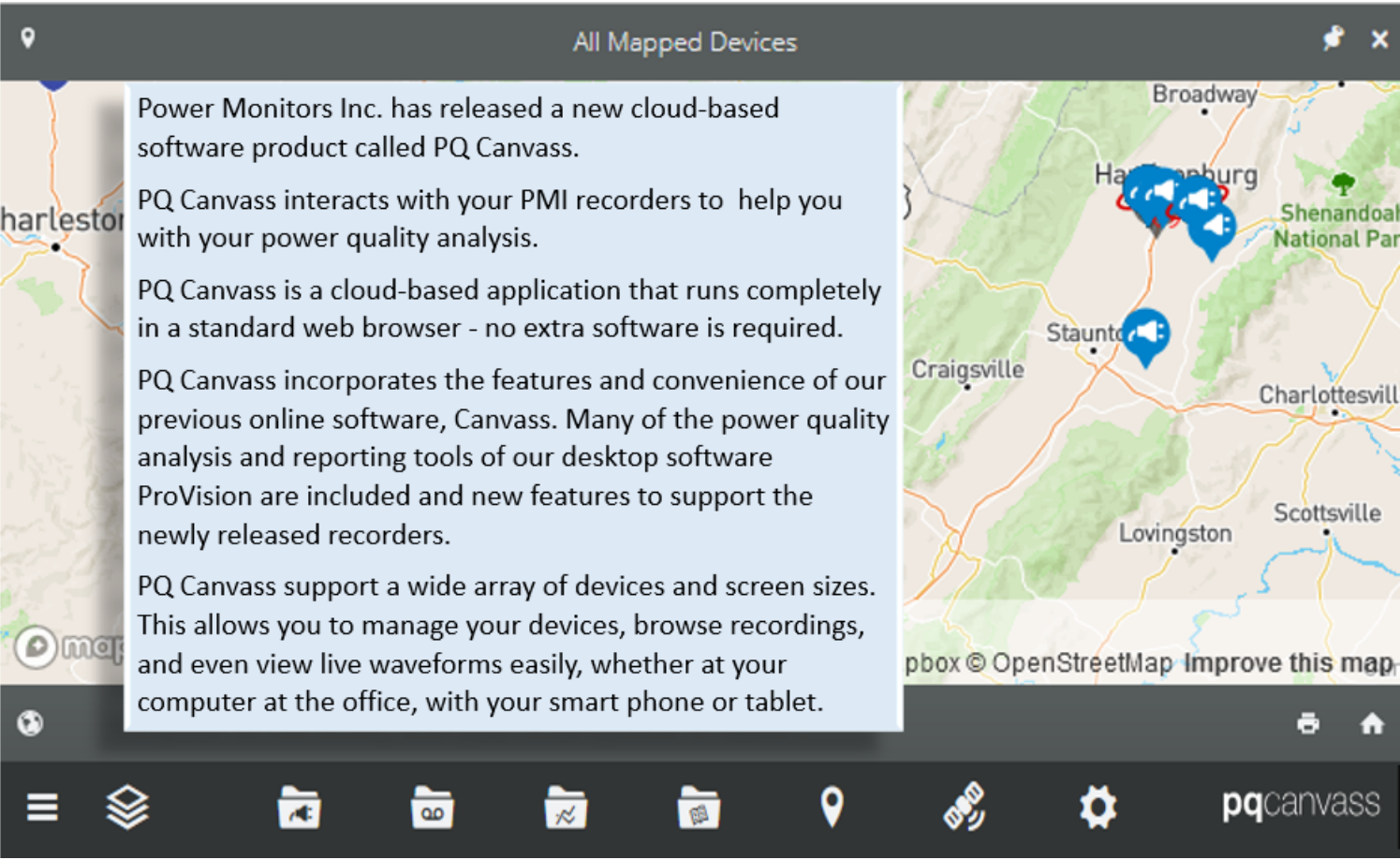


# PQ Canvass User Manual





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# How PQ Canvass works

Recorded data is sent to PQ Canvass using a cell or Ethernet connection, the data can be viewed in 1-second streamed data or analyzed in full Power Quality (PQ) data files.

PQ Data files can be viewed at any time, no need to wait until the completion of the recording session to download the entire recorder's memory. Recorders must be initialized to start a PQ data file, but the 1 second streamed data will begin when the recorder connects to the cell tower or to the Ethernet network.

Simply log into PQ Canvass and view all data gathered up to the present time.

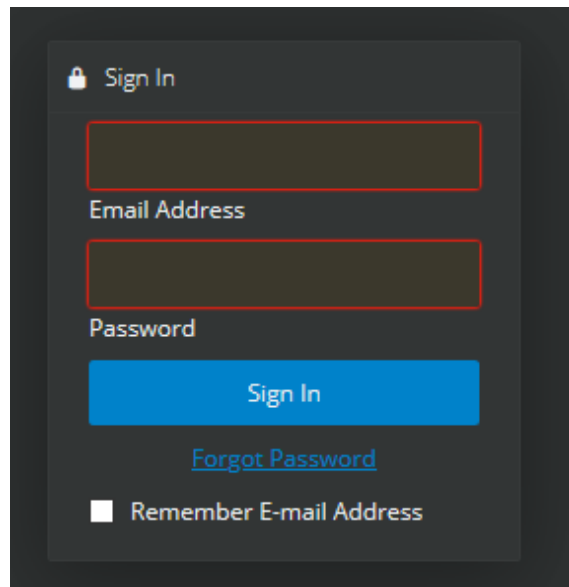
Live waveforms and meter displays are also available for real-time information from any PQ Canvass device.

SMS and email alerts can be configured for immediate notification on PQ events.

## Website Location

<https://pqcanvass.powermonitors.com>

login screen



PMI Tech Support will send you the password information.

- Other PQ Canvass Administrators in your company can also add users

## Help Center - Default Home Page

The screenshot shows the PQ Canvass Help Center home page. At the top, there is a dark grey header with the 'pqcanvass' logo in white. Below the logo is a white search bar with the placeholder text 'Search'. The main content area is light grey and contains six rounded rectangular cards arranged in a 2x3 grid. Each card has an icon, a title, and a brief description. The cards are: 'Getting Started' (info icon), 'FAQs' (question mark icon), 'Devices' (speaker icon), 'Recordings' (audio icon), 'Graphs' (line graph icon), and 'Glossary' (book icon). Below the cards, there is a 'Change Homepage' button with a dropdown menu currently showing 'Help Center'. At the bottom, there is a 'Download Links' section with three links: 'Quickstart Guide', 'Manual', and 'White Papers Library'.

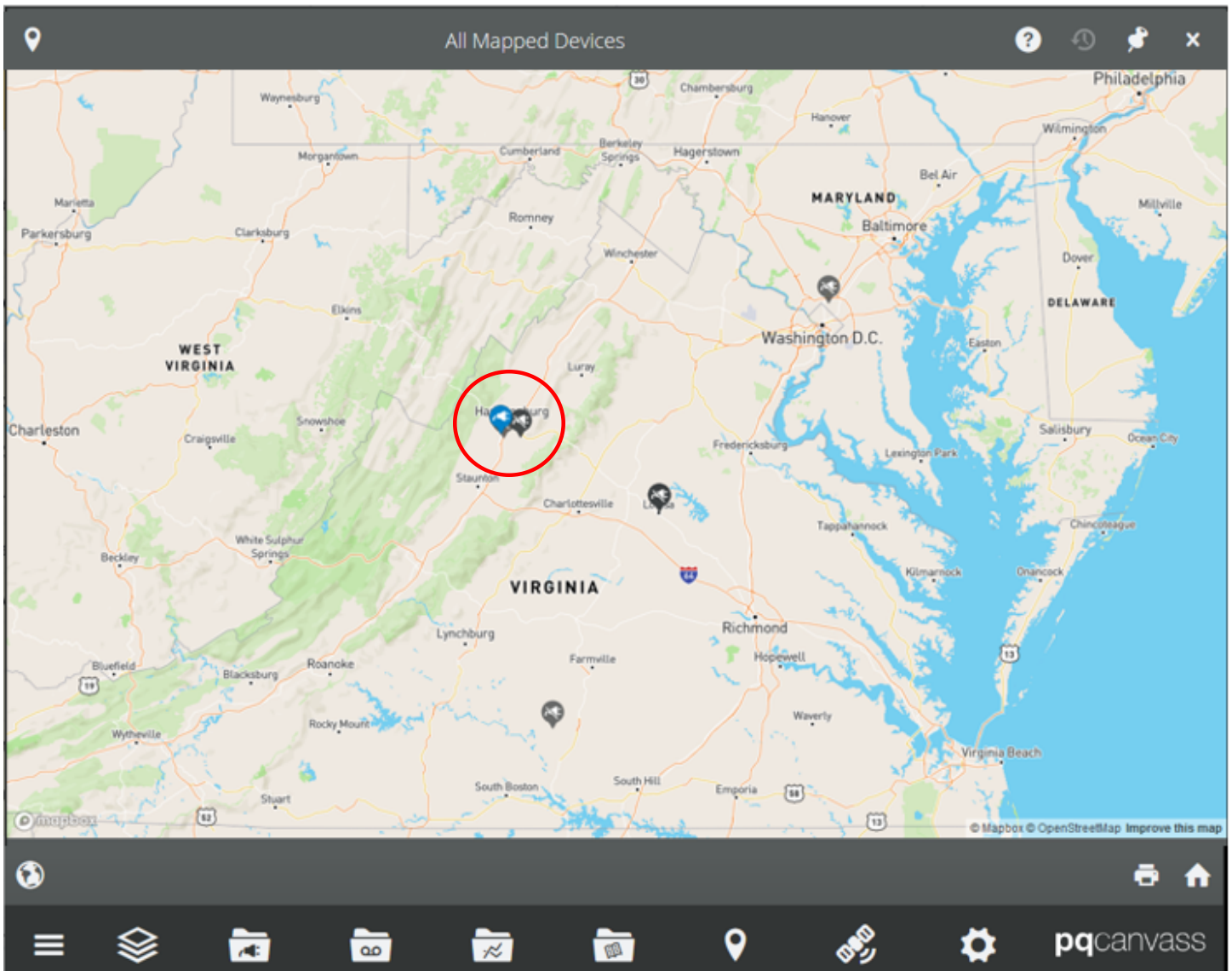
Once you are familiar with PQ Canvass, change your Default Home page from this page or from the Preferences Icon.

If you are new to PQ Canvass with new recorders, you may want to begin with the PQ Canvass Getting Started manual

Revised 1/17/2023




## Main Map Screen – Device locations are set by entering the address or longitude and latitude



Blue Icons are Online/Active recorders

Black Icons are Offline recorders

Amber Icons are recorders in an Alert State


A recorder can be selected from the map by clicking on its icon, or the recorder can be selected by using the Devices control icon 

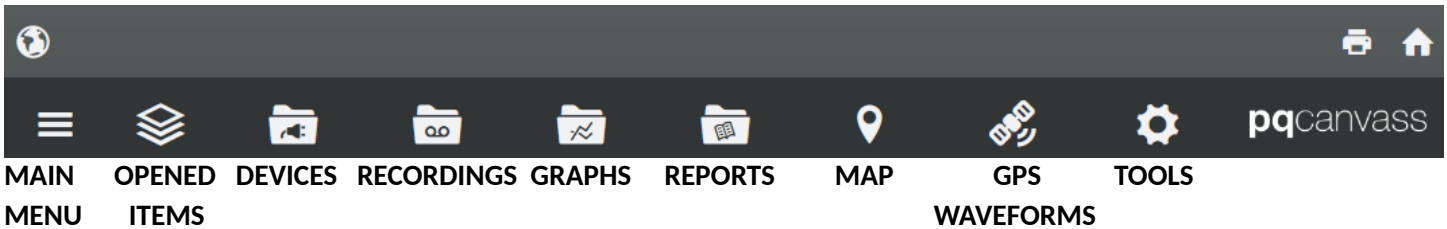
# Control Icons

Icons listed at the bottom of PQ Canvass pages


 View Satellite icon – Change from map to satellite view

 Print: Prints Map


 Home: Resets map page to default view




## Selecting Control Icons:


 Main Menu : Lists the Control Icons as well as any open items such as reports or graphs  
The Main Menu is also the location to log out of PQ Canvass

 Opened Items : Lists any Open Graph, Reports, or other open items


 Devices : Lists all your PQ Canvass devices by serial number  
Next select the device to view live data or initialize the device for a new recording


 Recordings : Displays active and completed Power Quality (PQ) data files  
Next select the data file to view Graphs, Reports, Daily Profiles, Histograms and Waveform Captures

 Graphs : Select to view graphs from any device, data file, live data, or create a graph template

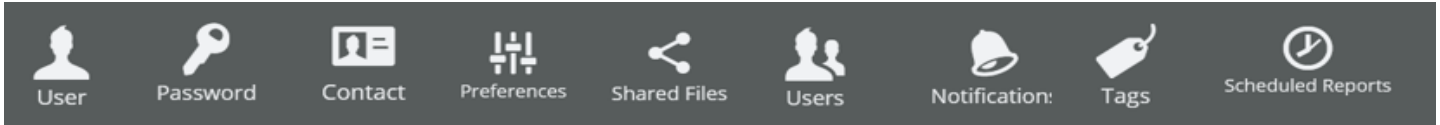
 Reports : Select to open reports from any data file or configure and run reports from a device

 GPS Waveforms : For GPS enabled devices, select to see High-Definition waveforms

 Map : Displays the map page

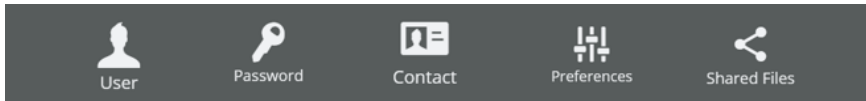
 Tools: Opens a selection of setting based on your user level

Administrators can add new users and configure alert settings, as well as all user options

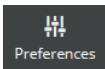


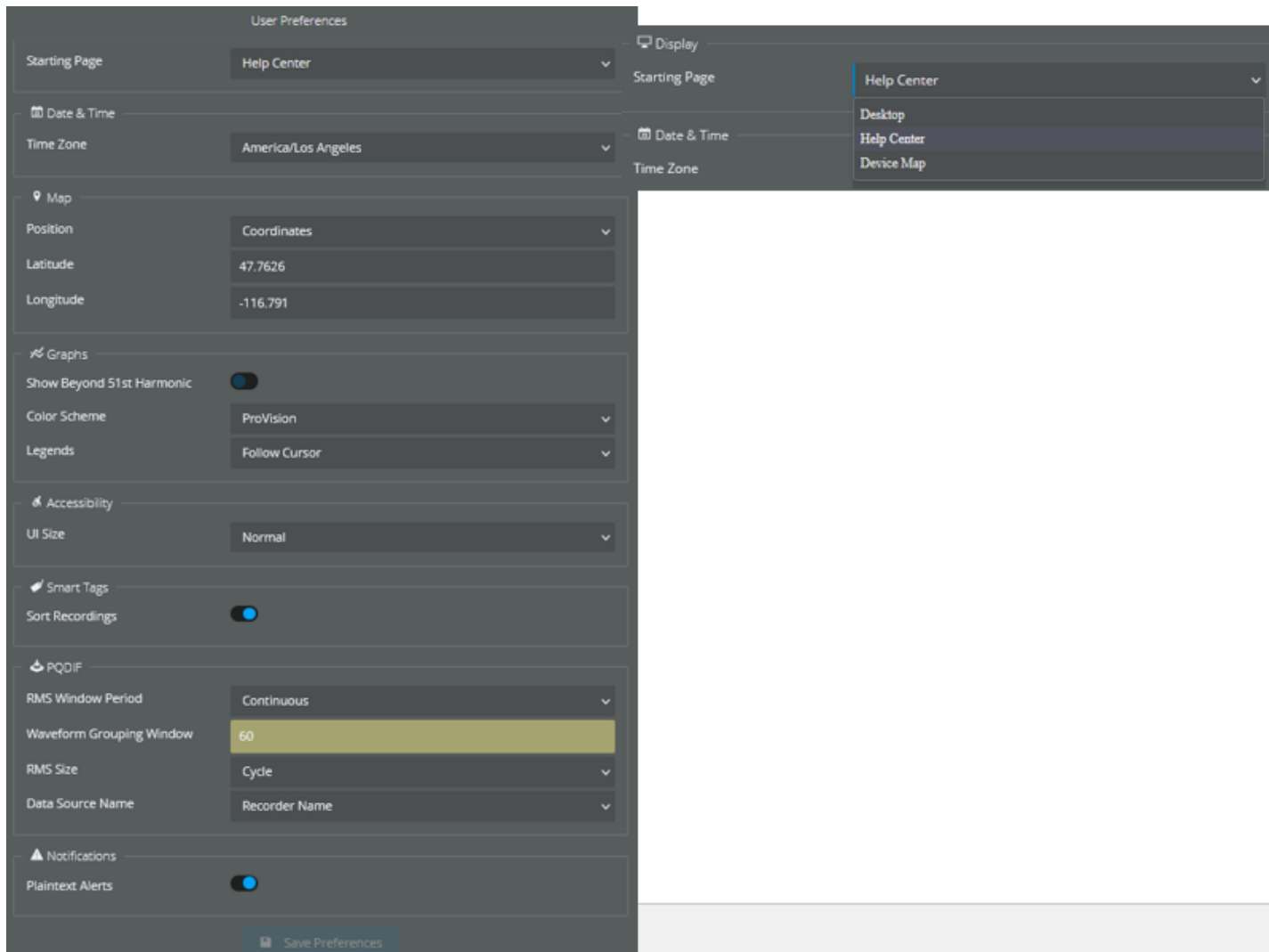
Administrator login view

Users can reset their password and select specific preferences

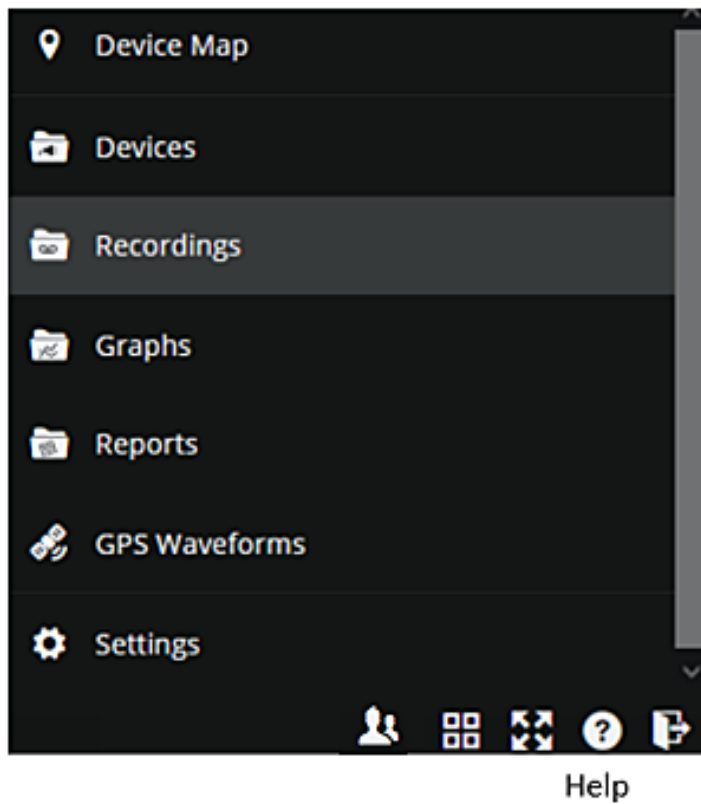


User login view





Select [**Preferences**]  to adjust Starting page, character size (UI SIZE) and Time Zones  
[**Save Preferences**] or use the [**X**] in the upper right corner to close window



## Main Menu









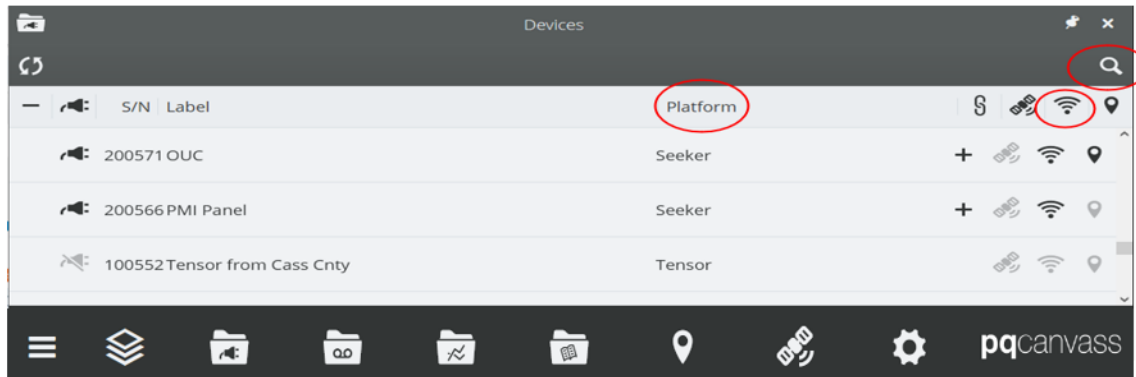
←  
Sign Out/ Log off



Grid Layout  changes display to a split screen view.  
Select  to go full screen. Help  opens the Help Center page.  
Select  to switch to another account when configured

## Devices

NOTE: Different recorder models may show different options

From the bottom of a page, the **Main Menu** or **Map** screen, select the **[Devices Icon]**  to list all devices  
The  column shows the device status: online/offline/in alert. The  icon shows if the firmware is up to date. The  icon shows if the GPS is active (model specific) and the  icon shows the map location when selected. Select the  to view live data for that device



Click on the heading **[Platform]** to cycle through a list of each recorder model, or select **[S/N]** or **[Label]** to change the listed order. Select the **[Magnifying Glass icon]**  to search for specific serial number or device  
The push pin icon  locks/unlocks that screen

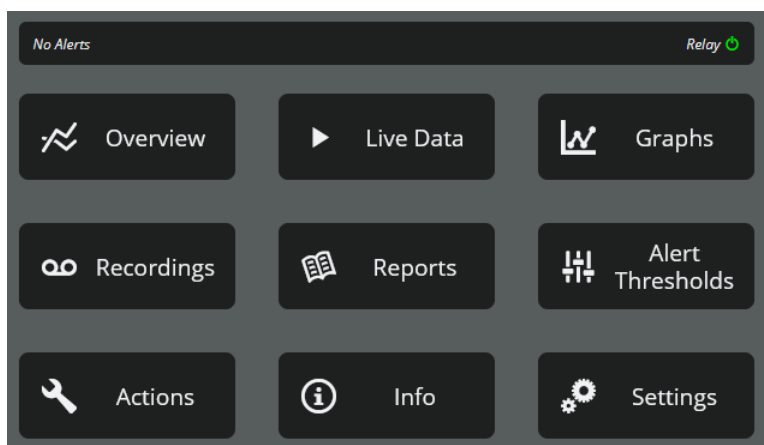
Select a Device - The information displayed will depend on the recorder model and status of the device (Online/Offline)

## Quick Access View Menu

Once you have selected a device, all menus and submenus refer to that device.

