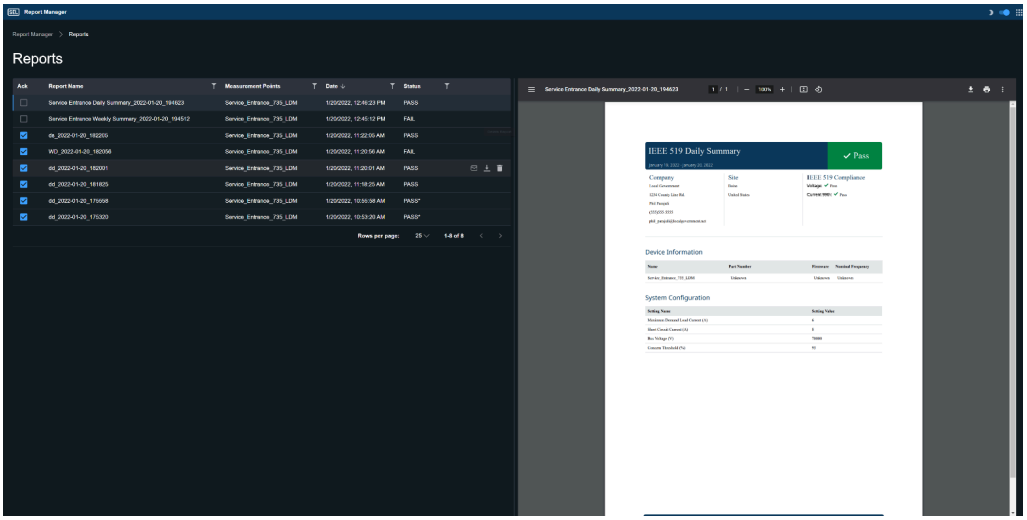
SEL-5705
Synchrowave Reports

Instruction Manual



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SECTION 1

Introduction

Synchrowave Reports is a suite of applications running on the Synchrowave Platform in order to provide automated and on-demand power system reports, including email delivery and automatic archiving.

Functional Overview

Figure 1.1 provides an overview of Synchrowave Reports and the Synchrowave Platform from an application perspective. In this manual, each application is discussed in detail. The primary data pathway is shown in *Figure 1.2*.

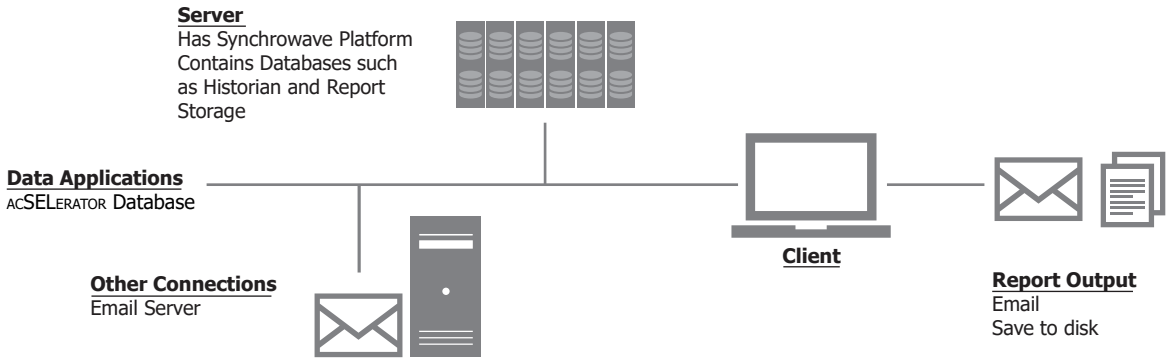

Figure 1.1 Synchrowave Reports and Platform Functional Diagram

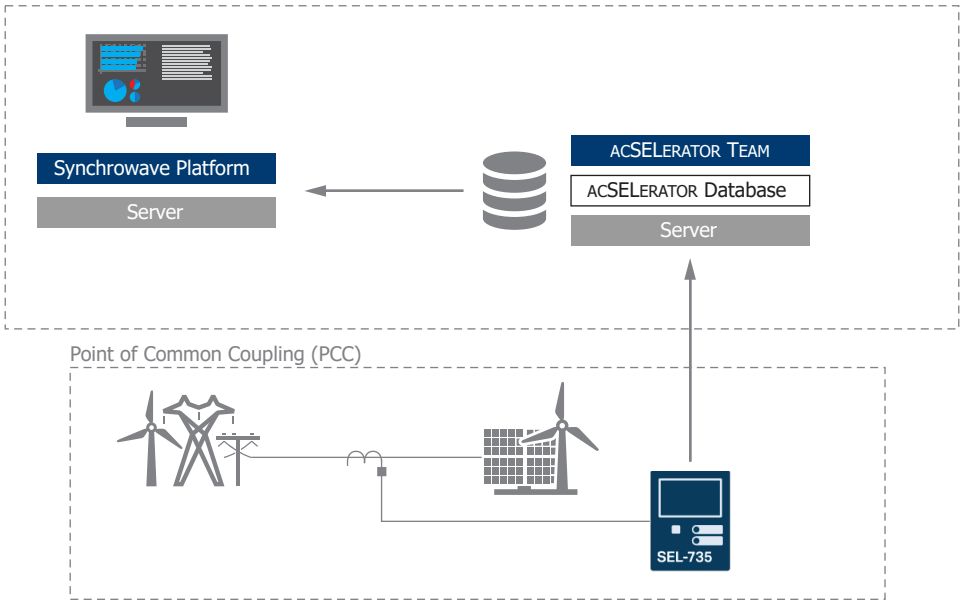

Figure 1.2 Synchrowave Reports Primary Data Pathway

Applications

Synchrowave Reports and the Synchrowave Platform support a variety of power system applications which work together to generate power system reports. *Table 1.1–Table 1.3* list the available applications and key features in the software. Within the Synchrowave Platform, every unit of functionality is deployed as an application. Therefore, while some applications in *Table 1.1–Table 1.3* are part of the software infrastructure, they are still visible and listed.

Table 1.1 Synchrowave Reports Application Highlights

Application	Key Features
Report Manager	Create, view, manage, and schedule reports.
Meter Calculations	Configure calculations for connected configuration providers, map measurement points to configurations, select quantities to publish.
Email Client	Send email using the Synchrowave Platform.
Task Scheduler	Manage and schedule recurring report generation.

Table 1.2 Synchrowave Platform Application Highlights

Application	Key Features
Application Manager	Manage and configure applications installed on the platform.
Web Gateway	Provides secure access to applications and data on the platform.
Signals	Collects, consolidates, and publishes signals to applications.

Table 1.3 Data Application Highlights

Application	Key Features
Time-Series Historian	Stores Signals data for later use.
ACSELERATOR Database Reader	Reads load profile data from an ACSELERATOR Database and publishes event reports to the platform for visualization and analysis.
DMA Receiver	Receives data from DMA applications and passes data to storage applications on the Synchrowave platform.

SECTION 2

Hardware Requirements and Deployment Options

This section describes installation features and installation requirements for the Synchrowave Platform and Synchrowave Reports.

Consider the following when installing the Synchrowave Platform and Reports:

- *Deployment Network Architecture on page 3*
- *Server and Client Requirements and Specifications on page 4*
- *Data Storage Requirements on page 6*

Deployment Network Architecture

Secure Network Deployment

When using the Synchrowave Platform for real-time operations decision making, SEL recommends installing the Synchrowave Platform on servers in the secure control center network. Synchrowave Reports could be added to the Synchrowave Platform on a secure control center network; however, installing the reporting application on the corporate network makes data more accessible. Additionally, Synchrowave Reports does not need to communicate with relays or PMUs directly, but it does need to access the ACSELERATOR Database, which is often installed on the corporate network.

Corporate Network Deployment

The Synchrowave Platform provides significant value to engineering and planning teams for near-real-time and post-event analysis. In this case, to provide efficient access to the Synchrowave Platform, deploy the software on servers located on the corporate network.

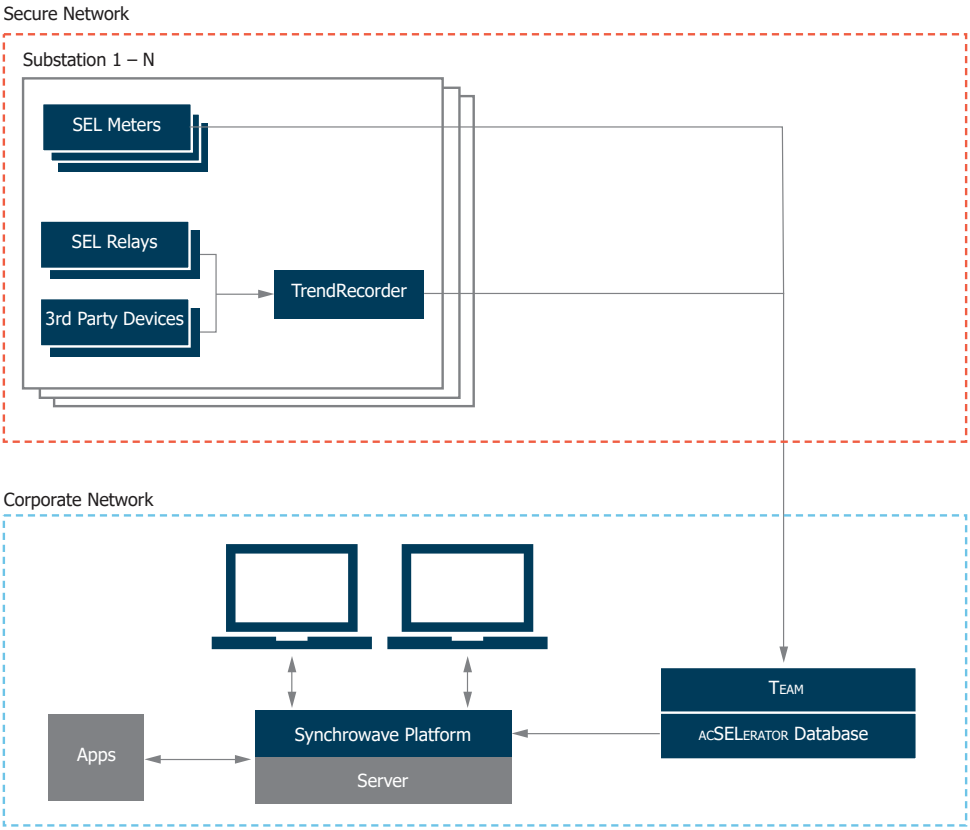

Figure 2.1 Corporate Network Deployment Architecture

Server and Client Requirements and Specifications

Synchrowave Reports can only be deployed on a physical or virtual Microsoft Windows machine.

Server Hardware Requirements

Minimum Server Requirements

Not all performance timing responses will be met with the minimum system.

- 2.1 GHz Dual-Core Processor
- 4 GB RAM
- 100 Mbps Network Card
- 240 GB SSD (see *Data Storage Requirements on page 6* for data archive requirements)

Recommended Server Requirements

For reporting:

- 2.1 GHz Processor With 16+ Cores
- 8 GB RAM

- 1 Gbps Network Card
- 240 GB SSD (see *Data Storage Requirements on page 6* for data archive requirements)

For continuous waveform streaming:

- 2.7 GHz Processor With 16+ Cores
- 32 GB DDR4 RAM
- 1 Gbps Network Card
- 1 TB SSD (see *Data Storage Requirements on page 6* for data archive requirements)

Virtual Machine

For deployment on a virtual machine, ensure the resource requirements are met by the virtual machine configuration as well as the host computer.

Additional Notes

Minimum and recommended requirements are intended for a system of 100 devices or fewer. Contact SEL for help planning a larger system.

Server Software Requirements

Supported Operating Systems

The Synchrowave Platform requires one of the following Microsoft Windows operating systems: Windows 10, Windows 11, Windows Server 2016, Windows Server 2019, or Windows Server 2022.

Server Time Synchronization

Server time synchronization is not currently required for Synchrowave Reports.

Client Requirements

Supported Web-Client

- Google Chrome (version 84.0 or later)
- Microsoft Edge (version 84.0 or later)

Network Requirements

Port and Protocol Requirements

The following section lists the ports used by the Synchrowave Platform and Reports applications. For Synchrowave to operate correctly, these ports must be opened on all firewalls between the nodes as specified in *Table 2.1*.

NOTE
When Table 2.1 indicates Clients, the port(s) must be open to allow connections from all desired client network addresses. Note that if a load balancer is used, the port(s) need to be open only to/from the load balancer.

Platform

The ports listed in *Table 2.1* must be opened on the server and on the network connecting the server to the client's LDAP server.

Table 2.1 Required Ports

Direction	Protocol	Port	From	To	Description
Inbound	TCP/HTTP	80	Clients	Platform	Web gateway traffic. Port 80 is used only to redirect HTTP requests to HTTPS, Port 443.
Inbound	TCP/HTTPS	443	Clients	Platform	Web gateway traffic.
Outbound	TCP/LDAP	As configured (Default: 389; use 636 for LDAPS)	Platform	LDAP Server	User authentication with LDAP server.

Reports Applications

Table 2.2 lists the required port for the application that is part of the Synchrowave Reports system.

Table 2.2 Monitoring Applications

Application	Direction	Protocol	Port	From	To	Description
ACSELERATOR Database Reader	Outbound	TCP	As configured (Default: 5434)	Platform	ACSELERATOR Database Server	Connection to database
CWS Receiver	Inbound	UDP	As configured (Default: 4703)	External Device	cws-receiver service in Platform	Continuous waveform data

The application listed in *Table 2.2* requires no network access beyond that provided by the Synchrowave Platform.

Data Storage Requirements

Storage Space Requirements

The amount of storage required for the Synchrowave Platform varies widely and is dependent upon several factors:

- How long the data are to be stored
- For Synchrowave Reports, the number of devices and type of reports
- The applications installed on the platform. Some applications may generate additional storage requirements.

All Historian data, application configuration, and logs are stored in a common storage location.

Table 2.3 Report Data Storage

Device Count	Reports/Device	Storage Required Per Year
5	1 Daily IEEE 519 and 1 Weekly IEEE 519	1 GB
25	1 Daily IEEE 519 and 1 Weekly IEEE 519	5 GB
100	1 Daily IEEE 519 and 1 Weekly IEEE 519	20 GB

Continuous waveform streaming requires significantly more data storage than reporting applications. Consequently, *Table 2.4* gives the required storage per day per signal.

Table 2.4 Continuous Waveform Streaming Storage

Device Count	Device Type	Storage Required Per Day
1	SEL-735	6 GB
5	SEL-735	30 GB
1	SEL-T35	85 GB
5	SEL-T35	423 GB

Contact SEL for additional information regarding choosing the correct archiving strategy.

Network Storage Requirements

For security reasons, Synchrowave Reports is, by default, run as an unprivileged user and therefore restricted from accessing network drives, which require additional permissions. Network drive access can be enabled by entering the required network credentials in the Configuration tab of the Platform Services application as described in *Configuring the Archive Data Directory on page 110*.

Contact SEL if you need assistance.

NOTE
If you need a networked location for the synchrophasor database, use the full network name for the path setting. Using the mapped drive letter alone does not work.

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SECTION 3

Installation and Configuration

Installing Synchrowave Reports

Pre-Installation Checklist

Complete the following items on the host computer prior to software installation:

- Configure the IP address.
- Set the time zone of the server.
- Ensure sufficient drive space is available.

Initial Installation Instructions

Step 1. Run **Synchrowave Platform Setup.exe**.

Step 2. Proceed through the installer wizard.

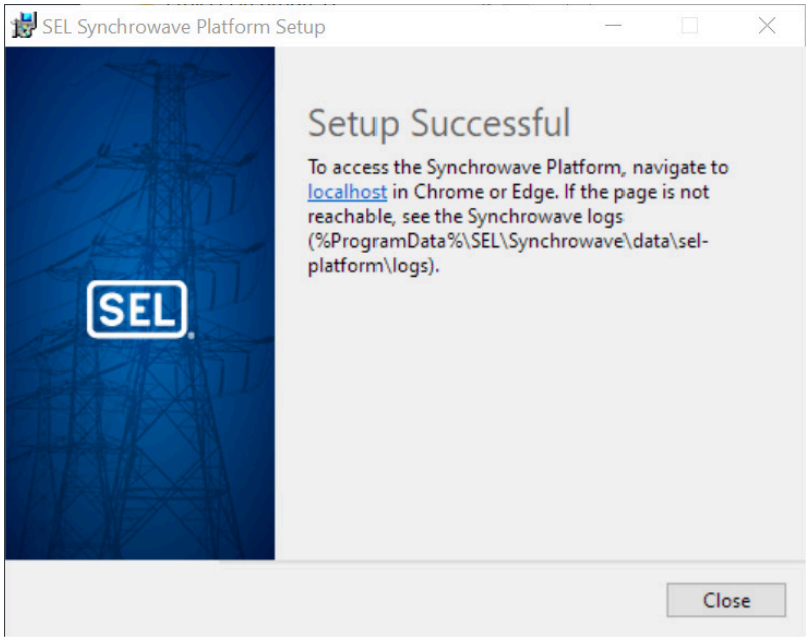


Figure 3.1 Successful Setup

Step 3. Once Synchrowave Reports is installed, navigate to https://localhost in your browser. SEL recommends using Google Chrome or Microsoft Edge.

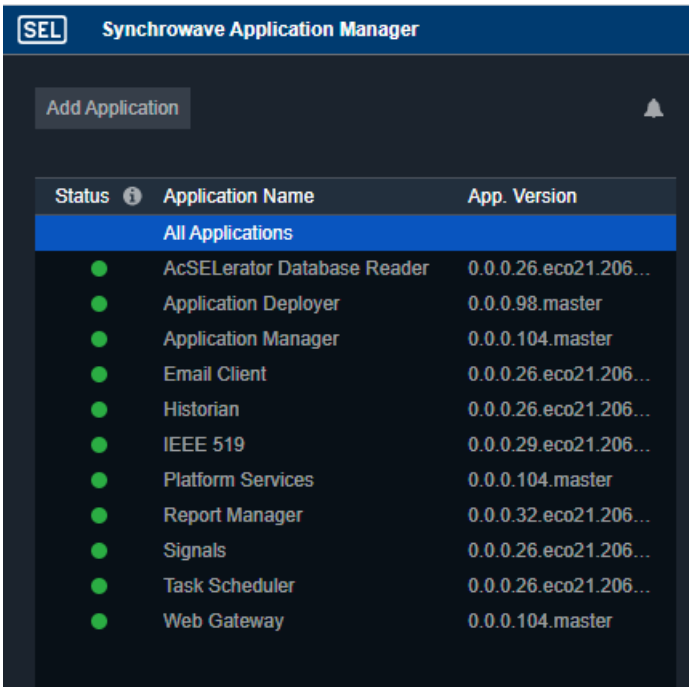


Figure 3.2 Add Application

Step 4. Select **Add Application**.

Step 5. Select the zipped package.

Step 6. After successfully installing the server, the Application Data Directory needs to be mapped to the desired location on the file system.

Complete this step by accessing the server via a web-client and navigating to the Platform Services Configuration tab in the Application Manager.

The default location is **C:\ProgramData\SEL\Synchrowave\data**.

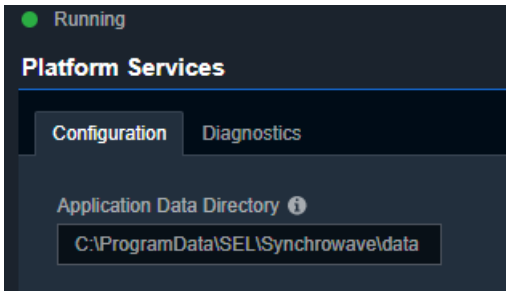


Figure 3.3 Configuration of Application Data Directory

Web Gateway Application

The Synchrowave Platform uses a server/web-client software architecture. All users interact with the software through a web-client user interface. The Web Gateway application ensures secure access to applications and data on the Synchrowave Platform.

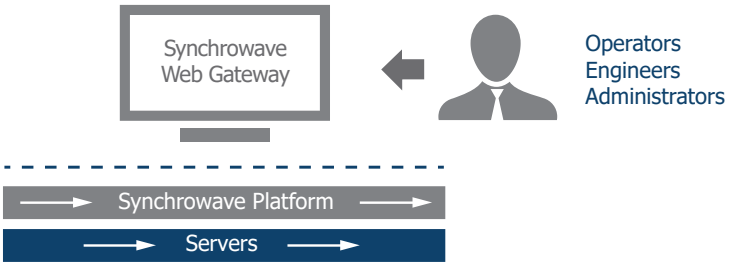


Figure 3.4 Web Gateway Overview

Configuration of HTTPS

The Synchrowave Platform requires HTTPS communication between the web browser and the Synchrowave Platform. HTTPS is a secure version of HTTP that employs Transport Layer Security (TLS) and certificates to encrypt the communication.

The Synchrowave Platform includes a self-signed HTTPS certificate automatically created at installation. Therefore, when accessing Synchrowave Monitoring or the Application Manager for the first time, the browser displays a message stating the connection is not private because the certificate signing authority is not trusted by the computer operating system. Select **Advanced Options** and then **Proceed to [IP address]** link to configure the web gateway in the Application Manager.

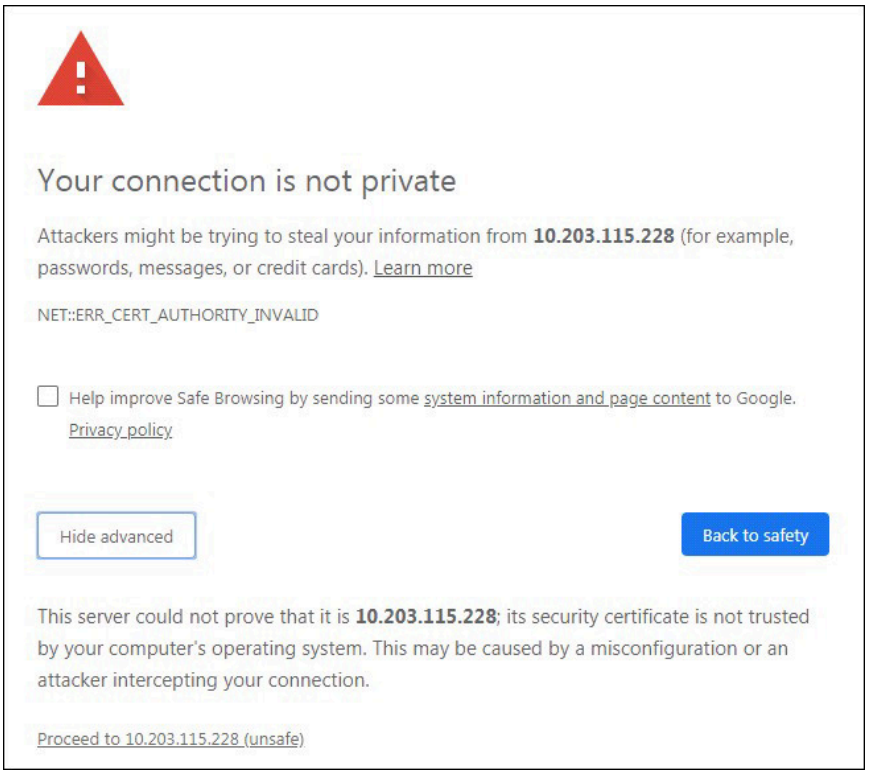


Figure 3.5 Web Browser Not Secure Warning

The Configuration tab for the Web Gateway application provides a **Select Certificate** button for loading an HTTPS personal information exchange (PFX) format certificate into the Synchrowave Platform. The PFX certificate can usually be generated by your IT/IS organization.

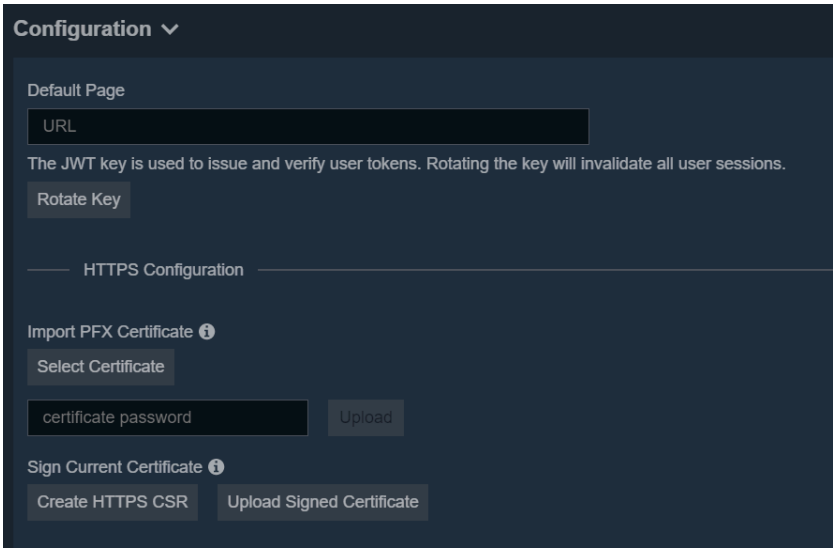


Figure 3.6 HTTPS Configuration

Upon loading a valid HTTPS certificate from your organization, the web browser shows a secure indication in the address bar. As shown in *Figure 3.7*, before the certificate is loaded, **https** is struck-through to indicate that the connection is not secure. Once a valid certificate is loaded, a lock symbol (🔒) appears to show that the connection is secured.

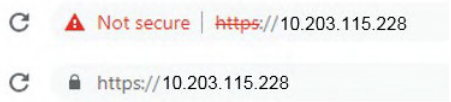


Figure 3.7 Web-Client HTTPS Status Indication

Authentication Configuration

Connecting to an LDAP Server

The Synchrowave Platform supports Lightweight Directory Assistance Protocol (LDAP) user authentication to ensure only authenticated users have access to applications and data.

Authentication on the Synchrowave Platform is disabled by default. System administrators can configure authentication by accessing the Configuration tab of the Web Gateway application in the Application Manager. Work with IT/IS personnel from your organization to enter the required information regarding the LDAP server of your organization.

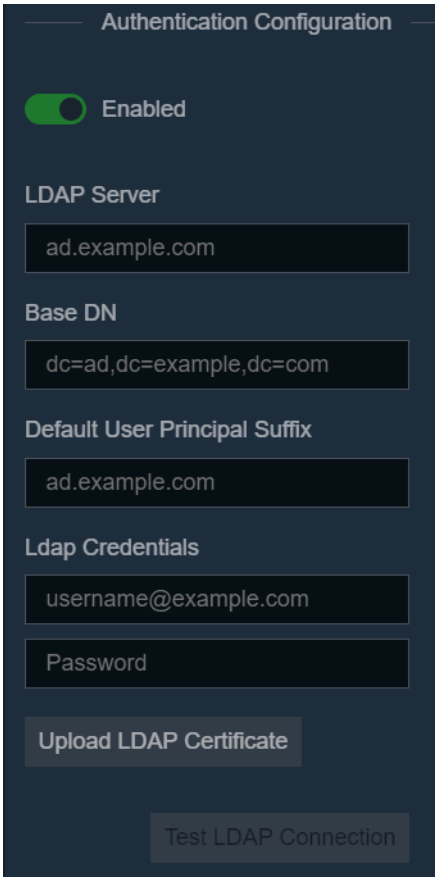


Figure 3.8 LDAP Server Connection Setup

Adding/Removing Users

Upon establishing a successful connection to an LDAP server, users and user groups can be added to the allowed users/groups list. A user or user group can be assigned to the following roles:

- **System Admin**: Install and configure applications from the Application Manager
- **Operator**: Access to Synchrowave Reports
- **Operations Admin**: Access to Synchrowave Reports
- **Engineer**: Access to Synchrowave Reports

If a user group is added, the selected role is applied to all users in the group.

NOTE

If a user is added to a group on the LDAP server, it may take as long as 10 minutes before the user can log in. The Web Gateway application checks LDAP user groups for changes every 10 minutes and upon restart.

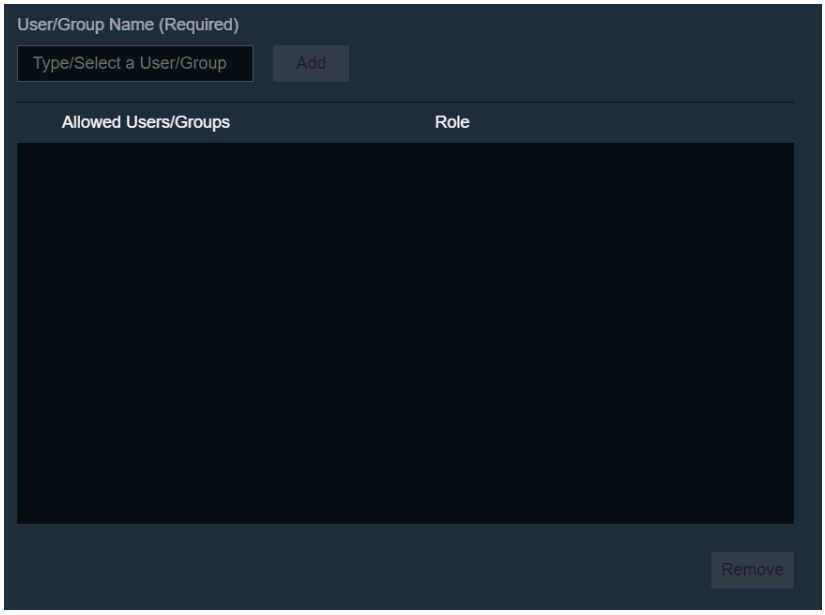


Figure 3.9 Adding/Removing Users and User Groups

If the web gateway is configured incorrectly or is unable to start, all users are locked out of the platform.

The "sel-webgateway" section of C:\ProgramData\SEL\Synchrowave \platform.settings or of the Web Gateway configuration files in C:\Program-Data\SEL\Synchrowave\config\sel-webgateway\config can be edited in a text editor to manually adjust the Web Gateway configuration. Alternatively, these files can be backed-up and deleted to reset the configuration. After making any manual changes to either of these configuration files, restart the SEL Synchrowave application in the Services tab in Windows Task Manager.

Logging Into Synchrowave Platform

When authentication is enabled, the Synchrowave Platform login screen requires a user to enter their username and password before being allowed access to Synchrowave applications.

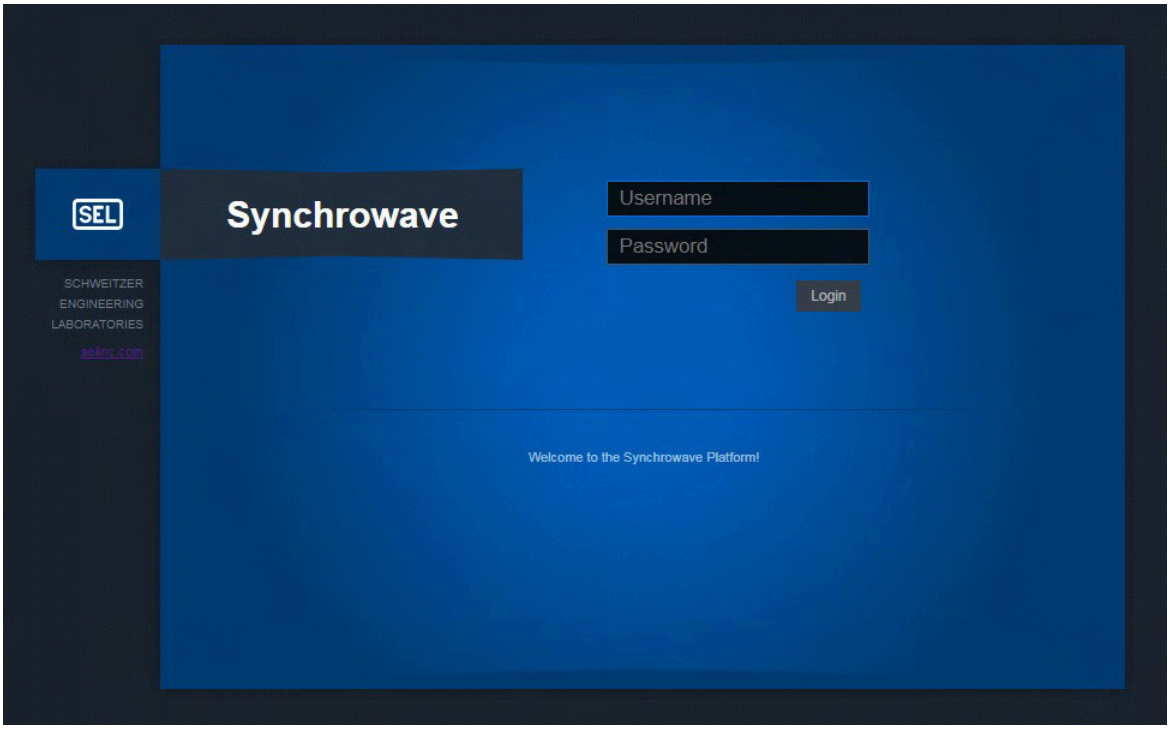


Figure 3.10 Synchrowave Platform Login Page

The default login page message is configurable in the Web Gateway application configuration. By default, the login screen appears as shown in *Figure 3.10*.

Remember Me Duration

Remember Me allows users to quickly return to the Synchrowave Platform for a set duration after closing the browser window without having to re-enter their login credentials. Users can opt into this feature by selecting the **Remember Me** check box on the login screen. Remember Me is enabled in the Application Manager by selecting the **Enable Remember Me** toggle switch and entering a duration greater than one hour, as shown in *Figure 3.11*. Select **Apply** to save the changes. Note that users who have manually logged out will no longer be automatically signed in.

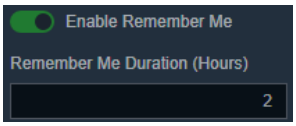


Figure 3.11 Enable Remember Me

Default Login Application Page

By default, upon entering the IP address or server name of the Synchrowave Platform into a web browser, the Application Manager (https://ipaddress/sel.applicationmanager) page is displayed. This is because it is helpful to have quick access to the Application Manager during configuration and initial setup.

As the software transitions to the deployment stage, you may change the default application to Synchrowave Reports in the **Configuration** tab by entering **sel.reportmanager** in the **Default Page** field for the Web Gateway, as shown in *Figure 3.12*.

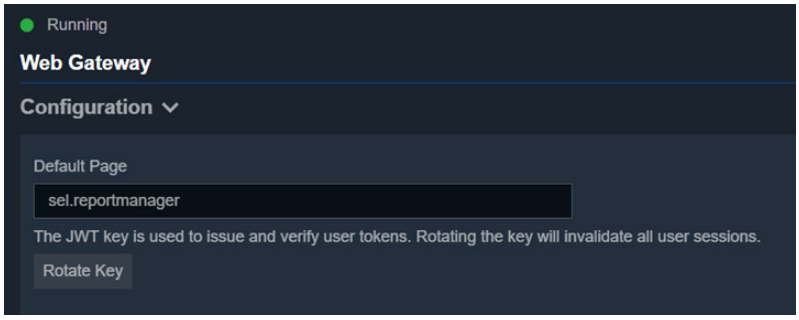


Figure 3.12 Configuration of Default Application Page

Report Manager Application

In Application Manager, the Report Manager configuration (*Figure 3.13*) allows users to configure where Report Manager stores reports and how the reports are named.

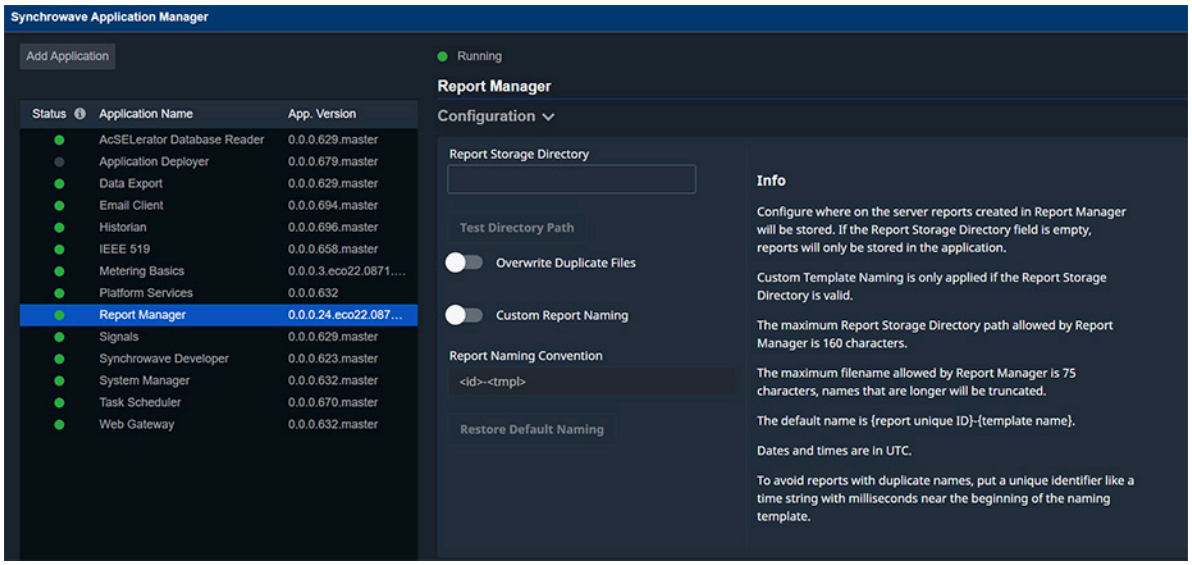


Figure 3.13 Report Manager Configuration

Report Storage Configuration

The Report Storage Directory determines where Report Manager stores reports. If no directory is specified, Report Manager stores reports within the application. If a file directory on the server is specified, Report Manager attempts to save a copy of every report it generates to that directory. In addition, the Test Directory Path button enables, as shown in *Figure 3.14*. Select **Test Directory Path** to verify whether Report Manager can write to the specified location.

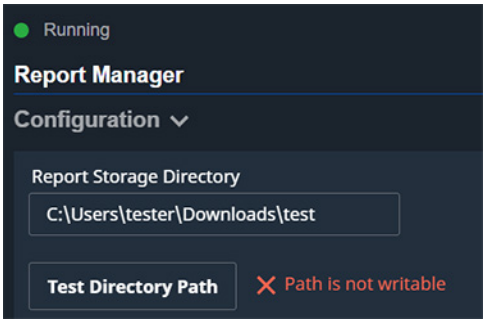


Figure 3.14 Path Is Not Writable

If the path is not writable, as shown in *Figure 3.14*, verify that the directory exists on the server and that the SEL Synchrowave service account has write permissions by browsing to the directory in Explorer, right-clicking it, selecting **Properties**, and selecting the **Security** tab (see *Figure 3.15*).

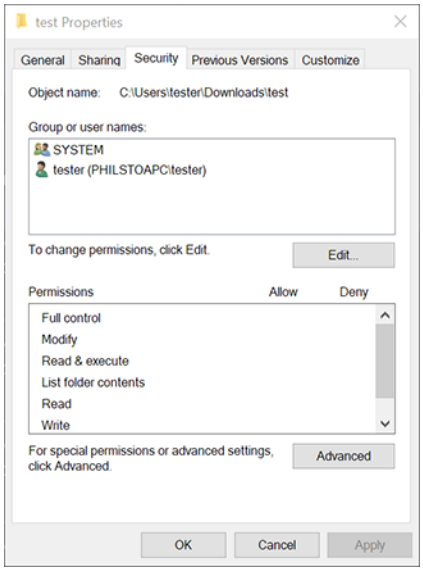


Figure 3.15 Users With Directory Permissions

If the SEL Synchrowave user is not present, select **Edit** and then **Add** to add a new user.

In the Select Users or Groups dialog that appears, select **Locations** and browse to and select the server computer. Then, in the text field, enter the user "NT SERVICE\SEL Synchrowave" (as shown in *Figure 3.16*) and select **Check Names**.

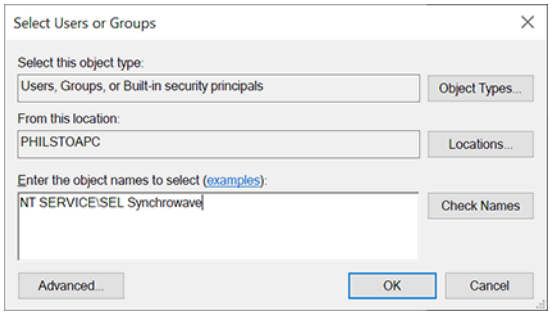


Figure 3.16 Select the SEL Synchrowave User

If the user is valid, the text field will change to "SEL Synchrowave", as shown in *Figure 3.17*.

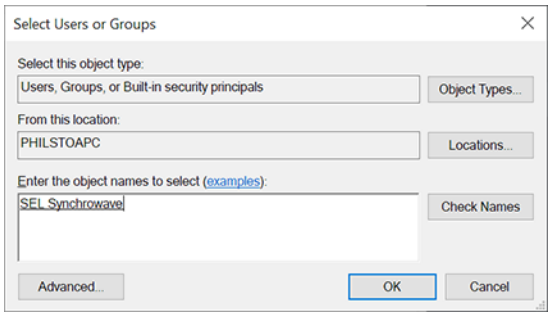


Figure 3.17 Verify That the User Is Valid

Select **OK**, and then select the new user. In the Permissions pane, select the **Allow** check boxes for the Modify, Read & execute, List folder contents, Read, and Write permissions, as shown in *Figure 3.18*.

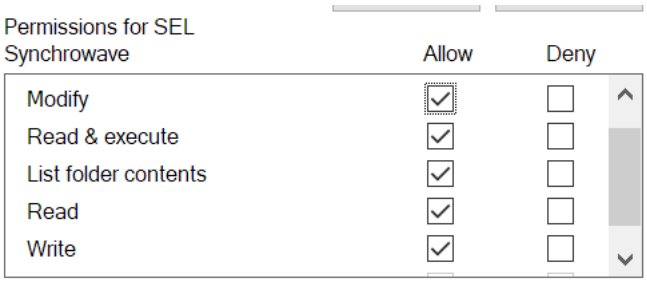


Figure 3.18 Set User Permissions

After creating any missing directories and fixing any permissions issues, select **Test Directory Path** again to ensure that the updated path is writable, as shown in *Figure 3.19*.

