# ProVision®

## User Manual

By Power Monitors, Inc.



Revised: *September 1, 2020*

# Contents

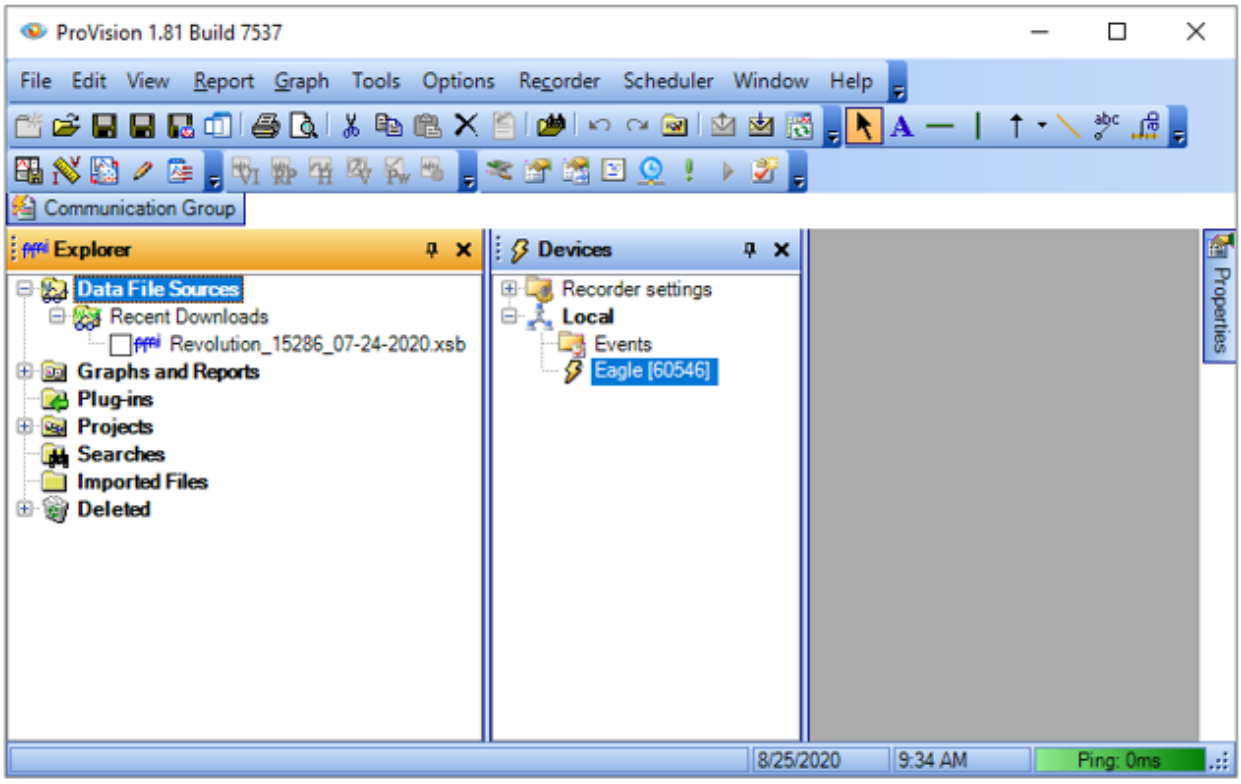
# Introducing ProVision®

ProVision® is Power Monitors' Power Quality (PQ) data analysis software. Sophisticated tools and advanced communications greatly expand the ability to record, manage and analyze power quality data.

The easy-to-use graphical user interface is designed to get both the novice and the advanced user up to speed quickly.

ProVision will connect to local recorders using a USB cable, or remotely to Bluetooth® capable recorders, Wi-Fi capable recorders, and to PMI recorders having cellular modems.

ProVision is used on Microsoft Windows based computers.




ProVision with an Eagle recorder connected

# Installing ProVision®

There is no cost or license fee for ProVision or the USB driver.

To connect and download PMI recorders, you will need the USB driver installed for your PC or Laptop to recognize the recorders.

Both ProVision and the USB driver can be downloaded from the PMI website:

https://powermonitors.com/downloads (select software)

Once downloaded, run the install Wizard to complete the installation. Take all the default settings and allow installation of the sub-USB drivers.

Note that your computer Administrator may need to perform the installs of ProVision and the USB driver.

# Assistance

Help is always available if you need additional assistance.

The technical support team at PMI is widely considered to be the best in the industry.

Contact us 24 hours a day, 7 days a week for live tech support by calling:
(800) 296-4120

There are also many helpful items and videos on the PMI Support webpage.
https://powermonitors.com/support

# Quick Start

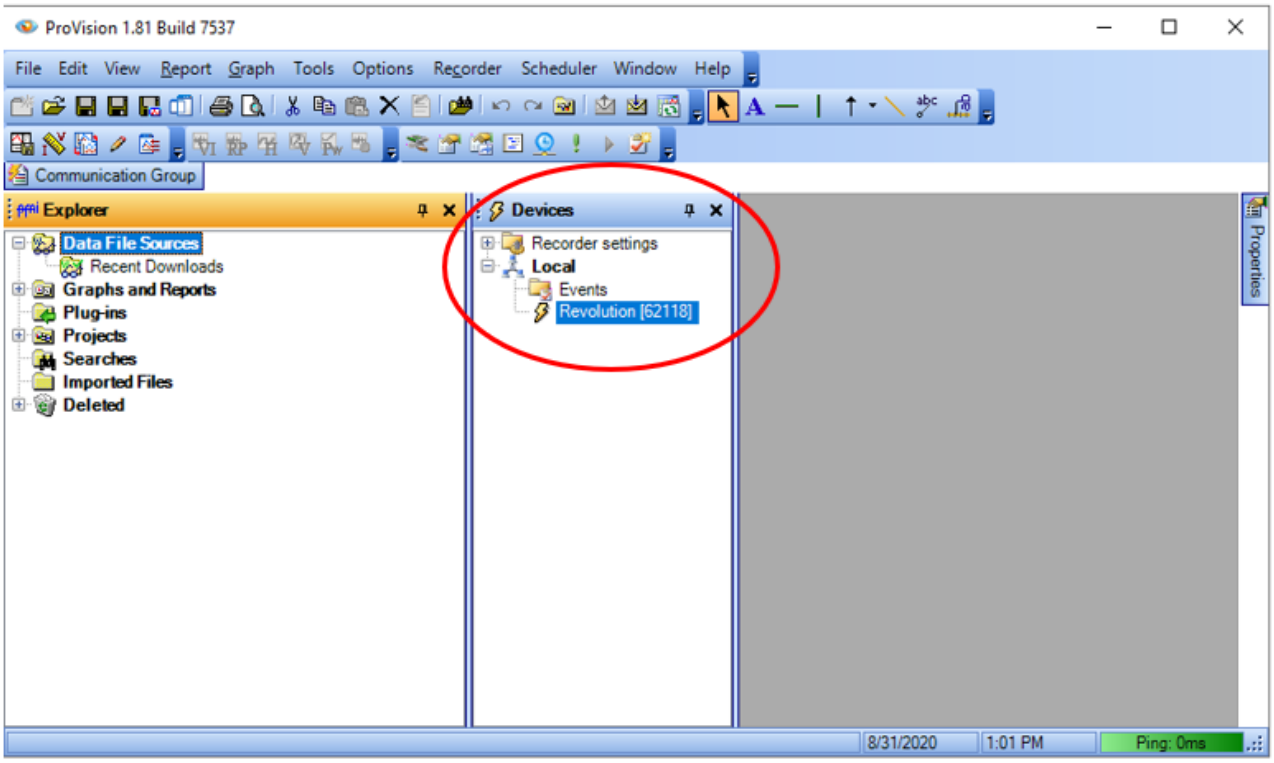
Now that you have received a new PMI recorder and downloaded the ProVision and USB software, let's walk through the basic Provision recording steps.

1) Connect the Recorder

Open the Provision software by clicking on the Eagle-eye icon that was created on your desktop during the installation, then connect the supplied cable to your recorder and to a USB port on your PC.

You will notice the recorder has a Status LED, and when connected to your PC, the LED will be a solid green to indicate it is powered up and communicating.

Note: If your recorder does not connect with a USB cable, see the chapter entitled '**Working with Recorders**' before proceeding.
Also note that some recorders have different LED patterns.



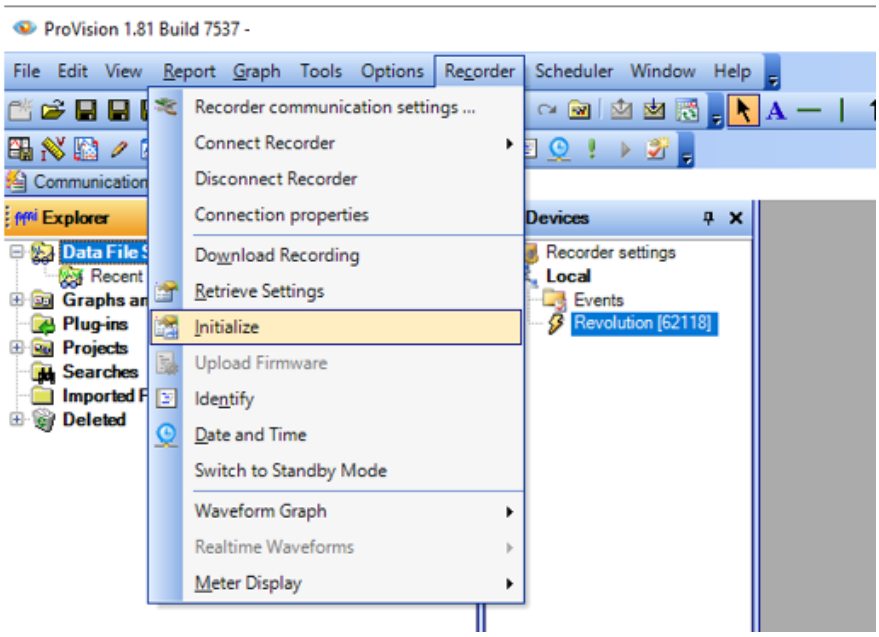

When connected to the PC, your PMI recorder will show in the Devices Pane

2) Initialize the Recorder

The next step is to initialize the recorder and choose what you want to record.

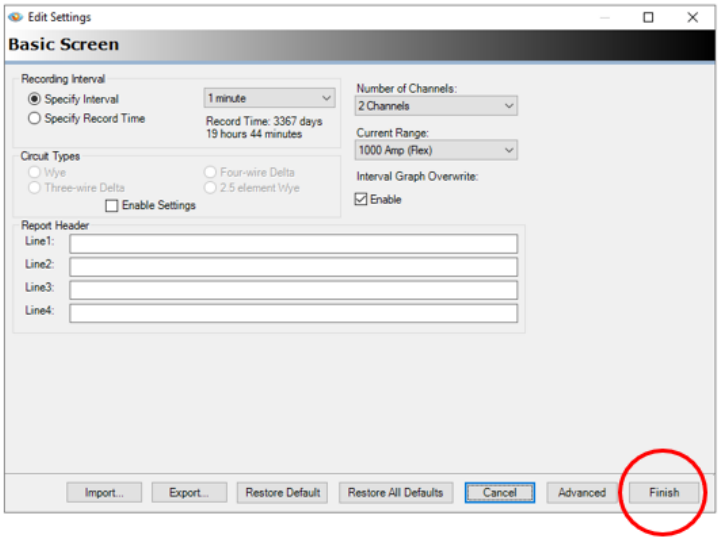
Select the **[Recorder]** menu at the top of ProVision, then select **[Initialize]**

Initialization settings may vary between recorders, some settings may be ‘grayed’ out and are not selectable. ProVision shows the settings for the connected recorder.

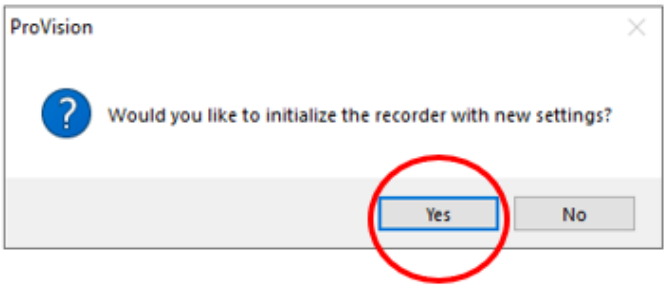



There are several pages of Initialization choices, see all the settings explained later in this manual. The default circuit type is set to Wye and will record phase to neutral voltages.

When all selections are completed, select **[Finish]** at the bottom of the Screen.



Answer **[Yes]** to the initialization message.
The data file is stored in the recorder's memory. After initialization the data can be downloaded again and again, until AC power is applied to the recorder and a new recording is started.




Note: Initializing a recorder will start a new recording when power is applied to the recorder. If the recorder is not initialized and power is applied, the previous recorded data will be appended to.

The recorder is ready to go. Disconnect the USB cable or for wireless connections select **[Disconnect]** from the Recorder menu.

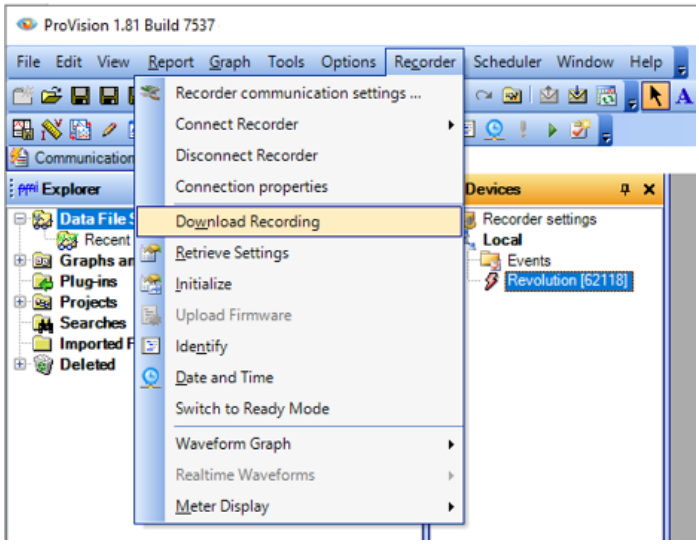
3) Set the recorder

Place the recorder at the site. See the recorder's manual on how to hook up the specific recorder. Circuit Hookup Diagrams are found later in this manual. Remember to look at the Status LED before leaving the site. If the LED is not blinking, you are not recording.

4) Download the Recording

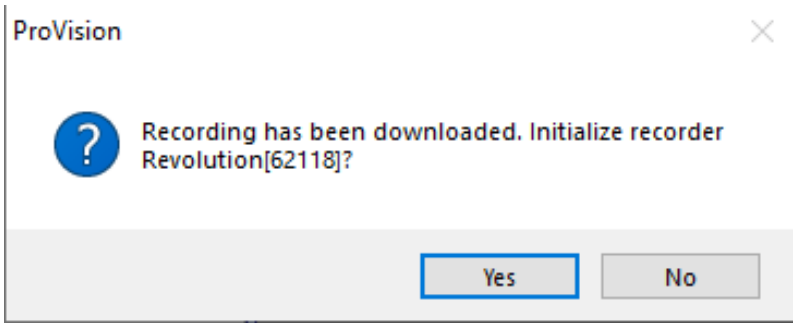
When you are finished recording at the site, it is time to download the data. For safety reasons. it is not recommended to download a recorder using the USB cable while still connected to AC voltage.

Connect the recorder to the USB port and wait until the model and serial number show in the Devices pane. Next select the **[Recorder]** menu (or right-click on the model/serial number) and select **[Download Recording]**



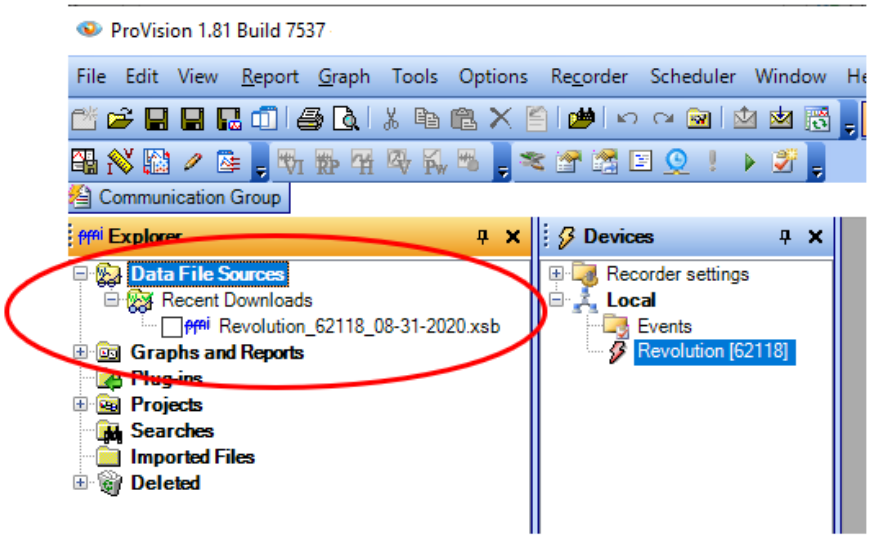

When the download is completed, a pop-up will ask you to name the recording. A default name is applied, but you can change the name. Then choose **[OK]**

You will be asked to initialize at this time. You can choose to initialize now or later.
Selecting **[Yes]** will initialize the recorder with the same settings used in the previous recording.

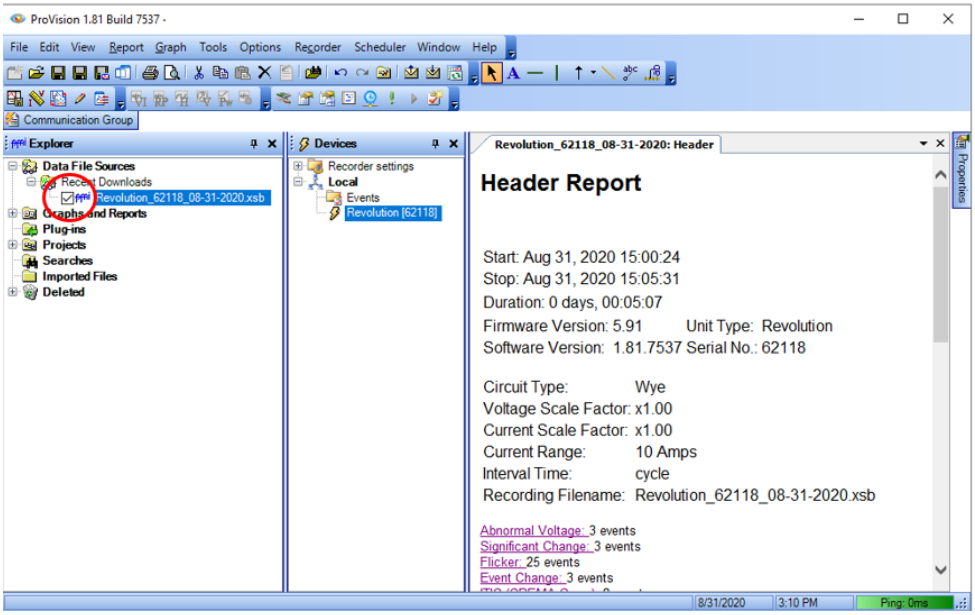



5) View the data

The date files are stored on your PC's C: drive and will be listed in ProVision under the '**Recent Downloads**' heading in the Explorer Pane.



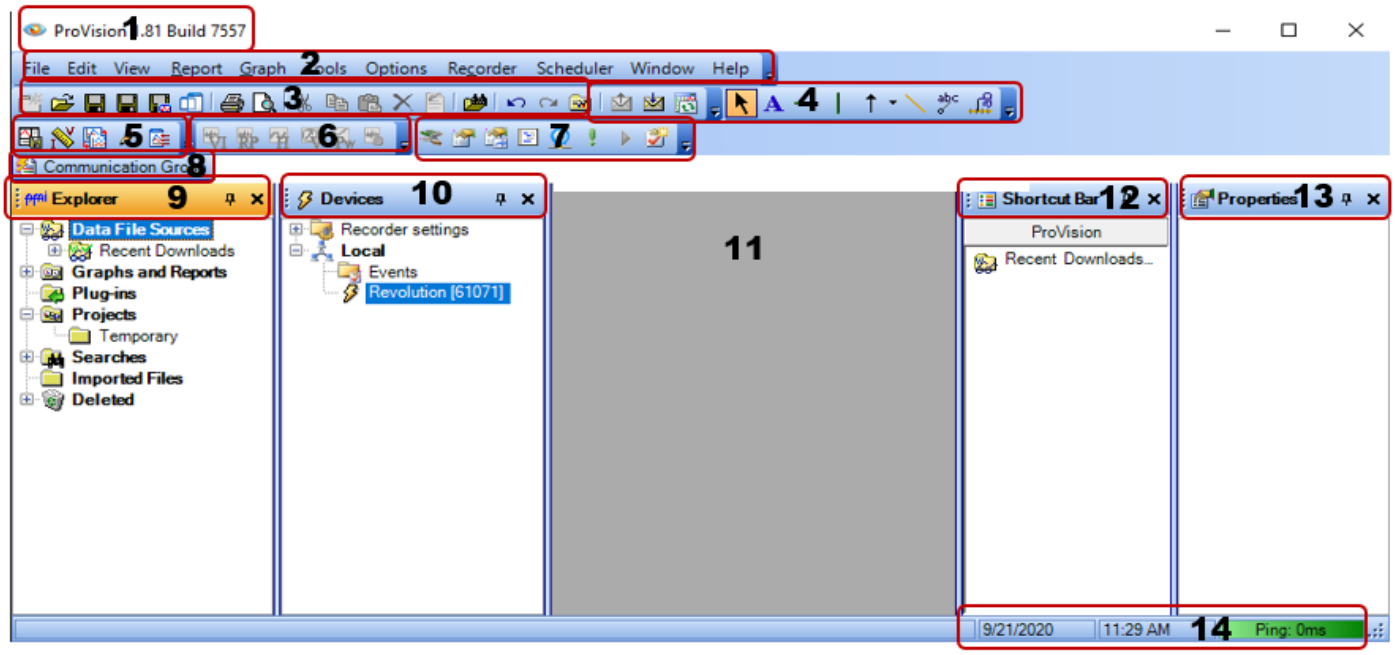
Double click on the data file (a check mark will appear in front of the filename) and the Header Report will open. The Header Report gives an overall view of what was recorded and has quick links to many reports and graphs. Select the **[Graph]** or **[Report]** menus for more options. For more in depth information, refer to **Working with Data Files, Working with Graphs, and Working with Reports** later in this manual.




**The basic features of ProVision allow the new user to get up and running quickly.**

**Remember to perform a [Disconnect] on any remote recorders to start or restart a recording.**

# Using ProVision®




ProVision User Interface

1. ProVision Version and Build number

2. Menu Toolbar:

File, Edit, View, Report, Graph, Tools, Options, Recorder, Scheduler, Window, and Help menus

3. Standard Buttons:

Create a New Project, Open, Save, Save as, Trace Mixer Template,File Merge, Print Now, Print Preview, Cut, Copy, Paste, Delete, Edit Report Header, Find in Files, Undo, Redo, PQCanvass, Send Via Email, Receive Via Email, and Sync Mobile buttons

4. Graph Annotation Buttons:

Pointer For Annotation, Text, Annotation, Horizontal Line Annotation, Vertical Line Annotation, Arrow Menu Tool, Line Annotation, Pointer Annotation, and X, Axis Annotation buttons

5. Advanced Buttons:

Capture View, Scale Factor, Trace Mixer Graph, Legend Editor, and Select Plot buttons

6. Waveform Buttons:

V/I Waveform, Real Power Waveform, Harmonic Graph, Vector Graph, Parametric Waveform, and Record Waveform buttons

7. Recorder Buttons:

Recorder communication settings, Retrieve Settings, Initialize, Identify, Date and Time, Standby, Ready, and Add Event

8. Communication Group Pane:

Displays the status of communication tasks.

9. Explorer Pane:

Watcher folders, Recent Downloads, Graphs and Reports, Projects, Searches, Imported Files, Deleted Files

10. Devices Pane:

Recorder Initialization Settings, Events, connected recorders

11. Main Workspace:

Main workspace where all graphs and reports will open

12. Provision Shortcut Pane

Add and remove commonly used graphs

13. Properties Pane:

Properties of currently viewed graph

14. Status Bar

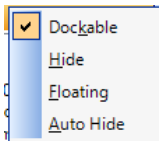
Date, Time, and ProVision Intercommunicator Status

*Shortcut Pane*, *Menu Pane*, *Device Pane*, and *Properties Pane*. These can be pinned or unpinned so that they are either always displayed or automatically minimized when the cursor is moved away from them.

# Customizing the Workspace

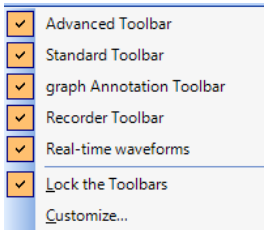
The ProVision® application window is fully customizable to suit individual preferences.

- All toolbars and window panes may be moved and docked to other locations or may be left free floating anywhere on the desktop. They may also be hidden from view if they are not needed.




Right click in a windowpane to see menu

- Use the **[View]** menu to hide and unhide each of the windowpanes and status bar. Hidden items will not have a check mark.
- Customize the toolbars from the popup menu to add or remove buttons or to lock the toolbars in place.




Right click in the toolbar area to see menu

- When docked the window panes may be placed in **Auto Hide** mode by clicking on the pin icon located in the upper right corner of the pane. The hidden window panes can be found on the left or right side of the ProVision window  auto-hide  pinned in place.
- Use the full-screen mode to maximize the viewing area by clicking on the **[View]** menu, and then clicking on [**Full Screen]**.

# Using the Explorer Pane

The Explorer Pane is the main window for organizing system data. It displays all information in a tree view allowing easy access to every part of the system, except PMI recorders, which are managed with the Devices pane.

The Explorer pane is fully configurable and contains several system folders to assist in managing data.

- To open or close the Explorer, click on the **[View]** menu, and then click **Explorer**. A check mark appears when the pane is open. The Explorer may also be closed by clicking on the X button in the upper right corner of the pane next to the pin button.. 
- To toggle the Auto-Hide feature, click the pin icon in the upper-right corner of the pane (Explorer must be docked to a side of the application window to use this feature).
- When in Auto Hide mode, Explorer will automatically slide out of sight when the mouse is moved away from the pane. Explorer will slide back into view when the mouse cursor is placed over the Explorer button located on the side of the application window.

- To move the Explorer pane to another location, click, hold, and drag the upper bar of the pane. The pane may be docked to another side of the application window, or may remain free floating anywhere on the screen
- To save space, panes may be grouped together forming a "tabbed pane" arrangement.
- To resize the Explorer, move the mouse cursor over the pane's border. When the cursor changes into a double-headed arrow, click, hold, and drag the border to the desired size.

### Understanding System Folders

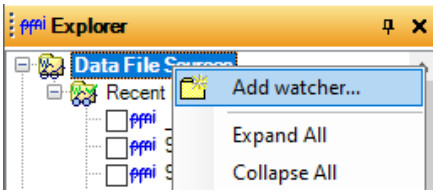
System folders permanently reside in the Explorer Pane and are the major components to the data system of ProVision. These folders may not be moved, copied, hidden, or deleted from the system.

### Data File Sources Folder - Watchers

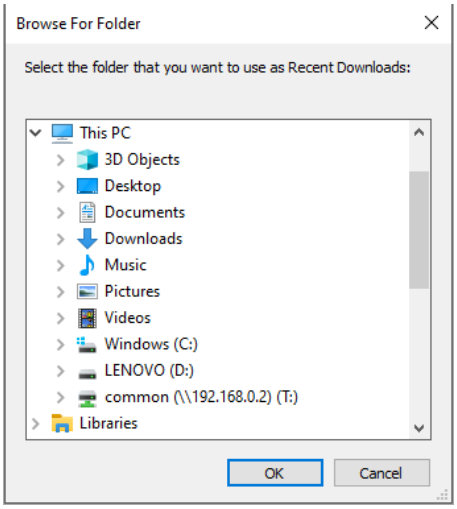
This folder contains the locations of data files to be monitored or watched by ProVision. Each “watcher” icon represents a directory on the local computer or network drive. **Recent Downloads** is the default ‘watcher’ folder.

*Creating a network ‘watcher’ is an easy way to share data files with other co-workers.*

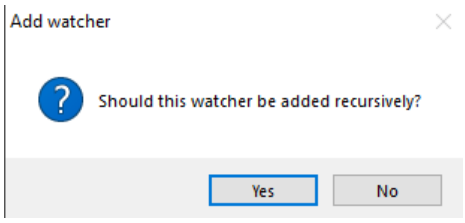
To add a new ‘watcher’, right-click on the **Data File Sources** heading and click **Add Watcher**.




A browsing window will appear, select the folder to watch.
*Note: Watchers should not be named the same, rename the folder before adding a duplicate watcher*



Once the folder is selected, another window will ask if this watcher is recursive. Selecting **Yes** will add the new folder and any subfolders. Selecting **No**, and only the selected folder's data files will be available to ProVision.




To remove a watcher, right-click on the watcher icon and then click **Delete Watcher** on the popup menu.

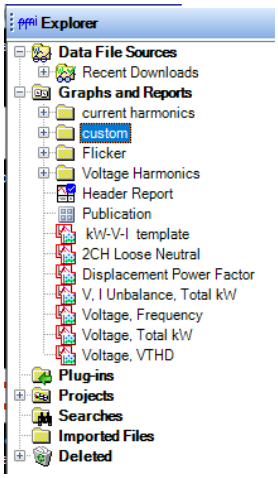
Watcher icons may be hidden from view by right-clicking on the watcher icon, and then check the **Hidden** menu item on the popup menu. To view hidden icons, click on the **View** menu, then check the **Show Hidden Nodes** menu.

You can 'drag and drop' or 'copy and paste' data files from one watcher to another. Dragging a file, moves the file to the other watcher. To create a second file, use the 'copy and paste' commands.

When you download a recorder, you can choose which watcher folder the data file will be stored in.

### Graphs and Reports Folder

This folder contains custom graph templates, custom report templates, views and publication templates. Folders may be created in the **Graphs and Reports** system folder to help organize the graphs, reports and views that are created.




To create a folder, right-click on the **Graphs and Reports** icon, or on an existing folder, and then click **Create Folder** from the popup menu. From the menu bar, click on **File** and then click **Create Folder**. From the toolbar, click the **Create Folder** button.

To remove a folder, graph, report, or view, select the item and press the **Delete** key, or right click on the icon and then click **Delete** from the popup menu. From the menu bar, click on **Edit** and then click **Delete**. From the toolbar, click the **Delete** button.

Icons may be hidden in the **Graphs and Reports** folder by right-clicking on the icon, and then checking the **Hidden** menu item on the popup menu. To view hidden icons, click on the **View** menu, then check the **Show Hidden Nodes** menu.

Custom Graphs will also be shown under the Graph/Custom Graphs menu. To edit a custom graph, select the listing in the Graphs and Reports folder.

### Projects

This folder contains project folders that are used for managing data files. It is structured in a hierarchical, tree-like fashion allowing projects and subprojects to be created as needed.

Data files that are directly selected outside of ProVision and not selected from a Watcher folder are placed in the Temporary Projects folder. Projects are links, not copies of the data file. These files may then be moved or copied to any other project folder.

To create a folder, right-click on the **Projects** icon, or on an existing folder, and then click **Create Folder** from the popup menu. From the menu bar, click on **File** and then click **Create Folder**. From the toolbar, click the **Create Folder** button.

To remove a folder or a data file, select the item and press the **Delete** key, or right-click on the icon and then click **Delete** from the popup menu. From the menu bar, click on **Edit** and then click **Delete**. From the toolbar, click the **Delete** button.

Icons in the **Projects** folder may be hidden by right-clicking on the icon, and then checking the **Hidden** menu item on the popup menu. To view hidden icons, click on the **View** menu, then check the **Show Hidden Nodes** menu.

Data files may be copied or moved between projects at will. Project folders may be renamed as needed.

### Searches

This folder contains searches saved using the '**Find in Files**' command found in the **Edit** menu.

Folders may be created in the **Searches** system folder to help organize searches.

To create a folder, right-click on the **Searches** icon, or on an existing folder, and then click **Create Folder** from the popup menu. From the menu bar, click on **File** and then click **New**.

To remove a folder or a search, select the item and press the **Delete** key, or right-click on the icon and then click **Delete** from the popup menu. From the menu bar, click on **Edit** and then click **Delete**. From the toolbar, click the **Delete** button.

Icons in the **Searches** folder may be hidden by right-clicking on the icon, and then checking the **Hidden** menu item on the popup menu. To view hidden icons, click on the **View** menu, then check the **Show Hidden Nodes** menu.

### Imported Files

This folder contains data files that have been imported into the system. Use this folder as a temporary holding place for imported files until they can be moved to an appropriate project folder.

As each import operation is performed, a folder is automatically created in the **Imported Files** system folder that represents a directory on the computer system.

To remove a folder or a data file, select the item and press the **Delete** key, or right-click on the icon and then click **Delete** from the popup menu. From the menu bar, click on **Edit** and then click **Delete**. From the toolbar, click the **Delete** button.

Icons in the **Imported Files** folder may be hidden by right-clicking on the icon, and then checking the **Hidden** menu item on the popup menu. To view hidden icons, click on the **View** menu, then check the **Show Hidden Nodes** menu.

### Deleted bin

The **Deleted** bin contains all items that have been previously deleted by the user, but have not yet been permanently removed from the system.

All items in the **Deleted** bin may be restored to their original locations by right-clicking on the item, and then clicking **Restore** from the popup menu.

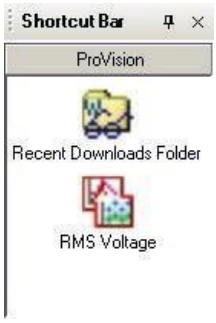
All items in the **Deleted** bin may be permanently removed by right-clicking on the **Deleted** bin, and then clicking **Empty Deleted Bin**.

To remove an individual item, select the item and press the **Delete** key, or right-click on the icon and then click **Delete** from the popup menu. From the menu bar, click on **Edit** and then click **Delete**. From the toolbar, click the **Delete** button.

Icons in the **Deleted** bin may be hidden by right-clicking on the icon, and then checking the **Hidden** menu item on the popup menu. To view hidden icons, click on the **View** menu, then check the **Show Hidden Nodes** menu.

#### Using the Shortcut Bar

The **Shortcut Bar** is a useful tool for storing frequently used items found in the **Explorer**, such as data files, graphs, reports, views, searches and projects. For example, use the **Shortcut Bar** to quickly launch a commonly used voltage graph from the active data file.




The **Shortcut Bar** is fully configurable for easy viewing.

- To open or close the **Shortcut Bar**, click on the **View** menu, and then click **Shortcut Bar**. A check mark appears when the pane is open. The **Shortcut Bar** may also be closed by clicking on the **X** button in the upper right corner of the pane.
- To toggle the Auto Hide feature, click the pin icon in the upper-right corner of the pane (the **Shortcut Bar** must be docked to a side of the application window to use this feature).

- When in Auto Hide mode, the **Shortcut Bar** will automatically slide out of sight when the mouse is moved away from the pane. The **Shortcut Bar** will slide back into view when the mouse cursor is placed over the **Shortcut Bar** button located on the side of the application window.
- To move the **Shortcut Bar** pane to another location, click, hold and drag the upper bar of the pane. The pane may be docked to another side of the application window, or may remain free floating anywhere on the screen
- To save space, panes may be grouped together forming a "tabbed pane" arrangement.
- To resize the Shortcut Bar, move the mouse cursor over the pane's border. When the cursor changes into a double-headed arrow, click, hold and drag the border to the desired size.

**Shortcut Groups**

The **Shortcut Bar** can be organized into groups, where a group represents a logical collection of items, such as “Reports”, or “ABC Company Data”. A group has a button with the group’s name and contains icons of the items added to the group. There’s no limit to the number of groups that can be created, however, groups that are not visible on the screen cannot be accessed.

To create a group, right-click on the **Shortcut Bar**, then select **Add Group** from the popup menu. Type a name to label the group.

To remove a group, click on the group’s button to open it, right-click on the group button and select **Remove Group** from the popup menu. Confirm the removal. The group and all items in it will be removed. (The items will not be removed from the **Explorer**.)

Items may be added to a group by simply dragging the item’s icon from the **Explorer** into the group. (The item is not removed from the **Explorer**.)

Items may be added by first selecting the item in the **Explorer**, then right-clicking in the **Shortcut Bar** group and selecting **Add Item** from the popup menu.

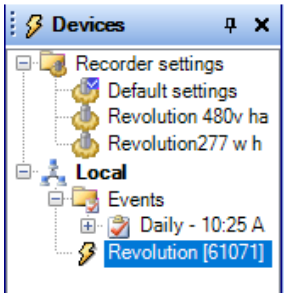
Items from the **Recent Downloads**, **Imported Files**, and **Deleted** system folders may not be added.

To remove an item from the group, right-click on the item, and then click **Remove Item** from the popup menu. Confirm the removal. (The item will not be removed from the **Explorer**.)

To resize the icons in a group, right-click anywhere within the group and click **Large Icons** from the popup menu. When checked, the icons in the group will be a larger size.

# Using the Devices Pane

The **Devices** pane is the main window for managing PMI recorders. It displays information in a tree view allowing full access to the recorders.




The **Devices** pane is fully configurable for easy viewing.

- To open or close the Devices pane, click on the **View** menu, and then click **Devices**. A check mark appears when the pane is open. The **Devices** pane may also be closed by clicking on the **X** button in the upper right corner of the pane.
- To toggle the Auto Hide feature, click the pin icon in the upper-right corner of the pane (the **Devices** pane must be docked to a side of the application window to use this feature).
- When in Auto Hide mode, the **Devices** pane will automatically slide out of sight when the mouse is moved away from the pane. The **Devices** pane will slide back into view when the mouse cursor is placed over the **Devices** pane button located on the side of the application window.
- To move the **Devices** pane to another location, click, hold and drag the upper bar of the pane. The pane may be docked to another side of the application window, or may remain free floating anywhere on the screen
- To save space, panes may be grouped together forming a "tabbed pane" arrangement.
- To resize the **Devices** pane, move the mouse cursor over the pane's border. When the cursor changes into a double-headed arrow, click, hold and drag the border to the desired size.

### Understanding the Devices System Folders

The **Devices** pane contains two system folders, **Events** and **Recorder Settings**, to assist in managing PMI recorders.

These folders cannot be moved or deleted.

### Events

Th Events folder contains the list of scheduled events that have been created to perform automated tasks, such as performing periodic data downloads from several recorders.

There is no limit to the number of scheduled events that can be created.

### Recorder Settings

Each PMI recorder has settings that determine how and what PQ data to record. These settings can be created on-the-fly and stored for future use in the **Recorder Settings** folder .

There is no limit to the number of sets of customized recorder settings that can be created.

