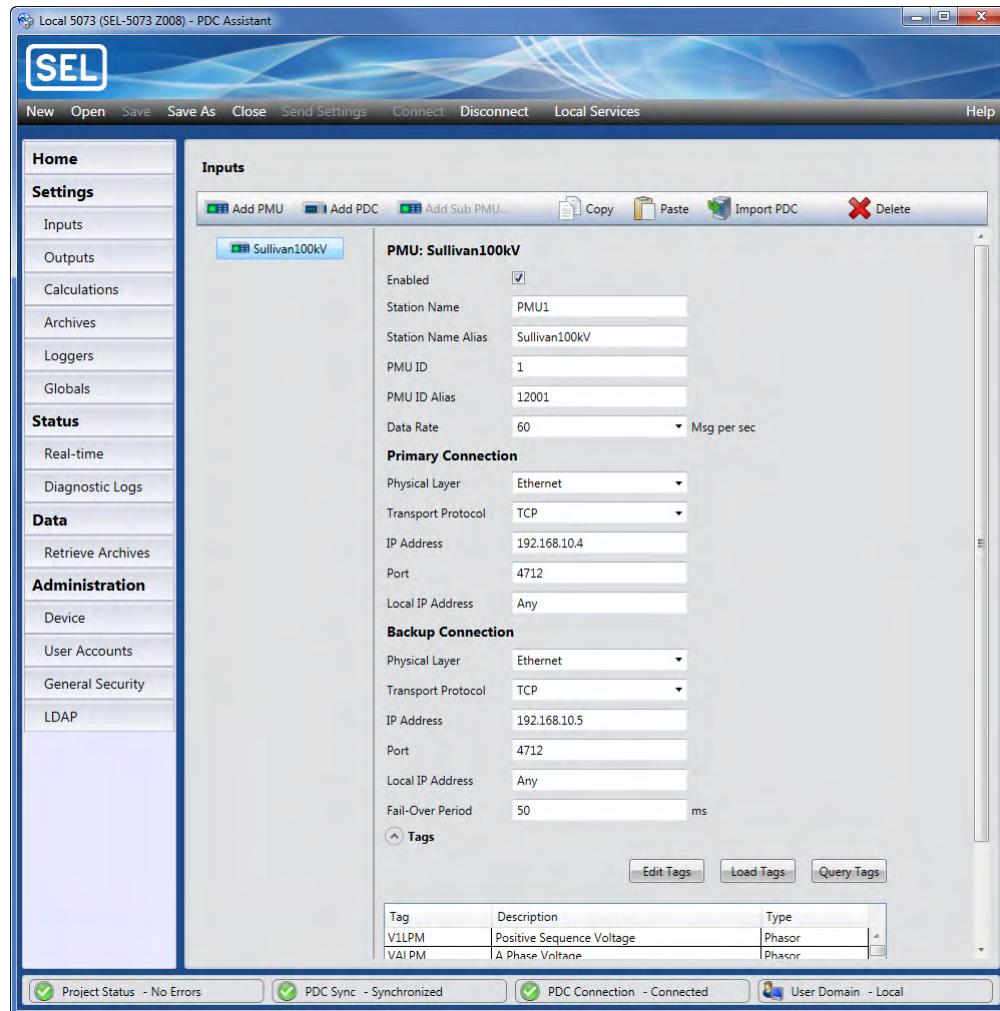


Figure 4.19 Configuring Backup Input Connections

Configuring Multicast Inputs

The PDC supports multicast inputs and outputs. Allowable multicast addresses include 224.0.0.0 through 239.255.255.255.

To configure the PDC for multicast inputs, configure the primary connection as follows:

- Select **UDP_S** for the transport protocol.
- Specify which local IP address to use.
- Check the **Enable Multicast** box.
- Enter the desired Multicast Group IP address.

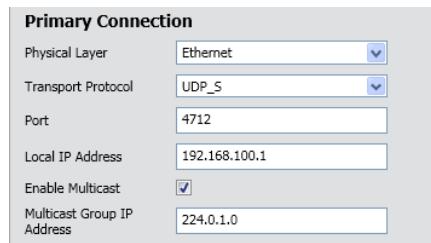


Figure 4.20 Configuring Multicast Inputs

Loading Data Tags

For PMU inputs, use the **Tags** section to select the incoming PMU data. A tag is the name of a data value. For each PMU, select the available tags by using the **Edit Tags** button.

The **Edit Tags** dialog box allows you to load predefined sets of tag names for each PMU. These names are stored in a device definition file. Several prebuilt device definition files are included with PDC Assistant. These files are only for devices compliant with IEEE C37.118-2005.

The device definitions are stored in text files using XML syntax. Device definition files are not required for PDCs unless they create new tag values (i.e., when cascading multiple PDCs). If a PDC creates a new power calculation result and this value is used by a subsequent PDC, then a device definition file provides a way to access the new tag value.

Table 4.2 PMU Device Definition Files (Non-SEL PMUs Included)

PMU	File Name
ABB-RES521	ABB-RES521.devx
GE-N60	GE-N60.devx
SEL-311C	SEL-311C_1_2_3.devx
SEL-351	SEL-351.devx
SEL-351A	SEL-351A.devx
SEL-351RS	SEL-351RS.devx
SEL-351S	SEL-351S.devx
SEL-411L	SEL-411L.devx
SEL-421-0, SEL-421-1, SEL-421-2, SEL-421-3	SEL-421.devx
SEL-421-4, SEL-421-5	SEL-421_4_5.devx
SEL-451-0, SEL-451-1, SEL-451-2, SEL-451-3	SEL-451.devx
SEL-451-5	SEL-451_5.devx
SEL-487E	SEL-487E.devx
SEL-487V	SEL-487V.devx
SEL-651R-2	SEL-651R-2.devx
SEL-651RA	SEL-651RA.devx
SEL-700G	SEL-700G.devx
SEL-751	SEL-751.devx
SEL-751A	SEL-751A.devx
SEL-787	SEL-787.devx
SEL-2431	SEL-2431.devx

Query Button

NOTE: The IEEE C37.118 standard requires that you use printable ASCII characters. If the PDC receives tags with non-printable ASCII characters, the characters will be replaced with spaces in the tag name. Additionally, if there are leading and lagging spaces in the name, the PDC strips them out.

To automatically discover the tags that are available from a PMU, enter the Station Name, PMU ID, Data Rate, and communications settings of the PMU. Send the settings to the PDC and check the Real-Time page to confirm that the PDC is receiving data from the PMU. Click the **Query Tags** button. The list of tags is automatically filled in.

You can also add a new tag by clicking **New Tag** (see *Figure 4.21*). By incrementally adding new tags, a complete PMU is defined and can be saved. Note that the initial **Validation Error** message that appears when you press the **New Tag** button goes away when you enter the new tag information (e.g., tag type, name).

Also, after loading the tags, you can remove the unwanted tags or the tags that are not present in the input stream by selecting them and clicking **Remove**. Finally, you can also save the selected tags by clicking **Save Tags**. See *Figure 4.21* for an example Edit Tags window. Leaving tags defined that are present in the input stream, but that are not used, has little impact on PDC performance.

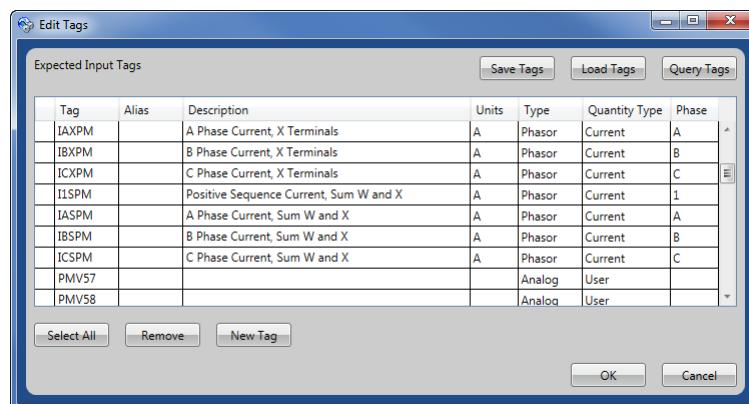


Figure 4.21 Edit Tags Screen

Figure 4.22 shows available tag definition files for SEL PMUs that are built into PDC Assistant.

Selecting tags that are not present in the input data stream results in an error message when the tag is used in an output, calculator, or archive.

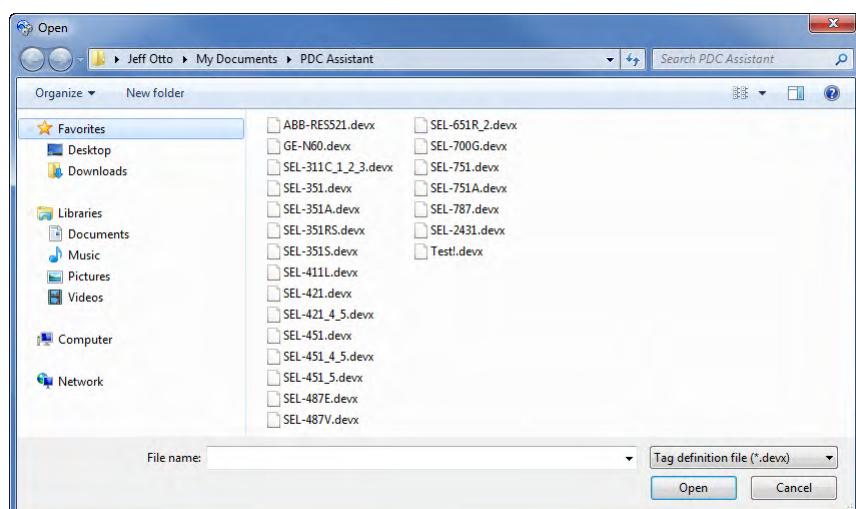


Figure 4.22 Prebuilt Device Definition Files

Data Tag Aliasing

The PDC allows you to change the tag name on any input. The new tag name is used on all downstream data streams and tags that are saved in the local archive or used for calculations in the PDC.

To change a tag name, use the **Inputs** selection located in the **Settings** tab. Select the **Edit Tags** button. In the **Edit Tags** window, enter the desired tag alias under the **Alias** column for each tag in the table. Remember that all tag references use these new tag names, so any downstream PDC must be configured to use these tag names. If you do not want to alias a tag, you can leave the alias column empty and the PDC outputs the same tag name that it receives.

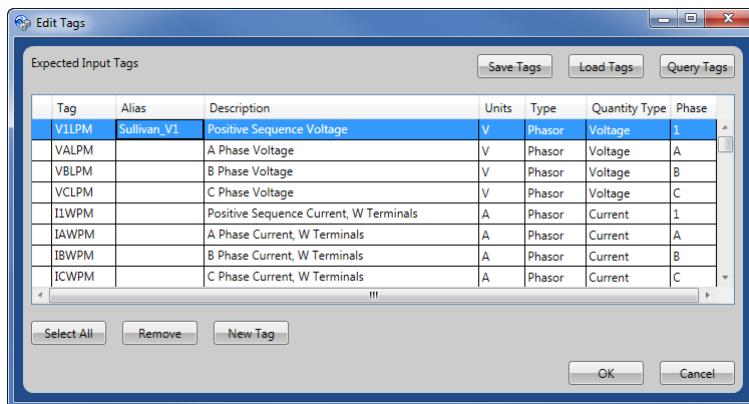


Figure 4.23 Enter Tag Alias Names for Each Tag Under the Alias Column

NOTE: The IEE C37.118 standard requires that you use printable ASCII characters. If the PDC receives tags with non-printable ASCII characters, the characters are replaced with spaces in the tag name. Additionally, if there are leading and lagging spaces in the name, the PDC strips them out.

Alias names must conform to the following same validation rules that apply to the original tag names:

- Must be printable ASCII
- Must be 16 characters or less
- Must not conflict with other existing tag or alias names in the same PMU
- Must not conflict with built-in tag name **Frequency** or **Dfrequency**

Adding a PDC Input

The settings for adding a PDC input are nearly identical to those for adding a PMU input. When adding a PDC input, however, the source name can be user-defined and does not need to match the incoming PDC name. The PDC ID and data rate, however, must match the external PDC settings. Although there is no incoming tag selection for a PDC input, the **Inputs** page toolbar provides an **Add Sub PMU** function that provides an option to automatically discover PMUs and associated data tags that are available from a connected PDC. Check the Real-Time Status page to confirm that the SEL-3573, SEL-3373, or SEL-5073 is receiving data from the input PDC before selecting the **Add Sub PMU > Automatically** option. *Figure 4.24* shows an example of PDC input settings.

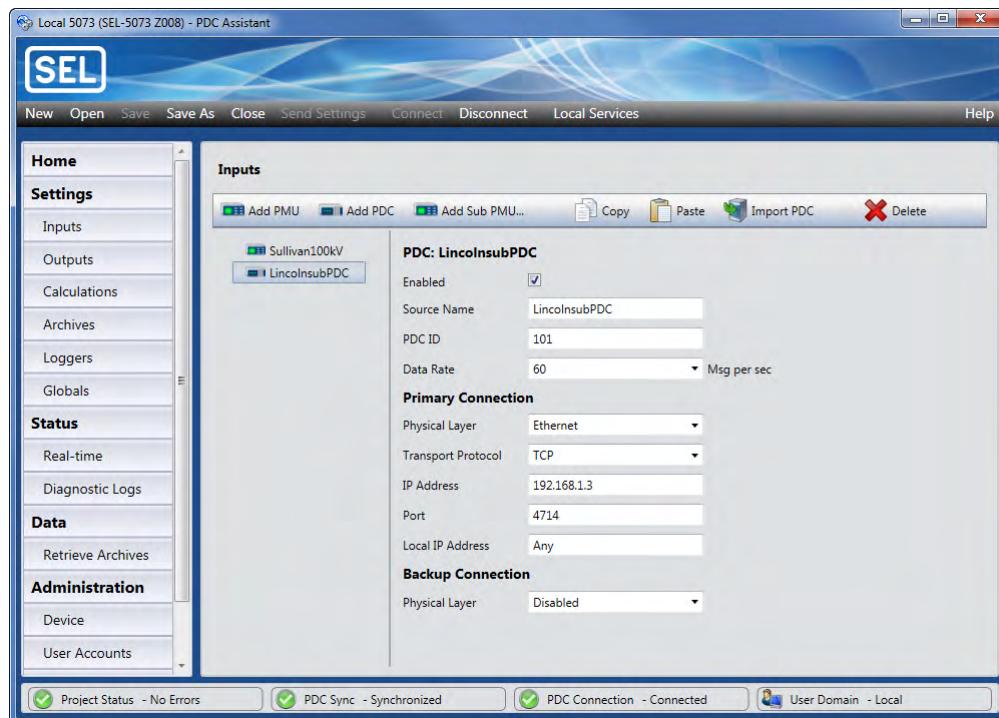


Figure 4.24 Input Setting Screen: Add PDC

Outputs

Add an output by selecting the **Add Output** option on the top menu bar.

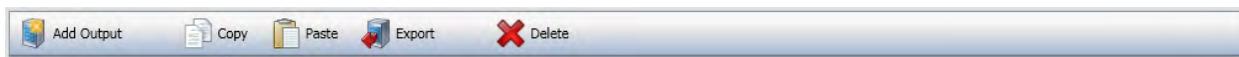


Figure 4.25 Top Menu Bar

Each menu item performs the following function:

- **Add Output:** Adds a user-configurable output PDC.
- **Copy/Paste:** Copies and pastes a PDC output.
- **Export:** Exports a PDC output that can be imported as a PDC input into PDC Assistant.

For each output, the following settings apply:

- **Enabled:** Select this check box to enable the output.
Outputs that are not enabled reject any connection attempt and will not send any packets.
- **Output Name:** Select the name associated with this set of concentrated data. This should be unique for each output.
- **PDC ID:** The ID of the SEL-3573, SEL-3373, or SEL-5073. This can be the same for more than one output.
- **Data Rate:** Select the data rate of transmitted data from the PDC for this output.
- **Waiting Period:** The time-alignment functionality of the PDC will wait for up to this amount of time for all inputs concentrated into this specific output. See *Section 5: Troubleshooting* for more information about the PDC time-alignment function.

- **Phasor Domain:** Select either **polar** or **rectangular**.
- **Transport Protocol:** Select **TCP**, **UDP_S**, **UDP_T**, or **UDP_U** protocol.
- **Port:** For TCP, the port number selects the value of the local listening port. For details on UDP_S, UDP_T, and UDP_U, see *Figure 4.15*.
- **Local IP Address:** This address is used for all communication to and from this output. Use **Any** to allow the PDC to automatically choose the address, or enter the desired IP address. When you are using IP multicasting with UDP_S, you cannot use the **Any** setting.

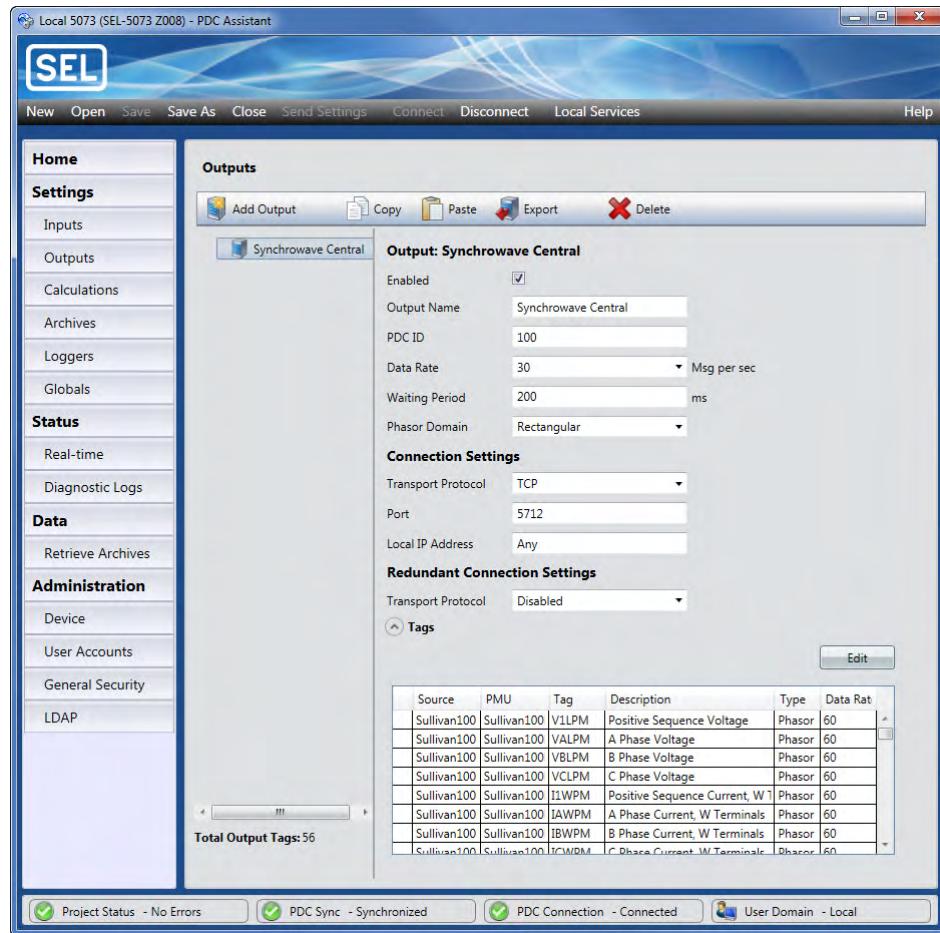


Figure 4.26 Output Settings Screen

Choose **Tags** to select the tags to output. Click **Edit** to display the **Available Tags** dialog with a list of available input tags from all of the inputs and calculations. The **Data Rate** setting is constrained to be a common divisor of the data rates of the selected input data. For example, if V1ZPM is received from PMU #1 at a rate of 60 messages/second and VAPM is received from PMU #2 at a rate of 20 messages/second, then the output rate can be set to 20, 10, 5, 2, or 1 messages/second.

The IEEE C37.118-2005 standard allows a maximum configuration frame size of 65,536 bytes. This limits the maximum number of tags available for sending in a single output. If this limit is exceeded, a message displays to alert you to select fewer tags.

Figure 4.27 shows the tag selection window for an output.

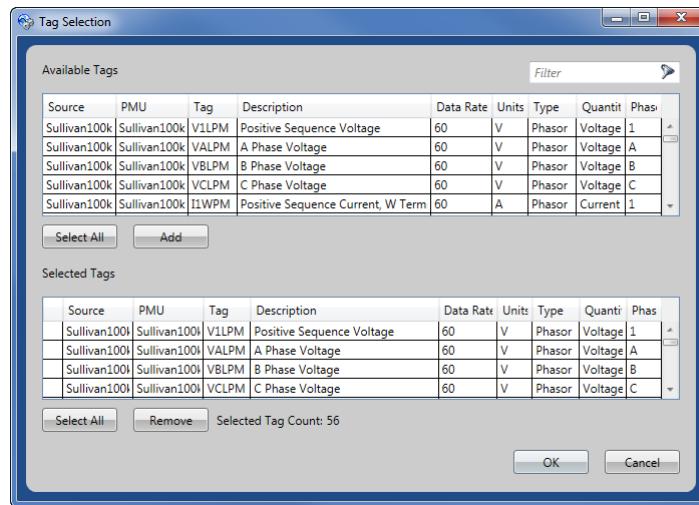


Figure 4.27 Tag Selection Window for an Output

Exporting PDC Output Configuration for Importing to a Downstream PDC

When the output of one SEL PDC is sent to another SEL PDC, PDC Assistant provides a feature to simplify the configuration of the downstream PDC. The output configuration can be exported as an XML file. This file can be transferred (emailed to another site, for example) to the location of the downstream PDC, where it can then be imported as a PDC input. Use the following steps for this process:

- Step 1. Open the upstream PDC configuration in PDC Assistant.
- Step 2. Select **Outputs** from the navigation menu and select the Output to be transferred.
- Step 3. Click the **Export** button and supply a filename for the exported file. The extension for PDC export files is **.pdcx**.
- Step 4. Open the downstream PDC configuration in PDC Assistant.
- Step 5. Select **Inputs** from the navigation menu.
- Step 6. Click the **Import PDC** button and select the exported file.

Note that the IP Address information is purposely stripped from the exported configuration file for security purposes. It will have to be manually entered in the downstream project.

Configuring the Redundant Output Data Stream

The PDC allows you to configure identical output data streams to be sent to two different downstream PDCs.

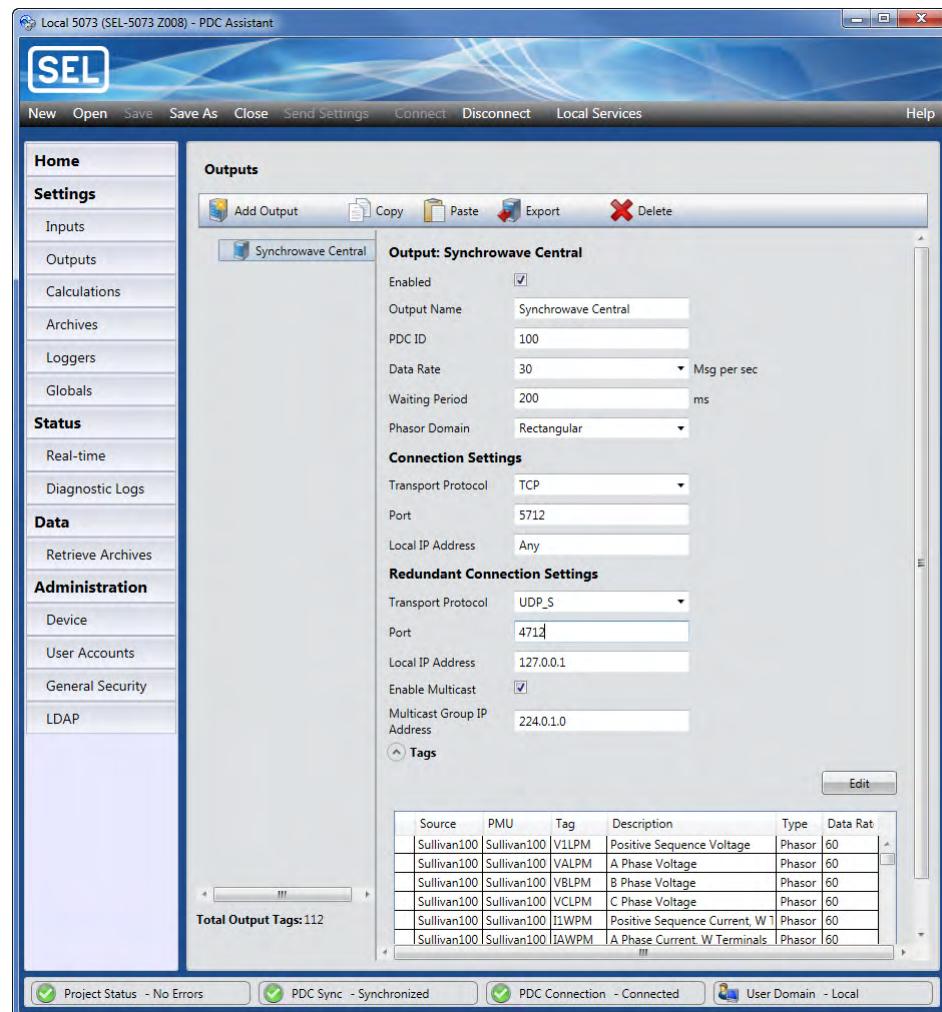


Figure 4.28 Configuring Redundant Output Connection Settings

By configuring the **Redundant Connection Settings**, you can enable redundant outputs. Note that the default setting for the **Redundant Connection Settings** is **Disabled**. Additionally, you can configure a different transport protocol for the backup output.

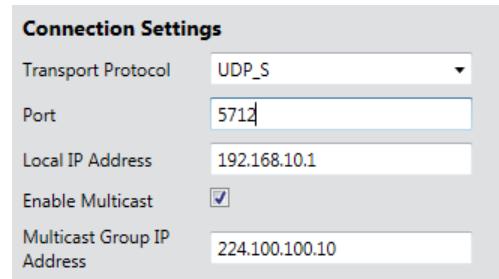
Configuring Multicast Outputs

NOTE: Data output from the PDC uses IEEE 754 floating-point format.