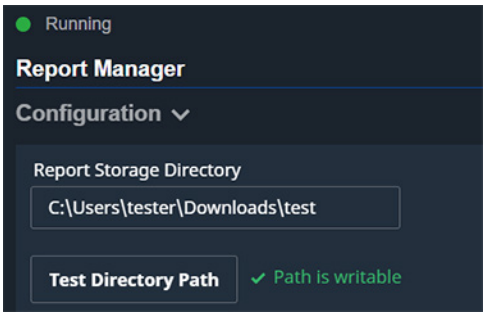


Figure 3.19 Path Is Writable

Once you verify that the Report Storage Directory is writable, choose whether you want Report Manager to overwrite existing reports in that directory if a new report is created with the same file name. If so, turn on the **Overwrite Duplicate Files** toggle. This can be useful for systems that programmatically import data from reports by combining this functionality with a custom report name that does not contain unique identifiers such as date or ID. If you do not want Report Manager to overwrite existing reports with the same name as a newly created report, turn off the **Overwrite Duplicate Files** toggle. Report Manager will add *(n)* to the end of the file name, as shown in *Figure 3.20*.

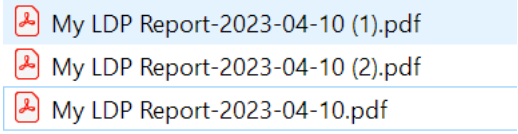


Figure 3.20 Automatic File Renaming When Overwrite Duplicate Files Is Off

Report Naming Configuration

To enable custom report naming, turn on the **Custom Report Naming** toggle. Note the following:

- Custom report naming is only applied if a Report Storage Directory is specified.
- Custom report naming applies to all reports created by Report Manager.
- The default name is *{report unique ID}-{template name}*.

Type static elements for report names directly in the **Report Naming Convention** field and add dynamic elements from the Tag Selector. For example, to create a report with a string-sortable datetime in the name, select the following tags: <yyyy>, <mm>, <dd>, <HH>, <MM>, <ss>, and then add hyphens between the date elements and periods between the time elements, as shown in *Figure 3.21* and *Figure 3.22*.

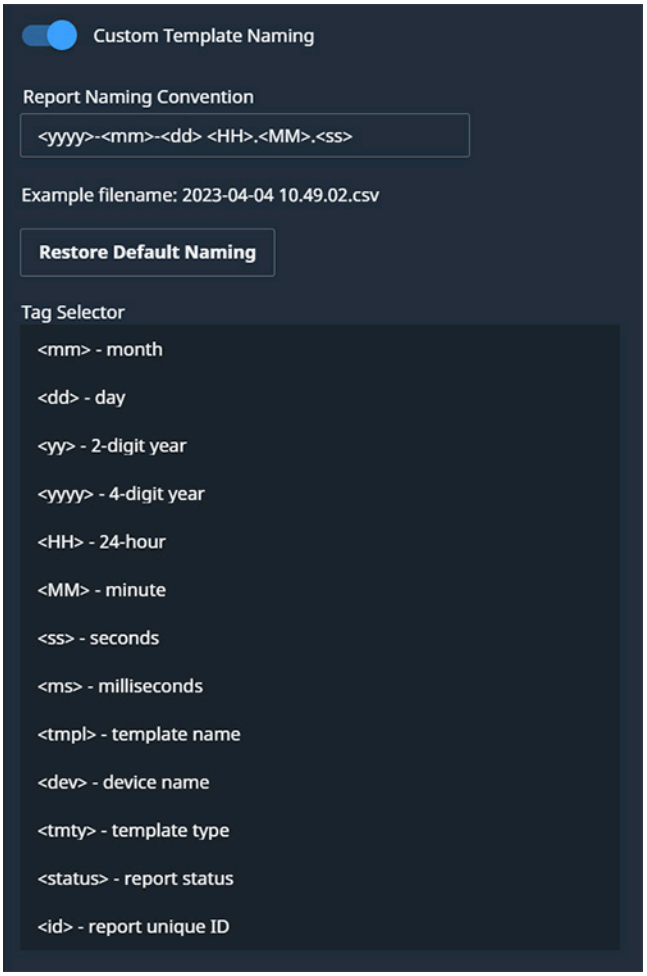
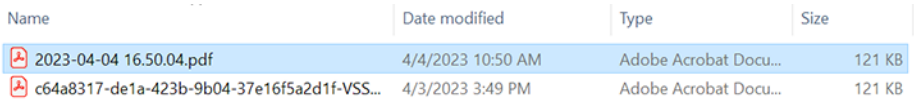


Figure 3.21 Custom Naming With a Sortable Datetime



Name	Date modified	Type	Size
2023-04-04 16.50.04.pdf	4/4/2023 10:50 AM	Adobe Acrobat Docu...	121 KB
c64a8317-de1a-423b-9b04-37e16f5a2d1f-VSS...	4/3/2023 3:49 PM	Adobe Acrobat Docu...	121 KB

Figure 3.22 Report With a Sortable Datetime as the Name

ACSELERATOR Database Reader Application

The ACSELERATOR Database Reader application connects to an ACSELERATOR Database and publishes Load Data Profile (LDP) data and event report information to the Synchrowave Platform signal bus. Synchrowave Reports uses the measurement points from ACSELERATOR Database Reader as well as the signal data and events created by ACSELERATOR Database Reader.

ACSELERATOR Database Reader Features

- Securely connects to ACSELERATOR Database
- Publishes event reports to Synchrowave Platform
- Retrieves LDP data

- Retrieves voltage sag, swell, and interruption (VSSI) data
- Retrieves SOE/SER (Sequence-of-Events/Sequential Event Recorder) data
- Maps devices to measurement points

ACSELERATOR Database Reader Configuration

Generate an ACSELERATOR Database Connection Key

The ACSELERATOR Database Reader requires a connection key to connect to an ACSELERATOR database. To generate an ACSELERATOR Database Connection key, complete the following steps:

Step 1. Open ACSELERATOR QuickSet SEL-5030 Software as an Administrator on the computer where the ACSELERATOR Database is located.

Step 2. Select **File > Database Manager**.

Step 3. Select the **AcSELerator Database** tab.

Step 4. Select the **Allow remote database connections** check box.

Step 5. Select **Create Connection Key**, as shown in *Figure 3.23*.

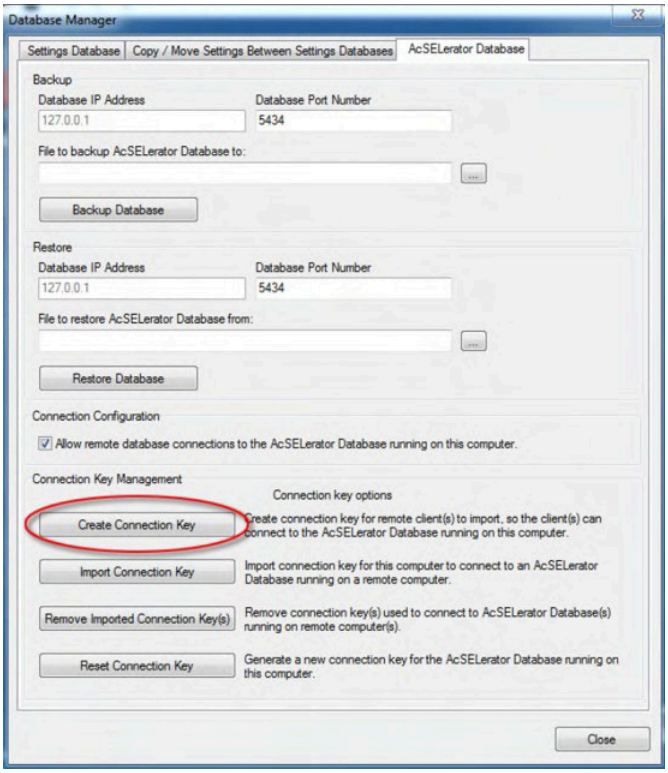


Figure 3.23 ACSELERATOR Database Manager

Step 6. Enter a password for the Connection Key, as shown in *Figure 3.24*.

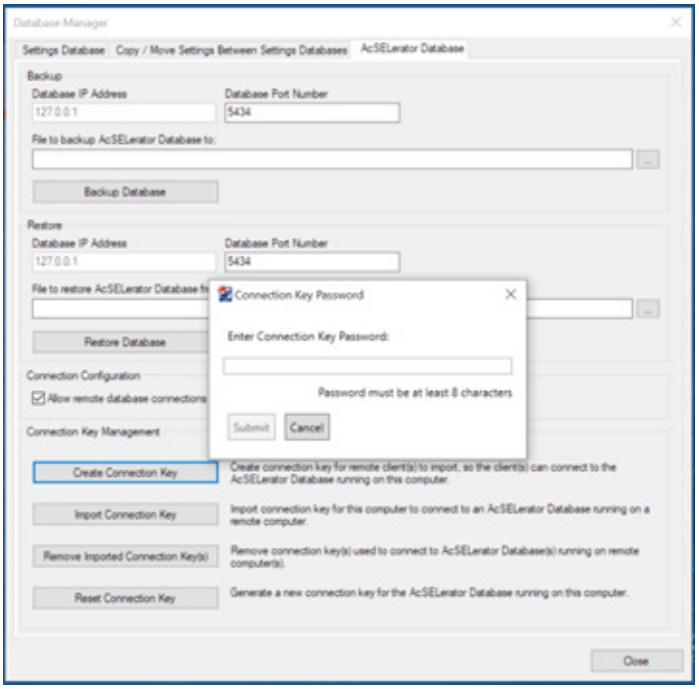


Figure 3.24 Create Connection Key

Connect to an ACSELERATOR Database

To connect to an ACSELERATOR Database, complete the following steps:

Step 1. Open Synchrowave Application Manager in a web browser.

Step 2. Add the ACSELERATOR Database Reader application, if not already installed.

Step 3. Select the **AcSELerator Database Reader** application from the Application List and select the **Configuration** tab.

Step 4. Select **Import Connection Key** and load the previously generated Connection Key.

Step 5. Enter the Connection Key Password for the connection key.

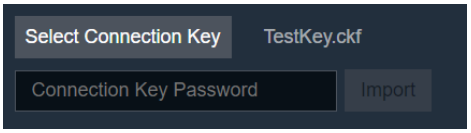


Figure 3.25 Add Connection Key Password

Step 6. Select **Test Connection** and verify a successful connection to the ACSELERATOR Database.

Step 7. Select the time zone of the events in the ACSELERATOR Database. The default time zone of LDP data is set on the metering point in Device Manager.

Step 8. Select **Apply**.

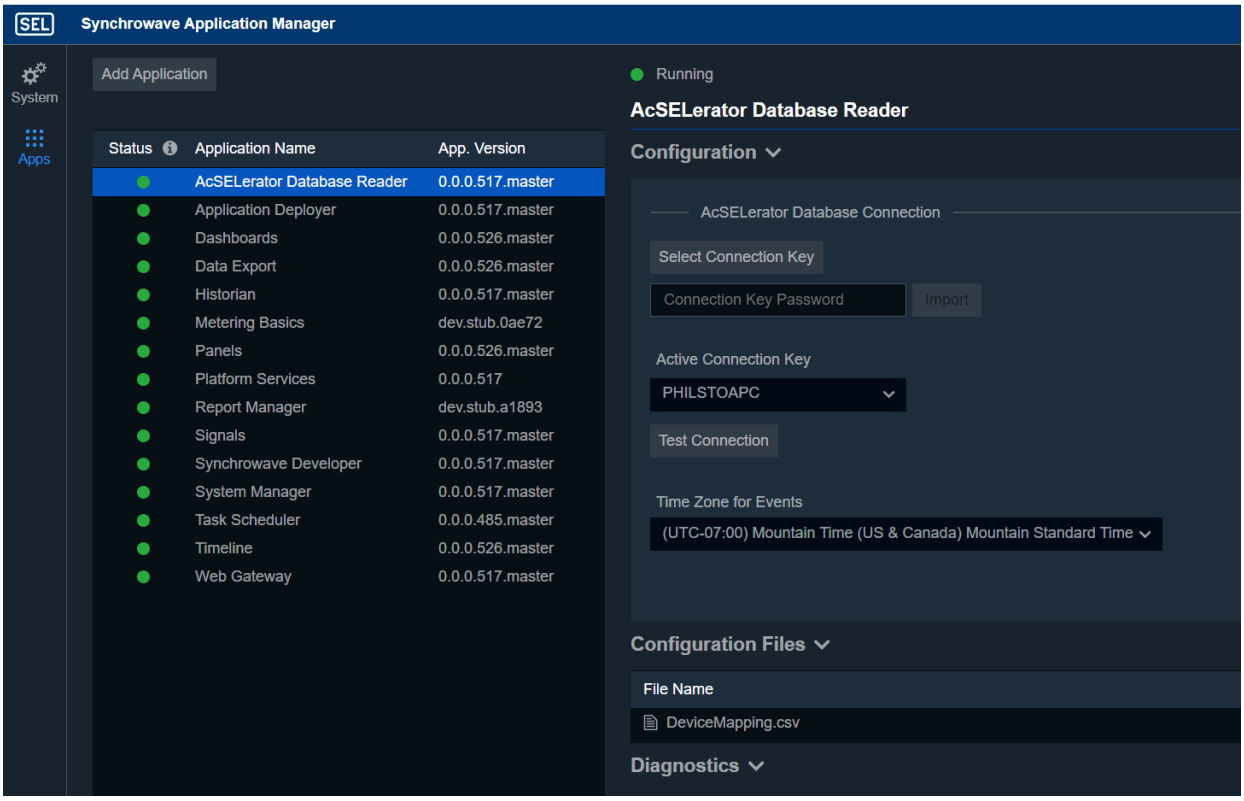


Figure 3.26 ACSELERATOR Database Reader Configuration

Email Client Application

The Email Client Application provides Microsoft Exchange Online and SMTP email clients for the Synchrowave application.

Microsoft Exchange Online Configuration

The Exchange Online **Email Server Type** provides configuration options for connecting to a Microsoft Exchange Online email server, as shown in *Figure 3.27*. Configure the Exchange Online server type as follows:

Step 1. Set a Default Sender. This sender is used if an application does not specify the sender. In Exchange Online, only approved senders can use the service.

Step 2. Set the Client Secret.

Step 3. Set the Client ID. This is also called the Application ID and is the unique identifier of the Exchange Online application your IT department has created.

Step 4. Set the Tenant ID. This is your organization's Exchange Online unique identifier.

Step 5. Select **Apply**.

Step 6. (Optional) Select **Send Test Email** to test the configuration by sending an email using the Exchange Online configuration.

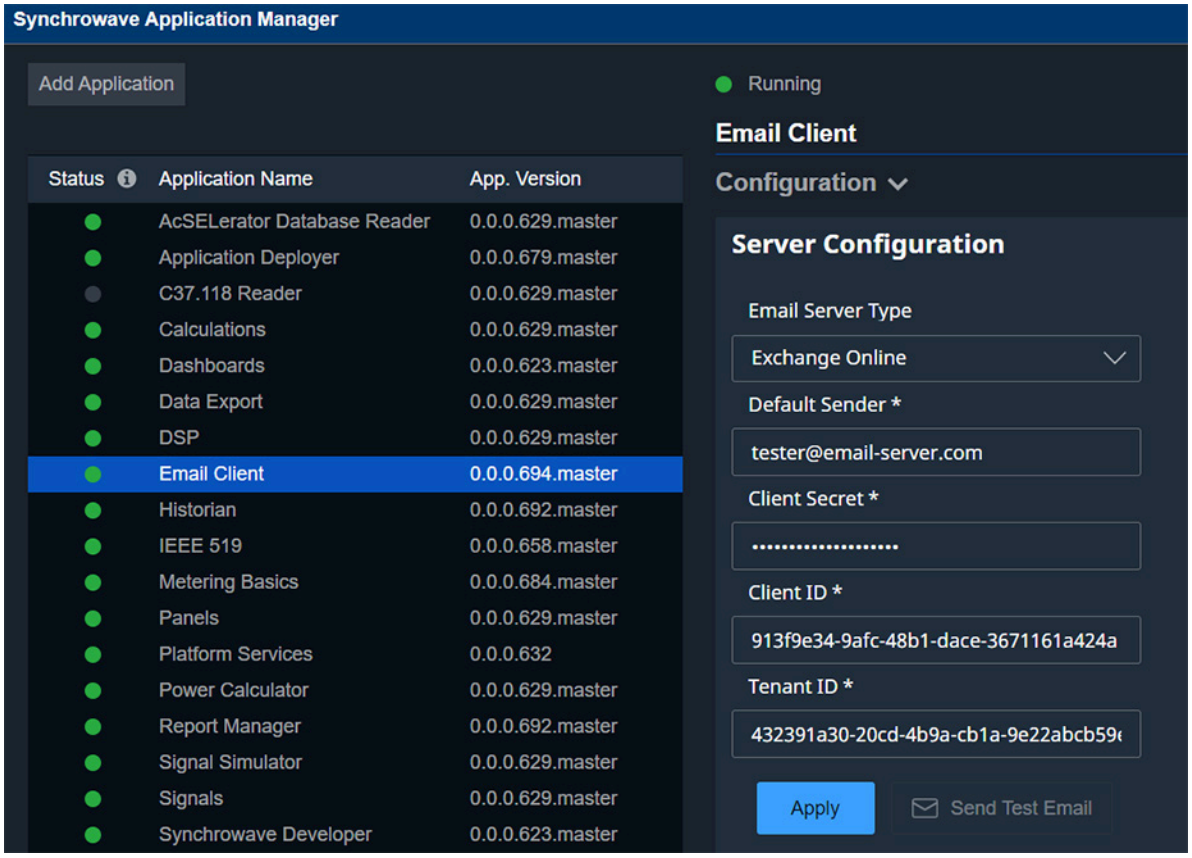


Figure 3.27 Exchange Online Configuration

SMTP Configuration

The SMTP **Email Server Type** provides configuration options for connecting to an SMTP email server, as shown in *Figure 3.28*. Configure the SMTP server type as follows:

Step 1. Set a Default Sender. This sender is used if an application does not specify the sender.

Step 2. Set the SMTP Server Address.

Step 3. Set the Port Number.

Step 4. Select a Connection Security option.

Step 5. If required, turn on Require Authentication.

Step 6. If Require Authentication is on, enter a username and password.

Step 7. Select **Apply.**

Step 8. (Optional) Select **Send Test Email** to test the configuration by sending an email using the SMTP configuration.

Once the application is set up, other Synchrowave applications can use the Email Client to send emails.

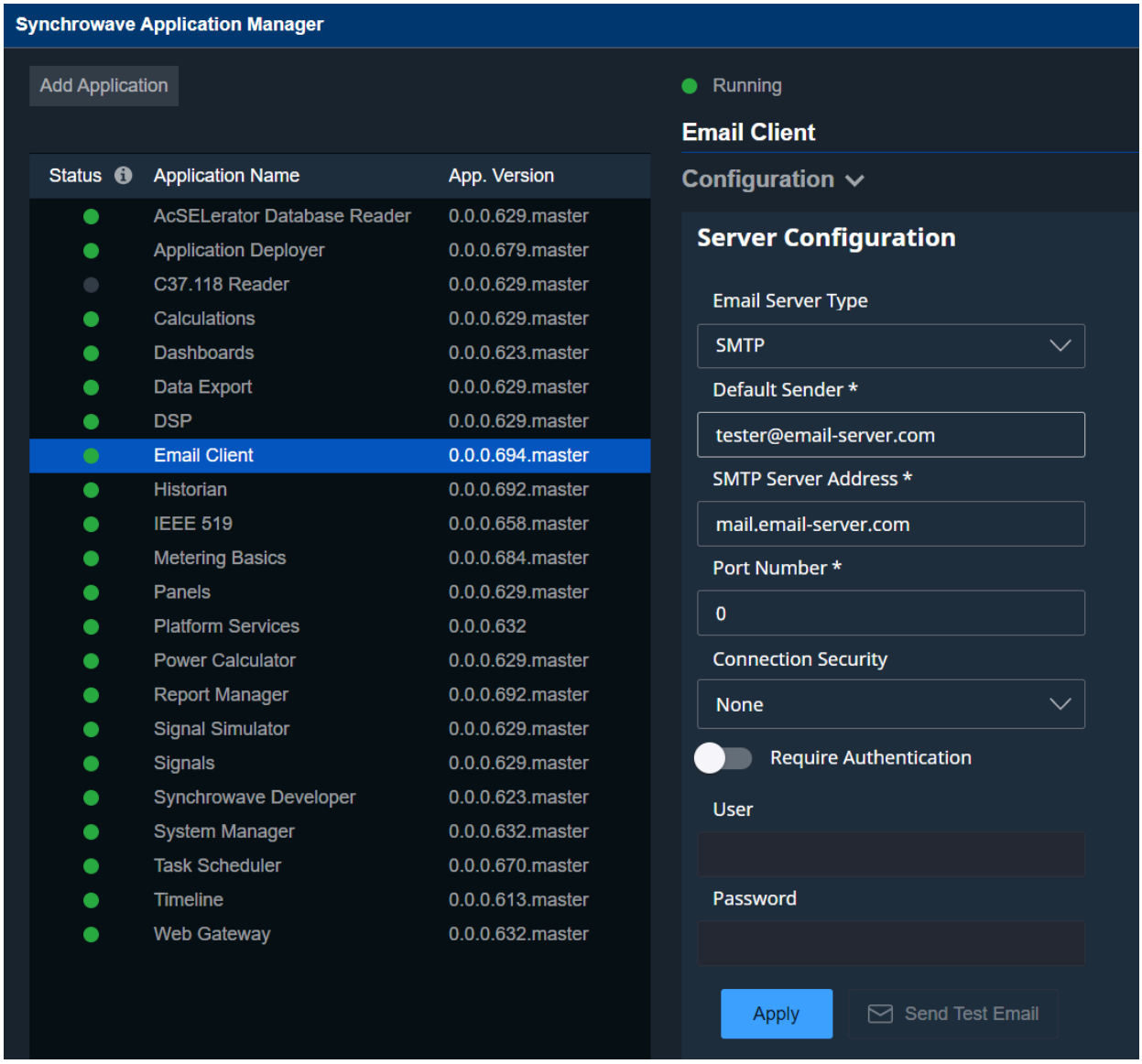


Figure 3.28 SMTP Configuration

SMTP Connection Security Options

The SMTP email server type provides five Connection Security options: None, Auto, SslOnConnect, StartTls, and StartTlsWhenAvailable.

- **None** provides no security. This may be adequate if the Synchrowave server and the SMTP server are on the same secured network, but it is not recommended.
- **Auto** allows the server to decide which encryption method, if any, to use.
- **SslOnConnect** uses either SSL or TLS encryption immediately.

- **StartTls** uses TLS encryption immediately after requesting information about the server. If the email server cannot use STARTTLS, the connection fails. All emails are encrypted with TLS, but not all communications.
- **StartTlsWhenAvailable** uses TLS encryption if the server supports STARTTLS. Otherwise, communications are not encrypted. Emails may not be encrypted.

Synchrowave Platform Backup Procedure

A Synchrowave Windows Platform system should be backed up to ensure resiliency in case of server or file system failure. There are two sets of data that may need to be backed up: the data on a local server and, if applicable, the data stored on the network file system.

Server Local File System Backup

To back up data on the server, perform the following:

Step 1. Stop the platform to avoid changes during the backup. From the Windows Task Manager, select the **Services** tab. Find the SEL Synchrowave service, right-click it, and select **Stop**. Wait until the service PID disappears.

Step 2. Back up the server's local file system.

Step 3. Restart the platform. From the Windows Task Manager, select the **Services** tab. Find the SEL Synchrowave service, right-click it, and select **Start**.

Server Local File System Restore

To restore a server from a backup, perform the following:

Step 1. Resolve the problem that necessitated the restore.

Step 2. Restore the server's file system from the backup.

Step 3. Start the platform. From the Windows Task Manager, select the **Services** tab. Find the SEL Synchrowave service, right-click it, and select **Start**.

Network File System Backup

Step 1. Take a snapshot of the Synchrowave NAS file system folder. Using snapshots provides:

- A synchronized view of all system states, avoiding possible issues related to some files being backed up at significantly different times than related files.
- The ability to copy files without interfering with active modifications by the system.

Step 2. Back up the file system snapshot.

Optionally, if the backups will not include historic data, exclude the sel-historian folder from the backup.

Network File System Restore

To restore a server from a backup, perform the following:

Step 1. Stop the platform to avoid changes during the backup. From the Windows Task Manager, select the **Services** tab. Find the SEL Synchrowave service, right-click it, and select **Stop**. Wait until the service PID disappears.

Step 2. Restore the file system from the backup.

Step 3. Restart the platform. From the Windows Task Manager, select the **Services** tab. Find the SEL Synchrowave service, right-click it, and select **Start**.

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SECTION 4

Using Synchrowave Reports

Mapping Devices to Measurement Points

ACSELERATOR Database is a QuickSet system component that allows storage of device information, settings, events, and LDP data.

SEL-735, SEL-734, SEL-751A, and SEL RTACs with TrendRecorder can provide LDP data to a TEAM Profile, which stores the data in the ACSELERATOR Database.

SEL devices generate event reports, which can be collected by ACSELERATOR TEAM® SEL-5045 Software and stored in the ACSELERATOR Database.

You can map devices in the ACSELERATOR Database to measurement points in the ACSELERATOR Database Reader application. This allows devices to be associated with their model, intelligently displayed, and queried by applications on the Synchrowave Platform.

The device mapping for the ACSELERATOR Database Reader is accomplished via a CSV file. Select the **Query & Download** button (⇥) shown in *Figure 4.1* to download the Device Mapping file with all available devices. Once the CSV file has been downloaded, open the CSV file with Microsoft Excel or a similar CSV editing software.

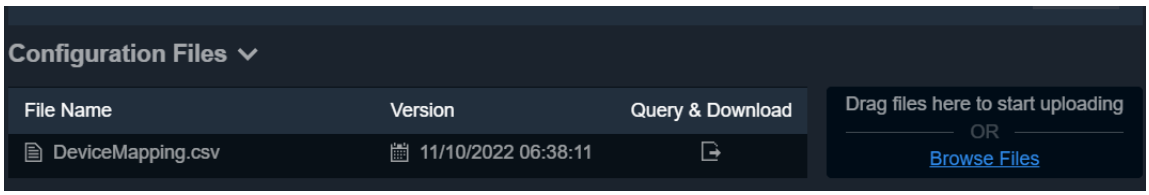

Figure 4.1 Exporting the ACSELERATOR Database Reader Device Mapping CSV

The CSV includes three columns: Device, MeasurementPoint, and Comment. The Device column is automatically populated by the ACSELERATOR Database Reader with the device paths, as shown in *Figure 4.2*.

	A	B	C
1	Device	MeasurementPoint	Comment
2	HighValleyRdWindFarm:HVR_Sub_351	HighValley_351	
3	HighValleyRdWindFarm:HVR_Turbine_735	HighValley_735	
4	StacklandRdSolarFarm:SR_Inverter_735_Advanced	Stackland_735_Advanced	
5	OperationsCenter:Ops_3555		
6	OperationsCenter:Service_Entrance_735_Advanced	HQ_735_Advanced	
7	MeyerPondSolarFarm:MP_Bus_2411		
8	MeyerPondSolarFarm:MP_Inverter_735_Advanced	Meyers_735_Advanced	
9	MillCreekRdHydroPlant:MCR_Gen1_400G		
10	MillCreekRdHydroPlant:MCR_Gen2_400G		

Figure 4.2 ACSELERATOR Database Device CSV Mapping

During the initial configuration, the MeasurementPoint field is empty. Use the information in the Device field to complete the MeasurementPoint field entries. The MeasurementPoint describes the location where the measurement took place and displays in the reporting apps to help users differentiate the device from other devices displayed.

Measurement Points have the following naming restrictions:

- Measurement Points may only contain numbers, upper-case and lower-case letters, underscores, and periods. Spaces are not allowed.
- Measurement Points may start with either a letter or an underscore.

ACSELERATOR Database Reader only publishes event reports to the Synchrowave Platform signal bus if the MeasurementPoint field is complete. You can import a file without all fields completed, but any event reports or LDP data from devices without a MeasurementPoint defined will be ignored by the ACSELERATOR Database Reader.

Upon completing the device mapping, save the file and drag and drop it into your Application Manager window. Alternatively, select the **Browse Files** button shown in *Figure 4.1*.

If new devices are added to the ACSELERATOR Database, after the initial update/import of the device mapping CSV, update the CSV again. ACSELERATOR Database Reader adds the new devices to the end of the CSV file. Complete the MeasurementPoint field for the new devices and reimport the CSV file.

To see only a list of currently mapped devices, select **Export**.

Setting Up Meter Calculations

Meter Calculations provides a place to configure all applications that perform meter calculations using a simple graphical interface. Meter Calculations applies saved changes to each application's configuration files, allowing users to change application configurations manually or through Meter Calculations. When first navigating to Meter Calculations, the list of available calculation services appears on the left sidebar. Navigate to the list item corresponding to the desired calculation service and select the **New Configuration** button (*Figure 4.3*).

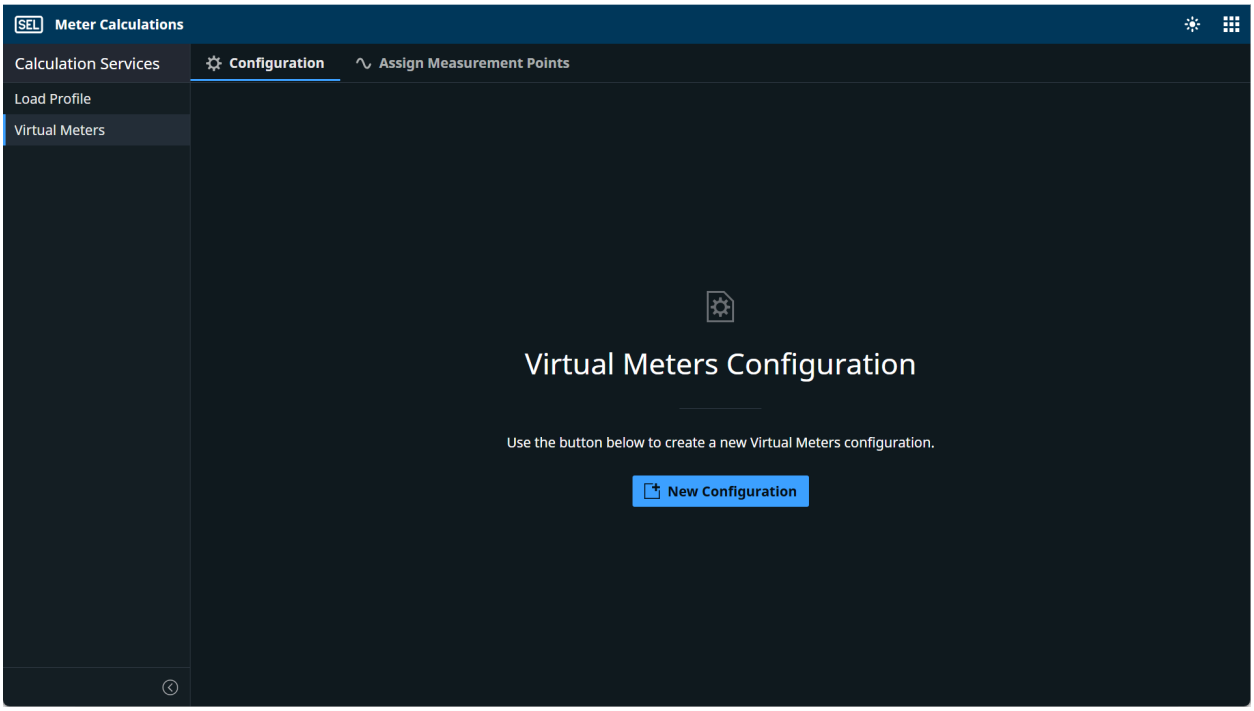

Figure 4.3 Meter Calculations With No Configurations

Fill in the settings on the Configuration tab, as shown in *Figure 4.4*. The settings available depend on the calculation service.

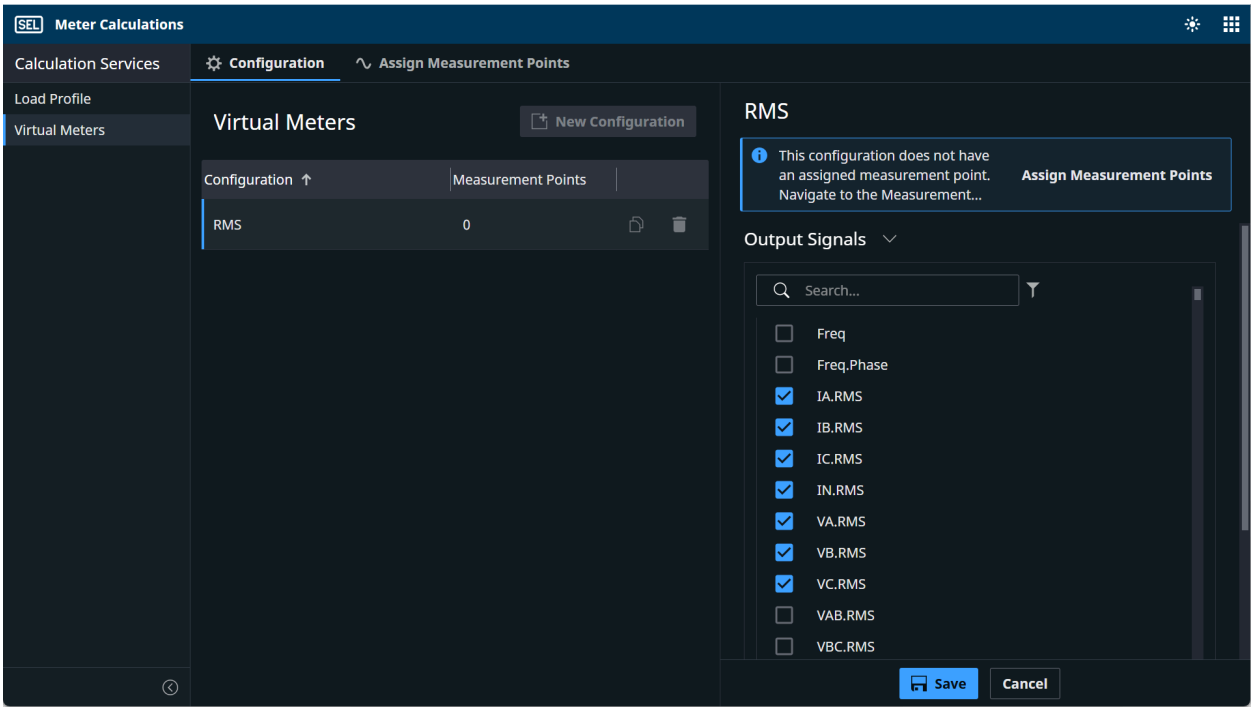

Figure 4.4 Meter Calculations Configuration

Assign measurement points to the configuration, as shown in *Figure 4.5*. The calculation service also supplies the list of available measurement points for assignment. Select the Play (▶) button to start the configuration and the Stop (■) button to stop a running one.

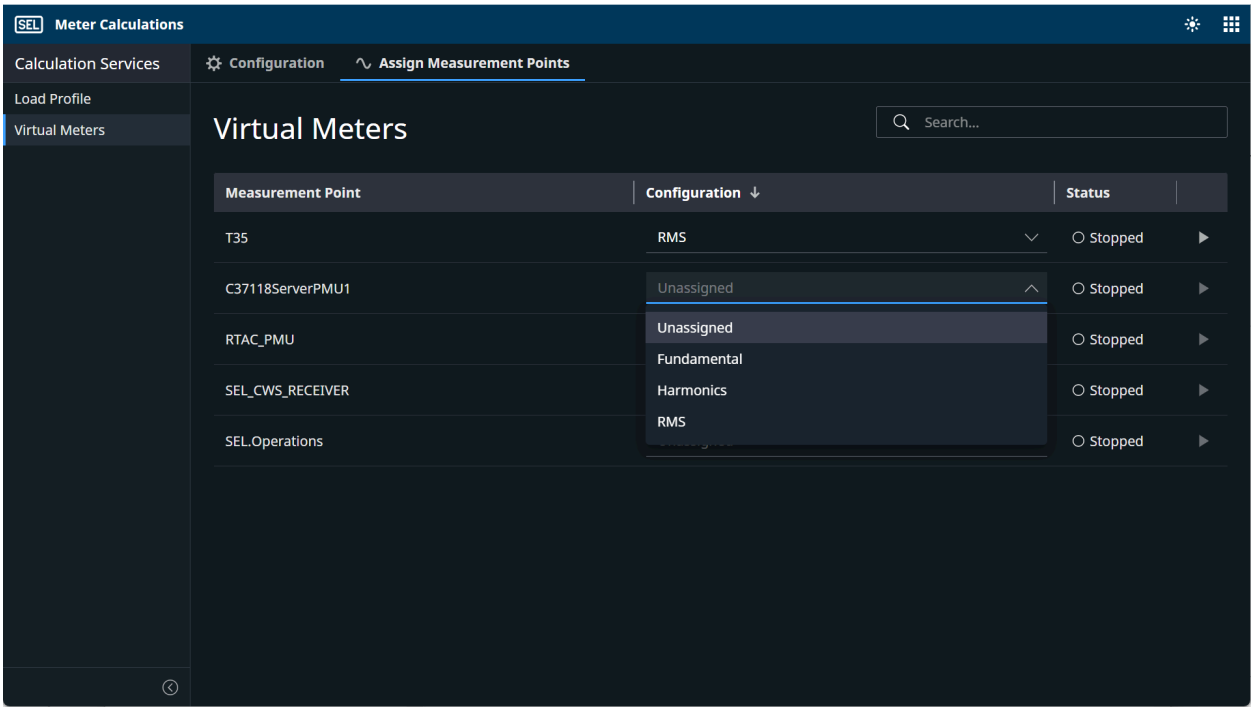

Figure 4.5 Meter Calculations Assign Measurement Points

Creating and Configuring Reports

Report Manager allows you to create, view, manage, and schedule report templates and reports. The layout of a template is defined by each individual reporting application (such as the IEEE 519 application) and is matched to the settings and measurement points.

Report Manager Features

- Creates reports
- Views reports
- Visualizes data
- Schedules reports
- Archives reports

Report Manager has three views: Templates, Reports, and Data Visualization.

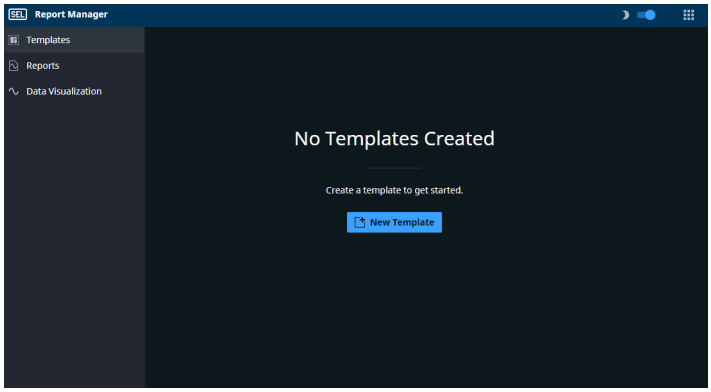

Figure 4.6 Report Manager Home Page

Templates View

To create a template, select the **New Template** button at the top of the screen. In the dialog box that opens, enter the desired name for the template and select the type of template that you would like to create. The Type dropdown menu contains each type of template that is available for creation in the system. For example, if the IEEE 519 Application is installed, the IEEE 519 Daily Detail, Daily Summary, Weekly Detail, and Weekly Summary template types appear as options.

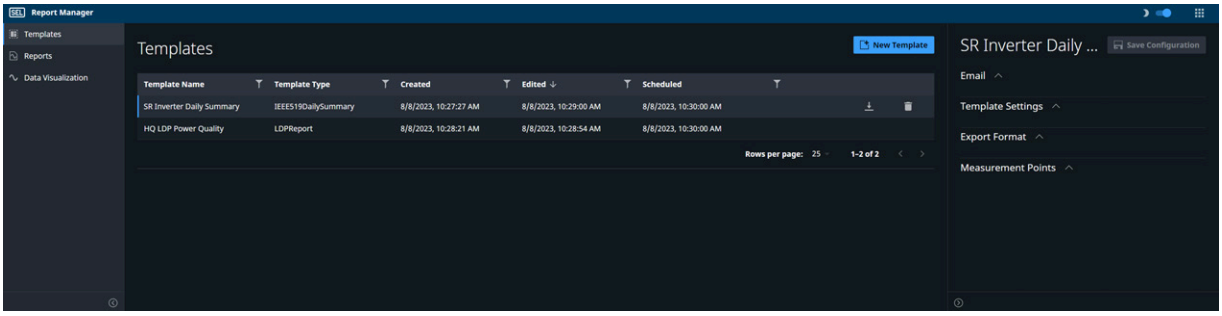

Figure 4.7 Templates Page

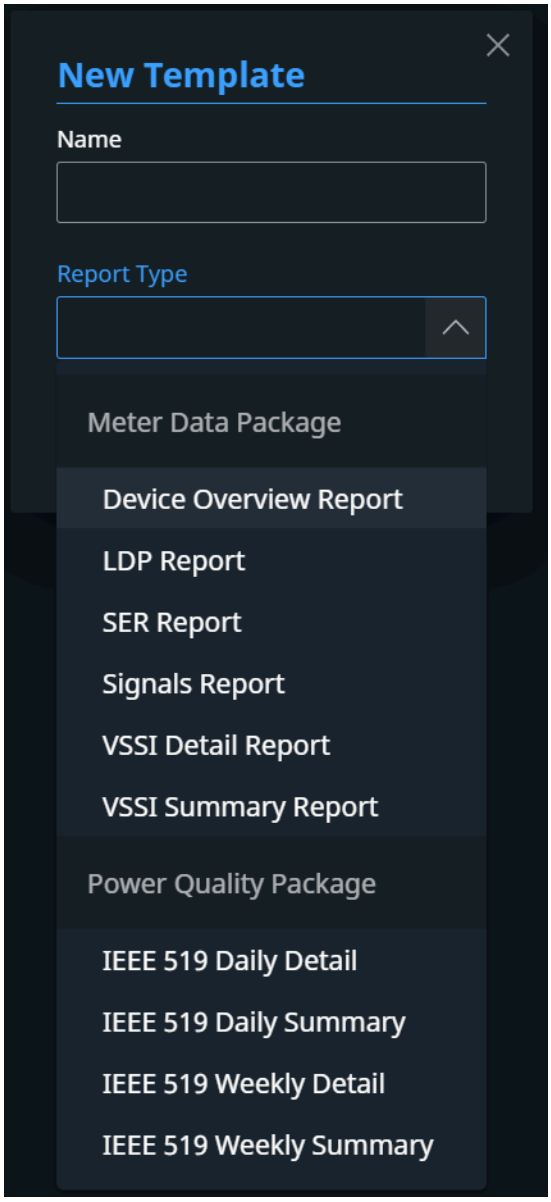

Figure 4.8 Select a Template Type for a New Template

After a template is created, configure the template by selecting a measurement point in the right sidebar, as shown in *Figure 4.9*.