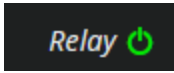
- Selecting similar Control icons from the bottom of the page, show information for all devices

Quick Access View menu – graphs and sub menus may vary depending on the device




The top line displays the alert status of a Tensor and Relay (AC receptacle) status

The AC receptacle on the face of the Tensor can be turned Off or On by selecting the Relay setting. Contact PMI Tech Support for the initial Relay password. Following a successful logon, you will be able to change the password.




Alert Thresholds show the settings to configure triggers when configuring a device for email or SMS alerts. See *Setting Alert Notifications* later in this manual

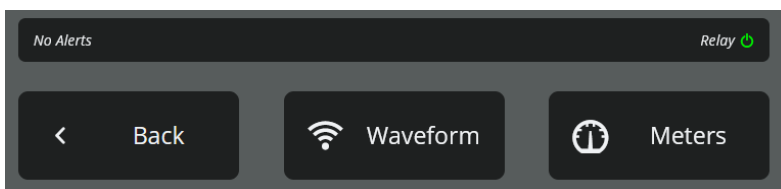
Overview will open a graph of 1 second averages that will show: RMS Voltage, Temperature, Humidity and Pressure

Select the Show Legends icon  to see data which follows your cursor location



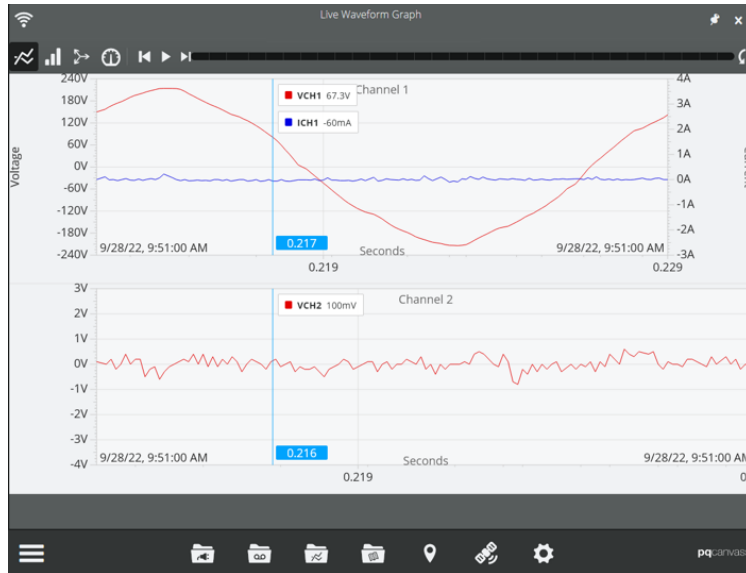
You can add annotations to a graph and save  to view later. See the 'Viewing Data from the Graphs Menu' section later in the manual for more information on the Icons at the bottom of the page.

Live Data displays a sub-menu to select Live Waveforms or a Live Meter display.

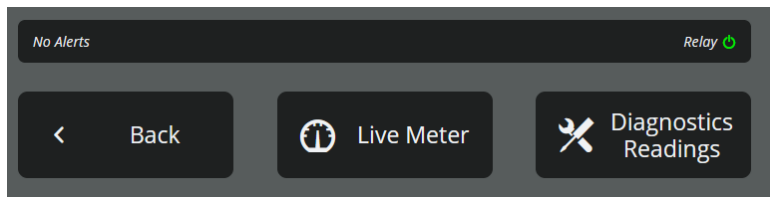


There will be a *Back* selection to go to the previous menu or an X in the upper right corner to close the window

Waveforms will stream a few cycles of live voltage and current waveforms.



Live Meters shows a sub-menu to select Live Meter or Diagnostic Readings



Live Meter will stream a few cycles of live data in a table view

	Ch 1	Ch 2
RMS Voltage	120.10 V	0.00 V
RMS Current	0.00 A	—
Real Power	0.00 kW	—
Reactive Power	0.00 KVAR	—
Apparent Power	0.00 kVA	—
Phase Angle	0.00°	—
Power Factor	0.00	—
Displacement Power Factor	0.00	—

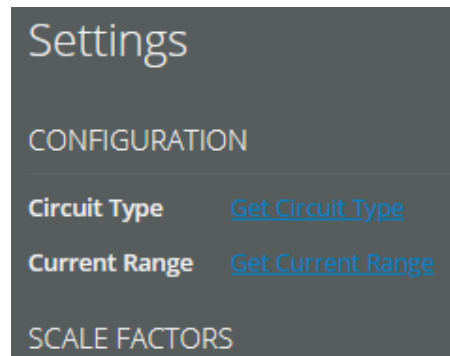
Current Range: 0 Amps

Diagnostic Readings will show some basic information about the selected recorder



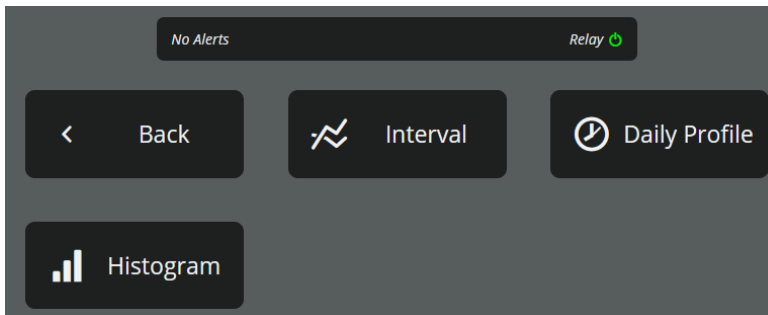
Firmware Version	1.37
# of Voltage Channels	2
# of Current Channels	1
Frequency	60.02 Hz
Lithium Battery	0.00 Volts
Nicad Battery	0.00 Volts
Temperature	36.00 °F

*Settings* lists information about the device and depending on the device a user can change the voltage and current Scale Factors of the graphs and/or the password of the Tensor relay. For Boomerang devices, select *Settings* to view and change the Circuit Type and Current Range as well as Scale Factors



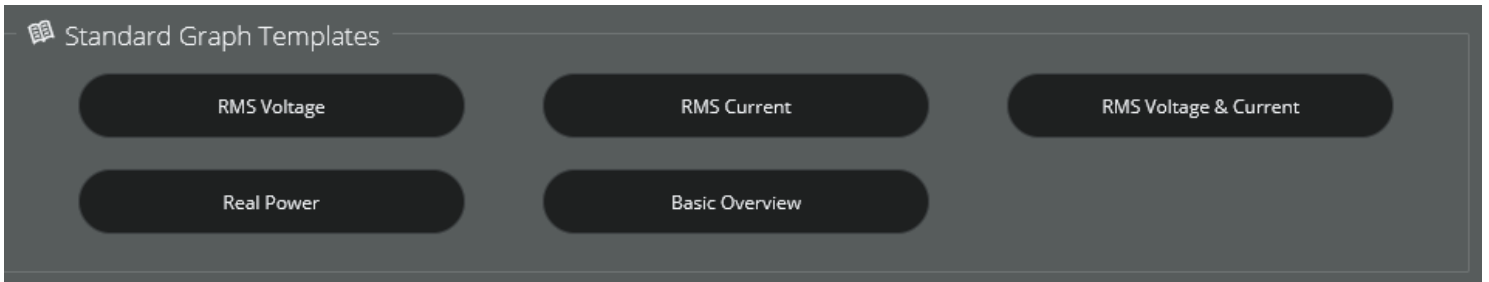
*Actions* can associate sub-devices

*Graphs* opens a sub-menu with more Graph selections

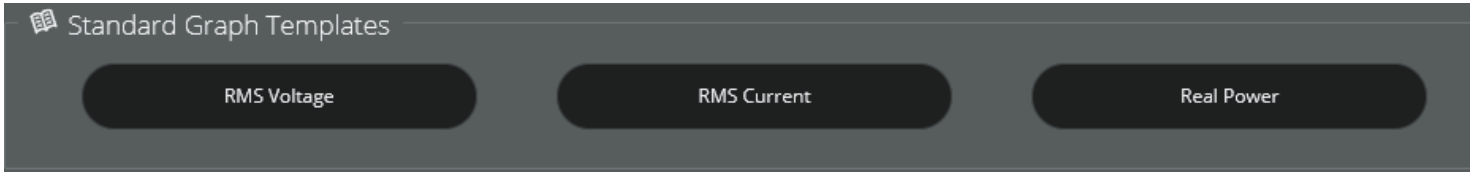


*Graphs* sub-menu

*Interval* sub-menu list specific standard graphs and will also list any custom graph templates created by the user



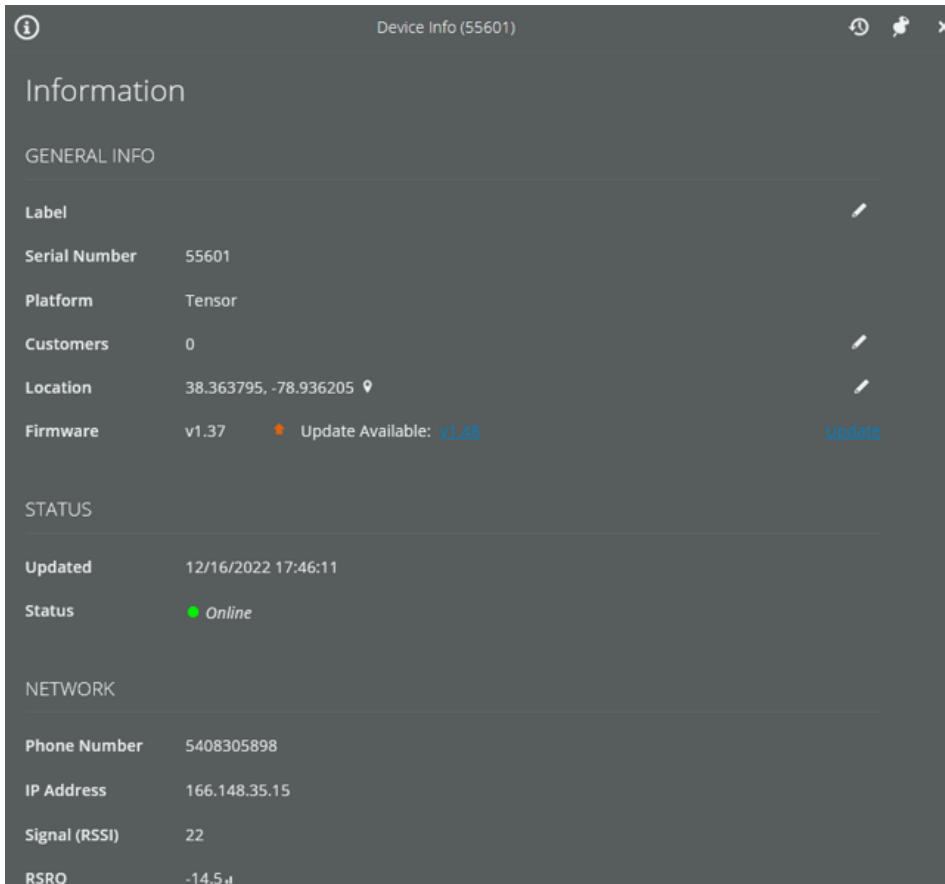
Daily Profiles sub-menu shows graph selections to display weekly trends – 7 days (adjustable) of accumulated data are shown for a 24-hour period



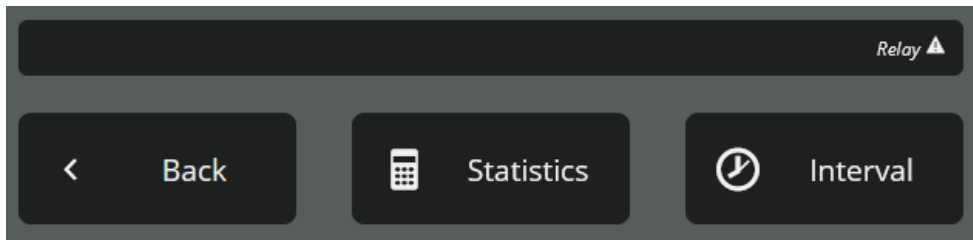
Histograms sub-menu shows graph selections also. Histograms are presented as a bar graph. The Interval can be adjusted from 1 second to 15 minutes



Info displays recorder information. Any pencil icon  is an area that can be edited

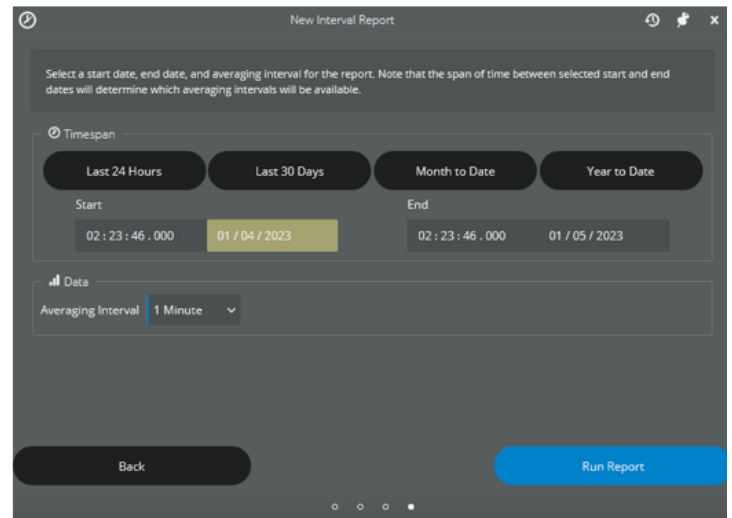
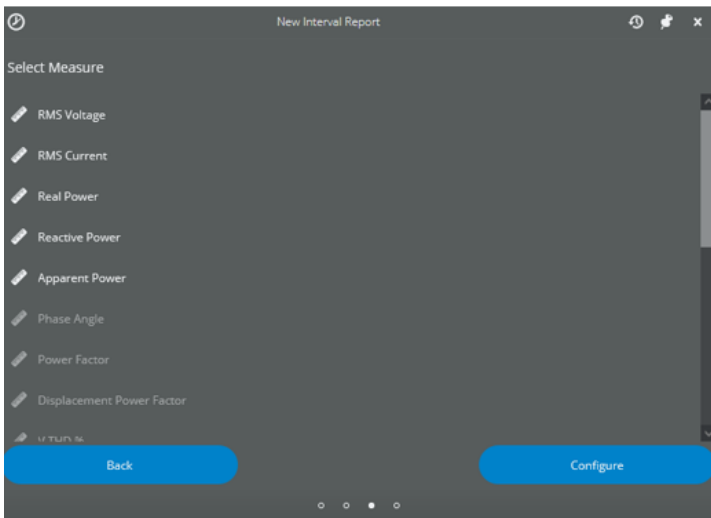


Reports opens a sub-menu

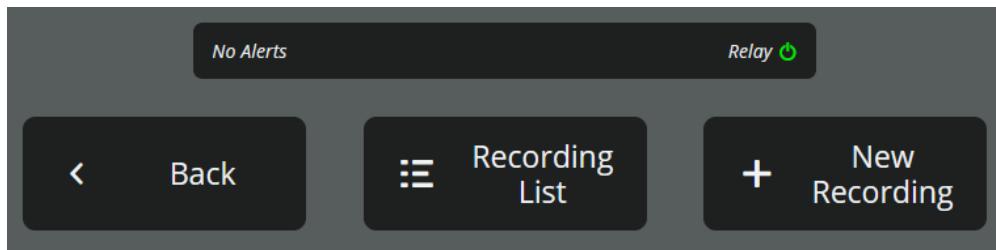


*Statistics* selections include Outage Lists, Outage Summary and Recloser Operations

*Interval* selections include many of the reports based on the graphs with selectable time frame and intervals



*Recordings* opens a sub-menu to see any recorded PQ (Power Quality) data files this recorder has saved and a selection to start a new recording.



Select *New Recording* to start a new PQ data file

In addition to the graphs, we have seen so far in this manual, the PMI recorders can be configured to record Power Quality (PQ) data files.

To start a PQ data file, the recorder will need to be initialized. Initializing has many options and what is recorded in a PQ data file can vary depending on the Initialization selections. The graphs and reports in a PQ data file will be based on the Recording Interval selected during the initialization. (Default is a 1 minute interval)

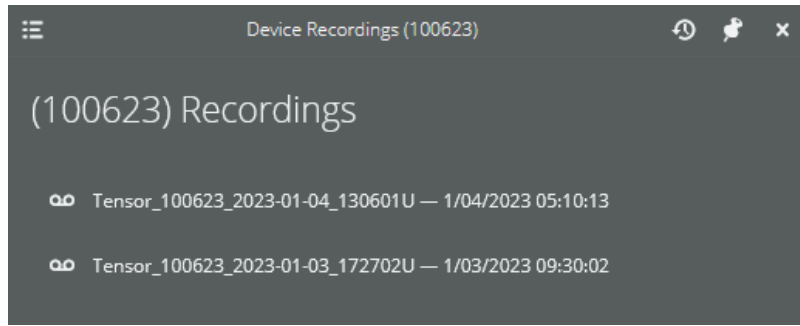
*NOTE: The PQ data file will continue to record until the next initialization. A recorder should be re-initialized after physically moving to a new location*


Select *New Recording* to begin. Select a template and modify the Initialization settings as needed and then choose *Start Recording*. See *Initialization Settings* later in this manual

Wait several minutes for the PQ recording to start

Select the *Recording List* for a list of one or more PQ files, the newest recording will be at the top

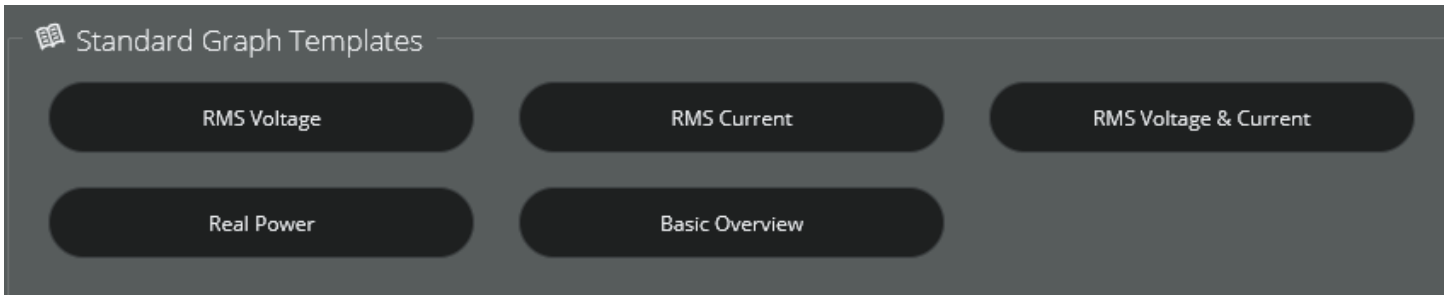
See *Viewing Data from PQ Data Files* later in this manual



Note: The Recording icon at the bottom of the page  will display all PQ data files for all your recorders.