The SEL PDC family supports multicast inputs and outputs. Allowable multicast addresses include 224.0.0.0 through 239.255.255.255.

Configure the PDC for multicast outputs by doing the following

- Select **UDP_S** for the transport protocol.
- Specify which local IP address to use.
- Enable multicast by selecting the **Enable Multicast** check box.
- Enter the desired **Multicast Group IP Address**: 224.0.0.0 through 239.255.255.255.

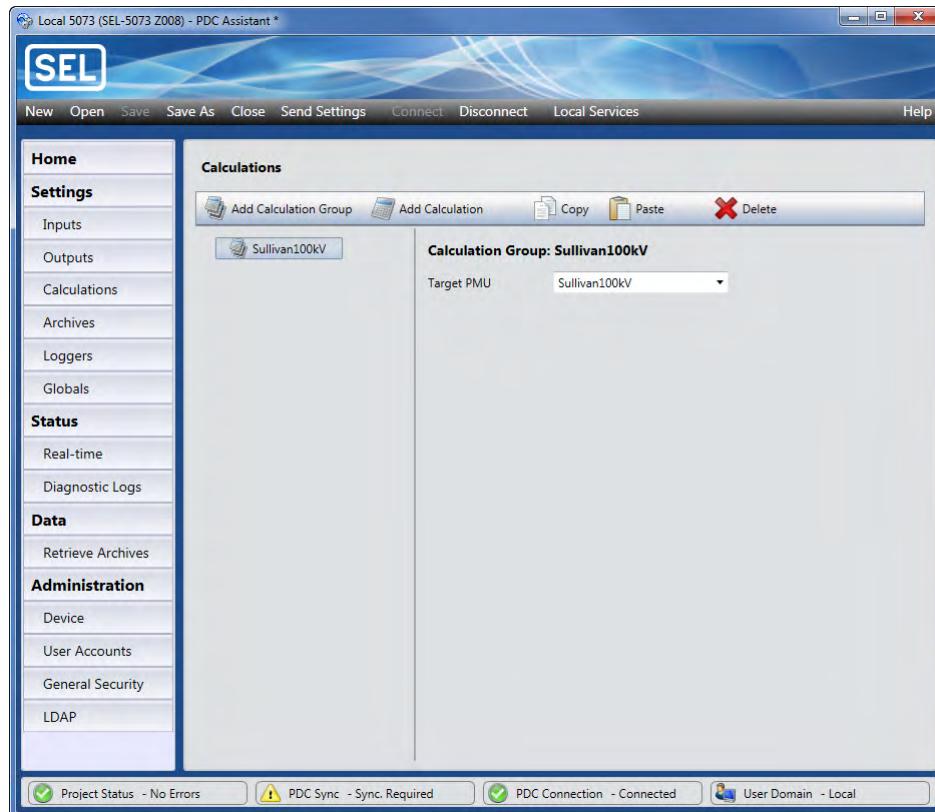
**Figure 4.29 Configuring Multicast Outputs**

Calculations

The PDC is capable of performing various phasor and analog calculations, including sequence component calculations, phasor and analog value math, phasor and analog value scaling, derivative (dx/dt) calculations, PMU latency measurement, inter-packet latency measurement, and separation of phasors into their respective components. To set up these calculations, first add a calculation group.

Adding a Calculation Group

To add a calculation group, select **Calculations** on the left menu bar and click **Add Calculation Group** on the Calculations menu bar. For each calculation group, you must choose a **Target PMU**. Calculation results are included in archives and outputs as additional data tags of the target PMU.

**Figure 4.30 Calculations Screen**

Calculation Details

When you have added the calculation group, click **Add Calculation** to display a drop-down menu of the calculations available on the PDC. Calculations are split into two categories: mathematical and utility. Select the type desired.

Mathematical options available include the following:

- **Power:** Calculates real and reactive power output.
- **Sequence:** Calculates positive-, negative-, and zero-sequence components.
- **Algebra:** Performs addition, subtraction, multiplication, and division of phasor or analog values. Phasor value math follows the rules of complex operations.
- **Scaling:** Scales magnitude and angle values by a user-defined constant value.
- **Derivative:** Calculates the rate-of-change in the analog value between subsequent measured values.

Utility options available include the following:

- **Network Latency:** Estimates the latency in microseconds between when the PMU time stamps the data and when the data are received at the PDC. The network latency calculation also supports instantaneous, average, and maximum results.
- **Inter-packet Delay:** Calculates the data-packet-to-data-packet delay in microseconds and provides instantaneous, average, and maximum results.
- **Component:** Separates a phasor into its rectangular or polar components.

Mathematical Calculations

Power Calculations

For each power calculation, the following settings apply:

- **Calculation Enabled:** Check box that enables the power calculation.
- **Voltage:** Selects the voltage phasor to be used in the power calculation.
- **Current:** Selects the current phasor to be used in the calculation.
- **Real Power:** The tag name that the PDC uses for the calculated real power.
- **Reactive Power:** The tag name that the PDC uses for the calculated reactive power.

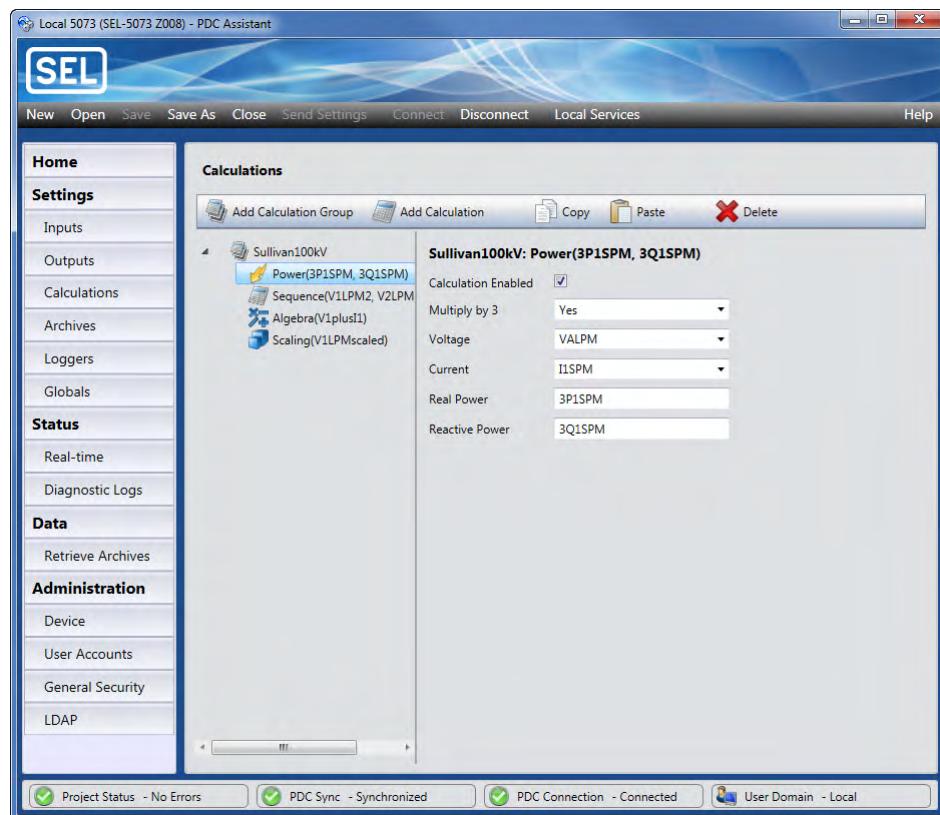


Figure 4.31 Power Calculations Example

Sequence Calculations

For each sequence calculation, the following settings apply:

- **Calculation Enabled:** Check box to enable the sequence calculation.
- **Quantity:** Select **Voltage** or **Current** for the sequence quantity.
- **Phase A, Phase B, Phase C:** This value is automatically populated by the Phase A/B/C phasor, if there is only one Phase A/B/C voltage or current tag in the Target PMU. If there are multiple Phase A/B/C values, select the appropriate phasor from the drop-down menu.
- **Positive Sequence:** Enables the positive-sequence calculation.
- **Positive-Sequence Tag:** The user-defined tag name for the calculated positive sequence value.
- **Negative Sequence:** Enables the negative-sequence calculation.
- **Negative-Sequence Tag:** The user-defined tag name for the calculated negative-sequence value.
- **Zero Sequence:** Select this to enable the zero-sequence calculation.
- **Zero-Sequence Tag:** The user-defined tag name for the calculated zero-sequence value.

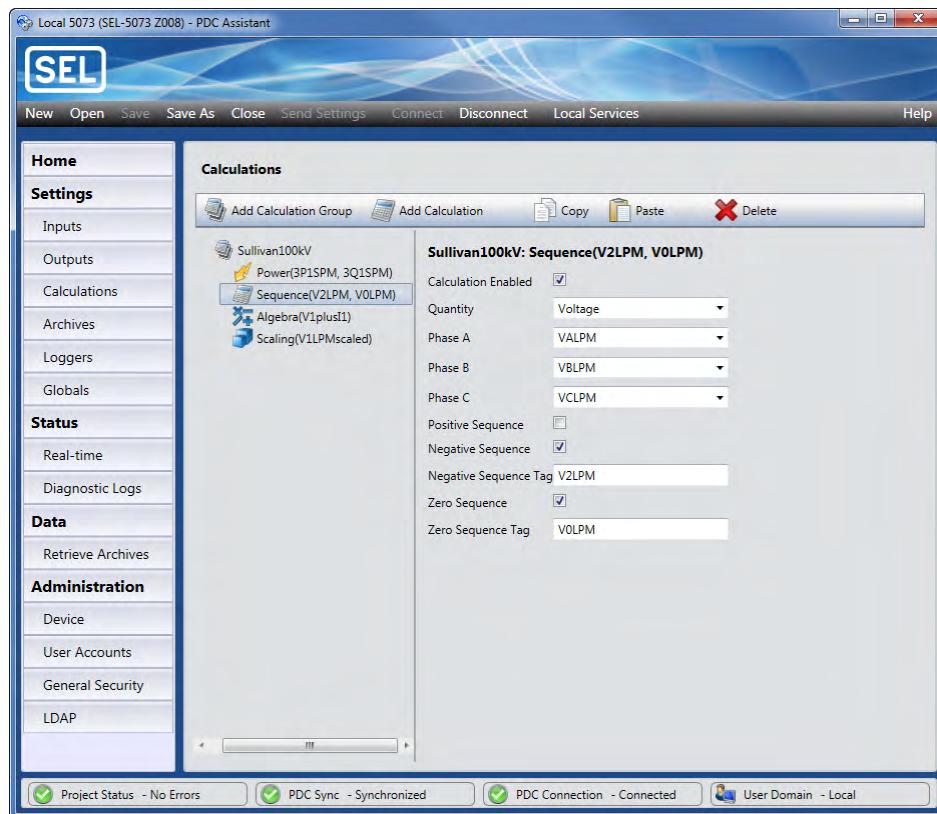


Figure 4.32 Sequence Component Calculations Example

Algebraic Calculations

For each algebraic calculation, the following settings apply:

- **Calculation Enabled:** Enables the algebraic calculation.
- **PMU for Left Tag:** Select the PMU with the desired tag for the intended operation.
- **Left Tag:** Select the phasor tag needed for the desired operation.
- **Operation:** Select the desired operator.
- **PMU for Right Tag:** Select the PMU with the desired tag for the intended operation.
- **Right Tag:** Select the phasor tag needed for the desired operation.
- **Calculated Tag Name:** The user-defined tag name for the resulting calculation.

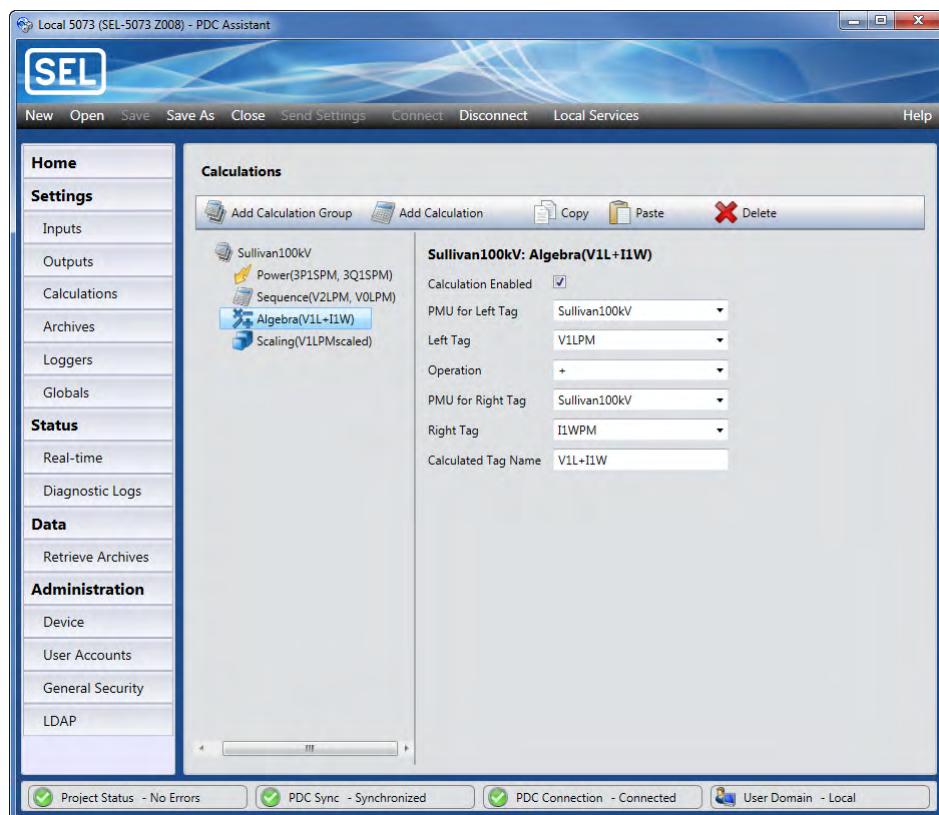


Figure 4.33 Algebraic Calculation Example

Scaling Calculations

NOTE: Use the scaling calculator to alias the frequency and df/dt and convert them into analog values.

For each scaling calculation, the following settings apply:

- **Calculation Enabled:** Check box to enable the algebra calculation.
- **Input Tag:** Select the tag desired to be scaled.
- **Magnitude Scale Factor:** The desired factor by which to scale the phasor magnitude.
- **Angle Rotation:** The number of degrees by which to rotate the phasor angle.
- **Calculated Tag Name:** The user defined tag name to the resulting calculation.

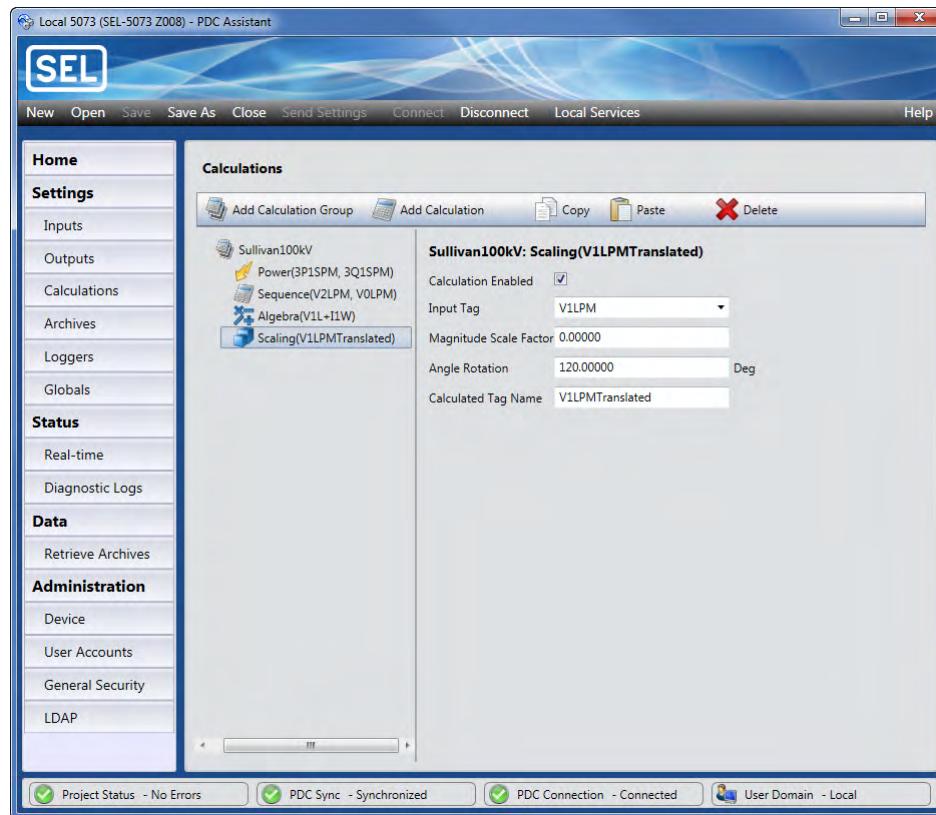


Figure 4.34 Scaling Calculation Example

Derivative Calculations

For each derivative calculation, the following settings apply:

- **Calculation Enabled:** Enable the algebra calculation.
- **Noise Reduction:** Specifies which previously measured value against which to perform the calculation.
- **Calculated Tag Name:** The desired tag name for the calculation.

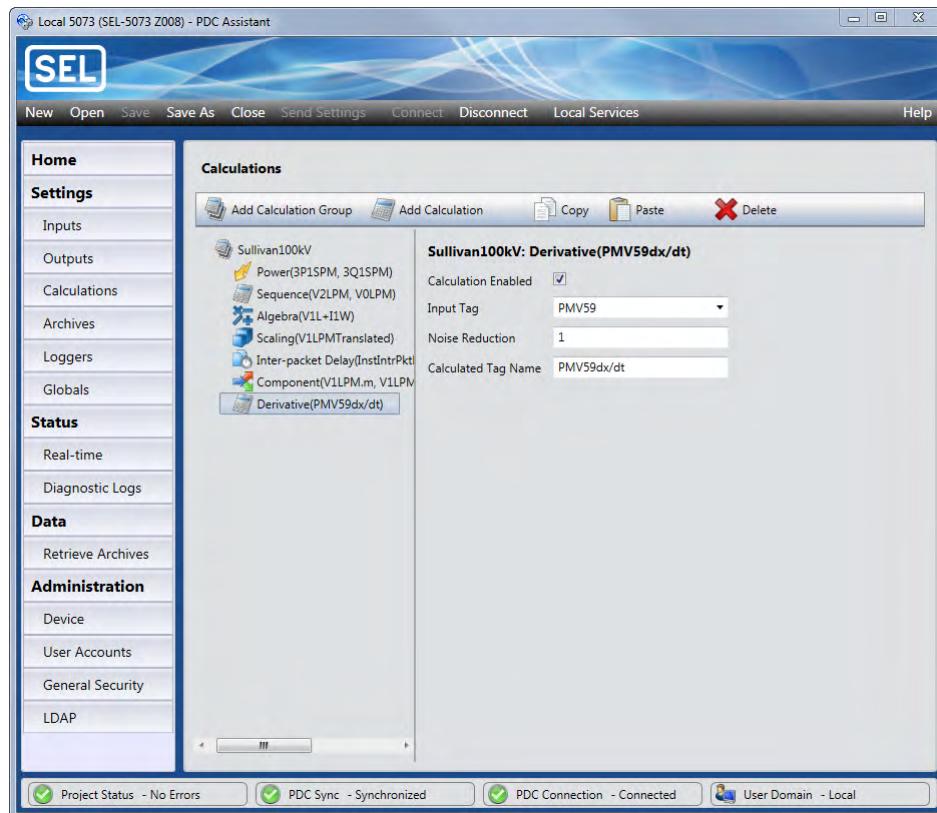


Figure 4.35 Derivative Calculation Example

Utility Calculations

Network Latency

Select the desired network latency measurement. Select from **Instantaneous**, **Average**, and **Maximum**.

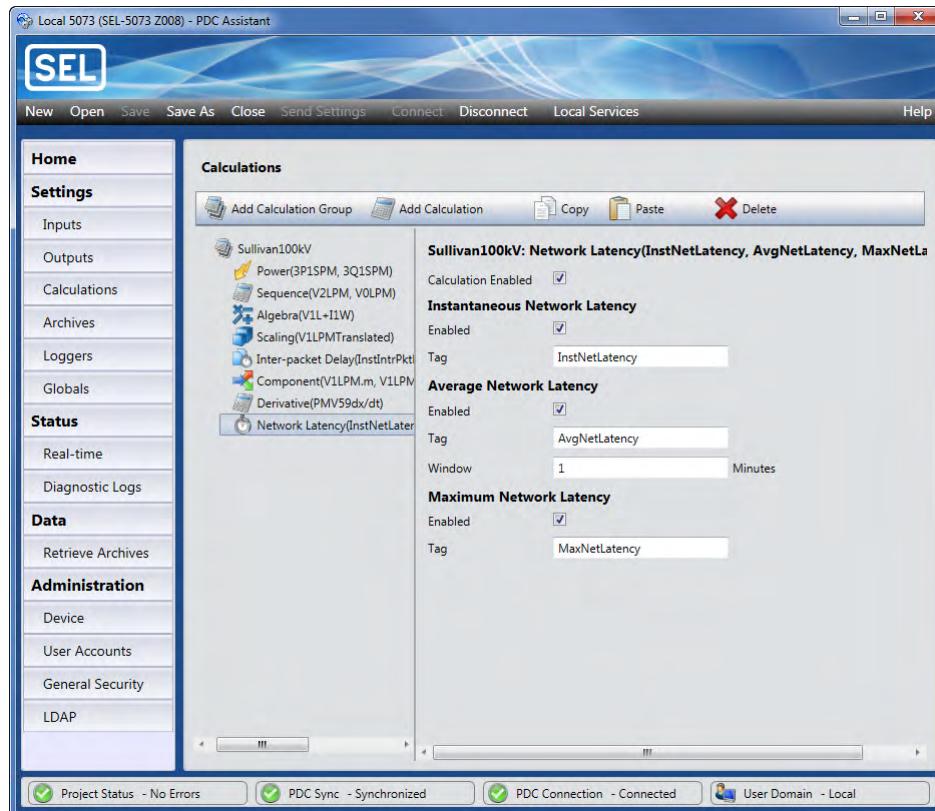


Figure 4.36 Network Latency Example

Inter-Packet Delay

Select the desired inter-packet delay measurement. Select from **Instantaneous**, **Average**, and **Maximum**.

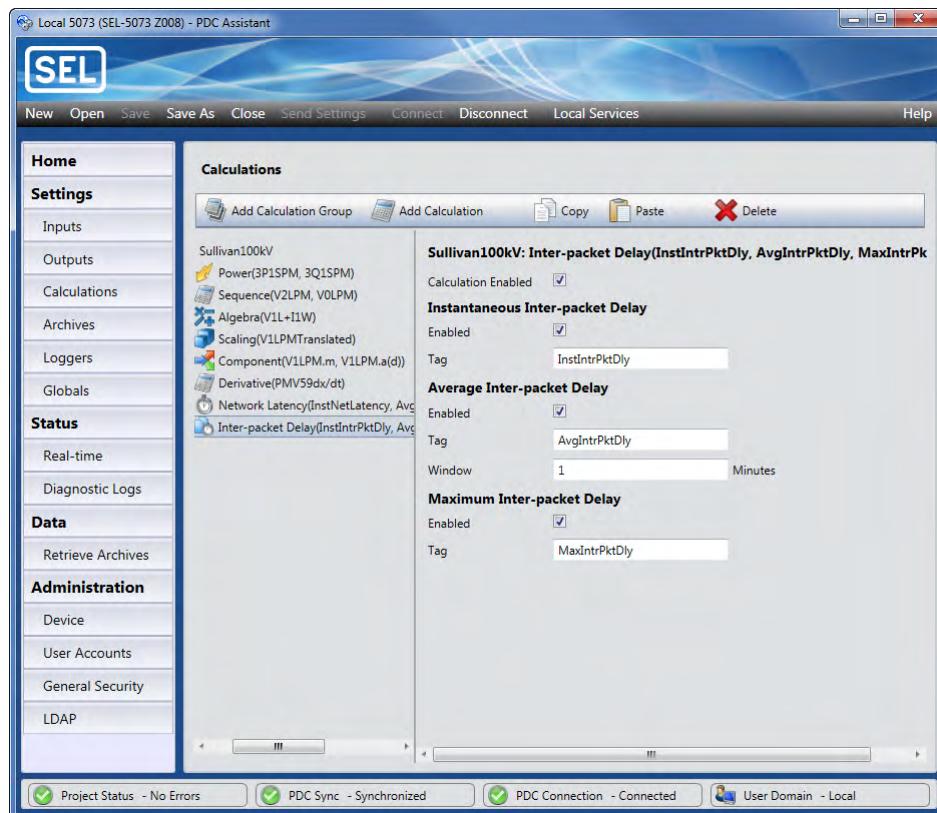


Figure 4.37 Inter-Packet Delay Example

Component

For each Component calculation, the following settings apply:

- **Calculation Enabled:** Enables the algebra calculation.
- **Phasor:** The phasor you want separated into its components.
- **Domain:** Specify the domain (**Polar** or **Rectangular**) for the separated components.