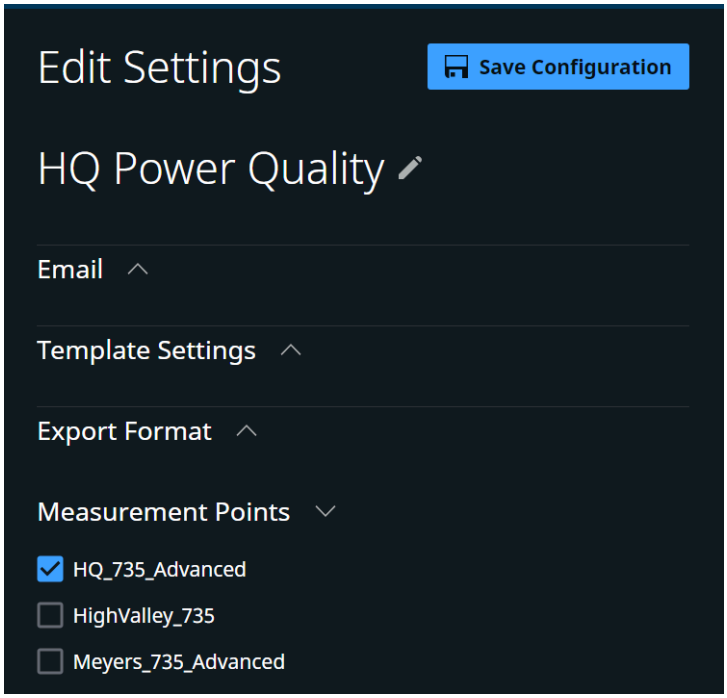

Figure 4.9 Select a Measurement Point for a Template

Add email recipients to email a copy of the report each time it is generated.

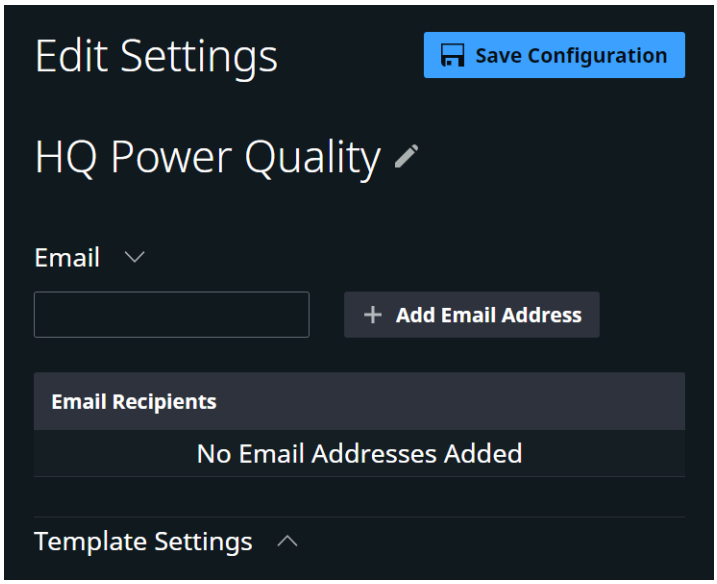

Figure 4.10 Add Email Recipients

Enter any Template Settings, then select the **Save Configuration** button. Use the **Export Format** drop-down menu to select whether the report is exported as a PDF or as a CSV.

When viewing a CSV file in Microsoft Excel, the Time column (shown in *Figure 4.11*) can be configured to display date and time values. Select the **Time** column and use the **Number Format** drop-down (shown in *Figure 4.12*) to select **More Number Formats**. Then, create a **Custom Number** format with the format string *yyyy-mm-dd hh:mm:ss.000* as shown in *Figure 4.13*.

	A
1	Time
2	45:00.0
3	00:00.0
4	15:00.0
5	30:00.0

Figure 4.11 CSV Time Format

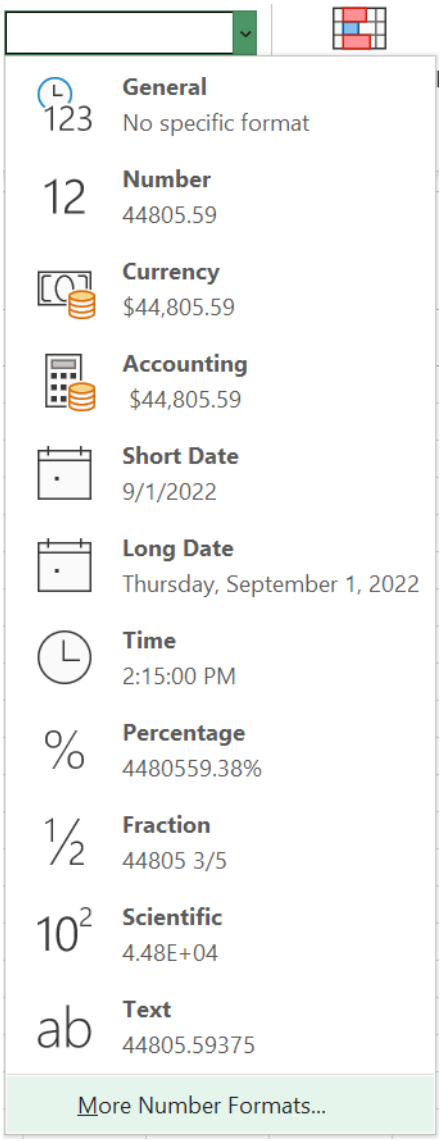

Figure 4.12 Number Format Drop-Down

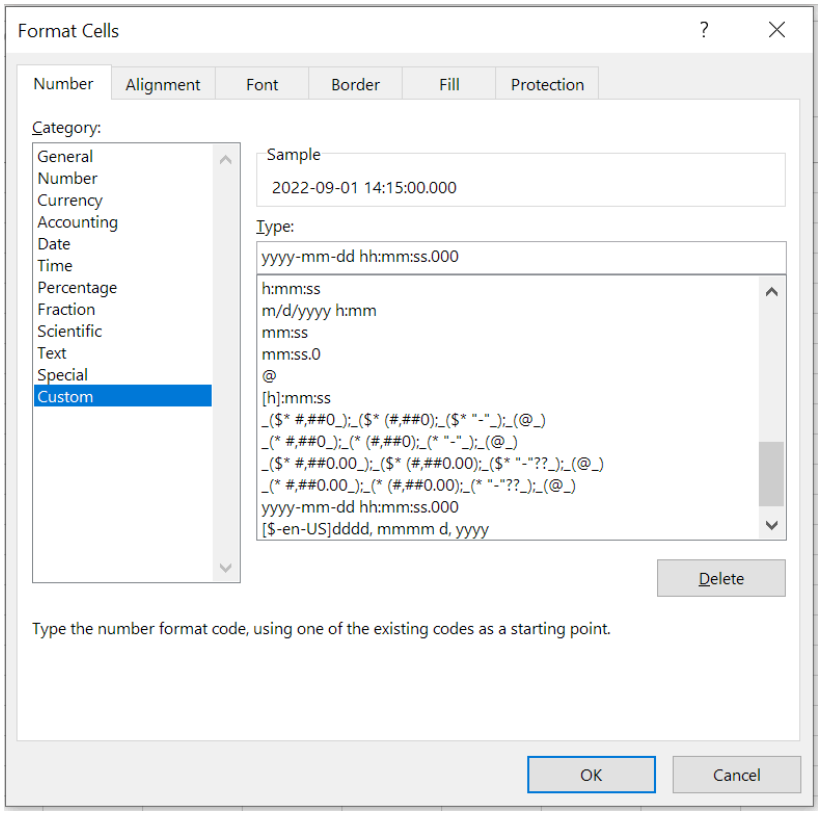

Figure 4.13 Format Cells

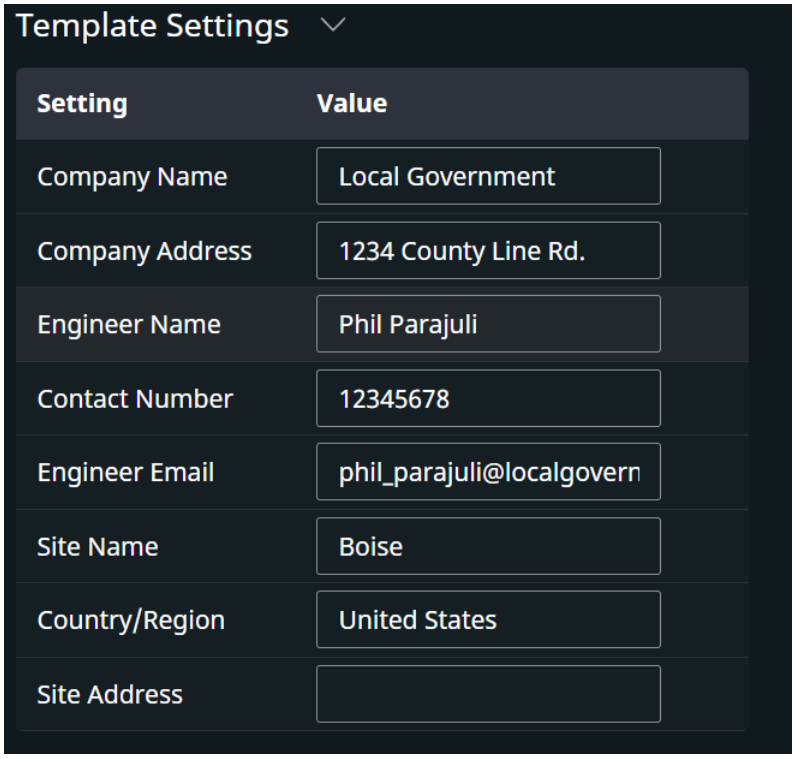

Figure 4.14 Configure the Template

Figure 4.15 Report Export Format Settings

If you navigate away from the currently selected template, a dialog appears asking you if you would like to discard your changes. **Discard** will discard your changes and navigate away. **Cancel** prevents the navigation and gives you the opportunity to save your changes.

To generate a report immediately, move your mouse over the value in the Template table and select the download icon (↓) that appears.

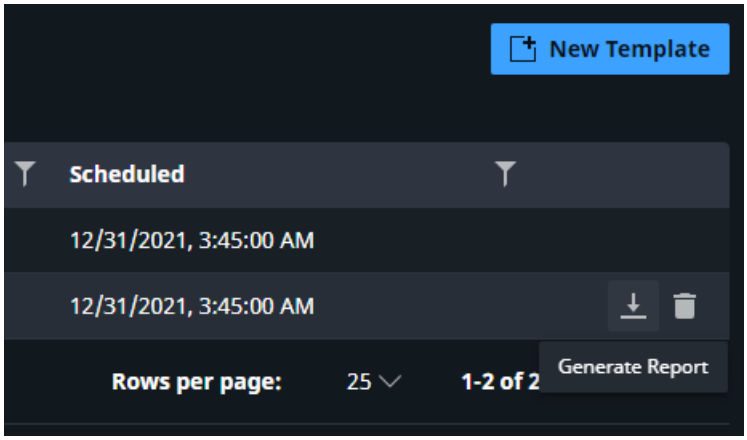

Figure 4.16 Generate a Report Immediately

NOTE
Synchrowave Report limits report size to 150 MB. Reports larger than this are not generated and result in an error message, as shown in Figure 4.17.

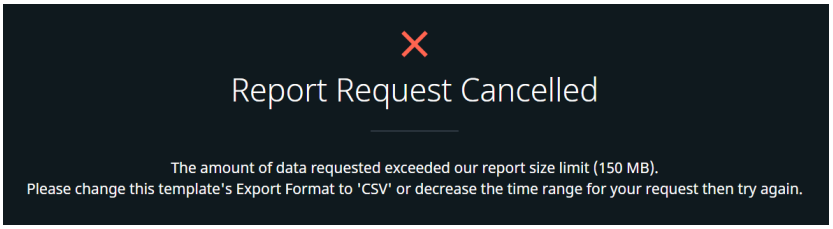

Figure 4.17 Report Too Large Error Message

Delete a Template by selecting the trash icon (🗑).

If a report is already scheduled, delete the task by moving your mouse over the value in the Scheduled column and selecting the close icon (✕).

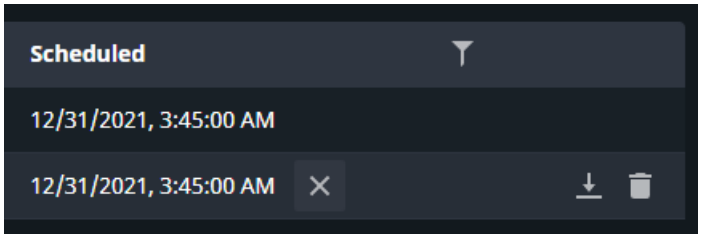

Figure 4.18 Delete a Task

To schedule a report, move your mouse over the value in the Scheduled column and select the Date/Time icon ( ).

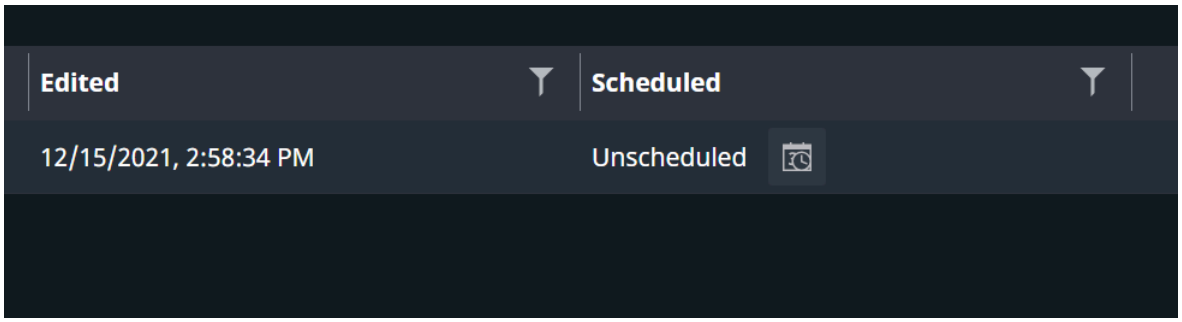

Figure 4.19 Schedule a Template

Fill out the Schedule Task form (*Figure 4.20*), then select **Schedule Task**.

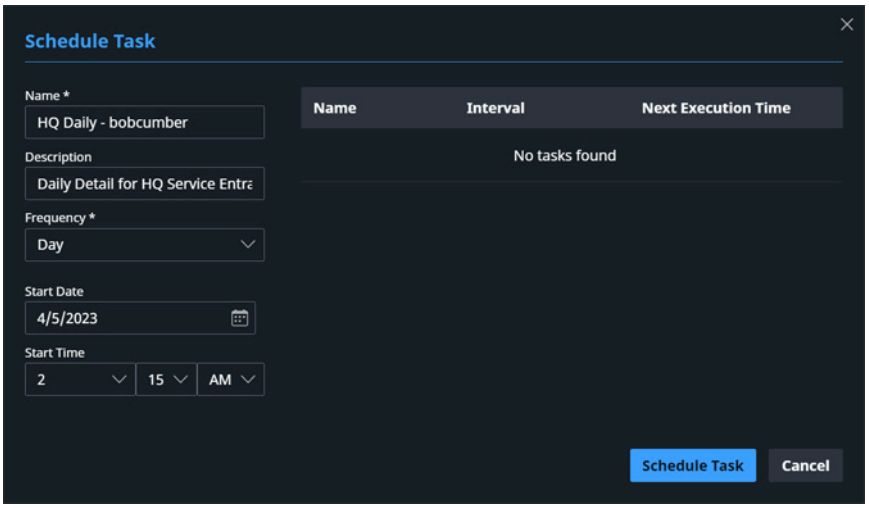

Figure 4.20 Configuring a Task

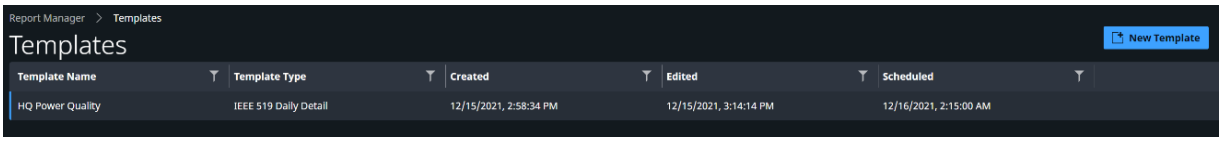

Figure 4.21 Created and Configured Template

At any point, you can rename a new or existing template by selecting the pencil icon ( ) next to its name. To finish editing the name, either select the checkmark ( ) to save it or the ✕ to discard it. *Figure 4.28* shows an example of editing a template name.

Reports View

The Reports view shows the reports in the database and allows you to email, save, and delete reports. Select a report row to preview a report.

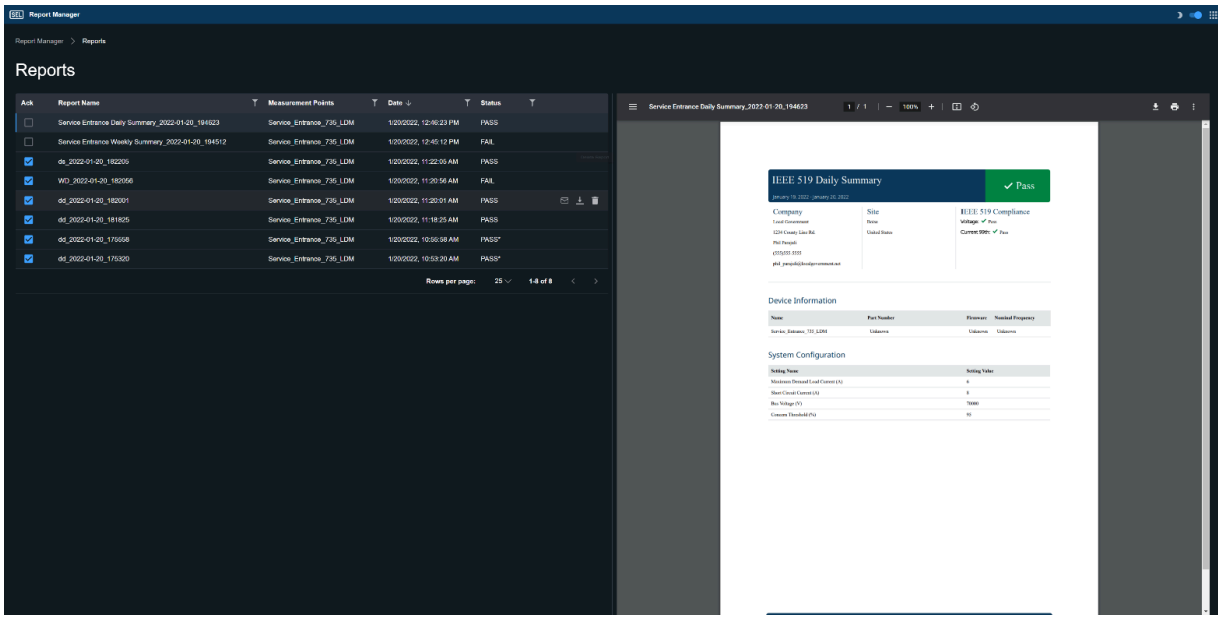

Figure 4.22 All Reports View

Move your mouse over a row to see the email, download, and delete options.

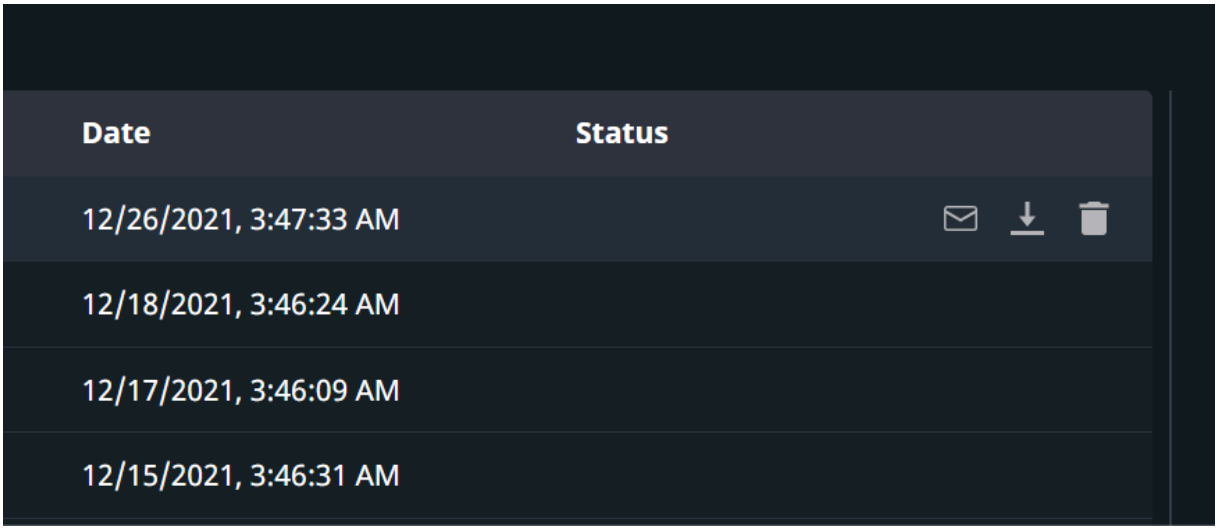

Figure 4.23 Email, Download, or Delete Report

Select the email icon (✉) to email the report to a recipient or a comma-separated list of recipients.

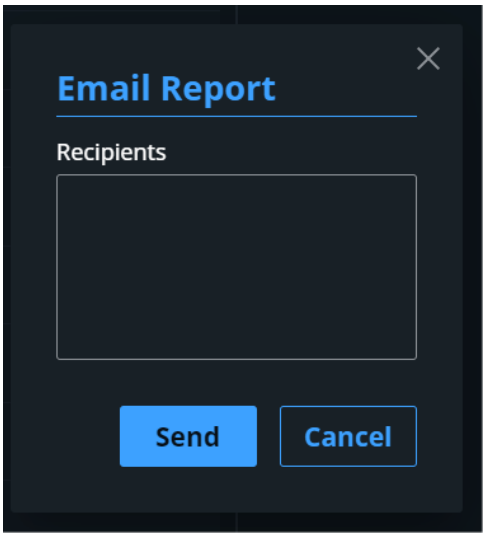

Figure 4.24 Email Report Recipients Window

To download a PDF of the report, select the download icon (⭳).

Selecting the trash icon (🗑) opens a dialog asking you to confirm the report deletion.

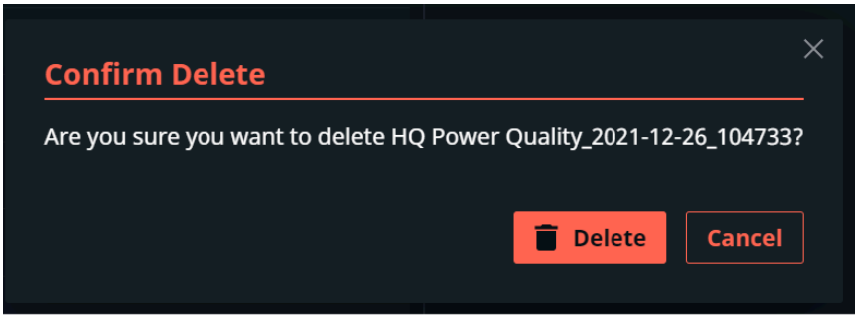

Figure 4.25 Confirm Deletion of a Report

Unlicensed Synchrowave Reports

Synchrowave Reports comes with a 60-day license. Once that license has expired, Synchrowave Reports will not display reports until the corresponding license is installed. To install a license for Synchrowave Reports, see *Appendix C: Synchrowave Reports License Activation*.

Data Visualization View

The Data Visualization view (*Figure 4.26*) allows you to plot data from a chartable template. You can also modify an existing chart and create a new template with those changes incorporated.

The Chartable Templates table at the bottom of the Data Visualization view shows the existing available templates. Select one of the reports to display its visualized data.

Changing a template setting without saving the template will generate a new chart.

NOTE
Some applications that provide charts may decrease the amount of data returned to increase chart responsiveness or decrease chart generation time.

Figure 4.26 Chart in the Data Visualization View

Chart Controls

Timeline

The timeline at the top of a generated chart allows you to narrow down the Date/Time range displayed to show an area of interest in more detail. Use the grips on the left and right side of the timeline to change the beginning and end, respectively, of the visualized data. Once the timeline narrows a chart's date range, you can save the template by selecting **Save Configuration** to use the current range as the template's range.

Legend

The legend shows the chart series that are in the graph. Each series has a marker that shows the color and line style of the series. Inside each marker is a checkmark that can be used to enable or disable a series.

Control Bar

Use the control bar at the top to turn the legend on or off, change the position of the legend, select a measurement point, or create a new chart from a chart type.

Chart Selector

Some chart types with a Measurement Points setting field generate separate charts for each measurement point. Use the chart selector to choose which one is displayed.

Chart Area

Hover your mouse over the chart area to highlight a point and view its exact coordinates.

Create a New Template From a Chart Type

Select a chart type from the Chart Types dropdown (as shown in *Figure 4.27*) to create a new template.

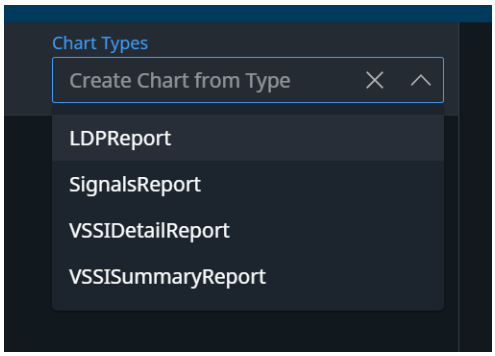

Figure 4.27 Create Chart From Type

When you select a template, the right sidebar displays the settings form for the template. Edit the name of the report (as shown in *Figure 4.28*), fill out the settings form, and select **Save Configuration**.

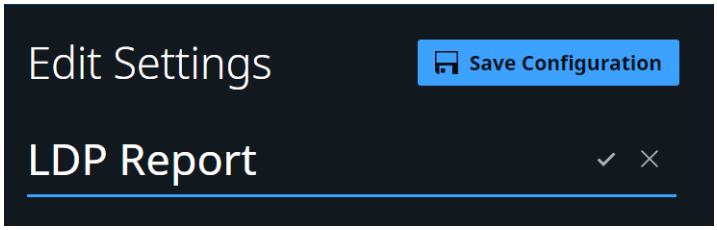

Figure 4.28 Edit the Report Name

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SECTION 5

Available Packages

Synchrowave Reports packages share the same infrastructure, but each provides a different set of report templates and reporting applications.

The available packages for Synchrowave Reports are:

- Meter Data (Metering Basics)
- Power Quality (IEEE 519, Monitoring, Continuous Waveform Streaming)

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SECTION 6

Meter Data Reports

Meter Data Application

The Meter Data Application provides a set of template types for Report Manager that can be used to generate general power system reports.

Meter Data Features

Meter Data provides the following reports:

- Device Overview Report
- LDP Report
- SER Report
- VSSI Summary Report
- VSSI Detail Report
- Signals Report

Data Sources

Meter Data uses a variety of data sources to populate reports, but primarily uses ACSELERATOR Database Reader as the root source of its data and uses the Signals interface as the main pathway for those data.

Reports

Device Overview Report

The Device Overview Report shows the devices present in the connected ACSELERATOR Database. This report shows the mapping of the Synchrowave Metering Point to the ACSELERATOR Database Device Name, the status of the device, and its time zone and current UTC Offset.

Device Overview Report

11/22/2022 | 11:32:59 AM

Devices

Metering Point	Status	Device Name	Status	Location	Time Zone	UTC Offset
Test Meter_SEL-735 Test Meter	✓ Enabled	SEL-735 Test Meter	● Online	Not Configured	US/Pacific	-08:00:00
Test Meter_DeskMeter	✓ Enabled	DeskMeter	● Online	Not Configured	US/Mountain	-07:00:00

11-22-2022 SEL SCHWEITZER ENGINEERING LABORATORIES Page 1 of 1

Figure 6.1 Device Overview Report

LDP Report

The LDP Report shows time-stamped data from as many as eight Load Data Profile (LDP) signals. LDP signals have the naming format MeasurementPoint:ChannelName.Function.AcquisitionRate.

The LDP Report handles NaN (not a number) values in its data source by replacing them with "-" by default or with "0" if Insert records for missing intervals is on.

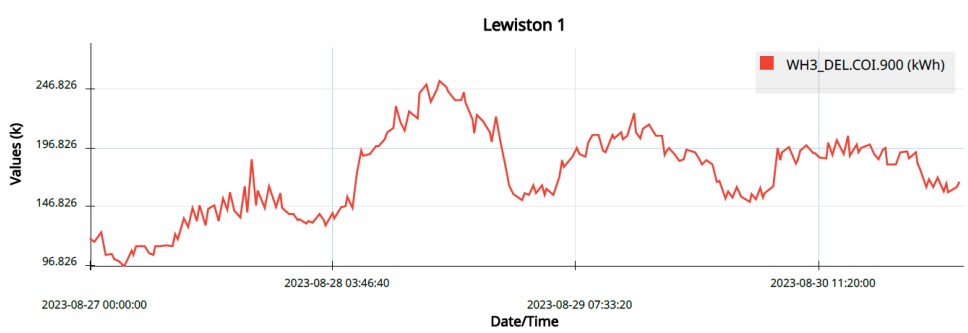
LDP (Load Data Profile) Report

9/5/2023 | 2:38:16 PM

Data Source & Settings

Metering Point: Lewiston_LEW_735
Device Name: LEW_735
Device ID: LEWISTON MAIN
Terminal ID: SERVICE 1
Firmware ID: SEL-735-R207-V1-Z102100-D20220601
CTR: 200
CTRN: 200
PTR: 1

Start Time: 2023-08-27 00:00:00.000
End Time: 2023-09-03 00:00:00.000
Time Zone: US/Pacific
UTC Offset: -07:00:00
Time Zone DST: True
Unit Scale: Kilo
Scale: Primary



8-27-2023 - 9-3-2023 SEL SCHWEITZER ENGINEERING LABORATORIES Page 1 of 18

Figure 6.2 LDP Report

Time	WH3_DEL	WH3_REC	QH3_DEL	QH3_REC	Status
2022-11-06 02:00:00.000	48.808	0.0000	9.3377	0.0000	
2022-11-06 02:15:00.000	49.664	0.0000	9.6356	0.0000	
2022-11-06 02:30:00.000	49.679	0.0000	9.2361	0.0000	
2022-11-06 02:45:00.000	50.970	0.0000	9.4195	0.0000	
2022-11-06 03:00:00.000	51.045	0.0000	9.3192	0.0000	
2022-11-06 03:15:00.000	51.132	0.0000	9.2001	0.0000	
2022-11-06 03:30:00.000	50.973	0.0000	9.0347	0.0000	
2022-11-06 03:45:00.000	50.971	0.0000	8.9773	0.0000	
2022-11-06 04:00:00.000	50.048	0.0000	8.9414	0.0000	
2022-11-06 04:15:00.000	50.748	0.0000	9.1531	0.0000	
2022-11-06 04:30:00.000	50.077	0.0000	9.1167	0.0000	
2022-11-06 04:45:00.000	50.015	0.0000	9.2115	0.0000	

Figure 6.3 LDP Report Data

LDP Report Settings

Scale

Use the scale setting to choose between primary and secondary scaling. Primary scaling represents the voltage and current values on the power system and scales values by the applicable current and potential transformer ratios configured in the device. Secondary scaling represents the voltage and current values at the point of the measurement device. Choosing secondary scaling will not scale values by the device's configured current and potential transformer ratios.

Select a unit scale to display values in Unity (watts, volts, watt-hours), Kilo (kilowatts, kilovolts, kilowatt-hours), or Mega (megawatts, megavolts, megawatt-hours). This setting does not affect units that do not scale, such as amperes, degrees, or percentages. It also does not affect values that are unitless, such as power factor.

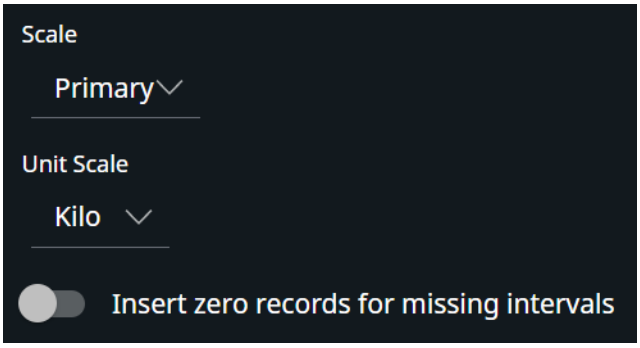


Figure 6.4 Scaling Settings

Time Range

Query data for a specific time range via the Time Range setting. The Time Range setting offers the following options, as shown in *Figure 6.1*.

- Custom — User-selectable date and time range
- Today — 12:00 a.m. today to 12:00 a.m. tomorrow
- Yesterday — 12:00 a.m. yesterday to 12:00 a.m. today

- Yesterday to present — 12:00 a.m. yesterday to 12:00 a.m. tomorrow
- Week to present — 12:00 a.m. on the previous Sunday to 12:00 a.m. tomorrow
- Last week — 12:00 a.m. on Sunday of last week to 12:00 a.m. on Sunday of this week
- Month to present — 12:00 a.m. on the first day of the month to 12:00 a.m. tomorrow
- Last month — 12:00 a.m. on the first day of last month to 12:00 a.m. on the first day of current month

When reports run on a schedule, all time ranges except Custom are relative to the time the report is run.

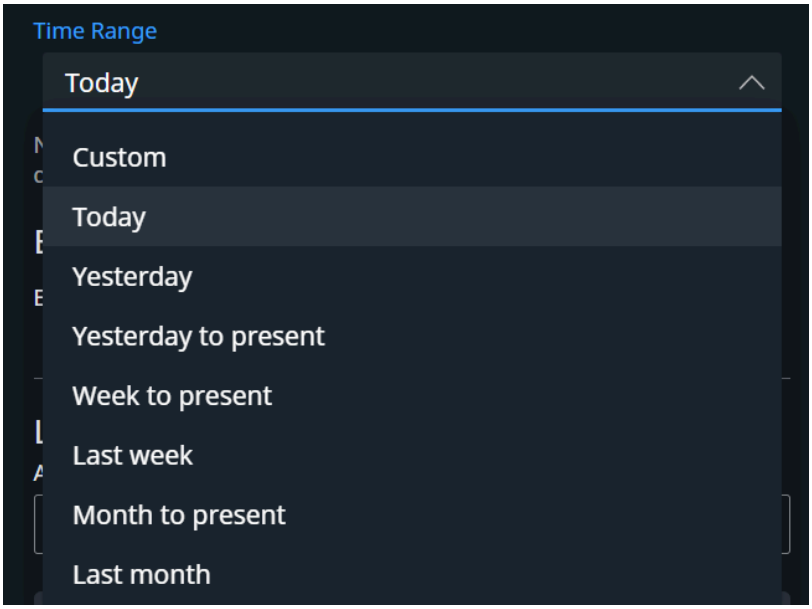


Figure 6.5 Time Range Selector

Custom, as shown in *Figure 6.6*, allows the user to select a start date and time and an end date and time. This time range is fixed and does not update when a report is scheduled.

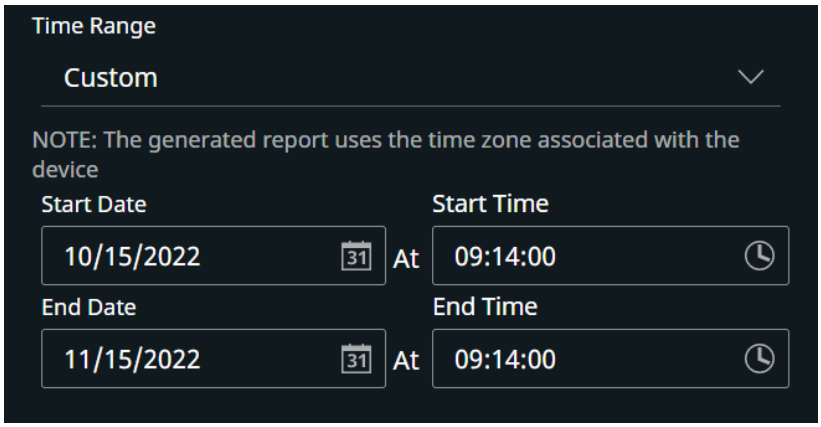


Figure 6.6 Custom Time Range Settings

LDP Signals Selector

Choose signals for an LDP Report with the Signal Selector.

The Signal Selector (*Figure 6.7*) for LDP has an auto-completion search that can be used to add LDP signals to the report. The LDP Report is designed for signals from Load Profile Recorders, which will have the format MeasurementPoint:ChannelName.ChannelFunction.AcquisitionRate. Signals with names in other formats are excluded from the selector. Once a signal is selected, the list is filtered to include only other LDP signals from that Measurement Point. Removing all selected signals from the Signals Selector will clear the Measurement Point filter and all LDP signals will be available again.

Edit a selected signal to create an alias for the signal's name in the reports. Use the undo button (↶) to revert the alias to the original name.

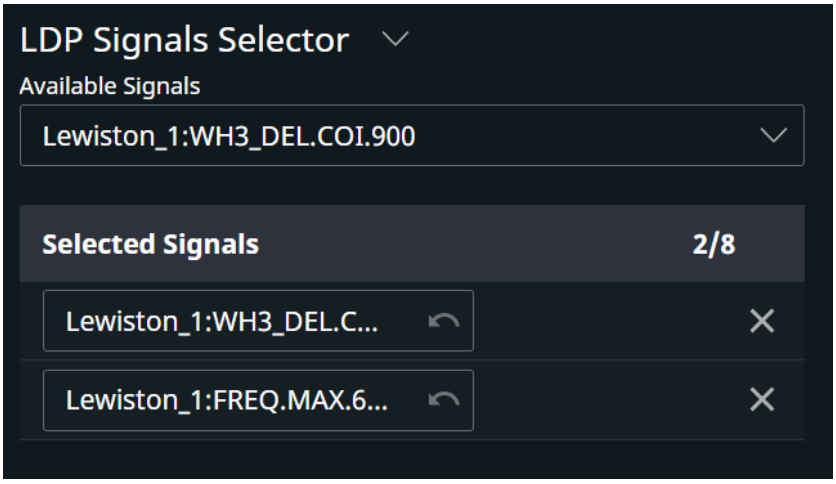


Figure 6.7 Signal Selector Settings

SER Report

The SER Report shows a list of Sequential Events Recorder (SER) events with the associated state. The Element is the Device Word bit (see the instruction manual accompanying your device for an explanation of the meaning of the Device Word bit) that changed state at the date and time indicated. The Status classifies what happened to the Device Word bit. Asserted means the Device Word bit went from FALSE to TRUE. Deasserted means the Device Word bit went from TRUE to FALSE. Other miscellaneous statuses will show as a blank cell in the Status column.

SER (Sequential Events Recorder) Report

11/22/2022 | 11:42:18 AM

Data Source & Settings

Metering Point: HighValley_735
Device Name: DeskMeter
Device ID: 236
Terminal ID: STATION A
Firmware ID: R207

Start Time: 2022-10-01 11:36:00.000
End Time: 2022-10-08 11:36:00.000
Time Zone: US/Mountain
UTC Offset: -06:00:00
Time Zone DST: True

Figure 6.8 SER Report

Events

Date	Element	Status
2022-10-01 12:34:57.525	SSI_EVE	Deasserted
2022-10-01 12:34:57.724	SSI_EVE	Asserted
2022-10-01 13:35:01.038	SSI_EVE	Deasserted
2022-10-01 13:35:01.238	SSI_EVE	Asserted
2022-10-01 14:35:04.554	SSI_EVE	Deasserted
2022-10-01 14:35:04.754	SSI_EVE	Asserted
2022-10-01 17:35:14.901	SSI_EVE	Deasserted
2022-10-01 17:35:15.101	SSI_EVE	Asserted
2022-10-01 18:35:18.418	SSI_EVE	Deasserted

Figure 6.9 SER Report Data

SER Report Settings

Set the time range for the template by using the Time Range setting (see *Time Range on page 49*).

Measurement Point

Select the measurement point or points to use with the template by selecting the check boxes next to each desired measurement point. When multiple measurement points are selected, Report Manager will generate a report for each.

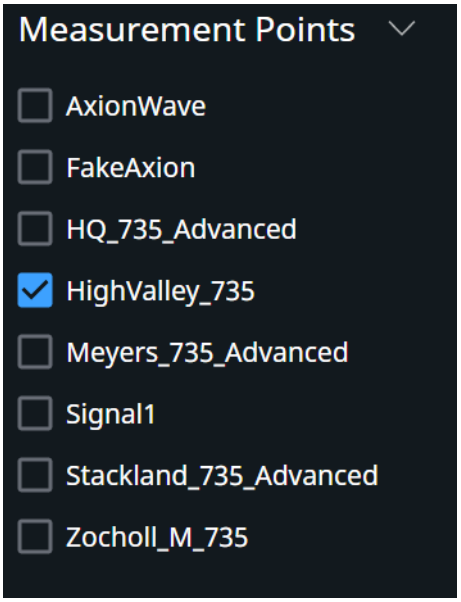


Figure 6.10 Measurement Points Setting

VSSI Summary Report

The VSSI Summary Report displays individual voltage sag, swell, and interruption (VSSI) events.