As an example, it may be found that at a particular customer site, a recording interval of 1 second is ideal in addition to some other parameters. This unique recorder setting can be created and stored for the next time the customer site is visited

# Working with Recorders

## Overview

Only USB cabled devices connect to ProVision automatically. All other devices must be configured in ProVision before manually selecting **[Connect]**. Once ProVision is connected to a device, all devices are listed and act the same. It is just a matter of getting the device connected, performing the needed action, and then disconnecting the device.

## Connecting Recorders

### Connecting a Recorder with a USB cable

Plug the USB cable into a USB port on your PC or laptop and into the PMI recorder. USB devices will power from the USB port. The status LED will become solid green or if it is a Guardian recorder the LED will flash red, orange and then green. The recorder name and serial number will auto-populate in the Devices Pane, there is no need to **[Connect]** or **[Disconnect]** a USB cabled recorder.


USB cabled devices will auto-populate in the Devices pane

### Connecting an RS232 Recorder

The older RS232 recorders will need an external power supply. An AC wall adapter was shipped with the recorder and plugs into the face of the Socket style recorders or into the cable for Box recorders. There are a few different cables for different RS232 recorders. Older RS232 cables have a 9-pin connector on one end and newer PC's may not support this type of connector and will need the updated link1 converter cable. Contact your PMI sales representative for more information.

Cables for older RS232 devices may not be supported on your PC

You can purchase a USB converter cable from PMI that has a USB connector on one end. Connect the RS232 cable to your PC USB port and the other end to the recorder.

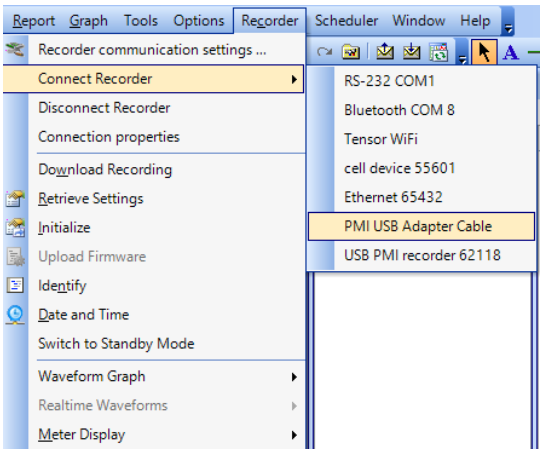
USB (link-1) Converter cable

The connector on the recorder side may vary depending on the model. The AC wall adapter will plug into the black box if connecting to a box recorder or the AC wall adapter will plug into the face of 2S and 3S meter socket recorders.

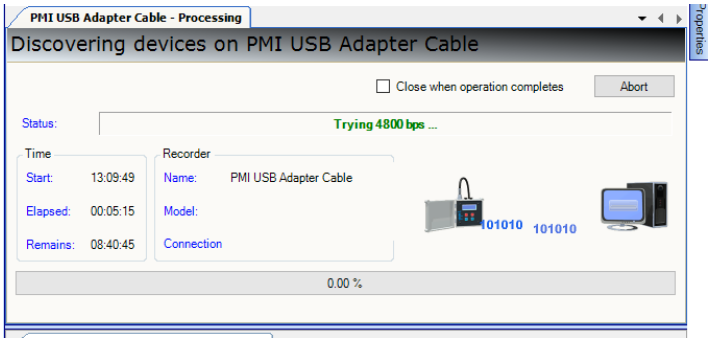
An AC wall adapter is needed to power older RS232 devices

**Connect an RS232 Recorder to ProVision**

1) In ProVision, select **[Recorder]** and **[Connect Recorder]**
2) For 9-pin serial cables select **[RS232 COM1]**
3) For USB adapter cables select **[PMI USB Adapter Cable]**
4) View the Communication Group pane in the ProVision Work area to see connection activity




For RS232 recorder, select **[Connect Recorder]** and either **[RS-232 COM1]** or **[PMI USB Adapter Cable]**




The Communication Group pane appears in the ProVision work area with connection information. The model and serial number will appear in the Devices pane

## Connecting a Bluetooth® Recorder

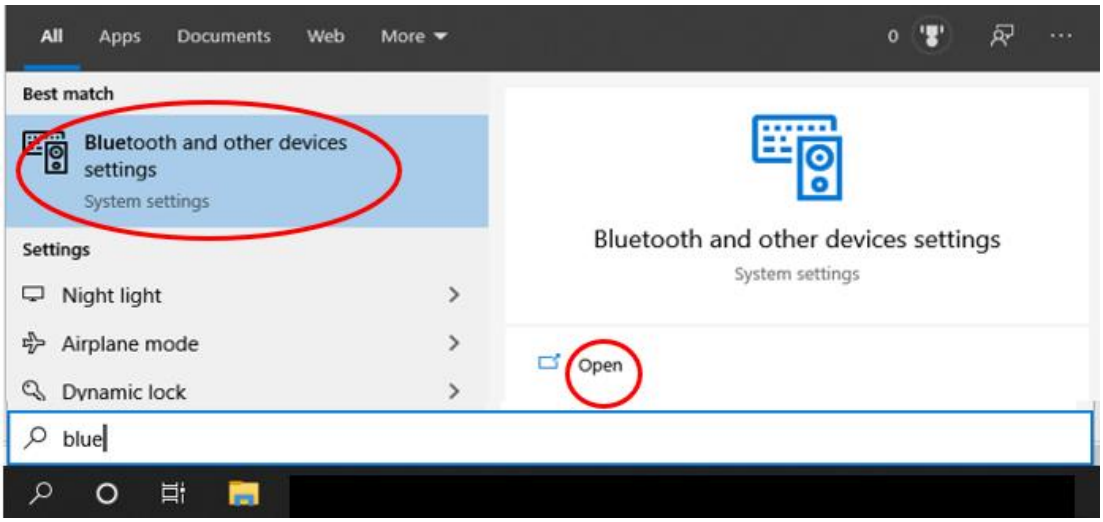
The Bluetooth device cannot be powered by a PCs USB port and connect to the same PC using Bluetooth communication. Use another PC's USB port or power the device using a 60V or greater AC voltage source.

Connecting a Bluetooth device to the ProVision software is a several step process and varies depending on the PC's operating system.

First connect your PC to the recorder using the Windows Bluetooth selections. Once connected, configure, and connect to ProVision.

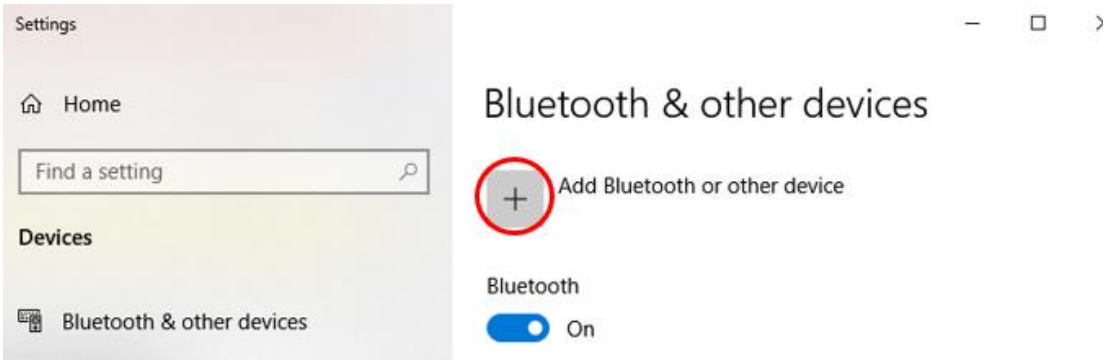
### Connect the Bluetooth Recorder to your PC

1) Power the device
2) In Windows 10, enter Bluetooth in the search area
3) Select '**Bluetooth and other devices**'



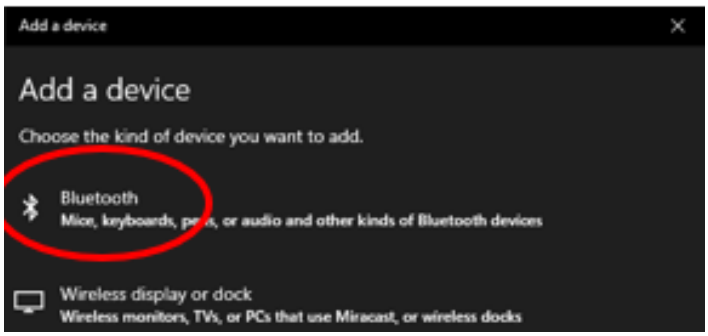

Steps 2 and 3 - Search for '**blue**', then select **[Open]** or click in the blue area

4) In the new window, select '**Add Bluetooth or other devices**'



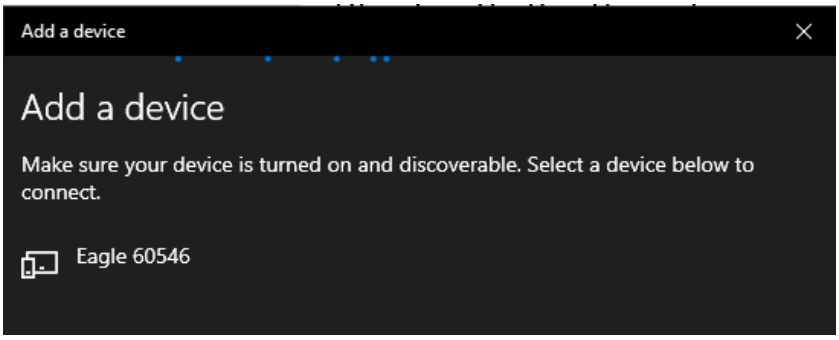

Step 4 – Select '**Add Bluetooth or other device'**

5) In the new 'Add a device' window, select **Bluetooth**



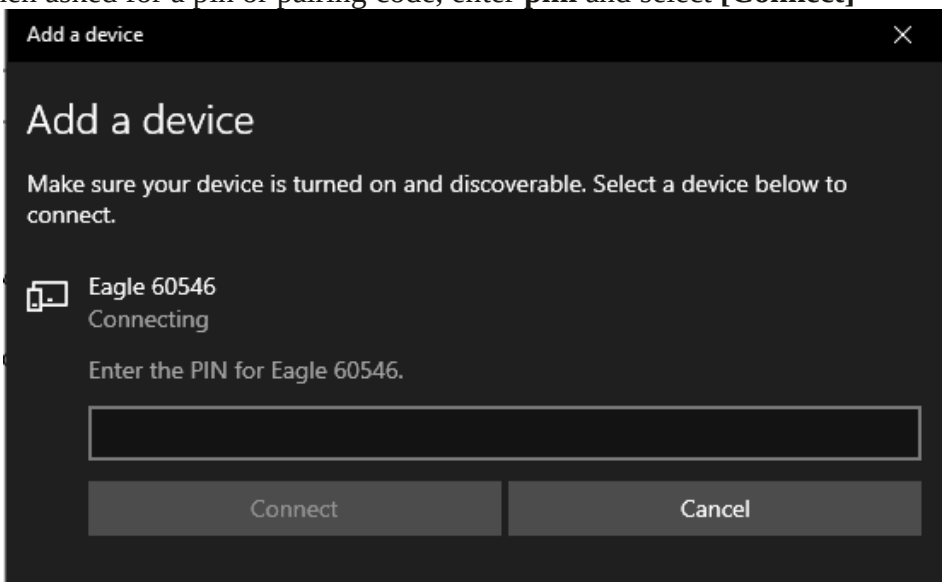

Step 5 – Select **Bluetooth**

6) The Device model and serial number will appear when found, select the Device



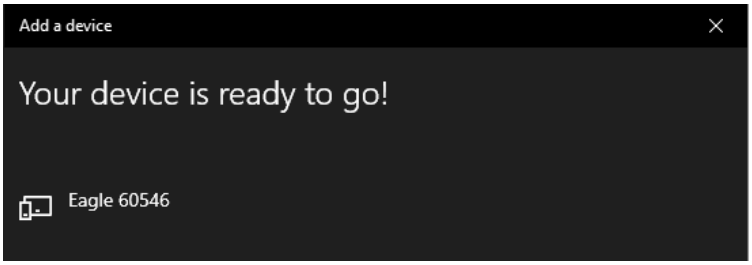

Step 6 – Your device displays model and serial number when discovered

7) When asked for a pin or pairing code, enter **pmi** and select **[Connect]**



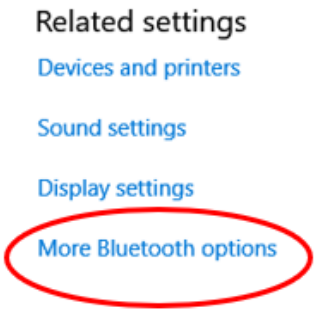

Step 7 - Enter '**pmi**' as a PIN and select **[Connect]**

8) You should see the message 'Device #### Paired' or similar message, select **[Done]**



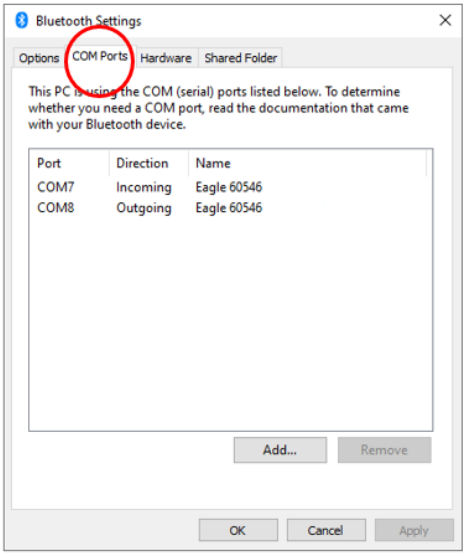

Step 8 – Confirmation, select **[Done]** at bottom of screen

9) On the 'Bluetooth & other devices' page, move down the page and select '**More Bluetooth options**'




Step 9 – Move down the page and select '**More Bluetooth options**'

10) In the new pop-up 'Bluetooth Settings', select the '**COM Ports**' tab
11) Write down or remember the '**Outgoing COM port number'**
12) Select [Cancel] and close the Bluetooth windows

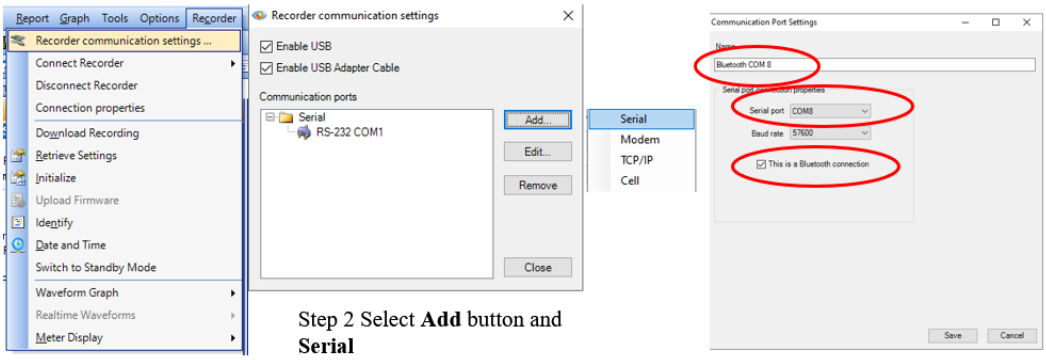



Steps 10 and 11 – Select the '**COM Ports**' tab. Remember the **outgoing COM port number**

## Configure a Bluetooth Recorder in Provision

Now that you have a COM port number, configure the COM port in ProVision.

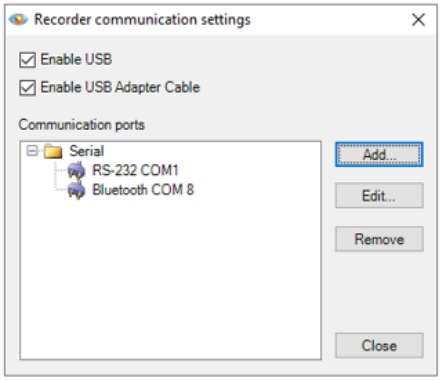
1) In ProVision, select **[Recorder]** and **[Recorder Communication Settings]**
2) Select **[Add]** and **[Serial]**
3) In the Name area, enter the Outgoing COM port number
4) Use the pulldown arrow to change the Serial Port to the Outgoing COM port number
5) Set the Baud rate to 57600 or higher
6) Select the check box 'This is a Bluetooth connection'
7) Select 'Save'
8) The previous pop-up will have the new Serial entry, [close] this pop-up




Step 1 Select **Recorder** tab and
**Recorder Communication Settings**

Step 2 Select **Add** button and
**Serial**

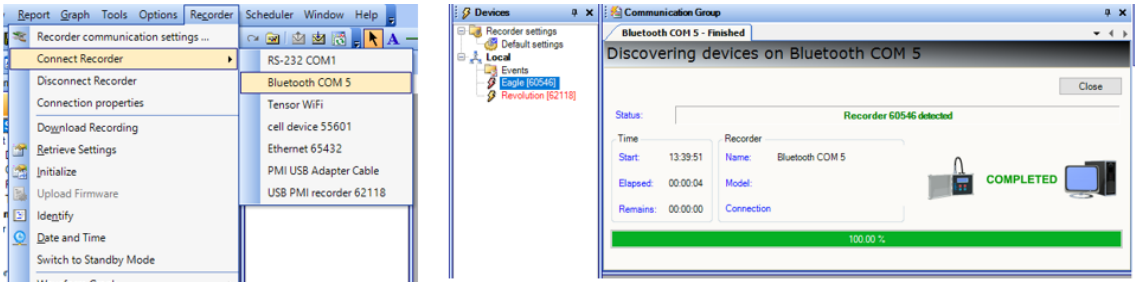
Step 3 Change the Name to reflect the outgoing COM port number
Step 4 Change pulldown to outgoing COM port number
Step 5 Verify Baud rate is 57600
Step 6 Check the box for '**This is a Bluetooth connection**'
Step 7 **[Save]**




Step 8 The new Bluetooth entry is listed
Select **[Close]**

## Connect a Bluetooth Recorder to ProVision

1) In ProVision, select **[Recorder]** and **[Connect Recorder]**
2) Select the **[Bluetooth entry]** you created




Select **[Recorder]** then **[Connect Recorder]** and then the **Bluetooth entry** you created. The model and serial will be added to the Devices pane. Connection information is displayed.

Both the Bluetooth Eagle and USB Revolution are shown.

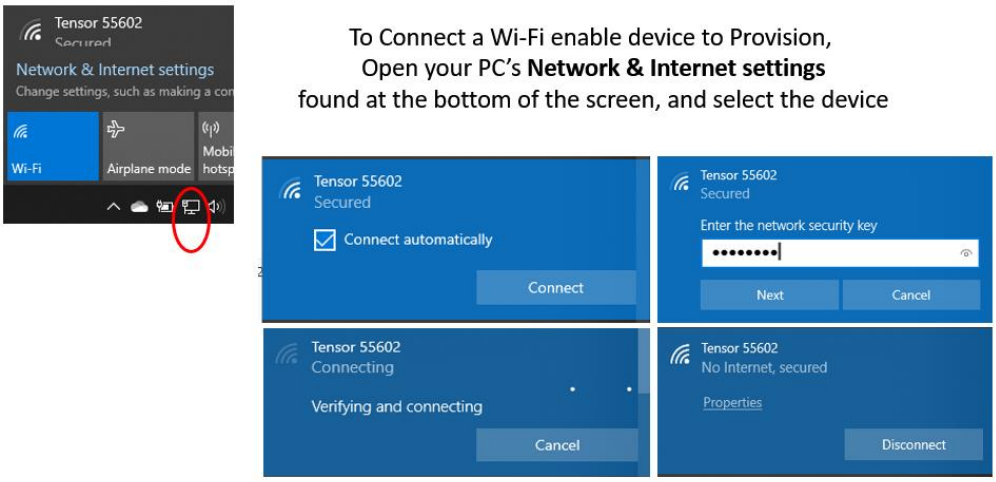
NOTE: A recorder with red lettering denotes a new firmware is available or the lithium battery voltage is low

# Connecting a Wi-Fi Recorder

## Connect the Wi-Fi Device to your PC

First connect your PC to the recorder using the Windows Wi-Fi selections. Once connected, configure, and connect to ProVision.

**1)** At the bottom of your PC or Laptop, select the Network icon
**2)** If a PMI Wi-Fi device is within range, the Model and Serial Number will be displayed
**3)** Select the device and enter the password
   a) A Wi-Fi Tensor uses the password: pmi12345
   b) A Wi-Fi Guardian uses the password Guardian

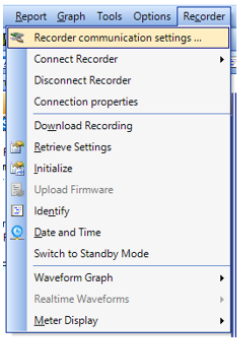


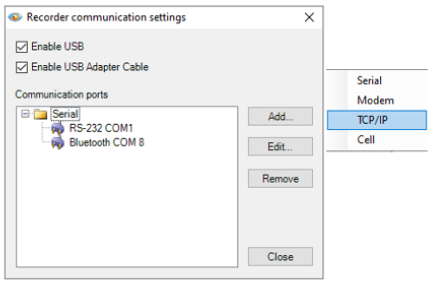

Select **Connect** , enter the password, then select **Next** and verify connection

## Configure a Wi-Fi connection in Provision

This step is only performed once for each recorder model, the Wi-Fi IP address does not change. Recorders of the same model use the same IP address.

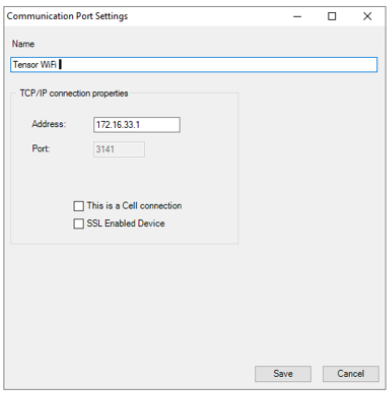
**1)** In ProVision, select **[Recorder] and [Recorder Communication Settings]**
**2)** Select **[Add]** and **[TCP/IP]**
**3)** In the **Name** area, enter the serial number of the Tensor
**4)** In the **Address** area, enter the IP address given to you by the PMI Tech Support Team
**5)** Select [**Save**] and **[close]**



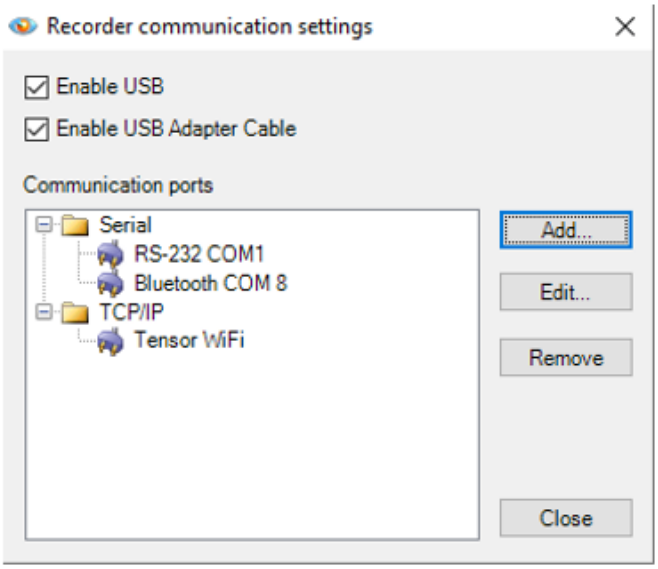




Step 1 Select **Recorder** tab and
**Recorder Communication Settings**

Step 2 Select **Add** button and **TCP/IP**



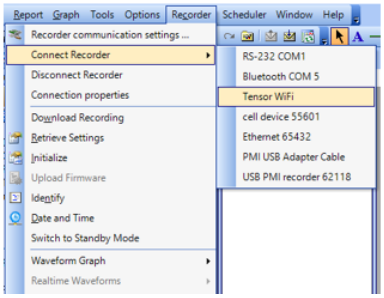

Step 3 Change the Name to match the device
Step 4 Enter the Wi-Fi IP address
(Tensor-172.16.33.1, Guardian-172.16.32.1)
Step 5 Select **[Save]**




Wi-Fi entry listed as well as previous Bluetooth entry

## Connect a Wi-Fi Recorder to ProVision

1) In ProVision, select [Recorder] and [Connect Recorder]
2) Select the [Wi-Fi entry] you created






Select **[Recorder]** then **[Connect Recorder]** and then the **Wi-Fi entry** you created. The model and serial will be added to the Devices pane. Connection information is displayed.
Both the Wi-Fi Tensor and USB Revolution are shown.
NOTE: A recorder with red lettering denotes a new firmware is available or the lithium battery voltage is low

## Connecting a Cellular Recorder

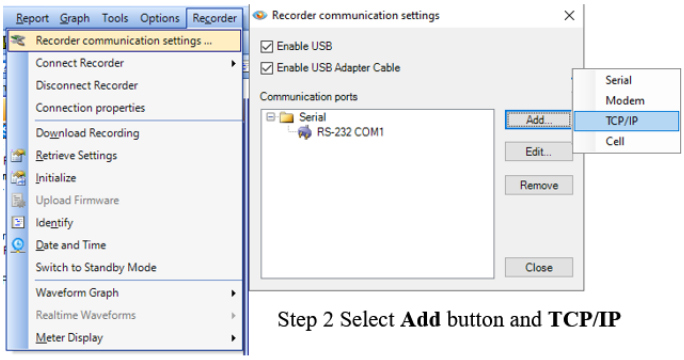
To communicate with your cellular recorder, the cell modem must be set up with a Verizon cell plan. Use the SIM and IMEI numbers found in the shipping container when purchasing the cell plan. The default is to use a Dynamic IP address, one that changes with every power-on, a public static IP address, which does not change, is preferred. Also, an Internal IP address can be supplied to Verizon by your company's IT group. If configured for an internal IP address, your PC must be on the internal network to access the internal IP addresses. Inform your IT that the cellular PMI recorders use ports 3141 (and port 11000 with dynamic IPs) for TCP/IP communications to the ProVision software.

### Configure a cellular IP in Provision

*Contact PMI Technical Support if your cell device is using a Dynamic IP address.*

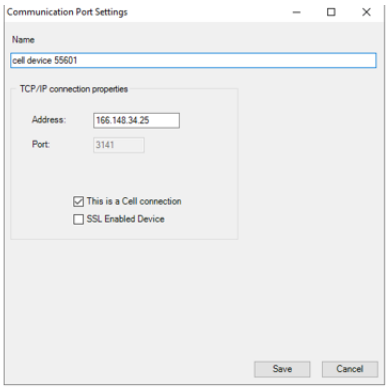
1) In ProVision, select **[Recorder**] and **[Recorder Communication Settings]**
2) Select **[Add]** and **[TCP/IP]**
3) In the Name area, enter the model and serial number of the cellular device
4) In the Address area, enter the IP address given to you by Verizon
5) Select the check box; 'This is a Cell Connection'
6) Select **[Save]**
7) The previous pop-up will have the new TCP/IP entry, **[Close]** this pop-up
8) Repeat for each cell device.
9) Previously added entries can be edited or removed

Adding a Cell Device to ProVision




Step 1 Select **Recorder** tab and **Recorder Communication Settings**

Step 2 Select **Add** button and **TCP/IP**



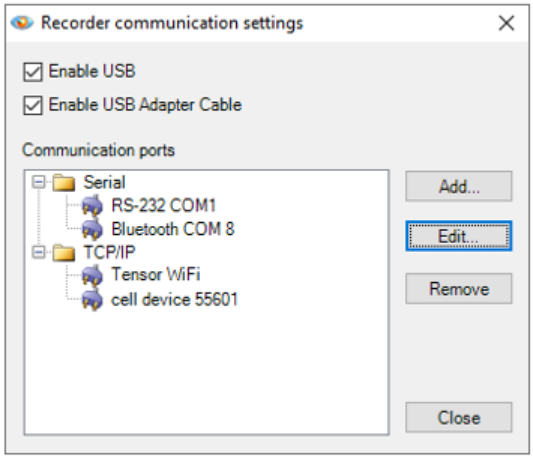

Steps 3 -6

Step 3 In the Name area enter the **Model** and **Serial Number** of the device

Step 4 Enter the IP address assigned by Verizon

Step 5 Select the box for '**This is a cell connection**'

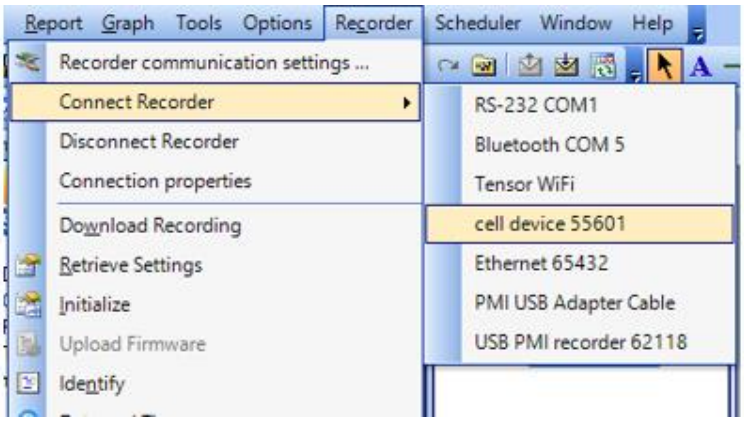
Step 6 Select **[Save]**




Step 7 New cell device is listed with previous Bluetooth and Wi-Fi entries

**Connect a Cell Recorder to ProVision**

1) In ProVision, select **[Recorder]** and **[Connect Recorder]**
2) Select the Cell Recorder entry you created





Select **[Recorder]** then **[Connect Recorder]** and then the **Cell Recorder entry** you created. The model and serial will be added to the Devices pane. Connection information is displayed.
Both the Wi-Fi Tensor and Cell Revolution are shown.
NOTE: A recorder with red lettering denotes a new firmware is available or the lithium battery voltage is low

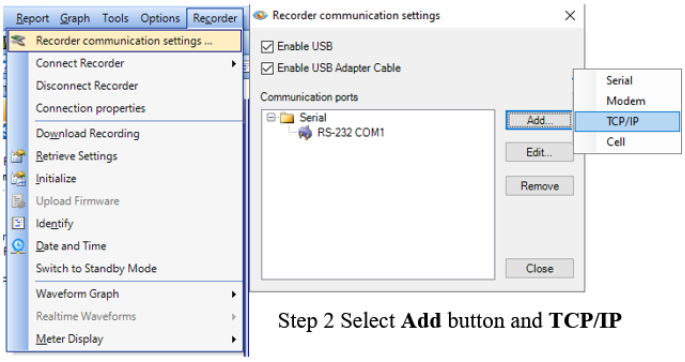
## Connecting an Ethernet Recorder

For a recorder connected to your local area network using the supplied Ethernet communications cable, upon connection, the recorder's Ethernet IP address is assigned by your network DHCP (Dynamic Host Configuration Protocol) Server. The DHCP supplied IP address is Dynamic, meaning that the IP address may change when the Revolution is power-cycled or rebooted. In most cases, the IP address will need to be modified and set to a Static, or a permanent IP address for ProVision to access it. Your company's Information Technology (IT) department will need to provide the Static IP address to use. Inform your IT that the Ethernet Revolution uses port 3141 for TCP/IP communications to the ProVision software.

There are two models of Ethernet Revolutions, one will power from the Channel 1 AC connection, the other powers from the Ethernet cable and will need a 3rd party 15v Power Over Ethernet (PoE) adapter or a network router that supplies PoE.

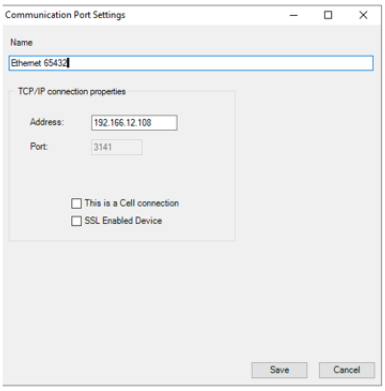
## Configure an Ethernet IP Address in Provision

1) In ProVision, select **[Recorder**] and **[Recorder Communication Settings]**
2) Select **[Add]** and **[TCP/IP]**
3) In the Name area, enter the model and serial number of the Ethernet device
4) In the Address area, enter the IP address
5) Select **[Save]**
6) The previous pop-up will have the new TCP/IP entry, **[Close]** this pop-up

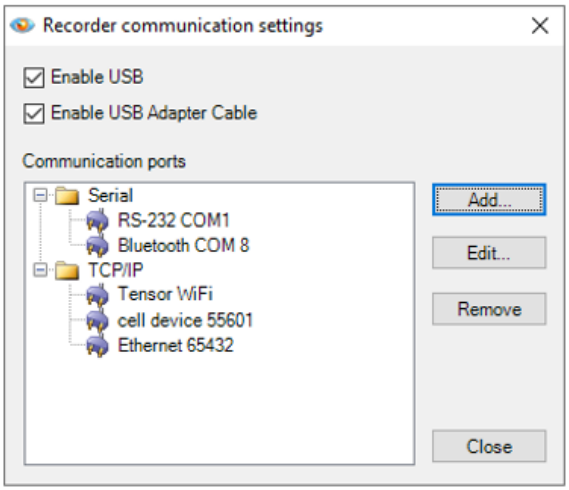



Step 1 Select **Recorder** tab and **Recorder Communication Settings**

Step 2 Select **Add** button and **TCP/IP**



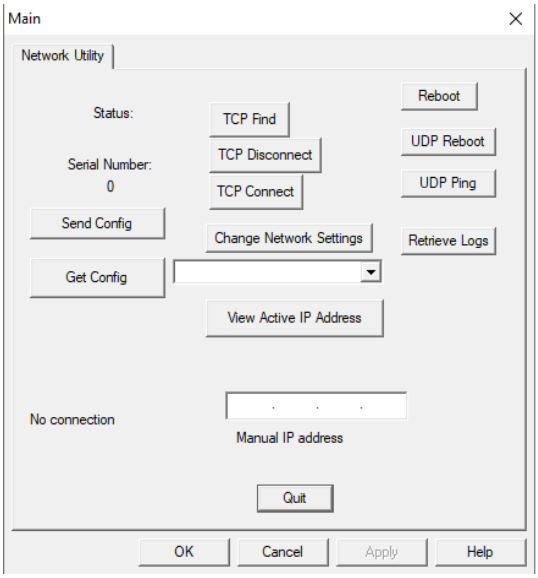

Step 3 In the Name area enter the **Model** and **Serial Number** of the device
Step 4 Enter the IP address
Step 5 Select **[Save]**




Step 6 New Ethernet device is listed with previous Cell, Bluetooth, and Wi-Fi entries

**Setting the Recorder's Ethernet IP address using the SNET Utility**

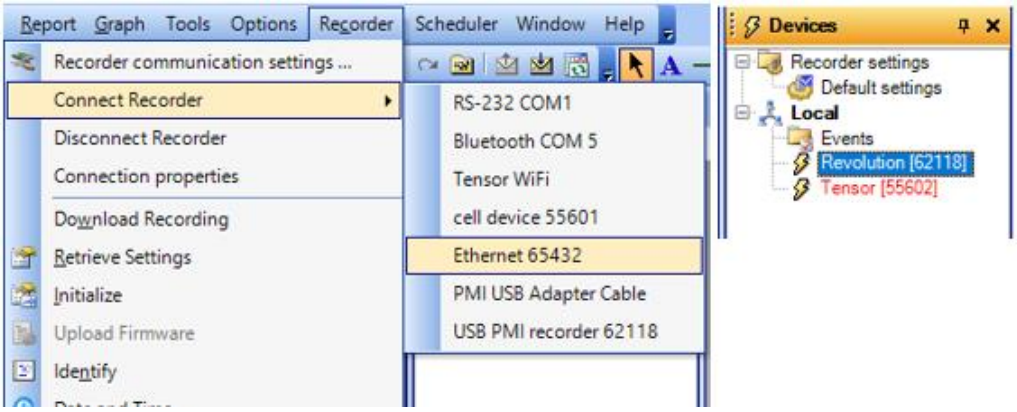
The separate SNET utility is used to set the static IP address when the device is already connected to a network and communicating on the default DHCP dynamic IP. Typically the Ethernet devices are located inside a private network and your IT will need to provide the static IP.
The SNET utility and manual can be downloaded from the PMI website: https://powermonitors.com/downloads
Contact Technical Support to change the Ethernet IP address when connected using a USB cable.




The SNET utility is used to find the dynamic Ethernet connected PMI devices and change them to static IP addresses

**Connect an Ethernet Recorder to ProVision**

1) In ProVision, select **[Recorder]** and **[Connect Recorder]**
2) Select the **[Ethernet Recorder entry]** you created

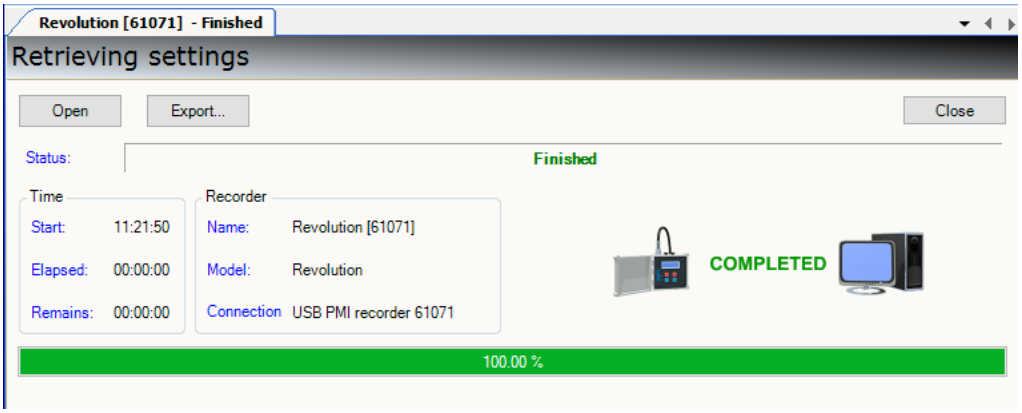



Select **[Recorder]** then **[Connect Recorder]** and then the **Ethernet Recorder entry** you created. The model and serial will be added to the Devices pane. Connection information is displayed.
Both the Wi-Fi Tensor and ethernet Revolution are shown.
NOTE: A recorder with red lettering denotes a new firmware is available or the lithium battery voltage is low

# Disconnecting a Recorder

A connected recorder may be disconnected from the system by clicking on the **Recorder** menu, and then clicking on **Disconnect**.

The **Communication Group** pane will display the progress of the disconnection:

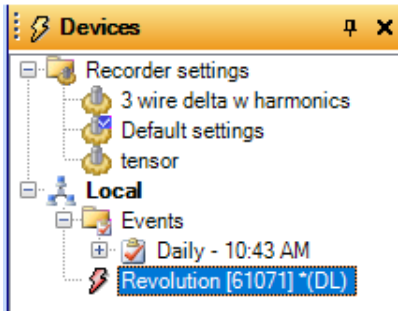
# Managing Recorders

Managing PMI recorders is easily accomplished with ProVision®. The **Devices** pane provides the primary location for organizing, scheduling, and configuring the recorders. If you do not see the Devices pane, select the **View** menu, and verify **Devices** is checked.