## Viewing Interval Data from the Graphs Menu

From the Quick Access View Menu select *Graphs* then select *Interval*



Select a graph to view

To Zoom: Left click and drag area to zoom into, or select Timespan icon for specific range, or + sign  
Use back-arrow to un-zoom. Data information tracks according to the location of the mouse cursor



Sub Menu Icons will vary depending on the Graph or Report selected  
 Only 'highlighted' icons are selectable

- New Graph, Set Timespan, Show Table Customize Axis, Toggle Show/Hide Annotations,
- Select Tool, Save Graph Zoom Out, Zoom In, Back/undo, Home/Revert
- Next/Redo, Reload, Annotate Graph, Add Device, Graph Template Editor, Print Graph
- Per Unit Scaling, Ave(raging) Interval: Select 1 second (default) to 15 minutes

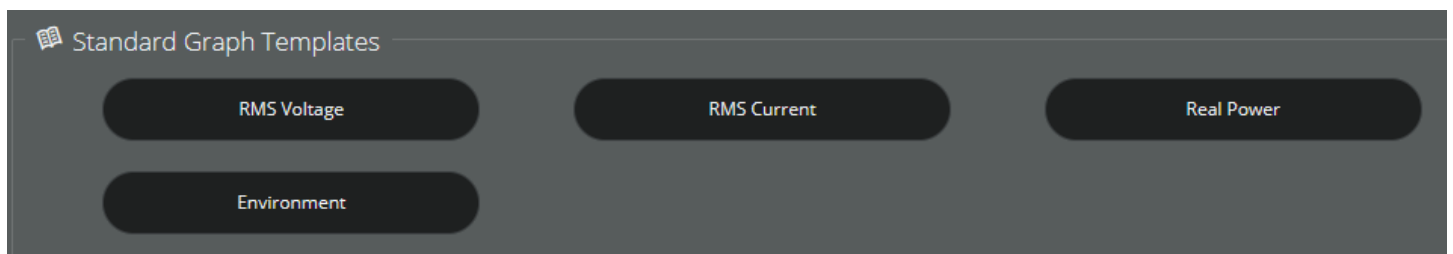
Select Tool: Legend follows cursor, can 'zoom' into a section of graph. Click to grab and move graph left or right. Click to lock onto a point, legend still follows cursor unless Show Table is selected.

Add multiple devices to an Interval, Daily Profile or Histogram graph. Select Add Device. A list of devices will appear, select one or more and then select **[Done]**, the data from the new device(s) will be added into the

graph



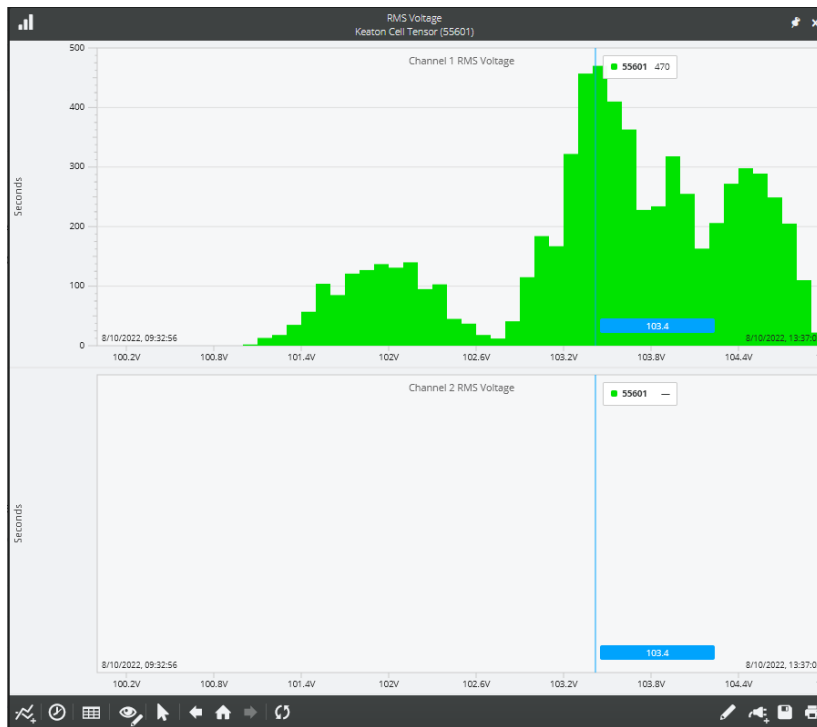
Select *Daily Profiles* from the *Graphs* Quick Access View Menu. Refer to 'Types of Data' for more information on Daily Profiles, later in the manual



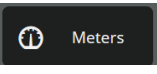
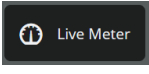
## RMS Voltage Daily Profiles – 24-hour averaging overview

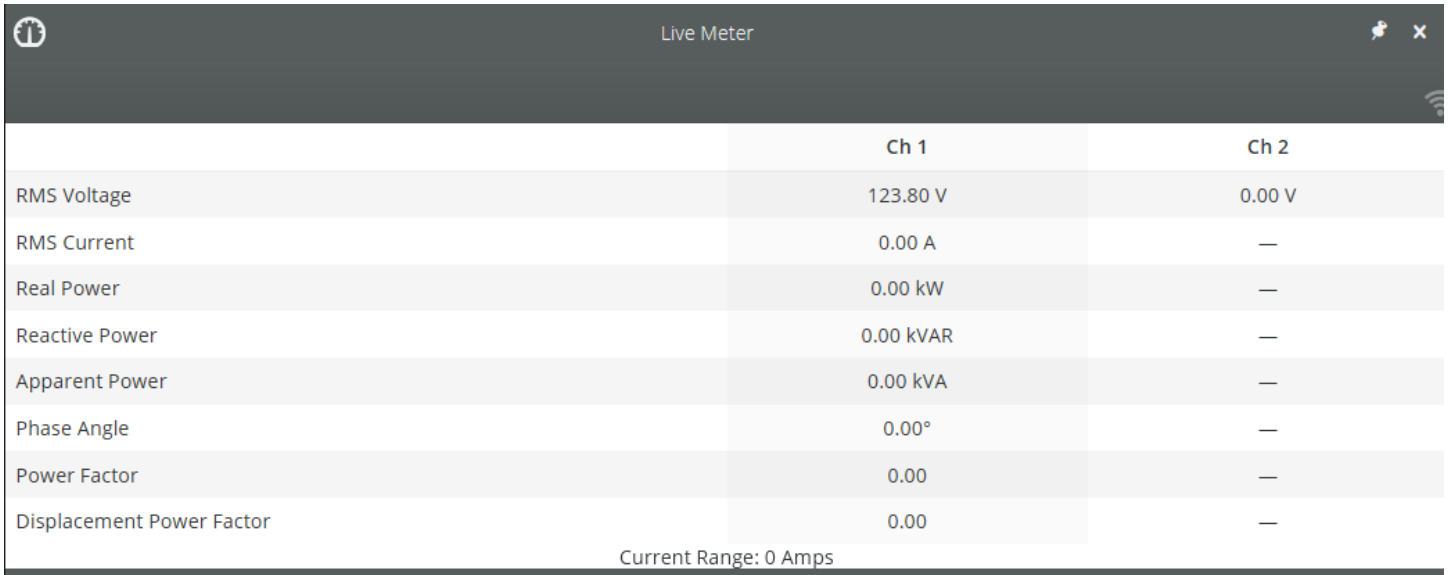


Select *Histograms* from the *Graphs Quick Access View Menu*, then select a graph template. Histograms display data in a column format. Refer to 'Types of Data' for more information on Histograms, later in the manual





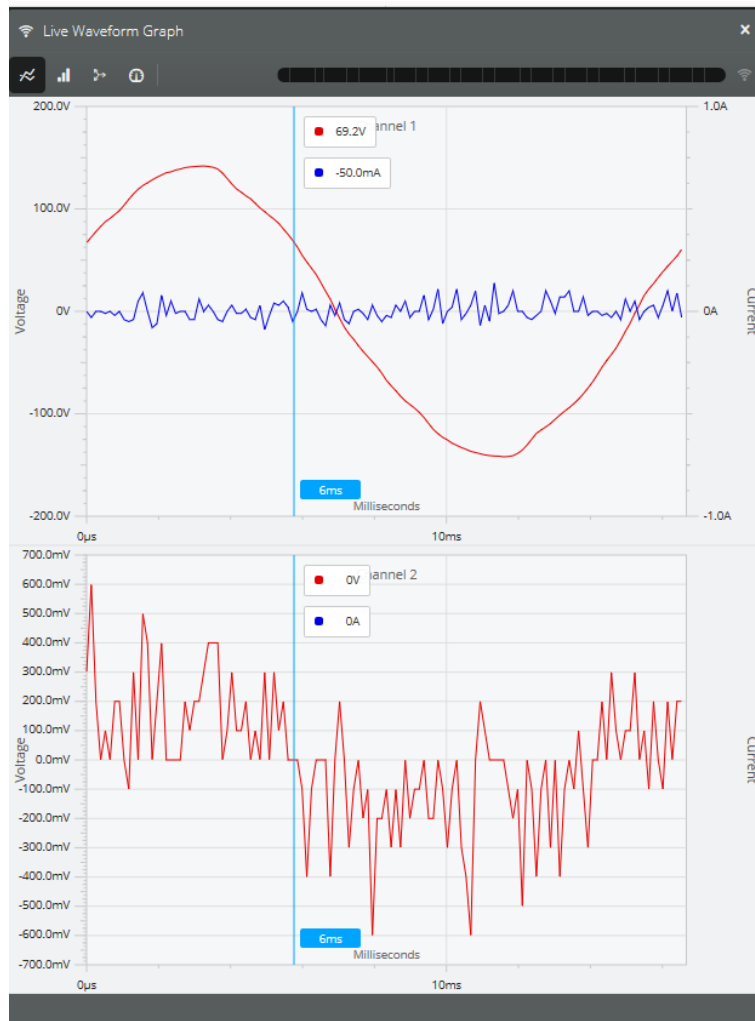
Select *Live Data* on the Quick Access View Menu then select  Meters and  to View live data



	Ch 1	Ch 2
RMS Voltage	123.80 V	0.00 V
RMS Current	0.00 A	—
Real Power	0.00 kW	—
Reactive Power	0.00 kVAR	—
Apparent Power	0.00 kVA	—
Phase Angle	0.00°	—
Power Factor	0.00	—
Displacement Power Factor	0.00	—

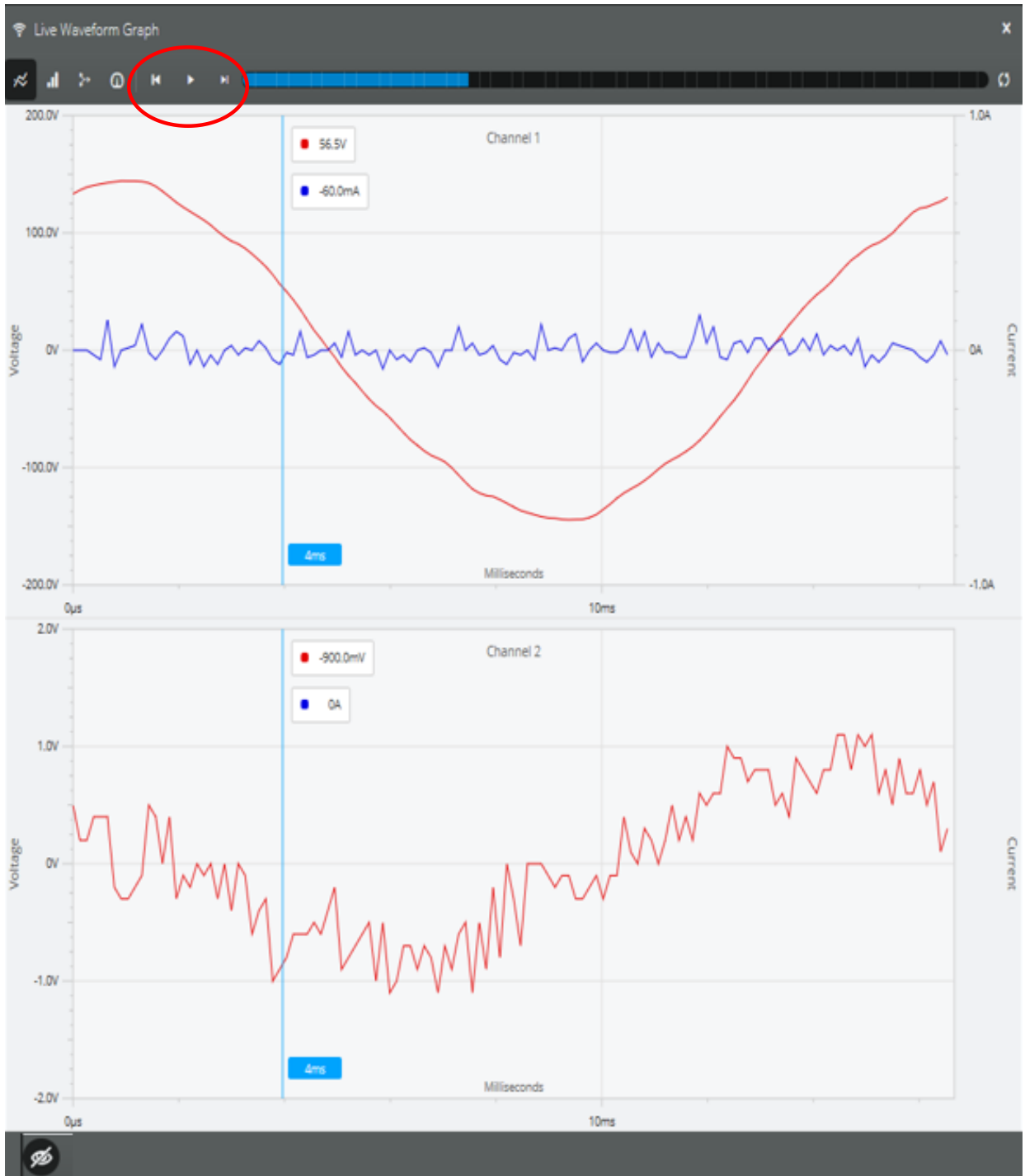
Current Range: 0 Amps


Select *Live Data* Quick Access View Menu then select  Meters and  to View a short burst of live waveform data




Live Waveform Data can be paused, restarted, and show previous and next frame

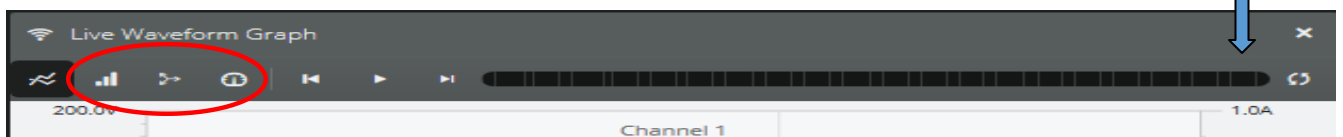




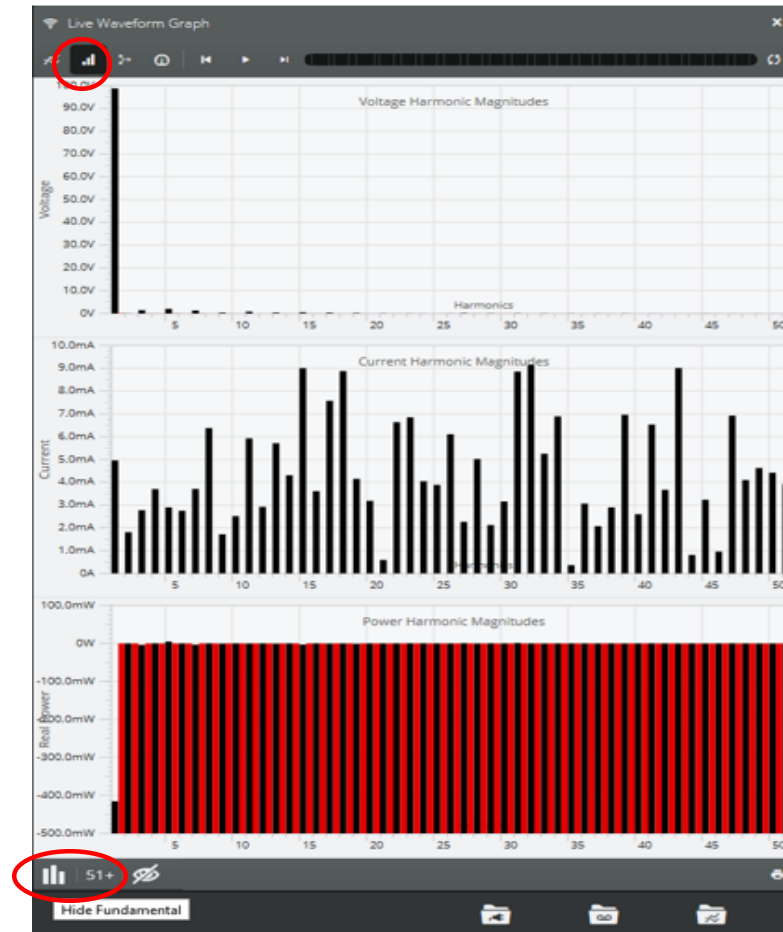
Select  to hide or show legends

Other [Live] views of the Waveform Captures are available


Restart Streaming Icon 



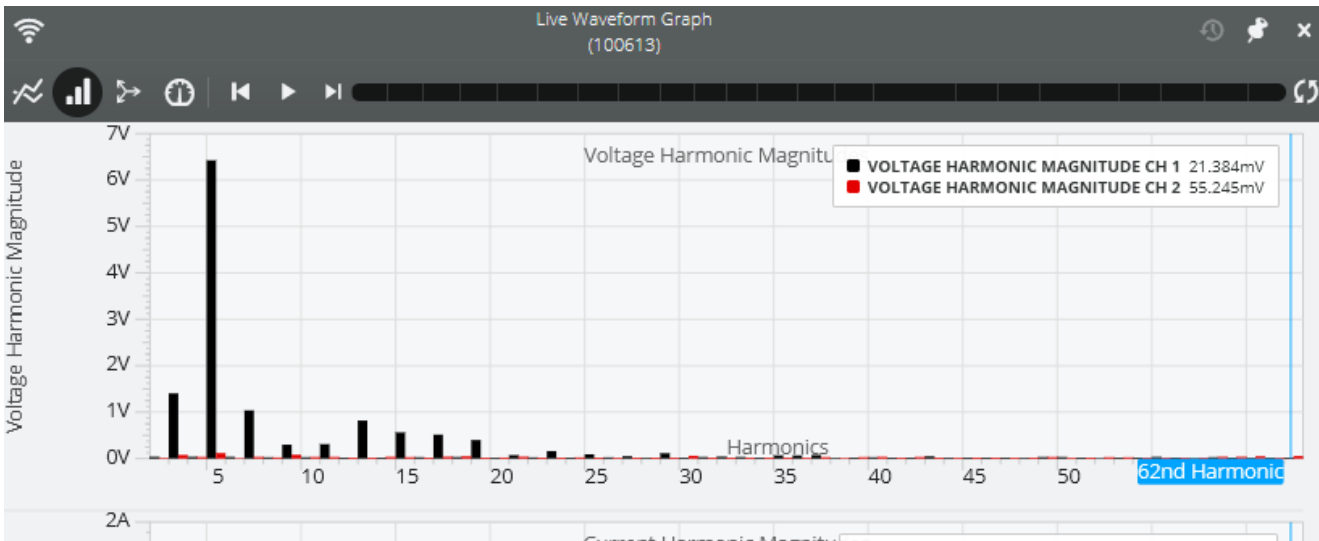
## Live Harmonics Graph



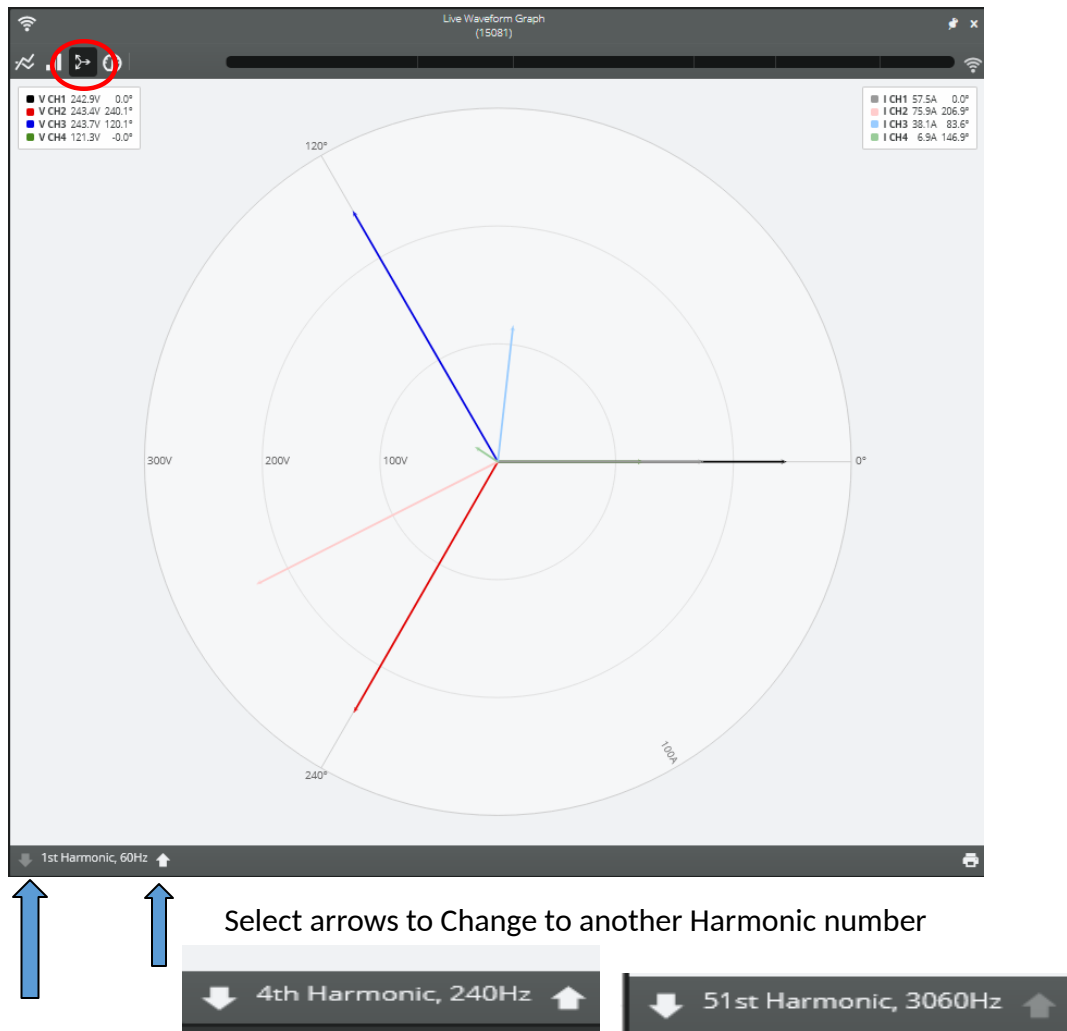
Select **51+** icon to extend the view to the 62<sup>nd</sup> harmonic