Each event has the following information:

- The type of the event
- The date and time of the event
- The duration of the event
- The depth of the event
- A-phase V_{base} Voltage
- B-phase V_{base} Voltage
- C-phase V_{base} Voltage
- A-phase minimum voltage (in percent V_{base})
- A-phase maximum voltage (in percent V_{base})
- B-phase minimum voltage (in percent V_{base})
- B-phase maximum voltage (in percent V_{base})
- C-phase minimum voltage (in percent V_{base})
- C-phase maximum voltage (in percent V_{base})
- ITIC curve region

The events are classified by type as Sag, Swell, Int (interrupt), and Trig (user-triggered). Sag, Swell, and Interrupt limits are configured in the device as a percentage of V_{base} to trigger event capture when the voltage magnitude crosses the threshold.

The Duration displays the length of time for which the event was active. The Depth is the minimum voltage in percentage of V_{base} of the three phases for a sag or interrupt and the maximum voltage in percentage of V_{base} of the three phases for a swell.

The ITIC Region corresponds to the regions of the curve defined by the Information Technology Industry Council (ITIC), which represents the effects of a voltage sag, swell, or interrupt event on information technology (IT) based on the duration and depth of the event.

ITIC Region	Definition
SR	Safe Region
ND	No Damage Region
PR	Prohibited Region

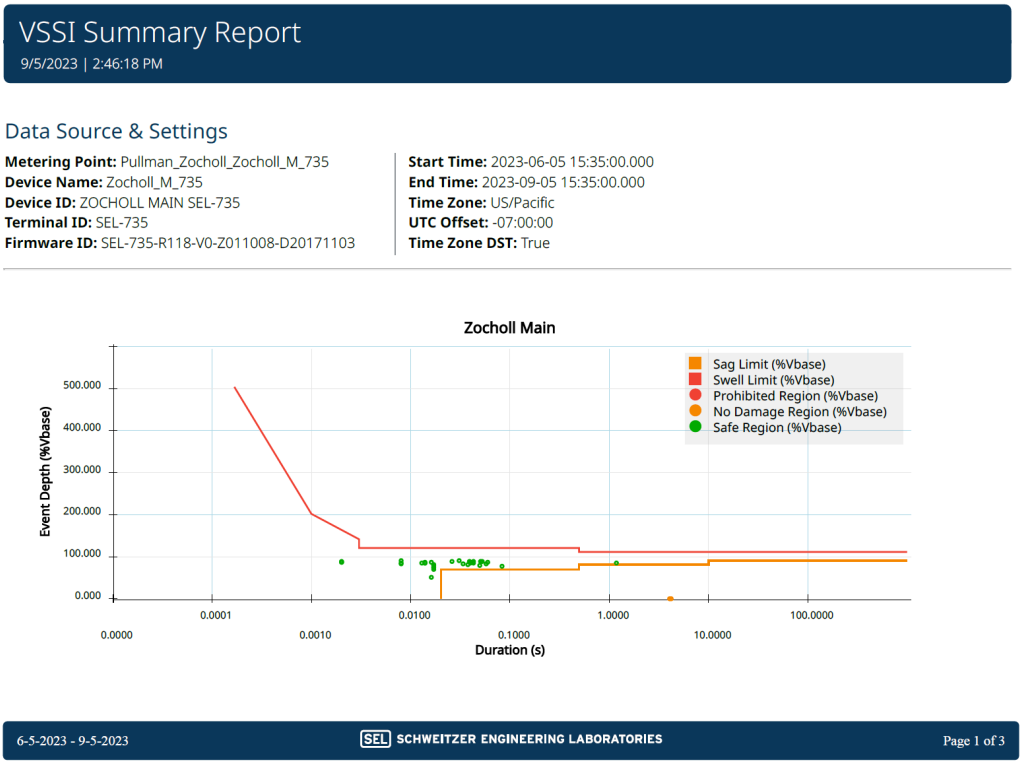


Figure 6.11 VSSI Summary Report

VSSI Summary Data

ITIC Region Descriptions
SR: Safe region
ND: No damage region
PR: Prohibited region

				VA			VB			VC			
Type	Time	Duration	Depth	Vbase	Min	Max	Vbase	Min	Max	Vbase	Min	Max	Region
Sag	2022-10-01 12:34:55.133	2.214 s	0.00%	120.00	0.00%	98.20%	120.00	0.00%	84.20%	120.00	0.00%	111.20%	ND
Swell	2022-10-01 12:34:57.349	0.169 s	139.50%	120.00	138.90%	139.00%	120.00	138.40%	138.70%	120.00	139.30%	139.50%	PR
Swell	2022-10-01 12:34:57.711	01:00:00.903 h	139.50%	120.00	99.90%	139.20%	120.00	107.90%	138.70%	120.00	128.00%	139.50%	PR
Sag	2022-10-01 13:34:58.626	2.212 s	0.00%	120.00	0.00%	94.80%	120.00	0.00%	28.70%	120.00	0.00%	95.20%	ND
Swell	2022-10-01 13:35:00.842	0.188 s	139.40%	120.00	138.90%	139.10%	120.00	138.50%	138.70%	120.00	139.30%	139.40%	PR
Swell	2022-10-01 13:35:01.225	01:00:00.887 h	139.50%	120.00	134.40%	139.10%	120.00	138.30%	138.70%	120.00	130.40%	139.50%	PR
Sag	2022-10-01 14:35:02.120	2.215 s	0.00%	120.00	0.00%	29.60%	120.00	0.00%	22.70%	120.00	0.00%	58.40%	ND
Swell	2022-10-01 14:35:04.336	0.207 s	139.50%	120.00	138.90%	139.10%	120.00	138.40%	138.80%	120.00	139.30%	139.50%	PR
Swell	2022-10-01 14:35:04.740	01:00:00.867 h	139.50%	120.00	98.40%	139.20%	120.00	100.90%	138.80%	120.00	131.20%	139.50%	PR
Sag	2022-10-01 15:35:05.619	2.213 s	0.00%	120.00	0.00%	98.00%	120.00	0.00%	44.20%	120.00	0.00%	94.90%	ND
Swell	2022-10-01 15:35:07.835	01:00:01.275 h	139.50%	120.00	137.80%	139.10%	120.00	99.60%	138.70%	120.00	130.20%	139.50%	PR
Sag	2022-10-01 16:35:09.114	2.216 s	0.00%	120.00	0.00%	6.00%	120.00	0.00%	20.80%	120.00	0.00%	28.40%	ND
Swell	2022-10-01 16:35:11.330	01:00:01.277 h	139.70%	120.00	99.10%	139.20%	120.00	99.60%	138.80%	120.00	100.10%	139.70%	PR

Figure 6.12 VSSI Summary Report Data

VSSI Summary Report Settings

You can select a measurement point for the report and/or select a time range using the applicable settings (see *Measurement Point on page 52* and *Time Range on page 49*, respectively, for more information).

VSSI Detail Report

The VSSI Detail Report displays individual VSSI records recorded during VSSI events.

Each record has the following information:

- Date and time the sample was recorded
- A-phase current (in percent of I_{nom})
- B-phase current (in percent of I_{nom})
- C-phase current (in percent of I_{nom})
- Ground current (in percent of I_{nom})
- Neutral current (in percent of I_{nom})
- A-phase V_{base} voltage
- A-phase voltage (in percent of V_{base} A)
- B-phase V_{base} voltage
- B-phase voltage (in percent of V_{base} B)
- C-phase V_{base} voltage
- C-phase voltage (in percent of V_{base} C)
- A-phase state
- B-phase state
- C-phase state
- Record status value indicating the recording rate when the record was recorded

VSSI detail records are captured at a variable rate that depends on the event length and when the voltage crosses the VSSI thresholds. The Status Code column indicates the recording rate for each record. The report includes status codes below the data table. These codes are defined as follows:

Status Code	Meaning
R	Ready (any channel is armed)
P	Pre-disturbance (4 samples per cycle)
F	Fast recording mode (4 samples per cycle)
E	End (post-disturbance at 4 samples per cycle)
M	Medium recording mode (1 sample per cycle)
S	Slow recording mode (1 sample per 64 cycles)
D	Daily recording mode (1 sample per day, triggered at midnight)

The individual phase states are represented as follows:

Phase State	Meaning
(blank)	No VSSI bits asserted for phase
O	Overvoltage
U	Undervoltage
I	Interruption

Figure 6.13 VSSI Detail Report

VSSI Detail Data

Phase State Descriptions
O: Overvoltage (SWp) asserted
U: Undervoltage (SAGp) asserted
I: Interruption (INTp asserted; SAGp asserted, unless setting VSAG := OFF)

Status Descriptions
R: Ready (any channel is armed)
P: Pre-disturbance (4 samples per cycle)
F: Fast recording mode (4 samples per cycle)
E: End (post-disturbance at 4 samples per cycle)
M: Medium recording mode (one sample per cycle)
S: Slow recording mode (one sample per 64 cycles)
D: Daily recording mode (one sample per day, triggered at midnight)

	Current(% Inom)					VA		VB		VC		Phases			
Time	IA	IB	IC	IG	IN	Vbase	%Vbase	Vbase	%Vbase	Vbase	%Vbase	A	B	C	Status
2022-11-05 03:09:25.685	9.30%	8.60%	8.80%	0.40%	0.00%	120.00	103.50%	120.00	103.50%	120.00	102.60%				P
2022-11-05 03:09:25.689	9.30%	8.70%	8.80%	0.50%	0.00%	120.00	103.50%	120.00	103.50%	120.00	102.50%				P
2022-11-05 03:09:25.693	9.30%	8.60%	8.80%	0.40%	0.00%	120.00	103.40%	120.00	103.50%	120.00	102.60%				P
2022-11-05 03:09:25.698	9.30%	8.60%	8.90%	0.40%	0.00%	120.00	103.40%	120.00	103.60%	120.00	102.60%				P
2022-11-05 03:09:25.702	9.40%	8.70%	8.90%	0.40%	0.00%	120.00	103.40%	120.00	103.50%	120.00	102.50%				P
2022-11-05 03:09:25.706	9.40%	8.80%	8.90%	0.40%	0.00%	120.00	103.50%	120.00	103.50%	120.00	102.50%				P
2022-11-05 03:09:25.710	9.30%	8.80%	8.90%	0.40%	0.00%	120.00	103.40%	120.00	103.50%	120.00	102.60%				P

Figure 6.14 VSSI Detail Report Data

VSSI Detail Report Settings

You can select a measurement point for the report and/or select a time range using the applicable settings (see *Measurement Point on page 52* and *Time Range on page 49*, respectively, for more information).

Because hundreds of VSSI Detail records correspond to a single VSSI Summary event, it can be helpful to use the custom time range setting to narrow down the data returned to a few minutes or hours.

Signals Report

The Signals Report allows users to create a report with as many as eight signals with any signal naming convention. Additionally, users can scale the selected signals in the template configuration.

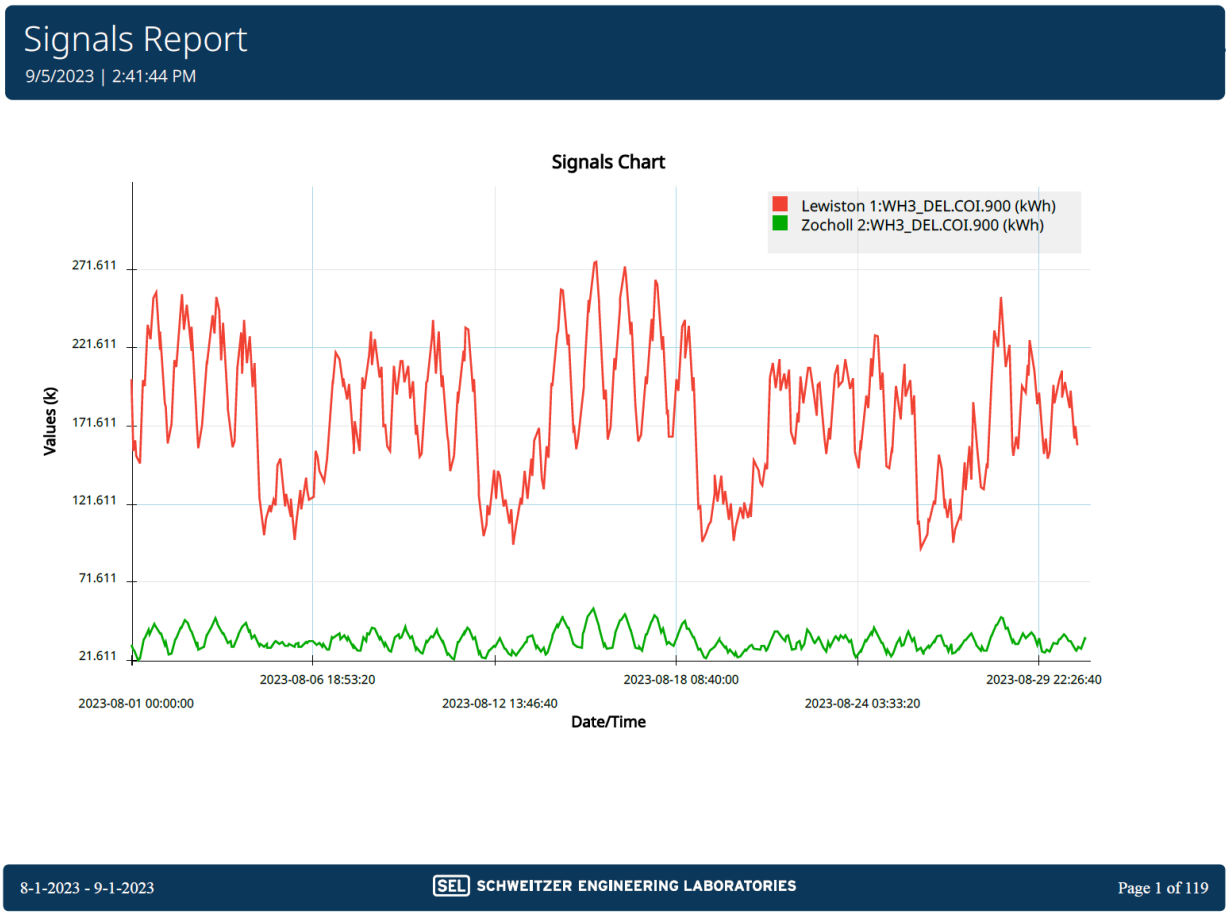


Figure 6.15 Signals Report

Signals Report Settings

Select a time range by using the Time Range setting (see *Time Range on page 49*).

Edit a selected signal to create an alias for the signal's name in the reports. Use the undo button (↶) to revert the alias to the original name.

Because the Signals report uses data from multiple measurement points, it cannot automatically evaluate in which time zone the data were collected. Choose a time zone to use from the Time Zone dropdown list (as shown in *Figure 6.16*).

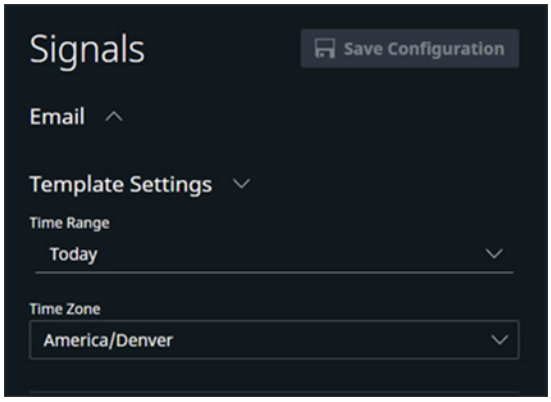


Figure 6.16 Time Zone Field

Signals Report Signal Selector

Choose signals for a Signals Report using the Signals Report Signal Selector.

The Signals Report Signal Selector allows users to select as many as eight signals for PDF reports and as many as 512 signals for CSV reports. These signals can use any naming convention and can come from any Measurement Point or Points.

Optionally, scale a signal or signals by entering a number next to the selected signal(s). *Figure 6.17* shows an example of scaling the Water Meter channel from units of 0.5 cubic feet to gallons (0.5 cubic feet = 3.74 gallons).

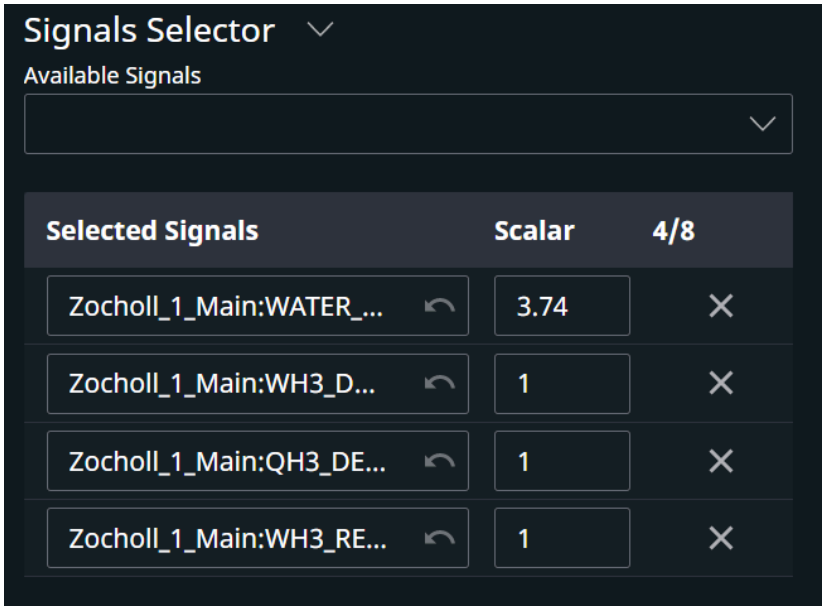


Figure 6.17 Signals Report Signal Selector

Charts

The charts in reports automatically scale to the magnitude of the largest value in the largest series. The Y axis label displays the scale as nano (n), micro (u), milli (m), unity (no units), kilo (k), Mega (M), or Giga (G).

LDP Chart

The LDP Chart plots the selected channels for a single measurement point.

VSSI Summary Chart

The VSSI Summary Chart shows the duration and depth of Voltage Sag, Swell, and Interrupt events plotted on the same chart as the lines that define the ITIC regions.

VSSI Detail Chart

The VSSI Detail Chart plots voltage and current during Voltage Sag, Swell, and Interrupt event recording.

Signals Chart

The Signals Chart plots the selected signals.

SECTION 7

Power Quality Reports

IEEE 519 Application

The IEEE 519 application is a set of template types for Report Manager that can be used to generate IEEE 519 harmonic compliance reports. Additionally, this application provides the necessary tools to collect data for an IEEE 519 report.

IEEE 519 Features

- Collects IEEE 519 data from the ACSELERATOR Database
- Provides IEEE 519 templates
- Maps IEEE 519 settings to measurement points

Data Sources

The IEEE 519 application uses the ACSELERATOR Database Reader to collect the necessary LDP data from the ACSELERATOR Database.

The IEEE 519 application only supports LDP data collected by an SEL-735.

Channels that are not present in the ACSELERATOR Database for the selected device cause the IEEE 519 report to have blank table rows. *Table 7.1* lists the required channels.

Table 7.1 IEEE 519 Data Sources

Channel Name[a]	Function	Acquisition Rate (s)	Max Duration (Days)
HRMM1_I*x*_3SEC	EOI	3	10
THDV*x*_3SEC	EOI	3	10
THDI*x*_3SEC	EOI	3	10
HRMM*n*_I*x*_3SEC	EOI	3	10
HRMM*n*_V*x*_3SEC	EOI	3	10

[a] Where x is the phase (A, B, or C) and n is the harmonic order (2–50).

The IEEE 519 application periodically collects and aggregates data from the ACSELERATOR Database.

Configure an SEL-735 for IEEE 519 Reporting

For an SEL-735 to collect the information necessary for IEEE 519 reporting, it must be a Form 9 Advanced Power Quality SEL-735.

To configure a compatible SEL-735 for IEEE 519 reporting in QuickSet, set the Harmonic Calculation Method (HARMCAL) setting to **SUBGROUP** in the Harmonics Settings, and then select the **IEEE 519 for Synchrowave Reports [All-50th, 3-second]** preset from the drop-down menu in the Load Profile Settings.

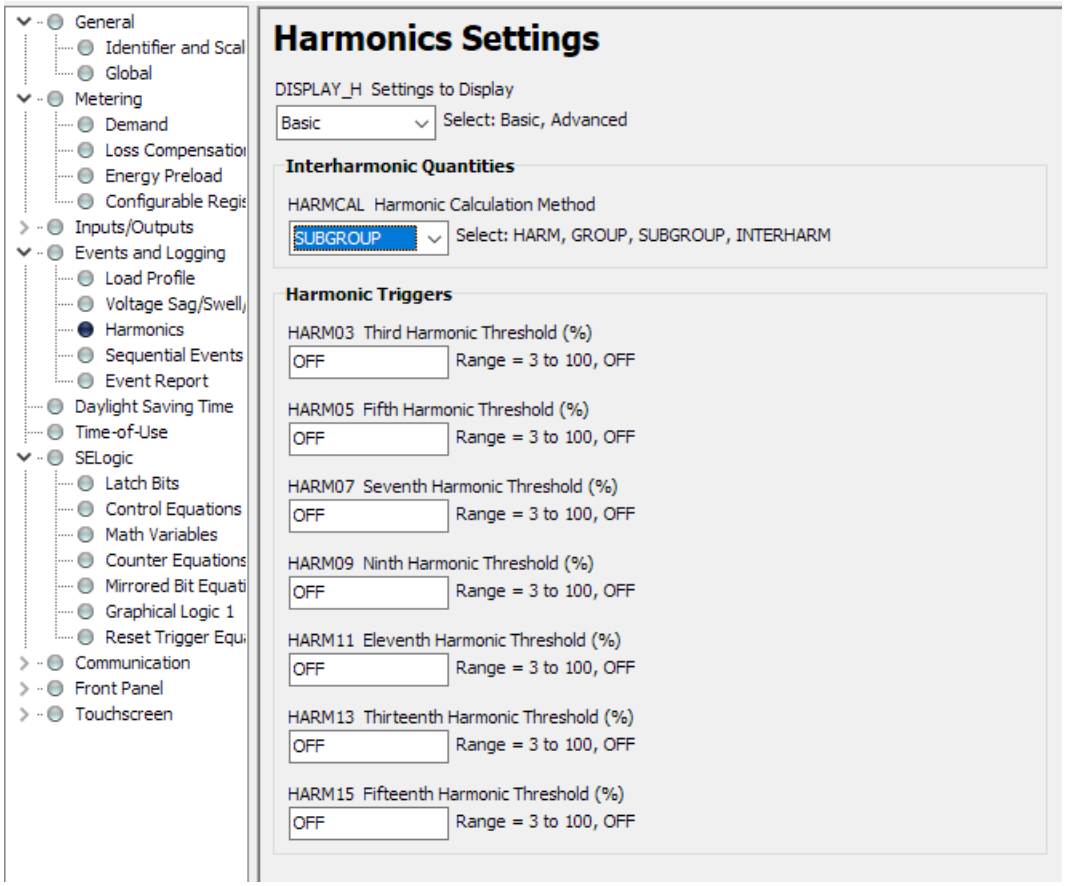
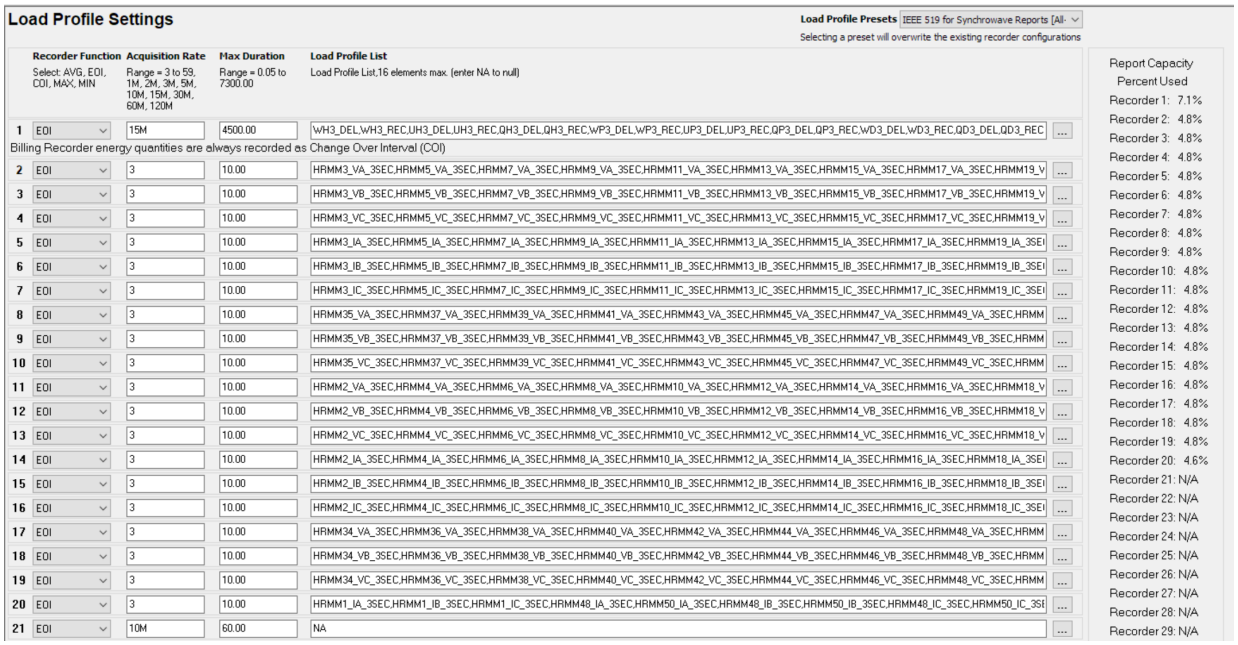


Figure 7.1 Change HARMCAL to SUBGROUP



Load Profile Settings

Load Profile Presets: IEEE 519 for Synchrowave Reports [All-
Selecting a preset will overwrite the existing recorder configurations

	Recorder Function Select: AVG, EOI, COI, MAX, MIN	Acquisition Rate Range = 3 to 59, 1M, 2M, 3M, 5M, 10M, 15M, 30M, 60M, 120M	Max Duration Range = 0.05 to 7300.00	Load Profile List Load Profile List,16 elements max. (enter NA to null)
1	EOI	15M	4500.00	WH3_DEL,WH3_REC,UH3_DEL,UH3_REC,QH3_DEL,QH3_REC,WP3_DEL,WP3_REC,UP3_DEL,UP3_REC,QP3_DEL,QP3_REC,WD3_DEL,WD3_REC,QD3_DEL,QD3_REC
Billing Recorder energy quantities are always recorded as Change Over Interval (COI)				
2	EOI	3	10.00	HRMM3_VA_3SEC,HRMM5_VA_3SEC,HRMM7_VA_3SEC,HRMM9_VA_3SEC,HRMM11_VA_3SEC,HRMM13_VA_3SEC,HRMM15_VA_3SEC,HRMM17_VA_3SEC,HRMM19_V
3	EOI	3	10.00	HRMM3_VB_3SEC,HRMM5_VB_3SEC,HRMM7_VB_3SEC,HRMM9_VB_3SEC,HRMM11_VB_3SEC,HRMM13_VB_3SEC,HRMM15_VB_3SEC,HRMM17_VB_3SEC,HRMM19_V
4	EOI	3	10.00	HRMM3_VC_3SEC,HRMM5_VC_3SEC,HRMM7_VC_3SEC,HRMM9_VC_3SEC,HRMM11_VC_3SEC,HRMM13_VC_3SEC,HRMM15_VC_3SEC,HRMM17_VC_3SEC,HRMM19_V
5	EOI	3	10.00	HRMM3_IA_3SEC,HRMM5_IA_3SEC,HRMM7_IA_3SEC,HRMM9_IA_3SEC,HRMM11_IA_3SEC,HRMM13_IA_3SEC,HRMM15_IA_3SEC,HRMM17_IA_3SEC,HRMM19_IA_3SE
6	EOI	3	10.00	HRMM3_IB_3SEC,HRMM5_IB_3SEC,HRMM7_IB_3SEC,HRMM9_IB_3SEC,HRMM11_IB_3SEC,HRMM13_IB_3SEC,HRMM15_IB_3SEC,HRMM17_IB_3SEC,HRMM19_IB_3SE
7	EOI	3	10.00	HRMM3_IC_3SEC,HRMM5_IC_3SEC,HRMM7_IC_3SEC,HRMM9_IC_3SEC,HRMM11_IC_3SEC,HRMM13_IC_3SEC,HRMM15_IC_3SEC,HRMM17_IC_3SEC,HRMM19_IC_3SE
8	EOI	3	10.00	HRMM35_VA_3SEC,HRMM37_VA_3SEC,HRMM39_VA_3SEC,HRMM41_VA_3SEC,HRMM43_VA_3SEC,HRMM45_VA_3SEC,HRMM47_VA_3SEC,HRMM49_VA_3SEC,HRMM
9	EOI	3	10.00	HRMM35_VB_3SEC,HRMM37_VB_3SEC,HRMM39_VB_3SEC,HRMM41_VB_3SEC,HRMM43_VB_3SEC,HRMM45_VB_3SEC,HRMM47_VB_3SEC,HRMM49_VB_3SEC,HRMM
10	EOI	3	10.00	HRMM35_VC_3SEC,HRMM37_VC_3SEC,HRMM39_VC_3SEC,HRMM41_VC_3SEC,HRMM43_VC_3SEC,HRMM45_VC_3SEC,HRMM47_VC_3SEC,HRMM49_VC_3SEC,HRMM
11	EOI	3	10.00	HRMM2_VA_3SEC,HRMM4_VA_3SEC,HRMM6_VA_3SEC,HRMM8_VA_3SEC,HRMM10_VA_3SEC,HRMM12_VA_3SEC,HRMM14_VA_3SEC,HRMM16_VA_3SEC,HRMM18_V
12	EOI	3	10.00	HRMM2_VB_3SEC,HRMM4_VB_3SEC,HRMM6_VB_3SEC,HRMM8_VB_3SEC,HRMM10_VB_3SEC,HRMM12_VB_3SEC,HRMM14_VB_3SEC,HRMM16_VB_3SEC,HRMM18_V
13	EOI	3	10.00	HRMM2_VC_3SEC,HRMM4_VC_3SEC,HRMM6_VC_3SEC,HRMM8_VC_3SEC,HRMM10_VC_3SEC,HRMM12_VC_3SEC,HRMM14_VC_3SEC,HRMM16_VC_3SEC,HRMM18_V
14	EOI	3	10.00	HRMM2_IA_3SEC,HRMM4_IA_3SEC,HRMM6_IA_3SEC,HRMM8_IA_3SEC,HRMM10_IA_3SEC,HRMM12_IA_3SEC,HRMM14_IA_3SEC,HRMM16_IA_3SEC,HRMM18_IA_3SE
15	EOI	3	10.00	HRMM2_IB_3SEC,HRMM4_IB_3SEC,HRMM6_IB_3SEC,HRMM8_IB_3SEC,HRMM10_IB_3SEC,HRMM12_IB_3SEC,HRMM14_IB_3SEC,HRMM16_IB_3SEC,HRMM18_IB_3SE
16	EOI	3	10.00	HRMM2_IC_3SEC,HRMM4_IC_3SEC,HRMM6_IC_3SEC,HRMM8_IC_3SEC,HRMM10_IC_3SEC,HRMM12_IC_3SEC,HRMM14_IC_3SEC,HRMM16_IC_3SEC,HRMM18_IC_3SE
17	EOI	3	10.00	HRMM34_VA_3SEC,HRMM36_VA_3SEC,HRMM38_VA_3SEC,HRMM40_VA_3SEC,HRMM42_VA_3SEC,HRMM44_VA_3SEC,HRMM46_VA_3SEC,HRMM48_VA_3SEC,HRMM
18	EOI	3	10.00	HRMM34_VB_3SEC,HRMM36_VB_3SEC,HRMM38_VB_3SEC,HRMM40_VB_3SEC,HRMM42_VB_3SEC,HRMM44_VB_3SEC,HRMM46_VB_3SEC,HRMM48_VB_3SEC,HRMM
19	EOI	3	10.00	HRMM34_VC_3SEC,HRMM36_VC_3SEC,HRMM38_VC_3SEC,HRMM40_VC_3SEC,HRMM42_VC_3SEC,HRMM44_VC_3SEC,HRMM46_VC_3SEC,HRMM48_VC_3SEC,HRMM
20	EOI	3	10.00	HRMM1_IA_3SEC,HRMM1_IB_3SEC,HRMM1_IC_3SEC,HRMM48_IA_3SEC,HRMM50_IA_3SEC,HRMM48_IB_3SEC,HRMM50_IB_3SEC,HRMM48_IC_3SEC,HRMM50_IC_3SE
21	EOI	10M	60.00	NA

Report Capacity Percent Used	
Recorder 1:	7.1%
Recorder 2:	4.8%
Recorder 3:	4.8%
Recorder 4:	4.8%
Recorder 5:	4.8%
Recorder 6:	4.8%
Recorder 7:	4.8%
Recorder 8:	4.8%
Recorder 9:	4.8%
Recorder 10:	4.8%
Recorder 11:	4.8%
Recorder 12:	4.8%
Recorder 13:	4.8%
Recorder 14:	4.8%
Recorder 15:	4.8%
Recorder 16:	4.8%
Recorder 17:	4.8%
Recorder 18:	4.8%
Recorder 19:	4.8%
Recorder 20:	4.6%
Recorder 21:	N/A
Recorder 22:	N/A
Recorder 23:	N/A
Recorder 24:	N/A
Recorder 25:	N/A
Recorder 26:	N/A
Recorder 27:	N/A
Recorder 28:	N/A
Recorder 29:	N/A

Figure 7.2 IEEE 519 for Synchrowave Reports [All-50th, 3-Second]

Recommended TEAM Configuration

To ensure that data are available to the IEEE 519 application when reports are run, set up TEAM LDP polling over a network connection at a 2-hour interval. More-frequent polling can be used, but less-frequent polling is not recommended.

Step 1. Navigate to a device in Device Manager and select the **TEAM** tab.

Step 2. Select **Edit**.

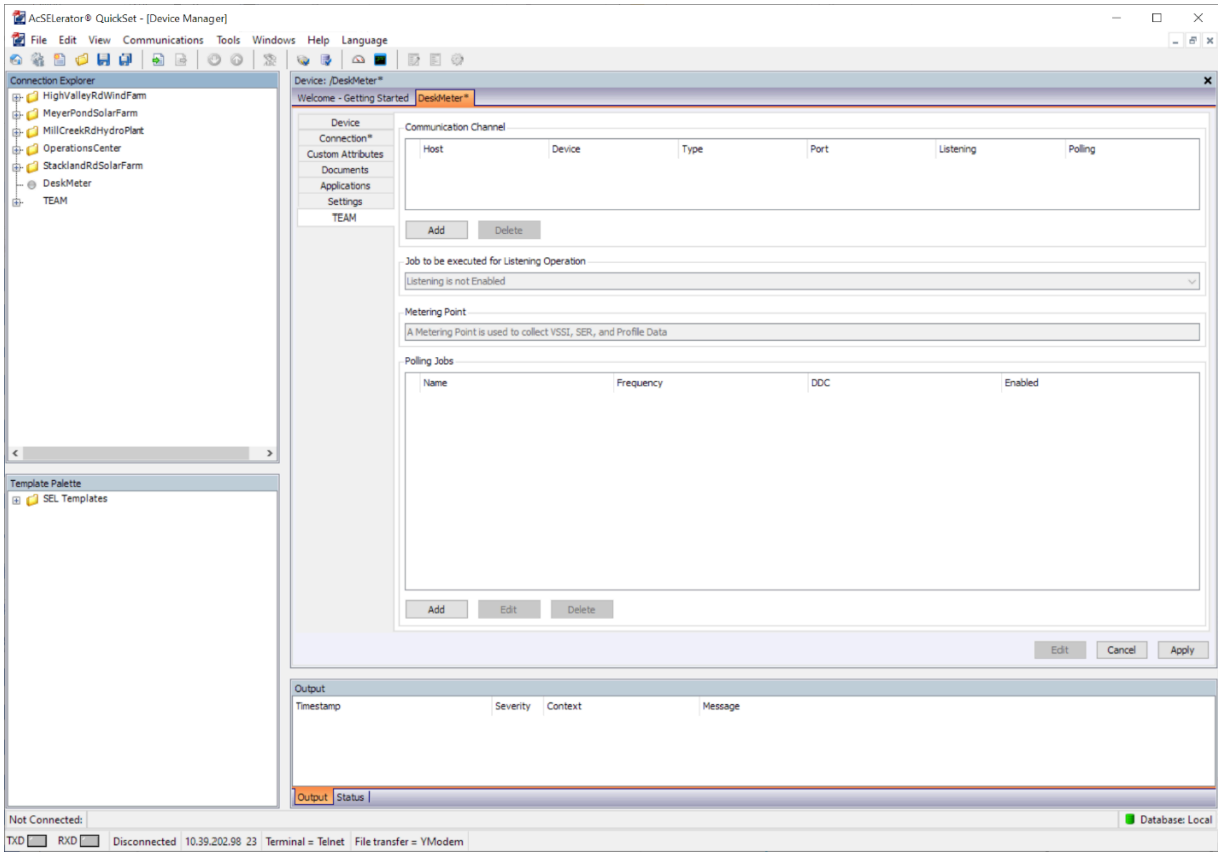


Figure 7.3 TEAM Tab

Step 3. Select the **Profile Collection** Job, as shown in *Figure 7.4*.

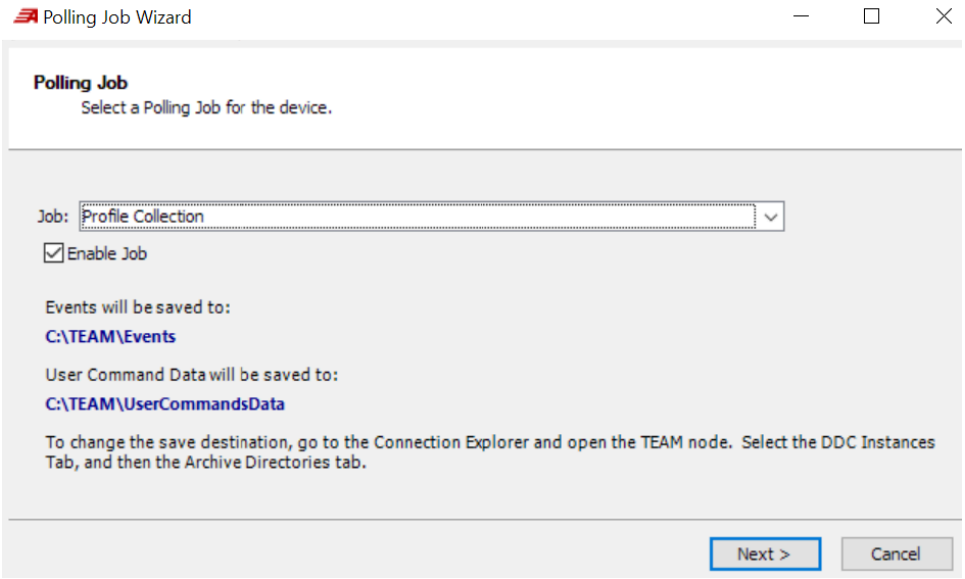


Figure 7.4 Polling Job Wizard

Step 4. Select recorders 1–20 and set a Beginning Timestamp.

NOTE

Set the **Beginning Timestamp** to the date the meter started recording data or to the number of days prior to the current date to match the LMDUR setting for the recorder.

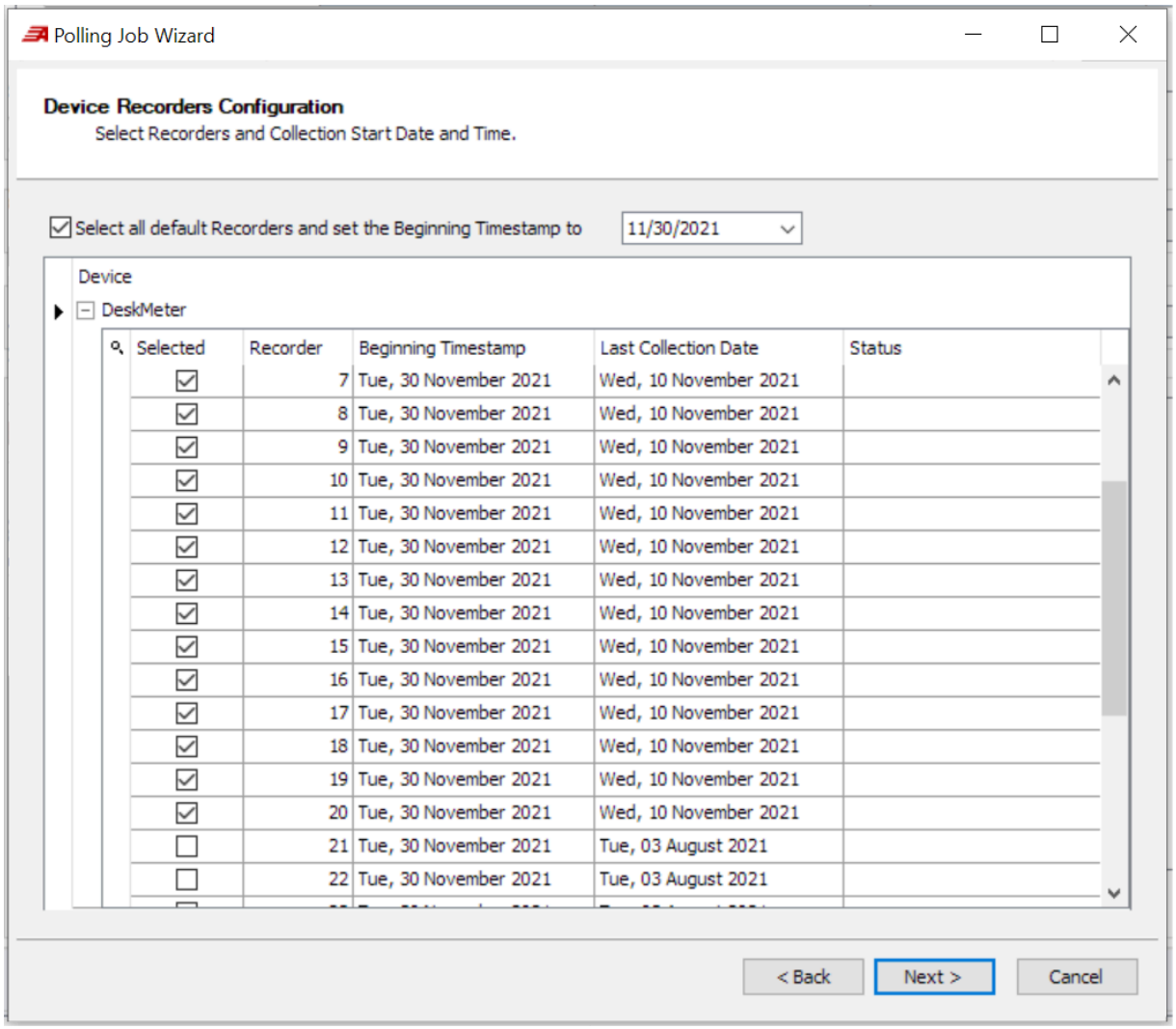


Figure 7.5 Select Recorders and Beginning Timestamp

Step 5. If the metering point does not already exist, select a Time Zone.