Directly under the **Recorder Settings** system folder is a list of recorder initialization templates. The default template is always listed. Users can create their own initialization templates as well as send and receive templates to or from other users.

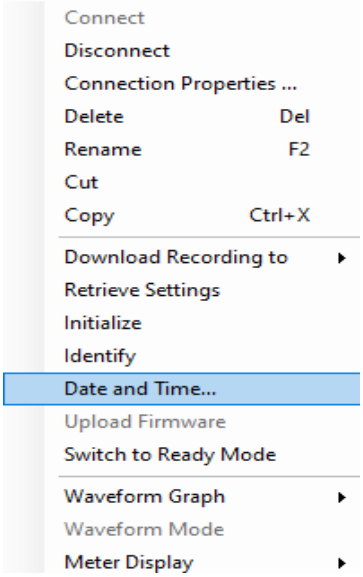
Under the Local heading is the **Events** system folder containing all scheduled events for automating recorder tasks, such as downloading data and also a list of connected recorders or remote recorders.

Additional folders may be added to help organize recorders by right-clicking anywhere in the **Devices** pane, and then clicking **Create Folder**.




Devices pane showing recorder templates, scheduled events and recorder being downloaded

There are two ways to see the available recorder functions; The first is to select the **[Recorder]** menu at the top of ProVision, the second is to right-click on the recorder name (model and serial number in the Devices Pane). If there is no recorder name listed, the options will be grayed out except for **[Connect]** and **[Recorder communication settings].**




Options for a connected recorder

## Using a Recorder

ProVision provides a sophisticated graphical user interface that expands the usability and management of PMI recorders.

Automating tasks, storing recorder configurations, viewing real-time data, communicating with multiple recorders simultaneously, are all features included with the ProVision system.

All PMI recorders function in one of two operational modes: Standby mode or Ready mode.

**Standby Mode**

The Standby mode is used for configuring a PMI recorder in preparation of recording data. The following operations may be performed while in Standby mode:

- Recorder identification
- Recorder initialization
- Data downloading
- Firmware uploading
- Setting date & time
- Retrieving recorder settings

**Ready Mode**

The Ready mode is used when a PMI recorder is actively collecting PQ data. The following operations may be performed while in Ready mode:

- Recording PQ data
- Displaying real-time PQ data

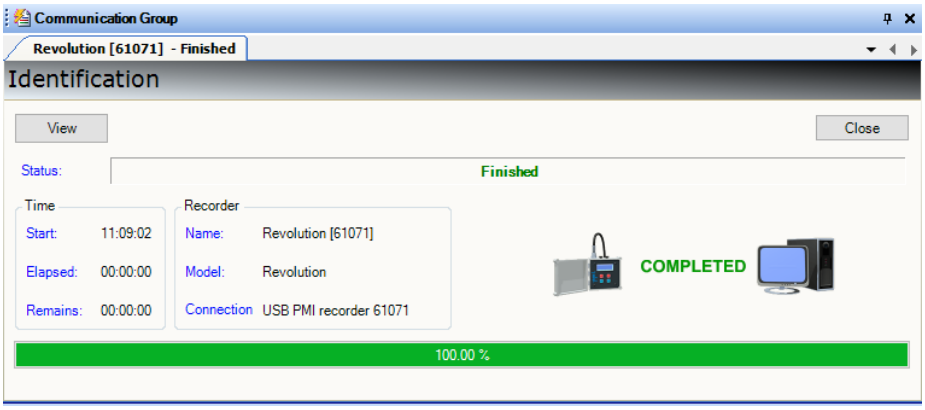
Note Normally, it is not necessary to manually change the operational mode of a recorder as ProVision will automatically change the mode.

## Identifying a Recorder

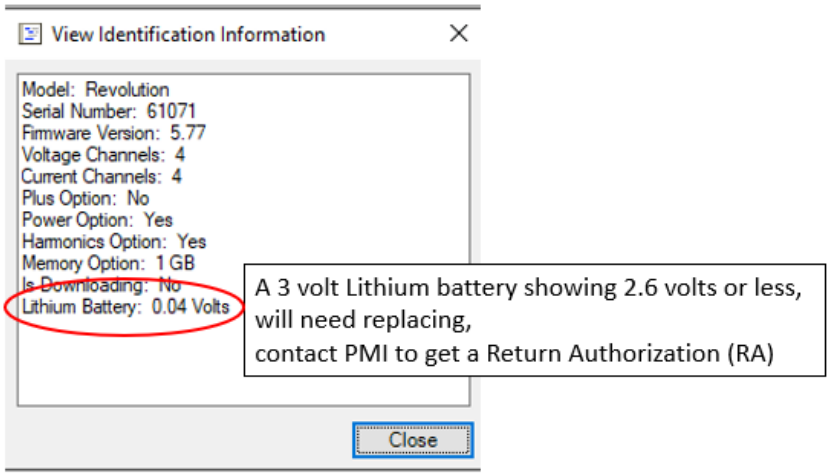
Identification is a quick and simple operation used to find additional information about a connected recorder.

Click on the **Recorder** menu, and then click **Identify**.

The **Communication Group** pane displays the progress of the identification process:




Once completed, click on the **View** button to display additional information about the recorder:




## Initializing a Recorder

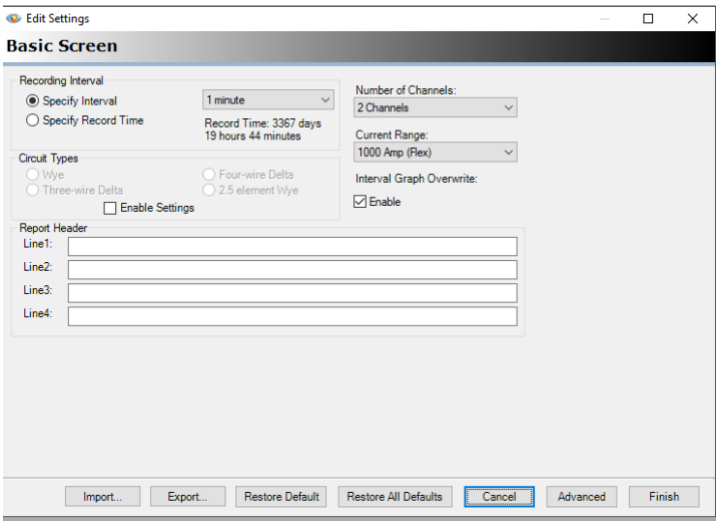
Initialization is an important operation used to configure a connected PMI recorder prior to recording PQ data. Once a configuration has been completed, save it for future use.

NOTE: Not all selections apply to all recorders. ProVision and the recorders are intelligent devices and will only use the selections that apply to that device being initialized. If a device is connected and a menu selection does not apply to that device, the selections will be "grayed out".

When the recorder is connected to ProVision, click on the **Recorder** menu, and then select **Initialize.**

The first screen to appear contains the basic settings used to initialize a recorder:

## Basic Screen




### *Record Interval*

Select either the Specify Interval button or the Specify Record Time button. For Specify Interval, select the Interval time in the pull down which ranges from cycle to 4 hours. The Record Time is displayed and varies depending on the interval selection, the Number of Channels selected, and the recorder's memory. For Specify Record Time, select time in the pulldown which ranges from ten minutes to one year. Note: the recorders sample at 256 samples per cycle or greater depending on the recorder model, the interval determines how often the data points (min, max, ave) are shown in the interval graphs.

### *Number of Channels*

Select the numbers to record.

### *Current Range*

Select the current range that reflects the type of current probes (Flex CT or TLARs) used is close to the expected amperage

### *Circuit Type*

The default or no selection will use a wye (phase to neutral voltages) circuit type. To change, select the ***Enable Settings*** box and then a circuit type. Refer to the hookup diagrams in the Appendices.

### *Interval Graph Overwrite*

A check in this box will cause the oldest data to be overwritten once memory is full. Also called FIFO or circular mode.

### *Report Header*

Four lines of optional text, which will display in the downloaded data on reports and graphs. Uses can include addresses, meter numbers, etc.

***Import***

Select to retrieve a previously stored configuration from memory.

***Export***

Select to store configuration to an xml file which can be used to Import to another recorder or used to create an initialization template.

***Restore Default***

Select to reset a particular parameter setting to its default value. Select the parameter to be reset before using this button.

Restore All Defaults

Select to reset all the settings to their default values.

***Cancel***

Select to close this window without initializing the recorder.

***Advanced***

Select to access additional recorder settings.

***Finish***

Select when changes are completed and ready to finalize initialization of the recorder.

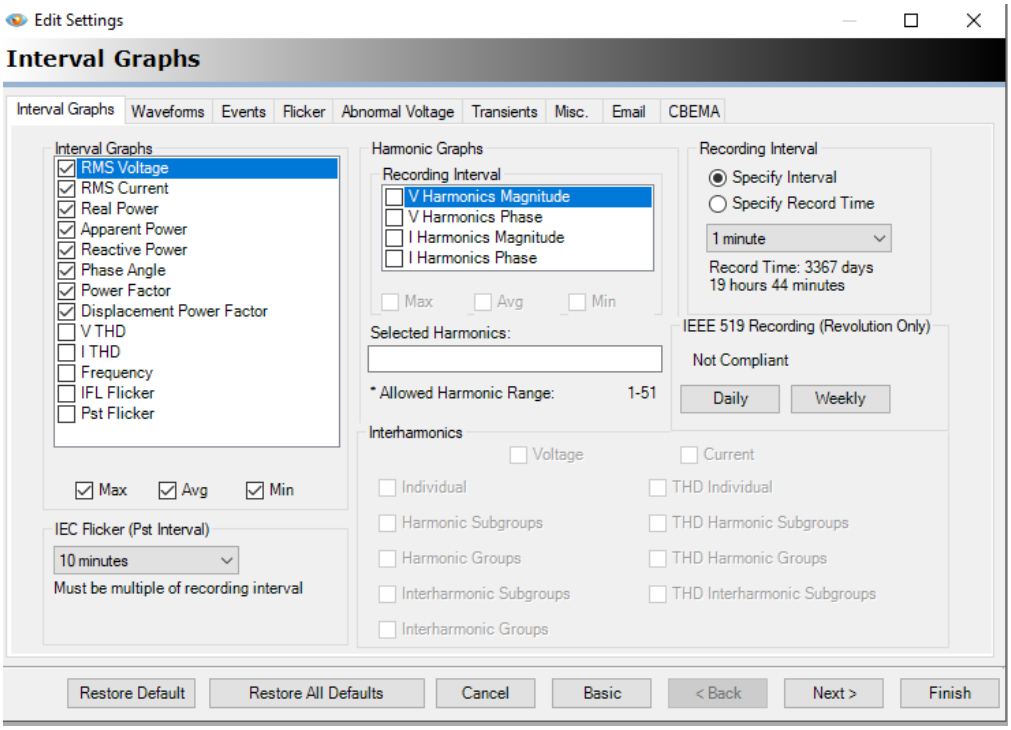
During the initialization process, ProVision® sends the configuration settings to the recorder and performs other tasks to initialize the recorder. The **Communication Group** pane displays the progress of the initialization:

## Advanced Configuration Settings

Modifying the default setting will change the record time. Always verify the record time after making changes and adjust the Recording Interval as needed.

Quick links the advanced reports and graphs can be found on the Header Report.

Note: Most Recorder memory is assigned to Interval Graphs/Strip charts (the Basic screen and Interval Graph screen). Waveform Captures, Events, Flicker etc., are assigned separate recorder memory. Changing these settings does not affect the Recording Interval time.




*Interval Graphs*

Check the boxes that you wish to record.

### *Harmonic Graphs / Selected Harmonics*

First make your selections of Harmonic Magnitude and/or Phase, then select the harmonics you wish to record. Entries can be: All Harmonics (1-51) some recorders have a lower range, smaller grouping of harmonics (1-25), Specific odd harmonics (3,5,7,9,11) or a mix of both (2-10,25,27).

Adding Harmonics to the recording drastically changes the record time.

### *Recording Interval*

A duplicate of the Basic Screen. Adjust the Recording Interval depending on the selections made. No need to go back to the Basic screen.

### *IEEE 519 Recording (Revolution Only)*

Selecting Daily will automatically set the required parameters for 3-second IEEE 519 recordings. Selecting Weekly will automatically set the required parameters for 10-minute IEEE519 recordings.

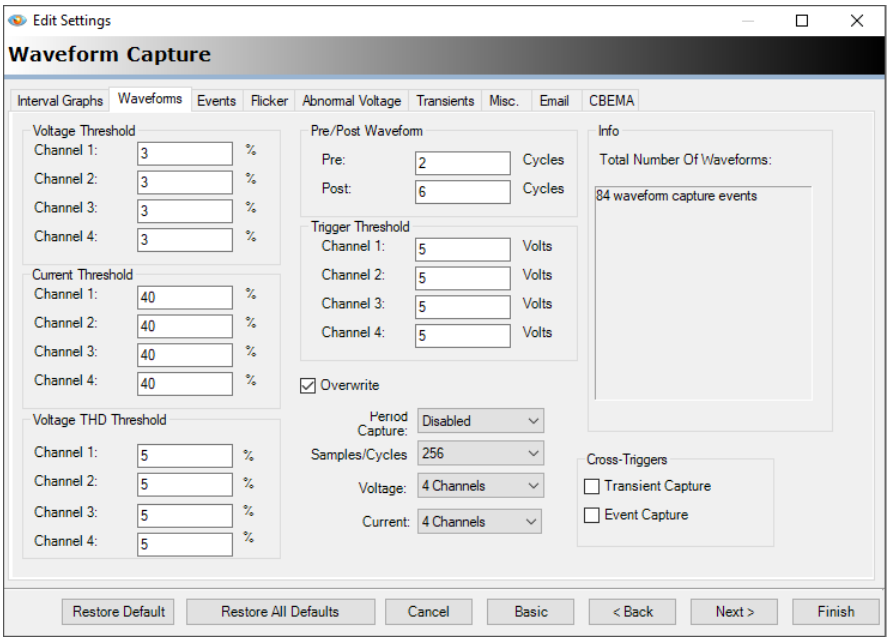
If any changes are made, verify that **Compliant** is still indicated. If **Not Compliant** is shown, then undo the changes until **Complaint** is again shown.

**Not Compliant** indicates the recording does not meet IEEE 519 requirements.

### *IEC Flicker (Pst Interval)*

Default setting is 10 minutes. Make changes as needed

## Waveform Capture




### *Voltage Threshold*

Enter in the percent of voltage reading that you wish to cause a waveform capture to occur. An example- If your unit is on a 120V service and you set the voltage threshold to be 10%, the unit would require a 12V change in voltage value to occur from one cycle to the next in order for a waveform to be triggered.

### *Current Threshold*

Enter in the percent of full-scale current that you wish to cause a waveform capture to occur. An example- If your unit is on a 1000A scale and you set the current threshold to be 10%, the unit would require a 100A change in current value to occur from one cycle to the next in order for a waveform to be triggered.

### *Voltage THD Threshold*

Enter in the percent of voltage Total Harmonic Distortion reading that you wish to cause a waveform capture to occur.

***Period Capture***

Default setting is Disabled. A selection 1-minute to 4-week will cause the recorder to capture a waveform at the selected setting.

***Samples/Cycles***

Some recorders allow a lower resolution (number of points) to be captured, A lower resolution increases in the total number of waveforms that can be captured.

***Pre/Post Waveforms***

Default setting is 9-cycles (2-cycles, the trigger cycle, 6-cycles) Enter in the number of cycles you wish to capture. Note that recorders have a maximum limit of total cycles in one waveform capture.

***Trigger Thresholds***

Select the number of volts (deviation from previous cycle) that would cause a waveform capture to occur.

***Overwrite***

A check in this box will cause the waveforms to overwrite the oldest waveforms once the waveform memory allocation is full.

***Voltage & Current***

Select the number of voltage and current channels to collect waveforms from.

Example:If you select 2 channels, only channels 1 and 2 will collect waveforms. If your unit has 4 channels, channel 3 and 4 will not collect any.

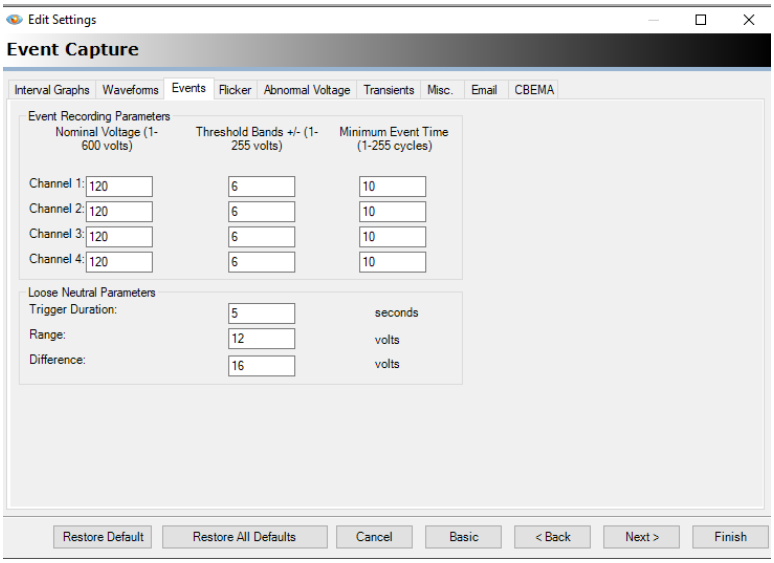
Changes to the number of channels will adjust the number of waveforms captures available.

***Cross-Triggers***

Selecting **Transient Capture** will cause a waveform capture to occur when a Transient capture occurs. Note that there can be several transients in one waveform capture.

Selecting **Event Capture** will cause a waveform capture to occur when an Event occurs.

# Event Capture




### *Event Recording Parameters*

Nominal Voltage is the voltage against which all events are measured. Factory setting is 120 volts. Adjust to match the site's voltage.

### *Threshold Bands +/-*

The variations in voltage above and below the nominal voltage set in the first column needed to signal a voltage event. Factory setting is 6-volts, meaning that at 120 volts a voltage of less than 114, or greater than 126, will create an event. Typical setting is 5% of the nominal voltage set in the first column.

### *Minimum Event Time*

The number of consecutive cycles that must elapse before a new event of the same slope can be triggered. Factory setting is 10 cycles.

Enter any changes in the appropriate boxes. The Recorder will record events that meet or exceed your settings. The **Event Change Table** is listed in the Header Report of the downloaded data file.

## Loose Neutral Parameters

### *Trigger Duration*

The number of seconds that the condition has to be present for it to be considered a loose neutral.

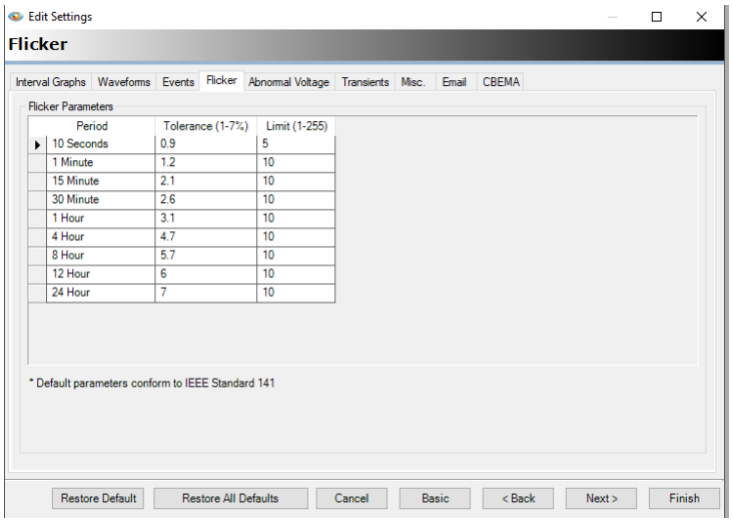
### *Range*

Number of volts above or below nominal voltage that the condition would need to be reached to be considered a loose neutral. (i.e.- nominal =120v AC and a range of 12 v AC, either
L1 or L2 would need to be outside of the 108 to 132 v AC range to meet the condition)

### *Difference*

The number of volts that the between channel 1 and channel 2 need to be in order for the condition to be considered a loose neutral. (i.e.- L1 would need to be 136 or 104 v AC if L2 was 120v AC to meet the condition of a loose neutral)

## Flicker




### *Flicker Parameters*

Contains three columns for each time span in the first column

***Period***

Set the percentage of variation

***Tolerance***

Set the minimum number of cycles

***Limit***

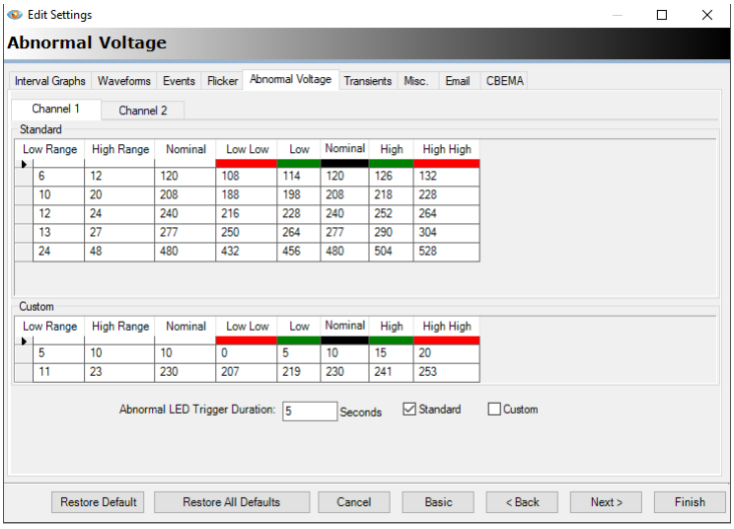
A flicker event occurs when the voltage varies from the nominal by more than the tolerance for more cycles than the limit within the given period. For example, using the factory settings for a 10-second period, a flicker event would be recorded when five or more variations of more than 1 percent occur within 10 seconds.

Enter changes in the appropriate boxes.

The Recorder will record events that meet or exceed your settings. The **Flicker Report** is listed in the Header Report of the downloaded data file

Note: These settings are for the IEEE Standard 141 report.  Settings for IEC Flicker are in advanced settings.

# Abnormal Voltage




This window displays a chart of low and high abnormal voltage ranges. There are four pages of charts—one for each recording channel in use. To switch from channel to channel, click on the numbered tab at the top of the charts.

### *Standard Settings*

The standard chart lists five nominal voltages (120, 208, 240, 277, and 480). To the left of the nominal voltages are columns marked “low range” and “high range.” These numbers determine the values in the five columns to the right of the nominals. For example, for the nominal 120, the default low-range setting is 6 and the default high-range setting is 12. In this case, a low range abnormal voltage event will be recorded if the voltage is below 114 or above 126. (That is, 120 volts plus or minus 6, the low-range setting.) A high-range abnormal voltage event will be recorded if the voltage drops below 108 or peaks above 132. (Again, 120 volts plus or minus 12, the high-range setting.)

### *Custom Settings*

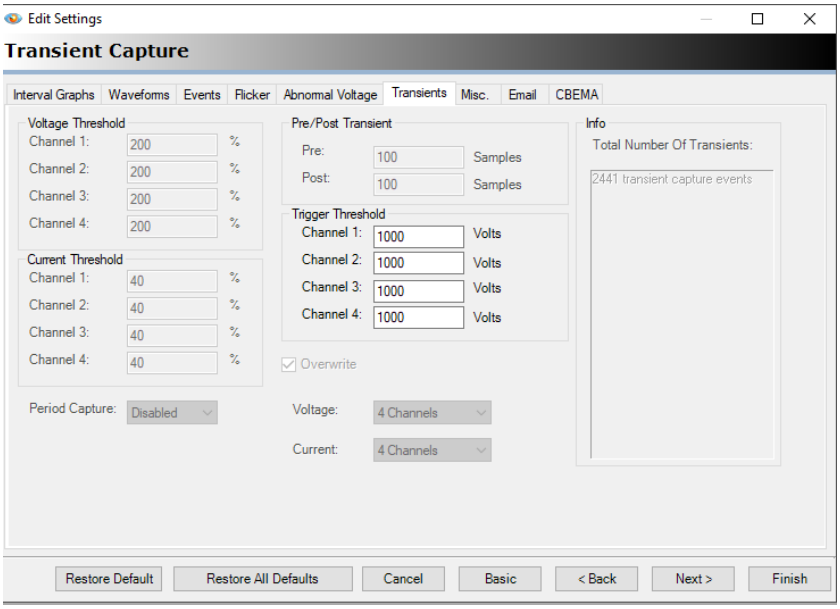
The custom scale works much the same way, except you are permitted to change the two nominal voltages.

If you want the Recorder to use only the settings in the standard chart, check “Standard” at the bottom of the page. If you want the Recorder to use only the settings in the custom chart, check “Custom.” If you want the Recorder to use both charts, check both boxes.

The Recorder will record the date and time of voltages which lie outside the ranges you have defined. The **Abnormal Voltage Report** is listed in the Header Report of the downloaded data file

## Transient Capture

Transient capture is an option for specific recorders.

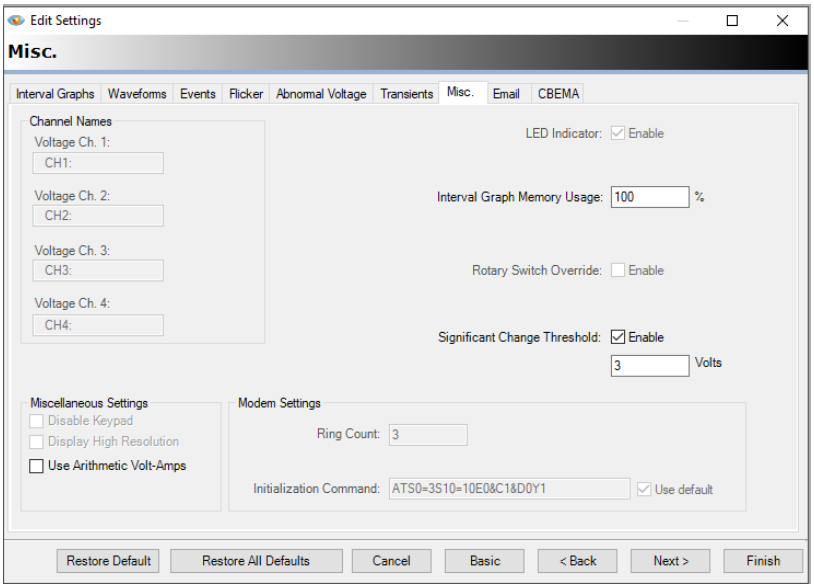



Trigger Thresholds

Select the number of volts (deviation from previous cycle) that would cause a Transient waveform capture to occur. Typically set to 2-3 times the nominal voltage.

## Misc.

Selections will change depending on the recorder.




### *Channel Names*

Enter in any tag names for channels.

***Disable Keypad***

A check in this box will disable the unit keypad.

***Display High Resolution***

A check in this box will provide a display with an extra significant digit.

Use Arithmetic Volts-Amps

There are two competing methods for resolving the mathematical impossibility of precisely computing 3-phase delta apparent power was given. The arithmetic method is the older method but is still seen in legacy meters and from manufacturer equipment specifications. The vector method more often gives intuitive results and is the default with all PMI power recorders.

***Modem Settings***

For older recorders with a dial-up modem. This is the number of rings the Recorder will wait before answering a call. If a Recorder is in a substation with a phone line also used for voice communications, you may want to set the ring count higher. That would allow a person the chance to answer the phone before the Recorder modem picks up. Factory setting is 3 rings. Modem Initialization Command string can also be set.

***LED Indicator***

This setting has no effect on the Recorder.

***Interval Graph Memory Usage***

Recorder memory is sectioned into several pieces, Interval data (Interval graphs also called strip charts) uses the largest memory section in a recorder. Recorders with 1GB of memory can create very large data files if the recorder is left recording for an extended period of time. Changing the Interval Graph Memory Usage setting can limit the amount of strip chart memory used and create smaller data files, but also shorter record time.

***Rotary Switch Overwrite***

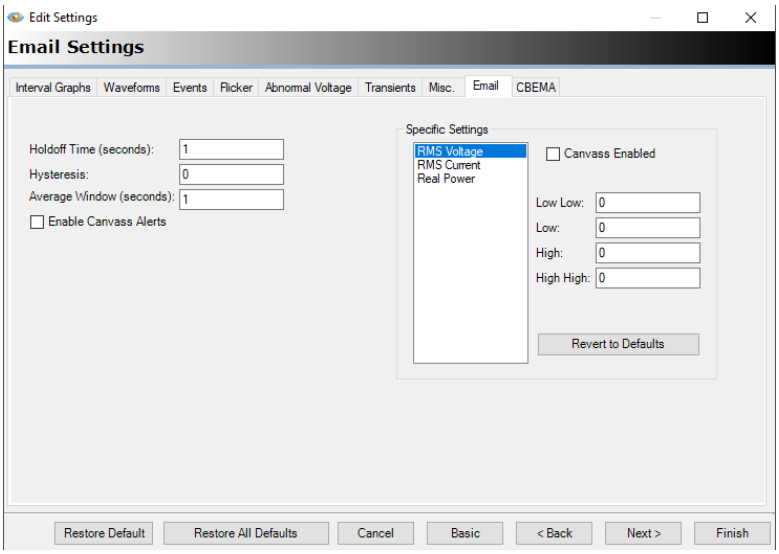
If checked, this feature prevents a user from changing Recorder settings manually from the faceplate keypad, or rotary switches on the IV Recorders. Factory setting is not checked (not enabled). For more information see the Recorder Manual.

***Significant Change Threshold***

This setting determines the change in voltage needed before the Recorder records a significant change. Factory setting is 3 volts. The permitted range is 1-8 volts, with a limit of 1000 events.

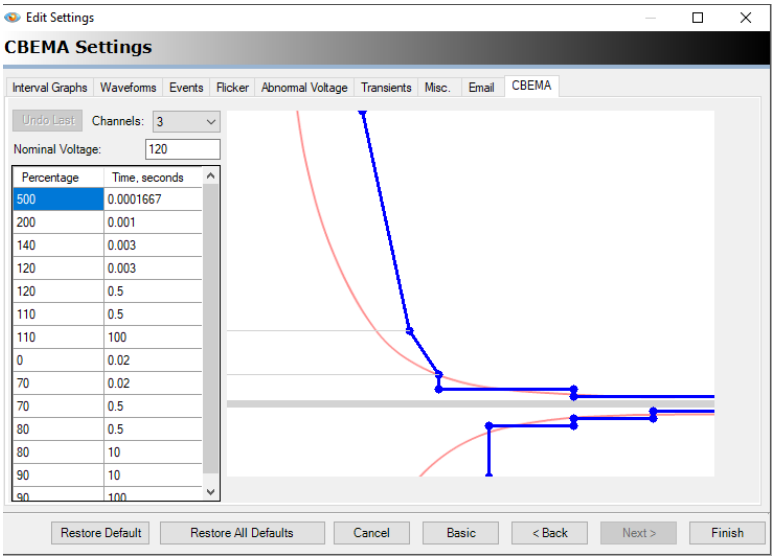
The significant change graph and report data is non-linear, it is based on voltage change and not the Interval Record Time. 3-volts for 120, 4-volts for 277 and 6-volts for 480 are common settings.

## Email Settings




Recorders with a cellular modem option can be configured with an Email notification option. See your sales representative for a cost of this option and contact PMI technical support for configuration.

## CBEMA/ITIC Settings

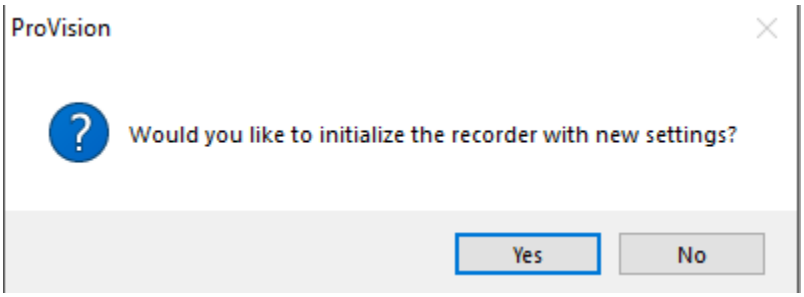



The CBEMA (blue) and ITIC (orange) curves are both used to visibly represent voltage events. The terms and associated curves are used somewhat interchangeably even though there are subtle differences between the two. The CBEMA (Computer Business Equipment Manufacturers Association) curve was originally created in the 1970's. It defines various regions based on input voltage where computer equipment may encounter operational issues. The ITIC (Information Technology Industry Council) curve is a modified version of the CBEMA curve created in the 1990's. It also defines regions based on input voltage but in a clearer fashion with discrete steps. Either can be used to create a visual representation of voltage acceptability by plotting the magnitude and duration of voltage events.

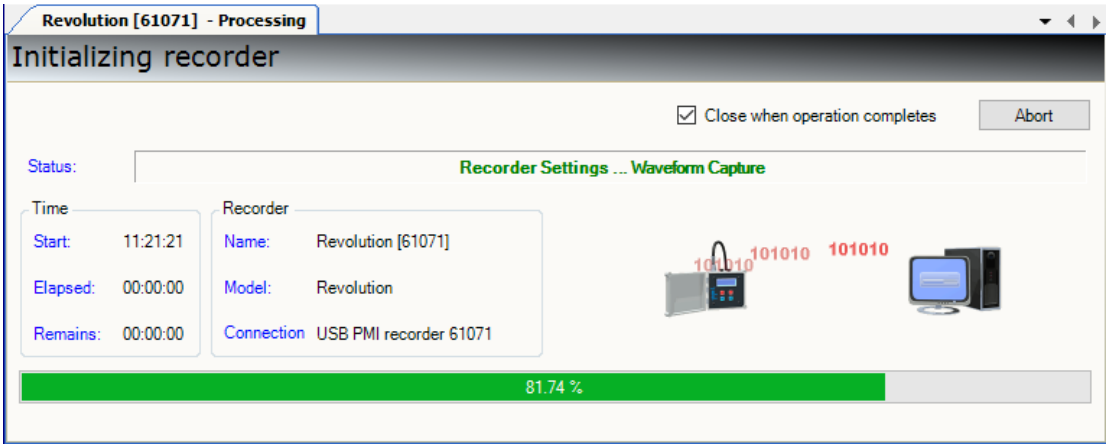
Set the number of **Channels** and the **Nominal Voltage**.

## Complete the Initialization

Select **Finish** and select **Yes** to complete the recorder initialization. The Communication Group pane will show the progress until completion



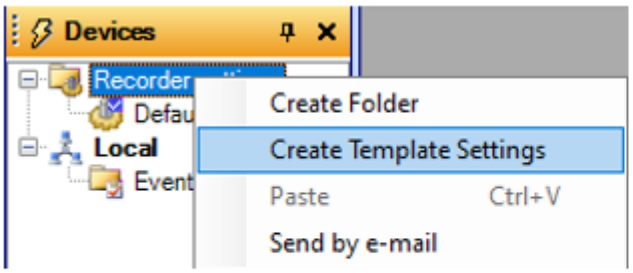

Once completed, the recorder is ready to record data based on the configuration that has been set.

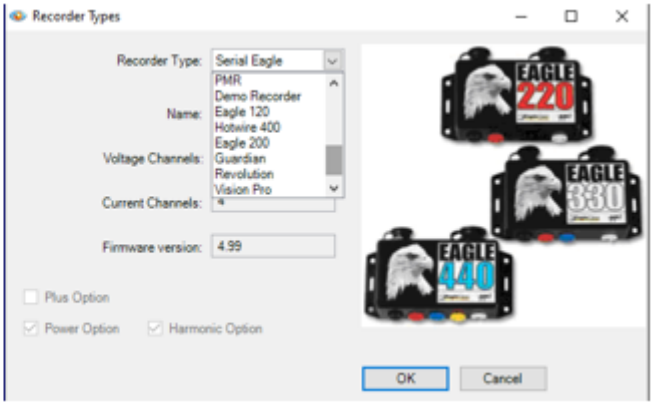



## Creating a Recorder Template

Recorder templates can be created to simplify and standardize the initialization process. Once a template is created, it can be ‘dragged and dropped’ onto a connected recorder to initialize with the template settings.

Right-click on **Recorder Settings** and select **Create Template Settings**. Choose your recorder and select **OK**. The Initialization Basic page will appear. Adjust the settings needed, select **Finish** and name the template. Custom templates can be shared with other co-workers.

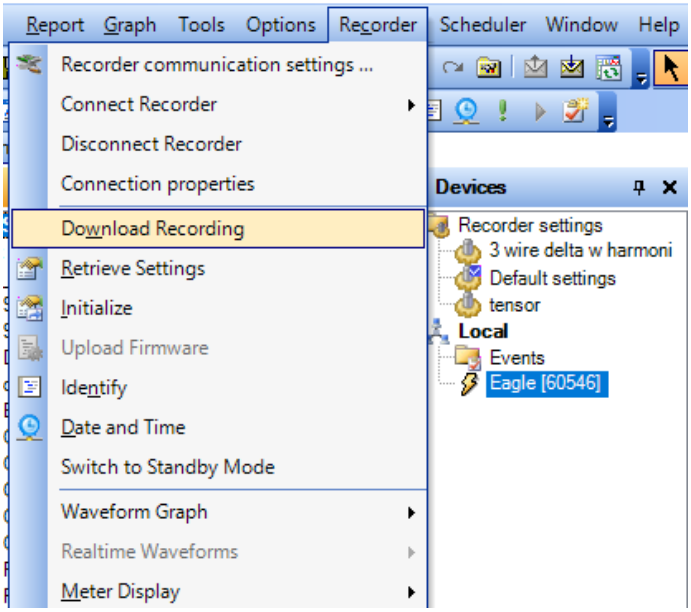


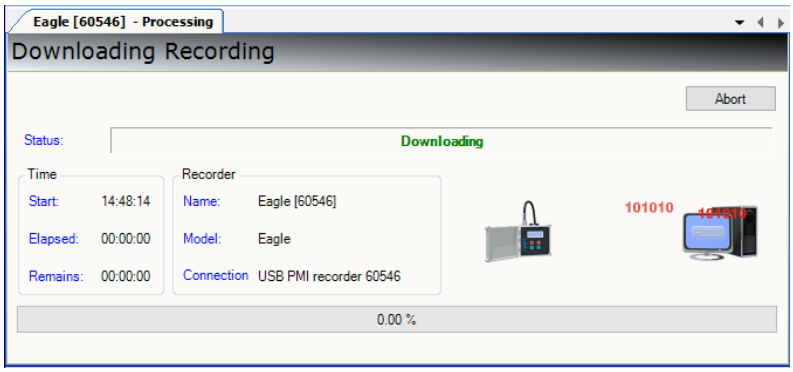
## Downloading a Recorder

After a PMI recorder has collected PQ data, it is necessary to download the data to the computer for further analysis. Refer to the section Connecting Recorders in this manual to connect ProVision to the recorder for downloading.