Select the **[Hide Fundamental]** icon  to remove the First Harmonic, then toggle Icon to return to original view

Top of live waveform graph showing 62<sup>nd</sup> harmonic and fundamental removed

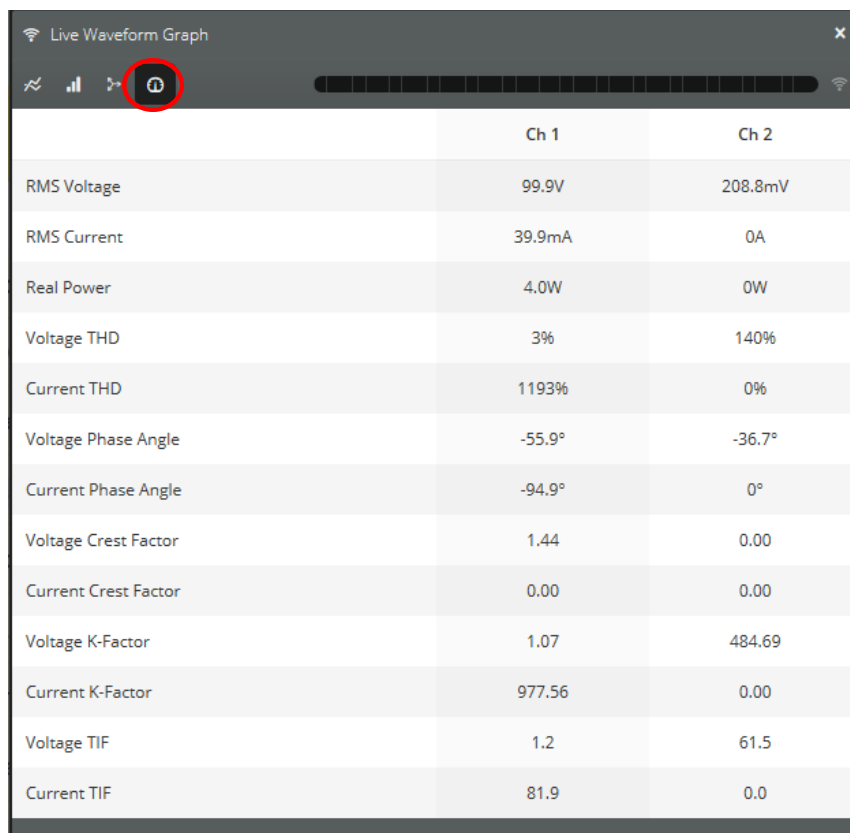


Live Vector Graph View icon 



Select arrows to Change to another Harmonic number

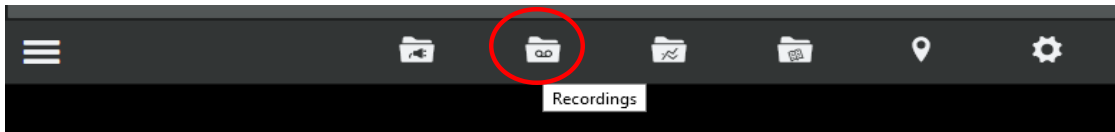
Live Meter View icon 




The screenshot shows a software interface titled "Live Waveform Graph" with a close button (X) in the top right corner. Below the title bar is a navigation bar containing several icons: a sine wave, a bar chart, a right-pointing arrow, and a meter icon (a circle with a vertical line) which is circled in red. To the right of these icons is a horizontal progress bar and a Wi-Fi signal icon. The main area of the interface is a table with three columns: a header column, "Ch 1", and "Ch 2". The table lists various power quality metrics and their corresponding values for each channel.

	Ch 1	Ch 2
RMS Voltage	99.9V	208.8mV
RMS Current	39.9mA	0A
Real Power	4.0W	0W
Voltage THD	3%	140%
Current THD	1193%	0%
Voltage Phase Angle	-55.9°	-36.7°
Current Phase Angle	-94.9°	0°
Voltage Crest Factor	1.44	0.00
Current Crest Factor	0.00	0.00
Voltage K-Factor	1.07	484.69
Current K-Factor	977.56	0.00
Voltage TIF	1.2	61.5
Current TIF	81.9	0.0

## Viewing Data from PQ Data Files



Select the Recordings  icon to display the list of all PQ data files. Or select *Recordings* on the Quick Access View Menu then *Recordings list* to see PQ files from individual devices

Name	S/N	Created	
Tensor_55607_2020-05-20_215628U	55607	5/20/2020	
Taylor's Amish Heater 05-21-2012.nsf	40891	5/15/2020	
Tensor_55602_2020-05-13_152955U	55602	5/13/2020	

Select a data file to show the Header Report – NOTE: File may still be actively recording

Data file Header Report

Seeker\_

Graph

Interval Daily Profile Histogram Waveform Capture 3D Harmonics

Report

Recording Interval Single-Cycle

General		Measures		Min	Ave	Max	
Title	Seeker_300577_2022-10-10_141125U			✓	✓	✓	
Serial Number	300577	Type		Ch 1	Ch 2	Ch 3	Ch 4
Recorded By	Horning Seeker	<a href="#">RMS Voltage</a>		✓	✓	✓	✓
Created	10/10/2022, 7:15 AM	<a href="#">RMS Current</a>		✓	✓	✓	✓
Overview		<a href="#">Real Power</a>		✓	✓	✓	✓
File Headers	—	<a href="#">Reactive Power</a>		✓	✓	✓	✓
Uploaded	No	<a href="#">Apparent Power</a>		✓	✓	✓	✓
Start	10/10/2022, 7:12:00 AM	<a href="#">Phase Angle</a>		✓	✓	✓	✓
End	12/16/2022, 10:19:00 AM	<a href="#">Power Factor</a>		✓	✓	✓	✓
Duration	67 days, 04:07:00	<a href="#">Displacement Power Factor</a>		✓	✓	✓	✓
Platform	Seeker	Scale Factors					
Firmware	1.47						
Software	3.0						
Circuit Type	Wye						
Current Range	20A						
Interval	60 seconds						
Events							
Waveform Capture	<a href="#">31</a>						
Transient Capture	0						
CBEMA	<a href="#">49</a>						
Event Change	<a href="#">1,002</a>						
Significant Change	<a href="#">435</a>						
Flicker	0						
Power Outage	<a href="#">2</a>						
Abnormal Voltage	0						

Highlighted areas are Quick links that will open a graph or report.

Pencil icons  are areas that can be edited



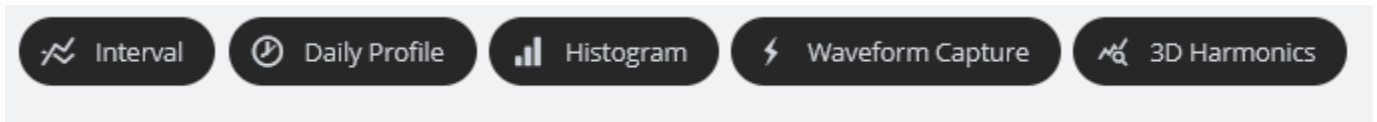
## Edit Scale Factor settings

Save New Scale Factor Settings

Undo Scale Factor Changes

Scale Factors	Ch 1	Ch 2
Voltage	1	1
Current	1	1

Select *Interval* from Header Report to view recorded strip chart data



Graph Selections



Interval

Daily Profile



















Histogram

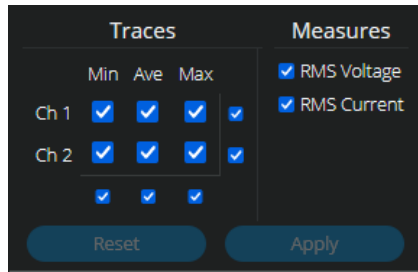
Waveform Capture

Select *Interval* then select RMS Voltage and Current graph

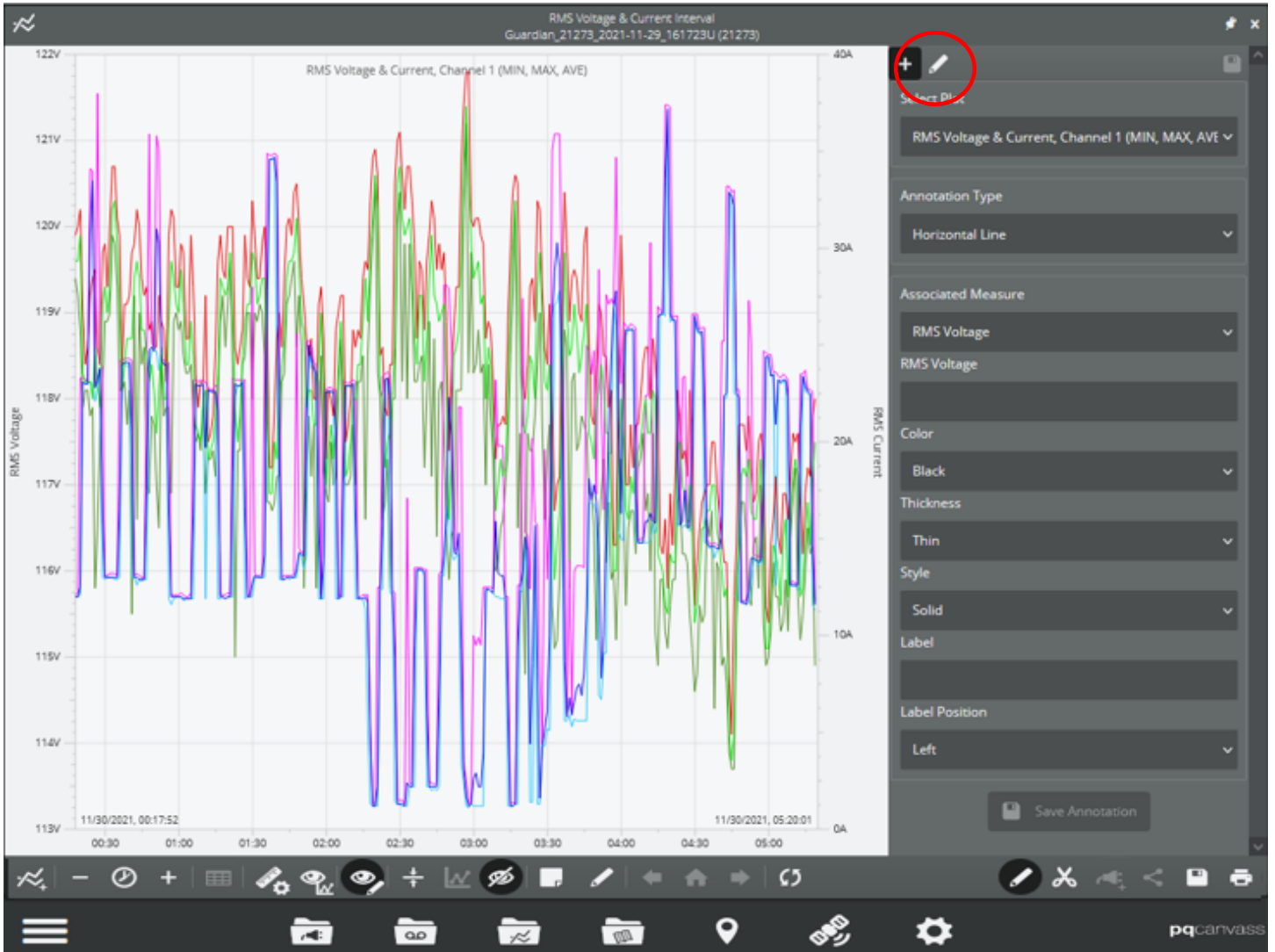
The RMS Voltage and Current graph shows min, max, and averages. The user's cursor shows information about the data points for the cursors position (select  to see more or less information) Waveform Capture overlays  can be applied to the graphs to show where the captures occurred





-  New Graph,  Set Timespan,  Customize Axis,  Toggle Show/Hide Annotations,  Select Tool,
-  Save Graph  Zoom Out,  Zoom In,  Toggle Graph Overlays,  Back/undo,  Home/Revert
-  Next/Redo,  Reload,  Annotate Graph,  Graph Template Editor,  Print Graph,  Per Unit Scaling
-  Quick Editor lets you de-select graph traces, or re-select them as needed




## Annotate Graphs



Select the  palette to Show Annotations (highlights icon as shown) and the  Annotate Graph to see the above view.

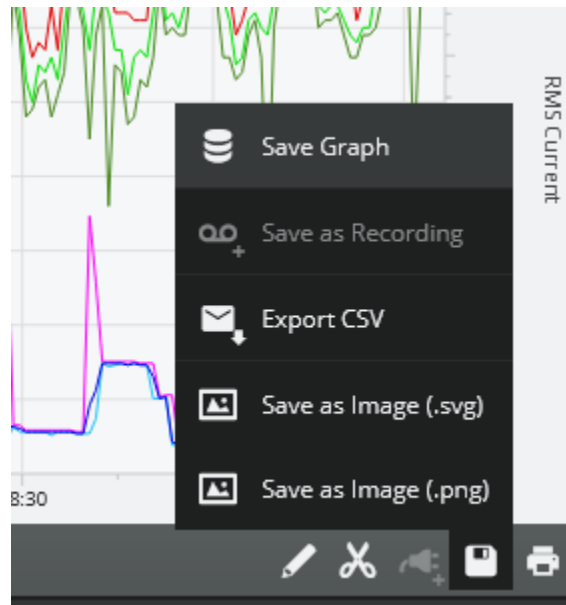
Choose your annotation type: Horizontal line, Vertical line, Arrow, or Text, then change color, size, thickness, or style. Add a Label to the annotation and position the label on the graph. Select **[Save Annotation]** after each addition.

Use the  pencil at the top to edit saved annotations




When completed, saving the annotated graph stores it under the data file.

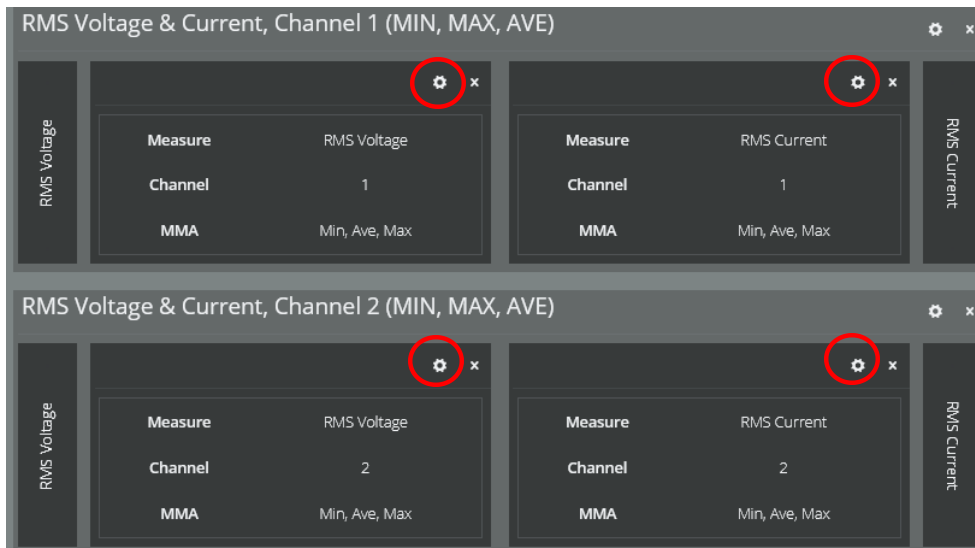
Additionally save the graph  as an image file or CSV report file





## Edit Graphs

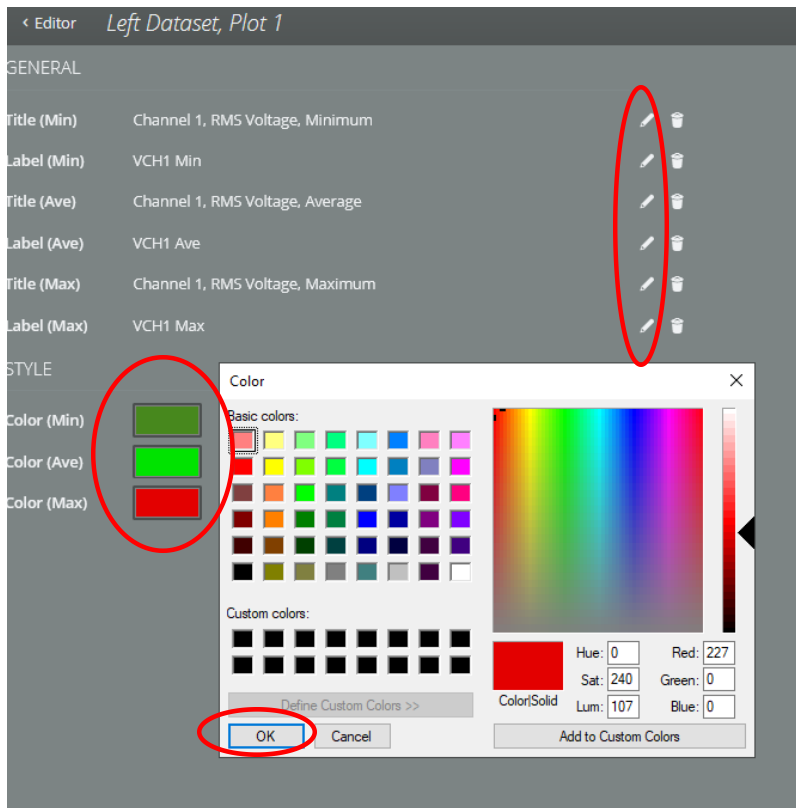
The Graph Template Editor can be used to adjust the default colors, labels, and titles of a displayed graph. Open a graph and select the Graph Template Editor  icon. Depending on the graph that was opened, and the recorder used, you may see 1 to 4 channels displayed.

Select a Configure Dataset  icon in the area you want to modify.