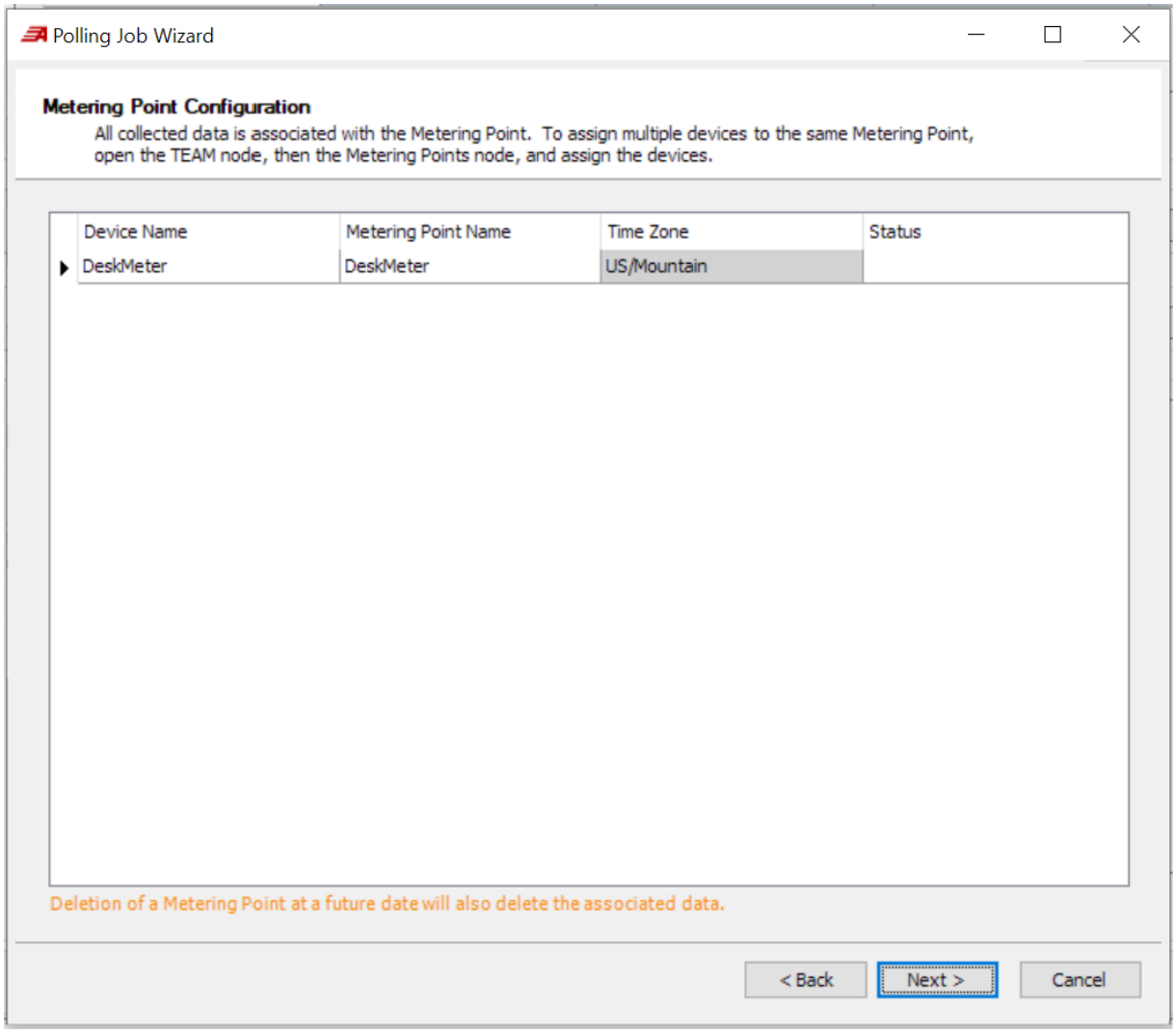


Figure 7.6 Metering Point Configuration

Step 6. Select **Hourly** as the Polling Frequency, as shown in *Figure 7.7*.

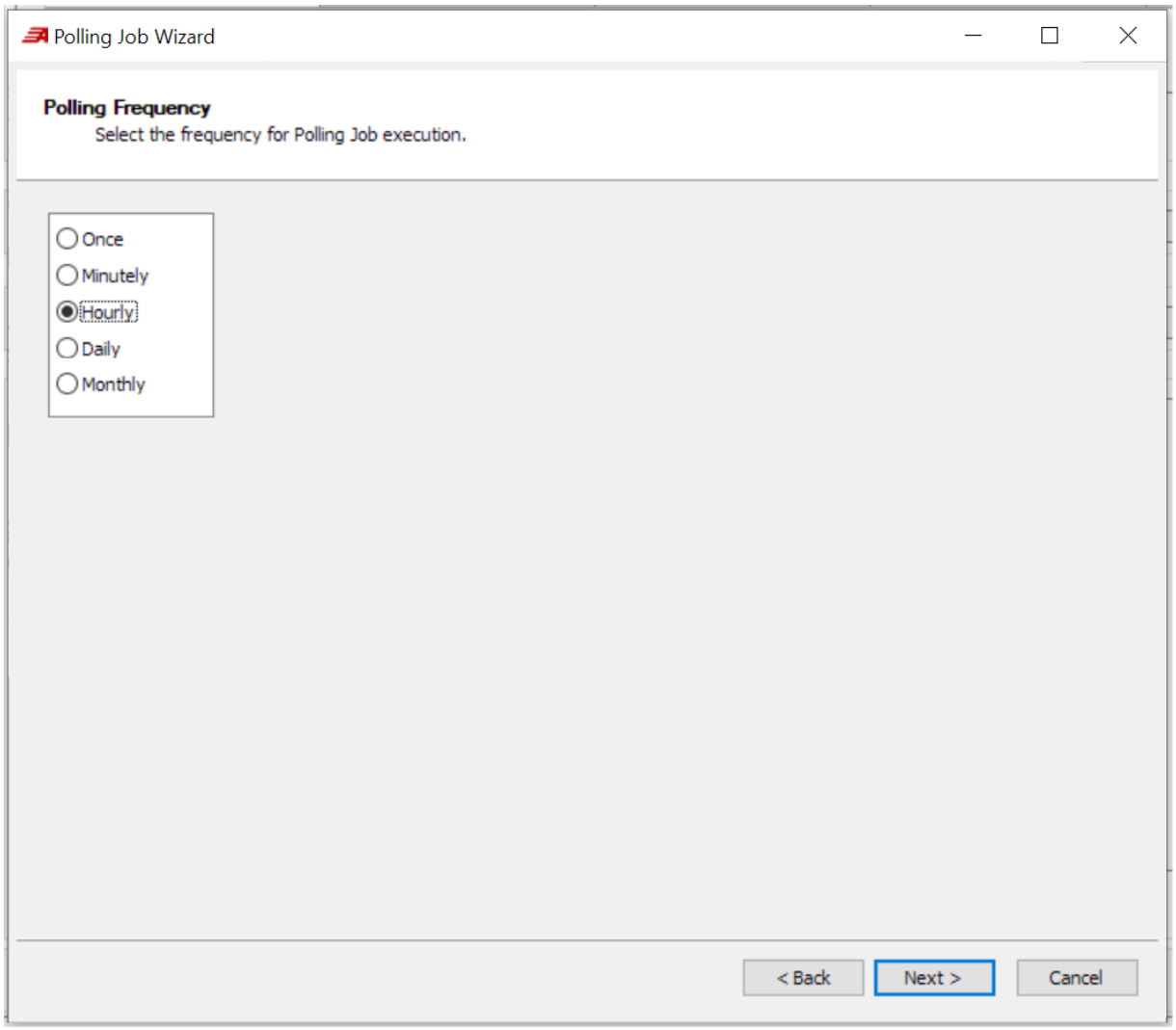


Figure 7.7 Polling Frequency

Step 7. Set Hourly Polling Interval to 2 hours, as shown in *Figure 7.8*.

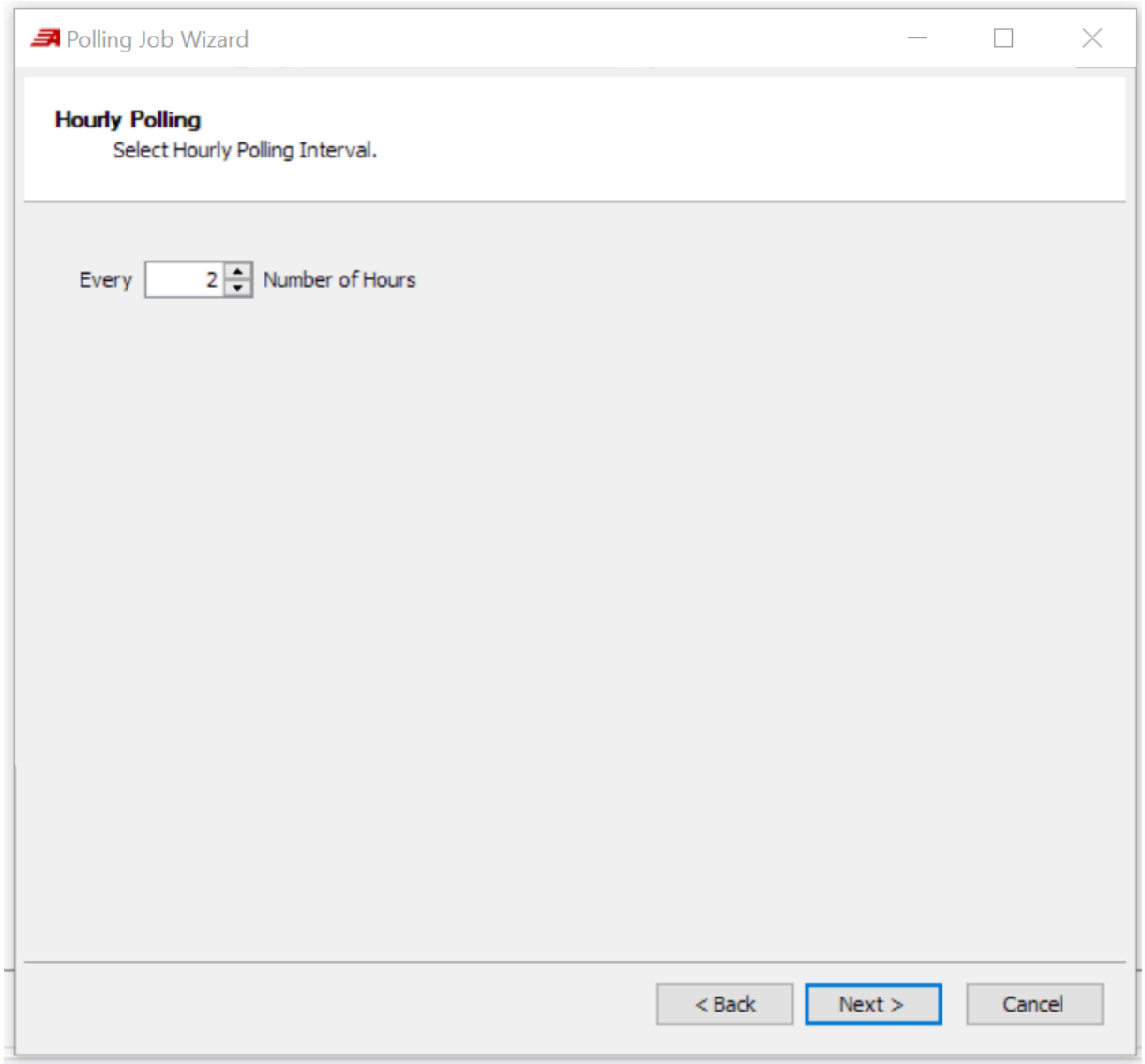


Figure 7.8 Hourly Polling Configuration

Step 8. Select **Next** and finish configuring the polling job.

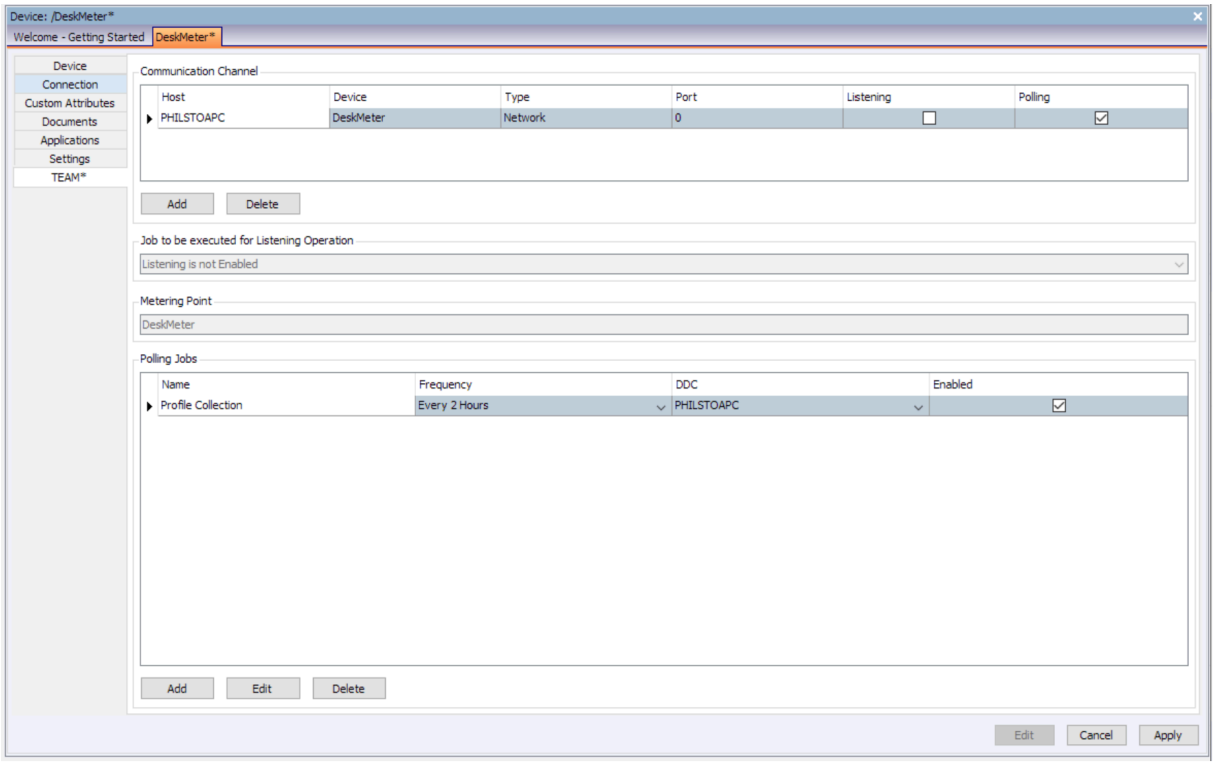


Figure 7.9 Completed TEAM Setup

IEEE 519 Configuration

In the IEEE 519 application, open the Configuration tab to associate IEEE 519 settings with measurement points. The Measurement Points table automatically populates with the Measurement Points configured in ACSELERATOR Database Reader.

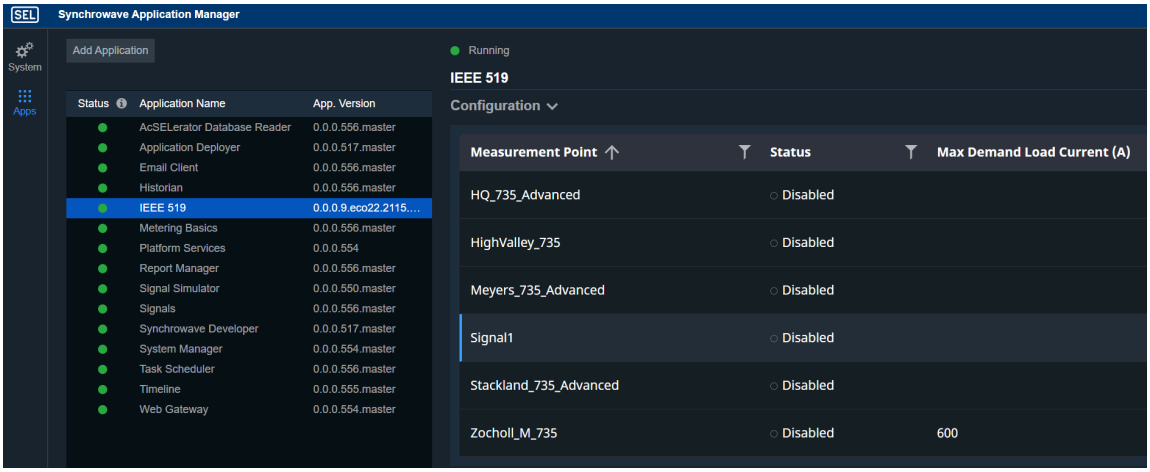


Figure 7.10 IEEE 519 Configuration Tab

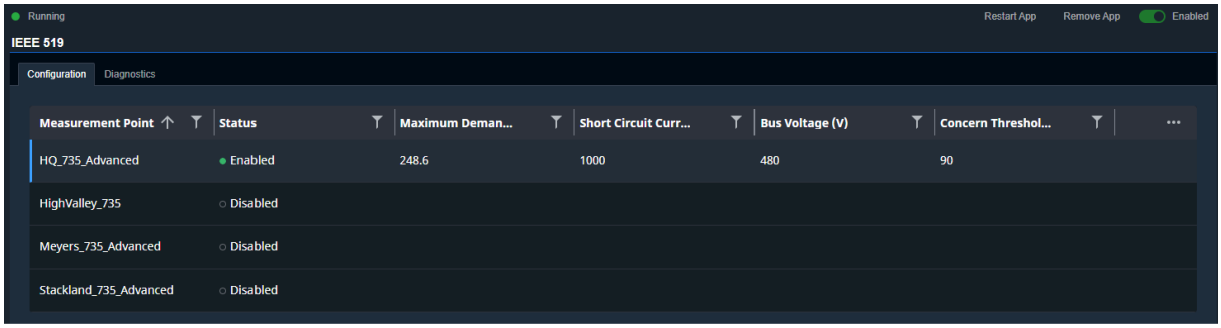


Figure 7.11 Pencil Icon Appears When Row Is Highlighted

Move your mouse over the row of the Measurement Point you want to edit, and then select the pencil (✎) icon that appears.

Step 1. To Enable IEEE 519 on the measurement point, select the **Enabled** toggle switch.

Step 2. Enter the Measurement Point's Maximum Demand Load Current in primary amperes (see IEEE 519-2014 for reference).

Step 3. Enter the Short Circuit Current at the Measurement Point in primary amperes.

Step 4. Enter the Bus Voltage at the Measurement Point in primary volts.

Step 5. Enter the Concern Threshold in whole numbers (for example, 95 for 95 percent). The Concern Threshold provides an early warning point for high harmonic values that are below the IEEE 519 compliance thresholds.

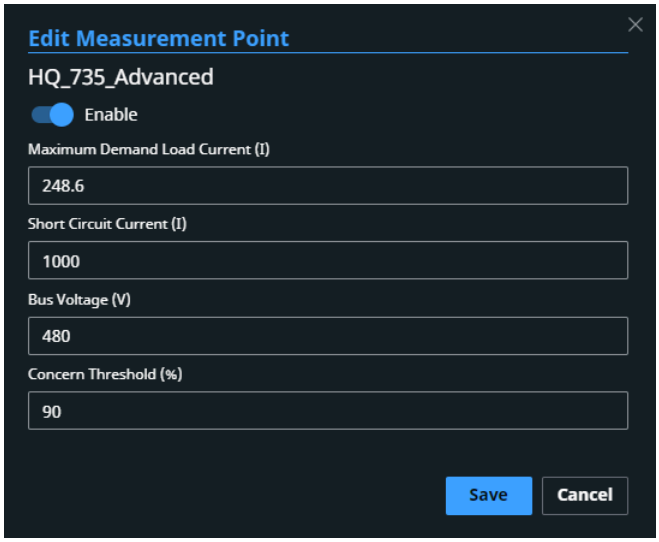


Figure 7.12 Edit a Measurement Point

Step 6. Once any changes have been made to a template, save the changes by selecting **Save**.

IEEE 519 Calculations

Sample Calculation

The IEEE 519 standard defines two different sample lengths for reporting: very short time and short time. Very short time samples are three-second rms values calculated from 200 ms (10–12 cycle) values as defined by IEC 61000-4-30. Short time samples are a 10-minute aggregation of 200 very short time samples.

NOTE
200 three-second samples is equal to 600 seconds (10 minutes) of data.

The IEEE 519 standard defines the harmonic orders according to the IEC 61000-4-7 definition of a subgroup: "a harmonic component magnitude is considered to be the value at a center frequency (60, 120, 180, etc. and 50, 100, 150, etc. Hz for 60 Hz and 50 Hz power systems, respectively) combined with the two adjacent 5 Hz bin values. The three values are combined into a single rms value that defines the harmonic magnitude for the particular center frequency component" (IEEE 519-2014).

These values are then converted into percent of rated power frequency voltage for voltage harmonics and percent of maximum demand load current at the PCC under normal load operating conditions (IL) for current harmonics.

In addition to harmonic orders 2–50, the IEEE 519 standard requires Total Harmonic Distortion (THD) and Total Demand Distortion (TDD). The SEL-735 calculates three-second voltage THD and current THD values using harmonics 2–63, which is permissible according to IEEE 519: "Harmonic components of order greater than 50 may be included when necessary" (IEEE 519-2014).

$$THDX = \left(\frac{\sqrt{\sum_{n=2}^{63} HX_n^2}}{HX_1} \right) 100$$

Equation 7.1

To convert from a current THD to a TDD value, the IEEE 519 reporting application multiplies by the current fundamental value (HRMM1_Ix_3SEC) and then divides by the fundamental maximum demand load current at the PCC under normal load operating conditions (IL).

$$TDDX = \left(\frac{\sqrt{\sum_{n=2}^{63} HX_n^2}}{\cancel{HX_1}} \right) 100 \bullet \frac{\cancel{HX_1}}{I_L}$$

Equation 7.2

Statistical Evaluation

"Very short and short time harmonic values should be accumulated over periods of one day and one week, respectively. For very short time harmonic measurements, the 99th percentile value (i.e., the value that is exceeded for 1% of the measurement period) should be calculated for each 24-hour period for

comparison with the recommended limits in Clause 5. For short time harmonic measurements, the 95th and 99th percentile values (i.e., those values that are exceeded for 5% and 1% of the measurement period) should be calculated for each 7-day period for comparison with the recommended limits in Clause 5. These statistics should be used for both voltage and current harmonics with the exception that the 99th percentile short time value is not recommended for use with voltage harmonics" (IEEE 519-2014).

Note that the IEEE 519 standard, unlike some other standards, does not specify accumulation of comparisons between measured values and a pass/fail condition. Instead, the IEEE 519 standard specifies collection of statistical data from a set of accumulated measured values. The IEEE 519 reports in Synchrowave Reports display the statistical data as well as the results of comparisons of those statistical data against the compliance limits.

The IEEE 519 Application uses fixed midnight-to-midnight windows for weekly and daily reports. These windows are from the previous day at midnight to the current day at midnight for daily reports and from midnight 7 days ago to midnight today for weekly reports.

Interpreting IEEE 519 Reports

IEEE 519 Reports have three potential results: Pass, Fail, and Warn. A passing report has measured values that are lower than the compliance limit values. A failing report has measured values that are higher than the corresponding limit values. A warning report has one or more measured values greater than the corresponding concern threshold set by the user but no values greater than their corresponding compliance limit values. Warn is denoted with "Pass*" because it is still considered a passing result by the IEEE 519 standard. However, Warn indicates that the harmonic values may be approaching levels that may be concerning.

The header of a report displays the status.

Table 7.2 Interpreting IEEE 519 Reports

Report Status	Header Indicator	Row Indicator	Meaning
Pass	Green, Pass (✔)	None	All values under concern and compliance limits
Warn	Green, Pass* (✔)	Amber, warn symbol (⚠)	At least one value above concern threshold or missing
Fail	Red, fail symbol (❗)	Red, fail symbol (❗)	One or more values above compliance, or no valid measurements available for report generation

IEEE 519 Daily Detail

✓ Pass

January 12, 2022 - January 13, 2022

Company

Local Government
1234 County Line Rd.
Phil Parajuli
(555)555-5555
phil_parajuli@localgovernment.net

Site

Boise
United States

IEEE 519 Compliance

Voltage: ✓ Pass
Current 99th: ✓ Pass

Device Information

Name	Part Number	Firmware	Nominal Frequency
SR_Inverter_735	0735LX20944EXXXXXX16101XX	R206	60 Hz

System Configuration

Setting Name	Setting Value
Maximum Demand Load Current (I)	248.6
Short Circuit Current (I)	500
Bus Voltage (V)	480
Concern Threshold (%)	90

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Figure 7.13 Passing Daily Detail Report

A summary report only has the cover page. A detail report has multiple pages that compare compliance limits to the measured statistical values.

Harmonic Voltage Compliance

● = Fail ▲ = Warn

Harmonic	VA Limit	VA Measured	VB Limit	VB Measured	VC Limit	VC Measured
THD	12%	8.66%	12%	8.49%	12%	8.66%
2	7.5%	4.86%	7.5%	4.69%	7.5%	4.86%
3	7.5%	5.38%	7.5%	5.21%	7.5%	5.38%
4	7.5%	5.9%	7.5%	5.73%	7.5%	5.9%
5	7.5%	6.42%	7.5%	6.24%	7.5%	6.42%
6	7.5%	6.93% ▲	7.5%	6.76% ▲	7.5%	6.93% ▲
7	7.5%	7.45% ▲	7.5%	7.28% ▲	7.5%	7.45% ▲
8	7.5%	7.97% ●	7.5%	7.8% ●	7.5%	7.97% ●
9	7.5%	8.49% ●	7.5%	8.31% ●	7.5%	8.49% ●
10	7.5%	4.69%	7.5%	4.52%	7.5%	4.69%
11	7.5%	5.21%	7.5%	5.04%	7.5%	5.21%
12	7.5%	5.73%	7.5%	5.55%	7.5%	5.73%
13	7.5%	6.24%	7.5%	6.07%	7.5%	6.24%
14	7.5%	6.76% ▲	7.5%	6.59%	7.5%	6.76% ▲
15	7.5%	7.28% ▲	7.5%	7.11% ▲	7.5%	7.28% ▲
16	7.5%	7.8% ●	7.5%	7.62% ●	7.5%	7.8% ●
17	7.5%	8.31% ●	7.5%	8.14% ●	7.5%	8.31% ●
18	7.5%	4.52%	7.5%	8.66% ●	7.5%	4.52%
19	7.5%	5.04%	7.5%	4.86%	7.5%	5.04%
20	7.5%	5.55%	7.5%	5.38%	7.5%	5.55%
21	7.5%	6.07%	7.5%	5.9%	7.5%	6.07%
22	7.5%	6.59%	7.5%	6.42%	7.5%	6.59%
23	7.5%	7.11% ▲	7.5%	6.93% ▲	7.5%	7.11% ▲
24	7.5%	7.62% ●	7.5%	7.45% ▲	7.5%	7.62% ●
25	7.5%	8.14% ●	7.5%	7.97% ●	7.5%	8.14% ●
26	7.5%	8.66% ●	7.5%	8.49% ●	7.5%	8.66% ●
27	7.5%	4.86%	7.5%	4.69%	7.5%	4.86%
28	7.5%	5.38%	7.5%	5.21%	7.5%	5.38%
29	7.5%	5.9%	7.5%	5.73%	7.5%	5.9%
30	7.5%	6.42%	7.5%	6.24%	7.5%	6.42%
31	7.5%	6.93% ▲	7.5%	6.76% ▲	7.5%	6.93% ▲
32	7.5%	7.45% ▲	7.5%	7.28% ▲	7.5%	7.45% ▲
33	7.5%	7.97% ●	7.5%	7.8% ●	7.5%	7.97% ●
34	7.5%	8.49% ●	7.5%	8.31% ●	7.5%	8.49% ●
35	7.5%	4.69%	7.5%	4.52%	7.5%	4.69%
36	7.5%	5.21%	7.5%	5.04%	7.5%	5.21%
37	7.5%	5.73%	7.5%	5.55%	7.5%	5.73%

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Figure 7.14 Compliance Tables

Values exceeding the limits are clearly marked with colored highlighting and either a Warn symbol (▲) or a Fail symbol (●).

SECTION 8

Continuous Waveform Streaming

Receiving Streaming Data

Continuous Waveform Streaming (CWS) is a type of streaming that uses high-rate data ranging from tens of samples per cycle to tens of thousands. CWS allows power system operators to analyze data with a resolution equal to that of event report oscillography. The Synchrowave Platform provides receivers for two CWS protocols: Wave Server and Continuous Waveform Streaming protocol (CWS protocol).

Configuring Wave Server Streaming

Wave Server data use a packet shape defined by IEEE C37.118.2, which allows a centralized device to collect data efficiently from several other devices. The Wave Server protocol is used for continuous waveform streaming and energy packet measurements. For more information about configuring Wave Server receiving, see *IEEE C37.118 Reader Application on page 106*.

Configuring CWS Protocol Streaming

CWS protocol is used by the SEL-735 Power Quality and Revenue Meter to stream continuous waveform data. The Synchrowave Platform receives CWS protocol using the CWS Receiver application. For more information about receiving CWS protocol, see *Continuous Waveform Streaming Receiver Application on page 108*.

Calculating Meter Values

Virtual Meters Application

The Virtual Meters application consumes continuous waveform signals and calculates meter analogs that are useful for reporting and monitoring. Virtual Meters generates outputs at a rate of 160 samples per second.

Setup

Configure the Virtual Meters application with Meter Calculations or through its configuration files. See *Setting Up Meter Calculations on page 30* for more information about Meter Calculations.

Setting Application Configuration

1. Download the Config.csv file.
2. Set the NominalFrequency setting to either 60 for a 60 Hz system or 50 for a 50 Hz system.
3. When you are finished, upload the Config.csv file to the Synchrowave Platform.

Creating Templates

In the Virtual Meters application, a template defines a set of calculations that you can apply to input signals. Configuration rows that share the same name are part of the same template. The Quantity field defines the calculation(s) to be performed. To add a new template to the application, follow these steps:

1. Download the Templates.csv file.
2. In the downloaded file, add a line for each desired quantity and fill out the Quantity field. Refer to *Meter Quantity List on page 78* for a list of the available quantities.
3. Set the Enabled field to **TRUE** for every quantity that should be enabled.
4. Add the same name to the Name field for all of the quantities.
5. Upload the Templates.csv file to the Synchrowave Platform.

See *Figure 8.1* for an example of a completed Templates.csv file.

	A	B	C
1	Name	Quantity	Enabled
2	RMS	Freq	TRUE
3	RMS	Freq.Phase	TRUE
4	RMS	IA.RMS	TRUE
5	RMS	IB.RMS	TRUE
6	RMS	IC.RMS	TRUE
7	RMS	IN.RMS	TRUE
8	RMS	VA.RMS	TRUE
9	RMS	VB.RMS	TRUE
10	RMS	VC.RMS	TRUE
11	Power	Freq	TRUE
12	Power	Freq.Phase	TRUE
13	Power	PA	TRUE
14	Power	PB	TRUE
15	Power	PC	TRUE
16	Power	QA	TRUE
17	Power	QB	TRUE
18	Power	QC	TRUE
19	Power	SA	TRUE
20	Power	SB	TRUE
21	Power	SC	TRUE
22	Power	P3	TRUE
23	Power	Q3	TRUE
24	Power	S3	TRUE
25	Fundamental	Freq	TRUE
26	Fundamental	Freq.Phase	TRUE
27	Fundamental	IA.Fund	TRUE
28	Fundamental	IB.Fund	TRUE
29	Fundamental	IC.Fund	TRUE
30	Fundamental	IN.Fund	TRUE
31	Fundamental	VA.Fund	TRUE
32	Fundamental	VB.Fund	TRUE
33	Fundamental	VC.Fund	TRUE
34	Fundamental	IA.Ang	TRUE
35	Fundamental	IB.Ang	TRUE
36	Fundamental	IC.Ang	TRUE
37	Fundamental	IN.Ang	TRUE
38	Fundamental	VA.Ang	TRUE
39	Fundamental	VB.Ang	TRUE
40	Fundamental	VC.Ang	TRUE
41	Harmonics	IA.1CYC.HRM01.Mag	TRUE
42	Harmonics	IA.1CYC.HRM02.Mag	TRUE
43	Harmonics	IA.1CYC.HRM03.Mag	TRUE
44	Harmonics	IA.1CYC.HRM04.Mag	TRUE
45	Harmonics	IA.1CYC.HRM05.Mag	TRUE
46	Harmonics	IA.1CYC.HRM06.Mag	TRUE

Figure 8.1 Configured Templates File

Configuring Measurement Points

Once one or more templates have been created, map the measurement point to templates by using the following steps:

1. Download the MeasurementPointMappings.csv file by using the Query & Download button.
2. The Virtual Meters application automatically creates a line in the file for each usable measurement point. Add the desired template name in the Config field.
3. Set the Enabled field to **TRUE** to turn on calculations and publishing for the measurement point.
4. Upload the MeasurementPointMappings.csv file to the Synchrowave Platform.

See *Figure 8.2* for an example of a completed MeasurementPointMappings.csv file.

	A	B	C
1	MeasurementPoint	Config	Enabled
2	Stackland_AxionWave	Fundamentals	FALSE
3	Conklin_SEL_T35	Fundamentals	TRUE
4	Meyers_SEL_735	RMS Quantities	TRUE
5			

Figure 8.2 Configured MeasurementPointMappings File

Meter Quantity List

The analog quantities listed in *Table 8.1* can be calculated by the Virtual Meters application and are available to use within templates.

Table 8.1 Meter Quantities

Name	Description	Units	Update Rate
Current			
I[A, B, C, N, 3].RMS	A, B, C, N, or three-phase rms current	A	1/2 cycle
I[A, B, C, N, 3].Fund	A, B, C, N, or three-phase fundamental current	A	1/2 cycle
I[A, B, C, N, 3].Ang	A, B, C, N, or three-phase fundamental current angle	A	1/2 cycle
Voltage			
V[A, B, C, LN3].RMS	A, B, C, N, or three-phase rms line-to-neutral voltage	V	1/2 cycle
V[A, B, C, LN3].Fund	A, B, C, N, or three-phase fundamental line-to-neutral voltage	V	1/2 cycle
V[A, B, C, LN3].Ang	A, B, C, N, or three-phase fundamental line-to-neutral voltage angle	V	1/2 cycle
V[AB, BC, CA, LL3].Rms	Phase A-B, B-C, C-A, or LL3 rms line-to-line voltage	V	1/2 cycle
V[AB, BC, CA, LL3].Ang	Phase A-B, B-C, C-A, or LL3 fundamental line-to-line voltage angle	V	1/2 cycle

Name	Description	Units	Update Rate
Power			
P[A, B, C, 3]	A, B, C, or three-phase rms watts	W	1/2 cycle
Q[A, B, C, 3]	A, B, C, or three-phase rms VARs	VAR	1/2 cycle
S[A, B, C, 3]	A, B, C, or three-phase rms VA	VA	1/2 cycle
PF[A, B, C, 3]	A, B, C, or three-phase rms fundamental power factor	Unitless	1/2 cycle
P[A, B, C, 3].Fund	A, B, C, or three-phase rms fundamental W	W	1/2 cycle
Q[A, B, C, 3].Fund	A, B, C, or three-phase rms fundamental VARS	VAR	1/2 cycle
S[A, B, C, 3].Fund	A, B, C, or three-phase rms fundamental VA	VA	1/2 cycle
PF[A, B, C, 3].Fund	A, B, C, or three-phase rms fundamental Power Factor	Unitless	1/2 cycle
Harmonics			
V[A, B, C].1CYC.HRM[X].Mag[a]	A, B, or C one-cycle harmonic voltage magnitude	V	1 cycle
V[A, B, C].1CYC.HRM[X].Ang[a]	A, B, or C one-cycle harmonic voltage angle	°	1 cycle
V[AB, BC, CA].1CYC.HRM[X].Mag[a]	AB, BC, or CA line-to-line one-cycle harmonic voltage magnitude	V	1 cycle
V[AB, BC, CA].1CYC.HRM[X].Ang[a]	AB, BC, or CA line-to-line one-cycle harmonic voltage angle	°	1 cycle
I[A, B, C, N].1CYC.HRM[X].Mag[a]	A, B, C, or N one-cycle harmonic current Magnitude	A	1 cycle
I[A, B, C, N].1CYC.HRM[X].Ang[a]	A, B, C, or N one-cycle harmonic current angle	°	1 cycle
P[A, B, C].HRM[X].1CYC[a]	A, B, or C one-cycle harmonic active power	W	1 cycle
V[A, B, C].1CYC.THD	A, B, or C one-cycle voltage total harmonic distortion	%	1 cycle
V[AB, BC, CA].1CYC.THD	AB, BC, or CA line-to-line one-cycle voltage total harmonic distortion	%	1 cycle
I[A, B, C, N].1CYC.THD	A, B, C, or N one-cycle current total harmonic distortion	%	1 cycle
Symmetrical Components			
I0	Zero-sequence current	A	1 cycle
I1	Positive-sequence current	A	1 cycle
I2	Negative-sequence current	A	1 cycle
V0	Zero-sequence voltage	V	1 cycle
V1	Positive-sequence voltage	V	1 cycle
V2	Negative-sequence voltage	V	1 cycle
Other			
Freq	System frequency	Hz	1/2 cycle
Freq.Phase	Indicator for which phase is used for frequency tracking (0 = A, 1 = B, 2 = C)	Unitless	1/2 cycle

[a]X represents the harmonic order from 02 to the maximum, which is 20 for 3000 samples-per-second streams and 100 for 14400 samples-per-second streams.

Voltage, Current, and Power Calculations

The following information details the meter quantity calculations performed by the Virtual Meters application. The application calculates all meter values from instantaneous waveforms sampled at 3 ksps.

Voltage Delta/Wye Waveform Calculations

The Virtual Meters application calculates either line-to-neutral or line-to-line voltages (whichever is not provided) from the raw waveform.

Delta-to-Wye Calculation

If the raw voltage waveforms are a line-to-line voltage, the line-to-neutral voltage waveforms are calculated as follows.

$$VA = (VAB - VCA)/3$$

$$VB = (VBC - VAB)/3$$

$$VC = (VCA - VBC)/3$$

Wye-to-Delta Calculation

If the raw voltage waveforms are a line-to-neutral voltage, the line-to-line voltage waveforms are calculated as follows.

$$VAB = VA - VB$$

$$VBC = VB - VC$$

$$VCA = VC - VA$$

Neutral Current Waveform

The Virtual Meters application uses the sum of the three-phase currents to calculate the neutral current IN, as shown in the following equation.

$$IN = IA + IB + IC$$

Voltage and Current RMS Magnitudes

The Virtual Meters application calculates voltage and current magnitudes. The values are recalculated every half cycle in a 1-cycle window.

The meter calculates rms voltage in accordance with the following equation.

$$Vx = \sqrt{\frac{\sum_{0}^{N-1}[s(n)]^2}{N}}$$

The meter calculates rms current in accordance with the following equation.

$$Ix = \sqrt{\frac{\sum_{0}^{N-1}[s(n)]^2}{N}}$$

where:
N = total number of samples
x = A, B, or C for line-to-neutral voltages, A, B, C or N for line-to-neutral currents, or AB, BC, or CA for line-to-line voltages and currents
n = index number
s(n) = array of *v* or *i* samples corresponding to X

Average Voltage and Current

The average voltage and current are calculated from the voltage and current magnitudes as follows.

$$VLN3 = (VA + VB + VC) / 3$$

$$VLL3 = (VAB + VBC + VCA) / 3$$

$$I3 = (IA + IB + IC) / 3$$

Half-Cycle Power Calculations

Active power (Px), reactive power (Qx), and apparent power (Sx) calculations use unfiltered 1 ksps or greater voltage and current samples as source data.

Active per-phase power is calculated as follows.

$$Px = \frac{1}{N} \sum_{n=0}^{N-1} (Vxn \bullet Ixn)$$

where:
x = A, B, C
Vxn, Ixn = discrete samples
N = the total number of samples in a 1-cycle period

Active three-phase power is calculated as the sum of per-phase quantities.

$$P3 = PA + PB + PC$$

Apparent per-phase power is calculated using per-phase rms quantities.

$$Sx = Ix \bullet Vx$$

where:
Ix, Vx = the respective phase rms quantities

Apparent three-phase power is calculated as the sum of per-phase quantities.

$$S3 = SA + SB + SC$$

Reactive per-phase power is calculated using per-phase power quantities.

$$Qx = \sqrt{Sx^2 - Px^2}$$

where:
x = A, B, C, or 3

Power Factor

The Virtual Meters application calculates three-phase and per-phase true power factor updated every half cycle.

$$PFx = \frac{Px}{Sx}$$

where:
x = A, B, C, or 3

Load Profile Application

The Load Profile application allows users to calculate load profile signals similar to the Load Profile functionality in the SEL-735 Power Quality and Revenue Meter. The application provides a variety of functions to aggregate high rate signals into lower rate ones.