If you select **Polar**, the **Angle Format** allows you to select from **-180 to 180 degrees**, **0 to 360 degrees**, or **-pi to pi radians**

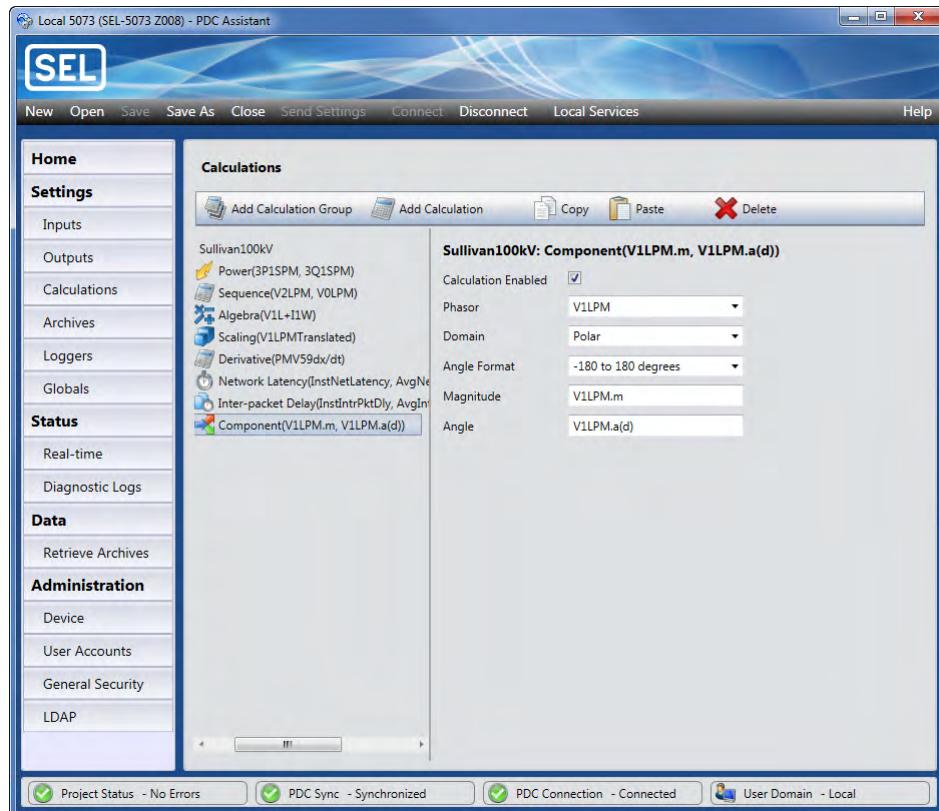


Figure 4.38 Component Separation Example

Archives

The SEL PDC family includes built-in internal archiving with a high-speed relational database. The SEL-5073 also supports external archiving to local directories, external drives, or other computers on the network. The following summarizes internal and external archiving:

- Internal archiving maintains a circular buffer of synchrophasor data in a relational database format within the PDC database. This data can later be extracted onto a network storage location in CSV or COMTRADE formats as desired.
- External archiving publishes synchrophasor data directly to a local directory or network storage location at a specified rate and in the desired format.

When the available storage space on the SEL-3573 or SEL-3373 decreases to a user-specified limit, the alarm contact asserts and remains asserted until more storage space is available. For all SEL PDCs, archiving stops when the drive is full. Use the archive information on the real-time status display to monitor available local storage space.

To approximate the disk space required for archiving, use the following equation.

$$\text{Peak Bytes of Archive} = [32 + (8 \bullet A) + (4 \bullet B) + (4 \bullet C) + (4 \bullet D) + (4 \bullet E) + (2 \bullet F)] \bullet 86400 \bullet G \bullet H$$

where

A = number of phasors

B = number of analogs

C = digital words (0 for no digitals, 1 for 1 to 16 digitals, 2 for 17 to 32 digitals)

D = number of frequencies

E = number of df/dt tags

F = number of status tags

G = data rate of archive

H = retention duration of archive in days

To make more disk space available, decrease archive retention. The settings for archive retention differ between internal and external archives and are explained in detail in this section.

Set up the database by using options from the top menu. You can add a triggered or continuous archive, or delete an archive. The archive data remain until they are deleted either manually or by using the data retention setting. Multiple archives can be set up and run simultaneously (e.g., continuous and triggered).



Figure 4.39 Archive Menu Bar

Triggered Archive

NOTE: Triggered archives are available for internal archiving.

Data archiving can be performed based on an event. The triggered archive starts archiving whenever any one of the trigger bits in any of the PMUs with a tag in the archive is asserted. The PMU settings determine the conditions for setting trigger bits.

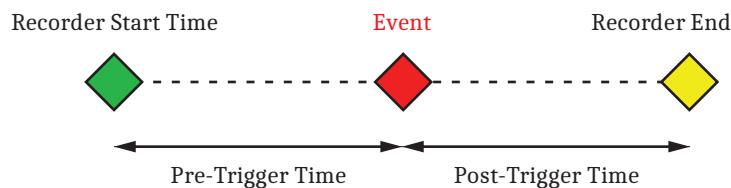


Figure 4.40 Triggered Archive: Pre- and Post-Trigger Times

The triggered archive options are as follows:

- **Archive Enabled:** Enables storing data on the archive.
- **Archive Name:** The archive name that refers to all data from the archive.
- **Waiting Period:** Maximum waiting time for all inputs to be received before archiving a set of time-aligned data.

- **Pre-trigger Duration:** The amount of data to save prior to the trigger condition (in minutes).
- **Post-trigger Duration:** The amount of data to save after the trigger condition (in minutes).
- **Archive Retention:** The duration of the archive in days. Data after this time interval is deleted.
- **Ridethrough:** This must be less than or equal to the post-trigger duration.

Use this to determine if you want to archive consecutive triggers in a single archive, or in separate archives if a second trigger occurs within the post-trigger duration of the first trigger.

For example, assume that the pre-trigger and post-trigger duration of a triggered archive is 2 minutes and 5 minutes, respectively. Its **Ridethrough** duration is 3. Now if a second trigger occurs within the post-trigger duration of the first trigger, then the **Ridethrough** time determines whether the first trigger and second trigger should be archived together or archived separately. If the second trigger occurs within 3 minutes of the first trigger, then both of the triggers will share a common archive. If the second trigger occurs longer than 3 minutes after the first trigger, both triggers are archived separately.

Select the archive tags in a manner identical to selecting the output tags.

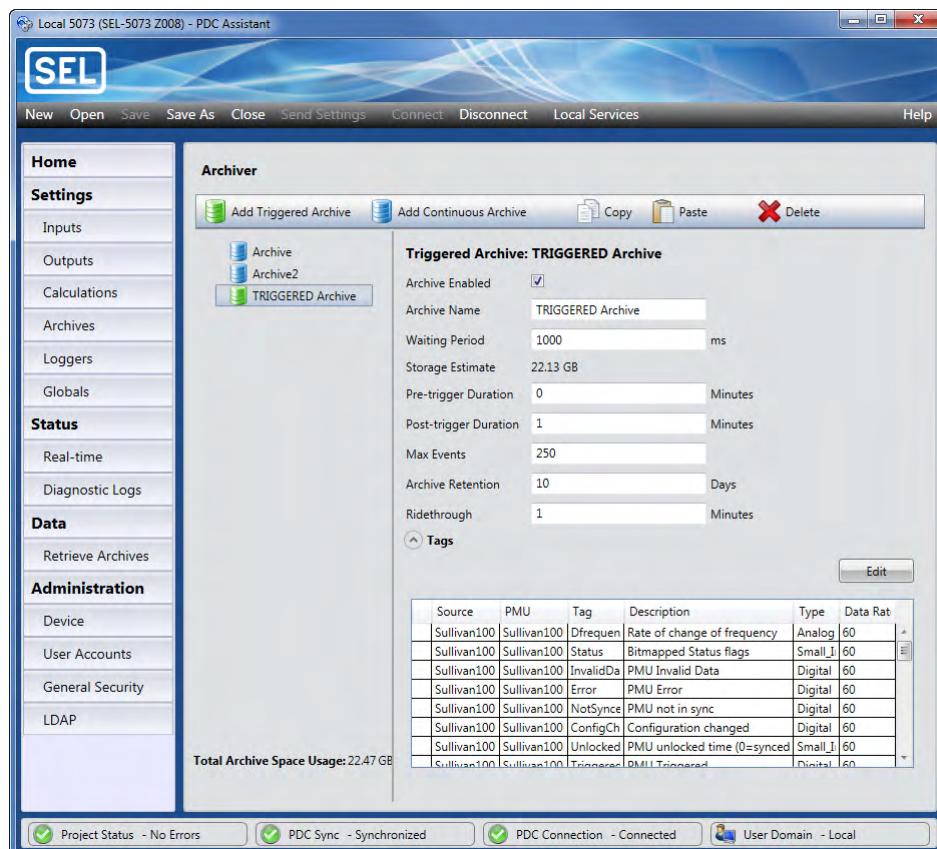


Figure 4.41 Triggered Archive Settings Screen

Use the **Tags** section for selecting which tags to archive. Click the **Edit** button to display the **Tag Selection** window with a list of the available input tags from all the inputs. Select all the input tags, or a set of tags from this list, to archive into the database. A maximum of 800 tags can be stored in a single archive.

Note that for triggered archives, you cannot combine data from two or more PMUs that have different message rates. Use **Continuous Archive** to archive data from two or more PMUs that have different rates.

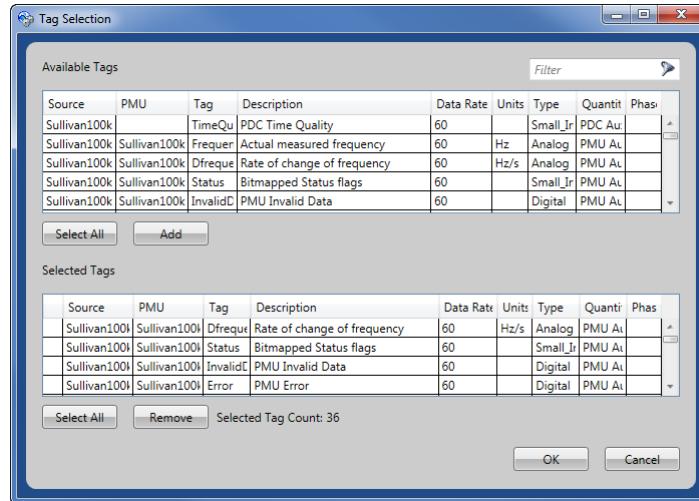


Figure 4.42 Tag Selection Window for Archives

Continuous Archive

The continuous archive begins archiving data when enabled and continues until disabled. The continuous archive options are as follows:

- **Archive Enabled:** Enables the storing of data into the archive.
- **Archive Name:** The archive name that refers to all data from the archive.
- **Waiting Period:** Maximum amount of waiting time for all inputs to be received before processing a set of time-aligned data.
- **Data Rate Format:** Messages per minute or messages per second.
- **Data Rate:** Rate at which the data are archived.
- **Archive Location (SEL-5073 only):** Archive data within the internal relational database of the PDC or directly to an external storage location.
- **Archive Retention:** Choose the circular buffer size of the internal relational database. After the specified number of days, the oldest data are deleted.

Use the **Tag** section for selecting the tags to archive. Click the **Edit** button to display the **Tag Selection** window with a list of the available tags from all the inputs and calculations. From this list, select a set of tags to archive into the database.

The **Data Rate** setting is constrained to less-than-or-equal-to the largest common multiple of the data rates of the input data selected. For example, if V1ZPM is received from PMU#1 at a rate of 60 messages/second and VAZPM is received from PMU#2 at a rate of 20 messages/second, then the archive rate cannot be set to greater than 20 messages/second.

External Archiving (SEL-5073 Only)

When the **Archive Location** setting is set to **External Archiving**, additional settings display which determine the formatting and collection of the data files.

- **Authentication:** Use the optional authentication settings when specific permission is required to write files to the desired local folder or network storage location. By default, the SEL-5073 attempts to write to this folder as the default SEL-5073 service user: **LocalSystem**. The **LocalSystem** account has limited access to local folders and no permissions for network locations.
- **User Name:** Specify a user that has the **Modify** permission enabled for the desired target directory.
- **Password:** Specify the password for the specified user.
- **Domain:** Specify a domain against which to authenticate the specified user. Leave blank to authenticate locally.

For example, an SEL-5073 residing on Cindy's computer can externally archive to Jim's computer by using Jim's credentials. Or Jim can enable the guest account on his computer and modify the security settings of the folder to grant **Modify** permissions to **Everyone**.

- **File Path:** Specify the path of the local or remote target directory. Use the full Universal Naming Convention (UNC) path instead of a mapped network drive as part of the Output Path Template. For example, instead of **T:\Archives**, use **\server\share\Archives**.
- **Filename Template:** Configure a file naming scheme from built-in macros and custom text.
- **File Format:** Choose between **CSV** or **COMTRADE** file formats.
- **Phasor Format:** Choose between **Polar**, **Rectangular**, or **Both** phasor formats.
- **Angle Format:** Choose between **degree** or **radian** angle formats.
- **Minutes per file:** Enter the number of minutes of data to be stored in each individual archive file.
- **Number of Files:** Specify the maximum number of files to be stored in the target directory. Once the target directory contains the specified number of files, the External Archive function manages the number of files in the target directory by deleting and replacing the oldest file with the most recent file.

Select the **Unlimited** option to disable External Archive file management.

Figure 4.43 shows an example of continuous external archive settings with some example tags selected.

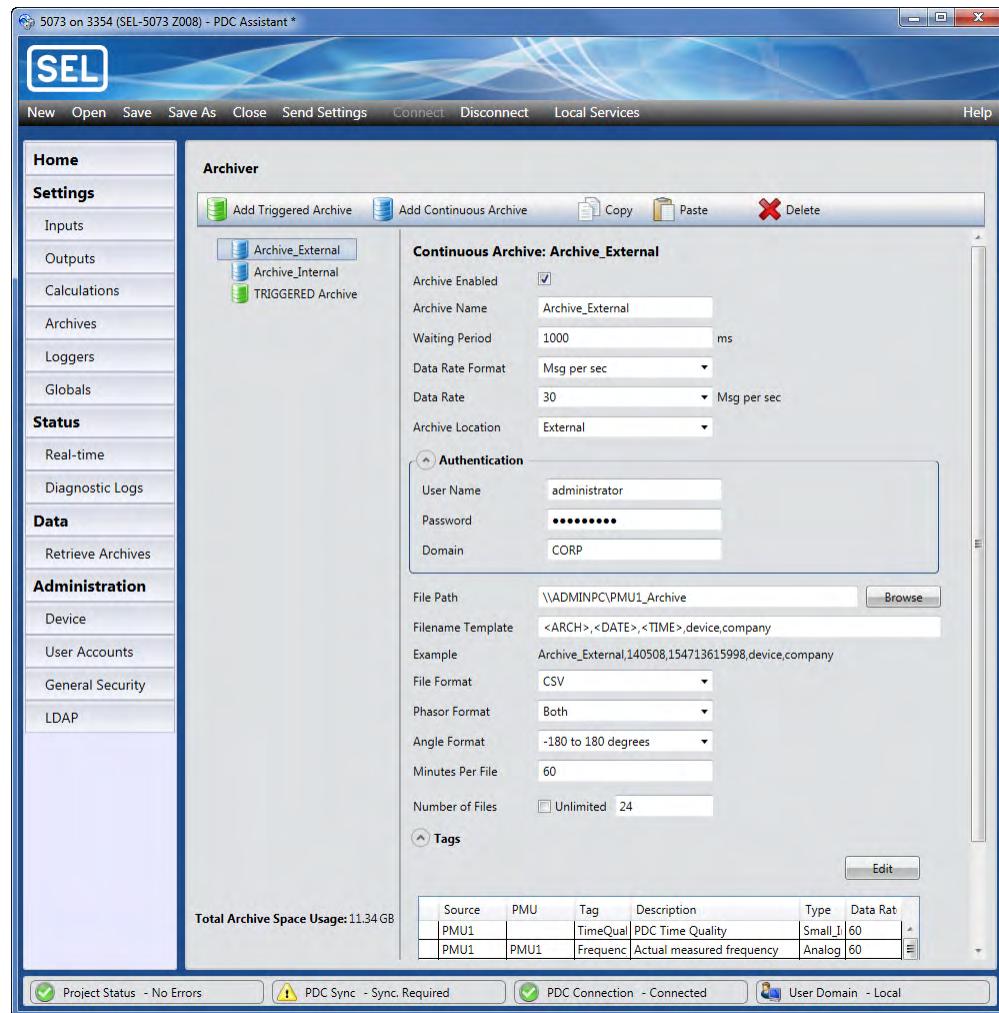


Figure 4.43 Continuous External Archive Settings

Internal Archiving

When the SEL-5073 **Archive Location** setting is set to **Internal**, the **Archive Retention** setting is available for specifying the duration of the archived data in terms of days. Data outside this time interval are deleted. The **Storage Estimate** indicates the amount of estimated space required for the archive. The storage estimate is automatically calculated based on the current settings. The SEL-3573 and SEL-3373 use internal archiving by default.

Figure 4.44 shows an example of continuous internal archive settings with some example tags selected.

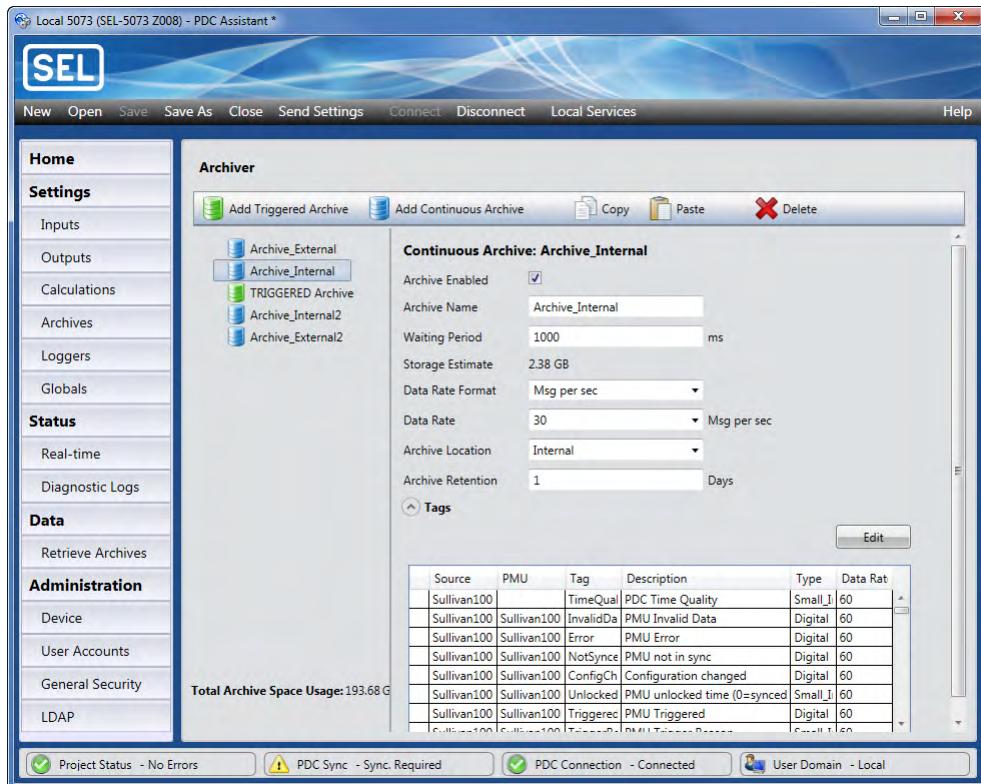


Figure 4.44 Continuous Internal Archive Settings

Archive Collection Service

NOTE: SEL recommends using the archive collection service to back up archived data in the PDC. Configure the service so that archived data are saved to a long-term storage location.

The Archive Collection Service (ACS) allows the user to automate the process of collecting archived phasor data from internal archives and storing the collected data on a local or network storage drive. ACS is a separate service running on the host computer and is launched through PDC Assistant. When ACS is running, it periodically (with a period determined by the **Minutes Per File** setting described later) connects to the configured PDC devices and exports archives to the specified location. The ACS logs errors, warnings, and information to the Windows Application Log under the source, **SEL PDC Archive Collection Service**. To access the Windows Application Log from the start menu, right click on **Computer**, select **Manage**, select **Event Viewer**, and find the Application log.

It is recommended that a specific account be set up on the PDC for the ACS. Set the role for this account to **Technician**, which is a read-only account on the device. This account should be used only by the ACS, easily allowing any account activity reported in the logs to be traced to the ACS service.

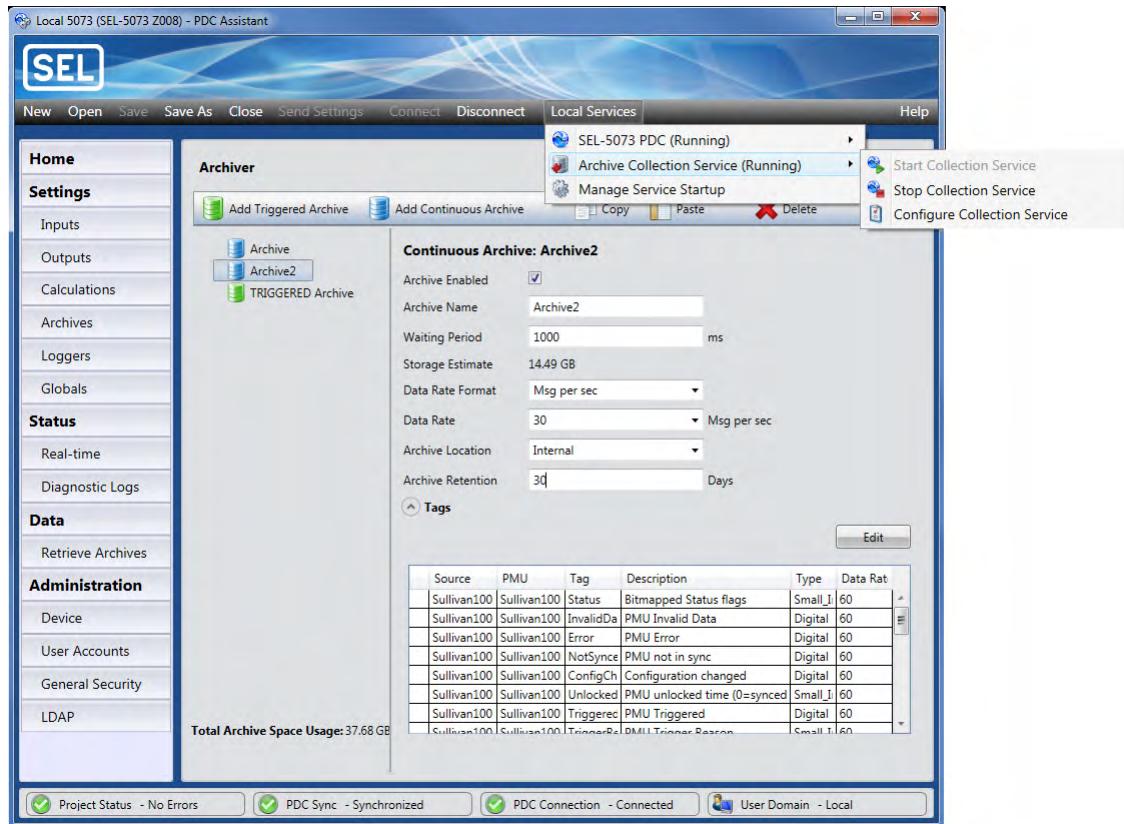


Figure 4.45 Archive Collection Service Menu Option

ACS Options

The following options are available for the ACS:

- **Start Collection Service:** Begin collection of archived phasor data
- **Stop Collection Service:** End collection or archived phasor data
- **Configure Collection Service:** Configure the archive collection parameters

Configure Collection Service

Selecting **Configure Collection Service** displays the screen shown in *Figure 4.46*:

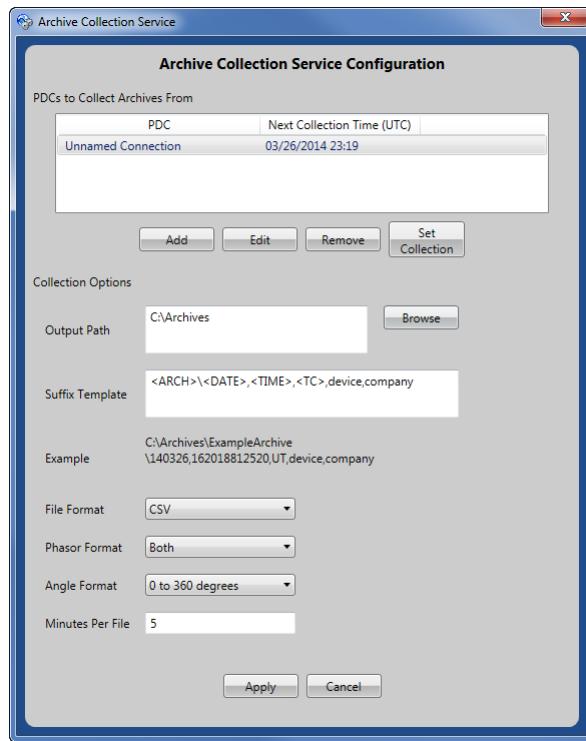


Figure 4.46 Archive Collection Service Configuration Screen

In the **PDCs to Collect Archives From** section, the following options are available:

- **Add:** Adds a PDC from which to collect archived phasor data. It is recommended that when adding archive collection, you specify a different network port than the port that is currently being used for PMU data collection. Using the same port may result in increased data latency.
- **Edit:** Edits the PDC data sources that have been added.
- **Remove:** Removes the selected PDC data source.
- **Set Collection Time:** Identifies the data time stamp in the archive at which to begin the collection of archived phasor data. Leaving this setting blank initiates the collection of all archived data on the PDC.

In the **Collection Options** section, the following options are available:

- **Output Path and Suffix Template:** Specifies the output path and file name of the archive by using a path name template. The output file can be stored locally, or on a network drive, by using the following steps:
 - Use the full UNC path instead of a mapped drive letter as part of the Output Path Template. For example, instead of **T:\Archives\<DATE>,<TIME>**, use **\server\share\Archives\<DATE>,<TIME>**.
 - Set up the service to log on as a network account with appropriate privileges to access the output folder, as follows:
 - In PDC Assistant, select the **Manage Service Startup** item under the **Local Services** menu.
 - In the Services window that appears, locate the service **SEL PDC Archive Collection Service**. Right click and select **Properties**.
 - Click the **Log On** tab.
 - Click the **This account** radio button and enter the network account name and password.
 - Restart the service by right clicking the service and selecting **Restart**.
 - Click **OK**.
 - **File Format:** Choose between **CSV** or **COMTRADE** file formats.
 - **Phasor Format:** Choose between **Polar**, **Rectangular**, or **Both**.
 - **Angle Format:** Choose between **degrees** or **radians** formats.
 - **Minutes Per File:** Enter the number of minutes of data to be stored in each individual archive. The ACS creates individual archive files of the length you specify. The initial archive file created only stores data to nearest even increment of the time specified in order to ensure that the subsequent files created are done so starting at whole number increments on the minute. This is only valid for Continuous archive triggers.