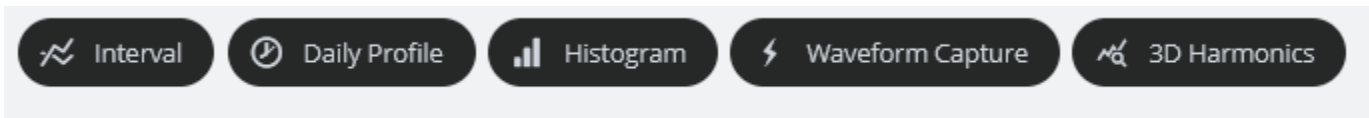
Select a pencil  icon to modify the associated line or a color button to modify the Min, Ave, or Max colors. Once you have finished the modification, select <Editor to go to the previous page. Make any other changes to the other channels. Select the  (will appear on the previous page) to load the modified graph. Save the graph as needed



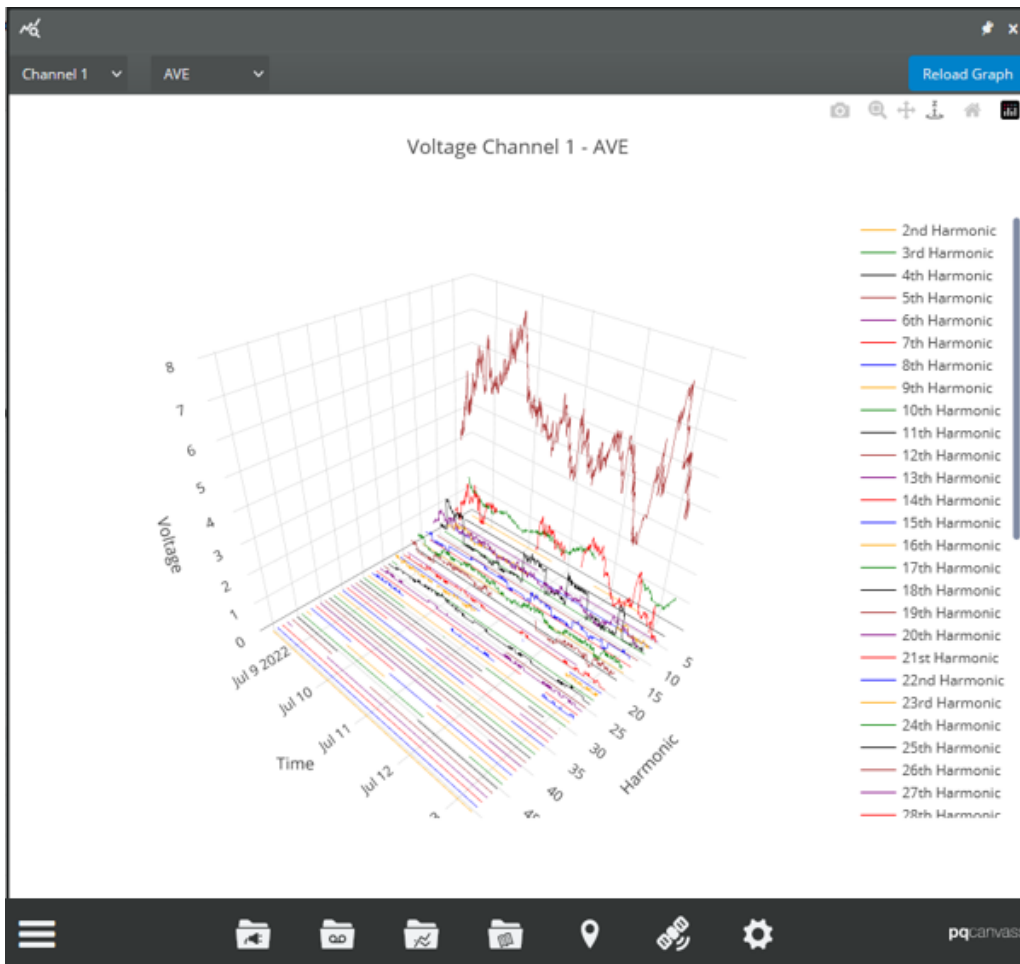


## 3D Harmonic Graphs

Select a data file that was configured to record Harmonics. In the Header Report select 3D Harmonics



Select either Voltage or Current and the Channel 1 Average 3D graph will be shown. You can select other channels and MAX, MIN, or AVE, then select Reload Graph to view. [Reload Graph](#)



## Adjusting the 3D graph






Once the 3D graph is open you can ‘Zoom’ in and out, tilt, pan and change position of the graph.

For laptop computers, it is easier to use the wheel of your mouse or drag 2 fingers up or down on a touchpad to ‘Zoom’ the graph in and out.

To tilt or rotate the graph using a mouse, place the cursor in the graph area and while holding the left mouse button move the mouse. For a touchpad, one way is to hold the left corner down with one finger and use a second finger to rotate or tilt the graph.

To move or reposition the graph on the page using a mouse, place the cursor in the graph area and hold the right mouse button, then drag the mouse to position the graph. Using a touchpad, hold the right corner with one finger and use a second finger to position the graph.

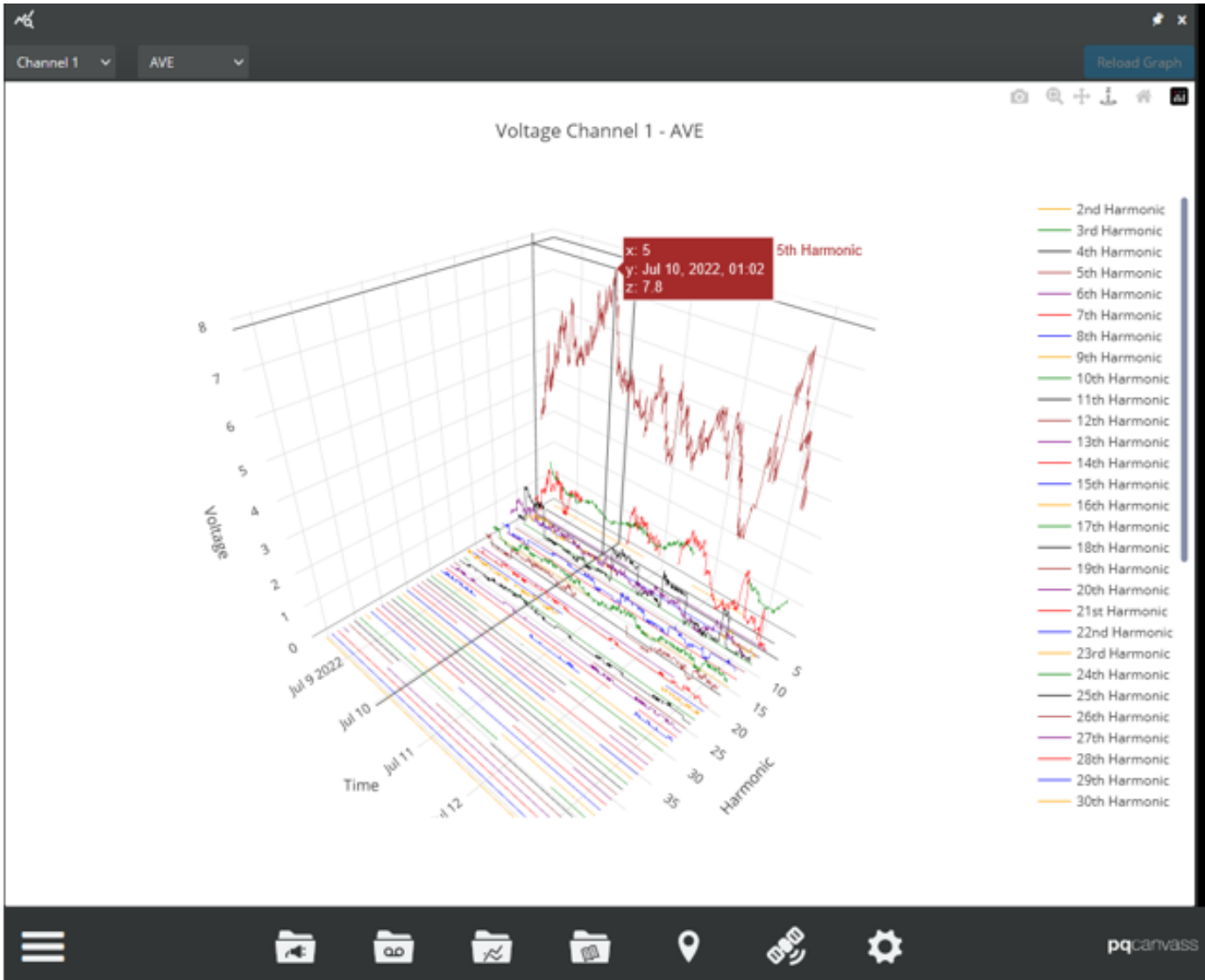
If you are accessing PQ Canvass from a phone or tablet, use the icons that appear at the upper right of the 3D graph to adjust the graph location.

Zoom , Pan , Turntable , Reset camera to default , or download as a png file 





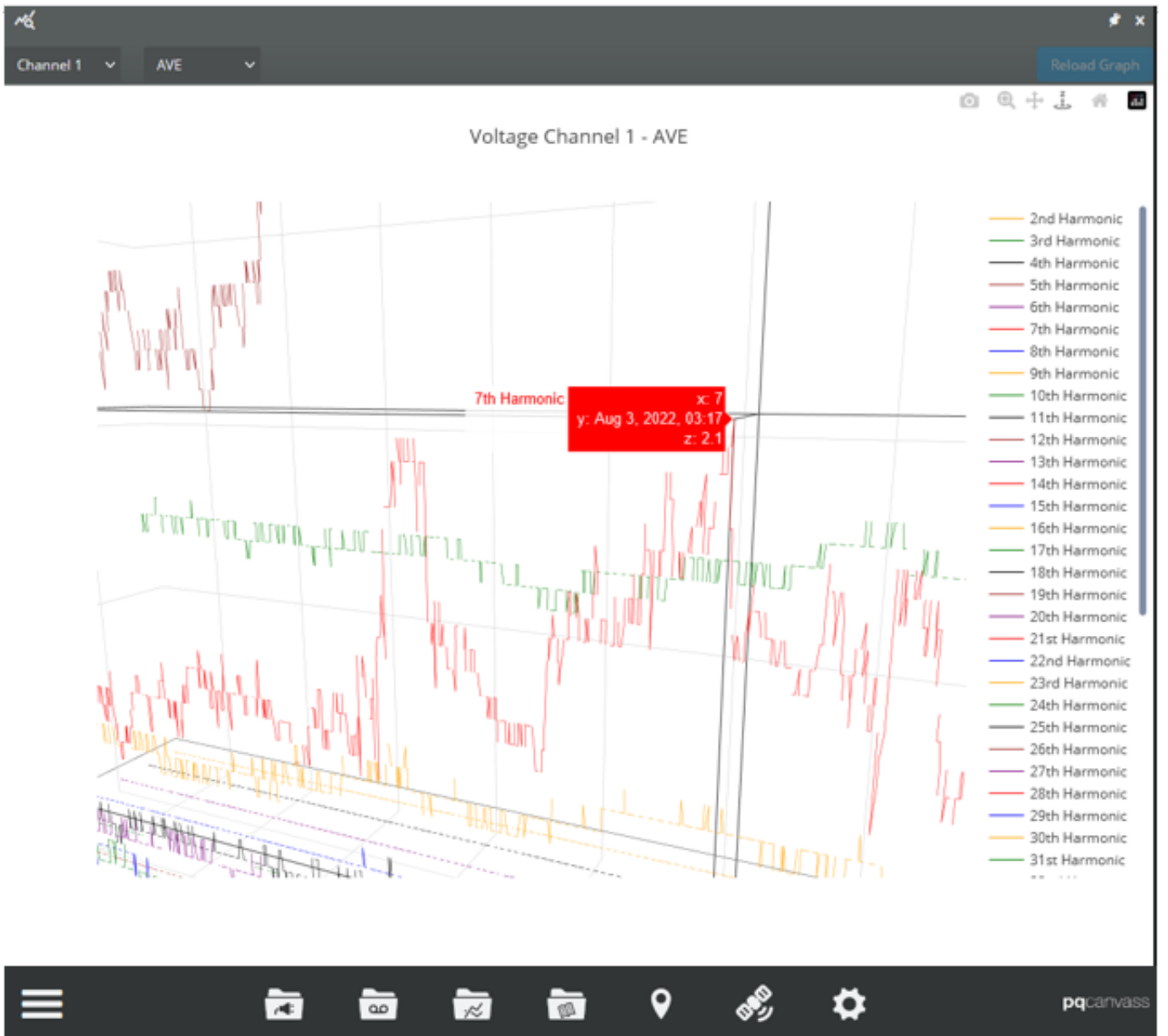
Placing the cursor on a point will give the coordinates and data of that point.



Showing the 5<sup>th</sup> Harmonic on July 10, 2022, at 1:02 AM with a voltage of 7.8v

Rotating and Zooming into a point may give you more precision in pinpointing a specific time or harmonic.



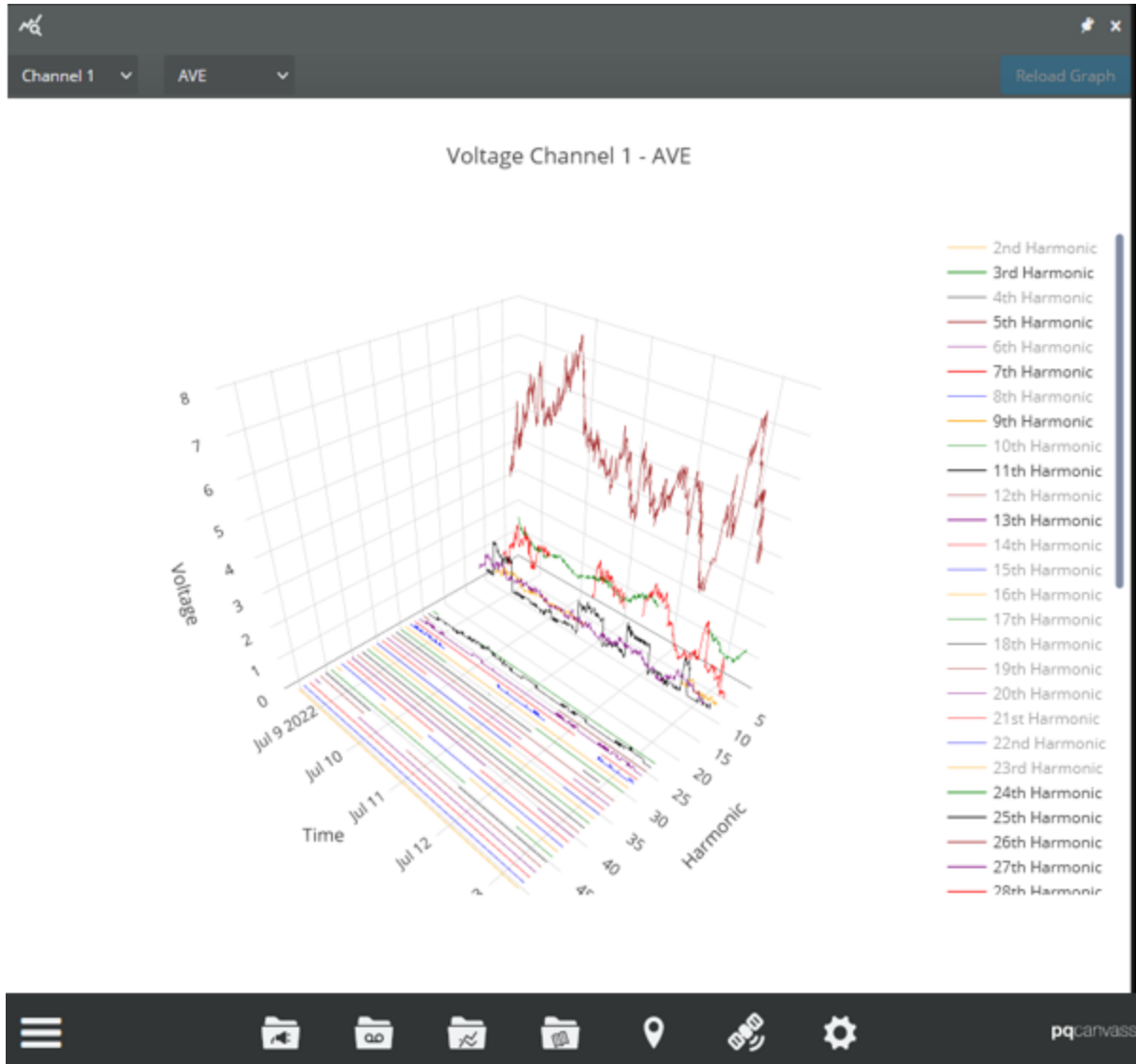


## Removing Harmonics from the 3D Graph

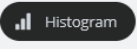
Listed on the Right side are the recorded Harmonics. De-select less important harmonics to enhance the view of the remaining harmonics.

Selecting each harmonic will remove that harmonic from the 3D graph.

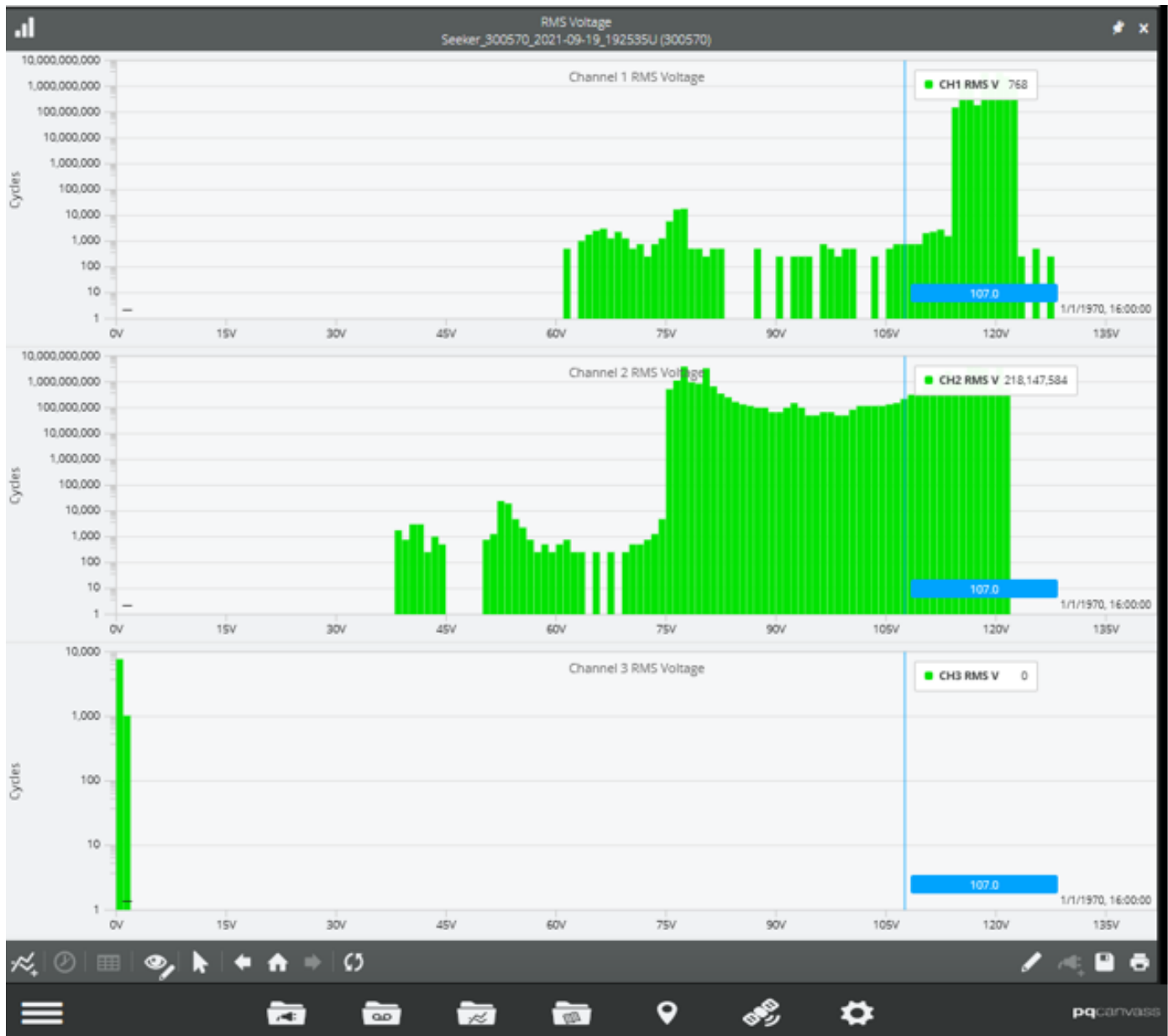
The de-selected harmonics will appear grayed out in the list.




# Histogram

Use Histogram to view Voltage, Current, Power, and other settings (depending on the recorder model and settings) by selecting the Histogram button  from a recording Header Report.

Histograms show the data in columns and the height of each column determines the number of cycles that occurred for the whole record time. You can zoom in and out to highlight specific columns.












# Daily Profile

Use Daily Profile to view Voltage, Current, Power, and other settings (depending on the recorder model and settings) by selecting the Daily Profile button  from a recording Header Report.

Daily Profiles combines up to 7 days of data into a 24-hour graph. There are 96 15-minute bins in the graph. Throughout the recording the average value of each quantity is added to the appropriate bin. The Daily Profile graphs are designed to help detect daily patterns or trends.