Load Profile creates new signal names by using the combination of the input signal name, the function, and the acquisition rate. The output signal's name includes the input signal measurement point and the output quantity, the latter of which is constructed by combining the LDP prefix, the input signal's name, the function name, and the acquisition rate (e.g., *LDP.[input signal].[function name].[acquisition rate]*).

The acquisition rate determines the length of the aggregation interval. The available acquisition rates are as follows:

- Subsecond: 0.05, 0.1, 0.2, 0.25, and 0.5 (aligned to the top of the second).
- Seconds: 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, and 30 (aligned to the top of the minute).
- Seconds: 60, 120, 180, 240, 300, 360, 600, 720, 900, 1200, 1800, and 3600 (aligned to the top of the hour).
- Seconds: 7200 (aligned to the top of an even hour).

NOTE
Top of hour and even hours are based on UTC time.

When the acquisition rate is part of a signal name, subsecond rates are converted to milliseconds and appended with *ms.* For example, an acquisition rate of 0.25 results in a signal named *LDP*.[*input signal].[function name].250ms*.

Table 8.2 Load Profile Functions

Function Name	Description	Units
MIN	Minimum value of values in the interval	Same as input signal
MAX	Maximum value of values in the interval	Same as input signal
AVG	Average of values in interval	Same as input signal
COI	Change over interval, which is the difference between the last value in the interval and the first	Same as input signal
EOI	End of interval, which is the last value in the interval	Same as input signal

Function Name	Description	Units
COUNT	Number of values in the interval. Useful for verifying data integrity.	Unitless
SUM	Sum of the values in the interval	Same as input signal
RMS	RMS of the values in the interval	Same as input signal

Setup

Creating Templates

Configure the Load Profile application with Meter Calculations or through its configuration files. See *Setting Up Meter Calculations on page 30* for more information about Meter Calculations.

In the Load Profile application, configuration rows that share the same name are part of the same template. To add a new template to the application, follow these steps:

1. Download the Templates.csv file.
2. In the downloaded file, add a line for each desired quantity and fill out the Quantity field. The available list of quantities can be found in the Virtual Meters application. For more information, see *Meter Quantity List on page 78*. If no Virtual Meters template is creating the input quantity, Load Profile will not create an output quantity until Virtual Meters publishes a sufficient quantity for the input. If Load Profile outputs a quantity from a saved template, that quantity may be used as an input quantity.
3. Add a function from the list in *Table 8.2* to the Function field.
4. Add a valid acquisition rate to the AcquisitionRate (s) field.
5. Set the Enabled field to **TRUE** for every quantity that should be enabled.
6. Add the same name to the Name field for all of the quantities.
7. Upload the Templates.csv file to the Synchrowave Platform.

See *Figure 8.1* for an example of a completed Templates.csv.

	A	B	C	D	E
1	Name	Function	Quantity	AcquisitionRate (s)	Enabled
2	Maxandmin	MAX	VA.RMS	3	TRUE
3	Maxandmin	MAX	VB.RMS	3	TRUE
4	Maxandmin	MAX	VC.RMS	3	TRUE
5	Maxandmin	MAX	VLL3.RMS	3	TRUE
6	Maxandmin	MAX	IA.RMS	3	TRUE
7	Maxandmin	MAX	IB.RMS	3	TRUE
8	Maxandmin	MAX	IC.RMS	3	TRUE
9	Maxandmin	MAX	IN.RMS	3	TRUE
10	Maxandmin	MIN	VA.RMS	3	TRUE
11	Maxandmin	MIN	VB.RMS	3	TRUE
12	Maxandmin	MIN	VC.RMS	3	TRUE
13	Maxandmin	MIN	VLL3.RMS	3	TRUE
14	Maxandmin	MIN	IA.RMS	3	TRUE
15	Maxandmin	MIN	IB.RMS	3	TRUE
16	Maxandmin	MIN	IC.RMS	3	TRUE
17	Maxandmin	MIN	IN.RMS	3	TRUE

Figure 8.3 Configured Templates File

Configuring Measurement Points

Once one or more templates have been created, map the measurement point to templates by using the following steps:

1. Download the Mappings.csv file by using the Query & Download button.
2. The Load Profile application automatically creates a line in the file for each usable measurement point. Add the desired template name in the Config field.
3. Set the Enabled field to **TRUE** to turn on calculations and publishing for the measurement point.
4. Upload the Mappings.csv file to the Synchrowave Platform.

See *Figure 8.3* for an example of a completed Mappings.csv.

	A	B	C
1	MeasurementPoint	TemplateName	Enabled
2	Stackland_AxionWave	Sums	FALSE
3	Conklin_SEL_T35	Averages	FALSE
4	Meyers_SEL_735	Maxandmin	TRUE

Figure 8.4 Configured Mappings File

SECTION 9

Monitoring

Introduction

Software User Interface Summary

Timeline Application Overview

The timeline provides both visualization and control of historic event information presentation. Notification icons are displayed on the timeline to indicate when notifications are generated. Selecting a date/time on the timeline synchronizes all dashboards and panels to that time. Operators can transition between real-time and historic data via the timeline. The timeline also allows choosing the range of data displayed in synchronized display panels.

Figure 9.1 Software User Interface—Timeline Application

Dashboard Application Overview

Dashboards provide the primary visualization of live power system data and information in the Synchrowave platform. Dashboards are composed of a collection of panel applications. Dashboards are dynamic and customizable, ensuring convenient and quick access to the actionable information needed for efficient analysis of the power system.

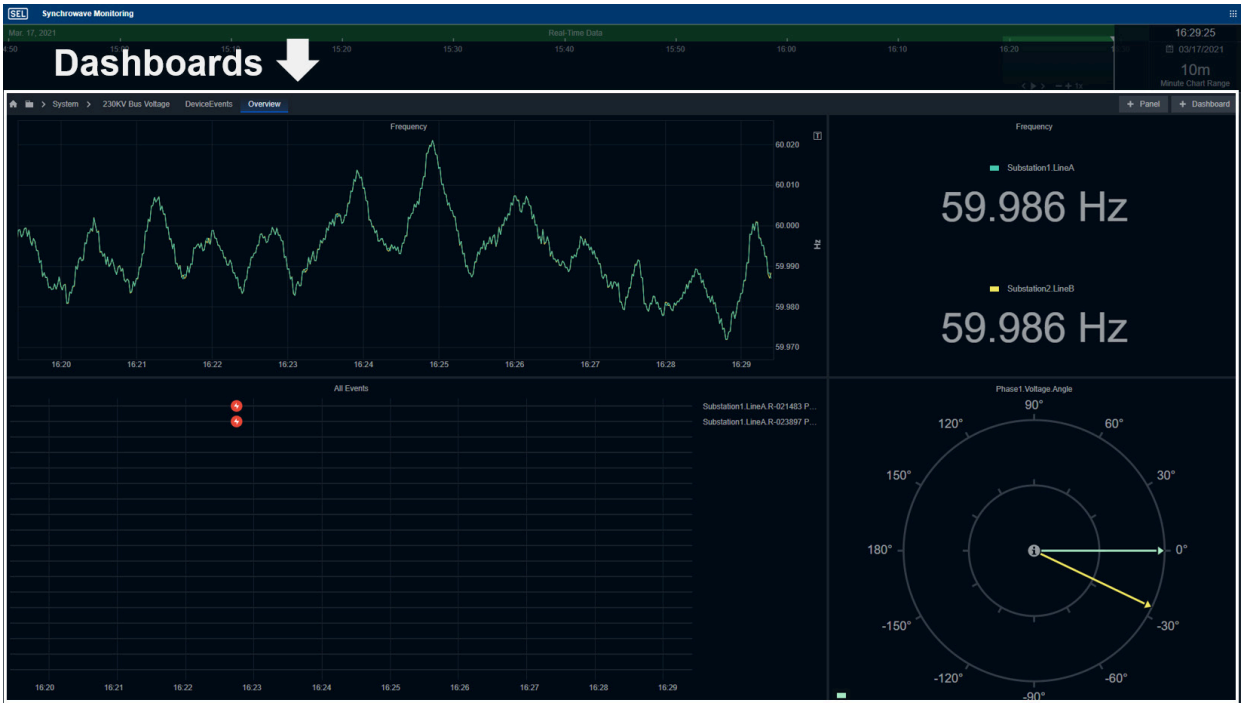

Figure 9.2 Software User Interface—Dashboards and Dashboard Navigation

Timeline Application

Synchrowave software provides time synchronization and time control through a timeline located along the top of the user interface.

The Timeline Time Range provides context for where the operator is in time within the software.

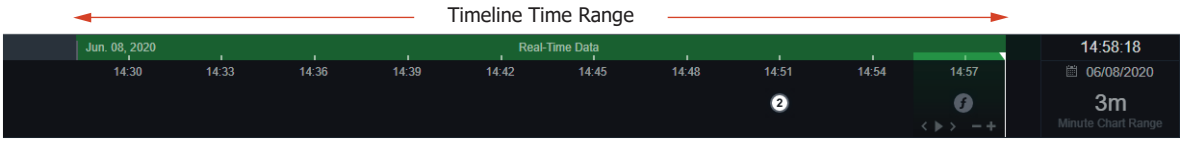

Figure 9.3 Timeline Time Range

The shaded region on the Timeline Time Range is the Chart Time Range. The Chart Time Range represents the time range for the data that is displayed in trend chart(s) for any dashboard. Any notification icons within the time range is displayed in the Notification List, even if acknowledged.

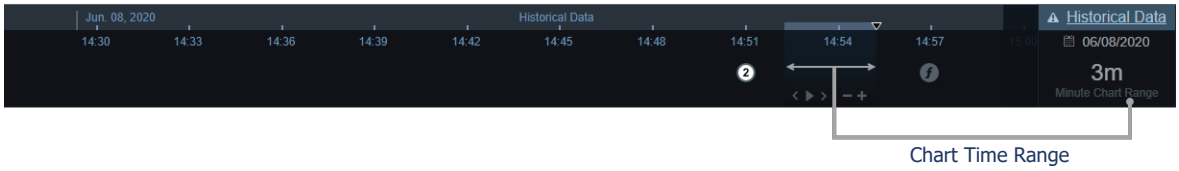

Figure 9.4 Timeline Chart Time Range

Modify the selected Chart Time Range value to one of the default values by selecting the Chart Time Range control. All trend charts automatically update to display the new range of data. The Chart Time Range can also be modified by scrolling the mouse wheel while hovering the mouse over the Chart Time Range indicator on the timeline.

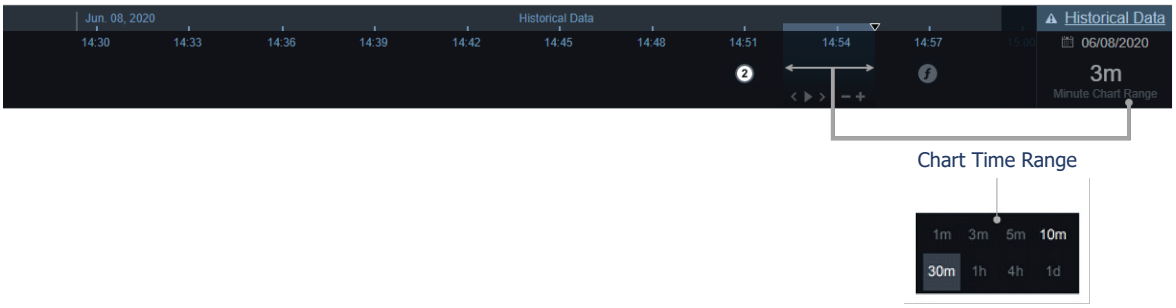

Figure 9.5 Timeline Chart Time Range Default Values

For chart panels that display an instantaneous value (Numeric Display, Table, Bar Chart, Phasor Scope, etc.), the time-marker shows the point in time that the instantaneous value chart panels are using to display data. In *Figure 9.6*, the cursor is at the right edge of the chart time range and indicates the most recent data within that range.

Figure 9.6 Timeline Time-Marker

Real-time mode is the default for Synchrowave software. Real-time mode is indicated by the green shading in the chart time range, the scrolling data on any trend chart, and the continuously updating time display. Synchrowave software offers a seamless transition to historical analysis mode by allowing the user to simply drag the Chart Time Range back in history on the timeline or selecting a historical notification. Historical mode is indicated by the gray shading in the chart time range, the shaded chart time range at a location other than the right side, and the time display is replaced by "Historical Data."

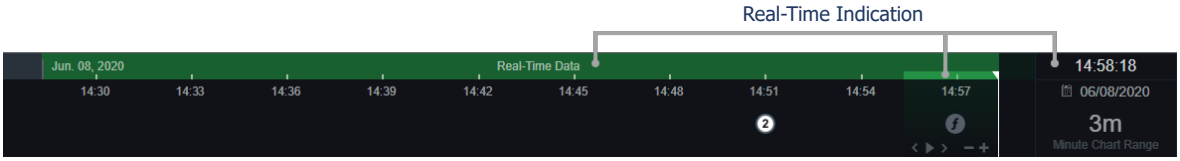

Figure 9.7 Timeline Real-Time Mode Indication

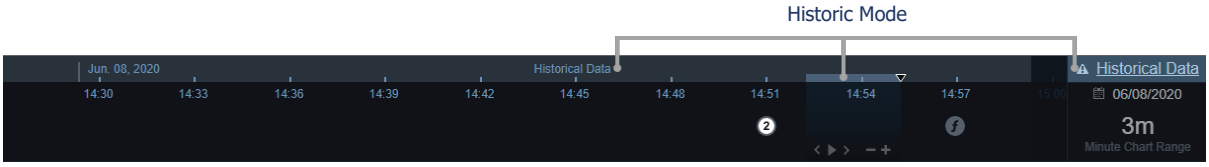

Figure 9.8 Timeline Historic Mode Indication

The calendar icon (see *Figure 9.9*) in the time control provides the ability to navigate the software to any date in history for analysis of historic conditions.

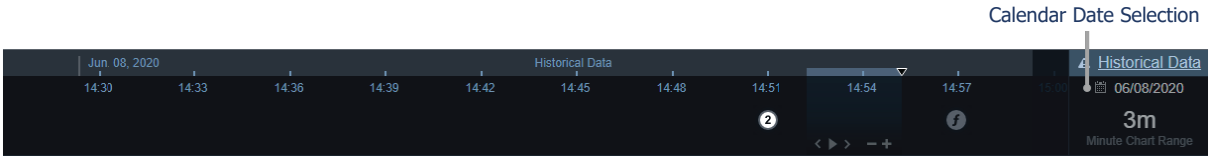

Figure 9.9 Timeline Calendar Date Selection

Operators can quickly begin analysis of any notification by simply selecting the Notification icon on the timeline. The Notification icon location on the timeline represents the start time of the condition.

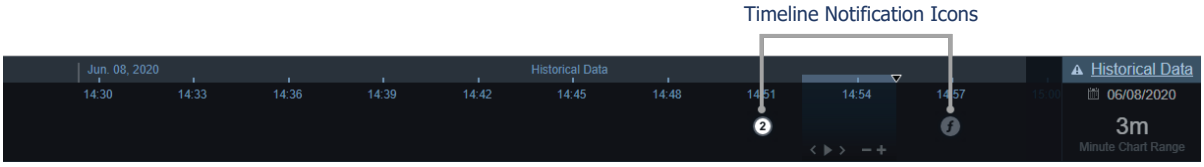

Figure 9.10 Timeline Notification Icons

Replay

Replay enables operators to visualize how the power system state changed over time. The replay controller features several buttons:

- The play button starts replay mode.
- The pause button pauses replay.
- The plus button increases the replay speed.
- The minus button decreases the replay speed.
- The step-forwards button moves the time cursor forward one data point in time.
- The step-backwards button moves the time cursor backwards one data point in time.

All instantaneous data panels—such as trend lines and bar charts—automatically update to display data at the time of the cursor during replay. Synchrowave automatically enters Historical Data mode when you start replay mode.

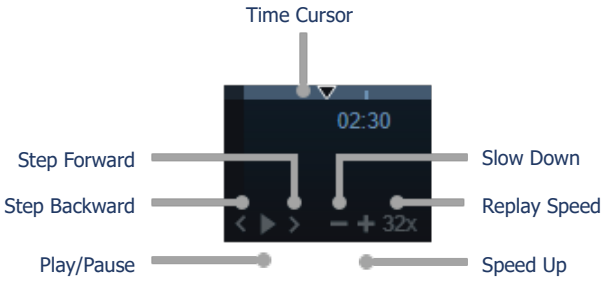

Figure 9.11 Timeline Replay Controller

Dashboards Application

Dashboards provide visualization of power system data and information through a collection of panels. Dashboards are dynamic and customizable, ensuring the actionable information users need to efficiently analyze the power system is always available.

Dashboard Navigation

Navigating Dashboards

Synchrowave software provides dashboards to visualize the state of the power system. You can access the Dashboards from the Dashboards Navigation toolbar below the timeline in the software.

Figure 9.12 Dashboard Navigation Toolbar

From the Dashboards Navigation menu, select a dashboards folder and then select the desired dashboard from the list of available dashboards.

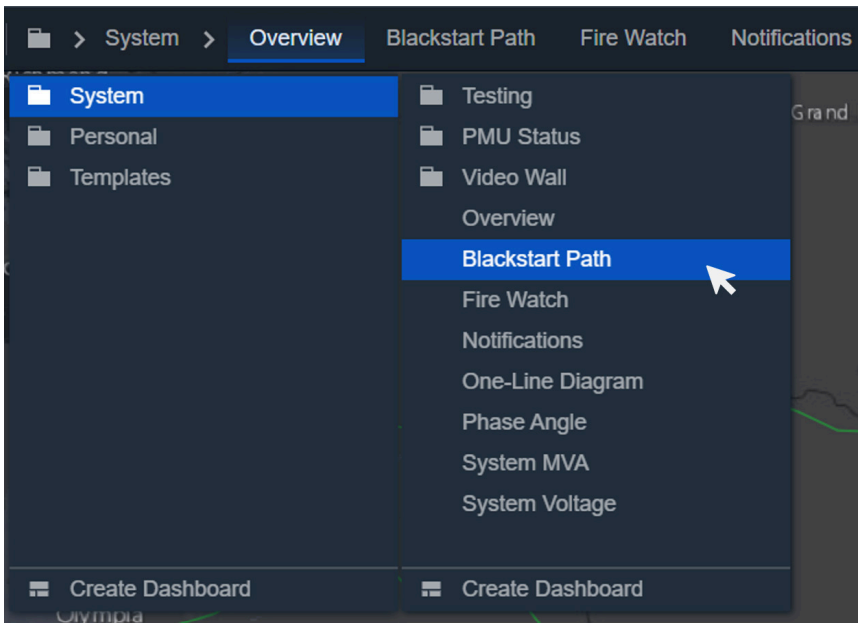

Figure 9.13 Dashboard Navigation Menu

The Dashboard Navigation toolbar updates the dashboard path and shows the selected dashboard. The dashboard path is shown to provide the operator context as to which dashboard is being displayed. The dashboard path follows the same concept that Microsoft Windows uses for folder navigation.

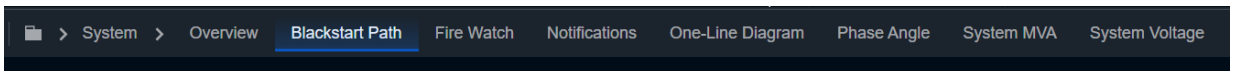

Figure 9.14 Dashboard Navigation Path

The Dashboard Navigation toolbar also shows other dashboards that exist in the selected dashboards folder. This allows the operator to switch between related dashboards quickly.

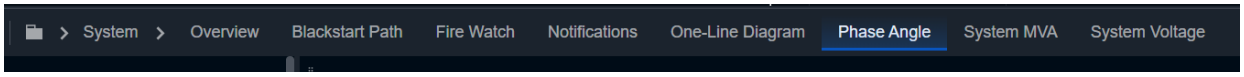

Figure 9.15 Navigating to Dashboards in the Same Folder

Configuring a Home Dashboard

The Home Dashboard serves as a reference dashboard that is frequently viewed. Each operator or engineer can configure their own Home Dashboard. The Home Dashboard is displayed when first logging into Synchrowave software or by selecting the **Home** icon in the Dashboard Path toolbar.

Figure 9.16 Navigating to the Home Dashboard

To set the Home Dashboard, right-click the Home icon in the top left corner. Select **Set Selected Dashboard and Chart Range as Home**. The current Timeline Chart Range is also saved so that when the user selects the Home icon, the Timeline Chart Range also returns to the saved value.

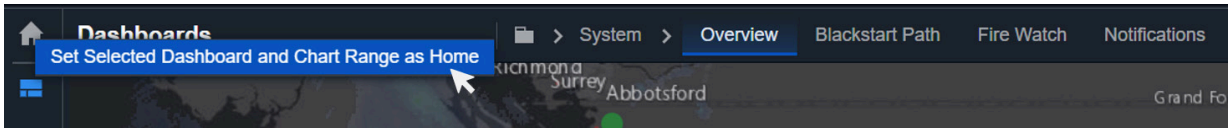

Figure 9.17 Setting the Home Dashboard

Configuring Dashboard Navigation Folders

The dashboard folder path is configured from the Dashboard Manager application. The Dashboard Manager application can be accessed from the Synchrowave Platform Navigation menu, accessible via the ⠿ icon in the upper right corner.

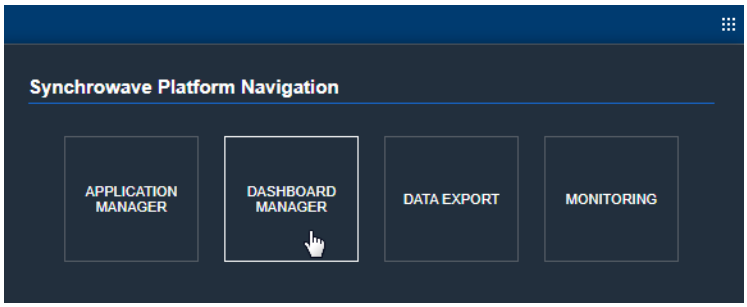

Figure 9.18 Dashboard Manager in Platform Navigation Menu

Import the dashboard folder by selecting the **Import Dashboards Menu** button and then selecting **Import Dashboards**. To export a copy of the existing dashboard folder path, select **Export Dashboards**.

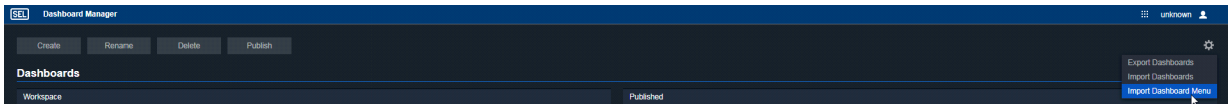

Figure 9.19 Importing Dashboard Folder Path

The dashboard folder path can be created or modified using a text editor. The folder structure is built by using forward slashes. Upon importing the Dashboard menu text file, users create dashboards for each folder through the Synchrowave user interface.

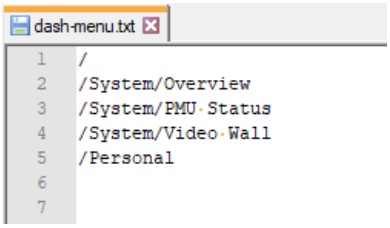

Figure 9.20 Example Dashboard Folder Path File

Folders can also be created and deleted directly from the Dashboard Navigation menu. To create a folder, navigate to the desired location in the folder tree and select **Create Folder**. Enter a name for the folder and select **OK**. To delete a folder, right-click the folder, choose Delete, and then select **OK**. The folder and all its subfolders will be deleted. Any dashboards in that folder or its subfolders, however, will persist. To delete a dashboard, either right-click it and select Delete *prior* to deleting the folder or use the Dashboard Manager.

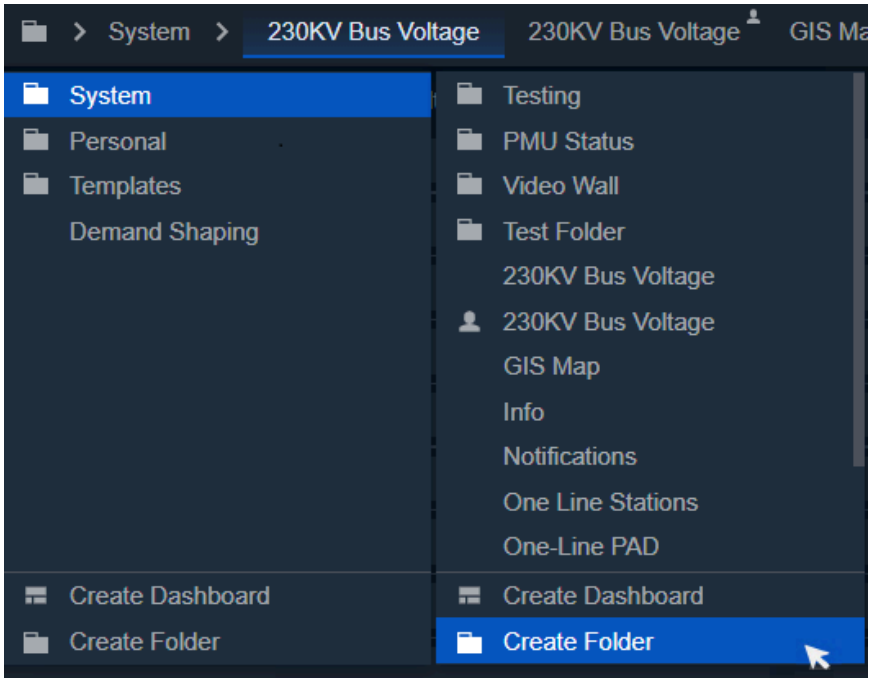

Figure 9.21 Creating a Dashboard Navigation Folder

Importing and Exporting Dashboards

Dashboards can be imported and exported using the **Import Dashboards**, **Export All Dashboards**, and **Export Select Dashboards** buttons in the Dashboard Manager.

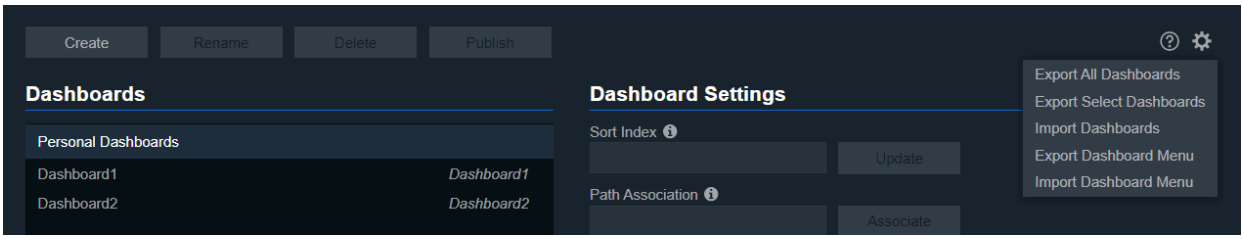

Figure 9.22 Importing and Exporting Dashboards

Selecting the **Export All Dashboards** button downloads a .zip file with all dashboards in the system, including published dashboards, all user dashboards, and all dashboard history. The dashboard folder structure is also included.

Selecting the **Export Select Dashboards** button opens a dialog that displays all published dashboards and all dashboards in the current user's workspace. Select the check boxes for the desired dashboards and select the **Export** button. A .zip folder will be downloaded with the current version (no history) of the selected dashboards and a dashboard menu file with folders associated with the dashboards. Folders are only included if the dashboard is associated with exactly one folder. If a dashboard is associated with more than one folder, no folders for that dashboard are included in the export. If they do not exist on the target system, they will need to be created manually.

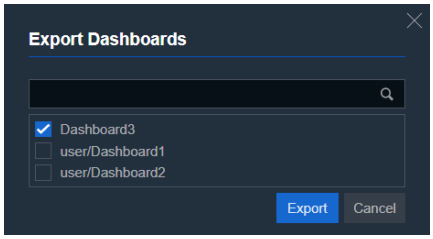

Figure 9.23 Export Select Dashboards

The behavior of the **Import Dashboards** button depends on whether the file to be imported was created using the **Export All Dashboards** button or the **Export Select Dashboards** button. If the .zip file was created with the **Export All Dashboards** button, the dashboard file structure currently on the system is overwritten by the structure contained in the imported dashboard menu file. If the file was created with the **Export Select Dashboards** button, the dashboard file structure in the imported dashboard menu file is merged with the existing file structure on the system. Logs for the Dashboard application will call out any conflicts. In both cases, dashboards are imported and any existing dashboards that have the same name as a new dashboard are overwritten.

Dashboard Creation

To create a Dashboard, navigate to the desired dashboard folder in the Synchrowave software and select the **Create Dashboard** button.

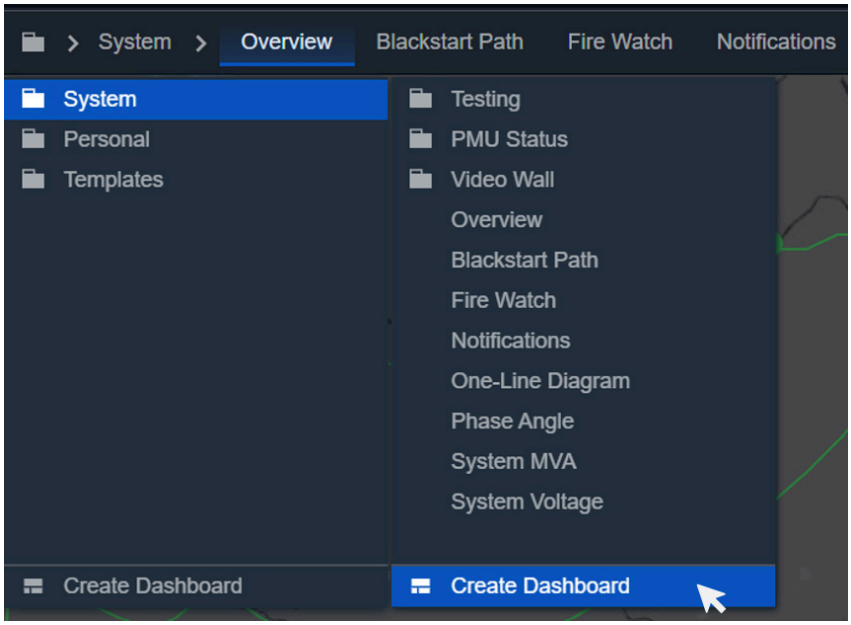

Figure 9.24 Creating a Dashboard

Enter a display name for the Dashboard.

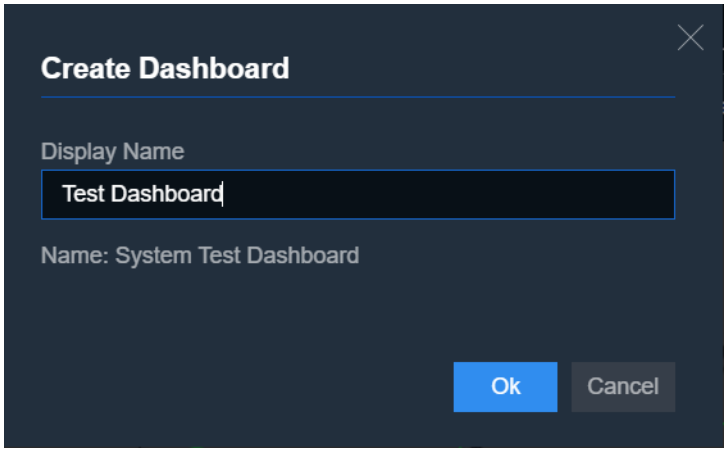

Figure 9.25 Naming a Dashboard

The Dashboard is now listed in the Dashboard Navigation toolbar. The (human figure icon) indication next to the Dashboard Name indicates that the dashboard is a private user dashboard. See *Publishing Dashboards on page 95* for information regarding sharing dashboards.

Any change to a dashboard is automatically saved as part of the private user dashboard for efficient ad-hoc analysis and to ensure changes are not lost.

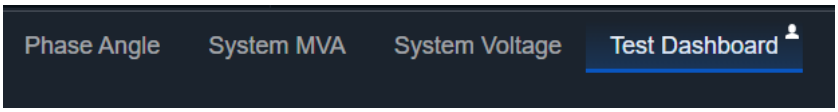

Figure 9.26 Private User Dashboard Indication

Right-click on any dashboard to access the Dashboard Option menu. From this menu the following options are available:

- **Delete** dashboard. (Private user dashboard only. Published dashboards can only be deleted from Dashboard Manager.) See *Publishing Dashboards on page 95*.
- **Rename** dashboard. (Private user dashboard only. Published dashboards can only be renamed from Dashboard Manager.) See *Publishing Dashboards on page 95*.
- Copy and paste dashboard content from one dashboard to another. This is a useful feature for efficient dashboard creation.
- Open dashboard in a new tab for analysis on multiple computer monitors.
- **Publish Dashboard.** See *Publishing Dashboards on page 95*.

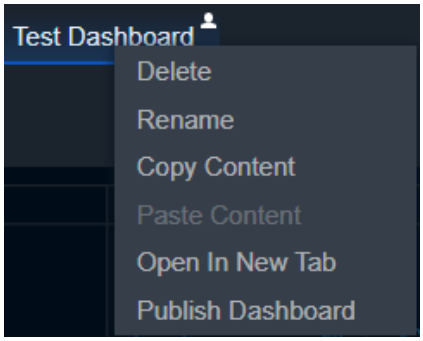

Figure 9.27 Dashboard Options Menu

Adding Dashboard Panels

Panel applications can be added to new or existing dashboards. Select **Add Panel** to add a panel to the selected dashboard. The dashboard panel is added to the center of the dashboard automatically. Select the type of panel application for each panel that is added to the dashboard. **Undo** and **Redo** buttons are available for reverting changes to dashboards.

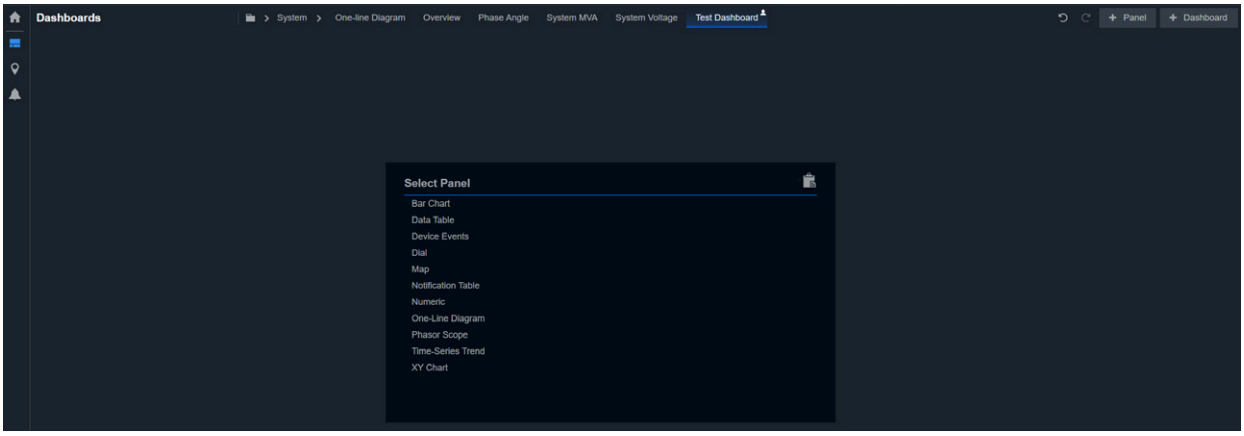

Figure 9.28 Adding Dashboard Panel

Panels can be arranged on the selected dashboard by selecting the grip icon in the top center of the panel and dragging the panel to the desired location. The grip icon is displayed when the mouse cursor hovers over a panel.

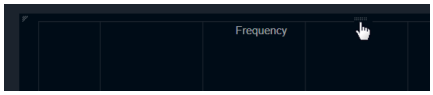

Figure 9.29 Rearranging Dashboard Panels

Resize a panel to take up the desired amount of space in a dashboard by selecting a resize arrow icon and dragging the mouse until the desired panel size is selected. Resize arrow icons are displayed in all corners when the mouse cursor hovers over a panel. The dashboard display area is divided into an 18x24 grid. The panels automatically snap to this grid when resized or moved.

Figure 9.30 Resizing Dashboard Panels

Remove panels from a dashboard by selecting the **Panel Options** menu in the top right corner of each panel.

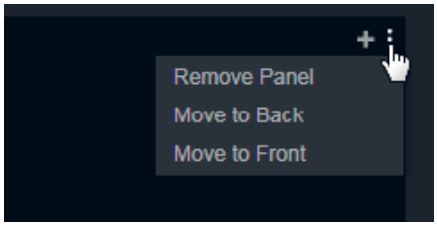

Figure 9.31 Dashboard Panel Options

Configure panels by selecting **Edit Panel** in the top right corner of each panel. See *Dashboards Application on page 89* for details regarding configuration for each panel type.

Figure 9.32 Dashboard Panel Configuration

Publishing Dashboards

Dashboards are only viewable to the user that creates the dashboard. This is a private user dashboard. A private dashboard can be published to make it available to other users. When deploying a system with many users, it can be helpful to have a set of published dashboards that are visible to all users.

NOTE
If user authentication is not enabled, all user dashboards and published dashboards are shared across all users.

New dashboards and modified versions of published dashboards are marked with a (human figure icon).

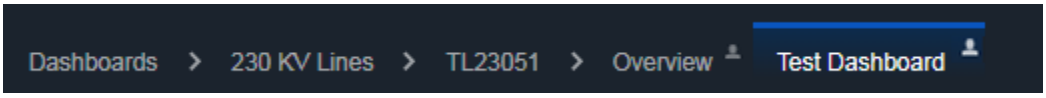

Figure 9.33 User Dashboard Indication

Private user dashboards can be published from the Dashboard Manager. Select the private user Dashboard from the list of available dashboards, then select **Publish**. The Dashboard is automatically copied to the Published dashboard list in the Dashboard Manager. Dashboards can also be published from the Dashboard Option menu (right-click a dashboard to open the menu).

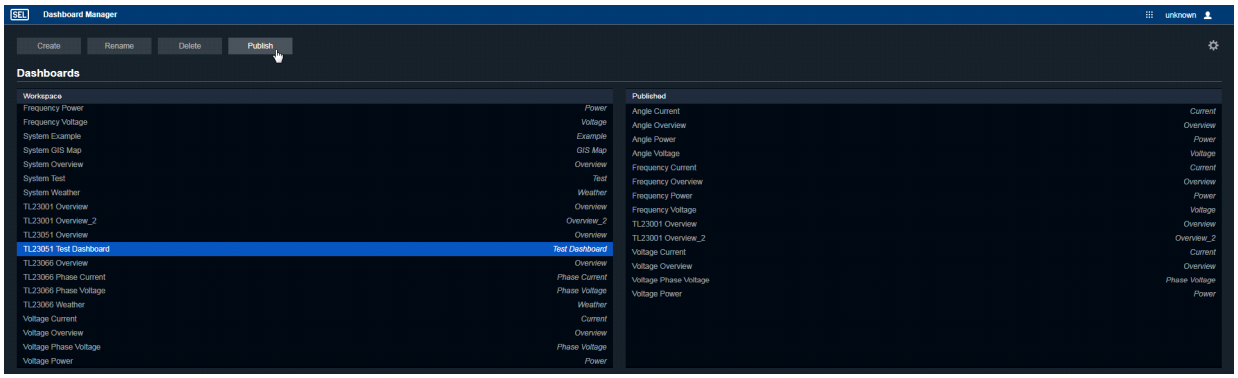

Figure 9.34 Publishing Dashboards

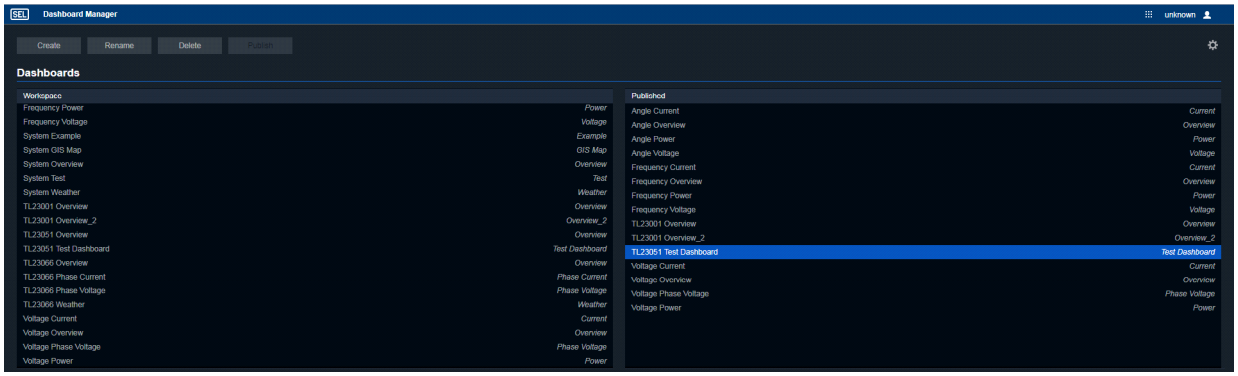

Figure 9.35 Navigating Published Dashboards

A published version of the dashboard is now available for all users to view. For the user that created the dashboard that was published, the private user version is automatically deleted.

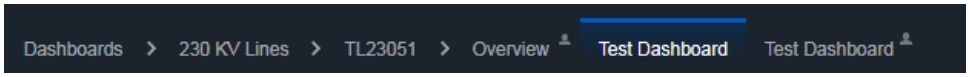

Figure 9.36 Published Dashboard Indication

Figure 9.37 shows the published dashboards visible to other users for the TL23051 Asset in the Dashboard Navigation toolbar.

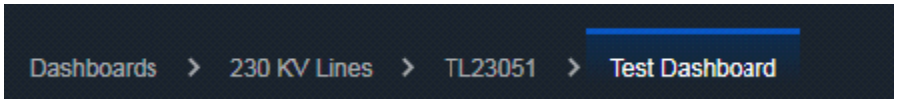

Figure 9.37 Dashboard Navigation Toolbar for Other Users

Any new changes made to a published dashboard are automatically saved in a private user copy of the published dashboard. If it is desired for the new changes to be published to all users, the publish process can be repeated for the new changes.