Loggers

Add syslog destinations or define the severity and length of the internal log by selecting options from the top menu bar.



Figure 4.47 Logger Menu Bar

NOTE: The PDC will store the most recent 50,000 diagnostic logs.

SEL recommends setting **Minimum Severity** to **Error** for normal operation. The internal logger options are as follows:

- **Minimum Severity:** Select the severity level of logs which are displayed. Use this to limit receiving an excessive number of low-priority tags, which could obscure more important error cases.
- **Maximum Length:** The length in time to save log data.

Figure 4.48 shows an example of internal log settings.

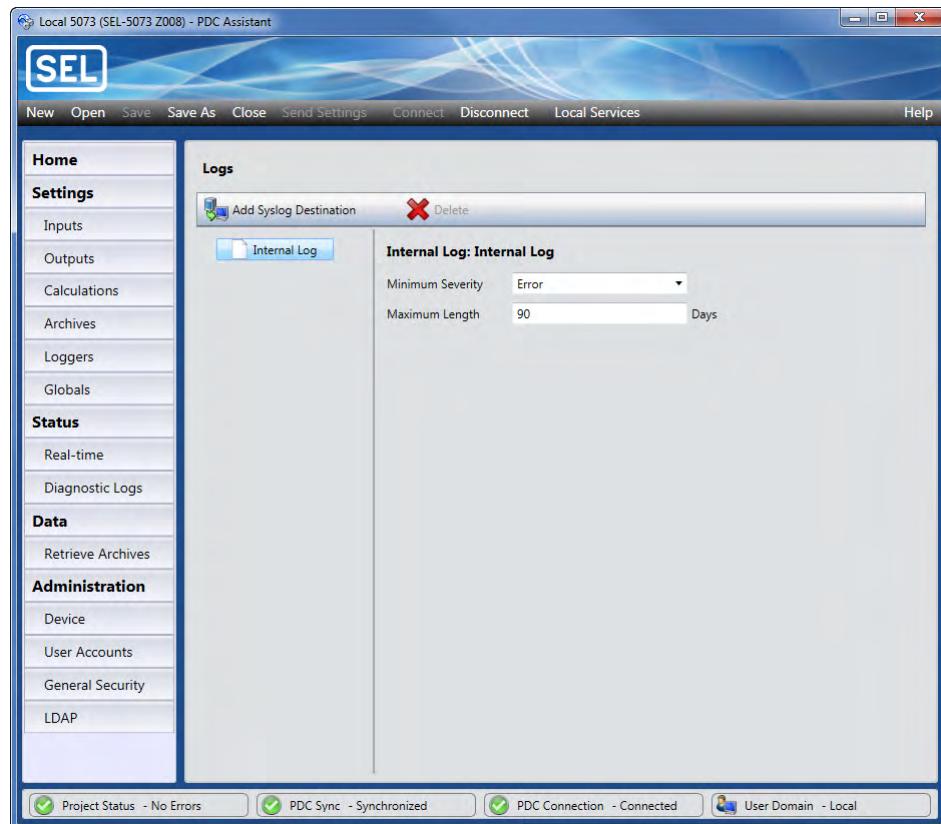


Figure 4.48 Logger Setting Screen

The settings options to add a syslog destination are as follows:

- **Name of Destination:** Select a unique name for the destination.
- **IP Address:** The IP address of the log location.
- **Port:** The port of the log location.
- **Minimum Severity:** Select the severity level of logs which are recorded. Use this setting to limit receiving an excessing number of low-priority tags, which could obscure more important error cases.

Figure 4.49 shows an example of syslog destination log settings.

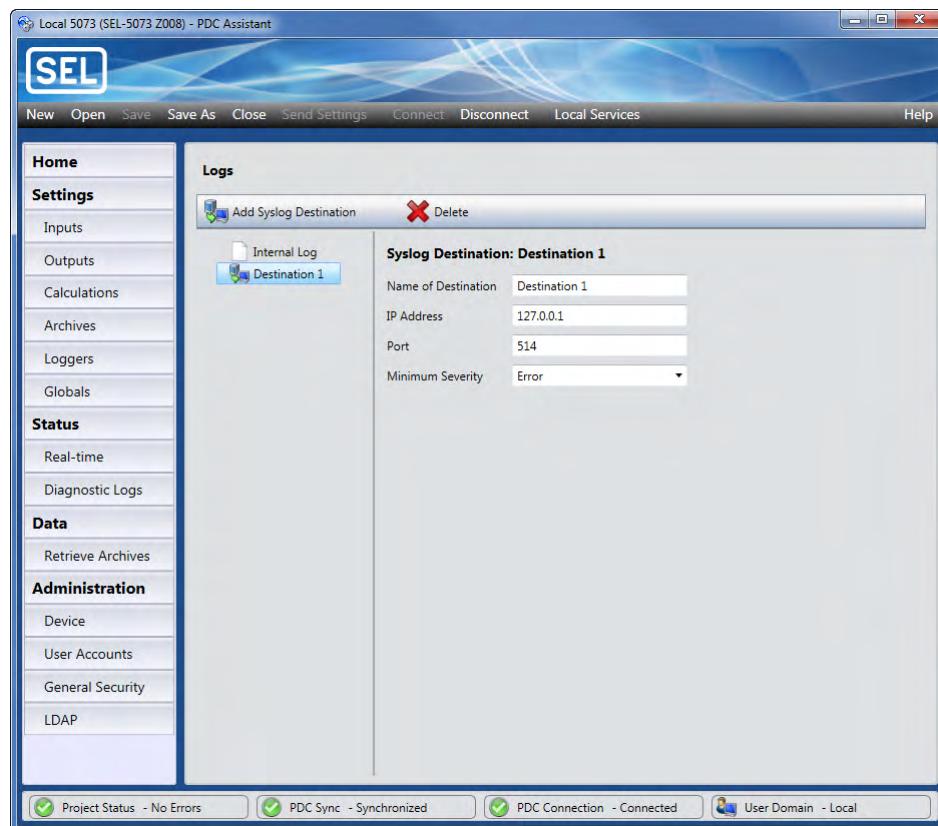


Figure 4.49 Settings for Addition of Syslog Destination

Global Settings

Global settings affect all aspects of the PDC. Any changes to the global settings restarts all inputs, archives, and outputs. Global settings include:

- **Frequency:** This is the nominal frequency of the power system to which the input PMUs are connected.
- **Free Disk Space Warning Threshold:** Sets the threshold for available disk space for archiving data. Exceeding this threshold causes a PDC alarm.
- **Maximum Waiting Period:** Sets the maximum waiting period allowed by the PDC. It also is used to limit how long the calculations wait for data.



Figure 4.50 Global Settings Screen

Status

The Status menu provides real-time information on the state of the synchrophasor system. PDC Assistant must be connected to an SEL PDC to receive status information. Real-time information displays for PMU inputs, PDC inputs and outputs, and the archiver.

PDC status provides real-time information and diagnostic logs:

- **Real-Time:** The real-time status is updated every few seconds. Information shown includes input/output connectivity states, PDC and PMU data status, and archive utilization.
- **Diagnostic Logs:** The log status keeps a running history of all PDC initiated diagnostic logs. This information can be sorted by sequence, severity, event, source, event source instance, or log time.

Real Time

Input Connections

Check the Input Connections section to determine the communications status of each input PMU and input PDC connection.

- **Name:** Source name from the PMU or PDC input settings.
- **PMU or PDC ID:** PDC ID number from the input settings.
- **Connection State:** **Receiving Data** if connected, **Not Connected** if not connected. See *Section 5: Troubleshooting* for additional information about the connection state.
- **Time Quality:** Shows the maximum time error as determined by the PMU clock function.
- **Received Data Frames:** Number of data frames received.

Click the (+) button to the left of the PDC name to access the following real-time information.

- **Latency:** Provides the maximum and average time latency (one minute average) of the data being received on this input. Latency is measured by using the local time of the PDC and comparing it with the received time-stamped data.
- Other information provided includes the number of data frames, missed data frames, duplicate data frames, past data frames, configuration frames received, and command frames sent.
- **Reset:** The left **Reset** button allows the latency maximum and average values to be reset. The right **Reset** button resets the frame counters.

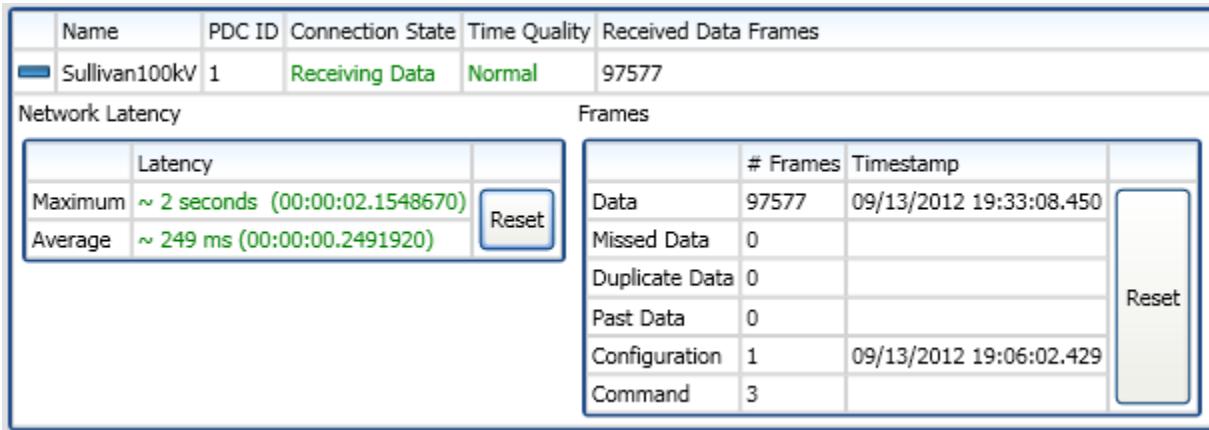


Figure 4.51 Input Connections Real-Time Status Detail

Input PMUs

Check the Input PMUs section to review status and data contained within IEEE C37.118 messages.

- **PMU Name:** Station Name or the PMU Station Name alias from the PMU input settings.
- **PMU ID:** PMU ID number or the PMU ID alias from the PMU input settings.
- **Input Connection:** The input connection that includes this PMU.
- **PMU State: Found** if the PMU is contained in the input connection. **Not Found** if it is not contained in the input connection. See *Section 5: Troubleshooting* for tips associated with a PMU state of **Not Found**.
- **PMU Status:** Indicates if there are invalid PMU data, a PMU error, or a PMU synchronization error per the STAT field of the IEEE C37.118-2005 standard.
- **Unlock Time:** Indicates a range of seconds from when the loss of synchronization was detected.

By clicking the (+) button to the left of the PMU name, the following additional real-time information displays:

- **Timestamp:** Displays the time stamp of the last data received.
- **Frequency:** Displays the measured frequency.
- **df/dt:** Displays the measured change of frequency with respect to time.
- **Phasors:** Displays measured phasor values, both magnitude and angle.
- **Analogs:** Displays measured analog values.
- **Digital:** Displays measured digital status bits 0 or 1. Nominal is always 0 after the data enters the PDC.

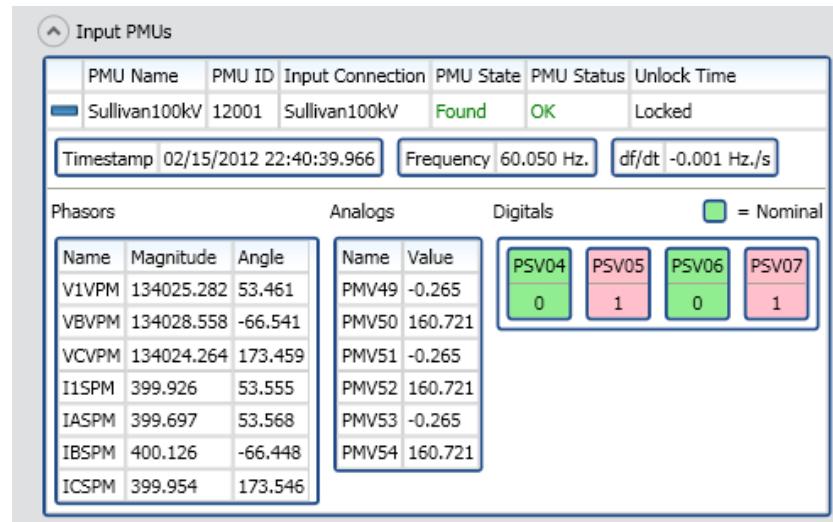


Figure 4.52 Input PMU Real-Time Status Details

Outputs

Check the Outputs section for output communications and time-alignment status.

- **Server:** Server name from the PDC output settings.
- **Connection State:** **Sending Data** if connected, **Not Connected** if not connected.
- **Missing Data:** Indicates whether any data are missing from the output data stream.
- **Sent Data Frames:** Number of data frames sent from that output.

Click the (+) button to the left of the server name to access the following real-time information.

- **Network Latency:** Provides the maximum and average time latency of the data being received on each input. Latency is measured by using the local time of the PDC and comparing it with the time-stamped data received. The **Differences** row takes the difference (the maximum minus the minimum) of all the inputs. This can be used to set the waiting period setting on the output.
- **Frames:** Provides a count of sent data frames, capability frames (CFG 1 frames), configuration frames sent (CFG 2 frames), and command frames received. Next to each count is the time stamp of the most recent associated message.
- **Missing:** Provides a per-PMU count of missing tags.
- **Reset:** Allows associated statistics and counts to be manually reset to zero.

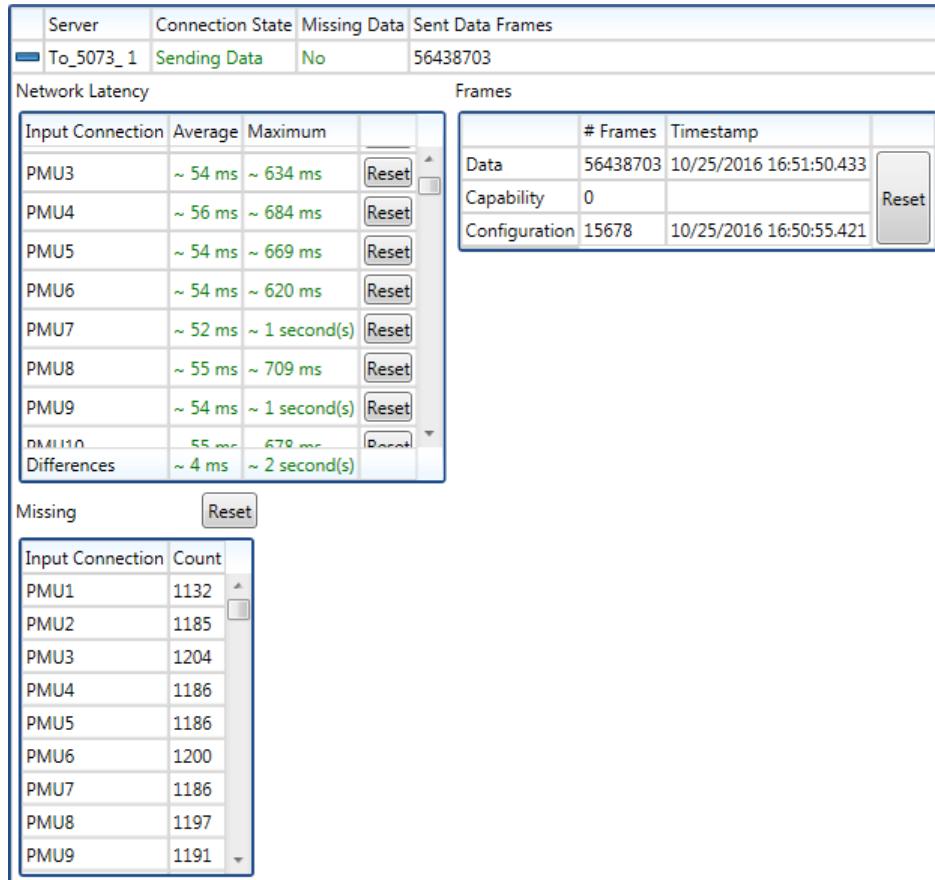


Figure 4.53 Output Real-Time Status Details

Internal Archives

Check the Internal Archives section (called **Archivers** on the SEL-3573 and SEL-3373) for the status of each configured archive.

- **Archive:** Archive name from the PDC settings.
- **Missing Data:** Indicates whether any data are missing from the data stream that flows into the archive.
- **Space Currently Used (MByte):** Approximate amount of space currently used by the Archiver in megabytes.
- **Input Rate (MByte/Hour):** The amount of data received by the Archiver in megabytes/hour. Note that this value is a running average and may not precisely match the instantaneous archive update rate.
- **Space Available:** The amount of space available for archiving data.

Click the (+) button to the left of the archive name to access a per-PMU count of missing tag instances.

Archivers			
	Archive	Missing Data	Space Currently Used (MByte)
+	CPU	No	54.42397
+	Archive	No	23271.07
+	Archive2	No	865.8738
+	Archive3	No	14175.56
+	Archive5	No	861.4012
+	Archive4	No	861.5248
+	Archive6	No	14183.7
+	Archive7	No	14187.15
+	Archive9	No	23270.96
+	Archive8	No	861.7939
-	Archive10	No	23271.03

Missing		Reset
Input Connection	Count	
PMU33	302	
PMU91	43	
PMU93	35	
PMU94	35	
PMU96	61	
PMU97	61	
PMU55	61	
PMU54	61	

Totals	115864.5	16960.02
--------	----------	----------

Space Available (MByte)	110956.6
-------------------------	----------

Figure 4.54 Internal Archives Real-Time Status Details

External Archives (SEL-5073 Only)

Check the External Archives section for the status of each external archive configured in the SEL-5073.

- **Archive:** Archive name from the PDC settings.
- **Files:** The estimated number of files currently in the target directory versus the **Number of Files** setting from the PDC settings. A tally of the files written and deleted is shown in parentheses.
- **Operations Backlog:** Total number of pending operations in the external archive process. The operations backlog is sensitive to network and local computer activity. During nominal conditions, this number will not increase over time.

External Archives		
Archive	Files	Operation Backlog
Archive1(E)	10/10 (+1, -1)	0
Archive2(E)	0/∞ (+1, -0)	0
Archive3(E)	0/∞ (+1, -0)	0

Figure 4.55 External Archives Real-Time Status Details

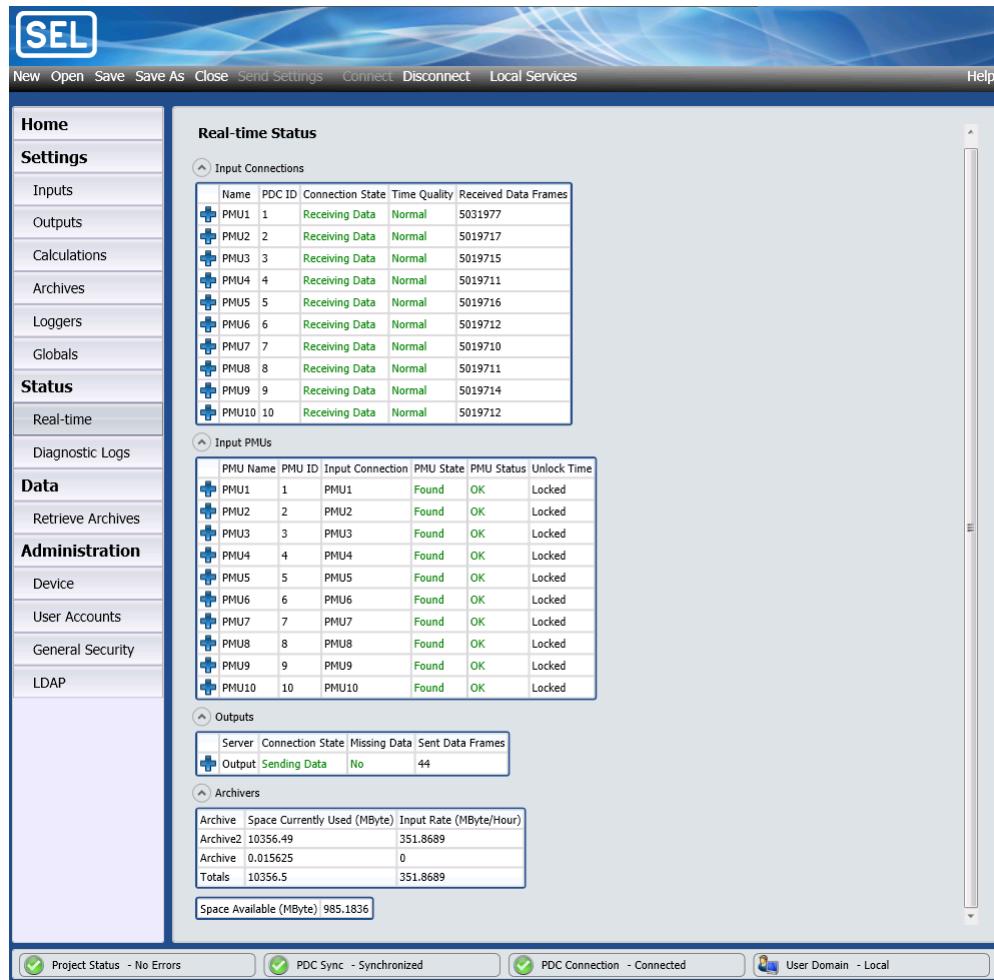


Figure 4.56 Real-Time Status Screen

When initially acquiring real-time status, it may take a few seconds to initialize the collection. *Figure 4.57* shows an example of how the screen appears during the initialization process.

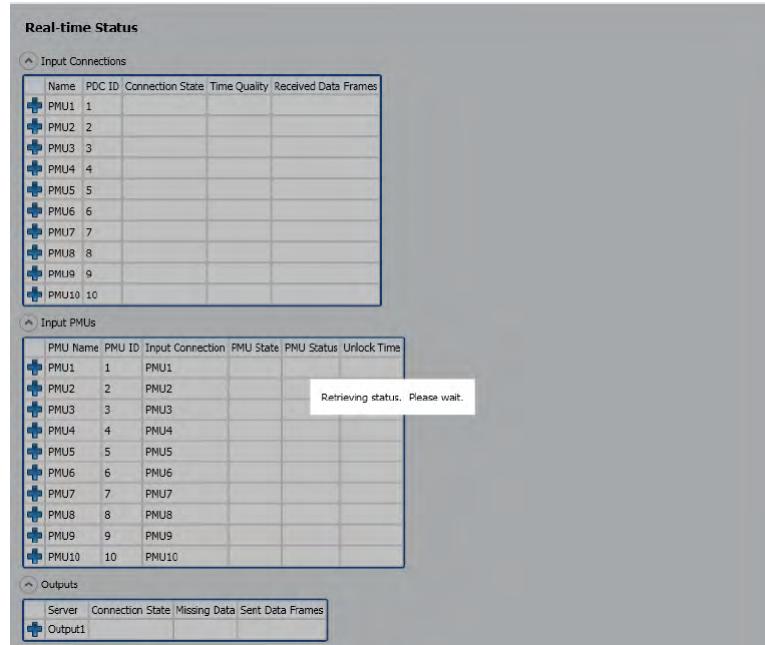


Figure 4.57 Real-Time Status Screen: Updating Status

Diagnostic Logs

The **Log** menu enables you to select of diagnostic information from the SEL PDC. Diagnostic logs can be exported to a user-defined location by using the **Export** button.

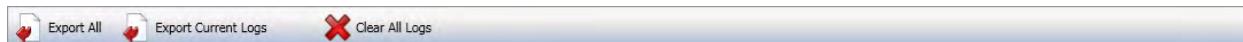


Figure 4.58 Diagnostic Logs Toolbar

NOTE: The PDC will store the most recent 50,000 diagnostic logs.

Log definitions are as follows:

- **Log Time:** Time of the event.
- **Severity**
- **Debug:** Detailed diagnostic information. This information is not relevant for normal PDC operation.
- **Informational:** Information regarding the state of the PDC. Informational logs do not indicate a problem.
- **Warning:** Logs an event that is abnormal in nature but does not present a problem for system performance.
- **Error:** Indicates a problem that must be resolved. The PDC is designed for an embedded environment and therefore automatically recovers from most error cases.
- **Event Source:** Indication of the subsystem (i.e., IEEE C37.118 Client, IEEE C37.118 Server, Calculator, Communications, Historian, Logging, Security, Settings, or System) related to the log.
- **Event Source Instance:** Instance of the subsystem.

- **Description:** Detailed information regarding the log.
- **Event Code:** Coded values of the description which allow for sorting.

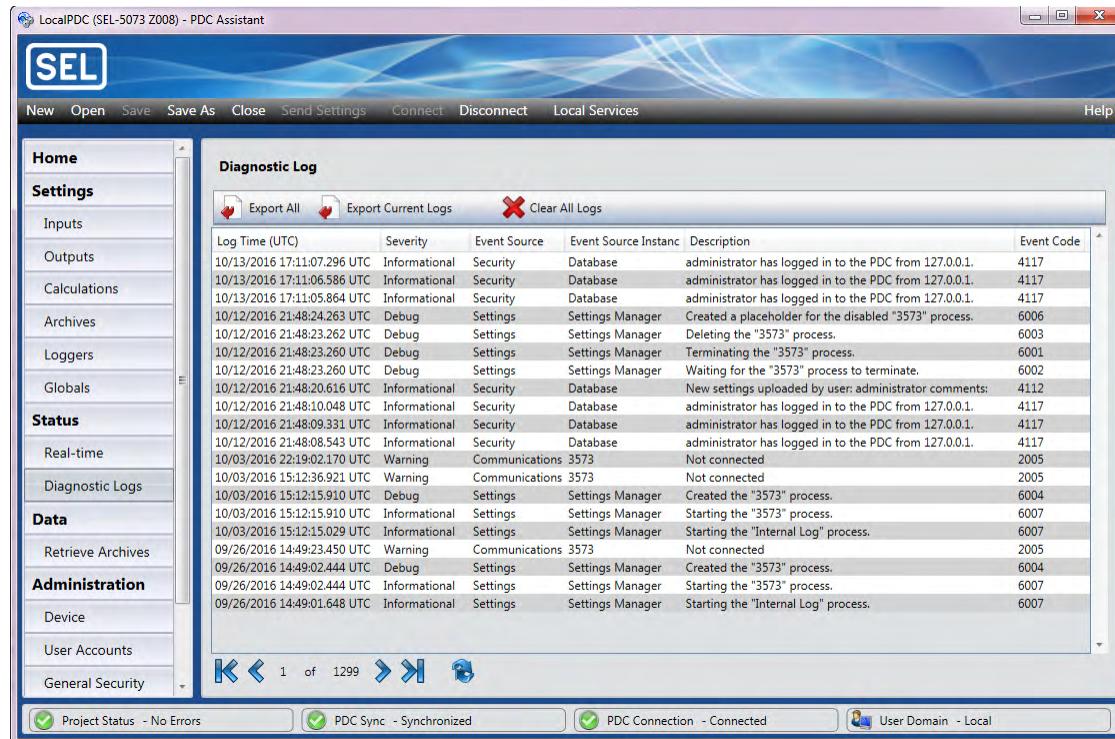


Figure 4.59 Diagnostic Log Screen

The diagnostic log includes user activity and error logs detected by the PDC. This user activity is saved in the archive of the PDC (note that to view these logs you must set the log **Minimum Severity** to **Informational**).