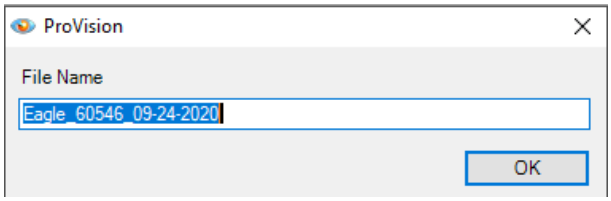
Once the recorder is connected, click on the **Recorder** menu, and then select **Download Recording**.




During the downloading process, the **Communication Group** pane displays the progress of the operation:




Once the download is complete, enter a name for the new data file. The data file is placed in the **Recent Downloads** folder.




You will be asked to initialize the recorder. Select **Yes** to remove the old data and start a new recording using the same initialization settings on the next power-up or select **No** to initialize later. If power is applied to the

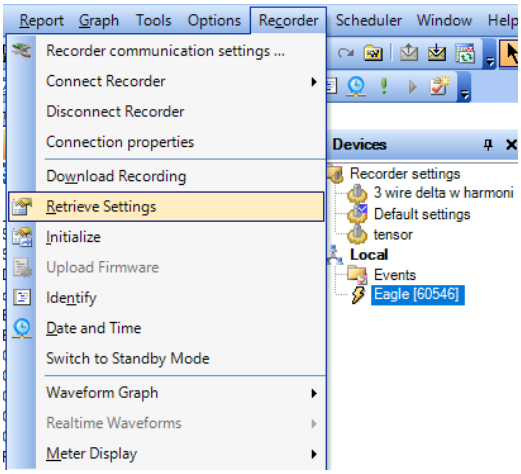
recorder that has not been initialized, the new data will be appended to the old data.

To open the downloaded data file, click the **View** button in the Communication Group pane or click on the data file name under the Recent Downloads folder.

## Retrieve the Settings from a Recorder

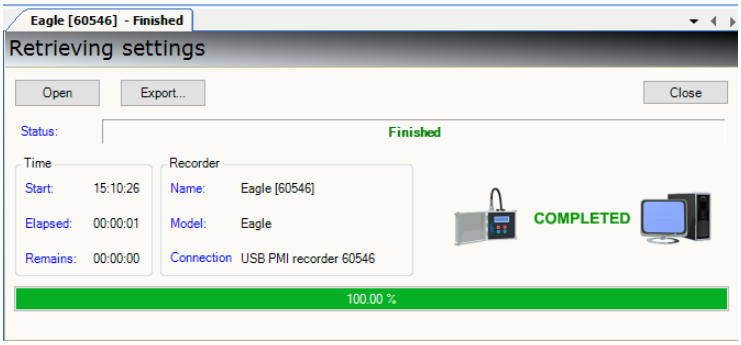
You can retrieve and modify the initialization settings of a recorder. The recorder must be connected before the settings can be retrieved. A remotely connected recorder will stop recording when retrieving the settings.

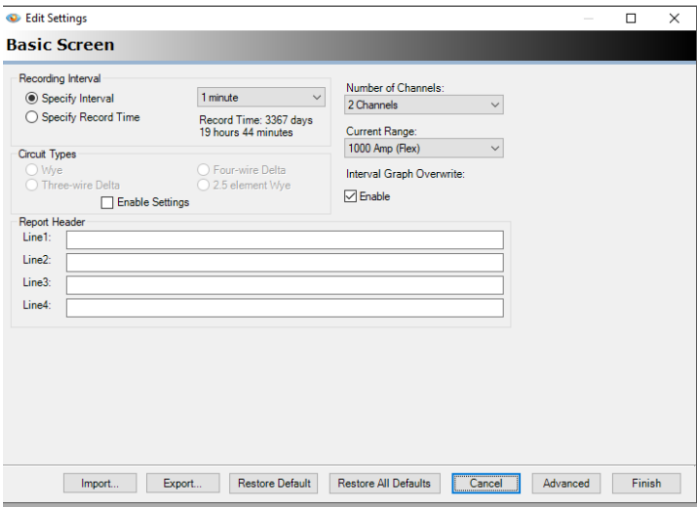
Click on the **Recorder** menu, and then click **Retrieve Settings**.




During the retrieval of the settings, the **Communication Group** pane displays the progress of the operation:

Once completed, click on the **Export** button to save the settings for future use, or click on the **Open** button to view the settings:



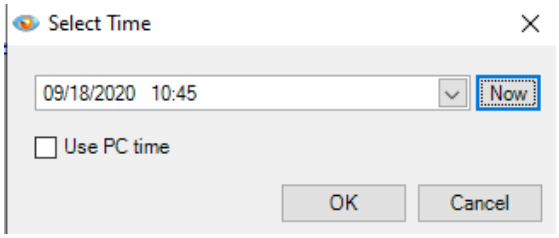



Verify or modify the settings from the recorder, and then click **Finish** to initialize the recorder with the changes.

## Setting the Date and Time

To set the data and time of a PMI recorder, click on the **Recorder** menu and then click **Date and Time**.

The current date and time of the recorder is retrieved and displayed in the following screen:




***Editing Box***

Use the editing box to manually change the date and time. Be sure to use a 24-hour time format, e.g. “4:57 PM” is “16:57” in 24-hour format.

Use the drop-down arrow to choose a date from the calendar.

***Now***

Use this button to overwrite the contents of the editing box with the current date and time.

***Use PC Time***

Check this box to send the date and time of the computer to the recorder instead of the time shown in the editing box.

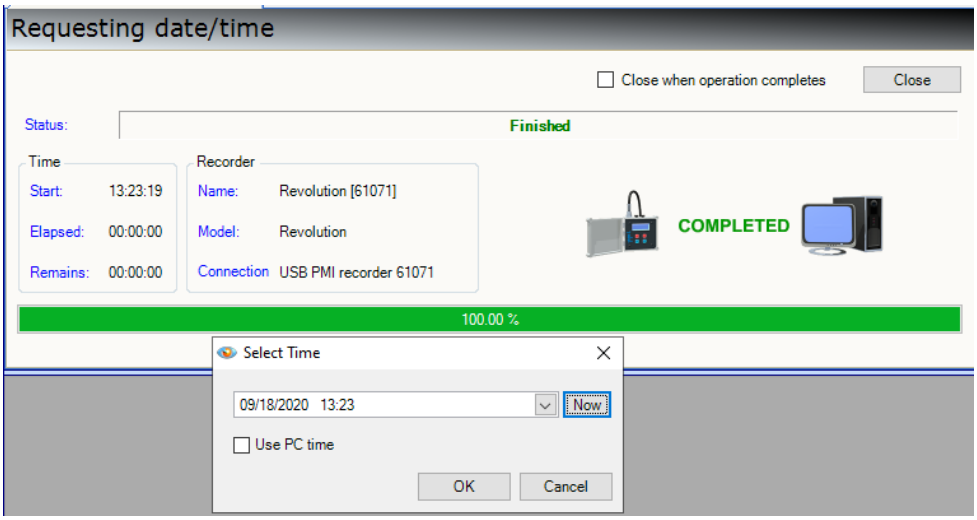
***OK***

Click this button to send the date and time to the recorder.

***Cancel***

Click this button to close this screen without sending the date and time to the recorder.

During the setting of the date and time, the **Communication Group** pane displays the progress of the operation:




## Uploading Firmware

Periodically, the firmware of a PMI recorder needs to be updated. Use the **Upgrade Manager** to load all Firmware files onto your PC.
Download any recorder data before updating the firmware. Any data will be removed during the update.

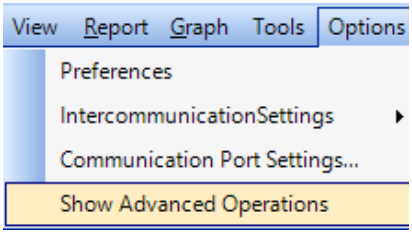
Auto Firmware update:

After each recorder download, ProVision will compare the firmware on the recorder with the firmware on your PC and if different will ask to update the firmware.

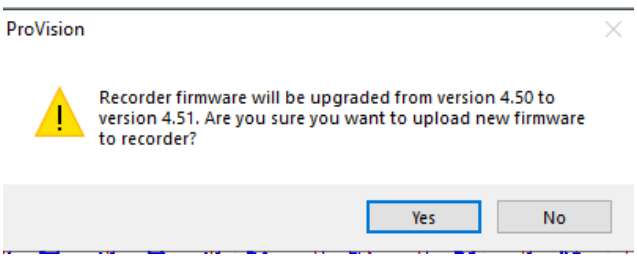
To manually update the firmware in your recorder:

Click the **Recorder** Menu and select **Switch to Standby**

Click on the **Recorder** menu, and then click **Upload Firmware**. If Upload Firmware is not visible, click on the **Options** menu and then select **Show Advanced Operations**.

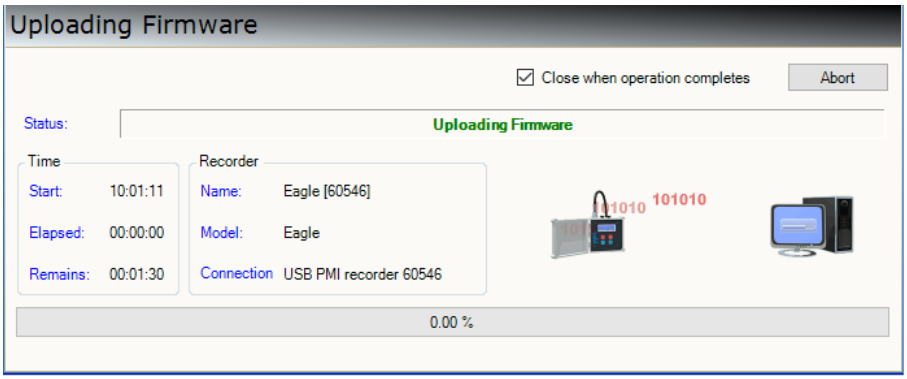



ProVision automatically locates the appropriate firmware file for the recorder, and if a newer version of firmware is found, a prompt will appear to verify that it is the one to use:



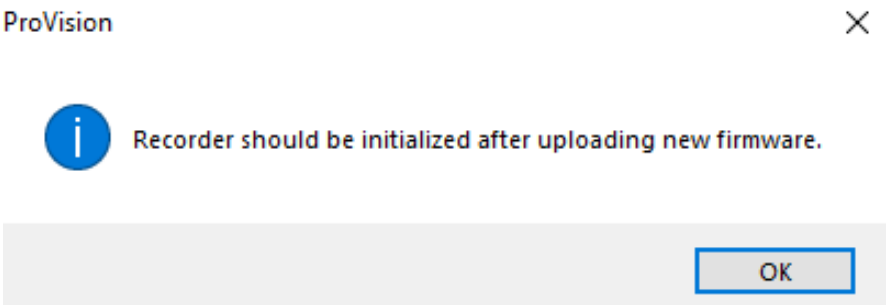

Click **Yes** to continue the operation or click **No** to stop it.

During the uploading of the firmware file, the **Communication Group** pane displays the progress of the operation:




Click the **Abort** button to cancel the operation.

When completed the following message is displayed.



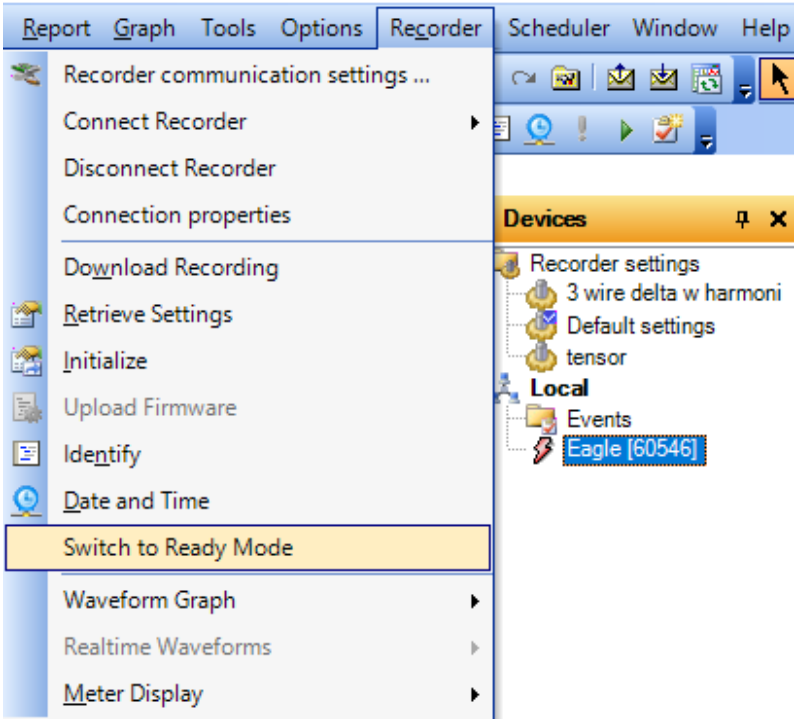

## Recording Data

To begin recording data, the PMI recorder must be connected to 60v AC or greater.
The recorder must also be placed in **Ready** mode.

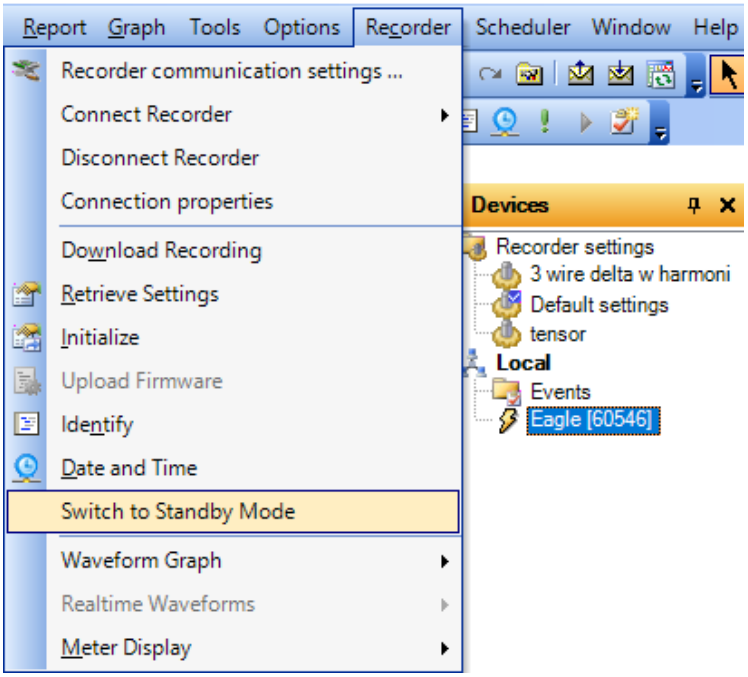
A PMI recorder is automatically switched to ready mode when it is disconnected from the computer. Either by physically removing the USB cable or for remote recorders, performing a **Disconnect Recorder** in the Device menu.

After disconnecting a countdown from one to two minutes depending on the recorder model, and then recording begins. (See the recorder owner's manual for more information.)

Another option is to stay connected to the recorder in ProVision and manually select **Switch to Ready mode**. After countdown you can view live data as it is recorded and **Disconnect** when finished.




When a recorder is actively recording, the **Device** Menu will show **Switch to Standby Mode** as an option. Use this option to stop the recording. Selecting Download Recording, Retrieve Settings, Initialize, or Identify will cause the device to Switch to Standby Mode which will interrupt active data recording.

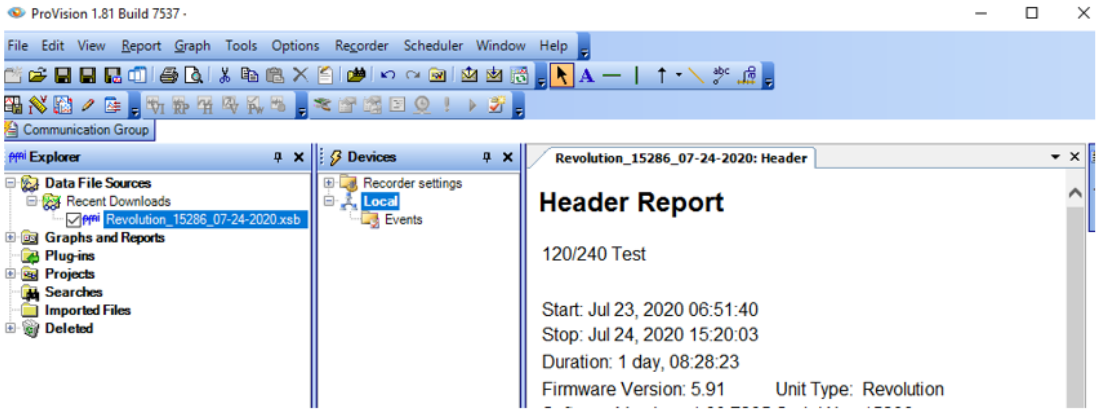


# Working with Data Files

Download data file are located under the Recent Downloads heading in the Explorer Tree

1) To open a data file in Recent Downloads, double click the file name and the Header Report will open in the main body of ProVision. A check mark will be placed in front of the data file

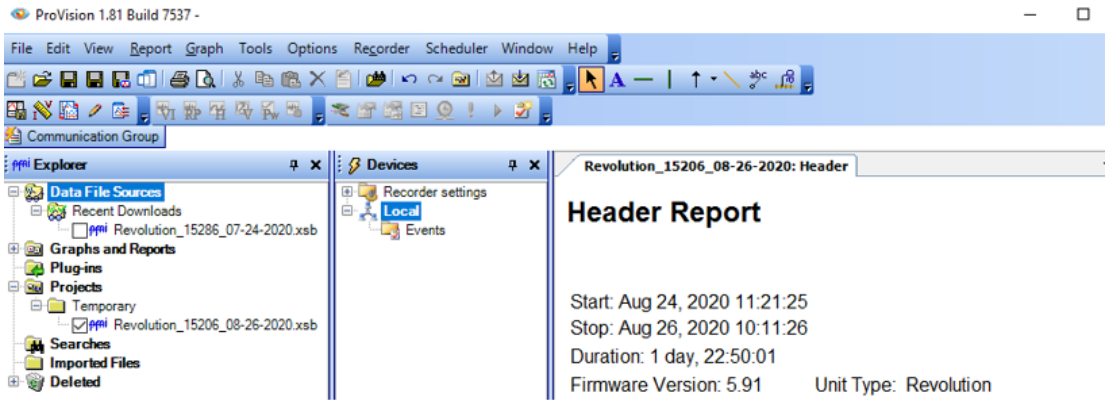
    a) Later in this manual you will learn about creating Watcher folders for files located on remote network servers




2) To open a data file that is not located in Recent Download, click on the **File** menu, and then click **Open**.

3) A dialog box appears to browse for data files located anywhere on the system. Select one or more files, and then click **Open**.

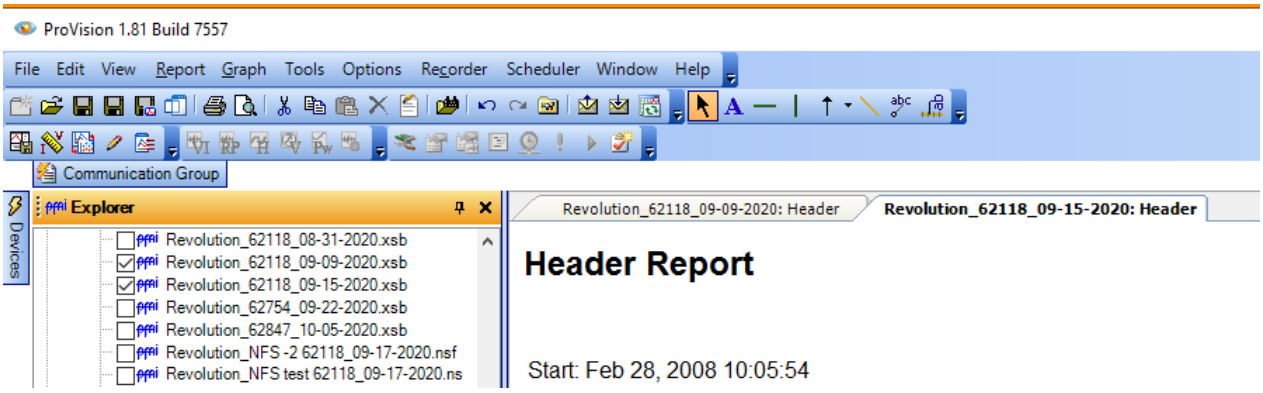
4) These data files will be listed under the Projects heading.



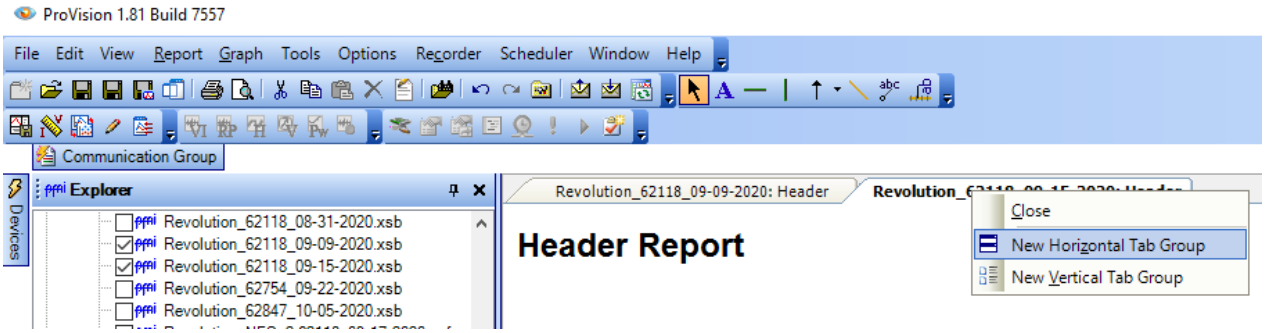

5) Once the file(s) are opened, they are considered active and may be used to generate graphs, reports and perform other operations.

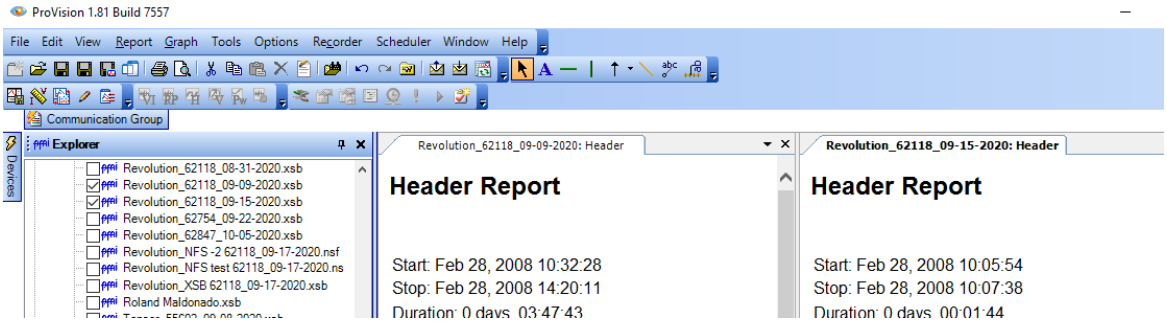
## Comparing Data Files

To compare the data between two or more data files, place a checkmark in front of the files. Then select the report or graph to compare.

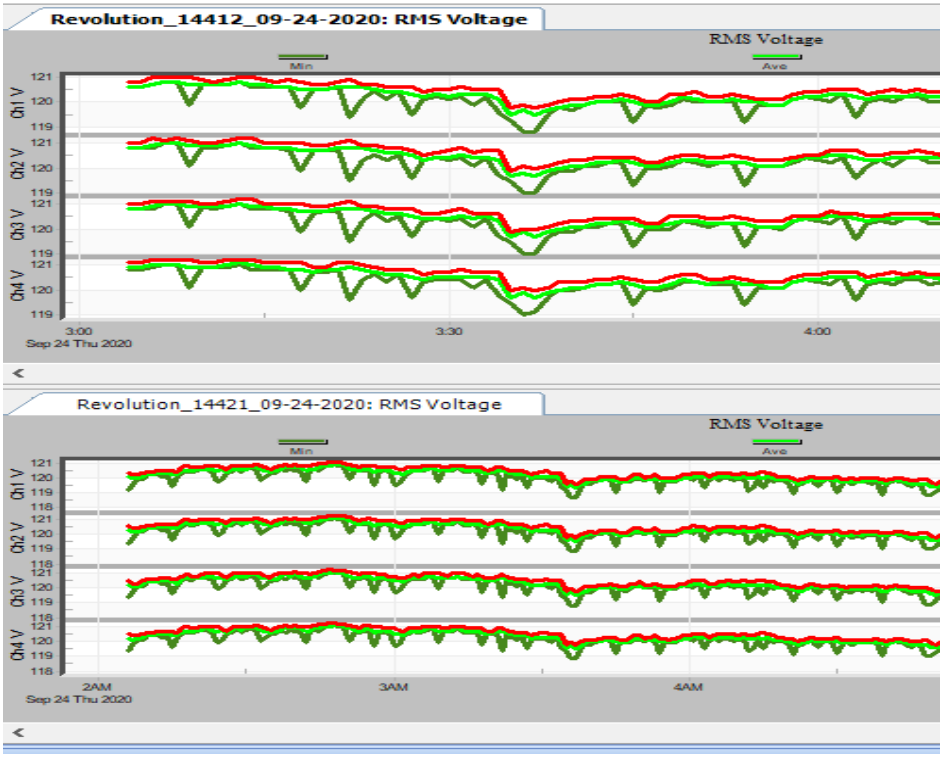



The Graph or Report will open for each selected data file in the ProVision Workspace. Right click on the Report or Graph tab and select **New Horizontal Tab Group** (view one over the other) or **New Vertical Tab Group** (view side-by-side).

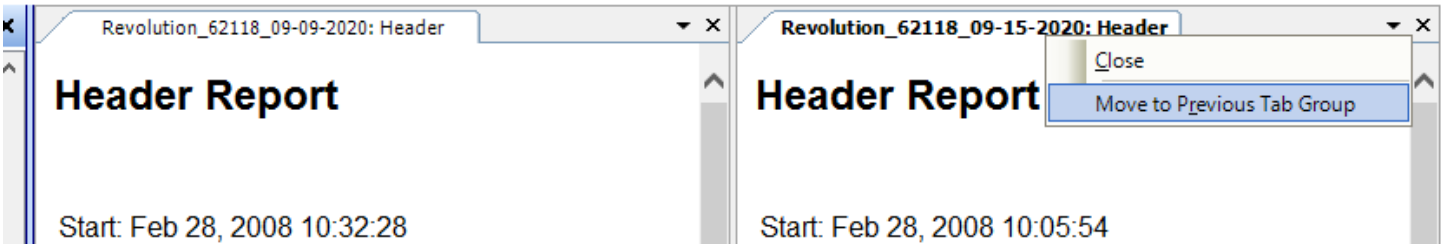



Reports are easy to compare side-by-side, and graphs compare easily one over the other.




To undo the Vertical or Horizontal view, right click on the Report or Graph tab and choose **Move to Previous Tab Group** or select the **X** to close.




## File Extensions used by ProVision

*.ISF: WinScan data files

*.XSB: Older ProVision data files

*.XSF: ProVision data files

*.NSF: Updated Provision data file for Revolution and Guardian+ recorders, also used in PQCanvass

*.EVM: Used by Custom graphs and Custom Recorder Templates

## Managing Projects

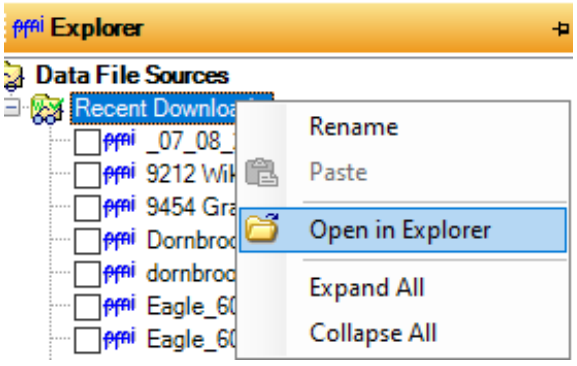
If projects or data files become too numerous or cluttered, they may be hidden by right-clicking on the icon and then clicking **Hidden**. These objects are not removed from the system and may be made visible again by clicking on the **View** menu, and then clicking **Show Hidden Nodes**.

Optionally, projects and data files that are no longer in active use, but must be kept around, may be archived. To archive data, right-click on the project or data file icon, and then click **Create Archive** from the menu.

For items no longer needed, select the icon and press the **Delete** key, or right-click on the icon and then click **Delete** from the popup menu. From the menu bar, click on **Edit** and then click **Delete**. From the toolbar, click the **Delete** button.

## Managing Recent Download and Watcher Files

Files downloaded to Recent Downloads or any Watcher folder cannot be deleted in ProVision. You must go to the actual location to delete the file. The files downloaded to the **Recent Downloads** folder can be found on your C; drive at this 'hidden' folder location: *C:\ProgramData\Power Monitors, Inc\ProVision\Common*
An easy way to get to the Recent Downloads location or any **Watcher** location, is to right-click on the watcher name and select **Open in Explorer.** The folder will open and all files in that Watcher can be managed just as any file on your PC.




## Generating a Graph

1) Open a data file or activate a data file in the Explorer by clicking its checkbox. (If more than one data file is active, a graph will be generated for each file.)

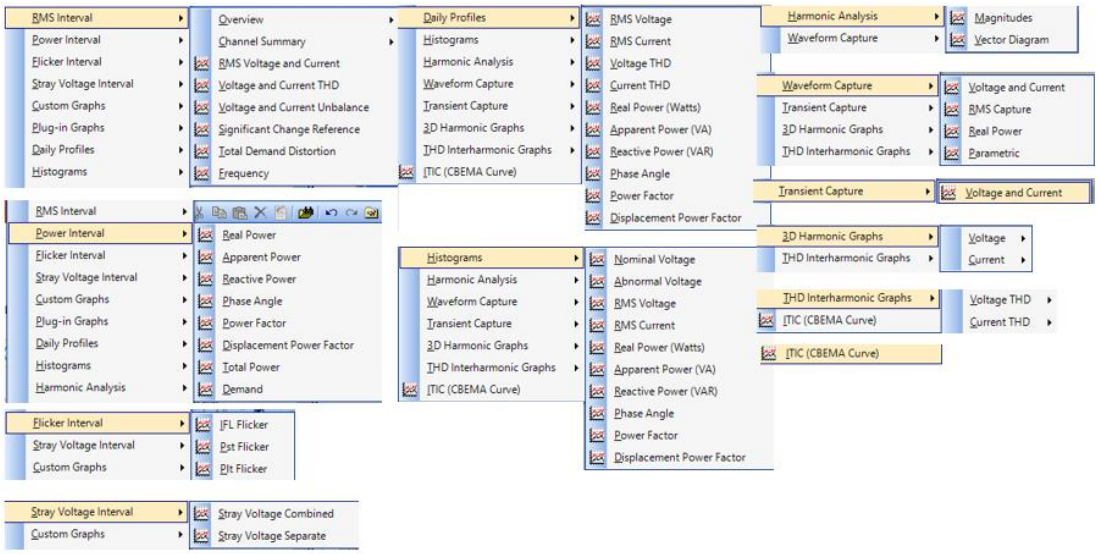
2) Click on the **Graph** menu, and then click on one of the available graphs, e.g. **Voltage and Current** in the **RMS Interval** submenu.

3) A graph will be created for each active data file.

*Hint: If you Zoom into a graph, then right-click and Launch Report, the report will only be for that Zoomed in area.*

Note: Custom graphs may be easily created by clicking **Custom Graph Wizard** in the **Tools** menu.

**Graph Menu list with First Sub-Menu**

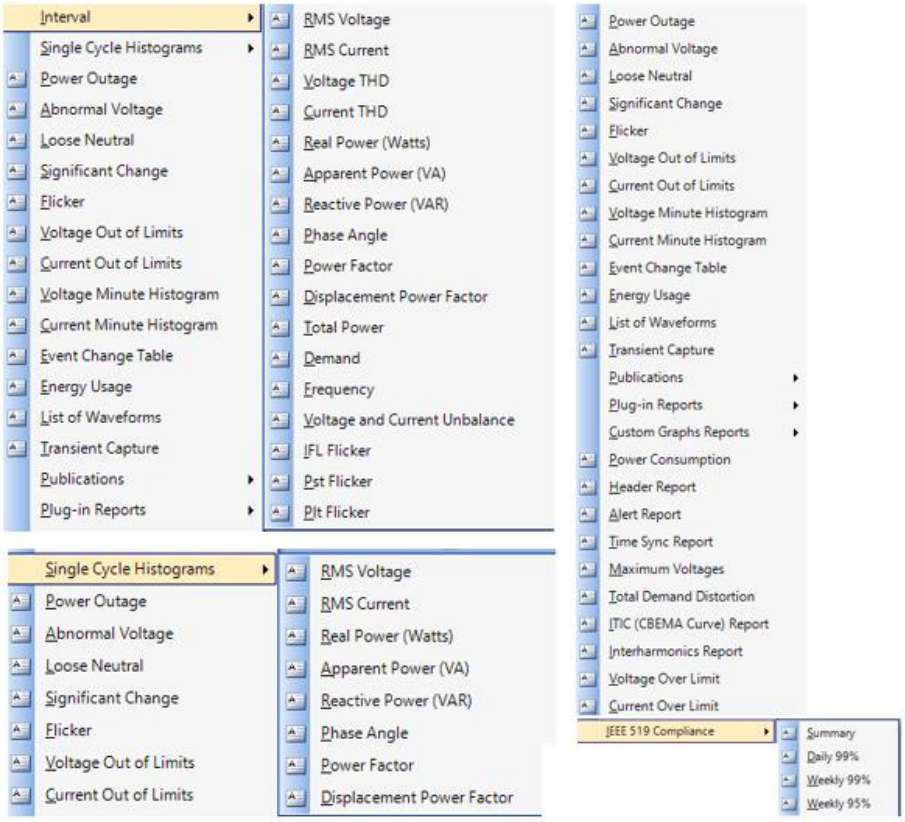


## Generating a Report

1) Open a data file or activate a data file in the Explorer by clicking its checkbox. (If more than one data file is active, a report will be generated for each file.)
2) Click on the **Report** menu, and then click on one of the available reports, e.g. the **Header Report**.
3) A report will be created for each active data file.
4) Right click in a blank area of the report to see the Export menu.

Note Custom reports may be easily created by using the Custom Report Wizard in the Tools menu.

**Report Menu list with First Sub-Menu**



# Advanced Features

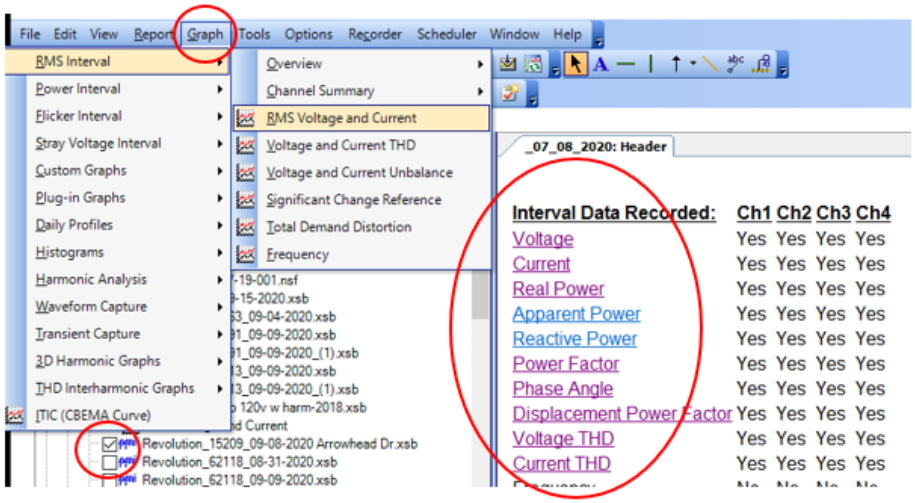
ProVision® contains many advanced features for users who want to get the most out of their power quality data.
The default graphs may be enough for most data reviews, but you may also need to add annotations to highlight events or create custom graphs or mixed graphs and also send those graphs to others.

## Working with Graphs

Graphs provide a visual look at the power quality data that has been recorded. ProVision's many powerful features will enhance the analysis of the data and improve the presentation of graphs.

### Opening Graphs

Graphs can be opened by using the quick links on the header report, or by placing a checkmark in the box in front of the data file, and then selecting a graph listed under the Graph menu.
Hint: To compare files place a checkmark in front of multiple data files and then select a graph



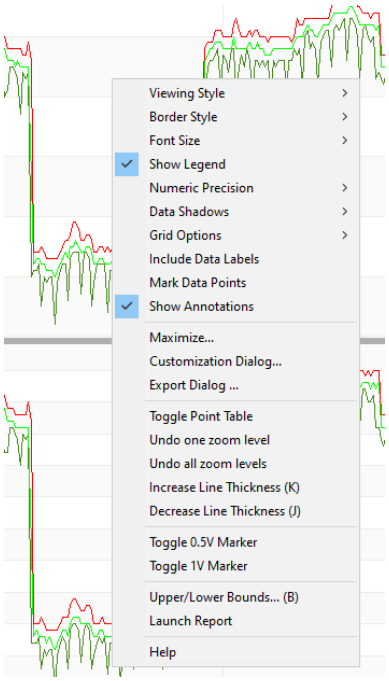
Header Report – Graph quick-links

### Zooming

On first opening a graph, the complete graph is displayed. To see a close up of a specific event or time you can zoom into that area. To zoom into a portion of a graph, click, hold, and drag your mouse directly on that portion of the graph then release. This will be expanded to fill the full width of the graph. You can zoom in several times. To unzoom one level, press the "U" key on the keyboard once or multiple times to revert more than one level. To go to the original view, press the "Z" key.

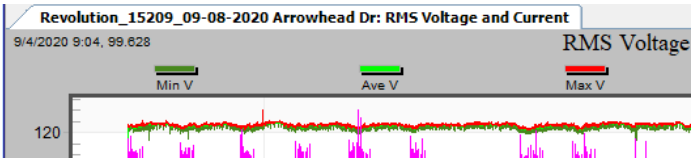
## Graph Options

Right click in a white area of any graph to see shortcuts and other options. Note: After ‘zooming’ into a section you can right-click and create a report for the zoomed in area by selecting **Launch Report**. Also print or save that graph view to a file or ClipBoard by selecting **Export Dialog**.