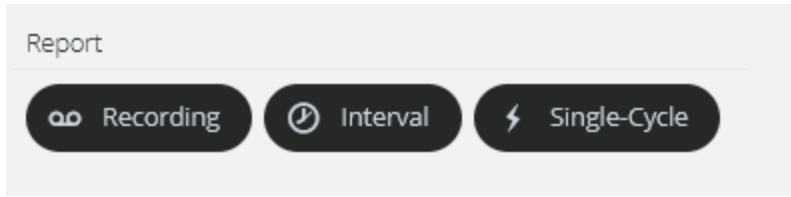
Viewing Daily Profiles from the Device Information page will show additional options, such as: set timespan , show deviation , weekdays only , show/hide table , show/hide annotation , show/hide points , per unit scaling , hide/show legends , select arrow or point tool . Use the timespan setting to adjust from the default 7 days to a month or even a year of data. Standard deviations will add the daily range to each bin, showing the fluctuations that occur.





# Viewing Reports from PQ Data Files

On the PQ Data File Header Report there are selections to view different types of reports



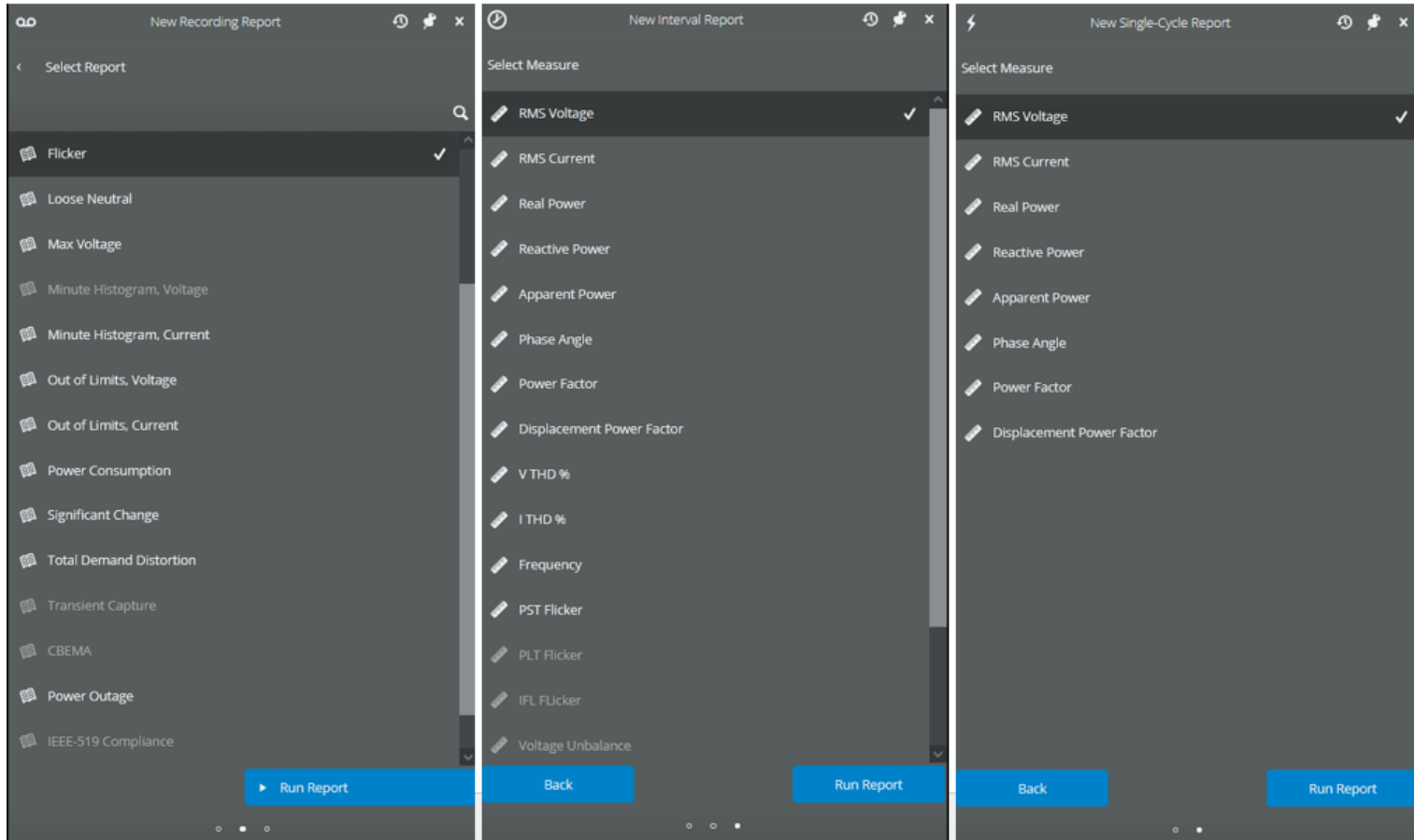
Select *Recording* to view reports that were created based on a Trigger setting

Select *Interval* to see reports based on the strip chart data recorded


Select *Single-Cycle* to see Histogram reports

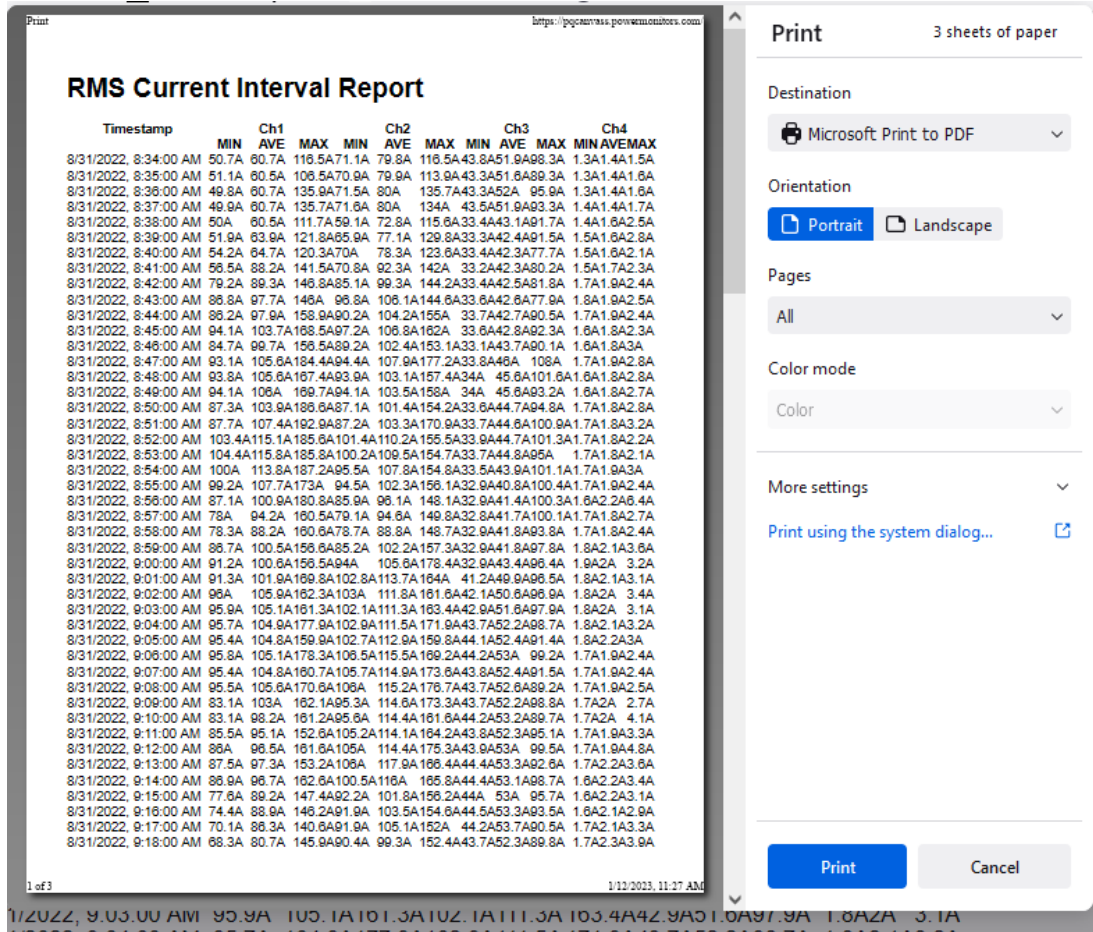
See Data Types later in this manual for information on triggered and non-triggered data.

From the selected data file, select the desired report and then select **[Run Report]** to open



Some reports may have additional configuration needed before opening, such as setting start and stop time.

Once a report is open, save it to a file or print it by selecting the Print  icon



**RMS Current Interval Report**

Timestamp	Ch1			Ch2			Ch3			Ch4		
	MIN	AVE	MAX	MIN	AVE	MAX	MIN	AVE	MAX	MIN	AVE	MAX
8/31/2022, 8:34:00 AM	50.7A	60.7A	116.5A71.1A	79.8A	116.5A43.8A51.9A98.3A	1.3A1.4A1.5A						
8/31/2022, 8:35:00 AM	51.1A	60.5A	108.5A70.9A	79.9A	113.9A43.3A51.6A89.3A	1.3A1.4A1.6A						
8/31/2022, 8:36:00 AM	49.8A	60.7A	135.9A71.5A	80A	135.7A43.3A52A	95.9A	1.3A1.4A1.6A					
8/31/2022, 8:37:00 AM	49.9A	60.7A	135.7A71.6A	80A	134A	43.5A51.9A93.3A	1.4A1.4A1.7A					
8/31/2022, 8:38:00 AM	50A	60.5A	111.7A59.1A	72.8A	115.6A33.4A43.1A91.7A	1.4A1.6A2.5A						
8/31/2022, 8:39:00 AM	51.9A	63.9A	121.8A65.9A	77.1A	129.8A33.3A42.4A91.5A	1.5A1.6A2.8A						
8/31/2022, 8:40:00 AM	54.2A	64.7A	120.3A70A	78.3A	123.6A33.4A42.3A77.7A	1.5A1.6A2.1A						
8/31/2022, 8:41:00 AM	56.5A	68.2A	141.5A70.8A	92.3A	142A	33.2A42.3A80.2A	1.5A1.7A2.3A					
8/31/2022, 8:42:00 AM	79.2A	89.3A	146.8A85.1A	99.3A	144.2A33.4A42.5A81.8A	1.7A1.9A2.4A						
8/31/2022, 8:43:00 AM	86.8A	97.7A	146A	96.8A	106.1A144.6A33.6A42.6A77.9A	1.8A1.9A2.5A						
8/31/2022, 8:44:00 AM	86.2A	97.9A	158.9A90.2A	104.2A155A	33.7A42.7A90.5A	1.7A1.9A2.4A						
8/31/2022, 8:45:00 AM	94.1A	103.7A168.5A97.2A	106.8A182A	33.6A42.8A92.3A	1.6A1.8A2.3A							
8/31/2022, 8:46:00 AM	84.7A	99.7A	156.5A89.2A	102.4A153.1A33.1A43.7A90.1A	1.6A1.8A3A							
8/31/2022, 8:47:00 AM	93.1A	105.6A184.4A94.4A	107.9A177.2A33.8A46A	108A	1.7A1.9A2.8A							
8/31/2022, 8:48:00 AM	93.8A	105.6A167.4A93.9A	103.1A157.4A34A	45.6A101.6A1.6A1.8A2.8A								
8/31/2022, 8:49:00 AM	94.1A	106A	169.7A94.1A	103.5A158A	34A	45.6A93.2A	1.6A1.8A2.7A					
8/31/2022, 8:50:00 AM	87.3A	103.9A186.6A87.1A	101.4A154.2A33.6A44.7A94.8A	1.7A1.8A2.8A								
8/31/2022, 8:51:00 AM	87.7A	107.4A192.9A87.2A	103.3A170.9A33.7A44.6A100.9A1.7A1.8A3.2A									
8/31/2022, 8:52:00 AM	103.4A115.1A185.6A101.4A110.2A155.5A33.9A44.7A101.3A1.7A1.8A2.2A											
8/31/2022, 8:53:00 AM	104.4A115.8A185.8A100.2A109.5A154.7A33.7A44.8A95A											
8/31/2022, 8:54:00 AM	100A	113.8A187.2A95.5A	107.8A154.8A33.5A43.9A101.1A1.7A1.9A3A									
8/31/2022, 8:55:00 AM	99.2A	107.7A173A	94.5A	102.3A156.1A32.9A40.8A100.4A1.7A1.9A2.4A								
8/31/2022, 8:56:00 AM	87.1A	100.9A180.8A85.9A	96.1A	148.1A32.9A41.4A100.3A1.6A2.2A6.4A								
8/31/2022, 8:57:00 AM	78A	94.2A	180.5A79.1A	94.6A	149.8A32.8A41.7A100.1A1.7A1.8A2.7A							
8/31/2022, 8:58:00 AM	78.3A	88.2A	180.6A78.7A	88.8A	148.7A32.9A41.8A93.8A	1.7A1.8A2.4A						
8/31/2022, 8:59:00 AM	86.7A	100.5A159.6A85.2A	102.2A157.3A32.9A41.8A97.8A	1.8A2.1A3.6A								
8/31/2022, 9:00:00 AM	91.2A	100.6A159.5A94A	105.6A178.4A32.9A43.4A96.4A	1.9A2A	3.2A							
8/31/2022, 9:01:00 AM	91.3A	101.6A189.8A102.8A113.7A184A	41.2A49.9A96.5A	1.8A2.1A3.1A								
8/31/2022, 9:02:00 AM	98A	105.6A182.3A103A	111.8A181.6A42.1A50.8A98.9A	1.8A2A	3.4A							
8/31/2022, 9:03:00 AM	95.9A	105.1A181.3A102.1A111.3A183.4A42.9A51.6A97.9A	1.8A2A	3.1A								
8/31/2022, 9:04:00 AM	95.7A	104.9A177.9A102.9A111.5A171.9A43.7A52.2A98.7A	1.8A2.1A3.2A									
8/31/2022, 9:05:00 AM	95.4A	104.8A159.9A102.7A112.9A159.8A44.1A52.4A91.4A	1.8A2.2A3A									
8/31/2022, 9:06:00 AM	95.8A	105.1A178.3A108.5A115.5A169.2A44.2A53A	99.2A	1.7A1.9A2.4A								
8/31/2022, 9:07:00 AM	95.4A	104.8A180.7A105.7A114.9A173.6A43.8A52.4A91.5A	1.7A1.9A2.4A									
8/31/2022, 9:08:00 AM	95.5A	105.6A170.6A108A	115.2A176.7A43.7A52.6A89.2A	1.7A1.9A2.5A								
8/31/2022, 9:09:00 AM	83.1A	103A	162.1A95.3A	114.6A173.3A43.7A52.2A98.8A	1.7A2A	2.7A						
8/31/2022, 9:10:00 AM	83.1A	98.2A	161.2A95.6A	114.4A181.6A44.2A53.2A89.7A	1.7A2A	4.1A						
8/31/2022, 9:11:00 AM	85.5A	95.1A	152.6A105.2A114.1A164.2A43.8A52.3A95.1A	1.7A1.9A3.3A								
8/31/2022, 9:12:00 AM	88A	96.5A	161.6A105A	114.4A175.3A43.9A53A	99.5A	1.7A1.9A4.8A						
8/31/2022, 9:13:00 AM	87.5A	97.3A	153.2A106A	117.9A166.4A44.4A53.3A92.6A	1.7A2.2A3.6A							
8/31/2022, 9:14:00 AM	86.9A	96.7A	162.6A100.5A116A	165.8A44.4A53.1A98.7A	1.6A2.2A3.4A							
8/31/2022, 9:15:00 AM	77.6A	89.2A	147.4A92.2A	101.8A156.2A44A	53A	95.7A	1.6A2.2A3.1A					
8/31/2022, 9:16:00 AM	74.4A	88.9A	146.2A91.9A	103.5A154.6A44.5A53.3A93.5A	1.6A2.1A2.9A							
8/31/2022, 9:17:00 AM	70.1A	86.3A	140.6A91.9A	105.1A152A	44.2A53.7A90.5A	1.7A2.1A3.3A						
8/31/2022, 9:18:00 AM	68.3A	80.7A	145.9A90.4A	99.3A	152.4A43.7A52.3A89.8A	1.7A2.3A3.9A						

1 of 3 1/12/2023, 11:27 AM

Choose the destination and select **[Print]**

## New Recording/Recorder Initialization

To start a new recording (which creates a Power Quality (PQ) data file) the recorder will need to be initialized. Select the device you are starting the new recording on, then from the *Quick Access View* page, select *Recordings* and *New Recording*

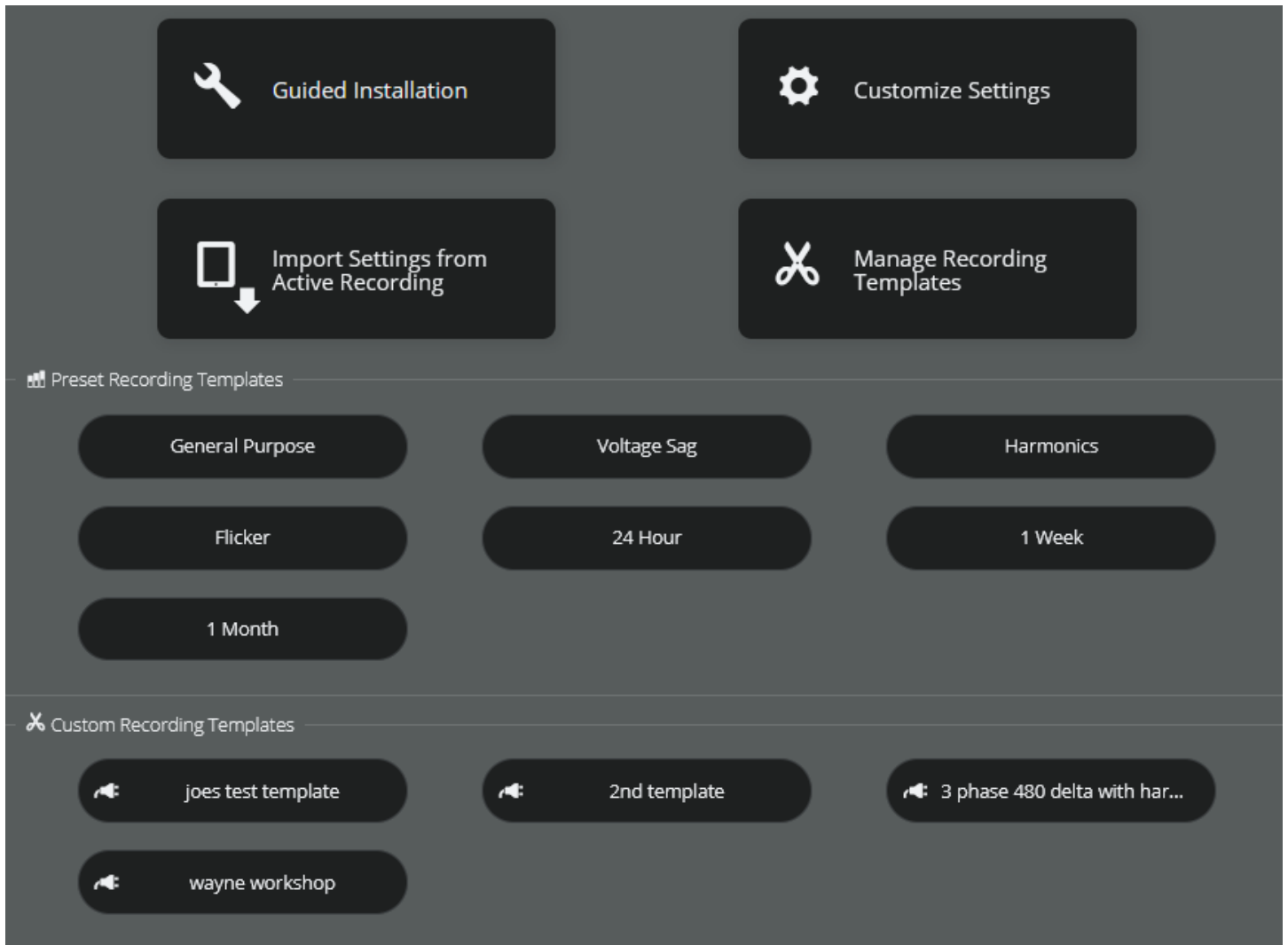
*When moving a recorder to a new site, the recorder should be initialized, which will create a new PQ data file. If the recorder is not re-initialized, the data file will continue to append new data to the old file.*

*New recorders will need to be initialized to start a PQ recording*

There are several pre-set templates as well as a Guided Installation to choose from.