User activity that is logged in the diagnostic log includes the following:

- User logins to the PDC
- User access to the diagnostic logs
- Users that clear the diagnostic logs
- Software/firmware change
- Time/date of settings changes, along with user-defined notes pertaining to the settings change
- PDC starting and stopping (e.g., PDC initialization complete or PDC shutdown)
- User logging out, including a user session timeout
- User account lock out
- User account unlocking

A complete list of all diagnostic logs and details regarding the cause of the log, as well as tips for resolving log items, are provided in *Appendix C: Detailed Diagnostic Logs*.

Data

Retrieve Archives

The PDC keeps a synchrophasor data history in its internal database. Use the archiver settings to configure the stored data. These data can be retrieved and stored on a local computer. Conduct data retrieval from the **Retrieve Archives** page.

Retrieve Archives: Select the retrieved archive file name, format, and location. Both the archive time range and individual tag names are options for selecting data.

After the PDC has collected synchrophasor data in its internal relational database, use this menu item to retrieve the archived information. Select an archive by its name from the archive configuration section. The data are available in binary COMTRADE, ASCII COMTRADE, or CSV format.

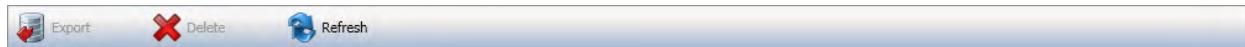


Figure 4.60 Retrieve Archive Menu Bar

Selecting the archive name provides you an archive summary along with the file settings. File settings options are as follows:

- **Filename Template:** You can input the desired name for the file. Alternatively, click the **IEEE** button to name the file in accordance with the IEEE C37.232 file naming standard.
- **Phasor Format:** Defines the phasor format of the data in the retrieved file. Options are **Polar**, **Rectangular**, or **Both**.
- **Angle Format:** Defines the angle format of the data in the retrieved file. Options are **-180 to 180 degrees**, **0 to 360 degrees**, or **Radians**.
- **Multiple Files:** Select this check box to retrieve the data in multiple files.
- **Minutes per File:** Defines the number of minutes per file when retrieving the data in multiple files.
- **File Format:** Retrieve the data in either **ASCII COMTRADE**, **Binary COMTRADE**, or **CSV** formats. Selecting **Zipped CSV** will zip the CSV file.
- **Output Directory:** You can specify the destination folder for all the retrieved archive files. By default, all recordings are stored in **C:\Documents and Settings\User\My Documents\PDC Assistant**.

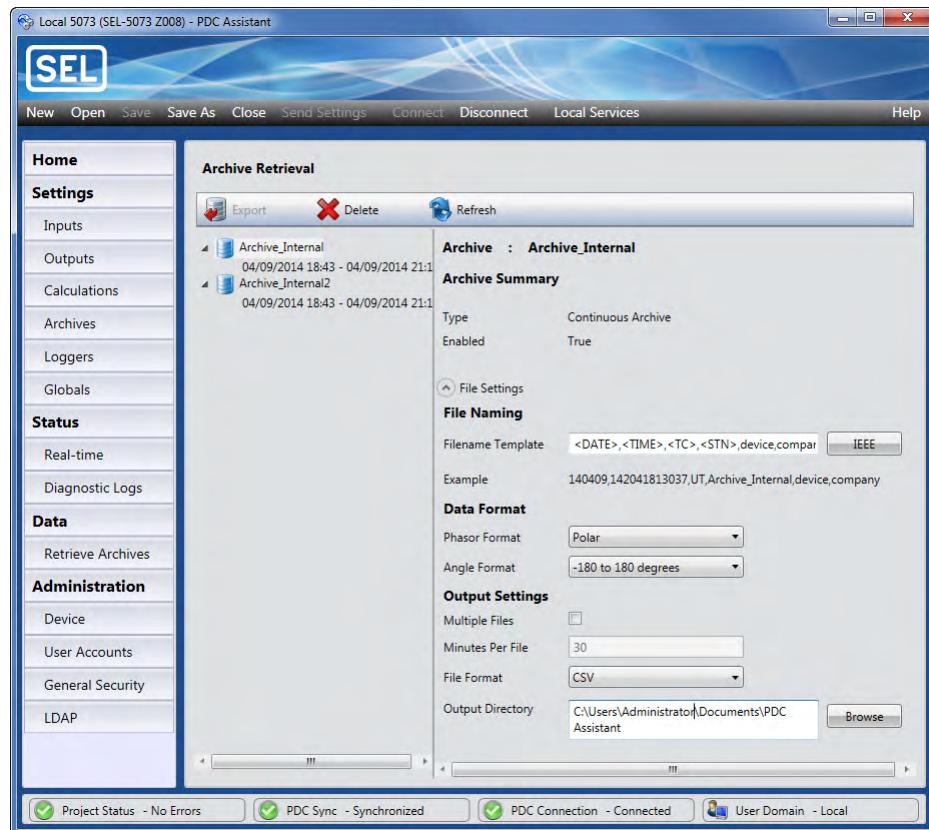


Figure 4.61 Archive Retrieval Screen: File Settings

Archive Filename Templates

When archives are exported to files from the PDC (either manually, using external archiving, or the ACS), the PDC uses filename templates to determine what to name the export files. The template includes user-defined text intermixed with fields. The fields are replaced with actual values at the time the file is written. A field is a text string surrounded by the brackets (<) and (>). The allowed fields are the following:

- <DATE> is replaced with the start date of the data.
- <DATE4> is replaced with the start date of the data using a four-digit year.
- <TIME> is replaced with the start time of the data.
- <TC> is replaced with the time code, which represents the time zone as an offset from Coordinated Universal Time (UTC).
- <ARCH> is replaced with the archive name.
- <DUR> is replaced with the file duration.
- <REASON> is replaced with the trigger reason (triggered archives only).

The format (e.g., date format) of the field replacement values matches the IEEE C37.232-2007 standard. The default template matches the file naming recommended in the standard:

<DATE>,<TIME>,<TC>,device,company (where *device* and *company* are manually replaced with user-defined text)

You must ensure that the names of generated files are unique. This is typically accomplished by including <DATE>, <TIME>, and <ARCH> fields in the template.

The ACS allows placing fields as part of the directory name. This allows you to configure the ACS to create directories based on archive names, dates, times, etc. For example, the following template will create a directory for each archive containing a subdirectory for each date, and place all archive files for that date within the subdirectory:

c:\Archives\<ARCH>\<DATE>\<TIME>

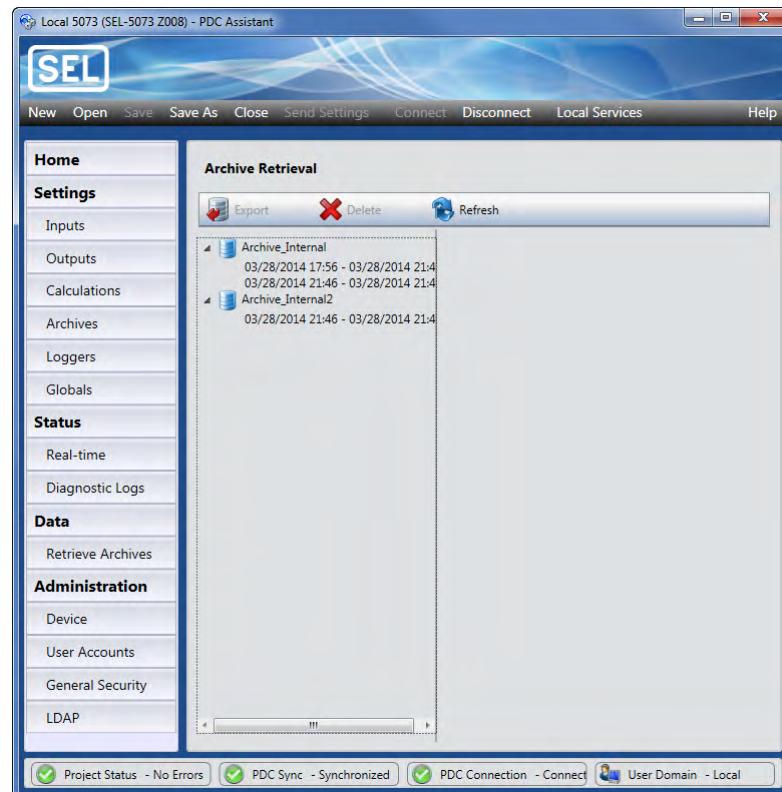


Figure 4.62 Archive Retrieval Screen: Segment Summaries

Export Filter Options

For each segment under the archive name, you are provided with the segment summary along with the export file filter options. Export filter options are as follows:

- **Begin:** Defines the begin time for the retrieved data file. By default, this is autofilled with the start time of the archive segment shown in the segment summary. The user can also edit this to apply a time filter.
- **End:** Defines the end time for the retrieved data file. By default, this is autofilled with the end time of the archive segment shown in the segment summary. The user can also edit this to apply a time filter.

Example

Assume that the begin time and the end time of an archive segment are those shown in *Figure 4.63*.

Date Filter		
Begin	05/26/2010 20:16:55.433333	UTC
End	05/26/2010 22:03:58.250000	UTC

Figure 4.63 Data Filter Settings for Archive Retrieval

Change the begin time and the end time (as shown in *Figure 4.64*) to retrieve the data packets archived only within that one-minute period of time.

Date Filter		
Begin	05/26/2010 20:16:55.433333	UTC
End	05/26/2010 20:17:55.433333	UTC

Figure 4.64 Data Filter Settings for Archive Retrieval: One Minute Filter

Use the **Tag Selection** menu for selecting the tags to retrieve. The **Available Tags** section shows the list of available tags selected in the archiver settings. Select a set of tags from this list to retrieve them in a file.

If the retrieved archive file appears to be missing data, the following are possible causes:

- For COMTRADE files, if there are no data for the archive (for example, a trigger has not occurred), a file is still exported, but it will be empty.
- If a tag is selected for the archive that is not being sent by a PMU, then that tag appears in the archive file, but no data will display.
- During a network interrupt, data are not received by the PDC. In this case, the data in the archive will depend on the archive file type.
 - For a CSV file, the entire row will be missing, including the time stamp.
 - For a COMTRADE file, a row is present with a proper time stamp, but no data will display.
- The internal message waiting period for the archive is settable. When this period expires, no other data arriving with that time stamp are included in the database. The initial connecting negotiation to a PMU, after settings are changed, could exceed this waiting period and a few values could be missing from the archive at startup.

Administration

Several settings and status pages are provided to aid PDC administrators in commissioning, monitoring, and maintaining the PDC. These pages are summarized in the following list.

- **Device:** Manages firmware updates and other maintenance services when PDC Assistant is connected to a hardware PDC. Device administration is not required when connected to a software PDC.
- **User Accounts:** Maintains user accounts.
- **Network:** Allows the user set up various network settings for the SEL-3573 and SEL-3373.
- **General Security:** Allows the user to set up various security parameters.
- **LDAP:** Provides the settings needed to configure the PDC for centralized user authentication using LDAP.
- **Certificates:** Allows the user to configure the local certificate chain of the PDC.

Device

Software version numbers are available on the **Device** page. Use the **Synchronize PDC Date/Time** button shown in *Figure 4.65* to set the date, year, and time of the SEL-3573 or SEL-3373 to match the local computer time. This option is not available when using SEL-5073 software. When using an external IRIG connection to the SEL-3573 or SEL-3373, the **Synchronize PDC Date/Time** button sets the year, as described in *Commissioning the SEL-3573 on page 2.8*.

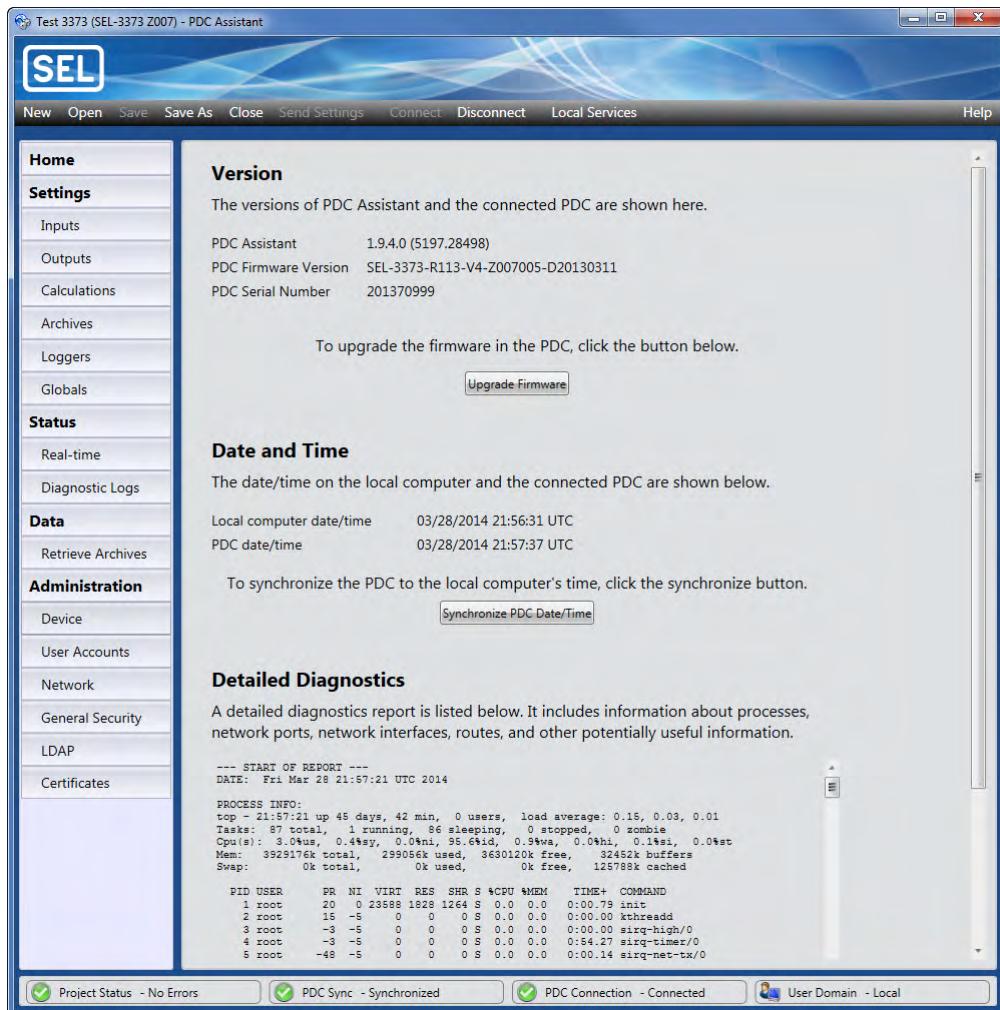


Figure 4.65 Device Information Screen

Audit Function for Ports and Services (SEL-3573 and SEL-3373 Only)

The SEL-3573 and SEL-3373 allow users to see detailed diagnostic information that includes the status of system performance, network settings, and firewall rules. This is not available to users in the Technician role.

Information provided about the PDC includes the following:

- CPU usage, memory usage, processes running
- Solid-state drive (SSD) usage
- Network connections and ports
- Network card statuses including IP address, netmask, bytes sent and received, and other information about network cards
- Host-to-IP mappings
- Domain name servers
- Routing table information
- Firewall rules
- Hardware information
- Whitelist antivirus information

Whitelist (SEL-3573 and SEL-3373 Only)

The whitelisting function used by the SEL-3373 and SEL-3573 allows only a preapproved set of tasks to run. This function generates diagnostic logs to indicate object integrity verification failures (whitelist blocking actions). The whitelisting function provides additional status information within the **Detailed Diagnostics** window on the **Device** page.

- Enabled (True(1)/False(0)): Whether whitelisting is enabled. This should always be True. A False indicates a major failure.
- Enforcing (True(1)/False(0)): Whether whitelisting is enforcing. This should always be True. A False indicates a major failure.
- Signature Count (number): This is a static count of the number of objects (executables, libraries, scripts, etc.) that are whitelisted. This only changes between firmware upgrades.
- Files Verified (number): This is a count of the number of objects (executables, libraries, scripts, etc.) that have been whitelisted (processed by SEL Whitelist cryptographic functions) since the last reboot. This will increment at various times (when objects are executed, loaded, etc.).
- Cache Hits (number): For use by SEL.
- Cache Success (number): For use by SEL.
- Cache Invalidates (number): For use by SEL.
- Integrity Failures (number): This is a count of the number of objects (executables, libraries, scripts, etc.) that have failed whitelist validation because they were modified. If this number is greater than zero, one or more corresponding diagnostic logs will have been generated, and the PDC should be removed from service and returned to SEL for investigation and restoration.
- Unknown files (number): This is a count of the number of objects (executables, libraries, scripts, etc.) that have failed whitelist validation because they do not have a signature. If this number is greater than zero, one or more corresponding diagnostic logs will have been generated, and the PDC should be removed from service and returned to SEL for investigation and restoration.

Firewall (SEL-3573 and SEL-3373 Only)

The SEL-3573 and SEL-3373 have a built-in firewall that automatically enables only the ports configured by the user. By default, all ports are disabled except for those required by PDC Assistant (TCP 26272). This minimizes the possible ports that can be accessed by unauthorized users, thus improving security. Disabled ports will not respond to data sent to them.

Ports are automatically enabled as part of setting up the PDC inputs and outputs. The firewall cannot be manually configured. Specifying the **Local IP Address** setting in inputs and outputs increases the firewall security by limiting which network interface is allowed through the firewall.

Firewall Configuration

The following are input connection types:

- **TCP:** User specifies a remote IP address and a remote port. Thus, no ports are enabled because only an outbound connection is established.
- **UDP:** User specifies a remote IP address, the remote device port to receive command frames, and the local port to receive data and configuration frames. Thus, a UDP port now accepts data on the local port that are from the remote IP address. If the **Local IP Address** setting is set to anything except **Any**, then data are only accepted on the set IP address.
- **UDP_T and UDP_U:** User specifies a remote IP address, a remote port, and a local port. Thus, a UDP port now accepts data on the local port that are from the remote IP address. If the **Local IP Address** setting is set to anything except **Any**, then data are only accepted on the set IP address.
- **UDP_S:** User specifies a local port. Thus, a UDP port now accepts data on the local port. If the **Local IP Address** setting is set to anything except **Any**, then data are only accepted on the set IP address.

The following are output connection types:

- **TCP:** User specifies a local port to listen for and accept connections. If the **Local IP Address** setting is set to anything except **Any**, then data are only accepted on the set IP address.
- **UDP_T and UDP_U:** User specifies a remote IP address, a TCP listening port to accept connections from the remote IP address, and a remote UDP port for data transfer. Thus, a TCP port now accepts connections to the local port from the remote IP address. If the **Local IP Address** setting is set to anything except **Any**, then data are only accepted on the set IP address.
- **UDP_S:** User specifies a remote IP address and remote UDP port. Thus, no ports are enabled because there are only outbound data.

NOTE: The firewall is disabled if the password jumper is installed in the SEL-3573 or SEL-3373.

By default, the firewall will also disable responses to ping requests. This can be configured on a per-interface basis on the **Network Settings** tab. Ping responses are limited to a rate of once-per-second to avoid ping flood security issues.

User Accounts

User Accounts and Passwords

The PDC has user-based accounts to increase the authentication, authorization, and accountability functions of the system. User-based accounts provide the ability to authenticate users to their identity rather than to their role. This means that the system knows the identity of persons performing any action on the system, rather than to only which group they belong. Knowing the identity of a user makes event tracking and forensics more accurate. User-based accounts also make password management easier because passwords can be set and changed by individual users or the administrator.

User Account Password Requirements

- **Password Length:** A minimum of 8 characters and a maximum of 63 characters.
- **Password Set:** Only ASCII characters are allowed. A valid password must have at least one uppercase and one lower case letter, one number, and one punctuation mark or special character.

User Account Roles



Figure 4.66 User Account Toolbar

There are three predefined roles for any given user: Administrator, Engineer, and Technician. *Table 4.3* shows the permissions for each role.

Table 4.3 Role Permissions

Permission	Administrator	Engineer	Technician
Add, edit, or remove other users	✓		
Update firmware	✓		
Synchronize PDC time	✓		
Create and edit settings	✓	✓	
Create, edit, or delete archives	✓	✓	
View settings	✓	✓	✓
Retrieve archives	✓	✓	✓
View status and diagnostics	✓	✓	✓
Change their own password	✓	✓	✓



Figure 4.67 User Accounts Screen

Multiple Users Logging Into PDC Assistant

Because PDC Assistant can be loaded onto multiple computers, it is possible that more than one user can be logged into the PDC simultaneously. PDC Assistant allows this, but SEL does not recommend it because changes made by one user cannot be seen by another user until logging off and logging back on.

Resetting Passwords

See *Password and Networking Reset* on page 5.5 for information on resetting user account passwords.

Network

When configuring an SEL-3573 or SEL-3373 with PDC Assistant, use the **Network** button on the navigation menu. The **Network** button is not available when using the SEL-5073 software. Clicking this button displays the Network Settings Configuration page, as shown in *Figure 4.68* and *Figure 4.69*. Incorrectly configuring network settings can cause the SEL-3573 or SEL-3373 to not be able to communicate with PDC Assistant. If this happens, refer to *Password and Networking Reset* on page 5.5 to reset the network settings.

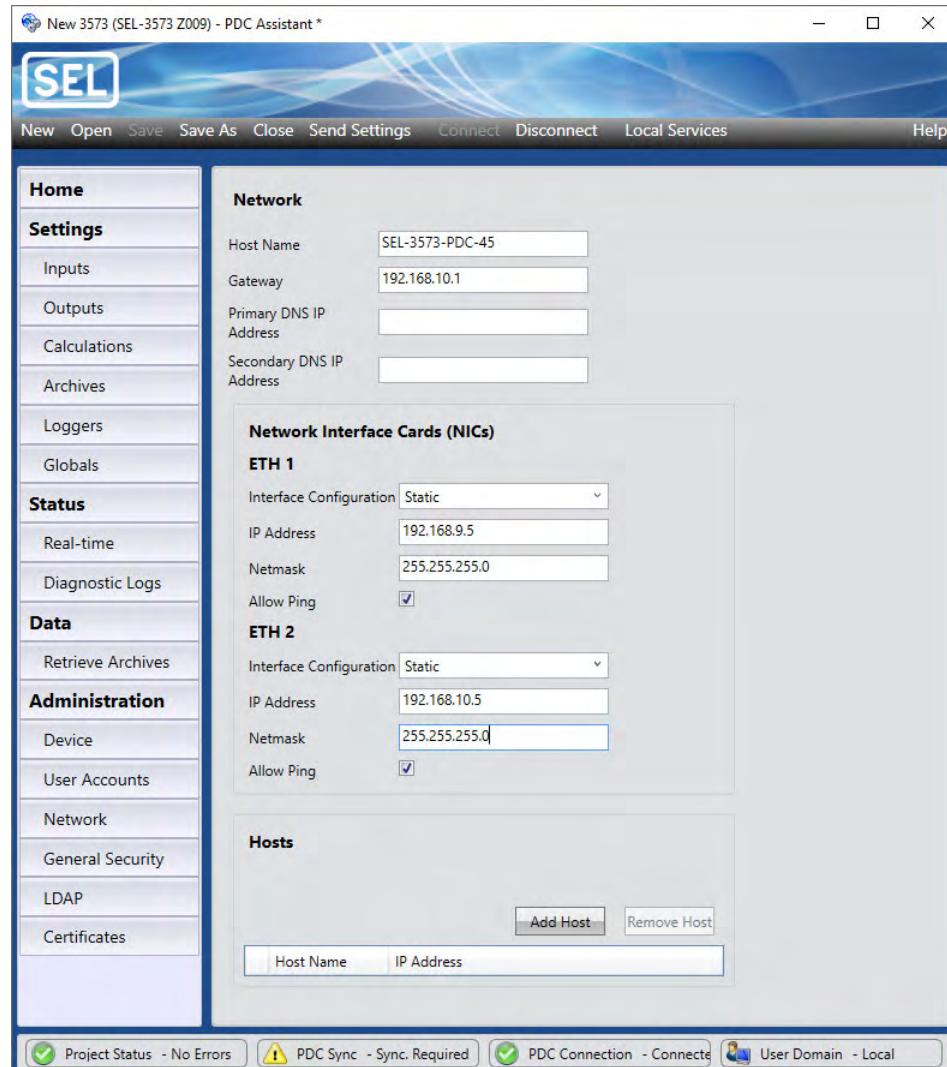


Figure 4.68 SEL-3573 and SEL-3373 Network Settings Configuration Screen

The SEL-3573 and SEL-3373 have multiple Ethernet ports. Each may be configured as **Disabled** or **Static**. A disabled port will not allow incoming or outgoing network traffic.

When a port is set to Static, as shown in *Figure 4.68*, the IP address and netmask are set to fixed values. These values are entered on the Network Configuration page. Consult your IT department to determine the appropriate network settings for your network.

Using this page, you can configure the following network settings for the PDC:

- **Host Name:** Specifies the device label for identification within the network. Each PDC on the network must have a unique Host Name.
- **Gateway:** Specifies the IP address of the gateway to use when accessing IP addresses outside local networks.
- **Primary DNS IP Address:** Specifies the IP address of the domain name server (DNS) to use when resolving the host name for the LDAP server. If you are not using centralized authentication through LDAP, this setting is not used.