## Editing Legends

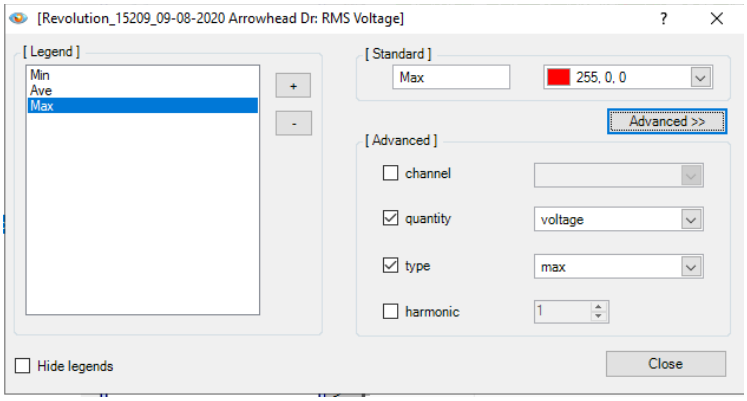
The legend of a graph shows the colors of the traces and their meaning. For example, the legend below shows three graphic elements for three of the traces. “Min V”, “Ave V” and “Max V” describe the meaning of each trace, and dark green, green and red are the colors of their respective traces in the graph.




Using the Legend Editor, each legend element can be changed as required. In addition, new elements may be added, or existing elements may be removed from the legend.

### Using the Legend Editor

To launch the Legend Editor, click on the **Tools** menu, and then click **Legend Editor.**




The Legend Editor has three sections: **Legend**, **Standard** and **Advanced**. **Legend**

Use this section to add or remove legend elements by using the + and – buttons, respectively. Each item in the list represents a legend element that will appear on the graph.

Select a legend element from the list to change its properties found in the next two sections.

***Standard***

Use this section to edit the text and color of the currently highlighted legend element. ***Advanced***

Use this section to alter the data represented by the currently highlighted legend element.

Optionally, hide the legends by checking the **Hide legends** checkbox.

Click the **Close** button when done making changes.

## Graph Annotations

Analysis of graph data is greatly enhanced when adding comments and other markings to draw attention to points of interest. To do this, ProVision® provides a number of graph annotation tools.

In addition to being able to annotate graphs, graphs with event changes or waveform capture events have clickable link annotations. These special annotations allow access to the captured data of the event by clicking on the annotation.

### Using Link Annotations

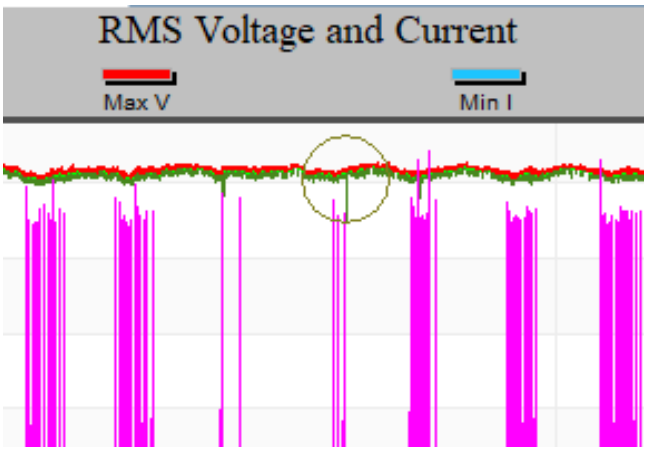
Link annotations are automatically created in voltage and current interval graphs when event changes or waveform capture events are present in the data.

Each annotation is located on the graph at the point in time when the event change or waveform capture event occurred.

### Event Change Link Annotation

The annotation symbol for event changes is a gray circle. When clicking on the circle, an Event Change Table Report is created for the event change.

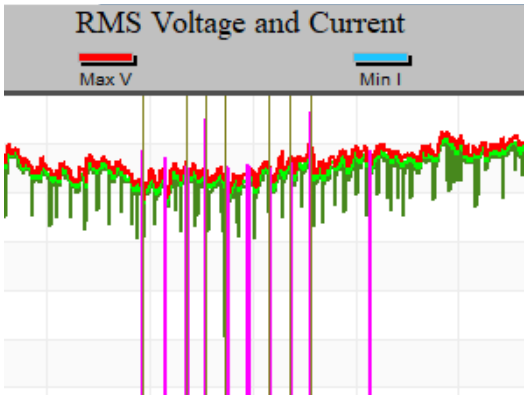
To launch the report, move the mouse over the circle. When the cursor changes into a hand shaped icon, click on the circle.




### Waveform Capture Link Annotation

The annotation symbol for waveform capture events is a vertical gray line. When clicking on the line, a graph with the waveform capture is created.

To launch the graph, move the mouse over the line. When the cursor changes into a hand shaped icon, click on the line.




### *Annotating Graphs*

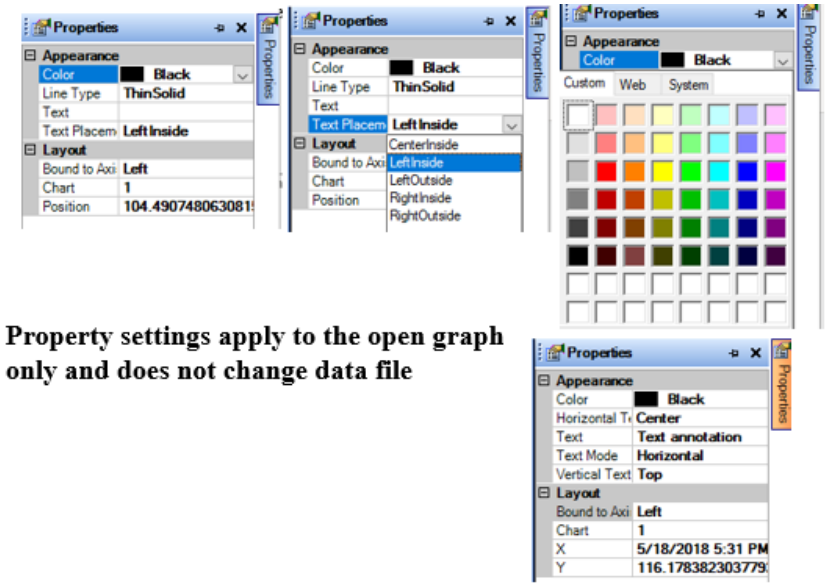
Graphs may be annotated by the user to provide helpful information about the data and to highlight areas of interest.

There are eight annotation tools available on the **Graph Annotation** toolbar:

## Annotation Properties

After selecting and placing the annotation in a graph, select the Properties pane which is located on the right-edge of ProVision. If you are not seeing the Properties, select the View menu at the top of Provision and place a check in the Properties box.

Each annotation has its own set of items that can be modified. Clicking back in the graph will show the graph properties.




**Property settings apply to the open graph only and does not change data file**

Use Annotation Properties Pane to set colors, line thickness, text, positioning and more

## Pointer for Annotation

Use this tool for selecting or moving a graph annotation already placed on the graph.

When using this tool, the cursor changes into a hand-shaped icon indicating that the mouse is pointing at a graph annotation or a link annotation.

## Text Annotation

Use this tool to add textual information anywhere on the graph.

Click on the **Text Annotation** button, and then click on the graph at the desired location. The words “Text annotation” appear on the graph and may be edited in the **Properties** pane along with other properties.

After the annotation has been added, the cursor changes into the **Pointer for Annotation** tool to allow the selection and movement of text.

To remove the annotation, move the mouse over it and right-click, then click **Remove Annotation Element** from the popup menu. (The cursor changes into a hand-shaped icon when the mouse is over the annotation.)

***Properties***

The following appearance and layout properties of the text annotation may be changed in the **Properties** pane:

**Color** – the color of the text

**Horizontal Text Alignment** – how the text is horizontally aligned in relation to the insertion point, i.e. the text will be to the left, the right or be centered on the point where clicked on the graph.

**Text** – the text of the annotation.

**Text Mode** – the direction of the text, either "horizontal" or "vertical".

**Vertical Text Alignment** – how the text is vertically centered in relation to the insertion point, i.e. the text will be at the top, the bottom or be centered on the point where clicked on the graph.

**Bound to Axis** – the Y-axis (see the **Y** property, below) to which the annotation is attached, either "left" or "right".

**Chart** – the plot in which the annotation is located. Plots are numbered from top to bottom, starting with "1".

– the X-coordinate of the annotation's insertion point. The number represents the horizontal location in relation to the bottom axis' unit of measurement, such as "seconds".

– the Y-coordinate of the annotation's insertion point. The number represents the vertical location in relation to the left or right axis' (see the **Bound to Axis** property, above) unit of measurement, such as "volts".

**Horizontal Line Annotation**

Use this tool to draw a horizontal line across the graph.

Click on the **Horizontal Line Annotation** button, and then click on the graph at the desired location. After the annotation has been added, the cursor changes into the **Pointer for Annotation** tool allowing the selection and movement of the line.

Properties for this annotation may be viewed and edited in the **Properties** pane.

To remove the annotation, move the mouse over it and right-click, then click **Remove Annotation Element** from the popup menu. (The cursor changes into a hand-shaped icon when the mouse is over the annotation.)

***Properties***

The following appearance and layout properties of the horizontal line annotation may be changed in the **Properties** pane:

**Color** – the color of the line.

**Line Type** – the appearance of the line, which essentially means the thickness and style, such as a "ThinSolid", dashed or dot line, also line thickness.

**Text** – the text associated with the line.

**Text Placement** – the location of the text, if any, in relation to the plot, e.g. "CenterInside" places the text inside the plot and centered between the left and right sides.

**Bound to Axis** – the Y-axis (see the **Y** property, below) to which the annotation is attached, either "left" or "right".

**Chart** – the plot in which the annotation is located. Plots are numbered from top to bottom, starting with "1".

**Position** – the Y-coordinate of the annotation's insertion point. The number represents the vertical location in relation to the left or right axis' (see the **Bound to Axis** property, above) unit of measurement, such as "volts".

### Vertical Line Annotation

Use this tool to draw a vertical line across the graph. This is the only annotation that can be created that will span across more than one plot of a graph.

Click on the **Vertical Line Annotation** button, and then click on the graph at the desired location. After the annotation has been added, the cursor changes into the **Pointer for Annotation** tool allowing the selection and movement of the line.

Properties for this annotation may be viewed and edited in the **Properties** pane.

To remove the annotation, move the mouse over it and right-click, then click **Remove Annotation Element** from the popup menu. (The cursor changes into a hand-shaped icon when the mouse is over the annotation.)

#### *Properties*

The following appearance and layout properties of the vertical line annotation may be changed in the **Properties** pane:

**Color** – the color of the line.

**Line Type** – the appearance of the line, which essentially means the thickness and style, such as a "ThinSolid" line dashed or dot line, also line thickness.

**Text** – the text associated with the line.

**Text Placement** – the location of the text, if any, in relation to the plot, e.g. "CenterInside" places the text inside the plot and centered between the top and bottom sides.

**Position –** The number represents the horizontal location in relation to the bottom axis' unit of measurement, such as "seconds".

**X** – the X-coordinate of the annotation's insertion point. Select the date to place the line.

### Arrow Annotation

Use this tool to add one of eight directional arrows to the graph.

Click on the **Arrow Annotation** button, and then click on the graph at the desired location. To change the arrow type from the toolbar, click on the dropdown arrow next to the **Arrow Annotation** button and select the desired arrow from the list.

Properties, such as **Arrow Type**, may be viewed and edited in the **Properties** pane.

After the annotation has been added, the cursor changes into the **Pointer for Annotation** tool allowing the selection and movement of the arrow.

To remove the annotation, move the mouse over it and right-click, then click **Remove Annotation Element** from the popup menu. (The cursor changes into a hand-shaped icon when the mouse is over the annotation.)

***Properties***

The following appearance and layout properties of the arrow annotation may be changed in the **Properties** pane:

**Arrow Type** – the direction of the arrow, e.g. the "NorthEast" arrow type points in the upper right direction.

**Color** – the color of the arrow.

**Horizontal Text Alignment** – how the text, if any, is horizontally aligned in relation to the insertion point, i.e. the text will be to the left, the right or be centered on the point where clicked on the graph.

**Text** – the text associated with the arrow.

**Text Mode** – the direction of the text, either "horizontal" or "vertical".

**Vertical Text Alignment** – how the text, if any, is vertically centered in relation to the insertion point, i.e. the text will be at the top, the bottom or be centered on the point where clicked on the graph.

**Bound to Axis** – the Y-axis (see the **Y** property, below) to which the annotation is attached, either "left" or "right".

**Chart** – the plot in which the annotation is located. Plots are numbered from top to bottom, starting with "1".

– the X-coordinate of the annotation's insertion point. The number represents the horizontal location in relation to the bottom axis' unit of measurement, such as "seconds".

– the Y-coordinate of the annotation's insertion point. The number represents the vertical location in relation to the left or right axis' (see the **Bound to Axis** property, above) unit of measurement, such as "volts".

**Line Annotation**

Use this tool to draw a line in any direction desired. The line, however, can only be drawn inside of one plot as determined by the **Plot** property, below. (Other properties may be viewed in the **Properties** pane, also.)

Click on the **Line Annotation** button, and then click on the graph at the desired location to begin the line. Next, move the cursor, and then click on a location to end the line.

To move the line, click and drag the endpoints of the line to their new locations. Move the cursor over an endpoint until the cursor changes into a hand-shaped icon and then click and drag the endpoint.

After the annotation has been added, the cursor changes into the **Pointer for Annotation** tool allowing the selection and movement of the line.

To remove the annotation, move the mouse over it and right-click, then click **Remove Annotation Element** from the popup menu. (The cursor changes into a hand-shaped icon when the mouse is over the annotation.)

***Properties***

The following appearance and layout properties of the line annotation may be changed in the **Properties** pane:

**Color** – the color of the line.

**Horizontal Text Alignment** – how the text, if any, is horizontally aligned in relation to the insertion point, i.e. the text will be to the left, the right or be centered on the point where clicked on the graph.

**Text** – the text associated with the line.

**Text Mode** – the direction of the text, either "horizontal" or "vertical".

**Vertical Text Alignment** – how the text, if any, is vertically centered in relation to the insertion point, i.e. the text will be at the top, the bottom or be centered on the point where clicked on the graph.

**Bound to Axis** – the Y-axis (see the **Y** property, below) to which the annotation is attached, either "left" or "right".

**Chart** – the plot in which the annotation is located. Plots are numbered from top to bottom, starting with "1".

– the X-coordinate of the line's starting point. The number represents the horizontal location in relation to the bottom axis' unit of measurement, such as "seconds".

**X2** – the X-coordinate of the line's end point.The number represents the horizontal location in relation to the bottom axis' unit of measurement, such as "seconds".

– the Y-coordinate of the line's starting point. The number represents the vertical location in relation to the left or right axis' (see the **Bound to Axis** property, above) unit of measurement, such as "volts".

**Y2** – the Y-coordinate of the line's end point. The number represents the vertical location in relation to the left or right axis' (see the **Bound to Axis** property, above) unit of measurement, such as "volts".

### Pointer Annotation

Use this tool to quickly draw a line with text at one end. This annotation is a combination of the **Text Annotation** and **Line Annotation** tools.

Click on the **Pointer Annotation** button, and then click on the graph at the desired location to begin the line. Next, move the cursor, and then click on the location to end the line. The word "Pointer" appears on the graph and may be edited in the **Properties** pane along with other properties.

To move the line, separately click and drag the endpoint of the line (furthest away from the text) and the text itself. Move the cursor over the endpoint until the cursor changes into a hand shaped icon and then click and drag the endpoint. Likewise, move the cursor over the text until the cursor changes into a hand-shaped icon and then click and drag the text.

After the annotation has been added, the cursor changes into the **Pointer for Annotation** tool allowing the selection and movement of the line and text.

To remove the annotation, move the mouse over it and right-click, then click **Remove Annotation Element** from the popup menu. (The cursor changes into a hand-shaped icon when the mouse is over the annotation.)

#### *Properties*

The following appearance and layout properties of the pointer annotation may be changed in the **Properties** pane:

**Color** – the color of the line and text.

**Text** – the text of the pointer.

**Bound to Axis** – the Y-axis (see the **Y** property, below) to which the annotation is attached, either "left" or "right".

**Chart** – the plot in which the annotation is located. Plots are numbered from top to bottom, starting with "1".

**Text X** – the X-coordinate of the text's insertion point. The number represents the horizontal location in relation to the bottom axis' unit of measurement, such as "seconds".

– the X-coordinate of the line's endpoint. The number represents the horizontal location in relation to the bottom axis' unit of measurement, such as "seconds".

**Text Y** – the Y-coordinate of the text's insertion point. The number represents the vertical location in relation to the left or right axis' (see the **Bound to Axis** property, above) unit of measurement, such as "volts".

– the Y-coordinate of the line's endpoint. The number represents the vertical location in relation to the left or right axis' (see the **Bound to Axis** property, above) unit of measurement, such as "volts".

### X-Axis Annotation

Use this annotation to quickly mark a position on the X-axis.

Click on the **X-Axis Annotation** button, and then click on the graph at the desired location. The X-axis itself doesn't have to be clicked; the annotation will automatically anchor itself at the X coordinate of the cursor when the mouse is clicked.

The words "Axis Annotation" appear on the graph and may be edited in the **Properties** pane along with other properties.

After the annotation has been added, the cursor changes into the **Pointer for Annotation** tool allowing the selection and movement of the annotation.

To remove the annotation, move the mouse over it and right-click, then click **Remove Annotation Element** from the popup menu. (The cursor changes into a hand-shaped icon when the mouse is over the annotation.)

#### *Properties*

The following appearance and layout properties of the X-axis annotation may be changed in the **Properties** pane:

**Color** – the color of the text.

**Text** – the text of the annotation.

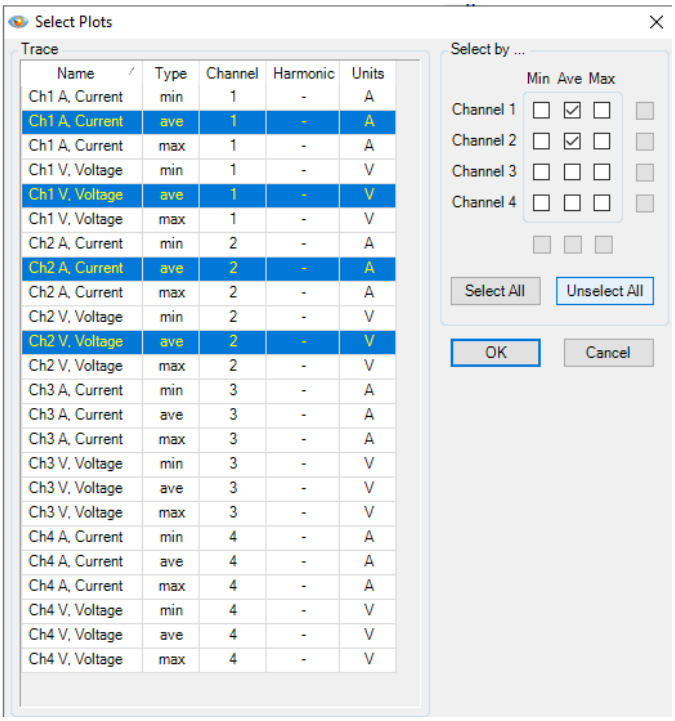
**X** – the X-coordinate of the annotation's anchor point. The number represents the horizontal location in relation to the bottom axis' unit of measurement, such as "seconds".

# Tool Menu

## Select Plots

Plots of a graph may contain many traces of data points. Sometimes the interesting data is hard to see because too much information is in the graph. Therefore, removing the unneeded traces is a good way to emphasize the important data.

To select specific traces of a graph, click on **Tools**, and then click on **Select Plots** to bring up the editing window.




The **Trace** section lists all available traces for the graph and what information they represent.

Highlight each trace in the list to be kept in the graph by clicking anywhere in the trace's row. Hold the **Shift** key down to select a group of traces at the same time by clicking on the first and last trace in the group. Hold the **Ctrl** key down to select multiple traces one at a time.

As each trace is highlighted, the grid on the right is updated accordingly.

The **Select by** section uses a grid for selecting traces by channel or by type (minimum, average and maximum).

Use the buttons at the right of the grid to select traces for an entire channel. Use the buttons on the bottom of the grid to select traces of a particular type. Use the **Select All** and **Unselect All** buttons to quickly select or unselect all traces of the graph.

As traces are selected, checkmarks are placed in the appropriate boxes of the grid. In addition, the list of traces on the left is updated accordingly.

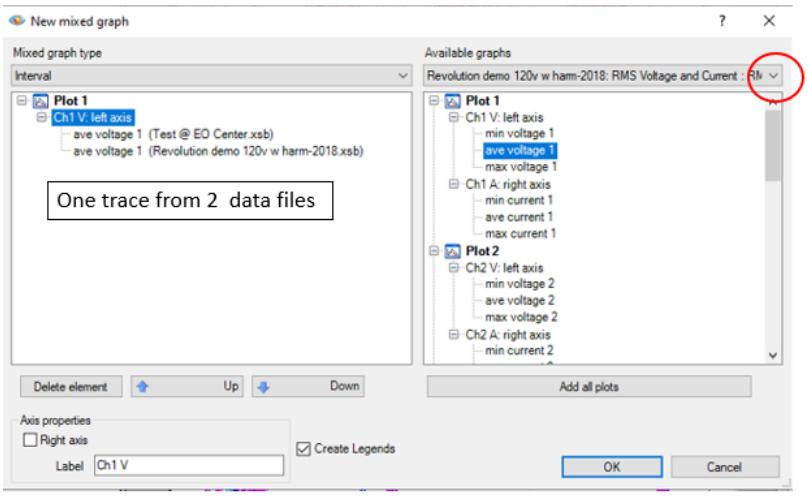
Click **OK** to keep the changes or click **Cancel** to ignore them.

## Trace Mixer Graph or Trace Mixer Template

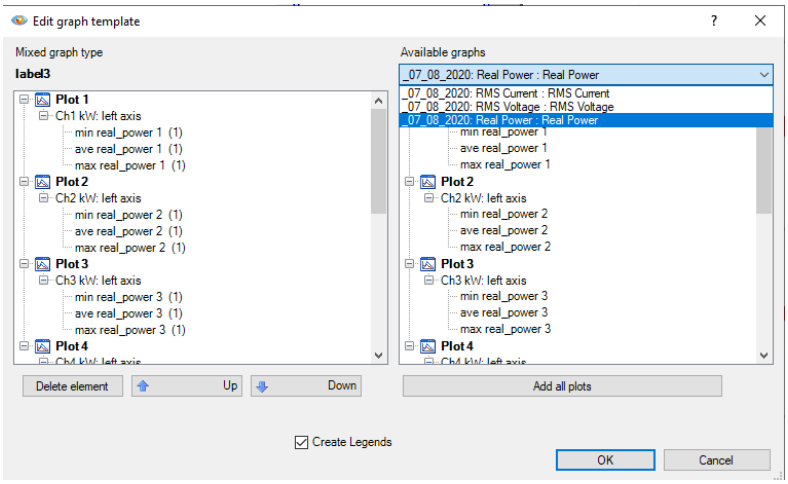
It is sometimes useful to select data from different files and combine them into one graph. The combined graph is called “mixed” since it merges data from more than one source.

Sources can be traces of data from a single data file, or they can be from multiple data files.Open the file(s) (To use multiple files, place a check mark in front of each of the data files) and open the graphs you want to combine.

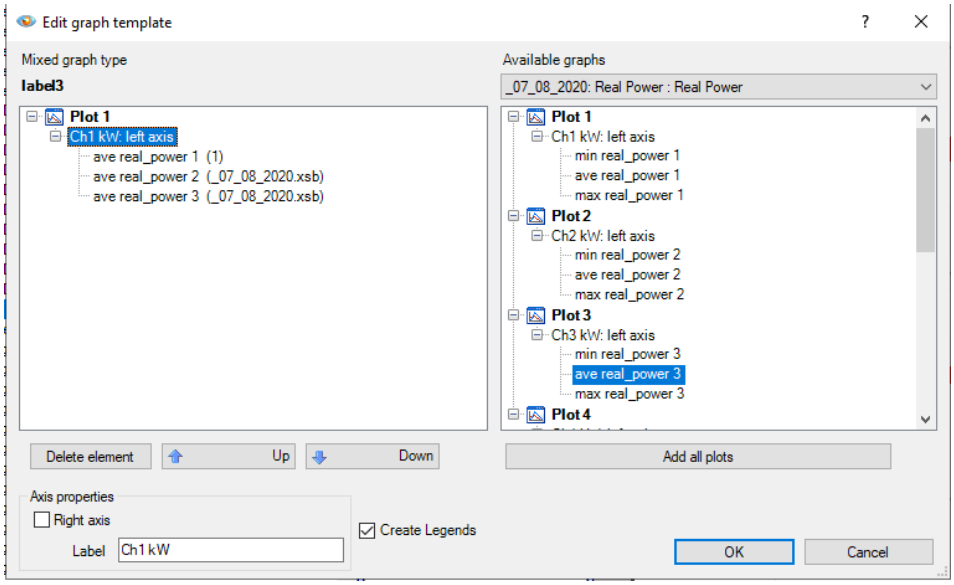
Then select the **Tools** menu, and then click **Trace Mixer Graph** to launch the mixed graph window. Drag a plot from right pane to left pane, select and delete any traces in the left pane, add other plots to the left pane or in the pull-down select the other data file and drag plots or individual traces to the plots in the left pane. Select OK, new mixed graph will display.
You can modify the axis and the color of the traces.




Select **Trace Mixer Template** if you want to combine graphs to create a reusable custom graph (another option is to create a custom graph using the Custom Graph Wizard) Select a file and open the graphs you want to combine.
Name the Template then locate and edit the template under the Graphs and Reports heading in the Explorer pane.

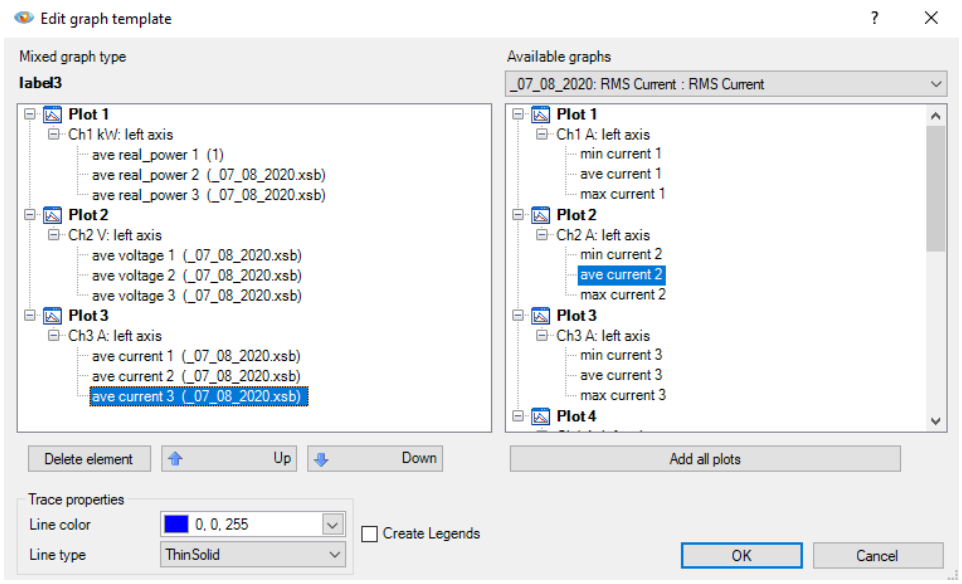



One of the graphs will be transferred to the left pane, modify the left pane as needed.



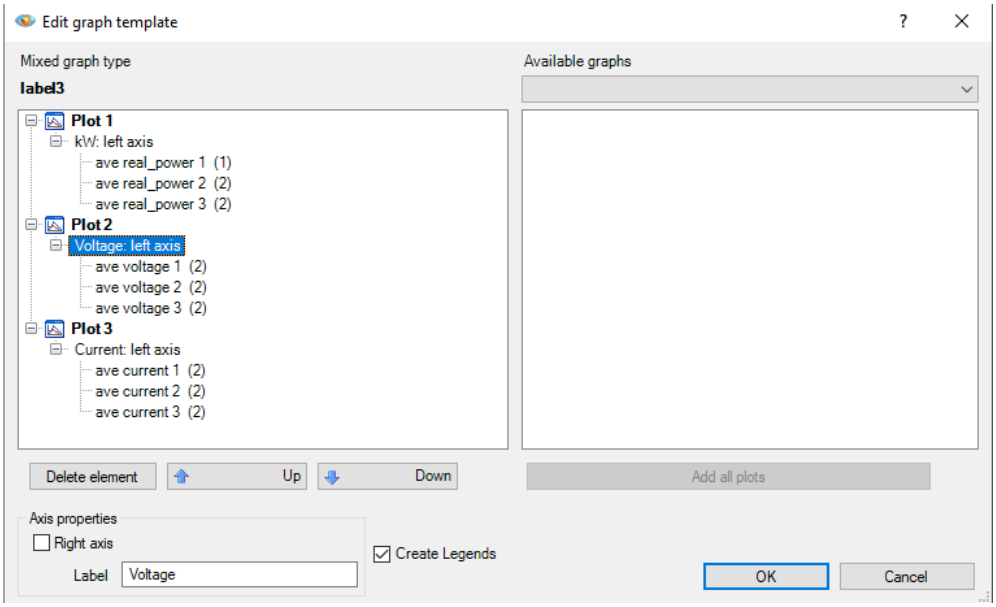

Plots 2,3, and 4 removed, and **ave real power** channels dragged from right pane to Plot 1 on left pane.

Move plots and traces from the right pane to the left pane as needed.

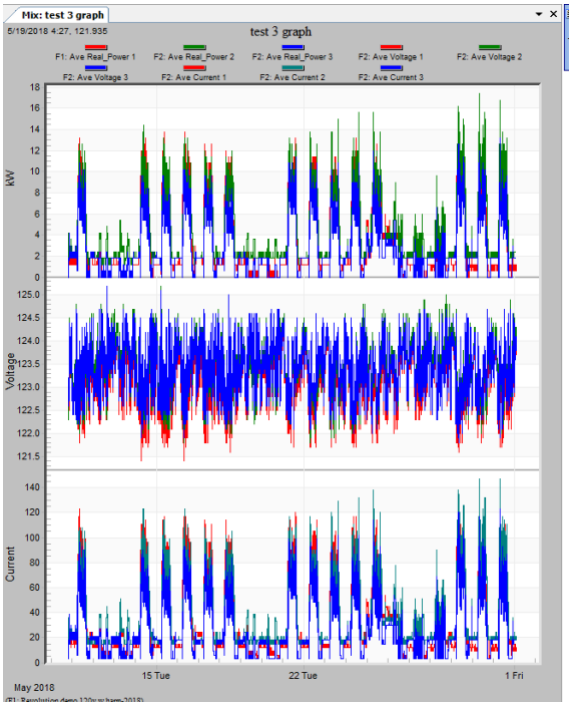



Moved average voltage from right pane Voltage graph to Plot2 on left pane. Moved average current from right pane to Plot3 on left pane. Changed colors to red (ch1), green (ch2) and blue (ch3).

Select OK to save. To use, select the data file and then select the mixed template located under the Custom Graphs heading in the Graph menu.




Closed data files and template, then edited template, changed Labels




Data file using new 3 graph template with Labels

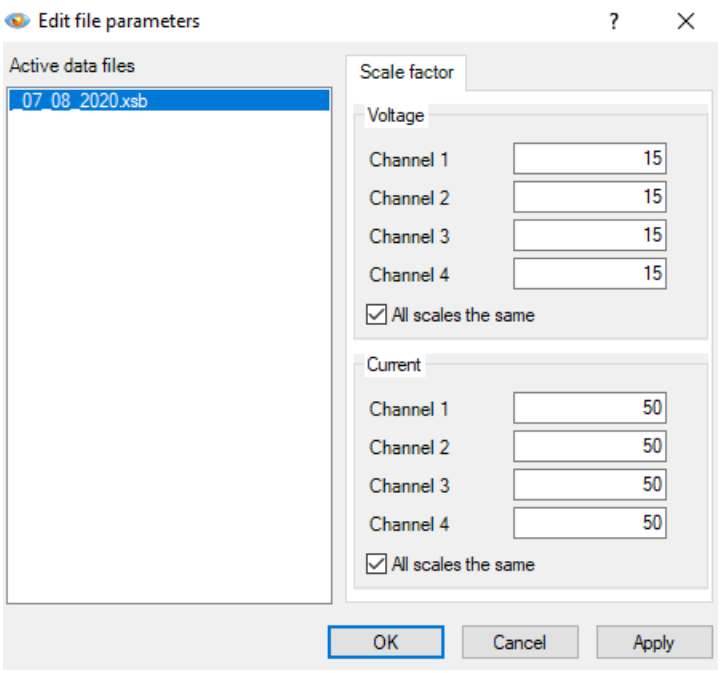
## Scale Factor

When recording on the secondary, Scale Factor can be used to add multipliers to the Voltage and Current of the recorded data to emulate primary voltage and current. Another use of Scale Factor is to correct the direction of the Flex CTs or TLARs. If the Flex CTs or TLARs were installed pointing toward the supply side, entering a -1 in the channel current setting will correct the direction. Another use of Scale Factor is to adjust the Flex CT multiplier. If the Flex Ct was wrapped more than once, a setting of .5, .33, or .25 entered in all the current settings will adjust the x2, x3, or x4 wrapping in the data file.

Changing the scale factor of the data is easily accomplished. Click on the **Tools** menu, and then click **Scale Factor** to open the **Edit File Parameters** window.

Use this window to adjust the scale factor for each channel's voltage and current data for the currently selected data file on the left. If there is more than one active data file, select the data file for which the scale factor is to be changed.

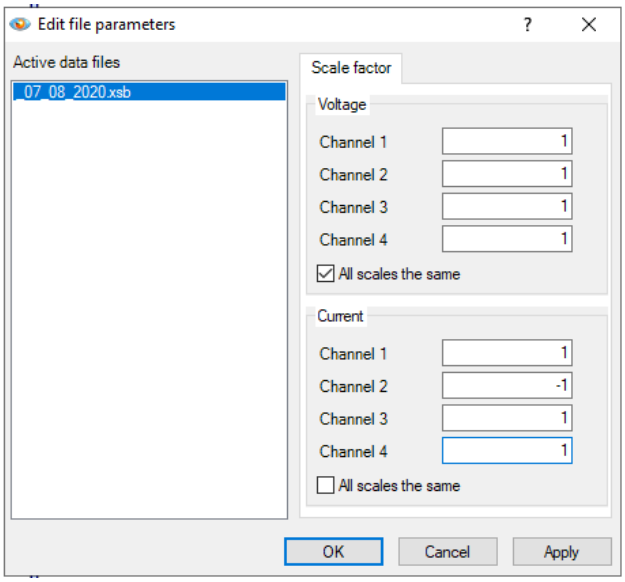
Any changes made to the scale factor are immediately applied to all the reports and graphs for the data file.




Any changes to the Scale Factor will show in the Header Report of the affected data file.

Firmware Version: 5.89 Unit Type: Revolution
Software Version: 1.80.7285 Serial No.: 62897

Circuit Type: Wye
Voltage Scale Factor: x15.00
Current Scale Factor: x50.00
Current Range: 5000 Amps
Interval Time: 1 minute

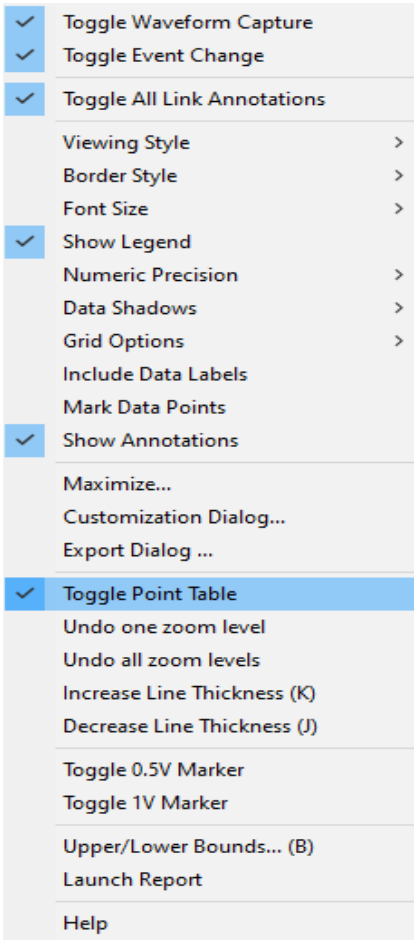



Entering a -1 in Channel 2 will correct a ‘flipped’ FCT or TLAR

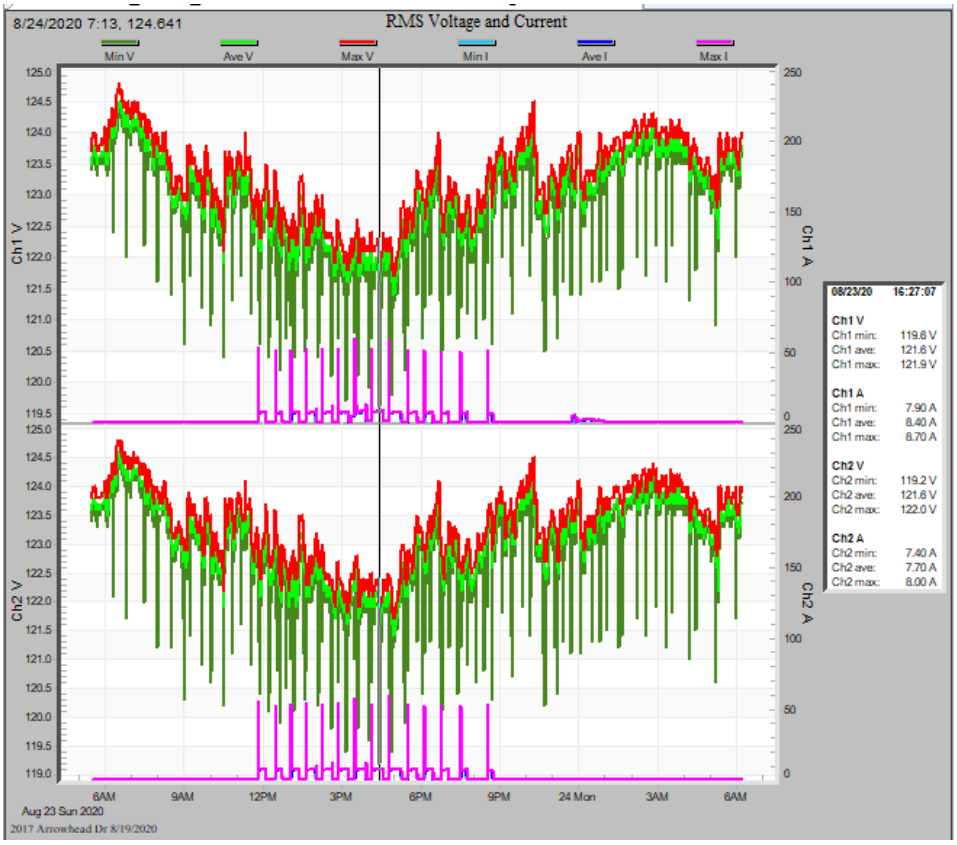
### Using the Toggle Point Table

The point table is a handy reference to view the exact values of a graph at any given point.