You can also create custom recording templates that match the type of recording you want to do. At times you may want a simple voltage only data file, other times an IEEE 519 file may be needed. A recorder will only 'pick up' the settings that it can use. If you create a custom template with 4 channels of voltage, it can be used for 3 channel recorders, the 4<sup>th</sup> channel settings will be ignored





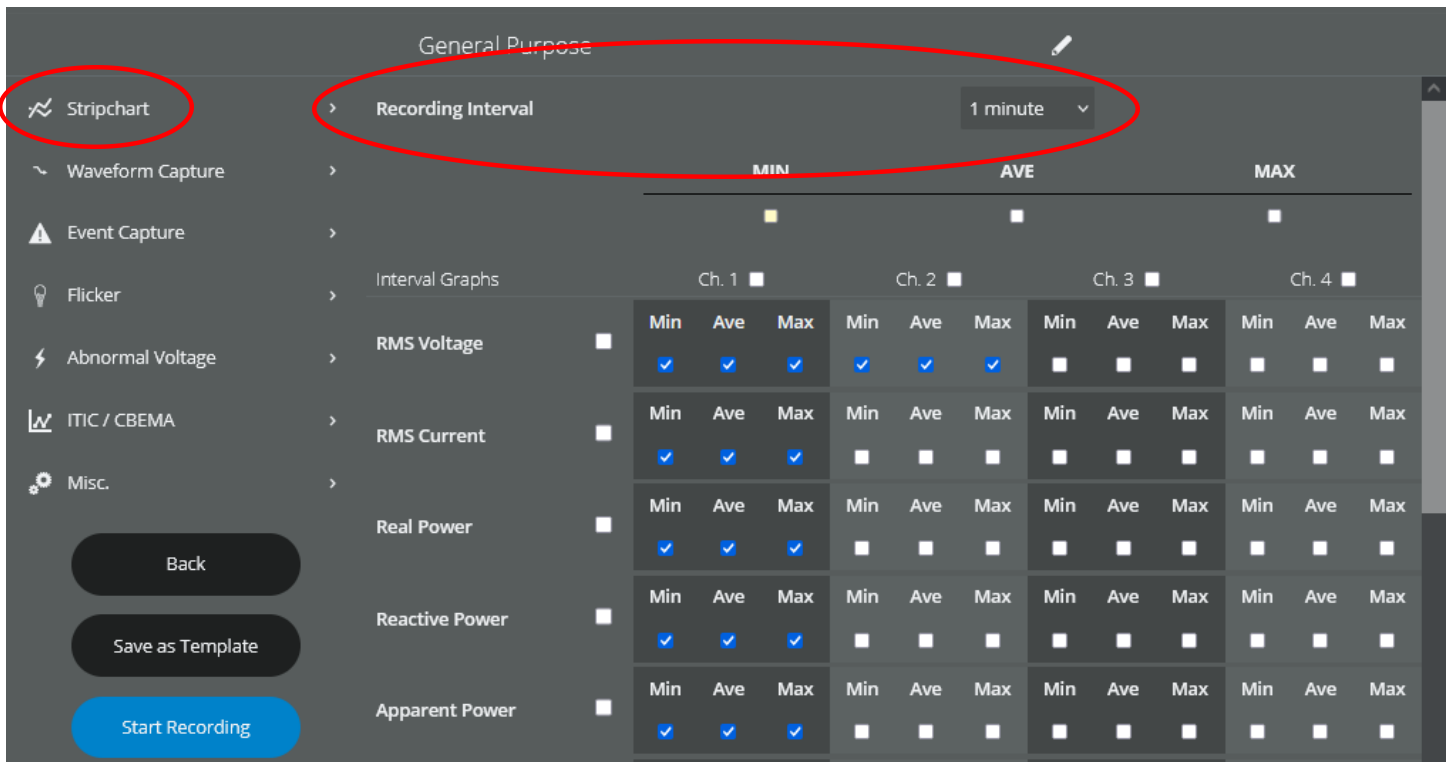
## Initialization Settings

There are many settings and different models of recorders will have different selections available.

*General Purpose* selection: *Advanced* General Purpose contains all the settings available; all other templates will be subsets of these settings or contain specific settings.

Set or remove check marks to adjust what is recorded. Select **[Start Recording]** when you have completed your selections

### Stripchart Initialization Settings (Recording Interval, Harmonics, and IEC Flicker Settings)



### Recording Interval

Select the Interval time in the pull down, the options range from 1 cycle to 4 hours.

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 placed in the interval graphs and listed on any reports (Each interval will be a separate line item).

A lower interval will increase the amount of data sent to PQ Canvass increasing the PQ data file size compared to a higher interval setting. Each interval time period shows the lowest cycle that occurred during that period, the highest cycle that occurred during that period and the average (of all the cycles recorded) for that period.

Use the 1 cycle interval setting sparingly, not all recorder settings will record even if selected. Use the 1 cycle interval for short recordings such as motor starts. The 1 cycle setting will show the average of all the samples for each cycle.

### Interval Graph/Stripcharts

Interval Graphs	MIN			AVE			MAX						
	Ch. 1	Ch. 2	Ch. 3	Ch. 1	Ch. 2	Ch. 3	Ch. 1	Ch. 2	Ch. 3	Ch. 1	Ch. 2	Ch. 3	Ch. 4
RMS Voltage	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
RMS Current	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Real Power	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Reactive Power	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Apparent Power	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Phase Angle	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Power Factor	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Displacement Power Factor	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Voltage THD	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Current THD	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Frequency	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PST Flicker	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
IFL Flicker	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Add checkmarks to record the Interval Graphs named in the first column.

No check mark means that Interval Graph will not be recorded.

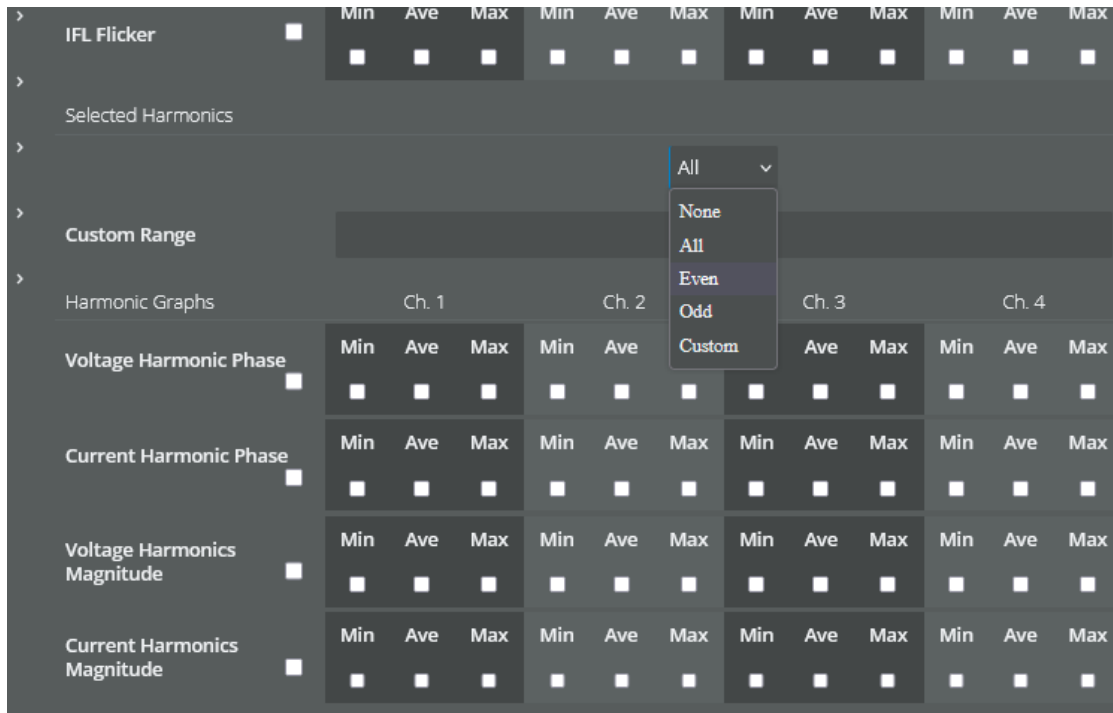
Note: Settings for PQ data files do not change what is shown in the 1-second or live data

Select the first column of boxes to enable all channels for that graph, select MIN/AVE/MAX boxes to select all graphs with that setting, Select Ch 1, Ch2, Ch3, Ch4 boxes to select individual channels, or select individual boxes.

RMS Interval Graphs include RMS Voltage, RMS Current, Real Power (kWh), Reactive Power (kVARh), Apparent Power (kVAh), Phase Angle, Power Factor (PF), Displacement Power Factor, Voltage Total Harmonic Distortion

(vTHD) , Current Total Harmonic Distortion(iTHD), Frequency (Channel 1 only), PST Flicker (Short Term Perceived), IFL (Instantaneous Flicker)

### Harmonics



Select Harmonics to record, selections are: **[All]** the harmonics 1-52 are recorded, **[Even]** Only even number harmonics are recorded, **[Odd]** Only odd numbered harmonics are recorded. Once selected the harmonics will appear in the Custom Range area. Select **[Custom]** to specify the harmonics you want recorded, by entering those harmonics into the Custom Range.

Enter comma separated numbers, enter number strings by using a - , or enter a mix of both types.



In the example for **[Custom]**, harmonics 3,5,7, and 9 will be recorded as well as 11 through 21

### IEC Flicker Setting/Pst Interval

Pst (Short Term Perceived Flicker) is used to determine severity of flicker. The default Pst Interval setting is 10

minutes.

IEC Flicker

Pst Interval 10 minutes ▾

Overwrite

### Overwrite

A check in this box will cause the oldest data to be overwritten once the recorder's memory is full. Also called FIFO or circular mode. This option has no effect on the PQ Canvass recorded data.

## Waveform Capture Initialization Settings

Waveform Capture is a snapshot of sinusoidal waveforms based on the triggered settings in this section. See Waveform Capture in the Type of Records section later in this manual for more information.

Thresholds		Ch. 1	Ch. 2	Ch. 3	Ch. 4
Voltage	[%]	3	3	3	3
Current	[%]	40	40	40	40
Trigger	[volts]	5	5	5	5
Voltage THD	[%]	25.6	25.7	0	0.3
Pre / Post Waveform					
Pre	[cycles]	2			
Post	[cycles]	4			
Cross-Triggers					
Event Capture		<input checked="" type="checkbox"/>			
Periodic Capture		1 minute ▾			
Samples / Cycle		256 ▾			
Voltage Channels		2 ▾			
Current Channels		1 ▾			
Overwrite		<input checked="" type="checkbox"/>			

### Voltage %

Enter in the percent of voltage reading that you wish to trigger a waveform capture.

Example: If your service is 120V and the Waveform voltage threshold is set to 10%, a 12V change in voltage would need to occur (from one cycle to the next cycle) for a waveform to be triggered.

#### *Current %*

Enter in the percent of full-scale current that you wish to trigger a waveform capture.

Example: If you set the current range to be 1000A and you set the waveform current threshold to be 10%, the unit would require a 100A change in current to occur (from one cycle to the next cycle) for a waveform to be triggered.

#### *Voltage THD %*

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

#### *Periodic Capture*

Default setting is Disabled. A selection of 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 the total number of waveforms that can be captured.

#### *Pre/Post Waveforms*

Default setting is 9-cycles. 2-cycles (pre), the trigger cycle, 6-cycles (post). 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*

Select the number of volts (deviation from previous cycle) that would cause a waveform capture to occur. The lower of the Voltage % trigger and this voltage setting will take prevalence.

#### *Overwrite*

A check in this box will cause the waveforms to overwrite the oldest waveforms once the waveform memory allocation is full. This setting will not affect the PQ Canvass recording.

#### *Voltage & Current (channels)*

Select the number of voltage and current channels shown in each waveform capture. This setting does not have to match the Stripchart number of channels.

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

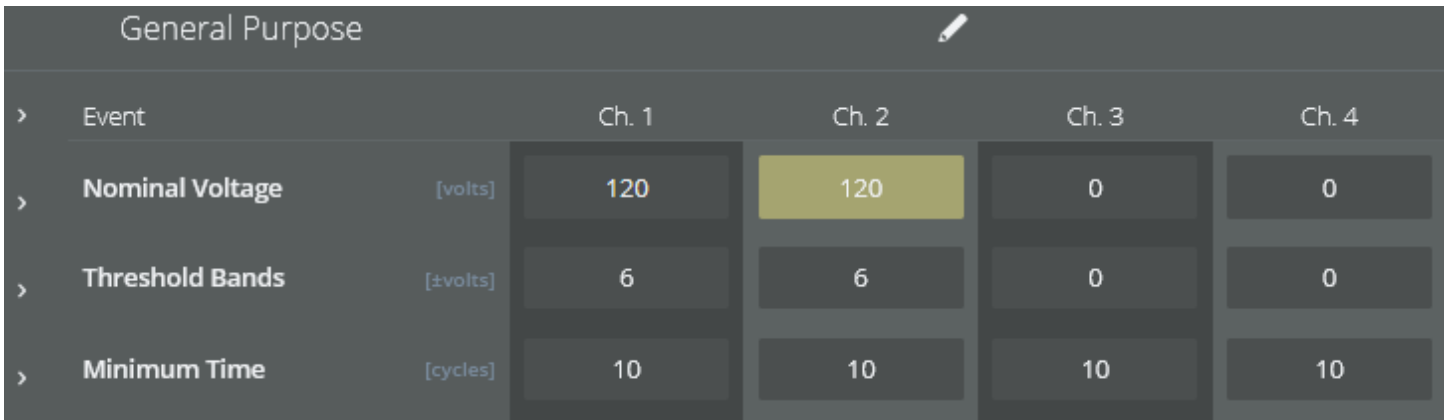
#### *Cross-Triggers*

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 Initialization Settings (Significant Change, Loose Neutral and Outage Settings)



Event	Ch. 1	Ch. 2	Ch. 3	Ch. 4
Nominal Voltage [volts]	120	120	0	0
Threshold Bands [±volts]	6	6	0	0
Minimum Time [cycles]	10	10	10	10

### Event Capture

Listed as Event Change (report) on recordings

Enter any changes in the appropriate boxes. The Recorder will record events that meet or exceed your settings.

#### Event - Nominal Voltage

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

#### Event - Threshold Bands

The variations in voltage above and below the nominal voltage used 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 Threshold Bands setting is 5% of the nominal voltage setting. Adjust according to site voltage

#### 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.

Significant Change	Ch. 1	Ch. 2	Ch. 3	Ch. 4
Enable			<input checked="" type="checkbox"/>	
Voltage [volts]	3	3	0	0

### Significant Change

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

### Enable

This setting when Enabled determines the change in voltage needed before the Recorder records a significant change

### Voltage

Factory setting is 3 volts. The permitted range is 1-8 volts, with a limit of 1000 events

Loose Neutral		
Minimum Time [seconds]		5
Voltage Range [volts]		12
Channel Difference [volts]		1.6

### Loose Neutral

#### Maximum Time

The number of seconds in duration of an event for the event to be considered a loose neutral

#### Voltage Range

Number of volts above or below nominal voltage that would need to be reached to be considered a loose neutral. (nominal =120v AC and a range of 12 v AC, either Ch 1 or Ch 2 would need to be outside of the 108 to 132 v AC range to meet the condition)

#### Channel Difference

The number of volts (difference) between channel 1 and channel 2 to be considered a loose neutral.

Example: Ch 1 would need to be 136 or 104 v AC if Ch 2 was 120v AC to meet the condition of a loose neutral



Outage		Ch. 1	Ch. 2	Ch. 3	Ch. 4
Minimum Time	[seconds]	0	0	0	0
Minimum Voltage	[volts]	0	0	0	0

## Outage

### Minimum Time

Set an amount of time when reached indicates a power outage

### Minimum Voltage

Set a voltage that when it is reached indicates a power outage

## Flicker Initialization Settings

Flicker			
* Default parameters conform to IEEE Standard 141 *			
Period	Tolerance 1-7 Multiple of 0.01	Limit 1-255	
10 seconds	0.9	5	
1 minute	1.2	10	
15 minutes	2.1	10	
30 minutes	2.6	10	
1 hour	3.1	10	
4 hours	4.6	10	
8 hours	5.6	10	
12 hours	5.9	10	
24 hours	6.9	10	

### Tolerance

For each Period, set the percent of variation to indicate a voltage dip

### Limit

Specifies the dip count that is acceptable for the particular tolerance over the given time period and is customizable from 1-255 in integer increments. 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 .9 percent occur within 10 seconds.

These settings are for the IEEE Standard 141

## Abnormal Voltage Initialization Settings

The screenshot displays the 'Abnormal Voltage' configuration screen with seven sections, each for a different nominal voltage. Each section includes input fields for 'Nominal Voltage', 'Low Range', and 'High Range', and a table of resulting voltage thresholds for 'Low-Low', 'Low', 'Normal', 'High', and 'High-High' categories across two channels (Ch. 1 and Ch. 2).

Section #	Nominal Voltage (V)	Low Range (V)	High Range (V)	Low-Low (V)	Low (V)	Normal (V)	High (V)	High-High (V)
# 1	120	6	12	108	114	120	126	132
# 2	208	10	20	188	198	208	218	228
# 3	240	12	24	216	228	240	252	264
# 4	277	13	27	250	264	277	290	304
# 5	480	24	48	432	456	480	504	528
# 6	106	5	10	96	101	106	111	116
# 7	230	11	23	207	219	230	241	253

Additional settings shown include 'Trigger Duration' set to 5 seconds and 'Enable LED' checked for both channels.

### Abnormal Voltage Settings

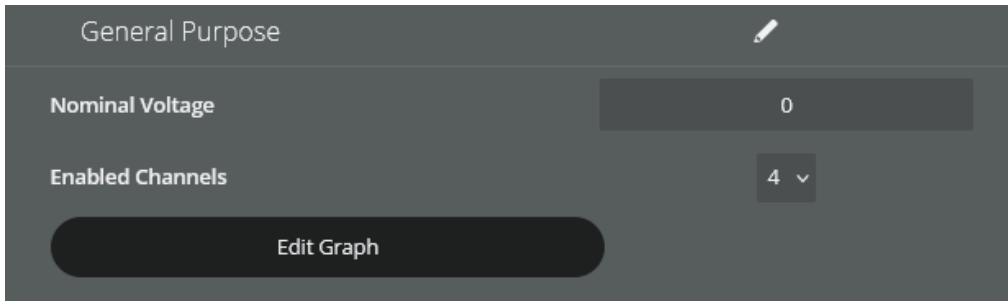
There are seven sections of nominal voltages (120, 208, 240, 277, 480, 106 and 230). Only one section is used per recording. The section used will be closest to the actual recording voltage.

Each section has a “low range” and “high range.” These numbers determine the values in the five columns below each section. For example, for the nominal 120, the default low-range setting is 6 and affects the values in the Low and High ranges. The default high-range setting is 12 affects the values in the Low-Low and High-High ranges. 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

If needed any of these seven sections can be adjusted for specific voltage requirements by changing the Nominal Voltage, Low Range and/or High Range. The changes will appear in the 5 columns below the section. Trigger Duration and Enable LED are used in older recorders.

## ITIC/CBEMA Curve Initialization Settings

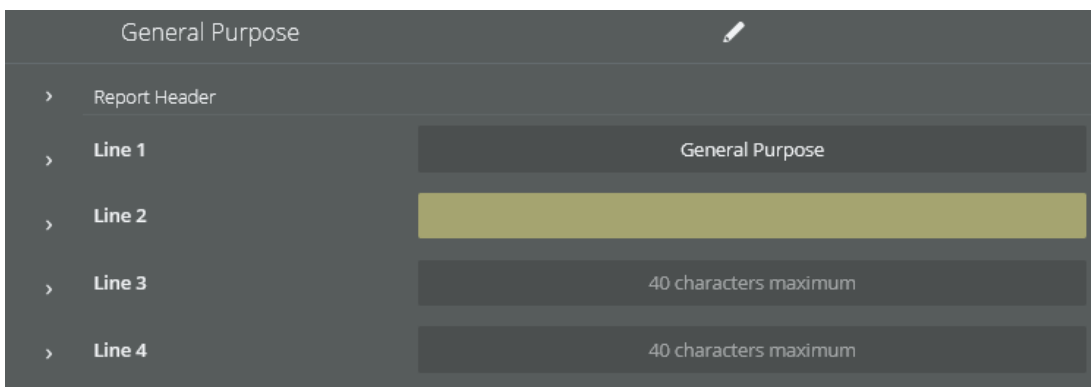


The CBEMA and ITIC curves are both used to visibly represent voltage events. The terms and associated curves are used somewhat interchangeably even though there are subtle differences between the two. The CBEMA (Computer Business Equipment Manufacturers Association) curve was originally created in the 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**

## Misc. Initialization Settings

### (Report Header, Enable Channels, Hookup Type and Current Range Settings)



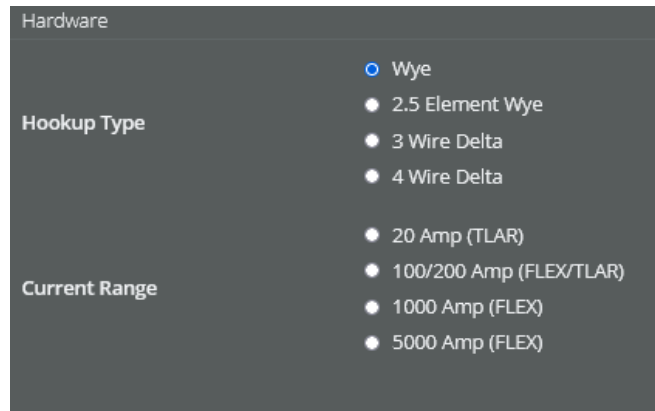
### *Report Header*

Enter recording information on the supplied lines. The first Three lines will show at the top of any report and on the bottom of any graph. The fourth line will show in files converted to PQDiff format



### *Enabled Channels*

Select the number of channels to record



### *Hardware - Hookup Type*

Select the type that matches the site. Wye, 2.5 Element Wye and 4 Wire Delta record phase to neutral voltages. 3 Wire Delta records phase to phase voltages

See the Hook Up Diagrams at the end of this manual and also shown in the Guided Installation menu

### *Hardware - Current Range*

Select the current range that reflects the type of current probes (Flex CT or TLARs) used and is close to the expected amperage. The closer to the actual current, the more accurate the recording.