- **Secondary DNS IP Address:** Specifies a backup to the primary DNS. If the primary DNS fails to resolve the host name, the secondary DNS is used.
- **Hosts:** Explicitly maps an IP address of a centralized authentication server to a host name. See *LDAP* on page 4.66 for more details.

DNS (SEL-3573 and SEL-3373 Only)

You can configure a primary and secondary DNS on the Network Settings page in the Administration section.

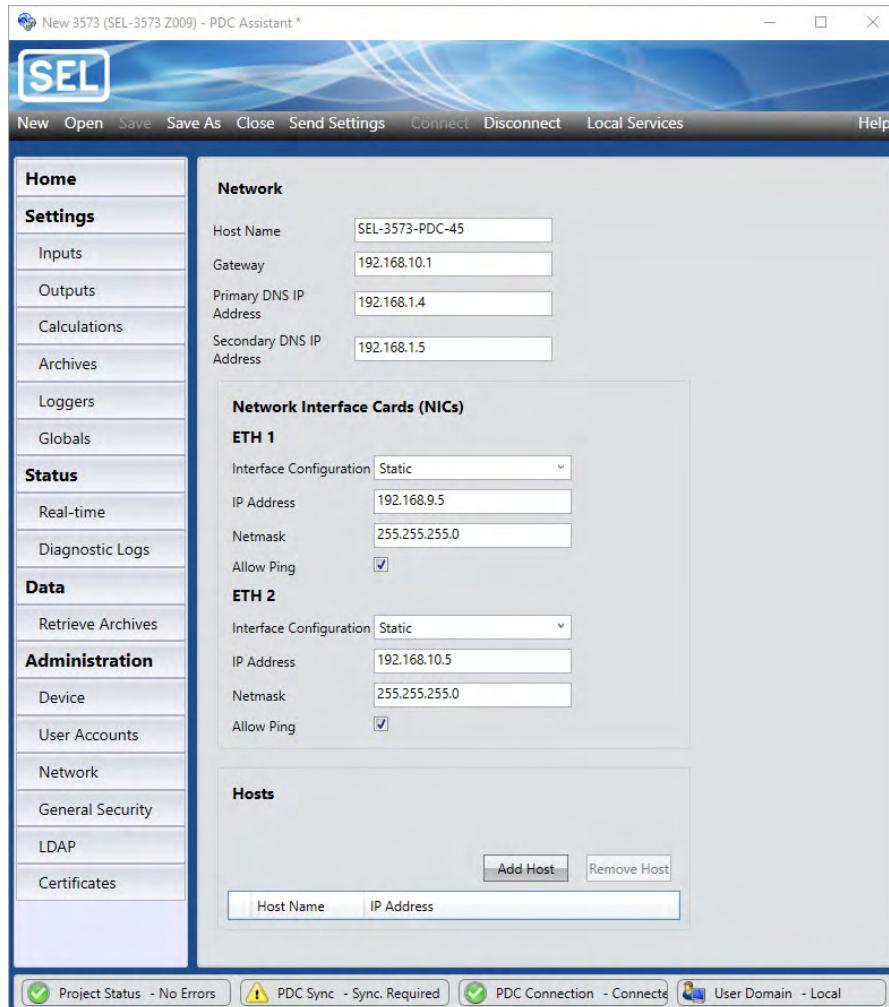


Figure 4.69 Configuring Primary and Secondary DNS

Explicit Hosts (SEL-3573 and SEL-3373 Only)

You can configure explicit mappings from host names to IP addresses on the Network Settings page in the Administration section. Click **Add Host** and enter a **Host Name** and **IP Address**.

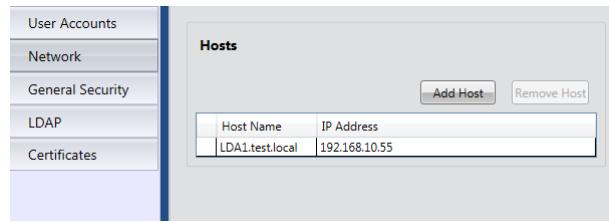


Figure 4.70 Configuring an Explicit Host Mapping to IP Address

General Security

The General Security page provides configurable timers and limits for securing access to the PDC.

- **Allowed Unsuccessful Login Attempts:** This sets the allowable number of unsuccessful login attempts with an incorrect password before the **Unsuccessful Login Lockout Timer** starts. This locks out a user that has exceeded the number of unsuccessful logins. The default setting is **3**. The settable range is **0** to **10**. A setting of **0** disables this feature.
- **Unsuccessful Login Lockout Time:** This sets the length of lockout time before a user is allowed to try to log in after exceeding the number of unsuccessful login attempts. The default setting is **10** minutes. The settable range is **1** to **60** minutes.
- **Session Idle Timeout:** This is the amount of idle time with no input activity from a logged in user before PDC Assistant automatically logs the user out. The default setting is **10** minutes. The settable range is **0** to **60** minutes. A setting of **0** disables this feature.
- **Refresh Period:** This is the time period elapsed before refreshing user credentials with the central server.

The **Refresh Period** setting is intended to reduce the overhead associated with pulling account information from an LDAP server. The PDC caches this information locally, improving access times. The Refresh Period at which the PDC synchronizes this information can be set from **0** to **24** hours. If the Refresh Period is set to **0**, then the PDC synchronizes every time a user logs on. A successful LDAP bind is necessary every time a user logs on, even if the account information is cached locally. The PDC only synchronizes when a user logs on. Thus, users who stay logged on for longer than the Refresh Period are not affected until they log off and log on again.

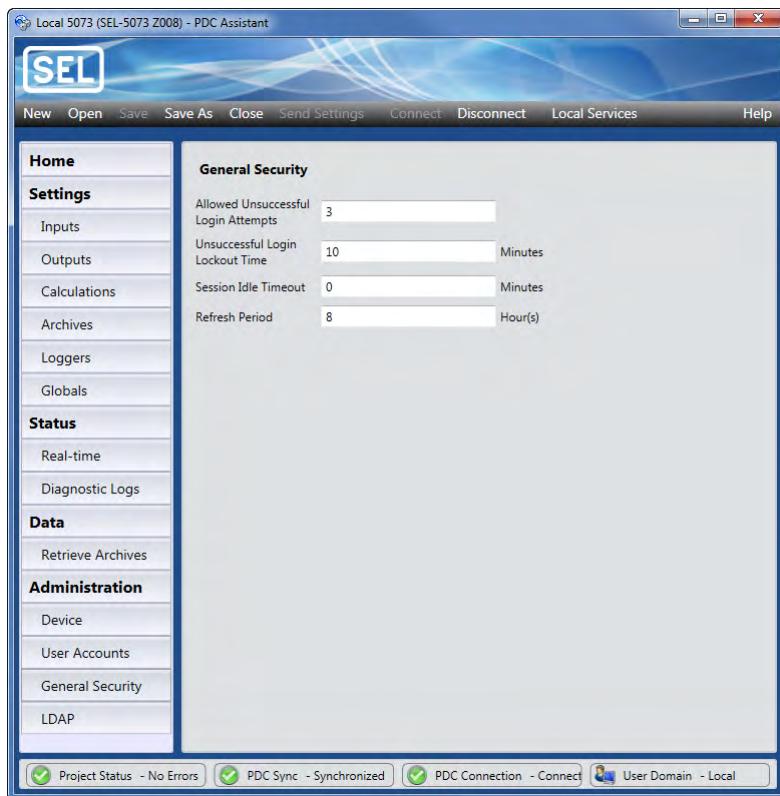


Figure 4.71 General Security Configuration Screen

LDAP

Centralized User Accounts With LDAP

Many IT departments use LDAP to manage users and devices on their corporate networks. LDAP is a powerful and flexible protocol that allows fast information lookups from servers that are optimized for read access. The information stored on LDAP servers can be any type of record-based information that is stored in a directory structure. The PDC includes LDAP as a mechanism for centralized user management. With LDAP, you can manage users from a central server. When a user who does not have a local account requests access to the PDC, the PDC will poll the central directory to verify that the user is authorized to access the unit (see *Figure 4.72*).

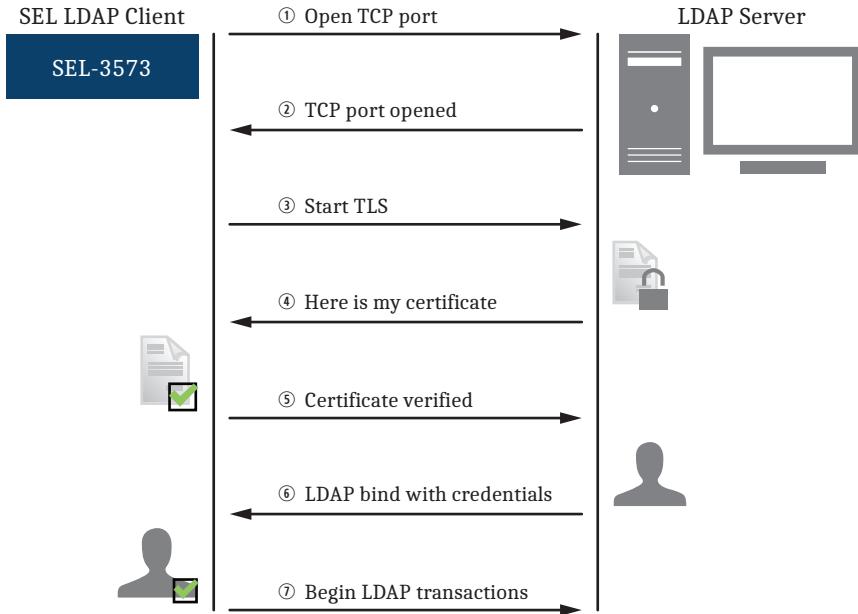


Figure 4.72 Centralized User Authentication Using LDAP

For the PDC to support this behavior, you must configure certain parameters in the PDC to allow it to communicate with your LDAP server. All of these parameters are configurable through PDC Assistant (SEL-3573 and SEL-3373 only). To configure LDAP on your PDC, connect to your PDC with PDC Assistant and use an account with administrative privileges to log on.

To begin, the PDC needs to know how to communicate with your LDAP server. Because this is done using a host name, you need a method to resolve this host name to an IP address.

SEL-5073 Only

Generally, this method uses a DNS. You can configure a primary and secondary DNS for each network interface card (NIC) on the machine. If an NIC is configured by dynamic host configuration protocol (DHCP), then the DNS for that NIC may be automatically configured for you.

You can check your DNS setup by opening a command prompt and running the following:

```
nslookup <host name of LDAP server>
```

This will either return the IP address of your LDAP server, or it will fail. If it fails, the PDC will be unable to communicate with your LDAP server, and you will need to reconfigure your DNS correctly as described in the preceding paragraphs.

SEL-3573 and SEL-3373 Only

You can use a DNS to automatically resolve the host name to an IP address, or you can explicitly define a mapping from the host name to the IP address.

When you have verified communication between the PDC and your LDAP servers, you can configure the PDC to access those servers. Navigate to the LDAP settings page in the Administration section to configure the PDC to access the servers.



Figure 4.73 Configuring the PDC to Access the LDAP Server

To simplify configuration, a form is included for your LDAP administrators to complete. You can use the information from that form to populate all of the LDAP settings.

LDAP Settings Form

Print the LDAP Settings form (see *Appendix E*) and give it to your Information Services department. Having this information ahead of time will facilitate setting up the PDC.

LDAP Hosts (SEL-3573 and SEL-3373 Only)			
Input these settings on the Network Settings page (at least one required)			
Host Name		IP Address	
Host Name		IP Address	
LDAP Servers			
Input these settings on the LDAP Settings page (at least one required)			
Host Name		Port Number	
Host Name		Port Number	
LDAP Settings			
Input these settings on the LDAP settings page			
Search Base DN			
Bind DN ^a			
Bind Password ^b			
User Filter			
Group Attribute			
<small>^a Optional. If left blank, the PDC will use anonymous binds.</small>			
<small>^b Optional. Required only if not using anonymous binds.</small>			
Group-to-Role Mappings			
This is required to map users to roles. Input these settings on the LDAP Settings page (at least one required)			
Administrator / Engineer / Technician	Group DN		
Administrator / Engineer / Technician	Group DN		
Administrator / Engineer / Technician	Group DN		
Administrator / Engineer / Technician	Group DN		

Figure 4.74 LDAP Settings Form

Enable LDAP settings by selecting the **Enable LDAP** check box. Enter the **Primary Host Name** and **Primary Port**. If there are two LDAP servers, configure the **Secondary Host Name** and **Secondary Port** to point to the second one.

Use the **LDAP Search Base** as the root directory from which to begin your user search. Form the search by listing all of the components of the search base, separated by commas, from the most specific component to the least specific component. In *Figure 4.73*, the **Search Base DN** setting is **dc=ldap,dc=local**. In this search base, **dc** refers to domain component. The domain components combine with (.) to create the search domain. In this case, the search domain is **ldap.local**. You can interpret this search base as, “Start the search from the root directory residing on an LDAP server in the **ldap.local** domain.”

Other common LDAP components are **ou** and **cn**. The abbreviation **ou** is short for organization unit, or directory, and **cn** stands for common name and is a name that refers to a specific object that may or may not be unique. Examples of common names are **groups** and **usernames**.

The PDC supports both authenticated and anonymous binds to your LDAP servers. Authenticated binds use a service account (Bind DN and Bind Password) to access the LDAP server. If the LDAP service account is revoked, or if the password expires, the PDC will be unable to access the LDAP server, and centralized users will be unable to access the PDC. Anonymous binds forgo the use of service accounts. Determine which method your LDAP administrator prefers.

The **User Filter** and **Group Attribute** settings identify the usernames and groups of users. If entered incorrectly, the PDC will be unable to determine which LDAP fields to search for usernames or group membership.

The PDC has specific roles that can be mapped to LDAP group memberships. Click the **Add Mapping** button create a new mapping from an LDAP group DN to a PDC role. It is possible to map more than one LDAP group DN to the same PDC role. It is also possible to map the same LDAP group DN to more than one

PDC role; however, only the most permissive PDC role will have an effect. Your server administrator may need to create new groups and assign members appropriate for these mappings. Work with your LDAP administrator to determine group-to-role mappings.

Certificates

For security, the PDC only supports SSL communication with LDAP servers when transmitting authentication information, such as usernames and passwords. The PDC confirms the identity of your LDAP server using the certificate the LDAP server provides and the locally stored certificate chain. The certificate chain, also known as the certification path, is a list of certificates used to authenticate the LDAP server. The chain, or path, begins with the certificate of the LDAP server (the one it provided to the PDC), and each certificate in the chain is signed by the CA identified by the next certificate in the chain. The chain terminates with a root CA certificate, which is always signed by the CA itself. The signatures of all certificates in the chain must be verified by the PDC. The certificate provided by your LDAP server must contain the same host name used to communicate with your LDAP server. Contact your LDAP administrator to acquire the certificates in the certificate chain.

SEL-3573 and SEL-3373 Only

You can configure the local certificate chain of the PDC by navigating to the Certificate Setting page in the Administration section.

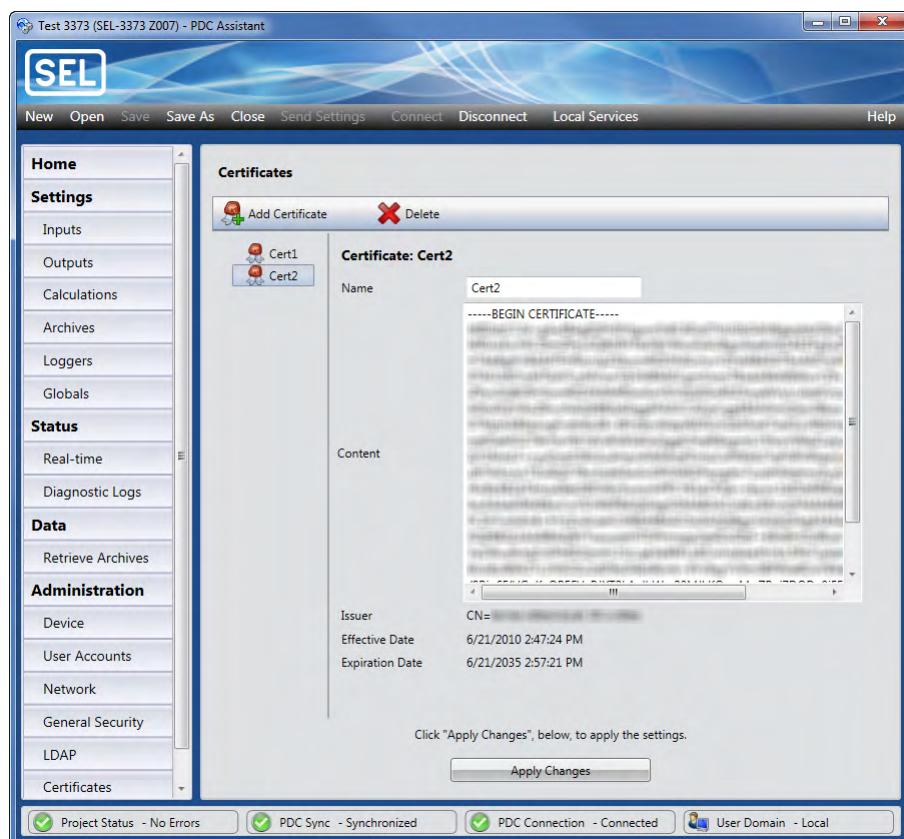


Figure 4.75 Configuring the Certificate Chain (SEL-3573 and SEL-3373 Only)

SEL-5073 Only

The easiest way to add a certificate chain that the PDC can use to verify the certificate provided by the LDAP server is by double-clicking on the certificate, clicking on **Install Certificate**, and telling the Certificate Import Wizard to place the certificate in the Trusted Root Certification Authorities certificate store. The local certificate chain of the PDC can also be configured through the Microsoft Management Console.

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S E C T I O N 5

Troubleshooting

Overview

If you experience any problems with the SEL-3573 Station Phasor Data Concentrator (PDC), the SEL-3373 Station PDC, or the SEL-5073 SYNCHROWAVE PDC, refer to this section for a solution.

One tool that is very helpful in determining if you have an issue is the diagnostic log. Using the **Loggers** tab, set the internal logger event severity to **Debug**, click **Send**, and then go to the Diagnostic Log tab and review the logs listed. A detailed listing of diagnostic logs, causes, and resolutions can be found in *Appendix C: Detailed Diagnostic Logs*.

Common Troubleshooting Issues and Solutions

Pinging

Not able to ping the PDC (SEL-3573 and SEL-3373 only):

- The default firewall settings prevent the PDC from responding to a ping. If desired, you can enable ping response on a per-interface basis from the Network Settings tab.
- Check if a corporate or local firewall is blocking ping attempts.

Connection

PDC Assistant to PDC

PDC Assistant will not connect to the PDC (e.g., you receive the notice, **Failed to establish a connection**):

- Check that the PDC is running before trying to connect to PDC Assistant.
- Check if a corporate or local firewall is blocking your connection attempts.
- Check if you are able to ping the PDC.
- Try connecting without encryption. Do this by selecting **Connect > Advanced Connection Settings** and clear the **Enable SSL** check box.

Real-Time Status Screen to PDC

The Real-Time Status screen indicates that it cannot connect to the PDC and remains grayed-out:

- Check if the PDC is running. Excessive CPU burden may cause the PDC to shut down. If this occurs, the PDC generates a diagnostic log to indicate the cause.
- Check if a corporate or local firewall is preventing PDC Assistant from connecting to the PDC.

Input Not Connected

The Real-Time Status screen indicates that an input is **Not Connected**:

- Check if the IP address and port number of the input PMU/PDC match those entered into the PDC.
- Check if a corporate or local firewall is blocking the connection attempts.
- Check if another IEEE C37.118 client on the network is also attempting to communicate with the PMU over the specified TCP (command) port.

Input Waiting for Silence

The Real-Time Status screen indicates that an input is **Waiting for Silence**:

- Check that the message rate of the input PMU matches the receiving rate of the PDC. The diagnostic log will show this information.

Input Configuring

The Real-Time Status screen indicates that an input is **Configuring** or toggles between **Configuring** and **Not Connected**:

- Check if the input PMU/PDC ID and the transport protocol exactly match between the sending PMU/PDC and the receiving PDC.
- If using the UDP_T or UDP_U transport protocol, make sure that the data port is set correctly.
- If using the UDP_S transport protocol, make sure the port is set correctly.
- Check if another IEEE C37.118 client on the network is also attempting to communicate with the PMU over the specified TCP (command) port.
- Inputs configured for the UDP_S transport protocol will display **Configuring** on the Real-Time page while the PDC awaits the server's configuration information. This state may persist for as long as two minutes during the initial stream configuration.

Output Missing Data

The Real-Time Status screen indicates that an output is **Missing Data**:

- Check if the tag names in the PDC input match the tags sent from the PMU. The diagnostic log provides details of missing data from particular PMUs. An indication of missing data on a per-PMU basis is also listed in the detailed output status. You can use the **Query** button to find out exactly which tags the PMU is sending.
- This problem can also be caused by late data. If the PMU data arrives too late to be time-aligned with other PMUs in that output (i.e., exceeds the waiting period set in Outputs), its tags will be zero-filled and considered missing.

Zero Received Data Frames

The Real-Time Status screen indicates that an input is **Connected** and **Receiving Data**, but the **Received Data Frames** count remains fixed at zero:

- If using UDP_T or UDP_U, check to see if a corporate or local firewall is blocking the UDP data frames from being received on the local UDP port (data port).

PMU Not Found

The Real-Time Status screen shows that an input is **Connected** and **Receiving Data**, and the **Received Data Frames** count is continuously incrementing but the PMU state is **Not Found**:

- Check if the input PMU station name exactly matches the station name in the PDC. Common errors include capitalization discrepancies or not accounting for spaces in the name or after the name. Spaces after the name are not supported.
- If the problem persists, or if the PMU station name is unknown, you can determine the PMU station name by recreating the PMU input as a PDC input. After applying the settings, confirm from the Real-Time Status page that the input is connected and receiving data frames.

On the Inputs page, click **Add Sub PMU > Automatically**. This allows the PDC to read the PMU station name directly from the PMU configuration. The station name will display on the Inputs page.

TCP Connection Error

An unexpected communications error in TCP connection prevents the PMU from reconnecting to the PDC when communication is reestablished:

- Enable the TCP Keep Alive (ETCPKA) setting in the relay or PMU. Using TCP Keep Alive allows the PMU to determine that the connection was interrupted and enable the PDC to reconnect. The only other way to reestablish a connection between the PMU and the PDC is to restart the PMU or change the settings.

Data Not Sending

The PDC momentarily does not send data and then resumes sending data:

- Check the incoming data path. The PDC will not send data if no data are being received.

Positive-Sequence Calculation Error

Creating a positive-sequence calculation generates an error:

- Check if positive-sequence data tags are being sent from the PMU. Many PMUs provide positive-sequence data tags as part of their output. The PDC does not allow duplicate tag names. Simply specify a nonconflicting name for the calculated positive-sequence tag, or remove the positive-sequence calculation altogether.

Archive Not Starting

The archive does not start, or data are not being archived:

- Check diagnostic logs to see if there is a large time-stamp difference between input sources (i.e., greater than one hour).
- Check if the clock in the PDC is within one hour of actual time (corrected from UTC). The archiver will not archive if the time difference is greater than one hour.
- Ensure that the PDC clock time is not set in advance of the time-stamped data (corrected from UTC).

Temporary Stopping

The archive stops archiving data for a period of time:

- Check if the used disk space has exceeded the set limit. Verify disk space via diagnostic logs.

Wrong Location

The archive collection service (ACS) is not archiving data to the specified drive or location:

- Check that the ACS has been started.
- Check the PC that is archiving the data. Its time cannot be set in advance of the time-stamped data.
- Check that the ACS has write permission for the designated directory.

Triggered Archive

The Real-Time Status screen indicates that a triggered archive is currently using hard drive space even though no event has been triggered:

- This is normal behavior. A triggered archive uses a portion of hard drive space to maintain its pretrigger data buffer.

External Archive

The Real-Time Status screen indicates that the operational backlog is steadily increasing for a given external archive (SEL-5073 only):

- Check the PDC host machine resource usage from the Performance tab of the Windows Task Manager. SEL recommends keeping the average CPU usage below 50 percent.
- This problem can also be caused by network congestion or mis-configuration between the PDC host machine and the network storage device.

PCD Stops

The PDC unexpectedly stops running:

- This is associated with the processor being overburdened during an operation. SEL recommends that nominal processor burden be kept below 50 percent to provide adequate overhead for events that can significantly increase processor burden.

Password and Networking Reset

In case you forget the administrator username or password, or if the network settings are configured so that PDC Assistant cannot connect, the SEL-3573 has a password disable control (DIP) switch that you can configure to temporarily fix the problem. The password control (DIP) switch location is identified in *Figure 3.3*.

After configuring the password control (DIP) switch, turn on the device. When the device is turned on with the password control (DIP) switch configured, the device does the following:

- Temporarily allows PDC Assistant login with no username or password.
- Temporarily overrides the networking configuration, restoring it to the factory default (**ETH1 = 192.168.1.2/255.255.255.0** and **ETH2 = disabled**).

If you forget the administrator username or password, follow these steps.

- Step 1. Turn off the SEL-3573, remove the SATA drive bay cover, and set the password disable control (DIP) switch to the **ON** position. For more information, see *Section 3: Hardware Serviceability*.
- Step 2. Turn on the SEL-3573.
- Step 3. Using PDC Assistant, connect to the SEL-3573 through the **ETH1** port. Configure the remote computer as described in *Commissioning the SEL-3573 on page 2.8*. Leave both the Username and Password fields empty.
- Step 4. PDC Assistant will prompt you for a new administrator username and password. You can create a new account or overwrite an existing account. After creating this account, you may view the existing accounts by clicking **User Accounts**.
- Step 5. Turn off the SEL-3573 and return the password disable control (DIP) switch to the **OFF** position.