Changing Dashboard Display Order in a Folder

By default, dashboards are displayed in alphabetical order in the Dashboard menu and Dashboard toolbar. Change the display order through Dashboard Settings in the Dashboard Manager. Dashboards with the lowest Sort Index are displayed first. The Sort Index range supports negative and positive values, and the default value is 0.

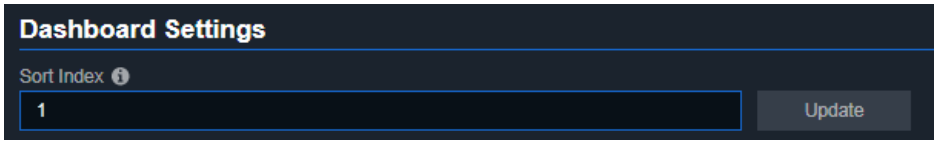

Figure 9.38 Changing the Dashboard Display Order

Changing Dashboard Theme

Synchrowave software includes a light theme mode. This is useful for taking screen captures that are to be printed.

Figure 9.39 Light Theme Dashboard Display

Use the Change Theme toggle button in the Synchrowave application bar to toggle between dark and light dashboard themes. Use the Font Size button to switch between small, medium, and large display fonts.

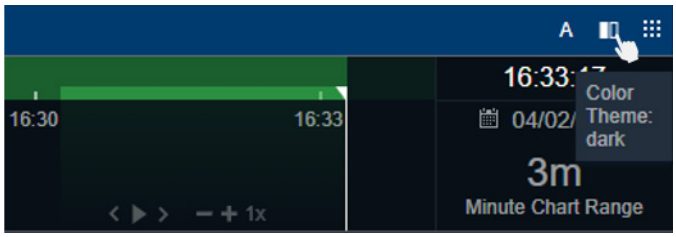

Figure 9.40 Theme Toggle Button

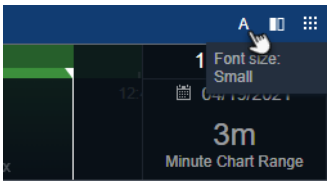

Figure 9.41 Theme Font Size

SECTION 10

Synchrowave Platform

Introduction

The Synchrowave Platform incorporates the latest in software technology to deliver the following benefits:

- Fast application development, integration, and customization through an open platform
- Modern server/web-client architecture
- Archive and email power system reports

Platform Technology Overview

Application Oriented

The Synchrowave Platform is modularized into small server and user-interface applications. Applications can be removed, replaced, or customized to provide the flexibility needed to meet the unique requirements of each utility.

Web-Based

The Synchrowave Platform is built on HTML5 web standards. Web-client visualization provides fast access to data and applications to end users without software installed on the client computers. Visualization clients include desktops, laptops, tablets, and phones. Web-clients reduce the total cost of software ownership by keeping software version and installation management at the server.

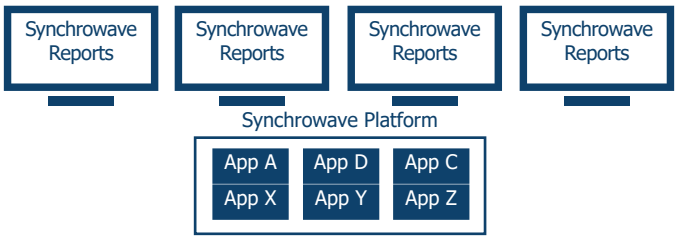

Figure 10.1 Web-Client Based Platform Diagram

Application Manager

The Synchrowave Platform was developed to support modular applications. As a result, the platform includes well-defined interfaces by which applications communicate with each other. Applications are added, configured, and managed through the Application Manager, as shown in *Figure 10.2*.

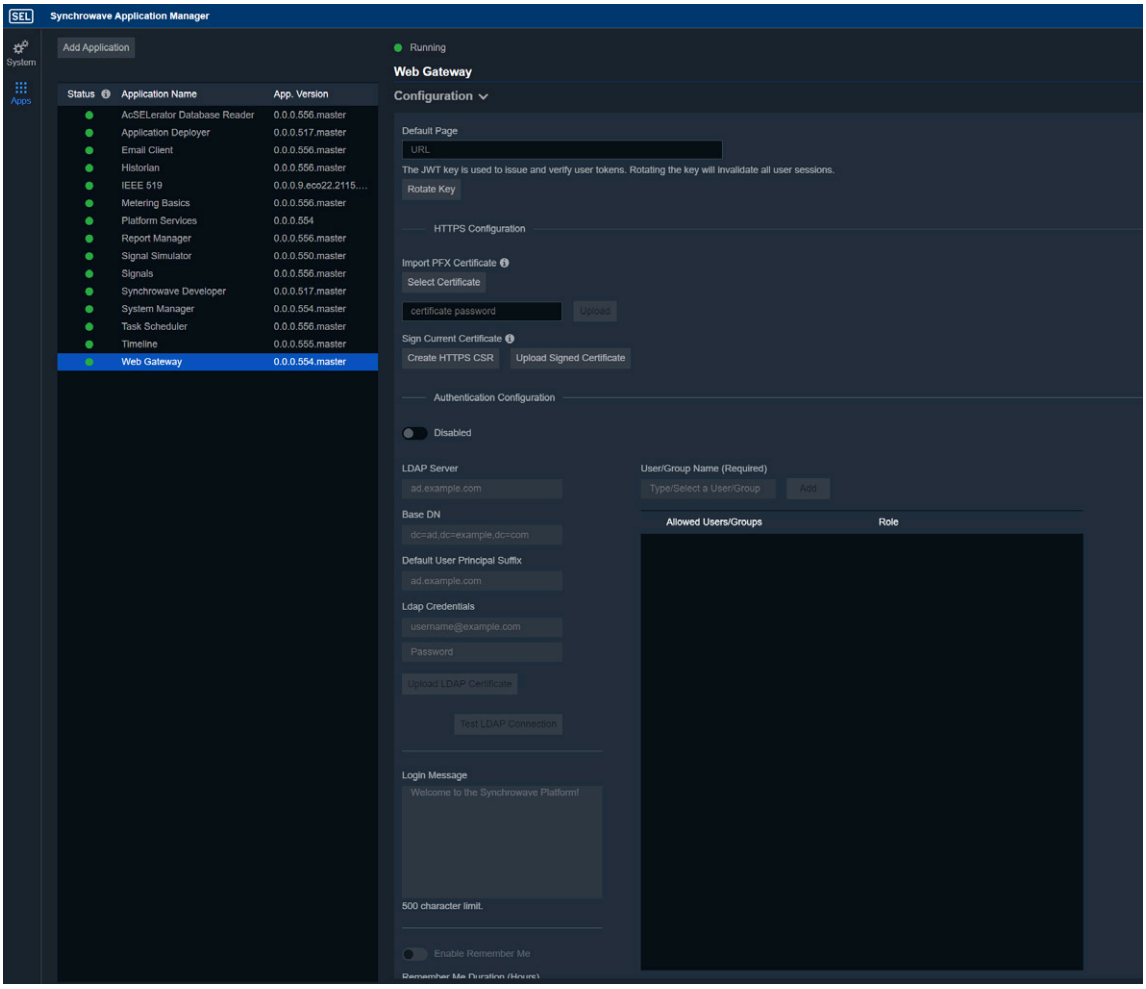

Figure 10.2 Application Manager

The Application Manager is accessed through the Platform Navigation menu icon ( ).

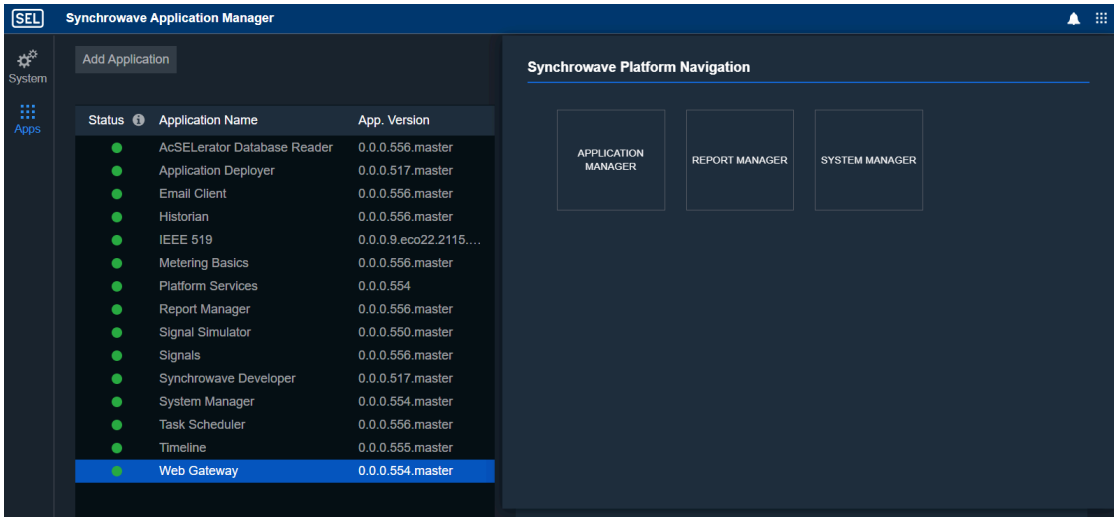

Figure 10.3 Application Manager in the Platform Navigation Menu

Adding Applications

Applications and application packages are added to the Synchrowave Platform by using the **Add Application** button.

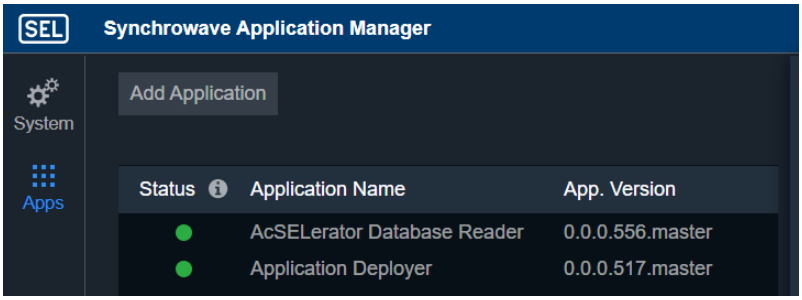

Figure 10.4 Add Application

Select **Add Application** to launch Windows Explorer. Use Windows Explorer to navigate to the zipped Application or Application Package folder. Applications appear in the Application menu as they are loaded into the platform.

Application Menu

The Application menu lists the applications installed on the platform. It also provides application status and version information.

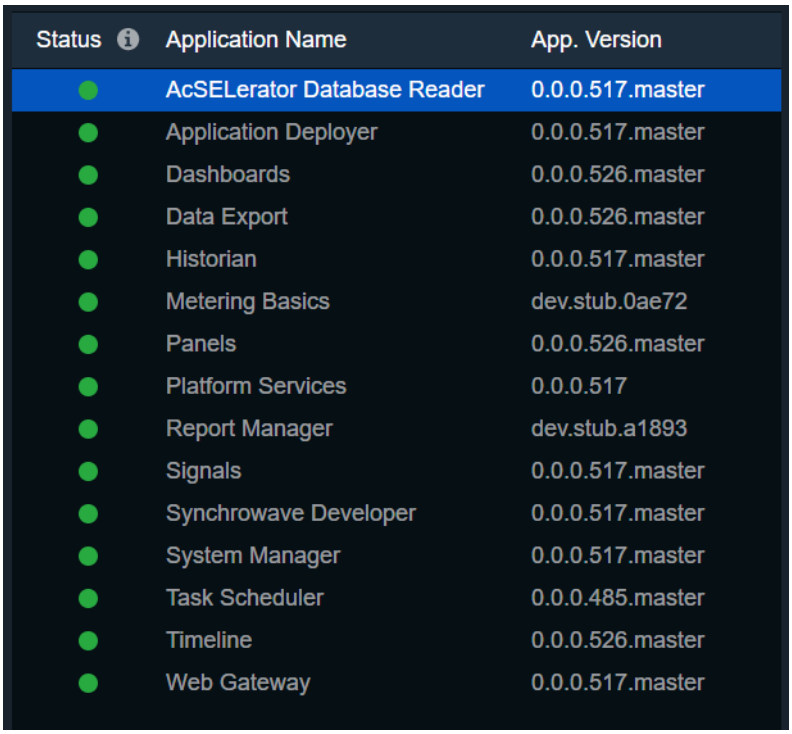

Figure 10.5 Application Menu

Access the status definitions shown in *Figure 10.6* by hovering over the Status Information icon ( ). Additional information regarding the reason for the status may be found in the Application Diagnostic logs.

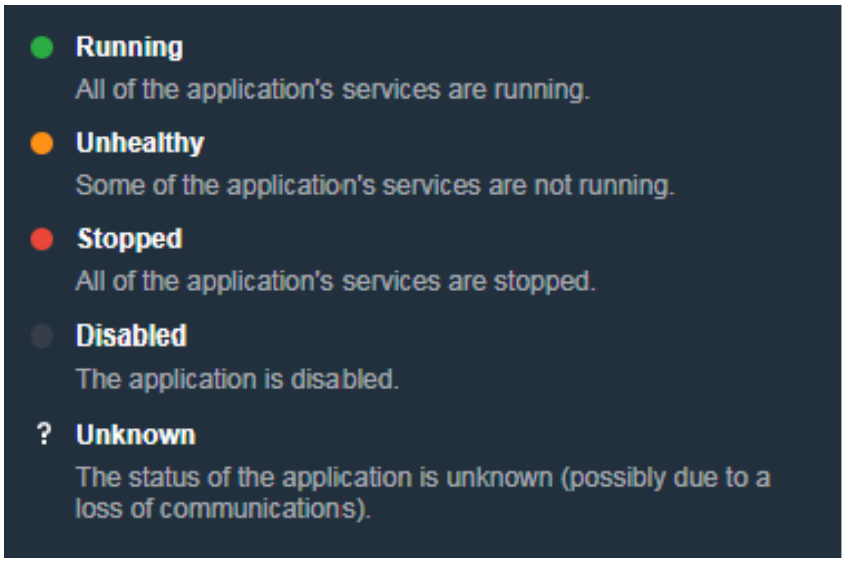

Figure 10.6 Application Status

Selecting an application in the Application menu also gives users the ability to restart, remove, or disable an application.

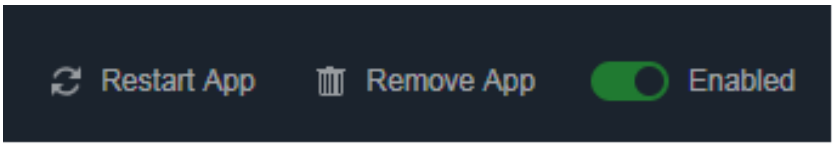

Figure 10.7 Application Management

Application Configuration

Application Configuration is accessed by selecting the Configuration tab for each application in the Application menu. Configuration steps for each application are located with the application in the instruction manual.

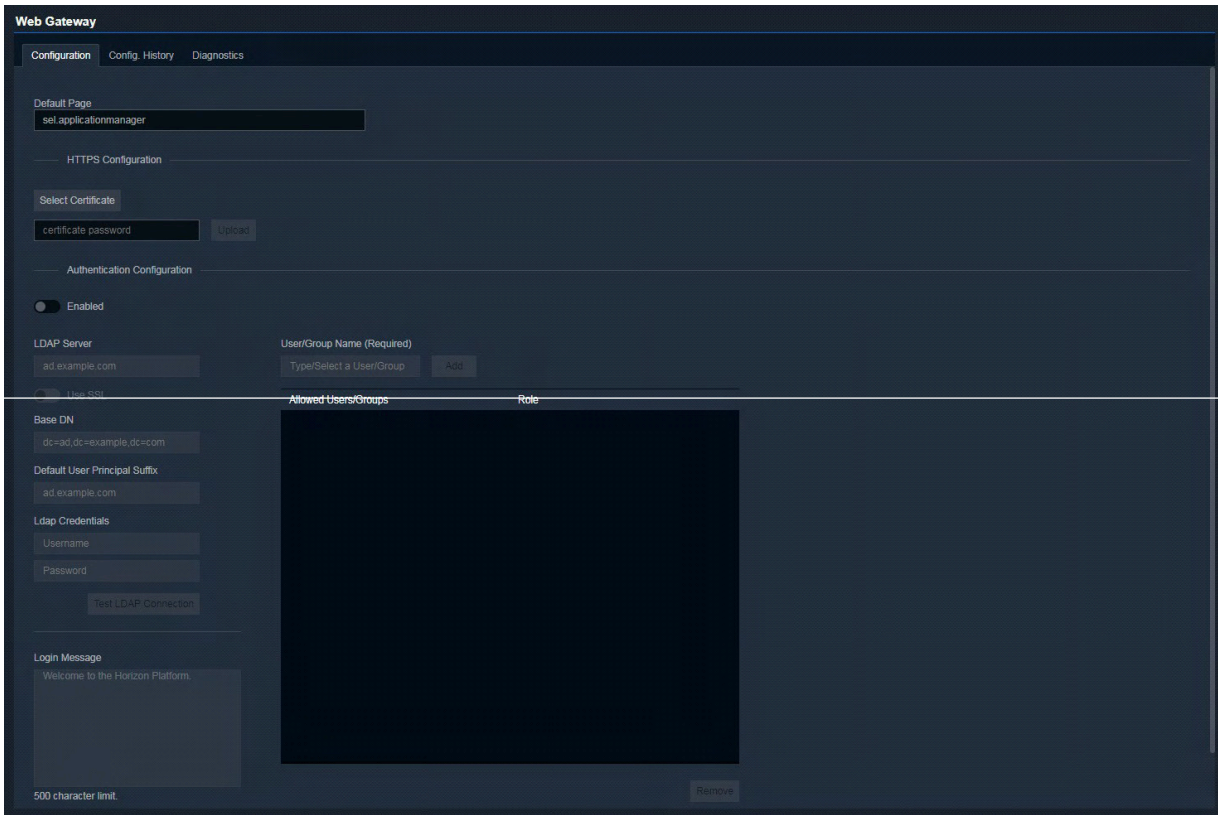

Figure 10.8 Application Configuration

Application Diagnostics

Diagnostic information for each application is accessible via the Diagnostics window for each application in the Application Manager. Diagnostic information helps system administrators understand an application's status and determine any corrective action that may be necessary.

While investigating an application error, it may also be helpful to see diagnostic log messages across all applications installed on the platform. The System Manager provides access to logs across all applications. The System Manager can either be accessed from the Synchrowave Platform Navigation menu (*Figure 10.9*) or by selecting the System button on the left side of the Application Manager.

Figure 10.9 System Manager in Synchrowave Platform Navigation

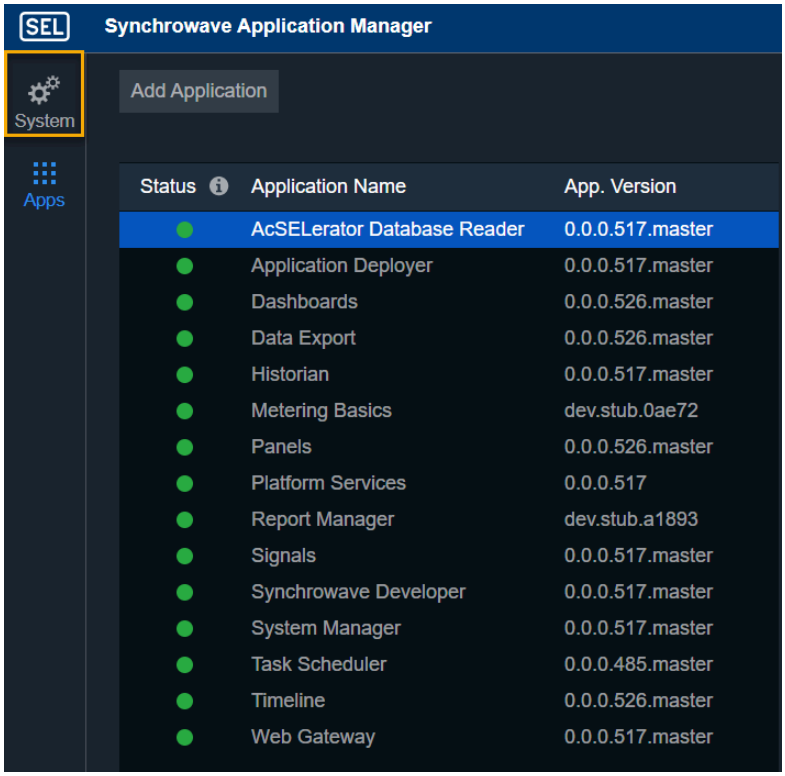

Figure 10.10 Accessing System Manager from Application Manager

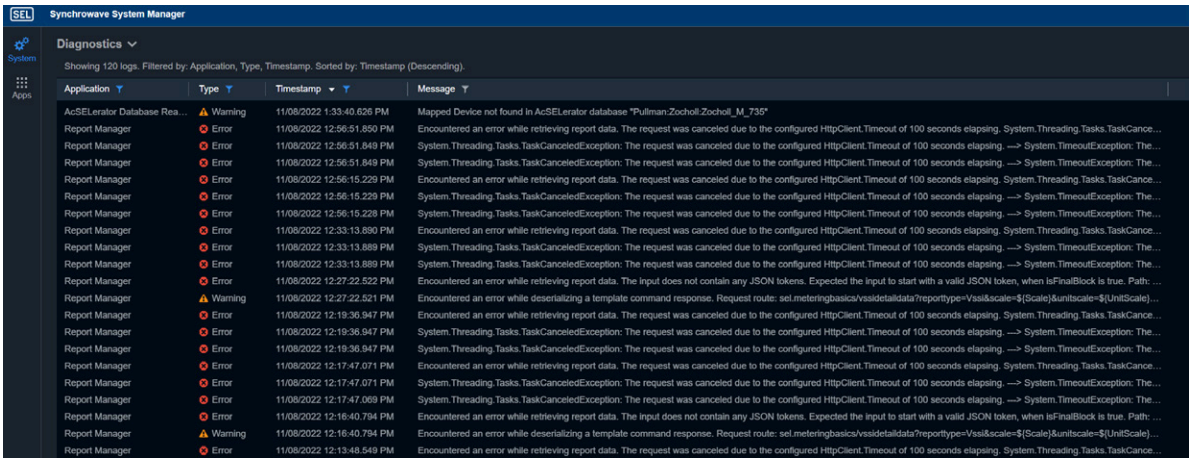

Figure 10.11 System Manager

You can sort each column in the Diagnostic logs in ascending or descending order by selecting the column name. Additionally, each column can be filtered by pressing the funnel icon (⏷) next to the column name. Filtering can be useful to find logs from a specific application or exclude logs of a specific type.

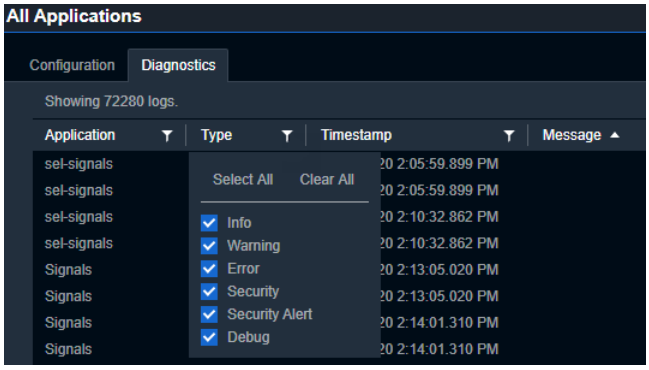

Figure 10.12 Filtering Diagnostic Log Columns

For advanced diagnostic log analysis, the logs for an individual application, or all applications, are exportable to a CSV file by selecting the **Export Logs** icon in the Diagnostic Settings menu.

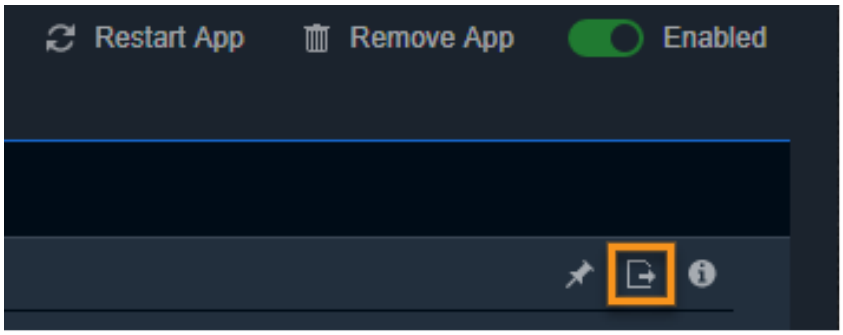

Figure 10.13 Export Diagnostic Logs to CSV File

Contact SEL support if you need assistance interpreting logs.

SEL Signals Application

The SEL Signals application collects, consolidates, and publishes signals to applications on the Synchrowave Platform via the signal bus.

Signals in the Synchrowave Platform are composed of two parts:

- **Measurement Point:** Represents the physical location at which the signal was measured.
- **Data Type (or Quantity):** Represents the type of signal measured.

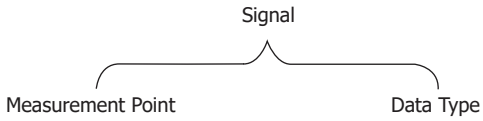

Figure 10.14 Signal Definition

Signals are published to the signal bus through well-defined interfaces by data reader applications and applications that generate signals. Reporting applications and panel applications then request signal data through interfaces for reporting and monitoring.

IEEE C37.118 Reader Application

The IEEE C37.118 Reader application connects to IEEE C37.118 sources and publishes signals to the Synchrowave Platform signal bus.

NOTE
During a node failure, data will be dropped while the IEEE C37.118 Reader reconnects.

IEEE C37.118 Reader Features

Signal Data Quality Processing

A poor-quality signal is published to the data bus as a NaN value unless the AllowInvalidData column in the Connections.csv file is set to true for a particular data stream. Poor signal quality includes the following values: PMU Error, Time-Synchronization Error, and No Data.

Signal Availability

All PMUs read by the IEEE C37.118 Reader have a corresponding Availability data type that describes the percent availability of the PMU per second. This can be helpful during system installation, adding or removing a PMU, and general troubleshooting.

The Availability data type can be displayed in any panel application by selecting **Availability** as the data type.

IEEE C37.118 Reader Configuration

To configure the IEEE C37.118 Reader, first download the Connections.csv file, edit it as necessary (see *Connecting to an IEEE C37.118 Source on page 106*), and import it back into Synchrowave. Then select the **Query and Download** button for the SignalMappings.csv file, edit it as necessary (see *Mapping Incoming IEEE C37.118 Signals on page 107*), and import that file back into Synchrowave.

NOTE
Measurement points, quantity (data type), and asset names can include the following characters: letters, numbers, periods, and underscores. Measurement points **must begin with a letter**.

Connecting to an IEEE C37.118 Source

To connect the IEEE C37.118 Reader to an IEEE C37.118 source, open the Connections.csv file and enter the IP address, port, and PDC ID of the source in the Connection.csv file.

To view data with an invalid data quality flag or time sync error(s), set the value in the **AllowInvalidData** column to **TRUE**.

If the time on the Synchrowave server is not synchronized to within 2 seconds of the PMUs, the reader can alternatively use the time stamp in the PMU stream to provide data alignment. Configure this by setting the value in the **OverrideAsSystemTimeSource** column to **TRUE**. The most recent time stamp for any source marked **TRUE** is used.

A blank entry in either the **AllowInvalidData** or **OverrideAsSystemTimeSource** column is interpreted as FALSE.

To establish a TCP connection, set the value in the **Udp** column to **FALSE**, thus ignoring any value in the UdpClientPort. To read a one-way UDP_S stream, set the value in the **Udp** column to **TRUE** and enter the client port number in the **UdpClientPort** column.

Finally, import the file back into Synchrowave.

	A	B	C	D	E	F	G
1	IPAddress	Port	ID	AllowInvalidData	OverrideAsSystemTimeSource	Udp	UdpClientPort
2	10.202.50.234	7000	0	FALSE	FALSE	FALSE	

Figure 10.15 Connecting to an IEEE C37.118 Source

Mapping Incoming IEEE C37.118 Signals

Signals received by the IEEE C37.118 Reader provide Station and Tag fields. Each of the new signals must be mapped to a measurement point for the signals to be associated with the model and intelligently displayed and queried by applications on the Synchrowave Platform.

The SignalMapping.csv file includes four columns: StationName, Tag, MeasurementPoint, and Quantity. The StationName and Tag columns are automatically populated by the IEEE C37.118 Reader with the signal information from the IEEE C37.118 data stream.

	A	B	C	D
1	StationName	Tag	MeasurementPoint	Quantity
2	PMU1	Frequency		
3	PMU1	Frequency Delta		
4	PMU1	I1X		
5	PMU1	IAX		
6	PMU1	IBX		
7	PMU1	ICX		
8	PMU1	V1Y		
9	PMU1	VAY		
10	PMU1	VBY		
11	PMU1	VCY		
12	PMU1	VS		

Figure 10.16 IEEE C37.118 Reader CSV Mapping File Format

During the initial configuration, the MeasurementPoint and Quantity fields are empty. The administrator uses the information in the DeviceAcronym and Description fields to populate the MeasurementPoint and Quantity fields. The MeasurementPoint describes the location in which the measurement takes place and is displayed in the legend of different dashboard panels to help users differentiate that signal from other signals displayed. The Quantity describes the type of measurement and type of signals that are being displayed.

Example

MeasurementPoint = SubstationA.TransmissionLine1

Quantity = PhaseA.Voltage.Magnitude

Signal = SubstationA.TransmissionLine1.PhaseA.Voltage.Magnitude

Signals are only published to the Synchrowave Platform signal bus if both the MeasurementPoint and Quantity fields are populated. You can import a file without all fields completed, but those signals will be ignored by the IEEE C37.118 Reader.

	A	B	C	D
1	StationName	Tag	MeasurementPoint	Quantity
2	PMU1	Frequency	Station1.Bus	Frequency
3	PMU1	Frequency Delta	Station1.Bus	Frequency.DxDt
4	PMU1	I1X	Station1.Line1	Phase1.Voltage
5	PMU1	IAX	Station1.Line1	PhaseA.Current
6	PMU1	IBX	Station1.Line1	PhaseB.Current
7	PMU1	ICX	Station1.Line1	PhaseC.Current
8	PMU1	V1Y	Station1.Bus	Phase1.Voltage
9	PMU1	VAY	Station1.Bus	PhaseA.Voltage
10	PMU1	VBY	Station1.Bus	PhaseB.Voltage
11	PMU1	VCY	Station1.Bus	PhaseC.Voltage
12	PMU1	VS	Station1.Line1	PhaseS.Voltage

Figure 10.17 Completed IEEE C37.118 Reader CSV Mapping File

Upon completing the signal mapping, save the file and import it back into Synchrowave. Signals are immediately available for display in dashboards and for use in other platform applications.

If new signals are added to the incoming IEEE C37.118 stream after initial import of the signal mapping file, use the **Query and Download** button to download the updated SignalMappings.csv file. The new signals will be added to the end of the file. Populate the MeasurementPoint and Quantity fields for the new signals and then import the file back into Synchrowave.

If previously configured signals are no longer present in the data stream when you select **Query and Download** (usually the result of a lost connection or a changed tag name), those signals will appear at the bottom of the file after a space. These inactive signal rows should be removed before import if they are no longer needed.

Managing Changed Data Rates

The IEEE C37.118 Reader does not support changing data rates for PMU data. If the real-time data rate on any PMU changes, the Synchrowave Platform must be restarted via the Services tab in Windows Task Manager. Note that Synchrowave Monitoring will function as normal when viewing historic data at different data rates. No action is required in this case.

Continuous Waveform Streaming Receiver Application

The Continuous Waveform Streaming (CWS) Receiver application collects CWS protocol streaming data.

CWS Receiver Configuration

To configure the CWS Receiver application, first configure the streaming device to stream to port 4073 on the Synchrowave server.

You can use the config.json file to change the data receiving behavior of the CWS Receiver application. The ContinuousWaveformPort setting defines what port CWS Receiver listens to for UDP streams. The EnablePlugAndPlay setting determines whether new devices are automatically mapped and enabled. By default, EnablePlugAndPlay is set to false to prevent unwanted streams from inadvertently using drive space and processing capacity to record unnecessary data.

Next, download the mappings.csv file by selecting the **Query and Download** button.

During the initial configuration, all of the fields for each row are filled with the default values of all the devices currently streaming to the CWS Receiver application. The MeasurementPoint contains the Terminal ID (TID) of the streaming device. The administrator may modify the MeasurementPoint field to rename the signals corresponding to the device.

NOTE
Measurement points, quantity (data type), and asset names can include the following characters: letters, numbers, periods, and underscores. Measurement points **must begin with a letter**. Incorrect measurement point names will automatically be corrected.

If the name automatically generated for the measurement point is a duplicate, the CWS Receiver application will append "_dup*x*" to the TID, where *x* is the duplicate number for that name.

To enable signal publishing for a measurement point, enter TRUE in the Enable field. Only measurement points that have TRUE in the Enable field will be published.

Upon completing the mapping, save the file and import it back into Synchrowave. Enabled measurement points are immediately available for display in dashboards and for use in other platform applications.

If new streaming sources begin streaming to the CWS Receiver application, use the **Query and Download** button to download the updated mappings.csv file. The new sources will be added to the end of the file. Populate the MeasurementPoint field for the new streaming sources and then import the file back into Synchrowave.

If previously configured signals are no longer present in the data stream when you select **Query and Download** (usually the result of a lost connection or a changed tag name), those signals will appear at the bottom of the file after a space. These inactive signal rows should be removed before import if they are no longer needed.

For each streaming source, the CWS Receiver application provides the signals shown in *Table 10.1*.

Table 10.1 CWS Receiver Quantities

Name	Description	Units
Phase[p].Voltage[a]	Instantaneous voltage	Volts
Phase[p].Current.Magnitude[a]	Instantaneous current	Amperes
Packets	Count of packets received since application startup	Unitless
Drops	Count of dropped packets since application startup	Unitless
Errors	Count of packets with an error since application startup	Unitless

[a] Where [p] = A, B, or C for phase-to-neutral, or AB, BC, or CA for phase-to-phase values.

Time-Series Historian Application

The high-performance Time-Series Historian application supports data rates as slow as 1 message per day and as fast as 14,400 messages per second. The maximum rate is determined by computing resources. The database serves to archive all signals published to the signal bus and to provide the archived data when requested by applications.

Historian Features

Data Retention

For deployments where archive storage availability may be limited, a data retention period can be configured. The Historian application deletes archived data as they become older than the retention setting.

For example, if the data retention setting is set to 7 days, on the 8th day, the first day of previously archived data is deleted to make space for the next day of archived data.

Historian Application Configuration

Configuring the Archive Data Directory

The Historian application creates an SEL-Historian folder at the Archive Data Directory location. This file location is configured in the Platform Services Configuration tab (see *Initial Installation Instructions on page 9*). The Archive Data Directory location also stores application configuration and other files used across the system. If specifying a network location, complete the necessary security credentials to access the network file share location.

Configuring Data Retention

The data retention feature for the Historian application is configured in the Application Manager. To enable this feature, enter the number of days that you want the Historian to retain. A value of 0 days means the application retains all data.

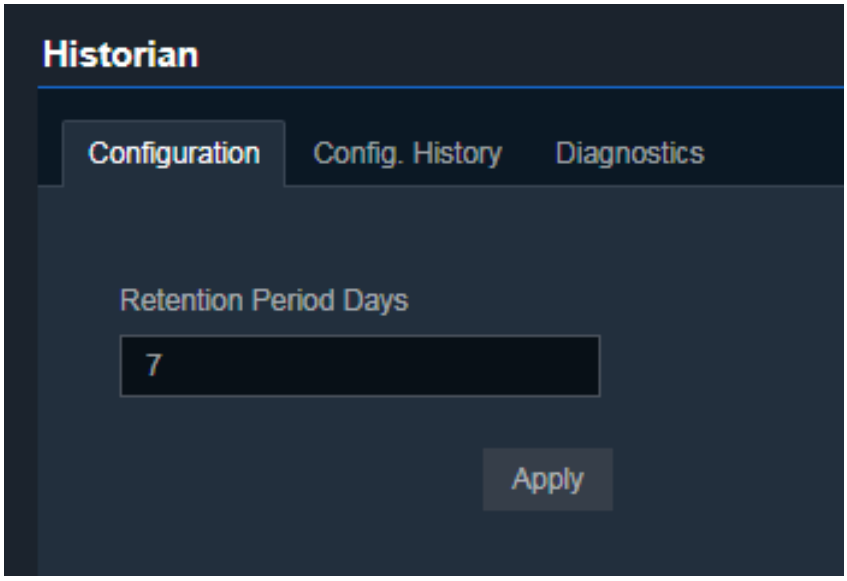

Figure 10.18 Synchrowave Historian Data Retention Configuration

Task Scheduler Application

Task Scheduler Features

- Schedules tasks
- Deletes tasks

Task Scheduler Interface

The Task Scheduler application allows applications to schedule the execution of tasks. The summary of all scheduled tasks is on the Task Scheduler Configuration tab in Synchrowave Application Manager. From this table, you can remove scheduled tasks that are no longer needed by selecting the trash (🗑) icon. The functionality to schedule tasks is used by other Synchrowave applications, including Report Manager.

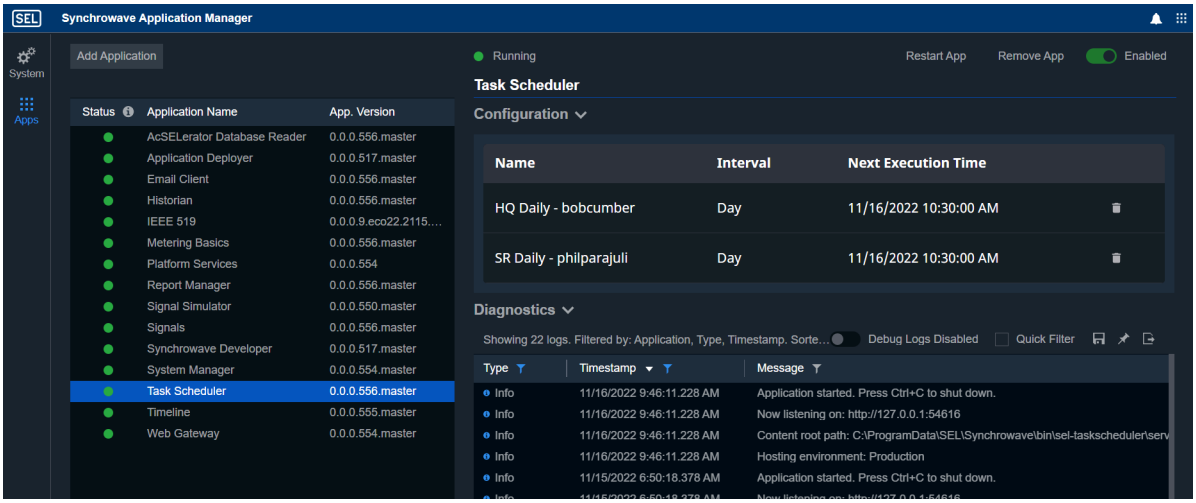

Figure 10.19 Task Scheduler Configuration

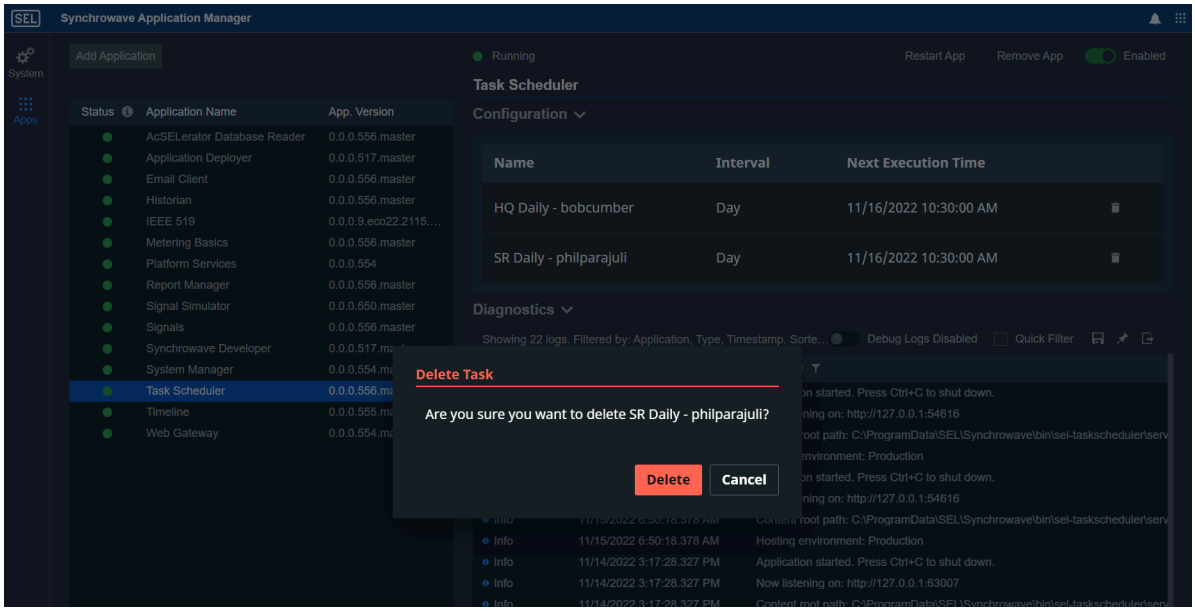

Figure 10.20 Delete Task Configuration Dialog

Metadata Store

The Metadata Store application provides storage for additional information about measurement points and signals.

SER Store

The SER Store application provides storage for Sequence-of-Events/Sequential Events Recorder events.

Event Store

The Event Store application provides storage for event oscillography.

APPENDIX A

Software and Manual Versions

Software

The software and application version information is available in the Application Manager.

Table A.2 lists the Synchrowave Platform software versions, a description of the modifications, and the instruction manual date code that corresponds to these versions. The most recent version is listed first.

Starting with revisions published after March 1, 2022, changes that address security vulnerabilities are marked with "[Cybersecurity]". Other improvements to cybersecurity functionality that should be evaluated for potential cybersecurity importance are marked with "[Cybersecurity Enhancement]".