To turn the point table on or off, right-click on the graph and then select **Toggle Point Table** from the popup menu.  Alternatively, use the **Alt+T** shortcut key combination if the graph is currently selected.



Right-click in a graph to bring up menu



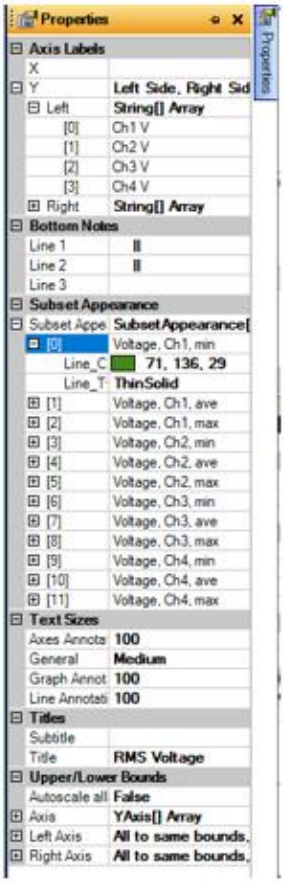

The point table appears to the right of the graph and lists all values of every trace at the current time. The current time is indicated by a black vertical reference line.

To change the time, move the mouse over a trace of data points. When the cursor changes into a hand-shaped icon, click the trace to move the reference line.

## Properties Pane

The Properties pane is located on the right-edge of ProVision. If you are not seeing the Properties pane, select the View menu at the top of Provision and place a check in the Properties box.

All graphs and graph annotations have properties, e.g. the title of the graph, that can be changed as needed. To make these changes easy, the Properties pane displays all available properties in a simple, editable grid:



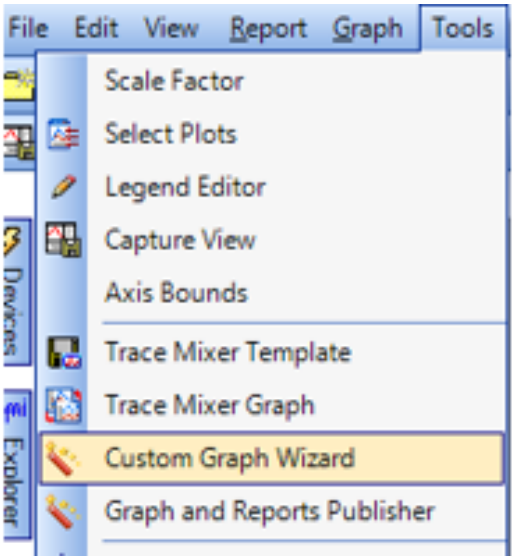

Expanded Graph Properties Pane:
**Property settings apply to the open graph only and does not change data file**

# Custom Graph Wizard

Custom graph templates are easily created by using the custom graph wizard.

The custom graph wizard helps to easily create graph templates that may be used repeatedly to generate custom graphs.

From the **Tools** menu, or by right-clicking on the **Graphs and Reports** folder in **Explorer**, click on **Custom Graph Wizard** to begin.




Use the following steps to complete the wizard.

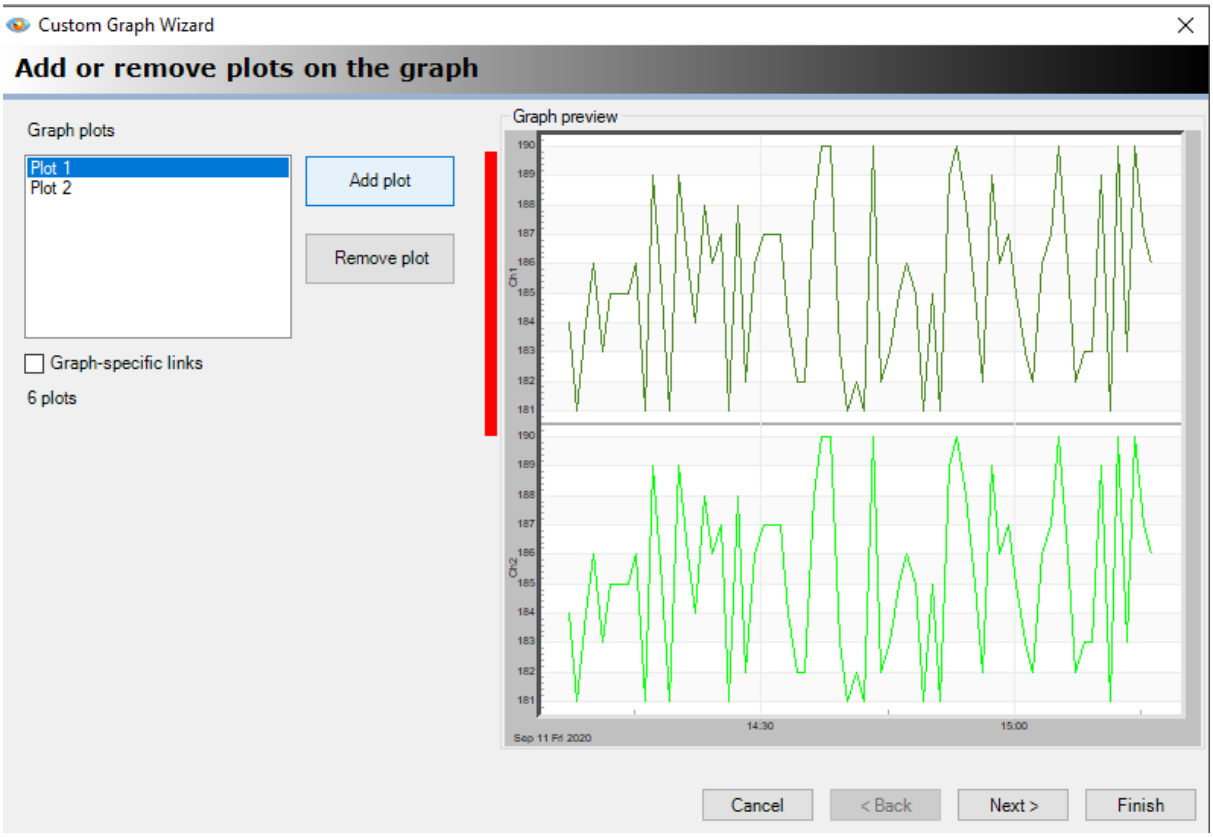
### Add Plots to Graph

Each graph will contain one or more plots on which to display graphical data. Each plot, for example, may represent data from each channel of the recording.

There may have up to 6 plots of data on a custom graph. Add or remove plots as needed using the buttons above.

A preview of the custom graph is on the right and is updated as changes are made. The red, vertical bar shows which plot is currently highlighted.

Click the **Next** button to continue customizing the graph or click **Finish** to complete the changes. Click **Cancel** to end the wizard.



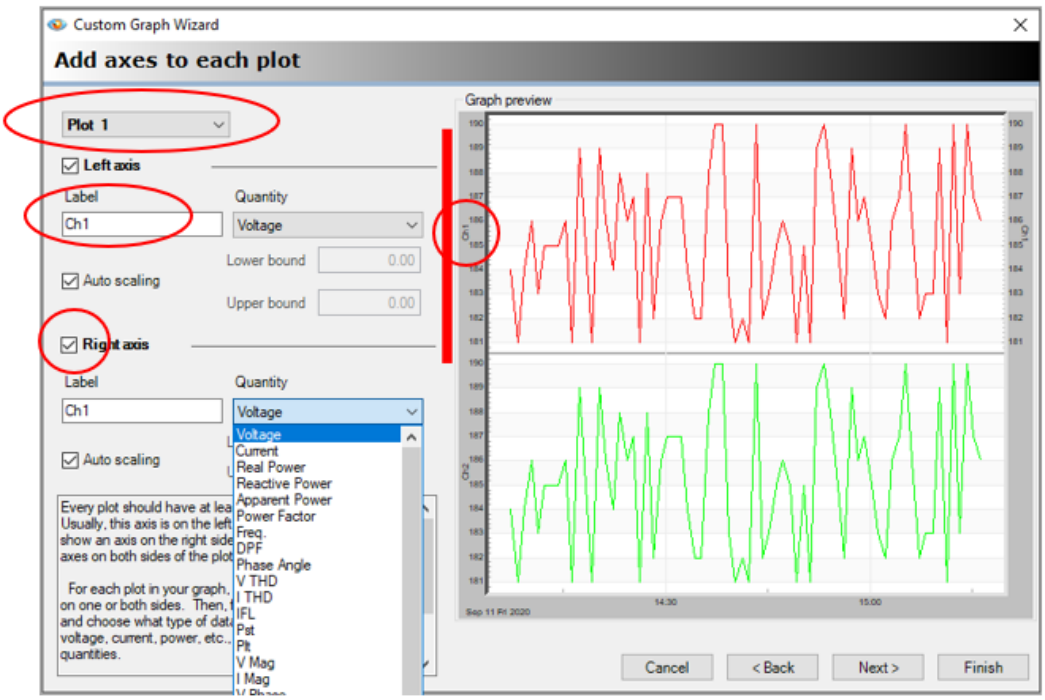
### Add Axes to Plots

Every plot should have at least one vertical, or y-axis, to describe the type of data being displayed. Usually, this axis is on the left, however, it can be shown on an axis on the right side of the graph or even show axes on both sides of the plot to display two types of data.

For each plot in the graph, decide if there is to be an axis on one or both sides. Then, for each axis, give it a name in the **Label** field and choose what kind of data is being displayed, e.g. voltage, current, power, etc., from the list of available quantities in the **Quantity** field.

As the graph is customized, the changes will update the graph preview screen to the right. The red, vertical bar shows which plot is being modified.

Click the **Back** button to return to the previous screen. Click the **Next** button to continue customizing the graph or click **Finish** to complete the changes. Click **Cancel** to end the wizard.




For each plot selected on the first page, modify the label and select what is recorded in that plot. Add a right axis if needed, modify the label and select what is recorded

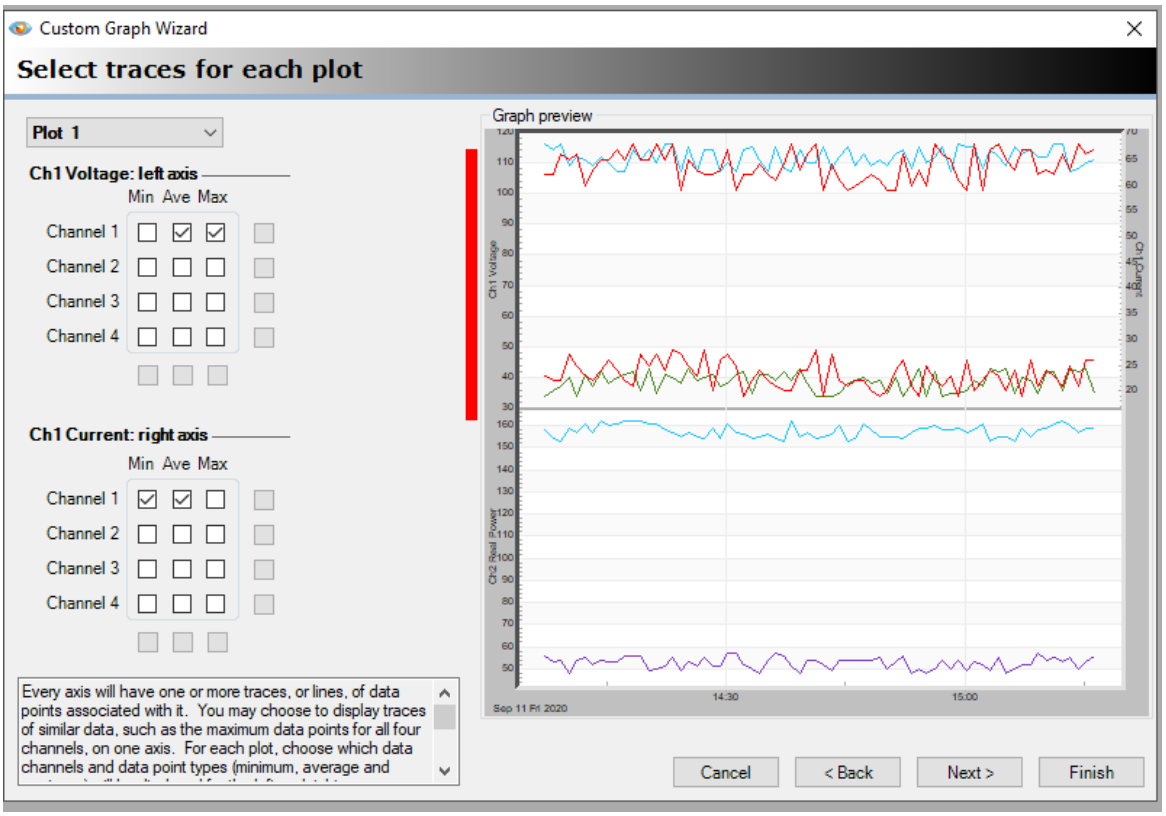
### Adding Traces to Axes

Every axis added to the graph will have one or more traces, or lines, of data points associated with it. Traces of similar data, such as the maximum data points for all four channels, may be displayed on one axis.

For each plot of the graph, choose which data channels and data point types (minimum, average and maximum) will be displayed for the left and right axes, as applicable. Use the square buttons to quickly select or deselect a row of data point types or a column of data channels.

As traces are added or removed, the graph preview on the right is updated accordingly. The red, vertical bar shows which plot is being modified.

Click the **Back** button return to the previous screen. Click the **Next** button to continue customizing the graph or click **Finish** to complete the changes. Click **Cancel** to end the wizard.



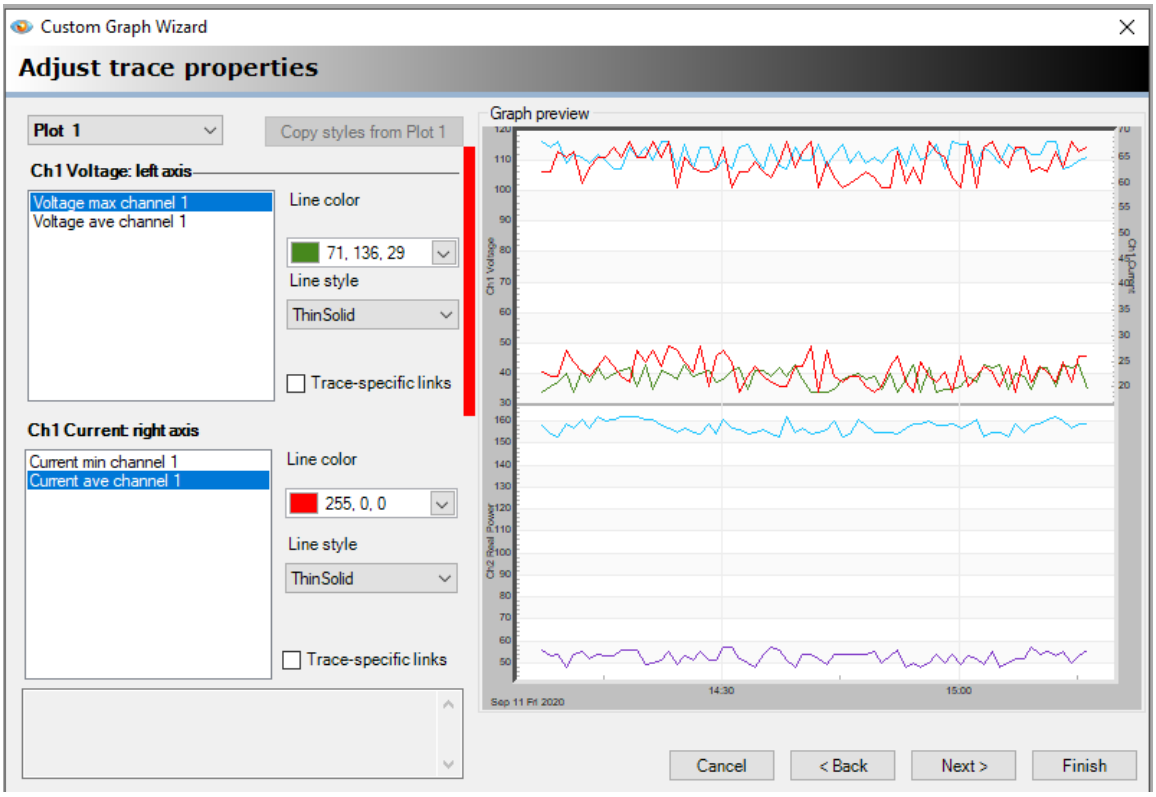
### Trace Properties

Individual traces of data points have customizable properties. The color or the style of each line can be changed to make certain data stand out more than others.

Look at the traces for each plot of the graph and change the line color or line style of the traces as needed.

As the color or style of a line is altered, the graph preview on the right will update to show the changes. The red, vertical bar shows which plot is being modified.

Click the **Back** button return to the previous screen. Click the **Next** button to continue customizing the graph, or click **Finish** to complete the changes. Click **Cancel** to end the wizard.



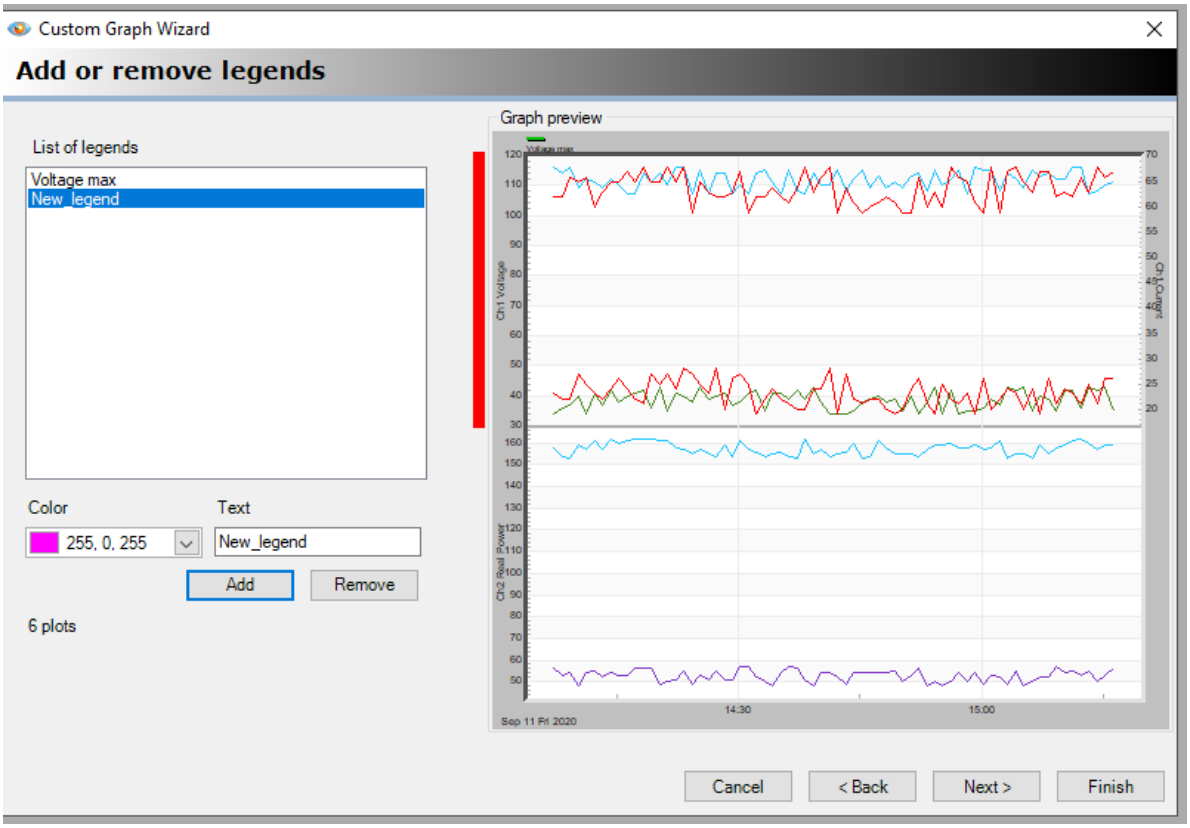
### Add Legends

Legends describe what particular trace color represents, e.g. a red trace may be the maximum voltage for all channels.

Use the list on the left to change the color and text of each legend. Legends may be added or removed, and their properties may be changed, too.

As changes are made to the legends, the graph preview on the right will be updated accordingly.

Click the **Back** button return to the previous screen. Click the **Next** button to continue customizing the graph, or click **Finish** to complete the changes. Click **Cancel** to end the wizard.



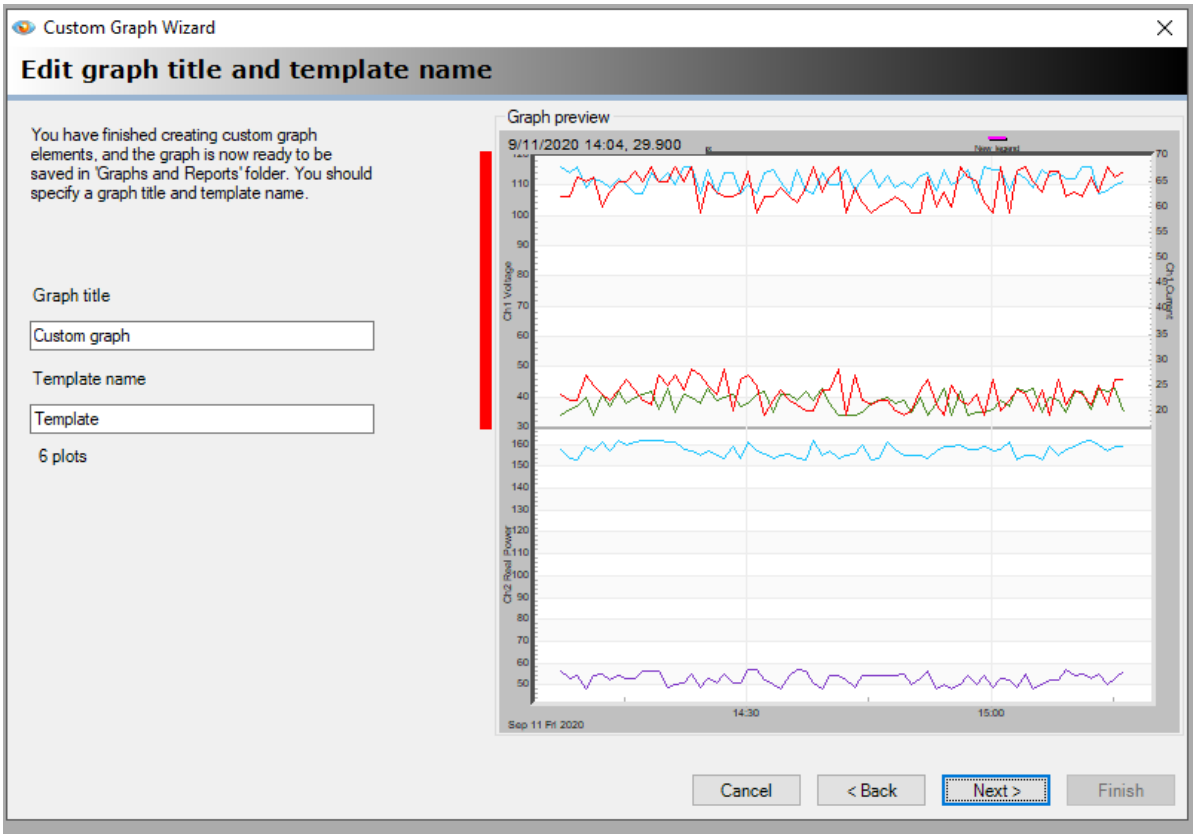
### Graph Title

Give the graph a title which will be displayed at the top. Since the customized graph will be saved as a template for future use, it is necessary to give the template a name, too.

Enter a title to be displayed at the top of the graph. Any changes made to the graph title will be shown in the graph preview on the right.

Also, type a name for the template that will appear in the **Graphs and Reports** folder.

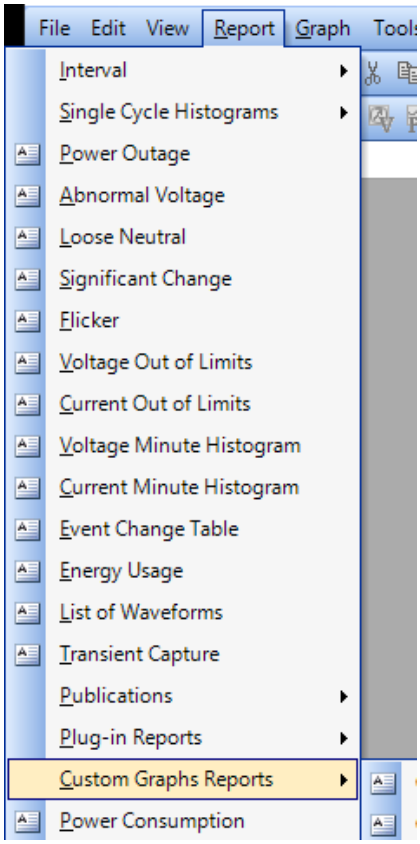
Click the **Back** button return to the previous screen. Click the **Next** button to continue customizing the graph or click **Finish** to complete the changes. Click **Cancel** to end the wizard.



**Wizard Finish**

Congratulations!  A custom graph template has been successfully created.

To locate this template, go to the **Graphs and Reports** folder in **Explorer**. Select a data file and double-click on the template icon to create a custom graph or select the Custom graph under the **Graph** menu – **Custom Graphs**. The report for this new custom graph is located under the **Report** menu – **Custom Graph Reports**




NOTE

Not all files will contain the data requested by the graph template.

Click on the **Finish** button to end the wizard.

# Working with Reports

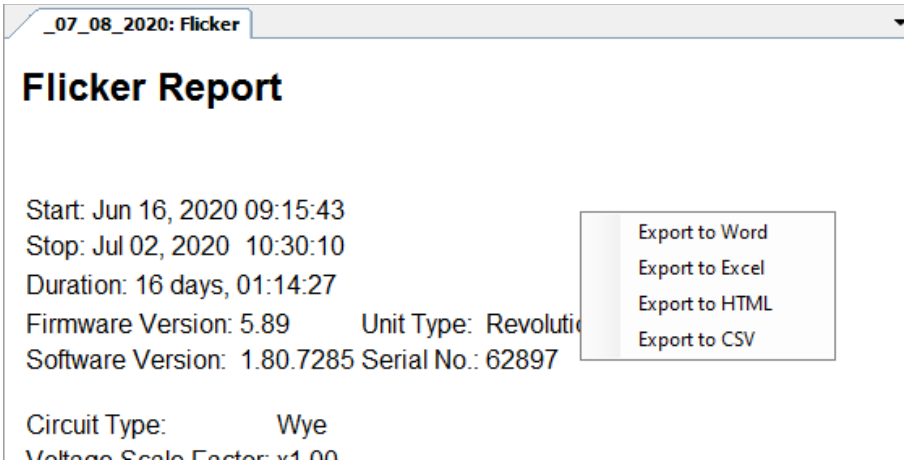
Reports provide a tabular presentation of data from a PQ data file. All reports are listed under the Report menu tab including reports from custom graphs. Reports can also be created from a graph or portion of a graph by right-clicking in a white area and selecting **Launch Report**.

### Exporting Data

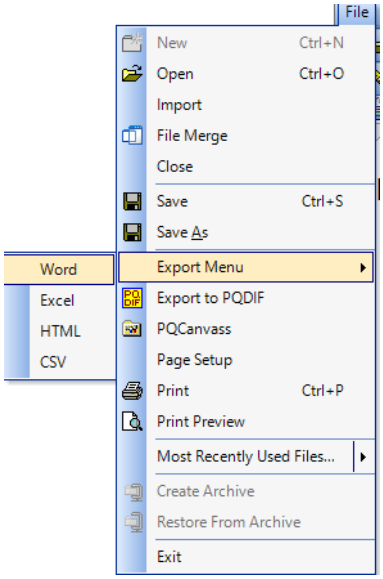
It can be useful to present a report in other applications, such as Microsoft Word or Excel.

In addition, rich-text format (RTF), hypertext markup language (HTML) and comma-separated values (CSV) are also available for export.

To export a report into one of these formats, simply right-click on the report and choose the format from the popup menu. A new window will appear for the appropriate application with the report data. (Applications like Word and Excel are assumed to be installed on the computer.)



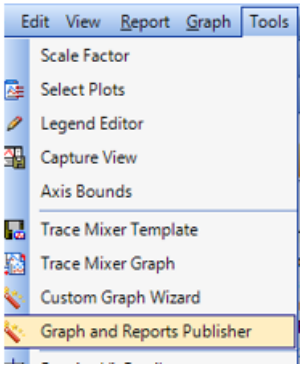
Or open a report and select the **File** Menu and then the **Export Menu**.




### Using the Graph and Report Publisher Wizard

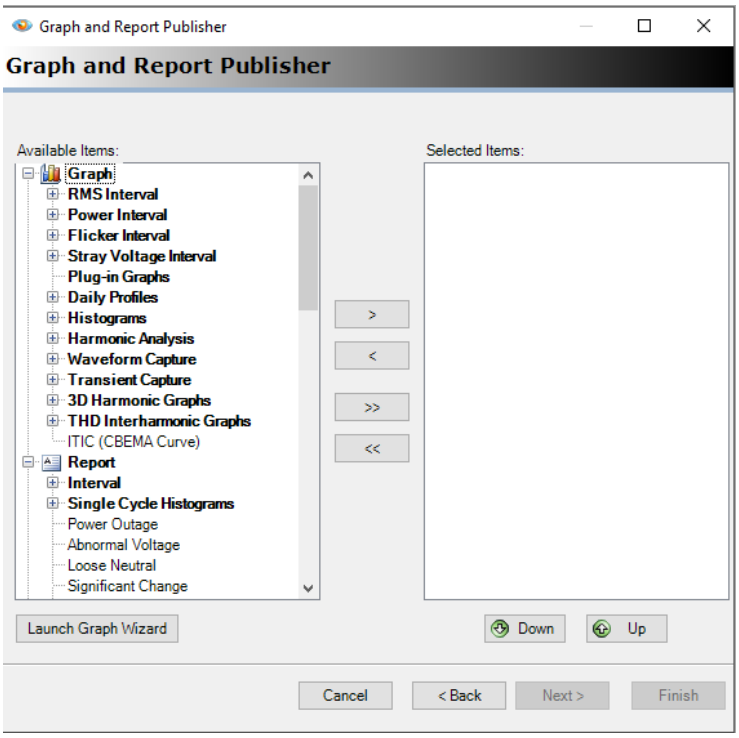
The Graph and Report Publisher wizard easily creates templates that may be used repeatedly to generate custom graphs and reports as RTF documents.

From the **Tools** menu, or by right-clicking on the **Graphs and Reports** folder in **Explorer**, click on **Graph and Report Publisher** to begin.

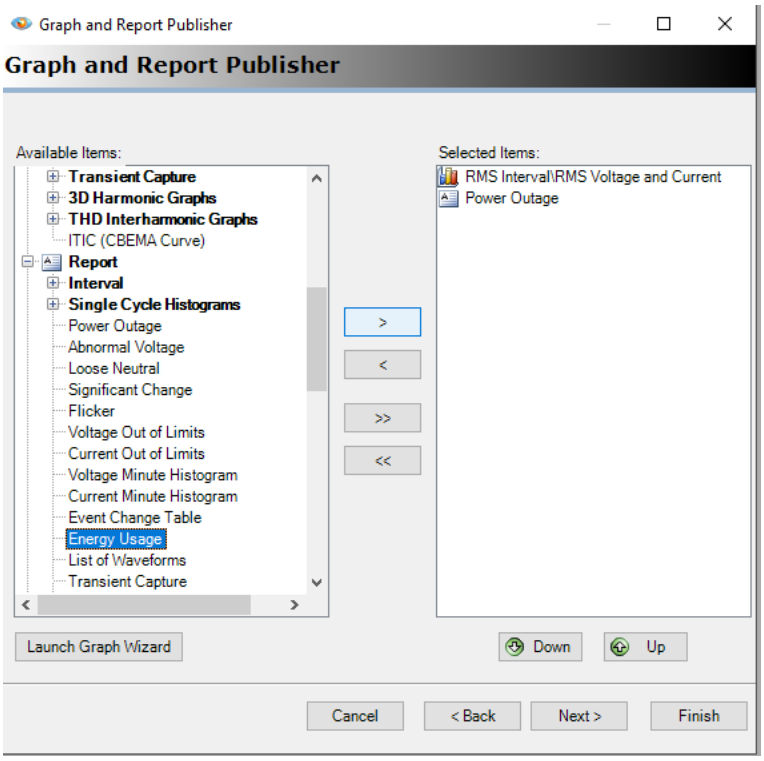


*Choose What to Create*

To generate a custom Graph and Report template, or to generate a custom Graph and Report from a specific data file, select the specific graphs and/or reports from the main screen.



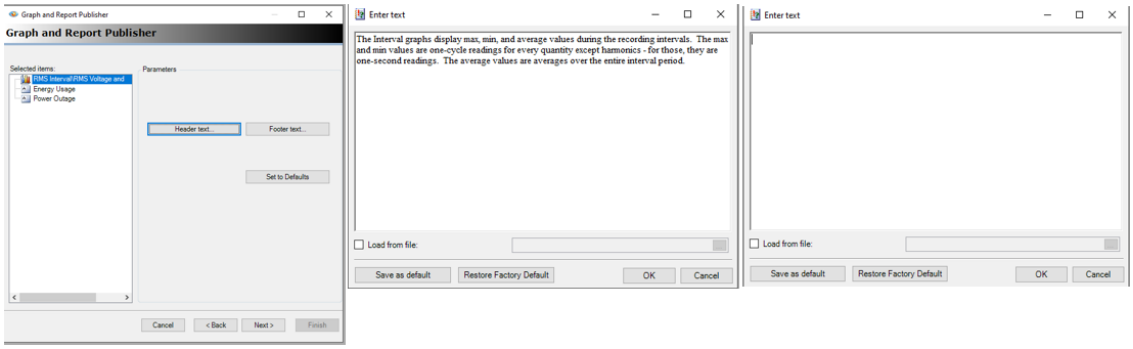

As you highlight them, move them to the right column using the arrow. Use the **Down** and **Up** buttons to arrange the order of selected graphs and reports



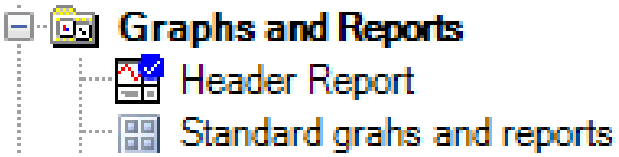
Any custom graphs and reports previously created are listed, or create a new custom graph and report using the **Launch Graph Wizard** button.

*Select the Next button*

The Header and Footer for each select graph or report can be modified. Company logos or pictures can be added.




Name the publication and select Finish. The template will be located in the Explorer pane under the Graphs and Reports heading. Select the data file and select the custom report and graph template, name the file and save the file.



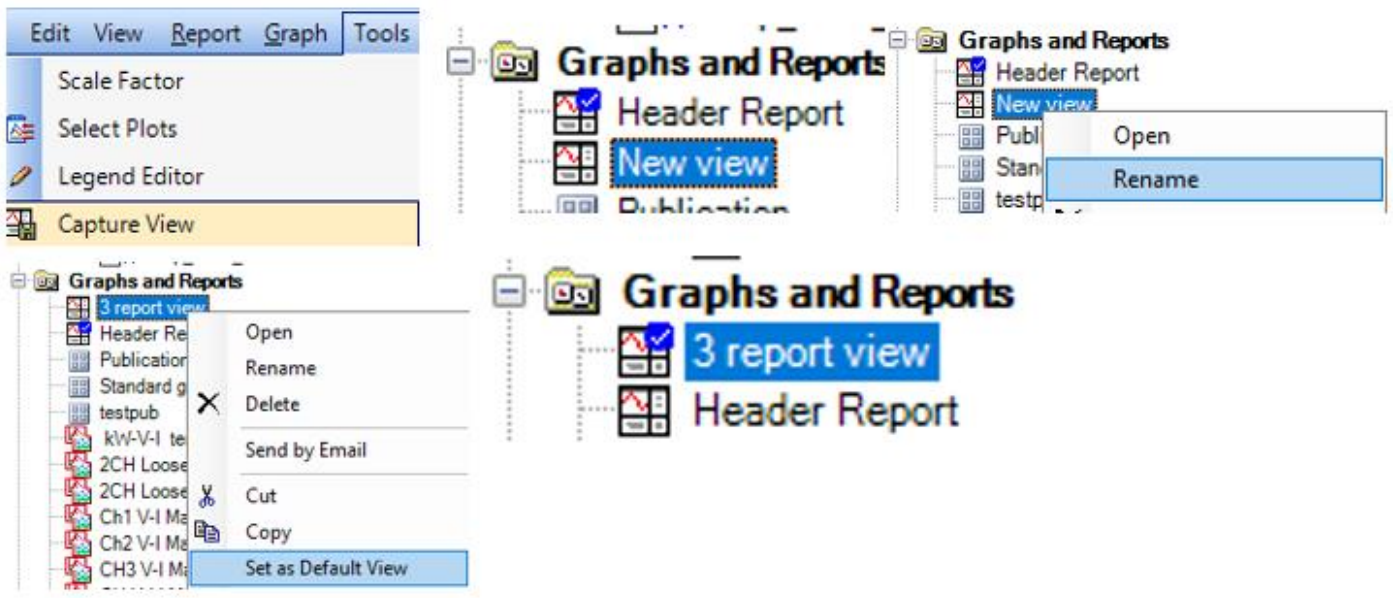
## Working with Views

A view is a template that will create any combination of graphs or reports from an active data file and then arrange them on the screen as they appeared when the view template was first created.

For example, if there were a couple of reports and a graph that were used on a regular basis, they could be arranged on the screen in any way desired, such as having the two reports side by side in the upper half of the window and the graph in the lower half. This arrangement constitutes a view and can be saved for future use on other data files.

The default view provides a template for data files when they are opened. The default view is indicated by a white checkmark on the icon .

To create a view, arrange the graphs and reports on the screen as desired. Click on the **Tools** menu, and then click **Capture View**. A new view icon will be created in the **Graphs and Reports** system folder. Right click on **New View** to rename, then right click and then set as the Default View. (The check mark will move from the default or previous view to the new view).