If the SEL-3573 network configuration is incorrect (making it impossible for PDC Assistant to connect), follow these steps to correct it:

- Step 1. Turn off the SEL-3573 and set the password disable control (DIP) switch to the **ON** position.
- Step 2. Turn on the SEL-3573.
- Step 3. Connect a PC to the SEL-3573 through the **ETH1** port. Configure the PC as described in *Commissioning the SEL-3573 on page 2.8*.
- Step 4. Open PDC Assistant and connect to the SEL-3573 by using server **192.168.1.2**, port **26272**, and your existing administrator username and password.
- Step 5. Click **Network Settings**. The incorrectly configured network settings will display. Modify this configuration and click **Apply Changes**.
- Step 6. Reconnect to PDC Assistant with the new network settings to verify you have corrected the problem.
If the problem is not corrected, turn off the SEL-3573 and repeat *Step 3* through *Step 6*.
- Step 7. When the network settings are corrected, turn off the SEL-3573 and return the password disable control (DIP) switch to the **OFF** position.

A P P E N D I X A

Firmware, Software, and Manual Versions

Firmware and Software

Determining the Firmware Version

To determine the firmware version, connect to the PDC by using PDC Assistant software and navigate to the **Device** page. **PDC Firmware Version** displays under **Version** at the top of the page.

The firmware version will be either a standard release or a point release. A standard release adds new functionality to the firmware beyond the specifications of the existing version. A point release is reserved for modifying firmware functionality to conform to the specifications of the existing version.

A standard release is identified by a change in the R-number of the device FID number.

Existing firmware:

SEL-3573-**R100**-V0-Z008007-Dxxxxxxxx

Standard release firmware:

SEL-3573-**R101**-V0-Z008007-Dxxxxxxxx

A point release is identified by a change in the V-number of the device FID number.

Existing firmware:

SEL-3573-R100-**V0**-Z008007-Dxxxxxxxx

Point release firmware:

SEL-3573-R100-**V1**-Z008007-Dxxxxxxxx

The date code is after the D. For example, the following is firmware version number R117, release date October 6, 2016:

SEL-3573-R117-V0-Z008007-**D20161006**

Revision History

Table A.1 lists the firmware versions, revision descriptions, and corresponding instruction manual date codes.

Table A.1 Firmware Revision History

Firmware Identification (FID) Number	Summary of Revisions	Manual Date Code
SEL-3573-R117-V3-Z009008-D20191101	<p>Includes all the functions of SEL-3573-R117-V2-Z008007-D20170711 with the following addition:</p> <ul style="list-style-type: none"> ➤ Added host name setting to the Network settings page. ➤ Added BIOS version number to the Device page. ➤ Addressed an issue that could prevent connection to servers that use the UDP transport protocol. 	20191101
SEL-3573-R117-V2-Z008007-D20170711	<p>Includes all the functions of SEL-3573-R117-V1-Z008007-D20170323 with the following addition:</p> <ul style="list-style-type: none"> ➤ Addressed an issue where the PDC diagnostic log function could exhaust remaining storage space, leading to adverse behavior and a failure to re-enable after a reboot. 	20170711
SEL-3573-R117-V1-Z008007-D20170323	<p>Includes all the functions of SEL-3573-R117-V0-Z008007-D20161006 with the following addition:</p> <ul style="list-style-type: none"> ➤ Addressed an issue where the PDC could use more than the available storage, leading to adverse behavior and a failure to re-enable after a reboot. 	20170323
SEL-3573-R117-V0-Z008007-D20161006	➤ Initial version.	20161006

Table A.2 lists the PDC Assistant Software revision number, revision descriptions, and corresponding manual date codes.

Table A.2 Software Revision History

Revision Number	Summary of Revisions	Manual Date Code
2.5.1.0	<ul style="list-style-type: none"> ➤ Addressed a security vulnerability when reading configuration files which could allow unauthorized operations, including disclosure of information. 	20210225
2.5.0.0	<ul style="list-style-type: none"> ➤ Updated archive file name macro for stricter compliance with IEEE C37.232 ➤ Resolved an issue that could cause a timeout while exporting archived data. 	20191101
2.3.0.0	➤ Updated for compatibility with R117-V2 PDC firmware.	20170711
2.2.0.0	➤ Initial version.	20161006

Instruction Manual

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

Table A.3 lists the instruction manual versions and revision descriptions. The most recent instruction manual version is listed first.

Table A.3 Instruction Manual Revision History

Date Code	Summary of Revisions
20221221	Section 1 ► Added UKCA Mark to <i>Specifications</i> .
20210406	General Edit ► Updated battery model to Panasonic BR2330A throughout manual.
20210225	Section 4 ► Updated <i>Table 4.1: Settings Version Map</i> . ► Specified units of latency calculation results. Appendix A ► Updated for PDC Assistant version 2.5.1.0.
20191101	Section 4 ► Added notes about diagnostic log retention. ► Updated <i>Table 4.1: Settings Version Map</i> . ► Updated <i>Figure 4.68: SEL-3573 and SEL-3373 Network Settings Configuration Screen</i> and <i>Figure 4.69: Configuring Primary and Secondary DNS</i> . Appendix A ► Updated for PDC firmware version R117-V3. ► Updated for PDC Assistant version 2.5.0.0.
20170711	Section 1 ► Added an updated security statement. Section 4 ► Updated <i>Table 4.1: Settings Version Map</i> . ► Added additional details on Whitelist function status indicators. Appendix A ► Updated for PDC firmware version R117-V2. ► Updated for PDC software version 2.3.0.0. Appendix B ► Updated firmware upgrade instructions. Appendix D ► Added <i>Appendix D: Network Ports and Services</i> .
20170323	Appendix A ► Updated for PDC firmware version R117-V1.
20161006	► Initial version.

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APPENDIX B

Firmware Upgrade Instructions

You can update the firmware version of SEL-3573 remotely using the PDC Assistant software. Before attempting a firmware upgrade, make sure you have installed the latest version of PDC Assistant software. You can check the version of PDC Assistant from the help menu on the PDC Assistant window. The latest PDC Assistant version can be downloaded from selinc.com/products/3573/ or selinc.com/products/5073/. When a new version of the SEL-3573 firmware is available, SEL will provide a firmware file which you can upload to the SEL-3573 using the following instructions.

NOTE: SEL recommends backing up existing settings and data before each firmware upgrade.

- Step 1. Connect to the SEL-3573 using PDC Assistant software.
- Step 2. Go to the Administration Device screen as shown in *Figure B.1*.

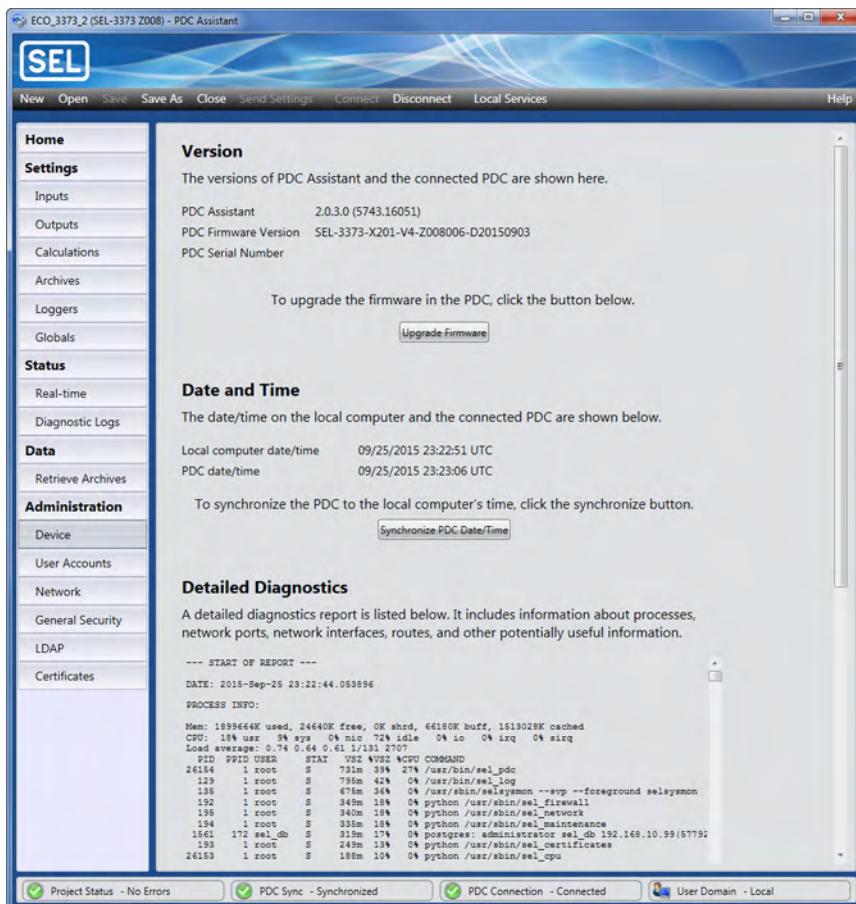


Figure B.1 Administration Device Screen

- Step 3. Click on the **Upgrade Firmware** button.

To upgrade the firmware in the PDC, click the button below.

Upgrade Firmware

Step 4. Browse to the firmware file.

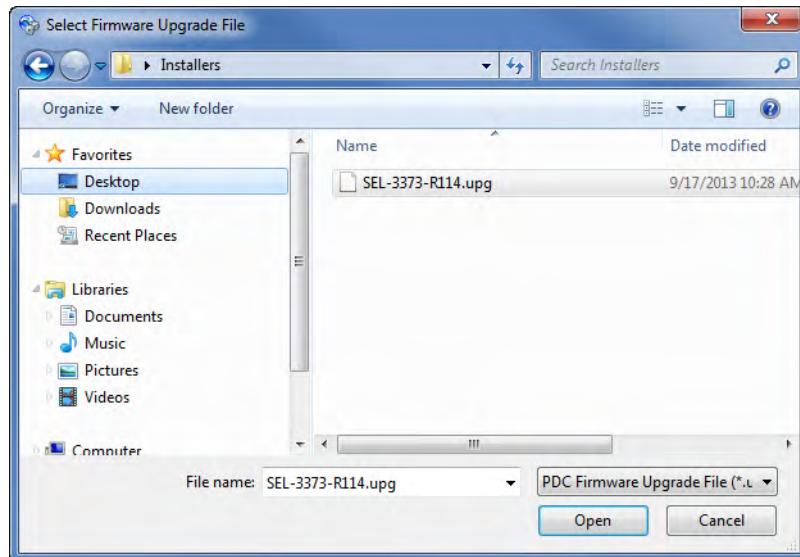


Figure B.2 Firmware File Browser Window

Step 5. The SEL-3573 will process the firmware upgrade and notify you when the upgrade has been completed. Please wait until the SEL-3573 is fully rebooted (ENABLED LED on the front panel is on) before connecting with PDC Assistant.

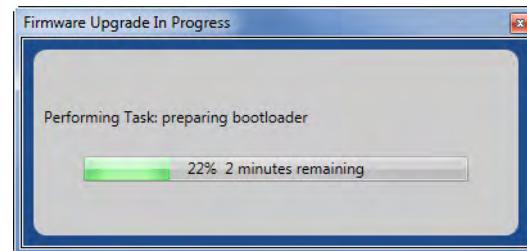


Figure B.3 Upgrade Progress Dialog Box

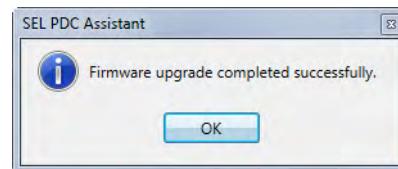


Figure B.4 Upgrade Complete Dialog Box

A P P E N D I X C

Detailed Diagnostic Logs

This section provides additional details on each diagnostic log that may appear on the Diagnostic Logs page of PDC Assistant.

Note that in the **Message** column in *Table C.1*, italicized variables, such as *xx*, indicate specific text that varies depending on what the situation is that prompts the message. Different variables in the same message, such as *xx* and *xy*, indicate different text within the same message.

Table C.1 Detailed Diagnostic Logs (Sheet 1 of 18)

Event	Source	Severity	Message	Cause	Resolution
100	Logging	ERROR	Communications Failure: Message= <i>xx</i>	Internal error.	Contact SEL.
101	Logging	ERROR	Deserialization Failure: Message= <i>xx</i>	Internal error.	Contact SEL.
102	Logging	ERROR	Standard exception occurred. Error message: <i>xx</i>	Internal error.	Contact SEL.
103	Logging	ERROR	Unhandled exception occurred.	Internal error.	Contact SEL.
120	Logging	ERROR	<i>xx</i>	An executable has failed its whitelist antivirus verification.	Contact SEL.
121	Logging	ERROR	Exception: <i>xx</i>	Internal error.	Contact SEL.
122	Logging	ERROR	Mandatory Access Control Violation: <i>raw=xx</i>	An executable has attempted to do something it is not allowed to do and has violated its mandatory access controls.	Contact SEL.
190	Logging	ERROR	Failed to Format: Event Code= <i>xx</i> Message= <i>yy</i>	Internal error.	Contact SEL.
191	Logging	ERROR	Failed to Emit: Event Code= <i>xx</i> Message= <i>yy</i>	Internal error.	Contact SEL.
200	Logging	ERROR	Database Error: State= <i>xx</i> Message= <i>yy</i>	Internal error.	Contact SEL.
201	Logging	ERROR	Error: Message= <i>xx</i>	Internal error.	Contact SEL.
202	Logging	ERROR	Error: Message=Unknown	Internal error.	Contact SEL.
203	Logging	WARNING	Logs Deleted: Reason=Retention period expired. Logs Deleted= <i>xx</i>	Old logs have been deleted.	No resolution is required. <i>(Optional)</i> Increase maximum length of the internal log on the Loggers page.

Table C.1 Detailed Diagnostic Logs (Sheet 2 of 18)

Event	Source	Severity	Message	Cause	Resolution
204	Logging	WARNING	Logs Deleted: Reason=Maximum total log size exceeded. Current Size (bytes)=xx Maximum Size (bytes)=yy Logs Deleted=zz	Old logs have been deleted.	No resolution is required.
220	Logging	ERROR	Communications Failure: Message=xx	Internal error.	Contact SEL.
221	Logging	ERROR	Serialization Failure: Message=xx	Internal error.	Contact SEL.
222	Logging	ERROR	Standard exception occurred. Error message: xx	Internal error.	Contact SEL.
223	Logging	ERROR	Unhandled exception occurred.	Internal error.	Contact SEL.
230	Logging	ERROR	Communication Failure: Message=xx	The syslog destination was not reachable.	<p>Check if the syslog destination is up and running.</p> <p>Check the network between the PDC and the syslog destination for disruptions or connectivity issues.</p>
400	System	DEBUG	Exception: xx	Internal error.	Contact SEL.
401	System	DEBUG	Exception: Unknown	Internal error.	Contact SEL.
402	System	WARNING	Invalid tag: Tag=xx	The diagnostic requested does not exist in the PDC.	Check the name of the diagnostic requested to make sure it matches a diagnostic provided by the PDC.
				Internal error.	Contact SEL.
1000	System	ERROR	Unhandled exception occurred.	Internal error.	Contact SEL.
1001	System	INFORMATIONAL	Upgraded to PDC Firmware Version: xx	The firmware was upgraded.	No resolution is required.
1200	PDC	INFORMATIONAL	The PDC is initializing...	The PDC is initializing.	No resolution is required.
1201	PDC	INFORMATIONAL	PDC Information: Version=xx	The PDC is initializing.	No resolution is required.
1202	PDC	INFORMATIONAL	The PDC initialization is complete.	The PDC is running.	No resolution is required.
1203	PDC	INFORMATIONAL	The PDC is shutting down...	The PDC is turning off.	No resolution is required.
1204	PDC	INFORMATIONAL	The PDC shutdown is complete.	The PDC is off.	No resolution is required.
1205	PDC	ERROR	Fatal error exception occurred in xx: yy	Internal error.	Contact SEL.
1206	PDC	ERROR	Nonfatal error exception occurred in xx: yy	Internal error.	Contact SEL.
1207	PDC	ERROR	Exception: xx	Internal error.	Contact SEL.
1250	Logging	INFORMATIONAL	The Log System is initializing...	Logging is initializing.	No resolution is required.

Table C.1 Detailed Diagnostic Logs (Sheet 3 of 18)

Event	Source	Severity	Message	Cause	Resolution
1251	Logging	INFORMATIONAL	The Log System initialization is complete.	Logging is running.	No resolution is required.
1252	Logging	INFORMATIONAL	The Log System is shutting down...	Logging is turning off.	No resolution is required.
1253	Logging	INFORMATIONAL	The Log System shutdown is complete.	Logging is off.	No resolution is required.
1254	Logging	ERROR	Fatal error exception occurred in xx: yy	Internal error.	Contact SEL.
1255	Logging	ERROR	Nonfatal error exception occurred in xx: yy	Internal error.	Contact SEL.
1300	Monitors	INFORMATIONAL	Version=xx	Monitoring has started.	No resolution is required.
1301	Monitors	ERROR	Exception: xx	Internal error.	Contact SEL.
1302	Monitors	ERROR	Temperature yy: Where=xx Value=zz Nominal=[xx,xxz]	The PDC is too hot.	Provide proper spacing around the PDC for air flow.
				The PDC is too cold.	Provide heating to meet the minimum temperature requirements of the PDC (see <i>Operating Temperature Range on page 1.7</i>).
				The PDC is no longer too hot or too cold.	No resolution is required.
1400	System	DEBUG	Caught an exception: xx	Internal error.	Contact SEL.
1401	System	ERROR	Shutting down the PDC do to overburden. Please modify settings to reduce burden.	The PDC was overburdened. This can occur when too many inputs, outputs, calculations, archives, etc. are specified in the settings.	Reduce the number of inputs, outputs, calculations, archives, etc.
1402	System	WARNING	CPU burden is high. Please modify settings to reduce burden.	The PDC is nearly overburdened. This can occur when too many inputs, outputs, calculations, archives, etc. are specified in the settings.	Reduce the number of inputs, outputs, calculations, archives, etc.
1500	System	INFORMATIONAL	Updating firewall rules and exceptions.	The firewall settings have changed.	No resolution is required.
1501	System	DEBUG	Caught an exception: xx	Internal error.	Contact SEL.
1502	System	INFORMATIONAL	Initialized firewall.	The firewall has established a baseline set of rules.	No resolution is required.
1503	System	ERROR	Initialization Failure: Reason=xx	Internal error.	Contact SEL.
1504	System	WARNING	Default initialized firewall.	The password jumper is set, and the firewall is essentially disabled.	No resolution is required.
					(Optional) Remove the password jumper and turn the PDC off and then back on.
1505	System	ERROR	Default Initialization Failure: Reason=xx	Internal error.	Contact SEL.

Table C.1 Detailed Diagnostic Logs (Sheet 4 of 18)

Event	Source	Severity	Message	Cause	Resolution
1506	System	DEBUG	Allowing pings on interface xx.	The network settings allow for pings on the network interface. <i>(Optional)</i> Uncheck the Allow Ping setting on the network interface on the Network Settings page.	No resolution is required. <i>(Optional)</i> Uncheck the Allow Ping setting on the network interface on the Network Settings page.
1507	System	ERROR	ICMP (Ping) Exception Failure: Interface=xx Reason=yy	Internal error.	Contact SEL.
1508	System	DEBUG	No longer allowing pings on interface xx.	The network settings no longer allow for pings on the network interface. <i>(Optional)</i> Check the Allow Ping setting on the network interface on the Network Settings page.	No resolution is required. <i>(Optional)</i> Check the Allow Ping setting on the network interface on the Network Settings page.
1509	System	ERROR	ICMP (Ping) Disallow Failure: Interface=xx Reason=yy	Internal error.	Contact SEL.
1510	System	WARNING	No network interface could be associated with xx. Defaulting to any interface.	The IP address specified did not match any of the IP addresses bound to any of the network interfaces. Check the input or output settings to make sure the IP addresses are correct. Check the IP addresses assigned to the network interfaces to make sure they are correct.	Check the input or output settings to make sure the IP addresses are correct. Check the IP addresses assigned to the network interfaces to make sure they are correct.
1511	System	ERROR	Calculated interface xx for local address yy and interface zz for address xxy. These should be the same. Defaulting to any interface.	The local IP address specified in either an input or an output did not match any of the IP addresses bound to any of the network interfaces. Change the Local IP Address setting of the input or output. Change the IP address of a network interface to match the Local IP Address setting of the input or output.	Change the Local IP Address setting of the input or output. Change the IP address of a network interface to match the Local IP Address setting of the input or output.
1512	System	DEBUG	Added a firewall exception for: Protocol: xx Local IP: yy Local Port: zz Remote IP: xxy Interface: xxz	A new firewall rule was created allowing network traffic into the PDC.	No resolution is required.
1513	System	ERROR	Exception Failure: Protocol=xx Local IP=yy Local Port=zz Remote IP=xxy Interface=xxz Reason=yyy	Internal error.	Contact SEL.
1514	System	DEBUG	Deleted a firewall exception for: Protocol: xx Local IP: yy Local Port: zz Remote IP: xxy Interface: xxz	A firewall rule was removed, disallowing network traffic into the PDC.	No resolution is required.

Table C.1 Detailed Diagnostic Logs (Sheet 5 of 18)

Event	Source	Severity	Message	Cause	Resolution
1515	System	ERROR	Disallow Failure: Protocol=xx Local IP=yy Local Port=zz Remote IP=xx Interface=xxz Reason=yyy	Internal error.	Contact SEL.
1600	System	INFORMATIONAL	Setting change detected.	Settings were changed.	No resolution is required.
1601	System	WARNING	Password jumper is installed.	The password jumper is installed.	Remove the password jumper and turn the PDC off and then back on.
1602	System	DEBUG	Caught an exception: xx	Internal error.	Contact SEL.
1603	System	WARNING	The initial setup user account is enabled.	The password jumper is installed.	Remove the password jumper and turn the PDC off and then back on.
				The PDC has not been commissioned (no administrator account created).	Create an administrator account.
1604	System	INFORMATIONAL	Updated the device time to xx.	The PDC was time-synced by PDC Assistant.	No resolution is required.
1605	System	WARNING	Enabling SSH access.	The firmware was upgraded, which requires the use of SSH access.	No resolution is required.
1606	System	INFORMATIONAL	Disabling SSH access.	The firmware was upgraded, which requires the use of SSH access.	No resolution is required.
1607	System	ERROR	Time Update Failure: Requested Time=xx Reason=yy	Internal error.	Contact SEL.
1609	System	ERROR	Starting upgrade process.	The firmware was upgraded.	No resolution is required.
1700	System	INFORMATIONAL	Updating network settings.	The network settings changed.	No resolution is required.
1701	System	DEBUG	Caught an exception: xx	Internal error.	Contact SEL.
1702	System	ERROR	Failed to set the default gateway: Gateway=xx Reason=yy	Internal error.	Contact SEL.
1703	System	DEBUG	xx has been disabled.	A network interface was disabled.	No resolution is required.
1704	System	ERROR	Failed to disable xx: Reason=yy	Internal error.	Contact SEL.
1705	System	DEBUG	xx set to ip=yy, netmask=zz.	A network interface was configured.	No resolution is required.
1706	System	ERROR	Failed to configure interface: Interface=xx IP=yy Netmask=zz Reason=xxy	Internal error.	Contact SEL.
1707	System	DEBUG	Added a mapping from host name xx to IP address yy.	A host mapping was configured.	No resolution is required.

Table C.1 Detailed Diagnostic Logs (Sheet 6 of 18)

Event	Source	Severity	Message	Cause	Resolution
1708	System	DEBUG	Added domain name server at IP address xx.	A domain name lookup server was configured.	No resolution is required.
1709	System	ERROR	Failed to update the domain name servers: Reason=xx	Internal error.	Contact SEL.
1710	System	ERROR	Failed to add the hostname to the hosts file: Reason=xx	Internal error.	Contact SEL.
1711	System	DEBUG	Default gateway has been disabled.	The default gateway was removed.	No resolution is required.
1712	System	ERROR	Failed to disable default gateway: Reason=xx	Internal error.	Contact SEL.
1713	System	DEBUG	Default gateway set to xx.	The default gateway was configured.	No resolution is required.
1714	System	INFORMATIONAL	Updating network settings to their defaults.	The password jumper is installed, and the network interfaces are configured with their default factory settings.	Remove the password jumper and turn the PDC off and then back on.
1715	System	ERROR	Failed to clear domain name servers: Reason=xx	Internal error.	Contact SEL.
1716	System	ERROR	Failed to clear hosts: Reason=xx	Internal error.	Contact SEL.
1800	System	INFORMATIONAL	Updating certificates.	The certificate settings have been changed.	No resolution is required.
1801	System	DEBUG	Caught an exception: xx	Internal error.	Contact SEL.
1802	System	DEBUG	Added the xx certificate.	A certificate has been added to settings.	No resolution is required.
1803	System	ERROR	Failed to open the certificate file for writing.	Internal error.	Contact SEL.
2000	Communications	DEBUG	Failed to set send buffer size, xx, yy	Internal error.	Contact SEL.
2001	Communications	DEBUG	Failed to set receive buffer size, xx, yy	Internal error.	Contact SEL.
2002	Communications	DEBUG	Failed to disable the Nagle algorithm, xx, yy	Internal error.	Contact SEL.
2003	Communications	DEBUG	CRC failed on C37.118 frame	Data were corrupted by the network equipment, cables, or software.	Identify what is causing the issue and address. This is not caused by the PDC but is a symptom of an external problem.
				The upstream device did not correctly calculate the CRC.	This indicates a bug in, or an incompatibility with, the upstream device.