Table A.1 Synchrowave Reports Package Revision History

Version Number	Summary of Revisions	Manual Date Code
2.9.1	➤ Added the Meter Calculations application. ➤ Fixed issue that would cause a partial lock-up of the Virtual Meters application. ➤ Reduced the Virtual Meters application's memory usage. ➤ Improved time awareness in the CWS Receiver application. ➤ Fixed issue that reduced the CWS Receiver configuration file's compatibility with Excel. ➤ Reduced the CWR Receiver application's memory usage. ➤ Removed license enforcement when generating reports to a custom location in the Report Manager application. ➤ Fixed an issue that caused VSSI Summary Reports to be empty even when data points were present. ➤ Fixed an issue that caused Device Overview Reports in the CSV format to not generate.	20250214
2.9.0	➤ [Cybersecurity] Updated Microsoft .NET third-party libraries to prevent remote code execution. ➤ [Cybersecurity Enhancement] Updated the ACSELERATOR Database Reader application to use remote server identity information from the ACSELERATOR Database Connection Key to enhance X.509 connection verification when connecting to the database. ➤ Added the CWS Receiver application. ➤ Added the Virtual Meters application. ➤ Added the Load Profile application. ➤ Added the Software PMU application. ➤ Added the IEEE C37.118 Reader application. ➤ Added the Dashboards application. ➤ Added the Data Export application. ➤ Added the Device Events application. ➤ Added the Digital Chart application. ➤ Added the Event Viewer application. ➤ Added the Monitoring application. ➤ Added the Panels application. ➤ Added the Power Calculator application. ➤ Added the Sequence Calculator application. ➤ Added the Timeline application. ➤ Added the DMA Receiver application. ➤ Added the Metadata Store application. ➤ Added the SER Store application. ➤ LDP data no longer show duplicate data when multiple data originate from multiple records. ➤ All chart data in Report Manager are in UTC. Each chart will now contain a time zone that is used to update the x-axis ticks as well as each point's tooltip. ➤ Added scaling support for SEL-734 devices. ➤ Synchrowave Web Gateway now includes support for basic authentication. ➤ Added notifications from Historian for when the disk is nearly full and if it has stopped writing. ➤ Improved Historian support for manually copied signal files. ➤ Improved support for digital signals.	20250108
2.6.0	➤ Added charting of VSSI Summary and Detail, Signals, and LDP data through the Data Visualization web interface in Report Manager. ➤ Added charts to PDF reports for VSSI Summary and Detail, Signals, and LDP data. ➤ Modified the Report Manager user interface to include a left-side panel for navigation to Templates, Reports, and Data Visualization. ➤ Added the ability to generate a report from the selected visible time range of a chart without modifying the original time range of the original template. ➤ Addressed an issue where report generation would fail if a VSSI event longer than 1,000 hours was part of the data set.	20230915

Version Number	Summary of Revisions	Manual Date Code
2.4.1	➤ Modified Report Manager to improve the user interface experience. ➤ Added a Report Manager configuration page to allow users to configure custom names for report files and a custom location to which to save generated reports. ➤ Added functionality to Email Client to allow emails to be sent over SMTP or Exchange Online. ➤ Addressed an issue where reports would not generate when the time period contained a daylight-saving time transition on Windows Server 2019. ➤ Addressed an issue where generated reports with more than 10,000 rows would return without the full set of requested data. ➤ Addressed an issue where LDP Reports inconsistently displayed gaps in Load Profile data. ➤ Added functionality to allow users to retrieve data in a signals report based on a user-selected time zone. ➤ Added functionality to allow the Email Client configuration form to a send test email. ➤ Added functionality to LDP and Signals templates to allow signals to have an alias applied to them. ➤ Improved Report Manager to create CSV reports with as many as 512 different signals. ➤ Addressed an issue where Load Profile signals with spaces in the name were not available for selection in a Load Profile Report.	20230503
2.1.0	➤ Added the ability to exclude specified signals from deletion by the Historian. ➤ Added Meter Data Reports, which includes the following reports: ➢ Device Overview ➢ LDP ➢ SER ➢ Signals/WAGES ➢ VSSI Summary and Detail ➤ Moved IEEE 519 reports into the Power Quality Reports option, which includes Meter Data Reports. ➤ Report Manager now includes a 60-day demo license, after which licensing is enforced based on which report is being generated. ➤ Template settings in Report Manager now indicate which fields are required. ➤ Reports in Report Manager can now be generated as a Comma Separated Values (CSV) file. IEEE 519 report templates created before package version 2.1.0 do not support CSV. ➤ Reports larger than 20 MB are now emailed from Report Manager as a link to Report Manager. Reports under 20 MB are attached to the email.	20221216
1.5.3	➤ [Cybersecurity] Improved security of stored data by encryption using a unique key generated when the database is installed.	20220628
1.5.2	➤ Initial version.	20220225

Table A.2 Synchrowave Platform Software Revision History

Version Number	Summary of Revisions	Manual Date Code
2.9.0	➤ [Cybersecurity] Updated Microsoft .NET third-party libraries to prevent remote code execution. ➤ [Cybersecurity] Addressed a vulnerability that allowed an Operations Admin to execute code in a different user's context. ➤ Synchrowave Web Gateway now includes support for basic authentication. ➤ Updated colors and fonts. ➤ Added support for Unicode characters. ➤ Addressed an issue where the SEL Synchrowave user was generating numerous .tmp files. ➤ Added support for LDAPS on Port 636. ➤ Added LDAP support for very large, nested user groups. ➤ Added support for special characters in usernames. ➤ Added support for Windows 11 and Windows Server 2022.	20250108
2.1.0	➤ Improved the reliability of retrieval of secure application configuration data. ➤ Added ability to display a custom banner on each page. ➤ Added Operations Support and View Only roles. ➤ Moved platform diagnostic logs from Application Manager to the new System Manager application. ➤ Improved the application configuration workflow for all applications. ➤ Added certificate-based validation of LDAP servers.	20221216
1.5.3	➤ No changes.	20220628
1.5.2	➤ Initial version.	20220225

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 product manual release dates and a description of modifications. The most recent product manual revision is listed at the top.

Table A.3 Manual Revision History

Date Code	Summary of Revisions
20250214	General ➤ Added *Section 9: Monitoring*. Section 1 ➤ Updated *Table 1.1: Synchrowave Reports Application Highlights* and *Table 1.3: Data Application Highlights*. Section 2 ➤ Updated *Table 2.4: Continuous Waveform Streaming Storage*. Section 4 ➤ Added *Setting Up Meter Calculations*. Section 8 ➤ Added *Virtual Meters Application* and *Load Profile Application*. Appendix A ➤ Updated Synchrowave Reports package to version 2.9.1.

Date Code	Summary of Revisions
20250108	**General** ➤ Added *Section 8: Continuous Waveform Streaming*. **Section 2** ➤ Added Windows 11 and Windows Server 2022 to *Server Software Requirements* in *Server and Client Requirements and Specifications*. ➤ Added CWS Receiver to *Table 2.2: Monitoring Applications*. **Section 9** ➤ Added *IEEE C37.118 Reader Application* and *Continuous Waveform Streaming Receiver Application*. **Appendix A** ➤ [Cybersecurity] Updated Synchrowave Reports package to version 2.9.0. ➤ [Cybersecurity] Updated Synchrowave Platform to version 2.9.0.
20230915	**General** ➤ Added *Appendix E: Cybersecurity Features*. **Section 4** ➤ Updated *Report Manager Features* and *Templates View* in *Creating and Configuring Reports*. ➤ Added *Unlicensed Synchrowave Reports* to *Reports View* in *Creating and Configuring Reports*. ➤ Added *Data Visualization View* to *Creating and Configuring Reports*. **Section 6** ➤ Added *Charts* to *Meter Data Application*. **Appendix A** ➤ Updated Synchrowave Reports package to version 2.6.0. ➤ Updated Summary of Revisions for 20221216 in *Table A.3: Manual Revision History* to include version numbers. **Appendix D** ➤ Updated *Overview* with information about Metering Basics reports.
20230503	**Section 3** ➤ Added *Report Manager Application*. ➤ Added *Microsoft Exchange Online Configuration* to *Email Client Application*. ➤ Added *SMTP Connection Security Options* to *SMTP Configuration*. **Section 6** ➤ Updated *LDP Report* and *Signals Report* in *Reports*. **Appendix A** ➤ Updated Synchrowave Reports package to version 2.4.1.
20221216	**General** ➤ Reorganized and reissued entire manual. **Section 1** ➤ Updated *Functional Overview*. ➤ Updated *Figure 1.1: Synchrowave Reports and Platform Functional Diagram*. ➤ Added *Figure 1.2: Synchrowave Reports Primary Data Pathway*. **Section 2** ➤ Title changed to *Hardware Requirements and Deployment Options*. ➤ Updated *Virtual Machine* and *Additional Notes* in *Hardware Server Requirements*. **Section 3** ➤ Title changed to *Installation and Initial Configuration*. ➤ Updated *Initial Installation Instructions* in *Installing Synchrowave Reports*. ➤ Updated *Figure 3.6: HTTPS Configuration*, *Figure 3.8: LDAP Server Connection Setup*, *Figure 3.9: Adding/Removing Users and User Groups*, *Figure 3.12: Configuration of Default Application Page*, *Figure 3.16: ACSELERATOR Database Reader Configuration*, and *Figure 3.17: Email Client Configuration*. ➤ Updated *ACSELERATOR Database Reader Features* in *ACSELERATOR Database Reader Application*. ➤ Updated *Generate an ACSELERATOR Database Connection Key* and *Connect to an ACSELERATOR Database* in *ACSELERATOR Database Reader Configuration*. ➤ Added *Figure 3.14: Create Connection Key* and *Figure 3.15: Add Connection Key Password*.

Date Code	Summary of Revisions
	Section 4 ➤ Title changed to *Using Synchrowave Reports*. ➤ Updated *Mapping Devices to Measurement Points*. ➤ Updated *Figure 4.1: Exporting the ACSELERATOR Database Reader Device Mapping CSV*, and *Figure 4.6: Select a Template Type for a New Template*. ➤ Updated *Creating and Configuring Reports*. ➤ Updated *Templates View* and *Reports View* in *Creating and Configuring Reports*. ➤ Added *Figure 4.9: CSV Time Format*, *Figure 4.10: Number Format Drop-Down*, *Figure 4.11: Format Cells*, and *Figure 4.13: Report Export Format Settings*. **Section 5** ➤ Added *Section 5: Available Packages*. **Section 6** ➤ Added *Section 6: Meter Data Reports*. **Section 7** ➤ Added *Section 7: Power Quality Reports*. ➤ Updated *Figure 7.10: IEEE 519 Configuration Tab*. **Section 8** ➤ Updated *Figure 8.2: Application Manager*, *Figure 8.3: Application Manager in the Platform Navigation Menu*, *Figure 8.4: Add Application*, *Figure 8.5: Application Menu*, *Figure 8.11: System Manager*, *Figure 8.16: Task Scheduler Configuration*, and *Figure 8.17: Delete Task Configuration Dialog*. ➤ Updated *Application Diagnostics* in *Application Manager*. ➤ Added *Figure 8.9: System Manager in Synchrowave Platform Navigation*, and *Figure 8.10: Accessing System Manager from Application Manager*. **Appendix A** ➤ Updated Synchrowave Reports package to version 2.1.0. ➤ Updated Synchrowave Platform to version 2.1.0. **Appendix C** ➤ Updated *Overview*. ➤ Added *Figure C.2: Invalid License Message*. **Appendix D** ➤ Added *Appendix D: Upgrading Synchrowave Reports*.
20220628	**Section 2** ➤ Updated the preset name in *Configure an SEL-735 for IEEE 519 Reporting* to match the preset name in QuickSet. ➤ Updated *Figure 2.19: IEEE 519 for Synchrowave Reports [All-50th, 3-Second]*. ➤ Updated the description of the polling windows in *Statistical Evaluation*. **Appendix A** ➤ Updated for version number 1.5.3.
20220225	➤ Initial version.

APPENDIX B

Troubleshooting SEL Synchrowave Platform and Reports

This section outlines the most common issues with Synchrowave based on the symptoms the issue causes along with remedies to resolve the issue. To use this section, first locate the symptom in the first column of *Table B.1*, then review the possible causes in the second column. The third column describes methods to resolve the problem and/or references solutions (found after *Table B.1*) that include step-by-step instructions to resolve specific problems.

Symptoms

Table B.1 Symptoms

Symptom	Possible Causes	Remedy
Unable to connect to Synchrowave at https:/ /localhost.	Port 443 (default for https) or 80 are already in use by another application.	Disable other applications (IIS, for example) that may be serving web traffic on port 443.
		If the system has containerization software (Docker, for example) or virtualization software (Hyper-V or VMWare, for example), they may be using or reserving these ports. Running the following command from an administrator command prompt may resolve the issue temporarily: net stop winnat. To resolve the issue, disable or reconfigure the virtualization software.
		Change the port numbers that Synchrowave uses for web access: %PROGRAM-DATA% \SEL\Synchrowave\platform.settings.
Unable to connect to Synchrowave from another client computer.	Windows firewall is blocking incoming ports.	Allow incoming traffic on ports 80 and 443 to allow external computers to access Synchrowave.
	Network is down between client machine and Synchrowave Platform nodes.	Run the ping command on the client computer to determine if it has network access to the computer running Synchrowave. Resolve any networking issues.
	Web Gateway application is disabled or not functioning.	Restart the SEL Synchrowave service using the Windows Services application.
Page Not Found is displayed when navigating to the platform URL.	The application serving the Web Gateway default page is not running.	Verify all applications are running following *Examining and Restarting Applications From the Application Manager on page 120*.
	The Web Gateway default page is set incorrectly.	Follow *Reset Web Gateway Default Page on page 120*.

Symptom	Possible Causes	Remedy
Part or all of the Reports page is not displayed correctly or is displayed very slowly.	One or more Reports applications are not functioning.	Verify all applications are running following *Reset Web Gateway Default Page on page 120*.
	The CPU is overloaded on server.	Use Windows Task Manager to ensure the computer running the Synchrowave service is not overloaded.
One application is not functioning. The Application Manager shows an application is Unhealthy (indicated with an orange status icon).	The application is incorrectly configured.	View the application Diagnostics logs in Application Manager. Correct the issue and, if needed, restart the application by selecting **Restart App**.
	The application services are malfunctioning or crashed.	In the Application Manager, restart the application by selecting the application and selecting **Restart App**.

Solutions

Examining and Restarting Applications From the Application Manager

Step 1. In a web browser, navigate directly to the application manager by using the URL **https://[domain]/sel.applicationmanager**, where [domain] is replaced with the domain name or IP address of the Synchrowave Platform.

Step 2. Examine the status icon of each application.

Step 3. If an application is not green, examine its logs by selecting the application and selecting the **Diagnostics** tab.

Step 4. Resolve the problem and restart the application by selecting **Restart App**.

Reset Web Gateway Default Page

Step 1. In a web browser, navigate directly to the application manager by using the URL **https://[domain]/sel.applicationmanager**, where [domain] is replaced with the domain name or IP address of the Synchrowave Platform.

Step 2. Select **Web Gateway**.

Step 3. Select the **Configuration** tab.

Step 4. Type **sel.applicationmanager** into the Default Page field. This restores the Application Manager as the default page.

Note that you can use another page for the default page. For example, entering **sel.monitoring** sets the Monitoring application (if it is installed) as the default page.

Step 5. Select **Apply**.

APPENDIX C

Synchrowave Reports License Activation

Overview

Synchrowave Reports software operates with a warning banner until licensed.

Figure C.1 Unlicensed Warning Banner

Additionally, Synchrowave Reports will not display reports until the corresponding license is installed.

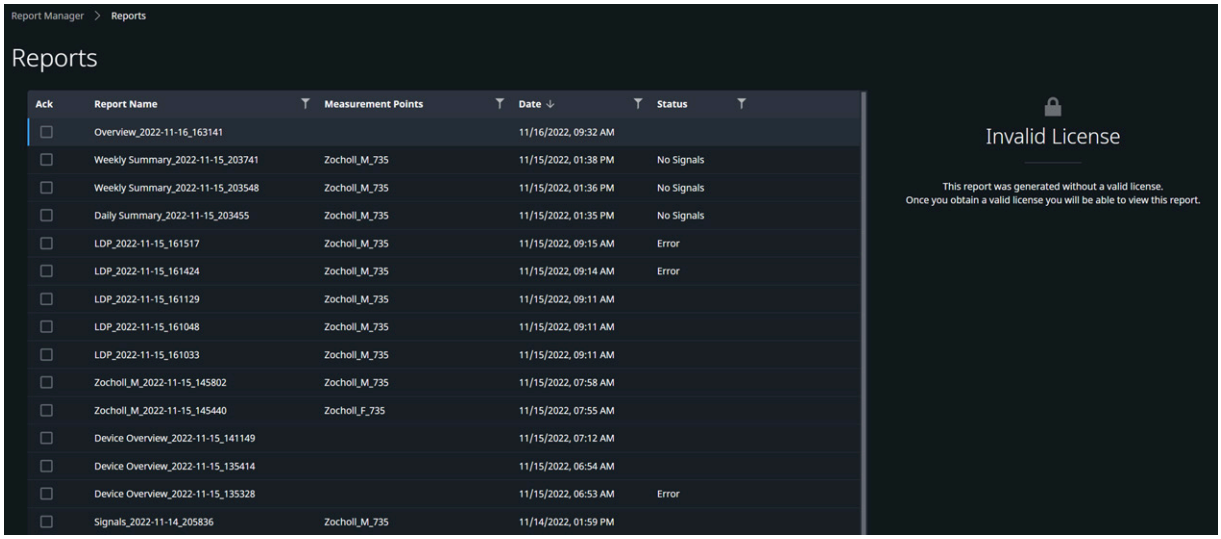

Figure C.2 Invalid License Message

To purchase a Synchrowave Reports license, visit the Synchrowave Reports product page at selinc.com or contact your local SEL sales representative. Once you have purchased a license, perform the following steps as necessary for software licensing:

- *Internet License Activation on page 122*
- *Internet License Deactivation on page 122*
- *Manual License Activation on page 123*
- *Manual License Deactivation on page 125*

The license for Synchrowave Reports does not expire. Once you have licensed Synchrowave Reports, you may use that licensed version in perpetuity. The license is applicable to any upgrades with the same major version number. For example, the major version number refers to the first digit, so version 1.3.2 would be a 1.x.x major version. A license for that version would *not* work with a 2.x.x version of Synchrowave Reports.

To move a license from one server to another, follow the deactivation steps first on the server from which you are removing the license and then follow the activation steps on the server to which you are moving the license.

Internet License Activation

Step 1. Download **Synchrowave Reports** from the SEL website (selinc.com).

Step 2. Install **Synchrowave Reports**.

Step 3. Open the **Application Manager** via the Synchrowave Reports web client.

Step 4. Select the **Configuration** tab for the **Platform Services** app.

Step 5. Enter your License Activation ID (also called License Authorization Code, LAC).

Step 6. Select the **Activate** button in the **Internet Licensing** tab (the activate button is disabled until the Activation ID is entered).

Step 7. If activation is successful, the License Status changes from **Unlicensed** to **Activated** with a green check mark and the Licensing warning banner should disappear.

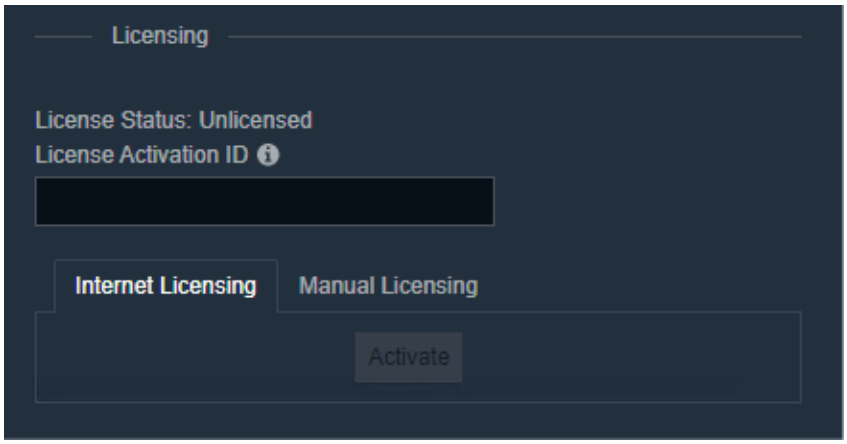

Figure C.3 Synchrowave Reports Internet License Activation

Internet License Deactivation

Step 1. Open the **Application Manager** via the Synchrowave Reports web client.

Step 2. Select the **Configuration** tab for the **Platform Services** app.

Step 3. Select the **Deactivate** button in the **Internet Licensing** tab.

Step 4. Select **Close**.

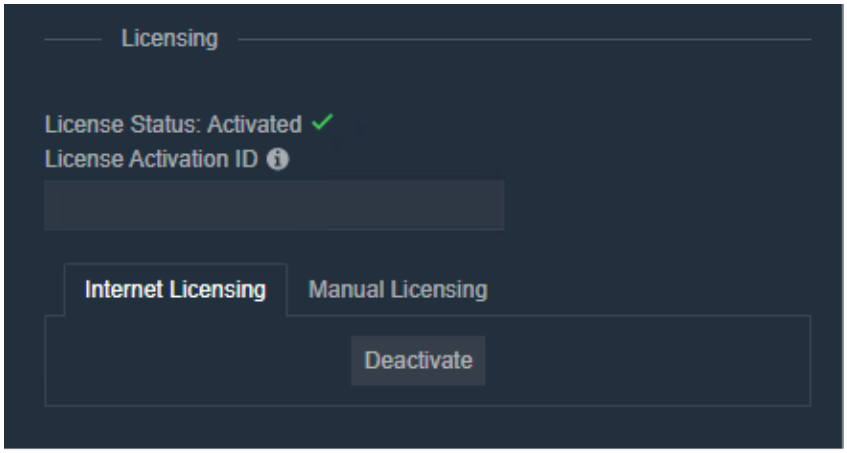

Figure C.4 Synchrowave Reports Internet License Deactivation

Manual License Activation

Step 1. Download **Synchrowave Reports** from the SEL website (selinc.com).

Step 2. Install **Synchrowave Reports**.

Step 3. Open the **Application Manager** via the **Synchrowave Reports** web client.

Step 4. Select the **Configuration** tab for the **Platform Service**s app.

Step 5. Enter your License Activation ID (also called License Authorization Code, LAC).

Step 6. Select the **Download Capability Activation Request** button in the **Manual Licensing** tab (the buttons are disabled until an Activation ID is entered).

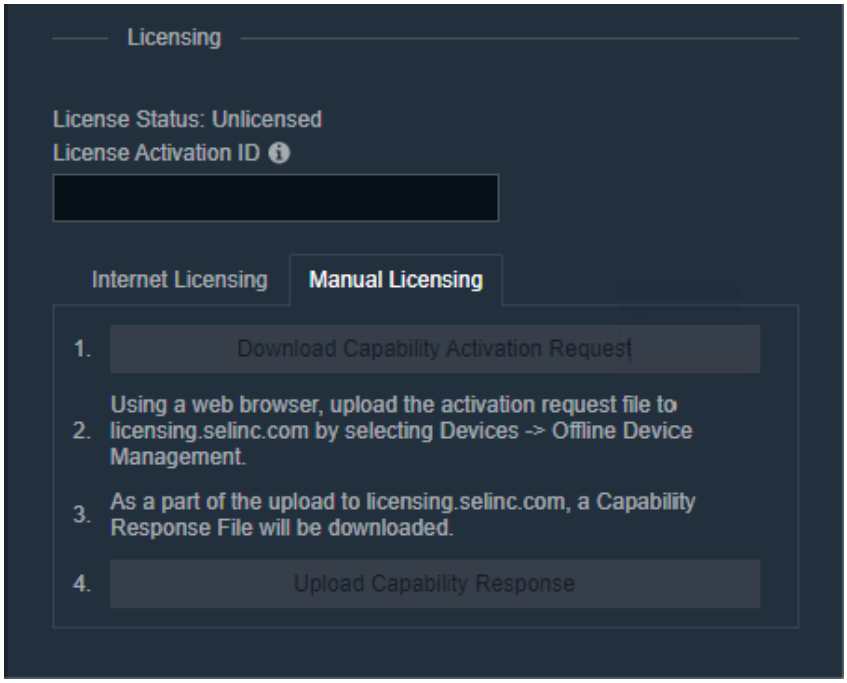

Figure C.5 Synchrowave Reports Manual License Activation

Step 7. Save the **Capability Activation Request** file to a thumb drive or a network drive that can be accessed via a computer with internet access, or email the **Capability Request** file to SEL.

Step 8. From a computer that has internet access, go to **https://licensing.selinc.com** and log in with the activation ID you are activating.

Figure C.6 SEL Licensing Portal Login Screen

Step 9. From the **License & Delivery** portal page, select the **Devices** tab and select **Offline Device Management**.

Step 10. From the **Offline Device Management** page, select **Browse**, and select the Capability Activation Request file generated in *Step 7*.

Step 11. Select **Upload**.

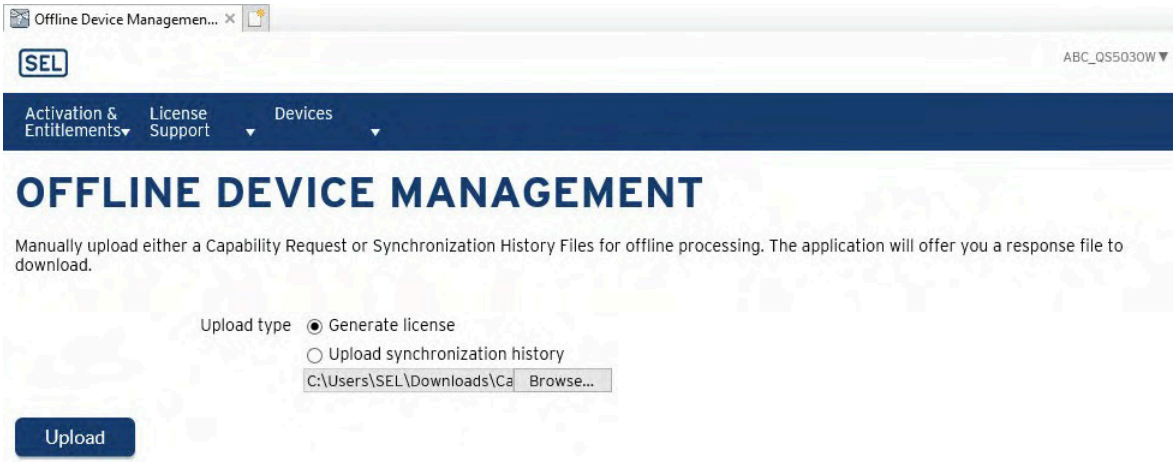

Figure C.7 Upload Capability Request

Step 12. Select the link highlighted at the top of *Figure C.8* to download the **Capability Response** file.

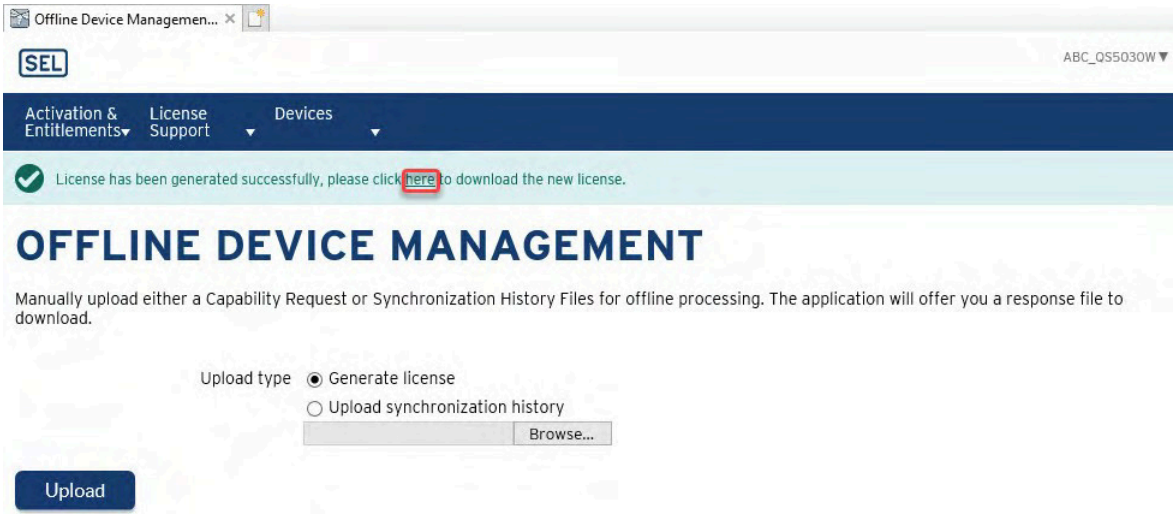

Figure C.8 Link to Download Capability Response File

Step 13. Select **Save**.

Figure C.9 Save the Capability Response File

Step 14. With the **Capability Response** file saved in *Step 13*, return to the computer where the Synchrowave Reports license is being activated.

Step 15. From the **Manual Licensing** form, select **Upload Capability Activation Response**.

Step 16. Navigate to the location of the **Capability Response** file created in *Step 13* and select **Open**.

Step 17. Select **OK** on the confirmation message that indicates the file was successfully imported.

Step 18. If activation is successful, the License Status should change from "Unlicensed" to "Activated" with a green check mark and the Licensing warning banner should disappear after a few seconds.

Manual License Deactivation

Step 1. Open the **Application Manager** via the Synchrowave Reports web client.

Step 2. Select the **Configuration** tab for the **Platform Services** app.

Step 3. Select the **Download Capability Deactivation Request** button in the **Offline Licensing** tab.

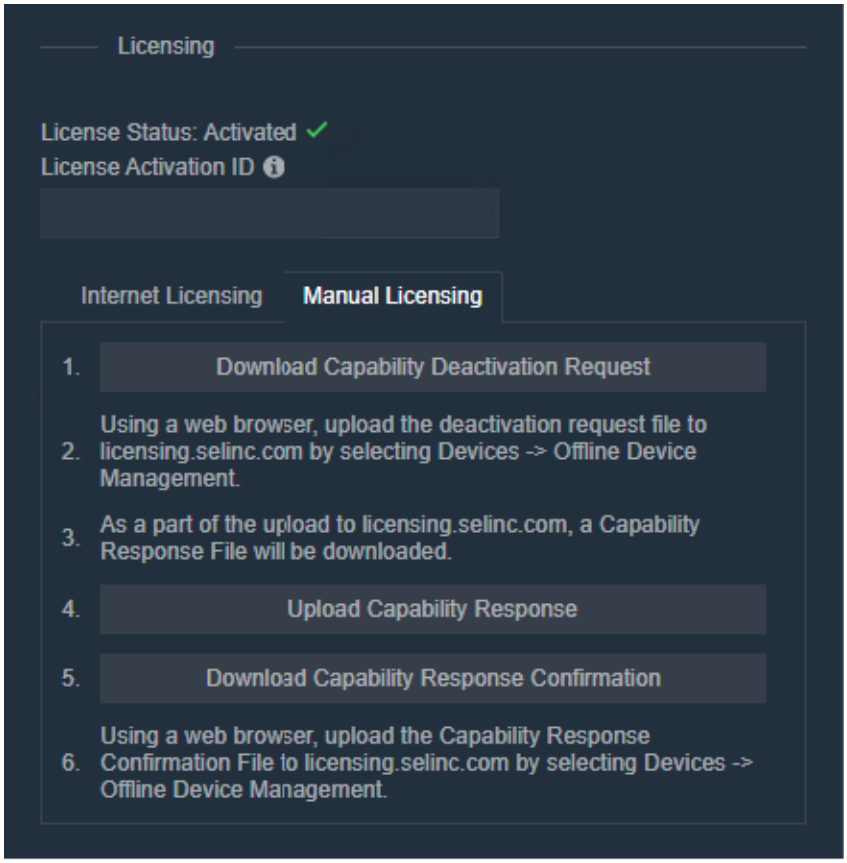

Figure C.10 Synchrowave Reports Manual License Deactivation

Step 4. Save the **Capability Request** file to a thumb drive or a network drive that can be accessed by a computer that has internet access, or email the **Capability Request** file to SEL.

Step 5. From a computer that has internet access, go to **https://licensing.selinc.com** and sign in with the activation ID you are deactivating.

Step 6. From the **License & Delivery Portal** page, select the **Devices** tab and select **Offline Device Management**.

Step 7. From the **Upload Capability Request** page, select **Browse**, and select the Capability Request file generated in *Step 4*.

Step 8. Select **Upload**.

Step 9. Select the highlighted link at the top of *Figure C.11* to download the **Capability Response** file.

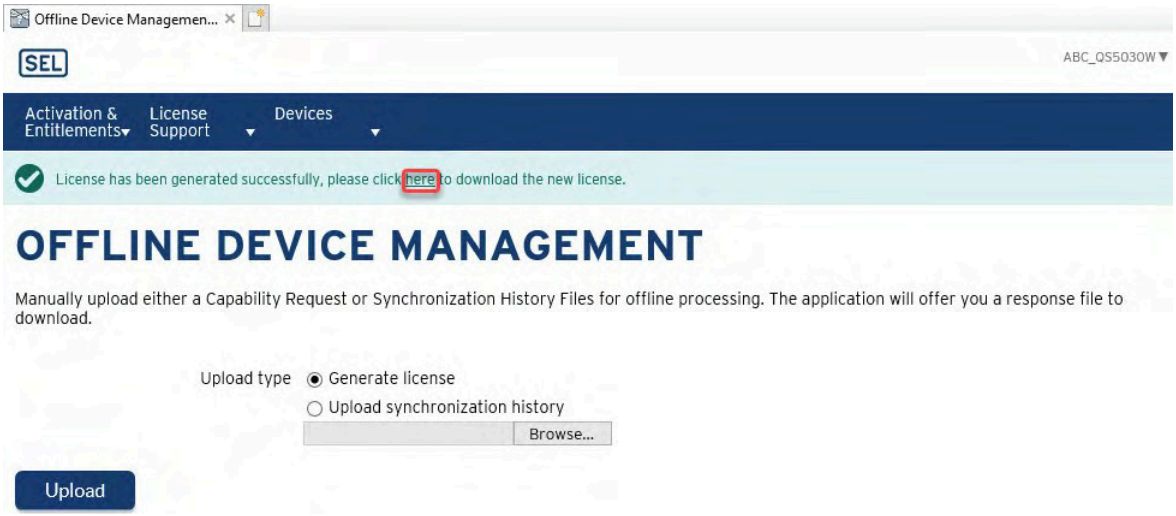

Figure C.11 Link to Download Capability Response File

Step 10. Select **Save**.

Figure C.12 Save the Capability Response File

Step 11. With the **Capability Response** file saved in *Step 10*, return to the computer where the Synchrowave Reports license is being deactivated.

Step 12. From the **Manual Deactivate** window, select **Upload Capability Response File**.

Step 13. Browse to the location of the **Capability Response** file created in *Step 10* and select **Open**.

Step 14. Select **OK** on the confirmation message that indicates the file was successfully imported.

Step 15. From the **Manual Deactivate** screen, select **Download Capability Response Confirmation** file.

Step 16. Provide a name and location for the **Capability Response Confirmation** file and select **Save**.

Step 17. From a computer that has internet access, go to **https://licensing.selinc.com** and log in with the activation ID you are deactivating.

Step 18. From the **License & Delivery Portal** page, select the **Devices** tab and select **Offline Device Management**.

Step 19. From the **Upload Capability Request** page, select **Browse**, select the Capability Response Confirmation file generated in *Step 16*, and select **Upload**. After you upload the confirmation file, the FlexNet software generates another response file. This additional response file is not required and does not need to be downloaded.

Step 20. Select **Close** on the **Manual Deactivate** form. The activation ID that was deactivated no longer shows in the **License Information** screen.

Technical Support

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

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Pullman, WA 99163-5603 U.S.A.
Tel: +1.509.338.3838
Fax: +1.509.332.7990
Internet: selinc.com/support
Email: info@selinc.com

APPENDIX D

Upgrading Synchrowave Reports

Overview

To upgrade Synchrowave Reports, follow the instructions in *Section 3: Installation and Configuration*.

IEEE 519 configurations, Report Manager templates and reports, and Task Scheduler tasks from previous versions of Synchrowave Reports will continue working.

Old IEEE 519 templates will not have the CSV export option. The user will need to re-create the IEEE 519 template in order to export the IEEE 519 data as a CSV file.

Metering Basics configurations, templates, reports, and tasks from previous versions of Synchrowave Reports will continue working.

Reports created from old Metering Basics templates will not have charts. The user will need to re-create the Metering Basics templates to include charts in reports.

Technical Support

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

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Email: info@selinc.com

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APPENDIX E

Cybersecurity Features

Introduction and Security Environment

Product Function

Synchrowave Monitoring and Operations (hereafter, Synchrowave) software hosts web applications that store and visualize power system data. Other applications analyze the data and notify users of events.

Security Requirements

Synchrowave is expected to be installed on secured servers with access restricted to administrators. The network storage (required for multi-node installations) is also expected to be secured with access restricted to administrators. Both the server and network storage should be isolated from the Internet.

Version Information

Obtaining Version Information

The Application Manager application in Synchrowave provides options for managing installed applications. The Application Manager displays installed applications' versions. The version of the platform can be found as the version of the Platform Services application.

Commissioning and Decommissioning

Commissioning

Synchrowave Windows Platform

A Windows service is created upon installation for orchestrating all the Synchrowave applications. The Windows service uses a virtual service account with the name "NT SERVICE\SEL Synchrowave" and has no credentials.

Synchrowave Linux Platform (Synchrowave Operations Only)

Installation requires root. See the Linux Software Installation section for details.

Data Storage

Sensitive Data Storage

Synchrowave encrypts all sensitive data (such as credentials and keys) at rest.

General Data Storage

Synchrowave stores other non-sensitive data on a shared network file system for multi-node clusters or optionally on a node's local file system for a single node installation. The network file system should be placed in the same trust zone (within the same security perimeter) as the Synchrowave server nodes.

This data store includes:

- Application configuration data such as user preferences, dashboards, and notification data.
- Application binaries (executables and DLLs).
- Power system data such as voltage signals and derived signals.
- System logs.

Encryption at rest, if required, is configured at the file system level.

SECURITY NOTE
Permission to the shared network file system should be restricted to system administrators only. Administrators may enable encryption at the file system level for this network share.

Secure Operation Recommendations

SEL recommends that administrators ensure the following:

- Servers used for hosting are dedicated solely to this purpose.
- Administrators are the only user with access to the Synchrowave servers.
- Authentication is enabled (see *Authentication Configuration on page 12*).
- Authorization roles are configured.
- A trusted HTTPS certificate is configured (see *Configuration of HTTPS on page 11*).
- Only system administrators have access to the network shared file system.
- Servers are not connected to the internet.
- Synchrowave server(s) and file system are placed behind a firewall that only allows the minimum set of required ports.

Decommissioning

A Synchrowave Linux installation can be decommissioned through the Synchrowave CLI command "system uninstall". This command preserves the k3s cluster and data stored on the network storage device.

A Synchrowave Windows installation can be decommissioned using Windows' Add/Remove program tool. This preserves stored data.

External Interfaces

Ports and Services

Logical Ports

Synchrowave accepts connection over HTTPS (443) and HTTP (80 redirected to HTTPS). For a complete list of ports that may be opened depending on installed applications, see *Network Requirements on page 5*.

Application Interfaces

Please contact SEL support for details on accessing application interfaces.

File System Interfaces

Synchrowave creates an application directory with sub-directories for data, configuration, logs, and application images. Default locations are /usr/local/synchrowave/app for Linux and C:\ProgramData\SEL\Synchrowave for Windows (both locations are user-configurable).

Access Controls

Privilege Levels

Role-based access control (RBAC) is used to manage access to Synchrowave with predefined roles and capabilities. See *Adding/Removing Users on page 13* for details on user roles.

Centrally Managed Accounts

Synchrowave authenticates all incoming web traffic via connection to an Active Directory server (LDAP over TLS). Synchrowave uses JSON Web Tokens (JWTs) for web application session management.

SECURITY NOTE
The connection to LDAP and list of authorized users and roles must be configured after Synchrowave installation.

Local Accounts

Synchrowave does not support local accounts.

X.509 Certificates

Synchrowave uses X.509 certificates for establishing trust for HTTPS and LDAP protocols. The certificates generated by default use the following certificate parameters:

- 4096-bit RSA
- SHA256 Hash Algorithm
- Pkcs1 Padding

SECURITY NOTE
A default HTTPS certificate is generated upon initial startup of the system. This certificate must be explicitly trusted by clients, or the certificate must be replaced by one issued by a trusted certificate authority.

Logging

Security Events

Synchrowave has two types of security events that can appear in the logs:

- Security Alert—Information alerting of potential security concerns.
  - Examples: login failure, unauthorized access attempts, invalid session token detection.
- Security—Information relating to security.
  - Examples: user logging in, user logging out.

The logs can be viewed from the System Manager page.

Internal Log Storage

Synchrowave stores logs for 90 days. Logs older than 90 days are deleted.

Syslog

Synchrowave provides the option in the Platform Services application to direct all logs generated by Synchrowave to syslog.

Backup and Restore

See *Synchrowave Platform Backup Procedure on page 26*.

Malware Protection Features

Synchrowave installers are digitally signed by SEL. Linux installers can be verified as authentic using SHA-256 hash values available from SEL. Installers should be verified as authentic. All Synchrowave applications are signed by SEL and Synchrowave verifies their signatures when they are installed.

Product Updates

Release notes for Synchrowave can be found in *Appendix A: Software and Manual Versions*. Information about the SEL process for disclosing security vulnerabilities can be found at https://selinc.com/security_vulnerabilities/.

Obtaining Updates

The latest software version can be found at https://selinc.com/products/software/latest-software-versions/. To obtain the latest software, contact SEL.

Update Verification

Synchrowave installers are digitally signed by SEL. Linux installers can be verified as authentic using SHA-256 hash values available from SEL. Installers should be verified as authentic. All Synchrowave applications are signed by SEL and Synchrowave verifies their signatures when they are installed.

Contact SEL

For further questions or concerns about product security, contact SEL at security@selinc.com or +1.509.332.1890.

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