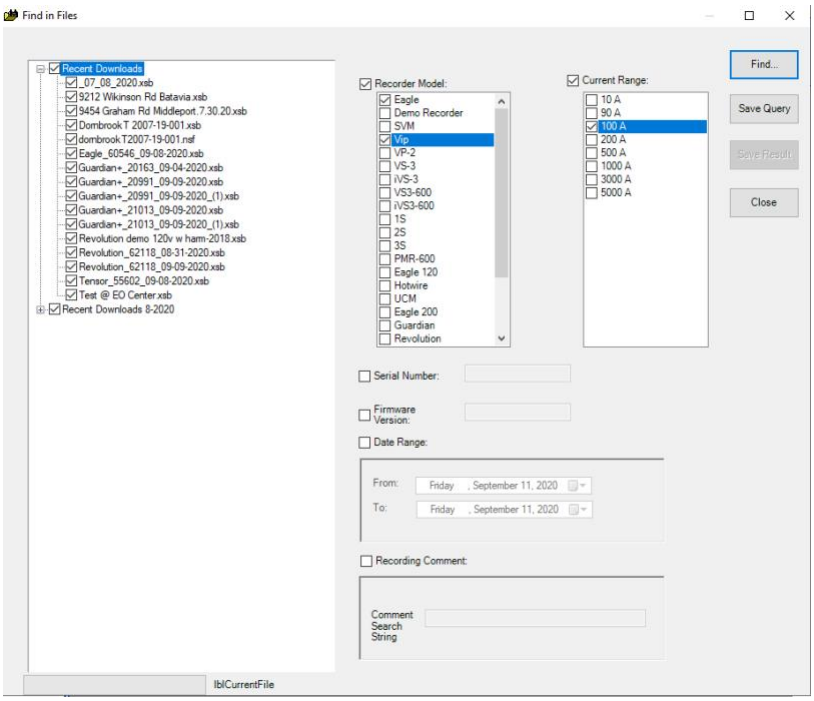



In this example, whenever a data file is opened by double clicking on it, the **3 Report view** will be used, and three reports will open at one time.

## Searching for Data

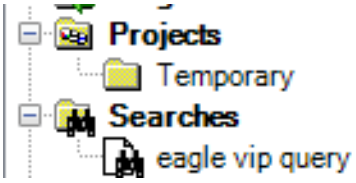
Locating data from hundreds of data files can be a difficult task. Use the **Find in Files** utility to search data files based on specific criteria:

Click on the **Edit** menu, and then click **Find in Files** to launch the search window:




In the example above, the search will look at data files that have recorder models “ViP” and “Eagle”, and use the “100 A” current range. Click the **Find** button to begin the search.

The search criteria can be saved for future use by clicking on the **Save Query** button. Enter a name for the query, which will then be stored in the **Searches** folder.

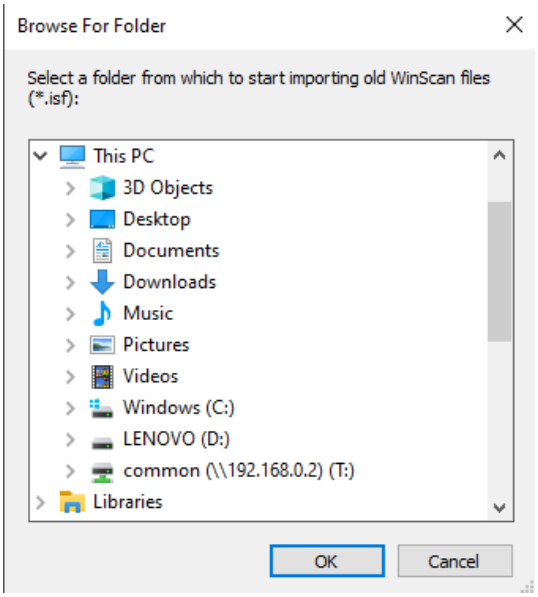



The results of the search can also be saved by clicking on the **Save Result** button. Enter a name to label the results folder in which the found data files will be stored. This new folder will be located within the **Projects** system folder.

## Importing Data Files

Data files that exist on the computer system are easily imported.

Click on the **File** menu, and then click **Import** to browse the system for the location of the data files:

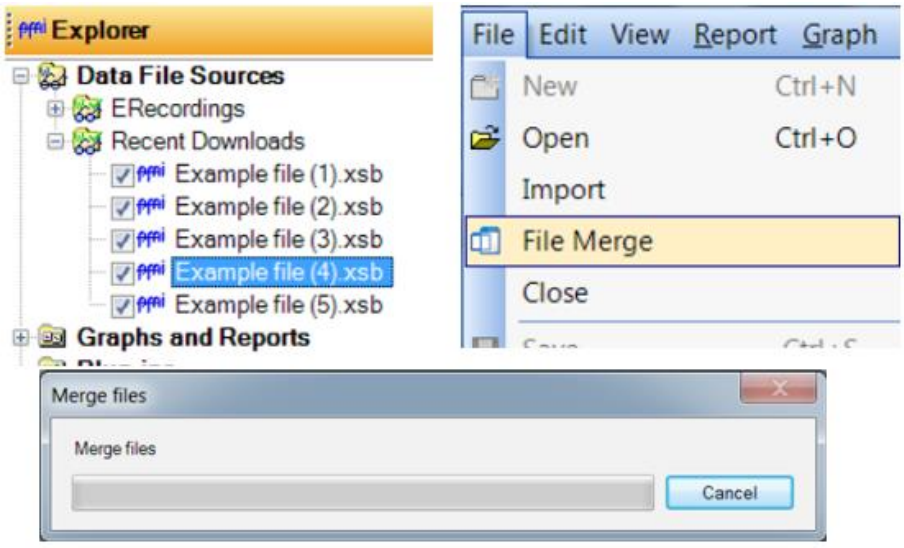



For any location on the computer system chosen, all folders beneath it will be searched for data files, also.

## Merging Data Files

File merge will combine two or more ProVision recordings into a single combined recording. File merging works best when the recordings are from the same device with the same settings. This is intended for files from the same recorder during different time periods, most commonly a “before” and “after” situation. It can also be used to combine multiple files from scheduled periodic downloads.

First select the data files you want to merge by checking the box in front of the data files. Next, open the **File** Menu and select **File Merge**. Name the combined file and open the new file to review the data.
Not all data record types can be merged.



## Viewing Real-Time Data

Real-time data capture is a powerful tool to view PQ data being measured “right now” by a recorder in a graphical and tabular format.

The **Waveform Graph** menu contains several graphs to present an overall view of the circuits being monitored.

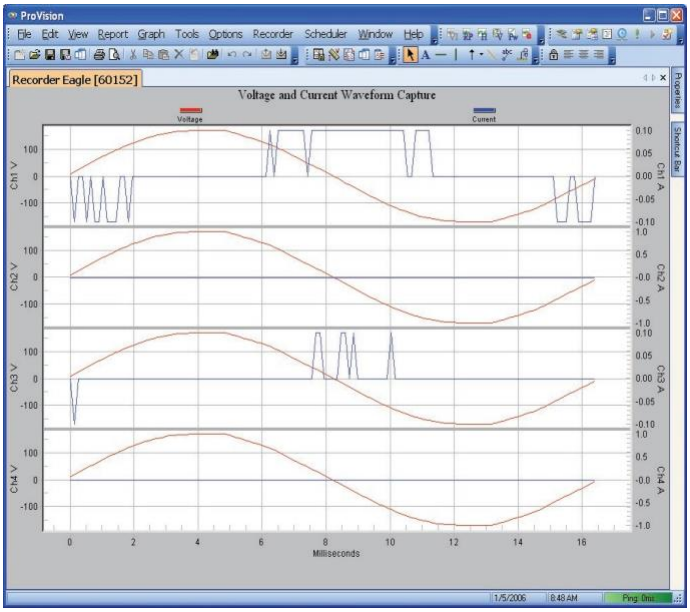
The **Meter Display** menu contains several displays of tabular data to view numerical readings.

### Waveform Graph

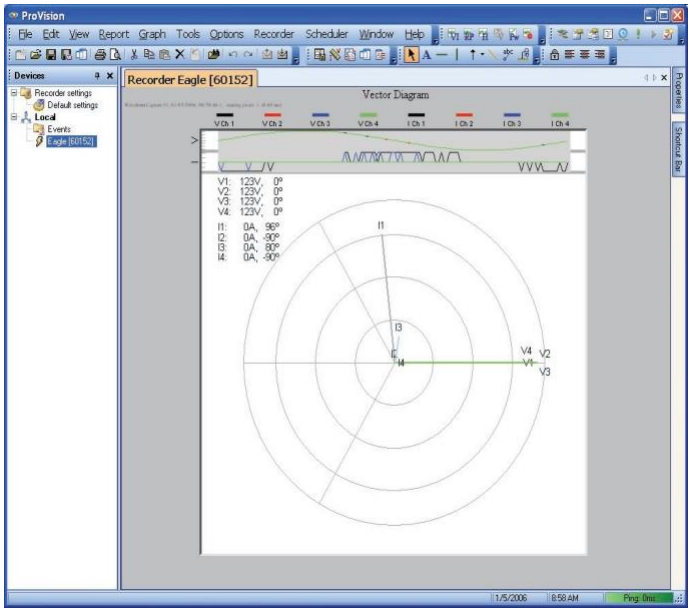
Five graphs are available for displaying real-time data:

- Voltage & Current Waveform
- Real Power Waveform
- Phasor/Vector diagram
- Harmonic Graph (also known as harmonic bar graph or FFT Graph)
- Parametric Waveform

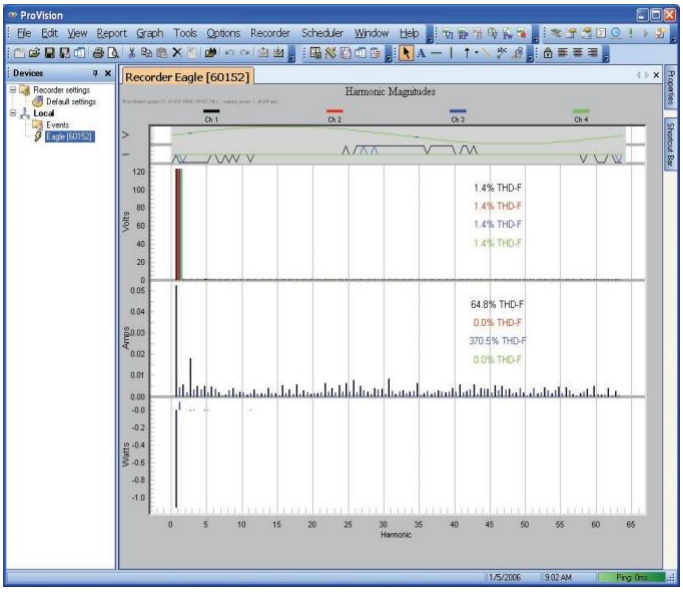
To access these graphs, ensure that the recorder is connected. Next, click on the **Recorder** menu and then click **Waveform Graph** to select one of the graphs.



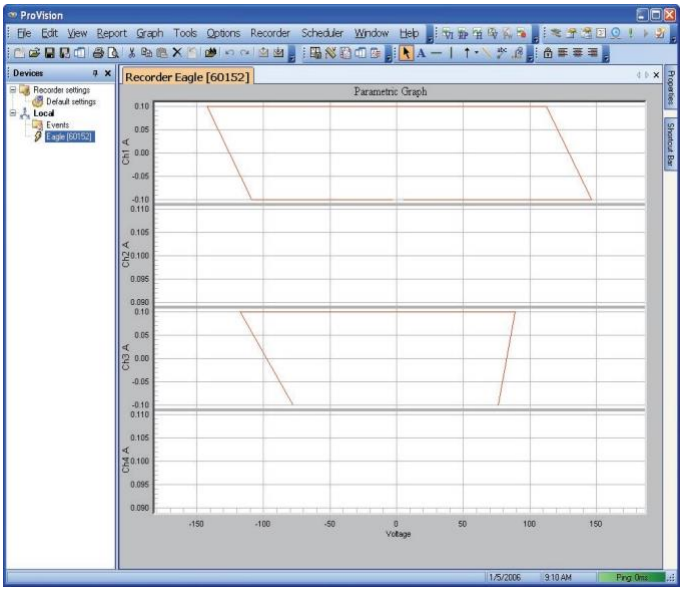

**Real-time Voltage & Current Waveform**




**Phasor/Vector Diagram**




**Harmonic Graph**

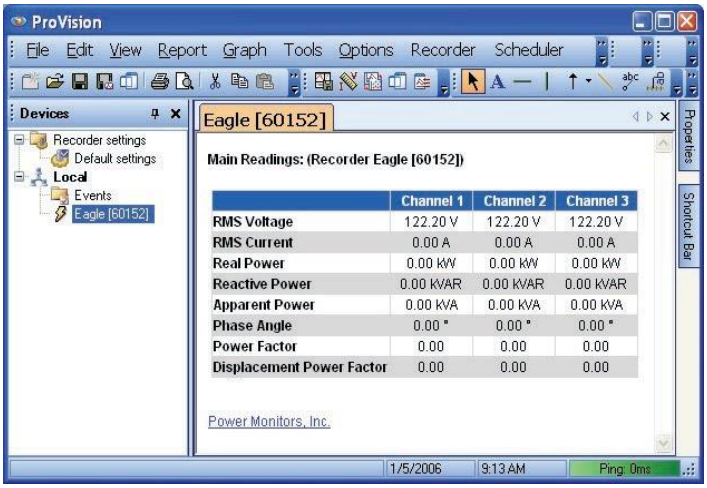



**Parametric Waveform**

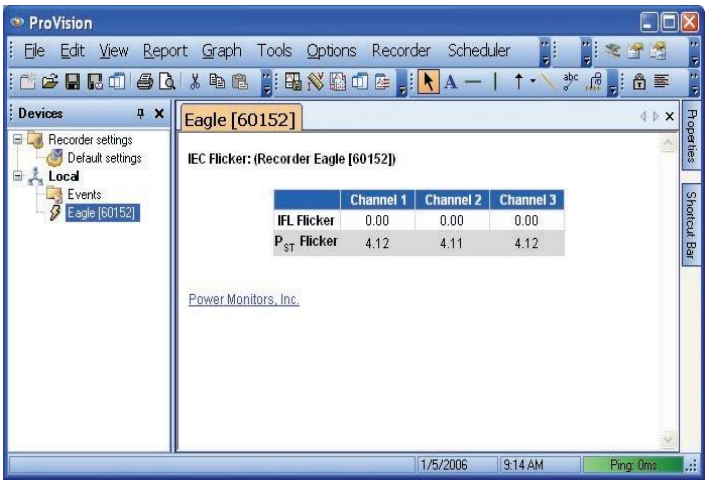
## Meter Display

Five displays of tabular data are available:

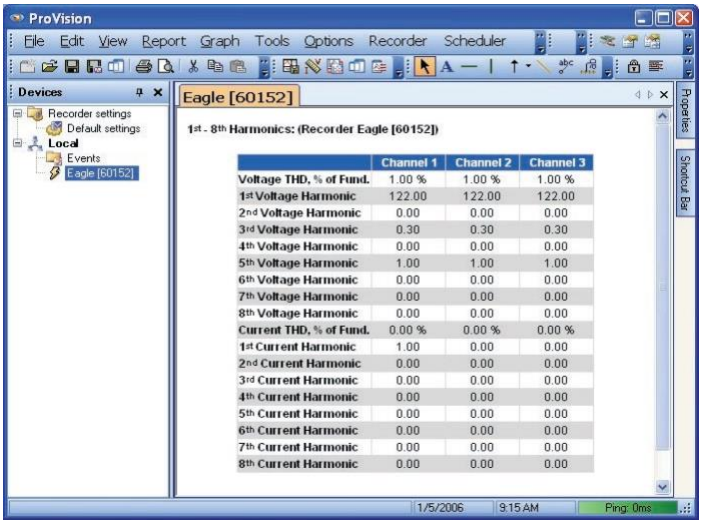
- Main Readings
- IEC Flicker Readings
- Harmonics, 1st – 8th
- Harmonics, 9th – 16th
- Diagnostics



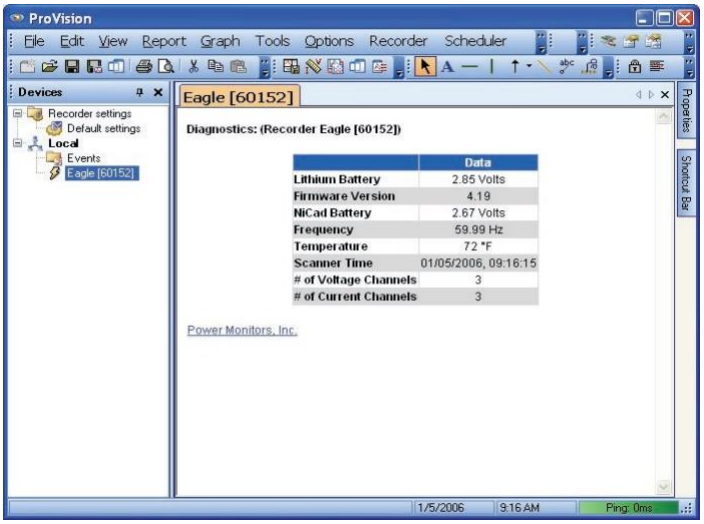

**Main Readings**




**IEC Flicker Reading**s




**Harmonic Readings**




**Diagnostics**

To access these tables, ensure that the recorder is connected and powered. Next, click on the **Recorder** menu and then click **Meter Display**.

Note

Not all PMI recorders are able to display real-time data. For real-time enabled recorders, the **Waveform Graph** and **Meter Display** menus will be enabled and available.

## Archiving Data

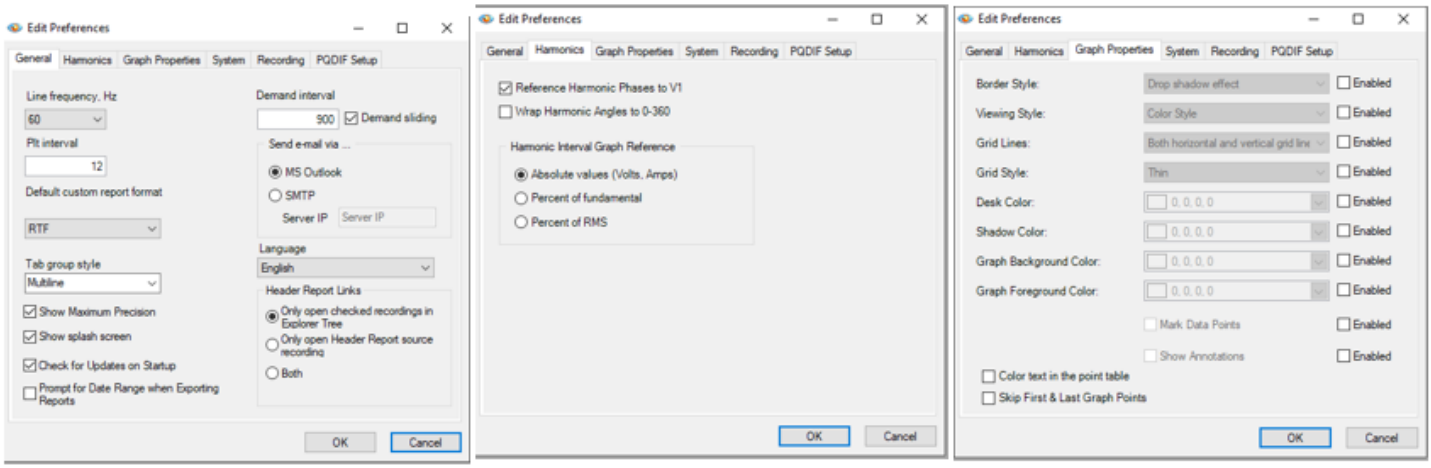
It may be necessary to remove old PQ data from the system. To do so, use the archiving feature to store project data files to any location. All archived data is fully recoverable.

To archive data, right click on the project folder to be archived, and then click **Create Archive** from the popup menu. Follow the wizard screens to complete the task.

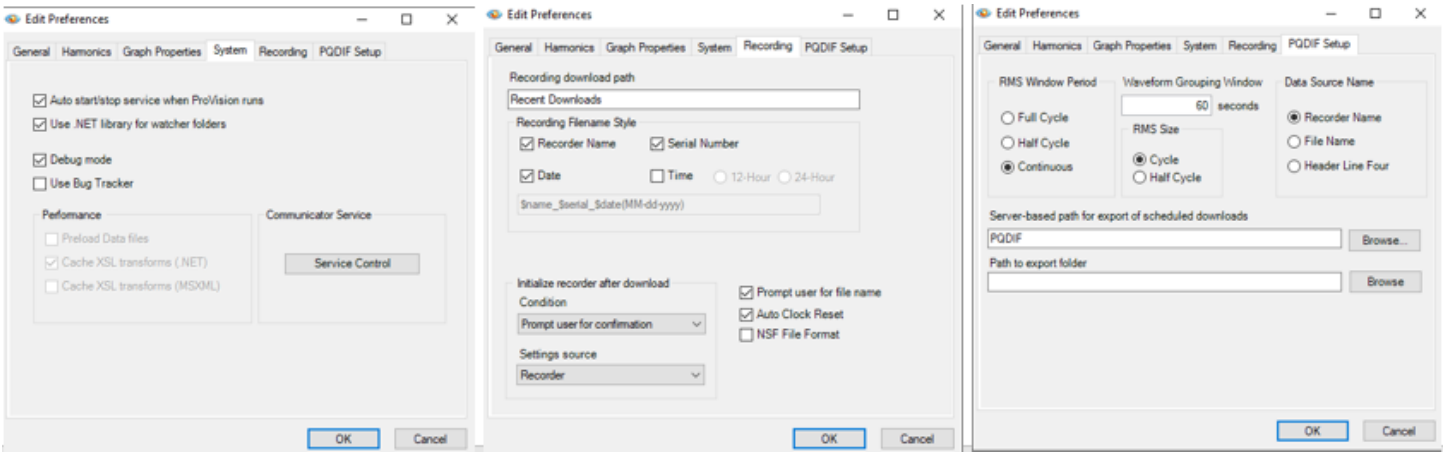
To restore an archive, right-click on the **Projects** system folder, and then click **Restore Archive** from the popup menu. Then, browse to the location of the archive.

## Preferences

In the Options menu choose **Preferences** to set selections which remain when ProVision is re-opened.
In the **General** settings, turn off the **Check for Updates**, or elect not to see the **Splash Screen**. **Demand Interval** can also be adjusted from the default 15 minutes/900 seconds.
In **Graph** Properties, choose to **Skip First and Last Graph Points**.



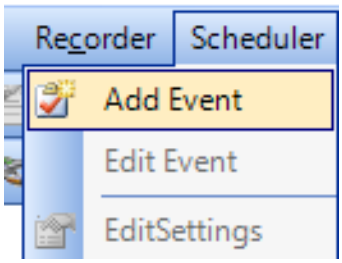

In **Recording** Preferences adjust the default file naming convention or add a 12 hour time to the default name. You can choose to save the data file using the new **NFS file format**.



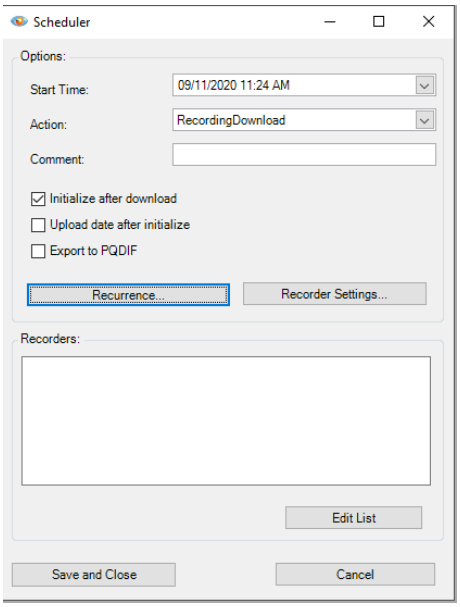
## Scheduling Events

Events are useful to perform automated recorder operations at a specified time.
Note: To use the Scheduler, the ProVision Communicator service will need to be installed when installing ProVision.

Click on the **Scheduler** menu, and then click **Add Event**.




The **Scheduler** window appears for creating a scheduled event with any number of recorders:




### Start Time

Select the date and time to begin the event.

### Action

Select one of two event types: Recording Download or Settings Upload.

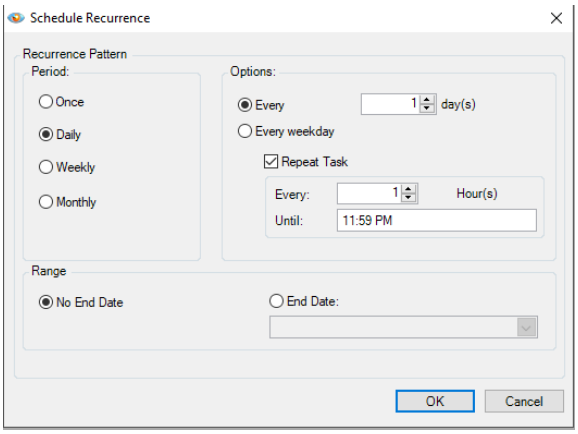
- **Recording Download** will automatically download a PQ data recording from the recorder.
- **Settings Upload** will automatically upload recorder settings to the recorder.

### Comment

Provide a comment to uniquely describe the event.

### Recurrence

Specify how often the scheduled action occurs

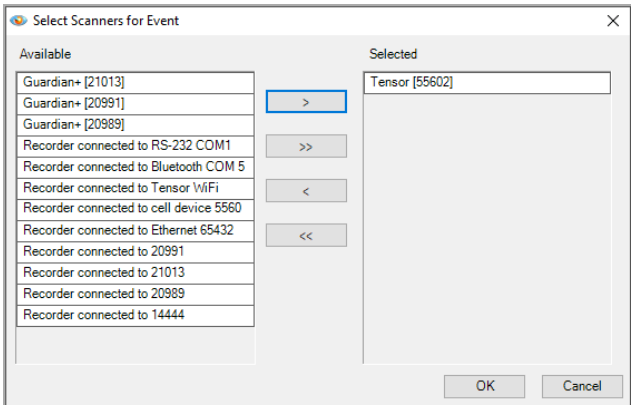



### Recorder Setting

Configure an initialization template to use

### Edit List

The list of recorders to be included in the event.




### Save and Close

Stores the event and closes the window. The newly created event may be viewed and edited from the **Events** system folder in the **Devices** pane:

# Types of Records

PMI recorders can record many different kinds of power quality data during a recording session.

### Interval Records

The interval record is one of the most useful record types. In a single interval graph, power quality events can be seen such as single-cycle voltage sags and current surges, as well as long term voltage trends. With the graph, an entire recording session can be examined at a glance.

*What's Recorded*

The only setting for the interval record is the Recording Interval. This Interval, which can be as small as one second to as large as four hours, determines how often the Recorder takes a data point. Every interval record the Recorder is recording uses the same Interval setting. During the Interval period, the Recorder keeps a history of the largest and smallest one-cycle values for each interval record, as well as a running average. At the end of the Interval, the max, min, and average values for that time period are recorded as a data point. For example, if the Recording Interval is set to one minute (a typical setting), at the end of each minute, the Voltage Interval Record will record the average RMS voltage, the minimum one-cycle RMS voltage, and the maximum one-cycle RMS voltage, all during that minute. All of the 3,600 60Hz cycles during that minute are used to calculate the average, and for max/min detection.

These values are presented to the user as three traces on a graph: a maximum, a minimum, and an average. The average trace roughly corresponds to a graph from a paper stripchart recorder. The maximum and minimum graphs are unique, however. Each gives the worst-case value for every Interval, with single-cycle measurement resolution.

Each Recorder has at least enough memory to record interval records for a week with a one-minute Interval. When the interval record data fills the interval record memory, the Recorder has two options: it can either stop recording interval records or go into "wrap-around" mode. In "wrap-around" mode, the oldest data points are erased to make room for the new ones as they are collected, which allows the Recorder to always have the latest data. This choice is made by the user during the Initialization. If the **Interval Graph Overwrite (Circular)** box is checked, the Recorder will go into "wrap-around" mode as needed, otherwise it will stop recording when memory is full. This does not affect other record types. For example, if there is memory for one week of interval records, and the Recorder was left in the field for three weeks, it would either have the first or the last week's interval record data, depending on the wrap-around setting.

Every Recorder can record an interval record of voltage. Some Recorders can also record an interval record of current.The ViP can also record interval records for real, reactive, and apparent power, power factor, phase angle, THD, and harmonics. The ViP, with harmonics, can record over 200 interval records at once. Typically, only a few are needed at one time. All the interval records share the same memory, so enabling more interval records reduces the total interval record recording time.

When creating an interval graph or report, any "gaps" in the data due to a power outage are filled with zeroes. This happens when the Recorder loses power, and its rechargeable battery (if present) runs down.

***Typical Settings and Suggested Uses***

There are three settings for the interval record types. The primary setting is the Recording Interval. This time setting determines how often the data is recorded. Since the recordings always give worst case one-cycle max

and min values, the Interval can be set to any time value without a loss of measurement resolution. For example, even if the Recording Interval is set to 15 minutes, the maximum and minimum one-cycle RMS values for each 15-minute period are recorded. What is lost by setting the Interval to larger values is time information. If there is a voltage minimum of 90 volts RMS during a recording interval, with the Interval set to 15 minutes, it's certain that the voltage dipped that low for at least a cycle, but it's not known when or how often or how long during those 15 minutes it happened. A smaller Interval, such as one minute, provides a finer time resolution. The smallest Interval, one second, gives excellent time resolution, but consumes memory 60 times faster than a one-minute setting. Often, the exact time of a voltage dip is not as important as the size -- for this case, any reasonable Interval setting is fine.

The most common setting is one minute. This is a good balance between frequent data collection and long recording time. Since most loads that start and stop usually run for longer than a minute, the start and stop effects (such as in-rush current) are easily spotted in the Recording. An example is an air conditioner load: a forty minute period of cycling on and off is obvious in the interval graph as twenty data points at one load current, then twenty data points at low current, all connected by straight lines on the graph. The first interval of the high current period will probably have a much larger current maximum than the rest due to the starting current of the air conditioner. The voltage interval will probably have a dip at the same time.

The most frequent reason to use an Interval smaller than one minute is for large loads that cycle on and off more frequently than one minute. For example, if an elevator is causing power quality problems, and it only takes 10 or 20 seconds to start at one floor and stop at another, a one second Interval is probably necessary; otherwise the entire elevator travel will occur during a single Recording Interval. In this case, the Recorder should not be left to record for days, since it would only hold the last few hours of Interval data. The best use in this case is to set the Recording Interval to one second, then cycle the load (such as the elevator) for a while, in an attempt to reproduce the problem, and then download the Recorder. In general, the Interval should be smaller than the quickest cycling time of a problem load.

The most frequent reason to use an Interval larger than one minute is to increase the recording time. Setting the Interval to two minutes doubles the recording time, without a serious loss of time resolution. Other common settings are five and fifteen minutes, used to match metering or billing increments or regulatory time periods.

The second interval recording setting is the Interval Graph Overwrite mode. The best setting for this depends on how the Recorder will be used. Some users leave a Recorder at a problem site until the customer calls with a power quality complaint. The Recorder is set to a small Interval such as one minute or thirty seconds and Overwrite is enabled. Because Overwrite is enabled, the interval records always have the latest few days of data in memory, by discarding the old data. The Recorder is downloaded and has the most recent days of interval data in memory, no matter how long it was recording. This recent data will have the voltage disturbance in it. Other users will disable Overwrite and leave a Recorder at a problem site where the power quality problem will definitely occur soon. The Recorder will record the first week or so of interval record data, then stop recording. The Recorder can be downloaded at any time later, knowing that the beginning of the recording session is locked in memory, and will not be overwritten. Other users always download the Recorder before it fills up interval record memory, which makes the Overwrite setting irrelevant. The choice depends on how the Recorder will be used. The factory default setting is for Overwrite to be enabled.

The third interval record setting is which interval records are enabled. For voltage-only Recorders, there is no choice: a voltage interval record is always recorded. For Recorders that can record current, the current interval record can be turned off to extend the recording time of the voltage interval record. It is usually better to increase the Interval time instead of disabling current to get more recording time. For the ViP Recorder, there are many more interval records to enable or disable. The choice depends on what information is needed. If a power factor study is being performed, for example, turn on power factor, and possibly apparent power and

displacement power factor. If a power quality problem is present, only voltage and current may be necessary, although adding Total Harmonic Distortion (THD) may be useful to see if harmonics are present. The total recording time is shown by ProVision® as interval records are enabled and disabled during the Recorder setup. Another method to increase interval record memory is to reduce the number of recorded channels. If only three channels are needed on the ViP, changing the number of channels from four to three gives 25% more recording time.

For quantities such as power factor, phase angle, THD, etc., often the average is much more important than the one-cycle max and mins. The max and min traces on the graph may be turned off so that they don't obscure the average trace.

**Daily Profile Records**

The Daily Profiles are used to spot daily trends in voltage, current, power factor, etc. The entire recording session is combined to form the "average" 24-hour day, which is plotted on a graph like a strip chart. Power quality issues are usually not addressed with Daily Profiles (except perhaps consistently low or high line voltage or harmonic distortion). Rather, average line conditions such as regulation voltage, load current, etc. are profiled.

*What's Recorded*

Each measured quantity has only one Daily Profile per channel in a recording session. For example, there are four voltage Daily Profiles in a recording session, one per channel. The Profile is averaged over the entire recording session. This average is created by dividing the 24hour day into 96 time periods, each 15 minutes long. During each 15-minute period, the Recorder computes the average value for that Profile (voltage, current, etc.). This 15-minute average is then averaged with all the previous days' averages of that 15-minute period. For example, the first Voltage Daily Profile data point is the average voltage during the 15-minute period from 12:00am to 12:15am, averaged again over the entire recording time. If a Recorder is recording for a week, then this 12:00-12:15am period is averaged seven times over the entire week.

There are no settings for Daily Profiles. All available Daily Profiles in a Recorder are always enabled, regardless of the settings for any other record types. Memory does not run out for a Daily Profile; it just keeps averaging as long as the recording session lasts (there is a practical limit of about a year). Some Recorders record just a voltage Profile, others voltage and current. The ViP Recorder records a Profile for voltage, current, real, reactive and apparent power, power factor, displacement power factor, voltage and current THD, and phase angle.

*Suggested Uses*

Daily Profiles are typically used to profile or characterize a parameter, such as average load current or power factor. Since the Profile is supposed to re reflect average line conditions, the more loads included in the recording, the better the average. Monitoring a single small load such as a small office building would not create a very good profile of distribution line conditions (such as distribution line power factor), since the building would be a small part of the total distribution load. Voltage is somewhat of an exception in that anywhere can be a good place to create a profile: every other load (at least those nearby) will see the same distribution line voltage. The ideal location for creating power factor profiles is where a PFC would be placed to correct power factor.

The voltage Daily Profile is normally used to identify voltage regulation problems, or other steady-state low/high voltage issues. The current Profile can be used to identify daily trends in load current. This is also

possible with the apparent power Profile. Power factor and reactive power Profiles can be used to set PFC timers to correct for power factor only when necessary during the day. The voltage and current THD Profiles show when harmonic distortion is present during the day.

The more days the Recorder records, the better the average created by the Profile. A recording session that just lasts a single day doesn't incorporate any daily averaging at all. Since a Profile starts with all zeros, a recording session that doesn't even last 24 hours will include some 15-minute blocks with the data still zeroed. A recording session that does not even last 15 minutes will have all zeroes for a Daily Profile.

An interval recording can also be used for profiling tasks but is not ideal. The recording interval is usually set to an interval faster than 15 minutes; a fast interval can show too much information, making it hard to form a good average Profile. Often the interval recording only has enough memory for a week or two, limiting the averaging time; the Daily Profiles have no such limit. Most importantly, the interval recording does not divide the data into an averaged day period, so it can be difficult to spot daily trends in the graph.

### Cycle Histogram Records

The cycle histograms contain valuable power quality information as well as information for distribution line profiling. Questions such as "what was the absolute highest and lowest RMS voltage?", "how many cycles was the voltage below 80 volts?", and "what are the most common load currents?" are easily answered. The histograms also contain the raw data necessary to answer more complicated statistical questions such as "what is the probability of a voltage sag below 100 volts?" and "what high and low limits does the line voltage meet 99.99% of the time?" Where the Daily Profiles give average current, power factor, etc. for distribution profiling, the histograms show what values are the most common -- the "mode" in statistical terms.

*What's Recorded*

A Histogram divides a measurement range into many bins. For example, in the ViP, the voltage Histogram divides the 600V voltage range into 600 bins, each one volt wide, giving a bin for zero volts, a bin for one volt, two volts, all the way to 600 volts. After each 60Hz cycle is measured, the voltage is rounded to the nearest volt and "put" in the appropriate bin. The bins are really counters that count how many cycles were at that voltage. If the 108 volt bin has a count of 45, then there have been 45 cycles with an RMS voltage of exactly 108 volts, sometime during the recording session. The Histogram throws away time information: those 45 cycles could have occurred anytime during the recording session. They may have been 45 cycles in a row, or three 15-cycle sags, or 45 isolated sags spread out during the entire recording session. (To recover the time information, use the interval graph or an event-based report.)

Every interval graph max and min value will have a non-zero count in the corresponding Histogram. For example, if the voltage interval graph shows six sags to 108 volts sometime during the recording session, there should be a count of at least six in the Histogram at 108 volts. The count will probably be somewhat larger, unless each sag was only one cycle long.

There are no settings for Histograms. All available Histograms in a Recorder are always enabled, regardless of the settings for any other record types. Memory does not run out for a Histogram; it just keeps classifying measurements into the bins (by incrementing the bin counters) as long as the recording session lasts.

The 600V (iVS-3/600), the S-series (VS-1S and iVS-1S), and the ViP record a voltage cycle Histogram for each voltage channel. The ViP also records cycle Histograms of current, real, reactive, and apparent power, power factor, displacement power factor, and phase angle.

*Suggested Uses*

The power of the Histogram is that *every cycle* is included in the report. Every cycle during the recording session is reflected in the count of one of the bins. If all the counts in a Histogram are totaled, the result is how many cycles the recording session lasted (minus any time under a power outage).

Histograms are presented as a bar graph and a report. The report is in some ways easier to read than the graph. The absolute highest and lowest voltages during the recording session are found by finding the highest and lowest bins with a non-zero count. At that point it's known how many cycles the voltage was at those extremes, and by glancing at the nearby bins, it's also known how many cycles the voltage was near those extremes. For example, if all the bins below 110 volts are zero, then it's immediately known that there was not even a single cycle of voltage below 110 volts anytime during the recording session. If the count at 111 volts is 1,352,200, then the voltage was at 111 volts for over 6 hours (1,352,200 = (60 X 60 X 60)). By totaling the counts for all the bins in a voltage range (for example, 0 to 90 volts), it's known how many cycles the voltage was in that range.

More complicated power quality questions can be answered by exporting the histogram data to a spreadsheet. By dividing each count by the total of all the counts, the histogram data is normalized, and can represent a sample probability distribution function. If a normal, or bell-shaped probability distribution is fit to this data, a standard deviation is created that can be used to answer "what high and low limits does the line voltage meet 99.99% of the time?". A cumulative sum over the data will convert the distribution function into a sample cumulative probability function. Correlations between channels can be performed by comparing the probability functions of channels.