Table C.1 Detailed Diagnostic Logs (Sheet 7 of 18)

Event	Source	Severity	Message	Cause	Resolution
2004	Communications	DEBUG	Invalid C37.118 frame data detected	The wrong version of IEEE C37.118 was used. The PDC only supports the 2005 version.	Use only IEEE C37.118-2005-compatible upstream and downstream devices.
				The IEEE C37.118 message type was not valid. The PDC only supports data, header, CFG1, CFG2, and command messages.	Check with the manufacturer of the upstream or downstream device for known issues or incompatibilities.
2005	Communications	WARNING	Not connected	An upstream or downstream device disconnected on purpose.	Reconnect the upstream or downstream device.
				An upstream or downstream device disconnected unexpectedly.	Check for network equipment issues such as cables, switches, routers, etc.
					Check for network software issues such as firewall or packet shaping.
				The PDC is unable to connect to either the upstream or downstream device.	Check the downstream device for any failures.
					Check for network equipment issues such as cables, switches, routers, etc.
2006	Communications	ERROR	Failed to Open: What=xx Code=yy Category=zz Message=xxy	Internal error.	Contact SEL.
2007	Communications	ERROR	Failed to Bind: Address=xx:yy What=zz Code=xxy Category=xxz Message=yyy Note=Make sure the local address is valid and the port is not in use by another program.	Internal error.	Contact SEL.
2008	Communications	ERROR	Failed to Listen: What=xx Code=yy Category=zz Message=xxy	Internal error.	Contact SEL.
2009	Communications	ERROR	Failed to Close: What=xx Code=yy Category=zz Message=xxy	Internal error.	Contact SEL.

Table C.1 Detailed Diagnostic Logs (Sheet 8 of 18)

Event	Source	Severity	Message	Cause	Resolution
2010	Communications	ERROR	Failed to bind to xx. Make sure the local address is valid.	The local IP address specified in either an input or an output did not match any of the IP addresses bound to any of the network interfaces.	Change the Local IP Address setting of the input or output.
					Change the IP address of a network interface to match the Local IP Address setting of the input or output.
2011	Communications	ERROR	Failed to set keep alive, xx, yy	Internal error.	Contact SEL.
2012	Communications	ERROR	Failed to set keep alive parameters	Internal error.	Contact SEL.
2013	Communications	ERROR	Failed to set keep alive parameters: xx – yy	Internal error.	Contact SEL.
2014	Communications	ERROR	Failed to join the multicast group. Make sure the local IP address (xx) is one of yy.	The local IP address specified in the input did not match any of the IP addresses bound to any of the network interfaces.	Change the Local IP Address setting of the input.
					Change the IP address of a network interface to match the Local IP Address setting of the input.
2015	Communications	ERROR	Failed to join the multicast group.	The local IP address specified in the output did not match any of the IP addresses bound to any of the network interfaces.	Change the Local IP Address setting of the output.
					Change the IP address of a network interface to match the Local IP Address setting of the output.
2016	Communications	ERROR	Failed to open socket: xx	Internal error.	Contact SEL.
2100	C37.118	WARNING	A xx overflow occurred while converting yy into an integer. Value (Before Scaling): zz Scaling: xxy Value (After Scaling): xxz yyy yyz: yyz zzy: zzz	The phasor being converted into Polar format was too close to the extremes (min. or max.) to fit into the new format.	Specify Rectangular as the phasor domain in the output. The Rectangular domain is larger than the Polar domain.
2101	C37.118	DEBUG	xx output as an irregular floating point number: yy	Converting the phasor into Polar format exceeded what can normally be expressed in a floating-point number.	Specify Rectangular as the phasor domain in the output. This will result in skipping the conversion to polar.
2102	C37.118	ERROR	Failed to convert the fractional seconds to a new time base: Fractional Second: xx Original Time Base: yy New Time base: zz	Converting the fractional seconds into SI units failed because the upstream device sent a CFG2 with an invalid time base.	This indicates a bug in, or an incompatibility with, the upstream device.
2200	C37.118 Server	WARNING	A C37.118 frame was received, but it wasn't a C37.118 command frame It was a C37.118 xx frame. This is unexpected and could mean the remote client is not properly configured.	The downstream device is not a valid IEEE C37.118 client or is incompatible.	Check with the manufacturer of the downstream device for known bugs or incompatibilities.

Table C.1 Detailed Diagnostic Logs (Sheet 9 of 18)

Event	Source	Severity	Message	Cause	Resolution
2201	C37.118 Server	WARNING	A C37.118 command frame was received, but it was too small to be valid. It was xx bytes in length. This is unexpected and could point to an issue with the remote client.	The downstream device is not a valid IEEE C37.118 client or is incompatible.	Check with the manufacturer of the downstream device for known bugs or incompatibilities.
2202	C37.118 Server	WARNING	A C37.118 command frame was received, but it contained an un-expected Id code. It was xx. The expected Id code is yy. Check the settings of the remote client and make sure it is using yy as its Id code. Or change the expected Id code of this output.	The downstream device sent a command to the output that had an ID code different from the ID code specified in the output settings.	Change the ID code of the downstream device to match the ID code of the output. Change the ID code setting of the output to match the ID code expected of the downstream device.
2203	C37.118 Server	INFORMATIONAL	A C37.118 command frame was received, but it contained a command that is not supported. It was xx.	The PDC only supports the stop, start, capability request, and configuration request commands.	Check the downstream device to see why it is sending that command and whether it is needed.
2204	C37.118 Server	ERROR	Connect Failed: Code=xx Category=yy Message=zz	The downstream device disconnected either on purpose or accidentally.	Check the downstream device to see why it disconnected. Check the network between the PDC and the downstream device for disruptions or connectivity issues.
2205	C37.118 Server	DEBUG	Waiting for reconnect.	The PDC is waiting for the downstream device to connect.	Check the downstream device to see why it is not connecting. Check the network between the PDC and the downstream device for disruptions or connectivity issues.
2206	C37.118 Server	ERROR	Attempted to send a frame that was too big for the C37.118 protocol. Adjust the settings of this server to reduce the frame size.	The total frame size for any IEEE C37.118 message is limited to 65,536 bytes, but the specified settings would require a larger frame than that.	Reduce the number of PMUs or tags in the output.

Table C.1 Detailed Diagnostic Logs (Sheet 10 of 18)

Event	Source	Severity	Message	Cause	Resolution
2207	C37.118 Server	ERROR	Missing data.	The upstream device and the input settings do not agree on what PMUs or tags should be included in the data.	Check the settings of the upstream device to make sure it is sending all the expected data.
					Change the PMU or tag names in the input settings to be identical to what the upstream device is providing, or you can use the Query Tags button and the Add Sub-PMU > Automatically button to direct the PDC to fill out the names exactly as it reads them.
				A whole PMU or an individual tag arrived too late to be included in an output.	Increase the output waiting period to allow for late arriving PMUs and tags, or investigate the cause of the latency.
				Due to the asynchronous nature of settings changes, it is possible for parts of the system to start in the middle of a data set and miss the data that came before.	No resolution is required. This issue should only occur briefly at startup or when settings are changed.
2300	C37.118 Client	ERROR	Data Rate Mismatch: Encountered=xx Expected=yy	The upstream device is providing data at a faster rate than specified in the input settings.	Change the data rate of the upstream device or the data rate setting in the input to be the same.
2301	C37.118 Client	ERROR	Configuration PDC Id Code Mismatch: Encountered=xx Expected=yy	The upstream device sent a CFG2 to the input that had an ID code different from the ID code specified in the input settings.	Change the ID code of the upstream device or the ID code setting of the input to the same ID.
2302	C37.118 Client	ERROR	Nominal Frequency Mismatch: Encountered=xx Expected=yy	The upstream device sent a CFG2 to the input that had a nominal frequency that was different than the global nominal frequency setting.	The nominal frequency is a global setting and must be the same for all inputs and the upstream device.
2303	C37.118 Client	ERROR	Data PDC Id Code Mismatch: Encountered=xx Expected=yy	The upstream device sent data to the input that had an ID code different from the ID code specified in the input settings.	Change the ID code of the upstream device or the ID code setting of the input to the same ID.
2304	C37.118 Client	ERROR	Configuration PMU Id Code Mismatch: PMU=xx Encountered=yy Expected=zz	The upstream device sent a CFG2 to the input that had a PMU with a different ID code than the ID code specified in the PMU in the input settings.	Change the ID code of the PMU in the upstream device or the ID code setting of the PMU in the input to the same ID.

Table C.1 Detailed Diagnostic Logs (Sheet 11 of 18)

Event	Source	Severity	Message	Cause	Resolution
2305	C37.118 Client	WARNING	Unexpected Timestamp: Reason=Gap in the data stream. Current Timestamp=xx Last Timestamp=yy Data Messages Missed=zz	Data were dropped by the network equipment or software.	Identify what is causing the issue and fix it. This is not caused by the PDC but is a symptom of an external problem.
				Data were corrupted by the network equipment or software.	
				The upstream device did not send the data.	No resolution is required.
				The PDC is overburdened.	Reduce the number of inputs and outputs to and from the PDC.
2306	C37.118 Client	WARNING	Unexpected Timestamp: Reason=Duplicate: Timestamp=xx	The network duplicated some number of UDP packets.	No resolution is required. If this occurs frequently, identify what network equipment or software is causing the duplication, or switch to a TCP transport scheme.
2307	C37.118 Client	WARNING	Unexpected Past Time-stamp: Current Timestamp=xx Last Timestamp=yy	The network reordered UDP packets.	No resolution is required. If this occurs frequently, identify what network equipment or software is causing the duplication, or switch to a TCP transport scheme.
				The timing signal for the upstream device jumped backwards in time.	No resolution is required. If this occurs frequently, address the issue of the timing signal in the upstream device.
2308	C37.118 Client	WARNING	PMU Station Name Not Found: Station name=xx	The upstream device and the input settings do not agree on what PMUs should be included in the data.	Check the settings of the upstream source to make sure it is sending data to all the expected PMUs.
					Change the PMU names in the input settings to be identical to what the upstream device is providing. Use the Add Sub-PMU > Automatically button to direct the PDC to fill out the names exactly as it reads them.
2309	C37.118 Client	INFORMATIONAL	Config Change Detected: Reason=Unexpected data frame size. Encountered Data Frame Size=xx Expected Data Frame Size=yy	The upstream device changed configuration without setting the configuration changed bit.	This indicates a bug in, or an incompatibility with, the upstream device.
2310	C37.118 Client	INFORMATIONAL	Config Change Detected: Reason=PMU is missing. PMU=xx	The upstream device changed configuration by removing a PMU and the configuration changed bit associated with it.	No resolution is required.

Table C.1 Detailed Diagnostic Logs (Sheet 12 of 18)

Event	Source	Severity	Message	Cause	Resolution
2311	C37.118 Client	INFORMATIONAL	Config Change Detected: Reason=Configuration change bit asserted in PMU. PMU=xx	The settings were changed in the upstream device.	No resolution is required.
2312	C37.118 Client	INFORMATIONAL	Trigger Detected: PMU=xx Trigger Reason=yy (zz)	The trigger bit of the status word for the PMU was asserted.	No resolution is required.
4000	Historian	ERROR	Unable to connect to data- base. xx	Internal error.	Contact SEL.
4001	Historian	ERROR	Failed to copy data into database.	Internal error.	Contact SEL.
4002	Historian	DEBUG	Failed to copy data into database. xx	Internal error.	Contact SEL.
4003	Historian	INFORMATIONAL	Bad database connection deleted. Attempting re-con- nect.	Internal error.	Contact SEL.
4004	Historian	INFORMATIONAL	Database re-connection attempt succeeded.	A connection to the data- base was recreated success- fully.	No resolution is required.
4005	Historian	ERROR	Database re-connection attempt failed. xx	Internal error.	Contact SEL.
4006	Historian	ERROR	Unable to save trigger event information to data- base. xx	Internal error.	Contact SEL.
4007	Historian	ERROR	Data timestamp out of range. Data timestamp=[xx] System timestamp=[yy]. The difference between the data timestamp and the cur- rent timestamp is zz. Please ensure that your GPS clock has IEEE C37.118 exten- sions enabled. xxy	The PDC system clock is not accurate enough for archiving.	Connect an IRIG-B time source to the PDC. Enable IEEE C37.118 extensions in the IRIG-B signal. Use the clock sync function on the Device page.
4008	Historian	ERROR	Data timestamp out of range. Data timestamp=[xx] System timestamp=[yy]. The difference between the data timestamp and the cur- rent timestamp is zz. xxy	The PDC system clock is not accurate enough for archiving.	Connect an IRIG-B cable to the PDC. Enable IEEE C37.118 extensions in the IRIG-B signal. Use the clock sync function on the Device page.
4009	Historian	DEBUG	Entering triggered archive Mode	Rising edge of one of the PMUs triggered bit.	No resolution is required.
4010	Historian	DEBUG	Exiting triggered archive Mode	Falling edge of one of the PMUs triggered bit.	No resolution is required.
4011	Historian	ERROR	Failed managing archive partition tables. Internal error, contact SEL for assistance. xx	Internal error.	Contact SEL.

Table C.1 Detailed Diagnostic Logs (Sheet 13 of 18)

Event	Source	Severity	Message	Cause	Resolution
4012	Historian	ERROR	Failed getting archive space used from the database. Internal error, if this message occurs frequently contact SEL for assistance. xx	Internal error.	Contact SEL.
4013	Historian	ERROR	The maximum number of bytes per timeslice in the archive has been exceeded. Try reducing the number of tags being archived. size xx, maximum size yy. Internal error, contact SEL for assistance.	The archive has too many tags.	Reduce the number of tags in the archive.
4014	Historian	ERROR	Failed getting database data directory. Internal error, contact SEL for assistance. xx	Internal error.	Contact SEL.
4015	Historian	ERROR	Stopping archiving, available disk space is less than or equal to xx MB.	The PDC has run out of available archive space.	Reduce the archive retention period, or manually delete archives.
4016	Historian	WARNING	Available disk space is less than xx MB. Archiving will stop when available disk space is less than or equal to yy MB.	The PDC has nearly run out of available archive space.	<p>Reduce the archive retention period.</p> <p>Decrease the number of tags archived.</p> <p>Decrease the data rate of the archive.</p>
4017	Historian	ERROR	Failed to flush archive data to the database. xx	Internal error.	Contact SEL.
4018	Historian	ERROR	Missing data.	The upstream device and the input settings do not agree on what PMUs or tags should be included in the data.	Check the settings of the upstream device to make sure it is sending all the expected data.
					Change the PMU or tag names in the input settings to be identical to what the upstream device is providing, or use the Query Tags button and the Add Sub-PMU > Automatically button to direct the PDC to fill out the names exactly as it reads them.
				A whole PMU or an individual tag arrived too late to be included in an archive.	Increase the archive waiting period to allow for the late arriving PMUs and tags, or investigate the cause of the latency.
				Due to the asynchronous nature of settings changes, it is possible for parts of the system to start up in the middle of a data set and miss the data that came before.	No resolution is required. This issue should only occur briefly at startup or when settings changes occur.

Table C.1 Detailed Diagnostic Logs (Sheet 14 of 18)

Event	Source	Severity	Message	Cause	Resolution
4019	Historian	ERROR	Failed getting the free disk space warning threshold setting. Internal error, contact SEL for assistance. xx	Internal error.	Contact SEL.
4020	Historian	INFORMATIONAL	Switching to New File: Old File=xx New File=yy Reason=A jump backwards in time within the current file has been detected in the data stream. In order to prevent file corruption, a new file was created.	The SEL-5073 External Archive file writer is switching to a new file because the time stamps on the incoming data have jumped backwards in time.	No resolution is required.
4021	Historian	DEBUG	Switching to New File: Old File=xx New File=yy Reason=The data does not fit within the current file, and so a new file was created. This is normal.	The SEL-5073 External Archive file writer is switching to a new file because the current file as reached its size limit.	No resolution is required.
4022	Historian	ERROR	Disposal Failure: File=xx Reason=yy	Internal error.	Contact SEL.
4023	Historian	ERROR	Failed checking free disk space. xx	Internal error.	Contact SEL.
4100	Security	ERROR	Unable to add user xx.	The user already existed.	Pick a different user.
				You do not have permission to add new users.	You must be an administrator to add users.
4101	Security	INFORMATIONAL	New User Created: User=xx (zz) Creator=yy	A new user was created.	No resolution is required.
4102	Security	ERROR	Unable to change password.	The user does not exist.	Specify a user that exists.
				The new password did not satisfy the complexity requirements.	Specify a password that is at least 8 characters, no more than 63 characters, and contains only printable ASCII characters, including an uppercase character, a lowercase character, a number, and a symbol or punctuation mark.
				You do not have permission to change the user's password.	You can change your own password. Administrators can change any user's password.
4103	Security	INFORMATIONAL	Password Changed: User=xx Changer=yy	The password for the specified user was changed.	No resolution is required.
4104	Security	INFORMATIONAL	xx users session has timed out. Please logout and log back in.	The user remained logged in without any activity for too long.	No resolution is required.
					Disable session timeout by setting Session Idle Timeout to 0 on the General Security Settings page.

Table C.1 Detailed Diagnostic Logs (Sheet 15 of 18)

Event	Source	Severity	Message	Cause	Resolution
4105	Security	ERROR	Dangling transaction detected. Transaction will be forcibly closed.	Internal error.	Contact SEL.
4106	Security	ERROR	xx reached the maximum number of allowed failed login attempts. This account will be locked for yy minutes.	The user failed to log in too many times.	No resolution is required. Increase the Allowed Unsuccessful Login Attempts setting on the General Security Settings page.
4107	Security	INFORMATIONAL	xx has logged in to the PDC from yy.	The user logged in.	No resolution is required.
4108	Security	INFORMATIONAL	xx has logged out of the PDC from yy.	The user has logged out.	No resolution is required.
4109	Security	ERROR	Unable to change user password expiration.	The user does not exist. You do not have permission to change password expirations.	Specify a user that exists. Only administrators can change password expiration.
4110	Security	ERROR	Unable to change user role.	The user does not exist. The new role was not valid. You tried to change your own role. You do not have permission to change user roles.	Specify a user that exists. Only administrator , engineer , and technician are valid roles. You can only change other users' roles. Only administrators can change user roles.
4111	Security	INFORMATIONAL	user: xx role changed by: yy. old role: zz new role: xxy	The user's role was changed.	No resolution is required.
4112	Security	ERROR	Unable to remove user.	The user does not exist. You do not have permission to remove users.	Specify a user that exists. Only administrators can remove users.
4113	Security	INFORMATIONAL	The user: xx was removed by: yy	The user was removed.	No resolution is required.
4114	Security	ERROR	Unable to remove last administrator.	You tried to remove the last administrator. You do not have permission to remove users.	The last administrator cannot be removed. This prevents a situation where no one can administer the PDC. Only administrators can remove users.
4115	Security	INFORMATIONAL	Database Process Id: xx was manually terminated by user: yy	A database connection was forcibly terminated by the user.	No resolution is required.
4116	Security	INFORMATIONAL	Restored to factory settings by user: xx	The PDC was restored to factory settings by the user.	No resolution is required.
4117	Security	ERROR	Failed Login Attempt by xx	The user failed to login.	No resolution is required.
4118	Security	INFORMATIONAL	Diagnostic logs were cleared by xx.	The diagnostic logs were cleared by the user.	No resolution is required.
4119	Security	INFORMATIONAL	xx accessed the diagnostic logs.	The user accessed the diagnostic logs for reading.	No resolution is required.

Table C.1 Detailed Diagnostic Logs (Sheet 16 of 18)

Event	Source	Severity	Message	Cause	Resolution
4120	Security	INFORMATIONAL	New settings uploaded: User=xx Comments=yy	New settings were uploaded by the user.	No resolution is required.
4121	Security	ERROR	xx attempted to yy, but lacked permission.	The user attempted to do something not permitted by his role.	No resolution is required.
4122	Security	WARNING	Failed to pulse alarm. Check previous logs for error that caused the alarm pulse.	Internal error.	Contact SEL.
4200	Security	ERROR	xx user failed to login. yy	Internal error.	Contact SEL.
4201	Security	ERROR	xx user failed to logout. yy	Internal error.	Contact SEL.
4204	Security	ERROR	Failed to update failed login attempts. xx	Internal error.	Contact SEL.
4205	Security	ERROR	Authentication Error. xx	Incorrect password for user.	Use the correct password.
				Internal Error.	Contact SEL.
4206	Security	ERROR	Account Management Error. xx	The user's account is locked.	Wait for the lock to time-out. The amount of time depends on the Unsuccessful Login Lockout Time setting on the General Security page.
				Internal Error.	Contact SEL.
4240	System	WARNING	Diagnostics xx failure: Message=yy	The diagnostic requested does not exist in the PDC.	Check the name of the diagnostic requested to make sure it matches a diagnostic provided by the PDC.
				Internal error.	Contact SEL.
4241	System	WARNING	Detailed Diagnostics failure: Message=xx	Internal error.	Contact SEL.
6000	Settings	DEBUG	Terminating the xx process.	The input, output, calculation, logger, or historian was removed from settings and must be turned off.	No resolution is required.
6001	Settings	DEBUG	Waiting for the xx process to terminate.	The PDC is waiting for a process to terminate.	No resolution is required.
6002	Settings	DEBUG	Deleting the xx process.	The input, output, calculation, logger, or historian was terminated successfully and cleaned up.	No resolution is required.
6003	Settings	DEBUG	Created the xx process.	A new input, output, calculation, logger, or historian was created based on settings.	No resolution is required.
6004	Settings	ERROR	An error occurred in the xx process (yy). It will be restarted. If this problem persists, please contact SEL for assistance.	Internal error.	Contact SEL.

Table C.1 Detailed Diagnostic Logs (Sheet 17 of 18)

Event	Source	Severity	Message	Cause	Resolution
6005	Settings	DEBUG	Created a placeholder for the disabled xx process.	An input, output, calculation, logger, or historian was disabled in settings.	No resolution is required.
					Re-enable the process.
6006	Settings	INFORMATIONAL	Starting the xx process.	A new input, output, calculation, logger, or historian was created and can now be started.	No resolution is required.
6007	Settings	DEBUG	Created a disabled process because of an error: Process Name=xx Error=yy	Internal error.	Contact SEL.
6008	Settings	ERROR	Standard exception (xx). If this problem persists, please contact SEL for assistance.	Internal error.	Contact SEL.
6009	Settings	ERROR	Unknown exception. If this problem persists, please contact SEL for assistance.	Internal error.	Contact SEL.
7000	Calculator	ERROR	xx needed for the xx input to the yy calculation could not be found. Check the source (zz) of xxy for errors, either in the logs or settings.	The upstream device and the input settings do not agree on what PMUs or tags should be included in the data.	Check the settings of the upstream device to make sure it is sending all the expected data.
				A whole PMU or an individual tag arrived too late to be used in the calculation.	Change the PMU or tag names in the input settings to be identical to what the upstream device is providing, or you can use the Query Tags button and the Add Sub-PMU > Automatically button to direct the PDC fill out the names exactly as it reads them.
					Identify the cause of the latency and correct it.
7001	Calculator	INFORMATIONAL	Using Primary Input: Data Timestamp=xx	A redundant input is using the primary channel.	No resolution needed. This issue should only occur briefly at startup or upon settings changes.
					No resolution is required. This issue should only occur briefly at startup or upon settings changes.
					No resolution is required. This issue should only occur briefly at startup or upon settings changes.
7002	Calculator	WARNING	Using Secondary Input: Data Timestamp=xx Reason=Availability	A redundant input switched to the secondary channel because the primary channel is missing.	Identify and fix the reason that the primary input is missing.
					No resolution is required, as the input will continue to function and will switch back to the primary channel when it becomes available.

Table C.1 Detailed Diagnostic Logs (Sheet 18 of 18)

Event	Source	Severity	Message	Cause	Resolution
7003	Calculator	WARNING	Using Secondary Input: Data Timestamp=xx Reason=Status	A redundant input switched to the secondary channel because the primary channel has a lower quality.	<p>Identify and correct the problem causing the primary input to have lower quality.</p> <p>No resolution is required; the input will continue to function and will switch back to the primary channel when its quality improves.</p>

A P P E N D I X D

Network Ports and Services

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

The following table lists the network ports that may be presented by the device. Configuring C37.118 inputs/outputs or syslog connections will open additional ports.

Physical Port	# Ports	Default State				Disableable
Serial Ports	8 default, as many as 26	Disabled				Yes (all)
Ethernet Ports	2	Eth 1 Enabled Eth 2 Disabled				Yes (all but one)
USB Ports	6	Active but not used				Yes (from BIOS)

Device Function	Protocol	Transport Protocol	Local Port	Listening	Default State	Disableable
C37.118 Server	IEEE C37.118 Synchrophasors	TCP	Settable	Yes	Disabled	Yes
C37.118 Server	IEEE C37.118 Synchrophasors	UDP	Ephemeral	No	Disabled	Yes
C37.118 Client	IEEE C37.118 Synchrophasors	TCP	Ephemeral	No	Disabled	Yes
C37.118 Client	IEEE C37.118 Synchrophasors	UDP	Ephemeral or Settable ^a	No	Disabled	Yes
Real-Time Diagnostics	Open Database Connectivity (ODBC)	TLS / TCP	26272	Yes	Enabled	No
Settings Transfer Archive Retrieval	Open Database Connectivity (ODBC)	TLS / TCP	26272	Yes	Enabled	No
Centralized Authentication/Authorization	Light Weight Directory Access Protocol (LDAP)	TLS / TCP	Ephemeral	No	Disabled	Yes
Audit Trails	Syslog	UDP	Ephemeral	No	Disabled	Yes
Firmware Upgrades	Secure Shell (SSH) Server	TCP	22	Yes	Disabled	Yes SSH is only enabled during firmware upgrades

^a The UDP transport scheme allows the specification of a local UDP port.

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APPENDIX

Lightweight Directory Access Protocol (LDAP)

LDAP Settings Form

Print this LDAP Settings Form and give it to your Information Services (IS) department. Recording this information in advance will better facilitate setting up the SEL-3573 Station Phasor Data Concentrator (PDC).

LDAP Hosts (SEL-3573 and SEL-3373 Only)

Input these settings on the Network Settings page (at least one required)

Host Name		IP Address	
Host Name		IP Address	

LDAP Servers

Input these settings on the LDAP Settings page (at least one required)

Host Name		Port Number	
Host Name		Port Number	

LDAP Settings

Input these settings on the LDAP settings page

Search Base DN	
Bind DN ^a	
Bind Password ^b	
User Filter	
Group Attribute	

^a *Optional.* If left blank, the PDC will use anonymous binds.

^b *Optional.* Required only if not using anonymous binds.

Group-to-Role Mappings

This is required to map users to roles. Input these settings on the LDAP Settings page (at least one required)

Administrator / Engineer / Technician	Group DN	
Administrator / Engineer / Technician	Group DN	
Administrator / Engineer / Technician	Group DN	
Administrator / Engineer / Technician	Group DN	

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