For the voltage histogram, most of the time the user is interested in the few cycles that are outside certain limits, not the vast majority of cycles that are perfectly normal. These few cycles usually represent power quality issues. The current, power, and power factor histograms are useful for distribution line or load profiling. For these histograms, the few cycles at the extremes are usually unimportant: the vast majority in the middle is the good data.

**Minute Histogram Records**

The Minute Histogram provides a much "smoother" version of the Cycle Histogram. Quick sags and swells are averaged out of the data, to show the nominal voltage or current level every minute. Voltage regulation problems are easy to see in the Minute Histogram.

*What's Recorded*

The Minute Histogram is similar to the Cycle Histogram. During each minute of the recording session, the voltage is averaged (every cycle is included). At the end of the minute, the Histogram bin counter for that average value is incremented. The result is a Histogram of one-minute average voltages, instead of one cycle voltages. For example, if the voltage were 123 volts for 55 seconds, then 115 volts for 5 seconds, the average would be 122 volts, and the 122 volt bin counter would be incremented. If the recording interval is also set to one minute, then the Interval graph voltage averages will match the Minute Histogram counts.

Like the Cycle Histograms, there are no settings for the Minute Histogram. All available Minute Histograms in a Recorder are always recorded, regardless of the settings for any other record types. Memory does not run out for a Minute Histogram; it just keeps classifying measurements into the bins (by incrementing the bin counters) as long as the recording session lasts. All Recorders record a voltage Minute Histogram. Recorders that can measure current also record a current Minute Histogram.

*Suggested Uses*

The voltage Minute Histogram can reveal voltage regulation problems. Ideally, the line voltage should be at the same value every minute. The larger the spread in the Minute Histogram, the more the voltage is varying. The center of the spread is (hopefully) the target regulation voltage. This information is also present to an extent in the voltage Interval graph, depending on the recording interval and amount of memory. Because the Interval graph spreads out the voltage averages as a time graph, it can be more difficult to gauge how long the voltage was at certain levels (although it may be easier to see *why* the voltage was moving).

The Minute Histogram is also better for this analysis because it does not run out of memory and is always set for one minute averaging.

The current Minute Histogram shows average load current on a minute basis. The maximum and average load currents are easily spotted on the Histogram as the edge and the center of the current spread. Again, this information is usually in the current Interval graph, but not as easy to see.

The cycle Histograms can also be used for voltage regulation problems and load profiling, but the Minute Histograms can be easier to read since the fast one-cycle events have been averaged out.

## Energy Usage Records

The Energy Usage report shows the accumulated real, reactive, and apparent power measured by the Recorder. The accumulated real power is energy, in kilowatt-hours. The accumulated reactive and apparent powers are kilovar-hours and kilovolt-amp-hours, respectively. These totals are for the entire recording session and are only available on Recorders which can compute power.

*What's Recorded*

Each cycle, the real, reactive, and apparent power values are computed and added to the running totals for the recording session. These values include the effects of voltage and current harmonics. The accumulated powers are totaled separately for each channel for a wye hookup. With a delta hookup, the individual phase powers cannot be measured, only the total. In this case, the three-phase total real, reactive, and apparent power values are totaled and reported.

Negative power values are included in the accumulation. For example, if a load is both absorbing and generating power (at different times, of course), the accumulated power will reflect it. A line that varies from leading to lagging power factor may have a small accumulated reactive power reading, even though at different times the actual reactive power flow was large. This would happen if the negative VARs accumulated during the periods of leading power factor mostly cancelled the positive VARs during the periods of lagging power factor.

*Typical Settings and Suggested Uses*

There are no settings for the Energy Usage report. This report can be used to measure energy consumption of a monitored load or accumulated reactive power in power factor studies. A revenue meter that doesn't total negative power, or doesn't include the effects of harmonics, may show readings that differ from this report.

## Significant Change Records

The Significant Change record type tracks quick fluctuations in the line voltage, with single cycle response, while ignoring gradual changes. Voltage events are time stamped to the second and listed in a report. If the

report is empty, there were no voltage events that exceeded the trigger threshold. This is a quick way to gauge the voltage power quality, because only voltage fluctuations exceeding the threshold are listed.

*Trigger Logic*

The Significant Change record type uses a voltage threshold parameter. At the end of each second during the recording session, the largest and smallest RMS voltages for that second are compared with the "standard" Significant Change voltage. This standard voltage starts as the nominal voltage picked by the Recorder during the two-minute countdown (typically 120, 208, 240, 277, or 480 volts). If the difference between the standard voltage and either the maximum or minimum voltage was more than the threshold, a Significant Change is recorded. In addition, the voltage (either the max or min) that caused the trigger becomes the new "standard" until the *next* Significant Change.

As an example, consider a "standard" voltage of 119 volts, and a threshold of 2 volts. After 40 seconds, the voltage drops to 118 volts. No Significant Change is recorded because the 1 volt change is smaller than the 2 volt threshold. After another 35 seconds the voltage increases to 120 volts. The change is 2 volts, from 118 to 120, but no Significant Change occurs because 120 volts is only 1 volt greater than the "standard" of 119. After another 23 seconds the voltage increases to 121 volts. A Significant Change is triggered because the 1 volt increase created a 2 volt difference between the 121 maximum voltage for that second, and the 119 volt standard. The standard voltage is now set to 121 volts, until the next Significant Change.

Only one Significant Change per second can be recorded per channel. If both the single-cycle max and min meet the threshold in the same second, the voltage that is furthest from the standard becomes the new standard.

*What's Recorded*

When a Significant Change is triggered, the triggering voltage is recorded, along with a date and timestamp (to the second), and the channel number.

Significant Change is recorded separately for each voltage channel (although they share the same voltage threshold parameter). If Significant Change memory is filled, Significant Change recording stops. All voltage channels use the same Significant Change memory. The amount of memory used for Significant Change is different for various Recorders, but every Recorder can record hundreds, and most over one thousand records.

On most Recorders, Significant Change is always enabled for recording. On some older Recorders, enabling Flicker recording disables Significant Change recording. This is true for the VP-1, and 300 volts Recorders (the VS-3, VS-1, VS-1M, iVS-3, iVS-1, and iVS-1M) with serial numbers below 6000.

*Typical Settings and Suggested Uses*

The default setting for the Significant Change threshold is 3 volts. This setting can be as small as 1 volt or as large as 8 volts. Normally, a threshold between 2 and 5 volts is appropriate, depending on the nominal voltage. A single-cycle disturbance such as a sag will trigger Significant Change if the sag is greater than the threshold. If this happens, the sag voltage becomes the standard, which will trigger another Significant Change if the voltage returns its previous level.

The Significant Change report is very useful for determining how often, and to what degree the line voltage is fluctuating. If there are no Significant Change records, then there were no fluctuations greater than the threshold. A Significant Change record can be correlated with the Interval record by using its timestamp. Find the same time period in the Interval record to see what the voltage and current were before and after. This may give some indication of the cause of the disturbance. All Significant Change records during a recording interval

will be included in a single Interval record max/min/average data point. For example, if the interval is one minute, and six Significant Changes occur within one minute, they may all fall into the same Interval record data point. (Of course, they are still reported individually in the Significant Change report). The Significant Change report provides more detail than the Interval record for these disturbances.

A key advantage of the Significant Change report is that only one disturbance per channel can be triggered each second. If multiple disturbances occur during a second, the worst one is recorded. This limits the size of the report, making it much easier to analyze, while still giving a single-cycle response. If detailed disturbance information on a cycle basis is required, use the Event Change report. Event Change gives much more detail but is more complicated to examine. The timestamp of a Significant Change event can be used to find the same disturbance in the Event Change report for further analysis.

For even more detail, Waveform Capture can be used (if available). If the disturbance triggered Waveform Capture, the raw waveforms of each voltage and current channel can be displayed. Again, the Significant timestamp is used to find the waveform in the list of captured waveforms.

**Event Change Records**

The Event Change report provides detailed cycle-level information about each voltage disturbance. This is the most detailed report available short of actually looking at raw waveforms with Waveform Capture. An event is triggered when the voltage moves past any of a series of trip points. Max and min voltages and currents during the event, the event duration (in cycles), and the current before and after the event are all recorded.

*Trigger Logic*

Event Change triggering involves three parameters. The first, the Nominal voltage, sets a baseline voltage level. This is not the same nominal voltage selected by the Abnormal Voltage record type during the two-minute countdown. The Event Change Nominal voltage is specified by the user and is not picked by the Recorder. The second parameter is the Threshold, in volts. The Threshold is added and subtracted to the Nominal to form voltage trip points. These trip points are created all the way down to zero volts and up to the maximum Recorder voltage by using multiples of the Threshold. For example, a Nominal of 120 and a Threshold of 6 would create trip points at 120 ± 6 = 114, 126; 120 ± 2 x 6 = 108, 132; 120 ± 3 x 6 = 102, 138; etc.

The voltage region around the Nominal, but before any trip points (115 to 125 volts in the above example) is the Nominal Band. If the voltage moves from the Nominal Band to cross a trip point, an Event Change is triggered. This Event Change continues until the voltage either returns back into the Nominal Band or moves past another trip point. Each time the voltage moves past another trip point, the existing Event Change ends and a new Event Change is triggered. The trip points can be visualized as a grid (every 6 volts in the above example) from zero volts to the maximum Recorder voltage, and any time the line voltage crosses a grid line, an Event Change is triggered.

There is one exception to the previous paragraph. The third setting, Holdoff Time, specifies in cycles how long to wait before allowing a new Event Change, if the voltage continues moving in the same direction. This setting is to prevent a slow sag from generating multiple Event Changes. For example, consider a Nominal of 120, a Threshold of 6, and a Holdoff Time of 10 cycles. The line voltage is 119 volts, and no Event Change has been triggered. Now a slow sag occurs. The voltage drops to 114 volts, triggering an Event Change. The next cycle, the voltage keeps dropping to 110 volts. On the third cycle, the voltage drops to 105 volts. This would normally cause the Event Change to end and a new one to be triggered, since the voltage crossed another trip point. However, with the Holdoff Time set to 10 cycles, no new Event Changes can be triggered for 10 cycles, as long as the voltage continues to drop. If the voltage changed direction and started to rise, then the Holdoff Time would not apply -- if the voltage rose past a trip point, the existing Event Change would end and a new one

would start. The Holdoff Time doesn't prevent Event Change from capturing short events, but keeps a slow voltage change from generating multiple events.

Event Change can be triggered by any voltage channel. The triggering logic (and settings) is separate for each channel. Another channel may trigger its own Event Change while other channels have running Events, resulting in overlapping Events.

*What's Recorded*

When an Event Change is triggered, the trigger time is recorded, with one cycle resolution. The RMS current one cycle *before* the trigger is recorded. The direction of the voltage change, or slope, is also recorded. This is displayed in ProVision® as a minus for a sag and a plus for a swell. While the event is occurring, the Recorder keeps track of the max and min current and voltage values. When the event ends, the max and min RMS voltage and currents are recorded, along with the duration (in cycles). One cycle later, the RMS currents are measured to record the currents *after* the event.

All voltage and current measurements are recorded for every channel, regardless of which channel triggered the event. If a sag occurs on three phases simultaneously, three Events will be triggered at the same time. These Events are recorded separately, even though they may have the same data in them.

*Typical Settings and Suggested Uses*

The Nominal voltage should be set as close as possible to the actual nominal line voltage. If a circuit normally runs at about 117 volts, use 117 as the Nominal, not 120. Event Change is not for steady-state line voltage regulation problems (like the Abnormal Voltage report), but for quick sags and swells. The Threshold should be set small enough to catch problem events, but large enough to avoid filling up memory with unimportant data. A good start is 5% of the Nominal. The Nominal and Threshold can be set separately for each channel. These should be set accordingly if some channels see different voltage levels (for example, in a single-phase setting where two channels are connected line to ground, and the third channel line to line.) To effectively disable Event Change on a channel, set its Threshold to something huge, like 500 volts.

The Holdoff Time is not as critical. Ideally, this is set to just larger than the slowest anticipated sag time. For example, if no sags (such as from motor starts, etc.) will take longer than 6 cycles for the voltage to drop to the sag value, the best Holdoff Time is 7 cycles. This will prevent multiple Events Changes from the same voltage sag. Otherwise, as the voltage dropped lower and lower, past voltage trip points, Events would continue to be triggered. Ideally, only one Event is triggered for a single sag or swell. A typical value is 10 cycles. This is longer than most sags take to reach the final sag voltage.

Event Change provides cycle-level detail on sags and swells. A sag which merely shows up as a single point on the Interval record can be analyzed in the Event Change report. Usually, Event Change is not the first report to analyze in a recording, due to its complexity. Check the voltage Interval record for min or max voltages out of tolerance, or the Significant Change report for voltage fluctuations. If a disturbance needs further study, use the timestamp to find the fluctuation in the Event Change report. Here detailed information such as cycle duration, pre- and post-event RMS currents, etc. is available.

The most useful values are the duration and max and min voltages. This information shows how long the event lasted, and how low or high the voltage went. The cycle timestamp can be useful to determine how far apart several events were which occurred in the same second. The timestamp is also used to correlate an Event Change with other reports, such as Significant Change and Waveform Capture.

The pre- and post- RMS current can be used to determine whether the load being monitored caused a sag. Consider a sag that triggers an Event Change. If the current one cycle before the event is low, but the max current during the event is high, and the current one cycle after is high (or at least higher than the pre-trigger current), the monitored load probably caused the event. In-rush current from a motor start will cause this type of pattern: the high in-rush current pulls the voltage down, triggering an event. When the in-rush current peak is over, the voltage goes back up, ending the event. The final current is lower than the in-rush current, but higher than the current before the event.

Another possibility is a voltage sag where the current during the event is lower than the pre trigger current (or about the same), and the post-trigger current is about the same. Here, the monitored load probably did not cause the event. Some other load pulled the voltage down, and the monitored load current dropped proportionately with the lowered voltage. When the voltage came back up, the current rose to its normal level also.

ProVision® groups closely occurring Event Change records into super-events. A super-event is started when an Event starts on any channel. The super-event lasts until there are no running Events on all channels for at least an entire second. A complicated voltage disturbance may trigger several closely spaced or back-to-back Event Changes but will be grouped into a single super-event for easier analysis.

Event Change is recorded separately for each voltage channel. If Event Change memory is filled, Event Change recording stops. All voltage channels use the same Event Change memory. The amount of memory used for Event Change is different for various Recorders, but every Recorder with Event Change can record hundreds, and most over one thousand records.

### Power Outage Records

The Power Outage report lists the date and time of all outages during the recording session. An outage is defined by the Recorder to be a voltage sag below 80 volts, lasting for at least 1/3 of a second. Only channel one's voltage is used to trigger an outage. The beginning and end of the outage are timestamped. In the report, the duration is also given, along with the total number of outages and the total outage time.

If the Recorder has battery ride-through capability, it will continue to record Histograms, Interval records, etc. during the outage. If there is no battery, or if the battery runs down, the Recorder loses power and stops recording. When power is restored, the Recorder records the end of that power outage and resumes recording normally.

A power outage often triggers Waveform Capture, which may help reveal the cause of the outage.

### Flicker Records

The Flicker record type is designed to show voltage variations that cause lights to flicker. The Recorder defaults to the threshold of irritation curve from IEEE Standard 141. This curve is designed to show only voltage flicker that is perceived as irritating. When this occurs, a flicker event is recorded with the time and magnitude.

#### *Trigger Logic*

A Flicker curve is specified by a list of allowable voltage thresholds, and a limit on their quantity in certain time spans. The default curve allows 5 voltage fluctuations of 1% or greater, in a ten second period; 10 fluctuations of 1.5% or greater, in a one minute period, and so on up to 10 fluctuations of 6% or greater, in a 24 hour period. In general, the larger the voltage variation, the less often it is allowed before triggering a Flicker record. There are nine pre-set time periods used, from 10 seconds to 24 hours. Each has an adjustable threshold percentage

and event limit. If the voltage variations exceed the threshold percentage more than the number of times allowed by the limit, in a certain time period, then a Flicker record is triggered.

For example, with the default settings, if the voltage varies more than 1% over 5 times in a ten second period, a Flicker record is generated. These variations also count for the longer Flicker time spans if they are large enough.

Flicker is computed once per second, based on the previous second's one-cycle max, min, and one second average RMS voltage levels. The thresholds are given as a percentage. If the max, min or average differs from each other by more than the percentage for a certain time period, then a flicker event counter is incremented. If the counter value exceeds the limit for a certain time period, a Flicker record is triggered.

Flicker is triggered separately for each voltage channel.

*What's Recorded*

When a Flicker record is created, the date and time are recorded, along with the number of voltage events that exceeded the tolerance. The time span over which the flicker occurred is also recorded. Each channel is reported separately.

*Typical Settings and Suggested Uses*

The Flicker report is designed to show whether utility customers will perceive voltage variations as flickering lights. The default curve is programmed to generate Flicker events when a person would become irritated by the level of Flicker. The IEEE also has a curve which shows when a person would just perceive flickering lights, but not become irritated. The validity of these curves depends on individual circumstances such as lighting (the curves assume 120V incandescent) and customer sensitivity.

The Flicker report is used both to confirm a customer complaint about flickering lights, and to measure progress in mitigating a problem. If no Flicker events were recorded, then no voltage variations occurred which exceeded the allowed limits, and the problem may have been solved. Since flickering light perception is so subjective, merely showing a customer a Flicker report, which shows no flicker according to a standard curve may lessen the complaint by showing that the voltage variations are within standard limits.

Flicker is recorded separately for each voltage channel.  If Flicker memory is filled, Flicker recording stops. All voltage channels use the same Flicker memory. The amount of memory used for Flicker is different for various Recorders, but every Recorder with Flicker can record hundreds, and most over one thousand records.

It is important to connect any unused voltage clip leads together, or in parallel with another voltage channel, to avoid generating bogus Flicker records. The threshold parameter is a percent change value, and applying a small percentage to an already small voltage creates tiny thresholds that are constantly exceeded. Flicker is not meaningful on neutral to ground voltage channels: only channels that are used to power lighting generate meaningful Flicker data.

On most Recorders, Flicker is always enabled for recording. On some older Recorders, enabling Significant Change recording disables Flicker recording. This is true for the VP-1, and 300 volts Recorders (the VS-3, VS-1, VS-1M, iVS-3, iVS-1, and iVS-1M) with serial numbers below 6000.

## Abnormal Voltage Records

The Abnormal Voltage record type shows if the average line voltage moved past a low or high threshold from the nominal voltage. On some Recorders, the low threshold exceedance is indicated by a green LED on the front panel, and the high threshold exceedance by a red LED.

When the trigger occurs, the event is time stamped to the nearest second. There is a separate LED and report for each voltage channel.

### *Trigger Logic*

The triggering logic uses a low and high threshold, a nominal voltage, and a trigger duration. The thresholds are added and subtracted to the nominal voltage to find triggering points. If the voltage crosses a triggering point for longer than the trigger duration, an Abnormal Voltage event occurs.

The Recorder is initialized with a list of potential nominal voltages (such as 120, 240, etc.), with low and high voltage thresholds for each. The actual nominal is picked by the Recorder during the two-minute countdown. The average voltage during the countdown is compared to each of the nominals; the closest one becomes the nominal voltage for the entire recording session. There are five standard nominals in the software setup (120, 208, 240, 277, and 480 volts), and two custom nominals. The custom nominals can be set to any voltage. It is possible to enable and disable the standard and custom nominals. For example, if it's desired to force the Recorder to use 230 volts as the nominal, the standard nominals should be disabled, and both custom nominals set to 230. If the standard nominals were not disabled, there would be a chance for the Recorder to pick 240 volts during the two-minute countdown, if the line voltage happened to be running closer to 240 than 230 at that time. The nominal is chosen by the Recorder separately for each voltage channel.

There are separate high and low thresholds for each of the seven nominal voltages. The applicable thresholds are used once a nominal is selected by the Recorder after the two minute countdown. Voltage channels are handled separately; there is a complete set of nominals and thresholds for each. This is useful for situations such as a hot-leg delta, where one voltage channel is at a different voltage, or in a single phase setup where two channels are connected line-to-neutral, and one channel is line-to-line. The Recorder will automatically select the correct nominal and thresholds for the different line voltages on each channel.

The last Abnormal Voltage parameter is a trigger duration, in seconds. This specifies how many seconds in a row the voltage must exceed the threshold before the Abnormal Voltage record is triggered.

At the end of each second during the recording session, the Recorder compares the one-second average voltage with the nominal and the low and high thresholds. Each threshold actually creates two trip points, one above the nominal and one below. For example, consider a setup where the nominal is 120 volts, the low threshold is 6, and the high 12. The low trip points become 120 ± 6, or 114 and 126 volts. The high trip points are 120 ± 12, or 108 and 132 volts. If the one-second average voltage rises above 126 or falls below 114 volts for longer than the trigger duration, the low Abnormal Voltage trigger occurs. This event is timestamped, and the green LED is lit (if present). If the voltage goes past either high trigger point (108 or 132 volts)

for longer than the trigger duration, the high Abnormal Voltage trigger fires. This is timestamped, and the red LED is lit (if present). It is possible for the low and high triggers to fire at the same time.

The use of one-second average voltages eliminates false triggering due to momentary sags and swells. Abnormal Voltage is designed to trigger for average line voltage exceptions, not sub second events.

Once an LED indicator is lit due to an Abnormal Voltage trigger, it stays on for the rest of the recording session, even if the voltage returns to the nominal. The LED indication of an Abnormal voltage trigger can be disabled through the software. The event is still recorded normally, but no LEDs are lit.

*What's Recorded*

When Abnormal Voltage is triggered, the date and time, along with the channel and triggering voltage are recorded. There is a separate listing for each voltage channel, as well as low and high thresholds. Only the first trigger for each threshold is recorded.

*Typical Settings and Suggested Uses*

The Abnormal Voltage report is used to determine whether the voltage drifted outside the thresholds during the recording session. Since the LED indicators stay lit after a trigger, they can be used to see at a glance whether a Recorder needs to be downloaded due to line voltage problems. Usually the Abnormal Voltage report is used to get a quick read of whether there was any line voltage drift -- if so, then other record types such as the Interval record and Significant Change are used for more information.

The default threshold settings are at 5% and 10% of the nominal voltage (for example, 6 and 12 volts for the 120 volt nominal). The high threshold must be larger than the low threshold. The two custom nominals are preset at 106 and 230 volts but should be changed if a different nominal is in use. The default trigger duration is five seconds, and can be set as small as one second, or as large as 255 seconds.

**Loose Neutral Records**

The Loose Neutral report shows whether the typical symptoms of a loose neutral have occurred. This report is intended for single phase services, with voltage channels one and two connected from line to neutral. Only a two-channel Recorder, or a Recorder set to use two channels, can record a Loose Neutral. The symptom of a loose neutral condition is for one voltage leg to rise in voltage, and the other to fall, with the sum of the two voltages remaining close to twice the nominal voltage. For example, if the voltages start at 119 and 121 volts, then move to 105 and 135 volts, a loose neutral is a likely cause: one leg went up, one went down, and the sum is close to twice the nominal (240 volts).

This happens when the load is not balanced, and the neutral is disconnected. If this condition is met for long enough, the Loose Neutral report is triggered.

*Trigger Logic*

The Loose Neutral logic uses three parameters: duration, range, and difference. These parameters are used to judge whether one voltage leg has risen, and one fallen, while the sum remained the same. The difference is a voltage that specifies the minimum difference between the two legs. For example, if the difference is 16 volts, then there must be at least a 16 volt separation between the two legs. The range is a voltage that specifies how close the sum of the two voltages must be to twice the nominal. For example, a range of 12 volts means that the sum of the two legs must be within 12 volts of twice the nominal voltage. Both the range and the difference conditions must be met for at least the number of seconds specified by the duration. If the duration is set to 5 seconds, then the difference and range conditions must be met for 5 consecutive seconds before a loose neutral is declared.  One-second average voltages are used. The nominal voltage is the nominal determined during the two-minute countdown by the Abnormal Voltage record type, and is typically 120 volts in a single-phase hookup.

As an example, assume the difference parameter is 16 volts, and the range 12 volts, with a duration of 5 seconds. The two-line voltages are 119 and 121 volts. Then one leg moves to 128 volts, and the other to 110 volts. The difference between the two legs is 18 volts, which meets the difference threshold. The sum of the two voltages is 238 volts, which is within the required 12 volts (specified by the range value) of twice the nominal (240 volts). If these voltages persist for 5 seconds in a row, then a Loose Neutral record will be triggered.

If one voltage leg changes due to heavy loading, the range parameter keeps the loose neutral from false triggering. For example, if the voltages start at 119 and 121 volts, then a heavy load to channel 1 causes it to drop to 105 volts, with the other leg still at 121, the difference condition is met (121 - 105 > 12), but the range condition is not met: 105 + 121 = 226, and 226 volts is not within 12 volts of the 240 volt nominal.

*What's Recorded*

The date and time of the loose neutral triggering is recorded, along with the voltage on the two channels. Only the first occurrence of a Loose Neutral is recorded; if the conditions are met again, nothing further happens. The Loose Neutral report shows whether the neutral may have a bad connection, not the exact times the connection was made and broken.

*Typical Settings and Suggested Uses*

The Loose Neutral Report can show the *symptoms* of an actual loose neutral connection. It is worth investigating if the report is triggered. However, it is possible for the Loose Neutral logic to be fooled. If both legs are equally loaded, then the two voltages will remain the same even if the neutral is removed. This will prevent the Loose Neutral trigger from firing. It is also possible for one leg to rise and one to fall due to grossly different loading, and not from an actual loose connection. Thus, it is possible for a Loose Neutral to trigger falsely, when there is no loose connection.

## Waveform Capture Records

Waveform Capture provides the most detailed report possible: the raw voltage and current waveforms themselves are recorded. With clues provided by the waveform shapes, it is sometimes possible to determine the cause of a voltage disturbance. Events such as capacitors opening and closing, reclosers operating, and lightning strikes can sometimes produce distinctive shapes. The voltage waveforms also reveal the exact duration and magnitude of an event, and how much was coupled across phases. Waveform Capture is also useful during steady-state conditions. The current wave shapes can show harmonic currents from non-linear loads, and the voltage wave shapes show the distortion due to harmonic currents and transformer loading. It takes a huge amount of memory to store raw waveforms. The memory size of a single 3-cycle Waveform Capture record is larger than the size of four hours of Interval data (at one-minute intervals).

*Trigger Logic*

Waveform Capture uses a single threshold for triggering. This threshold is a percentage. At the end of each 60Hz cycle, the RMS voltage for that cycle is compared with the RMS voltage of the previous cycle. If the percent change in RMS value is greater than the threshold, Waveform Capture is triggered. Any voltage channel can trigger waveform capture. The voltage must be at least 5 volts to trigger. If a trigger occurs, the waveform data is recorded. The trigger test is repeated every cycle, so if the RMS voltage keeps changing, Waveform Capture will continue to be triggered, until the voltage stabilizes.

Waveform Capture can be triggered manually from the front panel of the Recorder. This produces a three cycle Capture.

If a Waveform Capture trigger doesn't occur at all during a recording session, a one cycle Capture is still recorded. This waveform is taken at the very end of the session.

*What's Recorded*

When a trigger occurs, the waveform data for the triggering cycle is recorded, along with the date and time (to the nearest cycle). The waveform data for the previous cycle is also recorded, to provide a pre-trigger waveform. All voltage and current wave shapes are recorded, regardless of which channel caused the trigger. The waveforms of the next cycle are also recorded, to provide a post-trigger waveform. This creates a three cycle Waveform Capture record. If the trigger condition is met again on the next cycle, then an additional cycle of waveforms is added. In general, the Waveform Capture record continues until one cycle after the triggering stops. If the voltage is fluctuating wildly, the entire Waveform Capture memory could be filled by a very long Waveform Capture record. If the Waveform Capture memory is full before the end of the event, the Recorder erases cycles of the earliest record to make room for the new data.

The waveform data is presented as a graph and a report. The report is usually used only if the data will be exported to a spreadsheet.

*Typical Settings and Suggested Uses*

leads still attached. The Recorder will detect the cable and stop recording cleanly. Otherwise, the front panel menus should be used to bring up the "STOP" option. Selecting this option stops the recording session cleanly. The voltage leads can then be removed.

The default setting is 2%. With this threshold, the RMS voltage has to change by at least 2% in a single cycle. If the threshold is too tight, Waveform Capture will trigger so often that useless events overwrite the important waveforms. A Waveform Capture report consisting of just one very long record is an indication that the setting is too small. A report where all the waveform records occurred during the last few minutes of the recording session is another indicator of too small a threshold. In both these cases, the trigger was being met too often. Of course, if no waveform records are present, either the threshold was too large, or the voltage quality was too good. The optimal setting varies from system to system.

The exact nature of a voltage disturbance can be seen in the Waveform Capture report. The peak voltage, length of the sag or swell, and the coupling from phase to phase are easily seen in the graph. Sometimes there are clues regarding the cause of a voltage disturbance. A voltage sag that starts in the middle of a cycle but ends at a zero-crossing can be produced by a gas arrestor. The arc continues until the voltage reaches zero, then the arc is extinguished. A recloser operation usually begins and ends at random points in the cycle. A voltage sag that is preceded by an increase in current, but followed by a decrease in current, is usually caused by the monitored load. If the current went down during the sag, and was steady before and after, the sag was probably not caused by the monitored load.

Each triggered event is often captured by the Significant Change and Event Change reports. The min or max voltage is usually in the Interval record as well. These reports can be used to place the Waveform Capture record into the proper overall context. Use the timestamps for each record type to correlate the different reports.

A manual trigger captures the voltage and current waveforms during steady-state conditions (unless the user happened to press the button at the exact moment of a disturbance).

Transformer saturation often shows in a flattened voltage wave shape. If the positive voltage half-cycle is a different shape than the negative half-cycle, even-order voltage harmonics are present. Often the current waveforms will not be sinusoidal. The less they look like a sine wave, the higher the level of current harmonics. Frequently, the neutral current looks much less sinusoidal than the line currents, due to the fact that some

harmonics don't cancel out in a three-phase system, even with a balanced load. The more the current waveform is shifted from the voltage waveform, the worse the power factor.

It is important to provide a clean ending to a recording session when using Waveform Capture. If the Recorder is still recording while the voltage leads are disconnected from the line, several Waveform Capture records will be recorded as the voltage drops to zero on each channel  These useless records of the voltage leads being disconnected can overwrite the valuable recorded data. If the Recorder will be downloaded in the field, a serial cable can be connected with the voltage

# ProVision® Shortcut Keys

t Toggle the Point Table ON or OFF. Move your mouse to a peak on the graph, your cursor will turn into a finger, left-click mouse to set the reference line. With the Point Table ON you can: Use arrow keys (or page up/down) to move the 'Point' to the previous or next point.

Zooming: Zoom in on any graph. Left click mouse and hold, then drag mouse over the area to zoom in on. Release the left button to zoom into the window you made. Supports multiple zooms by using arrow keys to move the zoomed window Left or Right, through the interval data.

u Undo one zoom level

z Undo all zoom levels

*Control Key Shortcuts*

Ctrl+O: Open file
Ctrl+X: Cut
Ctrl+S: Save file
Ctrl+V: Paste
Ctrl+P: Print
Ctrl+C: Copy
Ctrl+Shift+U: Full screen
Ctrl+Shift+F: Find in files
Ctrl+Shift+B: Display or hide the shortcut bar
F1: Help
Ctrl+Z: Undo
Ctrl+Y: Redo

*Shortcuts for the Waveform Capture Only*

3 Toggle between 3-phase and individual phase views

I Toggle between Line-to-neutral voltages and Line-to-line Voltages
Only if recorded as a WYE

L Select a different waveform

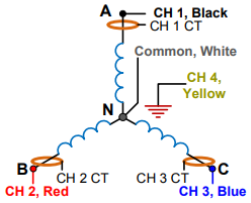
f Toggle fundamental harmonic

Page Up: Move to Previous Waveform Capture

Page Down: Move to next Waveform Capture

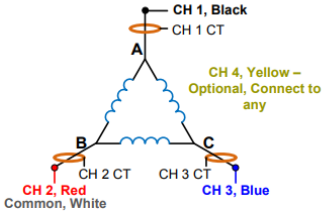
# Eagle and Revolution Hookup Diagram

### Three Phase WYE



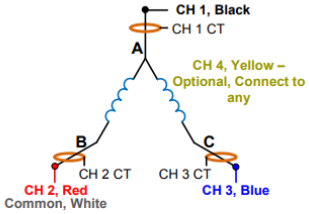

Set circuit type to "wye"

### Three Phase Delta



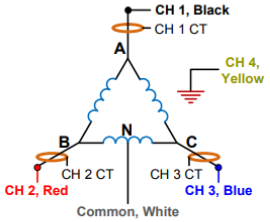

Set circuit type to "3 wire delta"

### Open Delta



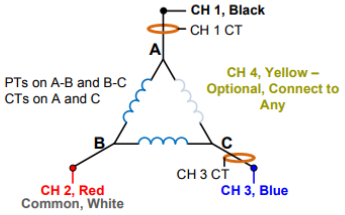

Set circuit type to "3 wire delta"

### Four Wire Delta



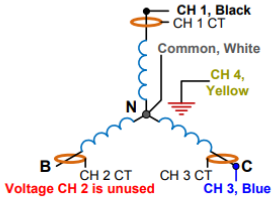

Set circuit type to "4 wire delta"

### Two Element Delta



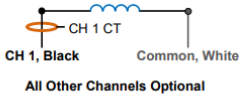

Set circuit type to "3 wire delta"

### 2½ Element WYE




Set circuit type to "2.5 el. wye"

### 2 Wire Single Phase




**All Other Channels Optional**

Set circuit type to "wye"

### Notes:

- Directional arrows on CTs should point TOWARDS the load.
- The banana jacks are color-coded by channel: Black – Ch1, Red – Ch2, Blue – Ch3, Yellow – Ch4, White – Common. (Not all channels may apply, depending on your model.)
- Do not exceed 600 volts RMS channel-to-channel or channel-to-common.
- Disable unused channels in software for more recording time.
- Phase-to-Phase voltages are measured in 3-wire delta hookups.
- Line-to-neutral voltages are measured in wye hookups.

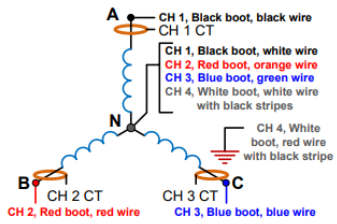
### 3 Wire Single Phase


**All Other Channels Optional**

Set circuit type to "wye"

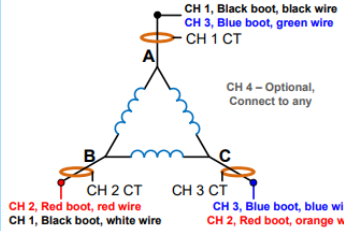
# ViP, iVS-3, & iVS-3/600P Hookup Diagram

### Three Phase WYE



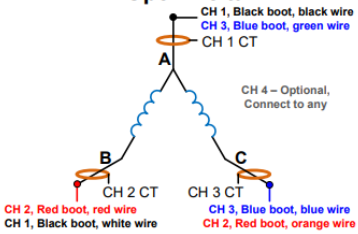

Set circuit type to "wye"

### Three Phase Delta



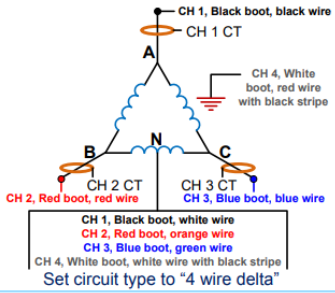

Set circuit type to "3 wire delta"

### Open Delta



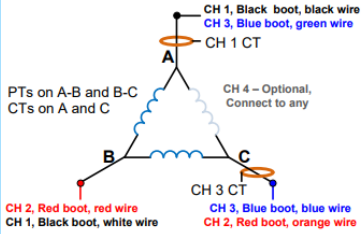

Set circuit type to "3 wire delta"

### Four Wire Delta



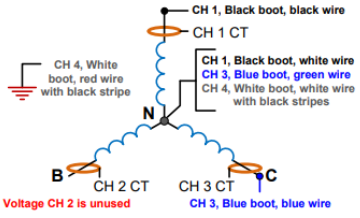

Set circuit type to "4 wire delta"

### Two Element Delta



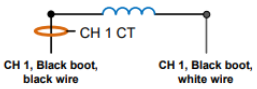

Set circuit type to "3 wire delta"

### 2½ Element WYE




Set circuit type to "2.5 el. wye"

### 2 Wire Single Phase



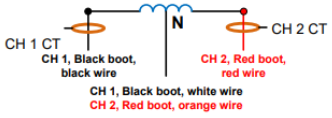

**All Other Channels Optional**

Set circuit type to "wye"

### Notes:

- Directional arrows on CTs should point TOWARDS the load.
- The rubber boots on the voltage leads are color-coded by channel: Black – Ch1, Red – Ch2, Blue – Ch3, White – Neutral. (Not all channels may apply, depending on your model.)
- Unused channels can be disabled in software for more recording time.
- Phase-to-Phase voltages are measured in 3-wire delta hookups.
- Line-to-neutral voltages are measured in wye hookups.

### 3 Wire Single Phase




**All Other Channels Optional**

Set circuit type to "wye"

# Additional Resources

## Technical Support

Help is always available if one needs additional assistance. The technical support team at PMI is widely considered to be the best in the industry. Use one of the following methods to obtain technical support.

## Email Support

Send email to: techsupport@powermonitors.com.

### Web Support

Submit a support request via the web at https://powermonitors.com/support

## Telephone Support

Contact us 24 hours a day, 7 days a week for live tech support by calling:
**(800) 296-4120**
Faxes should be sent to: **(540) 432-9430**

## Postal Mail Support

All correspondence by post should be addressed to:
**Power Monitors, Inc.**
**800 North Main Street**
**Mount Crawford, VA 22841**
**USA**

# Glossary of Terms

**Activate**

To make a data file active. (An active data file will have a checkmark next to its name in the Explorer.)

**Active**

The state in which a data file may be used to perform user actions, e.g. creating graphs and reports.

**Data File**

A file containing recorder data.

**Graph Template**

A blank form in which graphical data can be inserted to create a custom graph. Templates are kept in the Graphs and Reports folder.

**Plot**

A portion of a graph containing a single group of traces, e.g. voltage and current for channel 1.

**PQ**

power quality

**Ready Mode**

An operational mode in which a PMI recorder actively records PQ data and can display real-time graphical data.

**Recording Interval**

The amount of time between data points, e.g. a 'one minute interval' means that the recorder will record a data point every minute.

**Recording Session**

A period of time during which power quality data is gathered.

**Report Template**

A blank form in which reports, and graphs can be inserted to create a custom report. Templates are kept in the Graphs and Reports folder.

**RTF**

Rich-Text Format

**Standby Mode**

An operational mode in which a PMI recorder may be configured for recording PQ data.

**Trace**

A line drawn on a graph representing a series of data points.