## **Transient Capture Initialization Settings (Option)**

### *Voltage*

Enter in the percent of voltage reading that you wish to cause a Transient waveform capture to occur or 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.

### *Samples/Cycles*

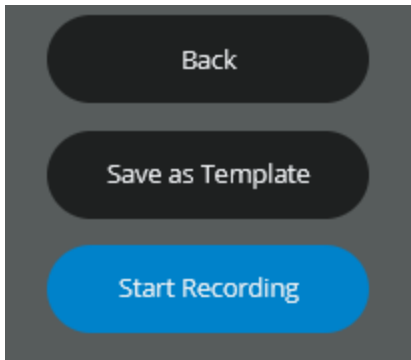
Some recorders allow a lower resolution (number of points) to be captured, A lower resolution increases in the total number of waveforms that can be captured.

### *Voltage & Current (channels)*

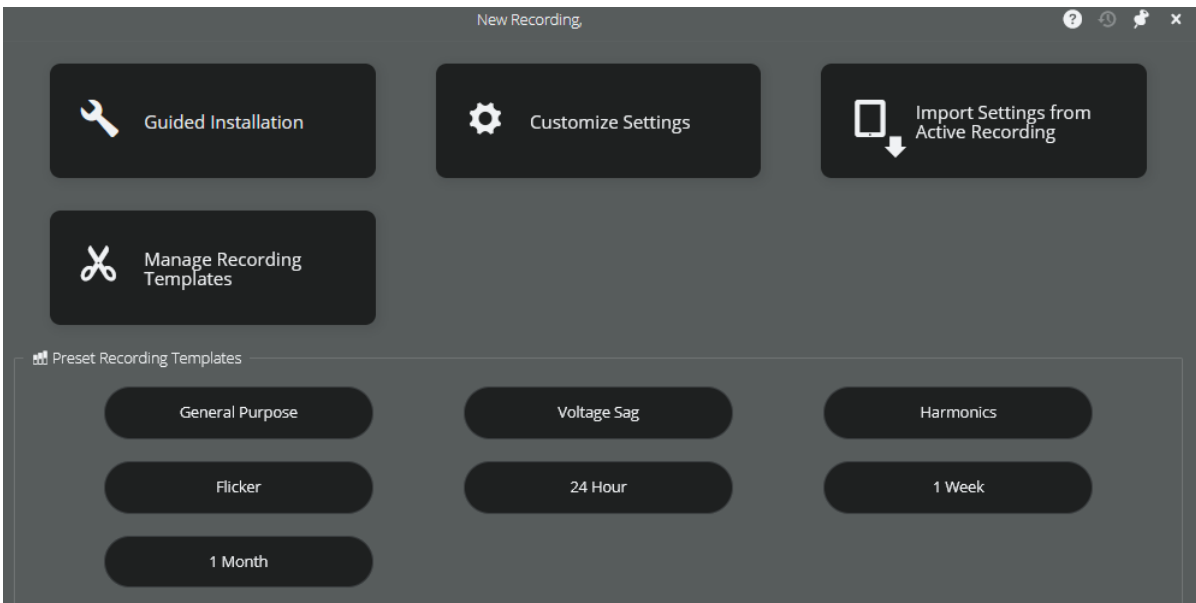
Select the number of voltage and current channels to collect waveforms from.

## **Start Recording**

Once all the Initialization Settings are completed, select *Start Recording*, the settings can also be saved as a template for future use by selecting *Save as Template*.



## Other Initialization Presets



## Guided Installation

### *Hookup Type*

This selection displays the different hookup diagrams. Select the Wye, 2.5 Element Wye, or 4 wire Delta for phase to neutral voltage readings. Select the 3 Wire Delta for phase to phase voltage readings.

Select Wye for 2 or 3 Wire single phase recordings.

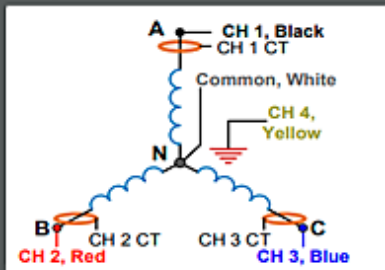
Select 3 Wire Delta for Open Delta or Two Element Delta configurations.

Note: if recording a motor start, match the Hookup selection to the motor configuration.

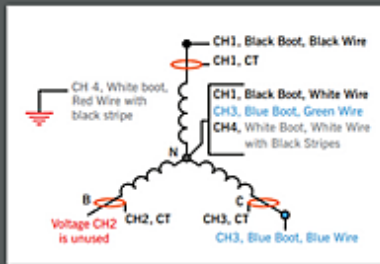
# Guided Installation

## Hookup Type

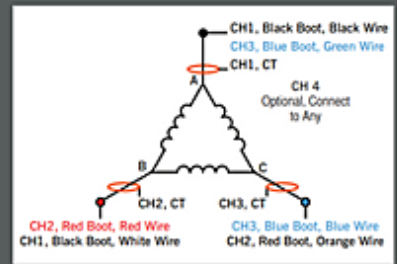
Wye



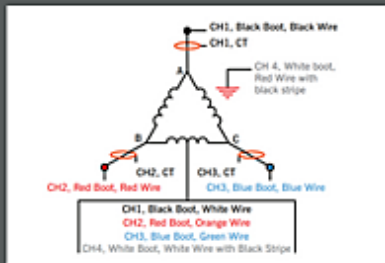
2.5 Element Wye



3 Wire Delta



4 Wire Delta



## Current Range

20 Amp (TLAR)

100/200 Amp (FLEX/TLAR)

1000 Amp (FLEX)

5000 Amp (FLEX)

Nominal Voltage 120 V ▾

Back

Next

## Current Range

Select the setting that matches your current probes and is closest to the expected amperage

## Nominal Voltage

Set the expected voltage

Select Next when completed, then select the template verify the settings before starting the recording

## Customize Settings

This option takes you to the Advanced General Settings selections

## Import Settings from Active Recording

This option allows you to 'pull' the settings from a recorder, then view and adjust the settings before starting a

new recording or create a template from the settings.

## **Manage Recording Templates**

This selection allows you to rename the saved templates and delete those not needed any longer

## **Preset Recording Templates**

Preset templates can also be modified, see the above Initialization section for details on settings

*Voltage Sag / Motor Starts* - Records RMS voltage and RMS current with a 1 cycle interval

*Harmonics* - Odd harmonics from 1 to 15 are recorded

*Flicker* - Interval is set to 5 seconds and Pst and IFL are enabled

*24 Hour* - Interval is set to 1 second with all major settings enabled

*1 Week* - Interval is set to 10 seconds, all major settings enabled, 8 hour period waveform capture set

*1 Month* - Interval is set to 30 seconds, most settings enabled and daily periodic captures set



# Setting Alert Notifications

PQ Canvass can be configured to send email or text messages when the trigger thresholds of a monitored setting are reached. The Notification List must be configured, then each device will need its Trigger Thresholds set.

Note: SMS Notification setting for 'Plain Text Alerts' is found in the User Preferences options.


## Notification List

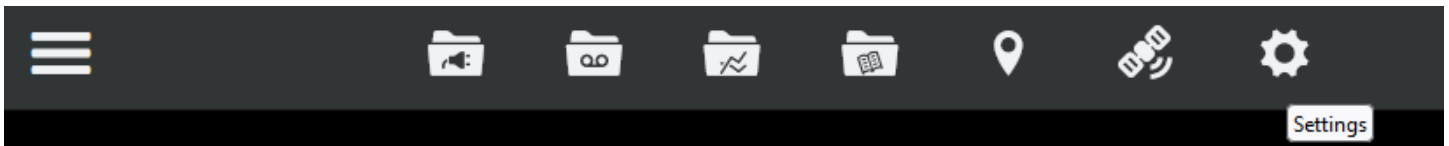
A Notification List or multiple Notification Lists must first be created. The list consists of one or more devices and one or more users who will receive the alerts. Also in the list are the Alerts or Events selected for the notification.

Before creating a Notification List decide which scenario is best for your needs:

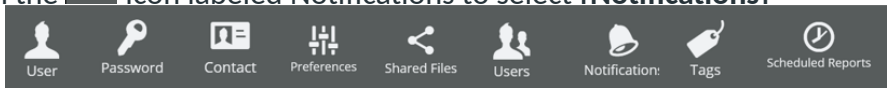
You can create a separate list for each PQ Canvass user and assign them one or more devices; You can create a list with all users and all devices; You can create lists for each device and the user(s) responsible for the device; Or you can create lists depending on the alarm and the user(s) who responds to the alarm.

To Configure Notification Lists and set an Alert for one or more devices:

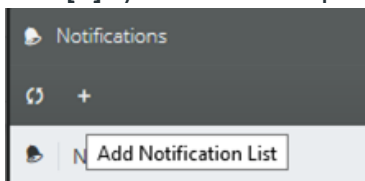
1. Login into PQ Canvass
  - a. You will need PQ Canvass Administrative privileges
  - b. Contact PMI Technical Support if you do not see the icons mentioned
2. Click on the  Icon on the bottom of PQ Canvass to select **[Settings]**



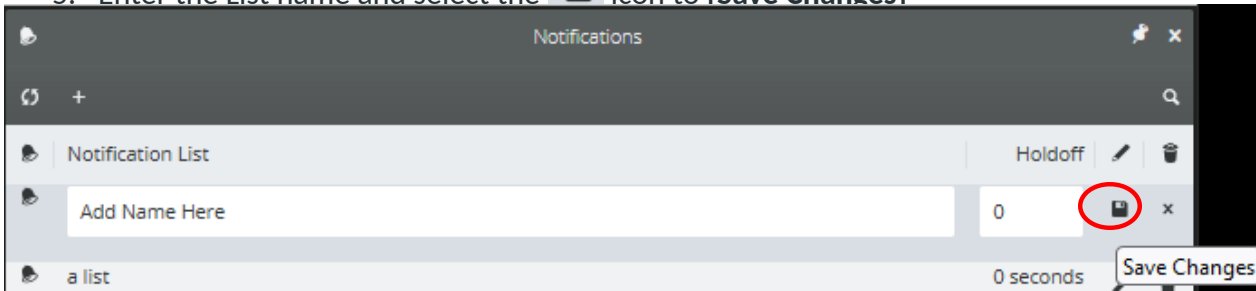
3. Click on the  Icon labeled Notifications to select **[Notifications]**



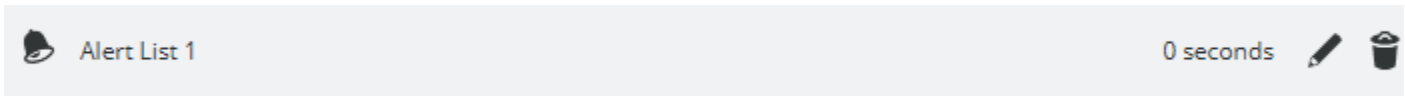
4. Click on the **[+]** symbol at the top left to Add a Notification list



5. Enter the List name and select the  icon to [Save Changes]



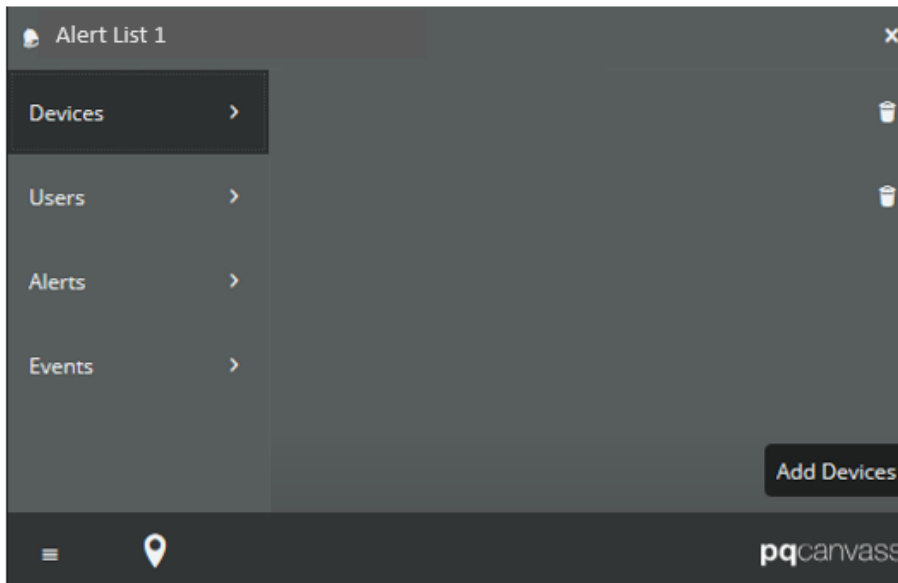
6. To set the notifications, click on the new list you created



- 7. The Holdoff time can be modified now or later
  - a. The Holdoff Time can limit the number of alerts sent
  - b. An alert will not be sent until the event reaches the specified number of minutes
- 8. No alert is sent if the alarm condition returns to normal before the Holdoff value is reached



9. Select [Devices] and click on [Add Devices] at the bottom right

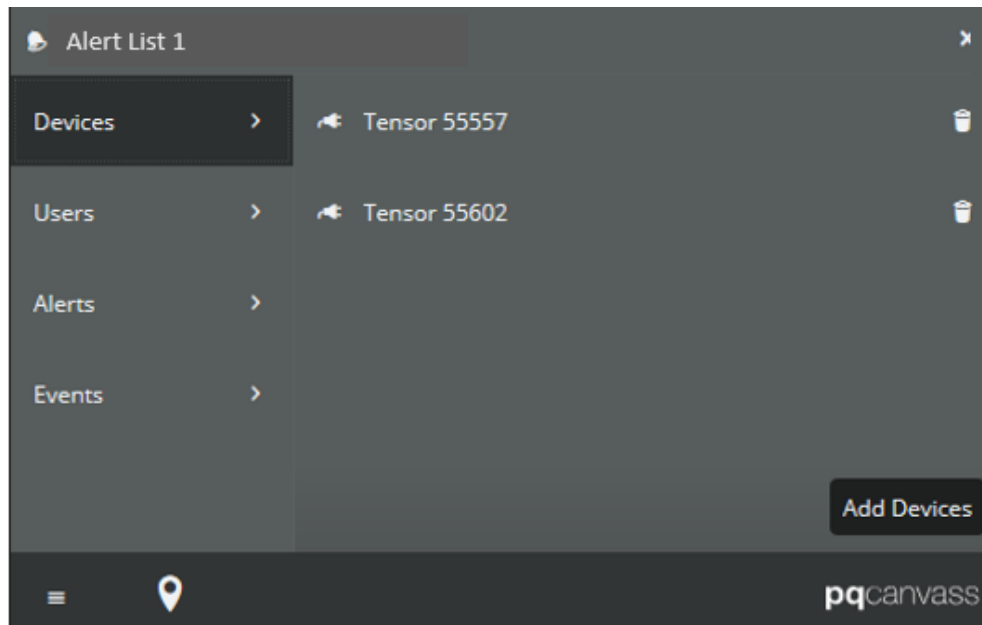


10. A list of all your configured devices will be displayed

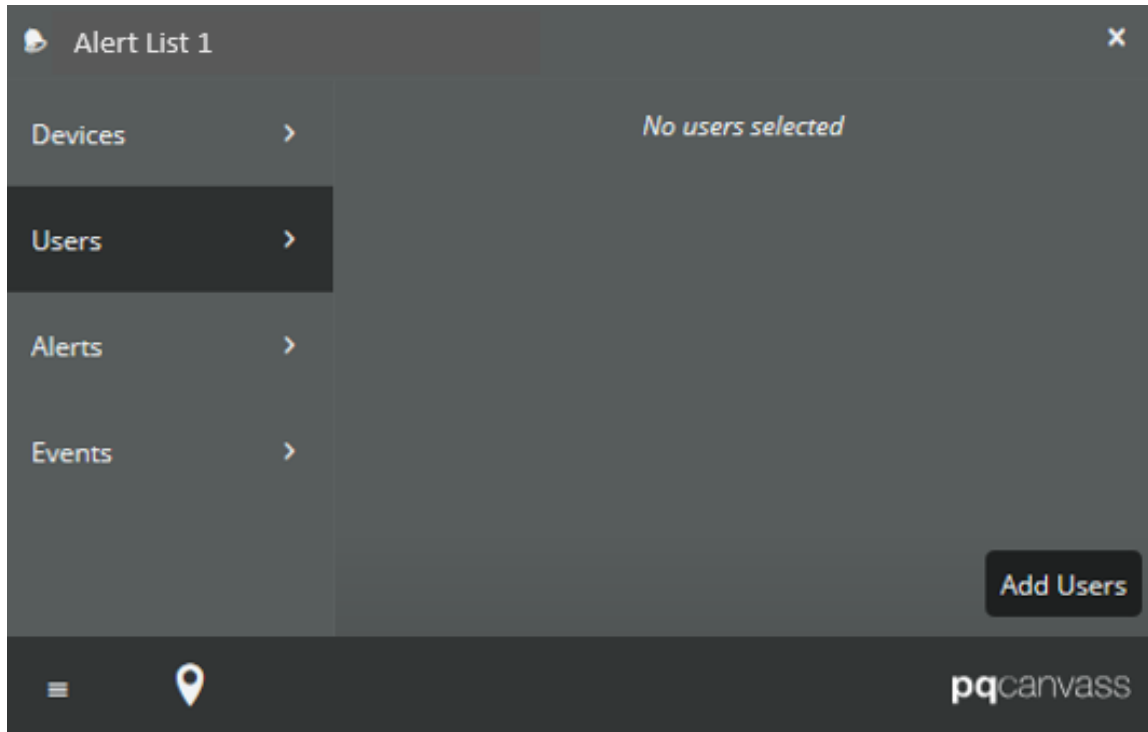


11. Select each device you want to include in the Notification list

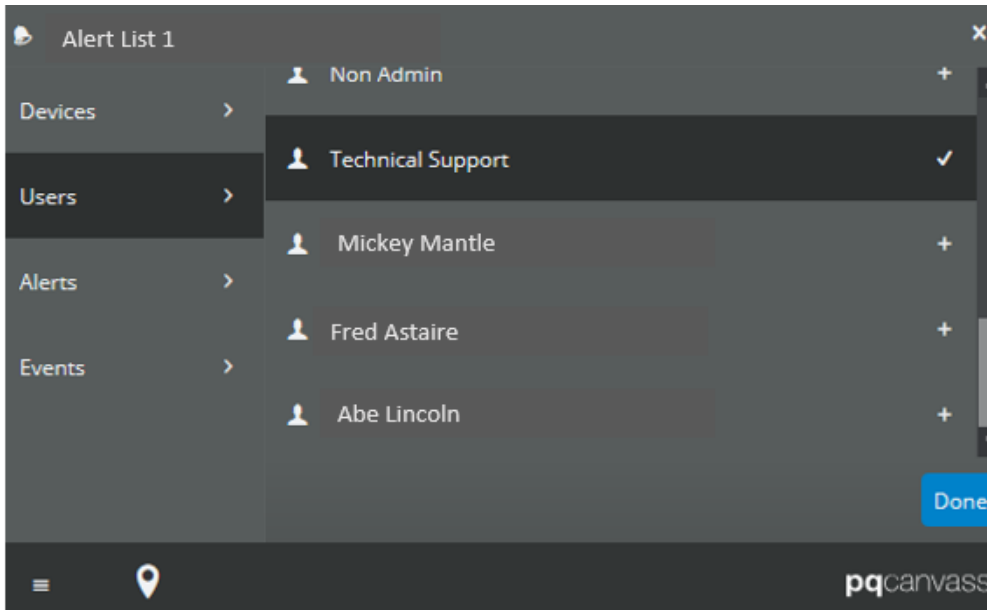
- a. A check mark will appear on the right margin of each selected device
- b. When all devices are selected, click **[Done]** on the bottom right of the page
- c. The selected devices will be listed



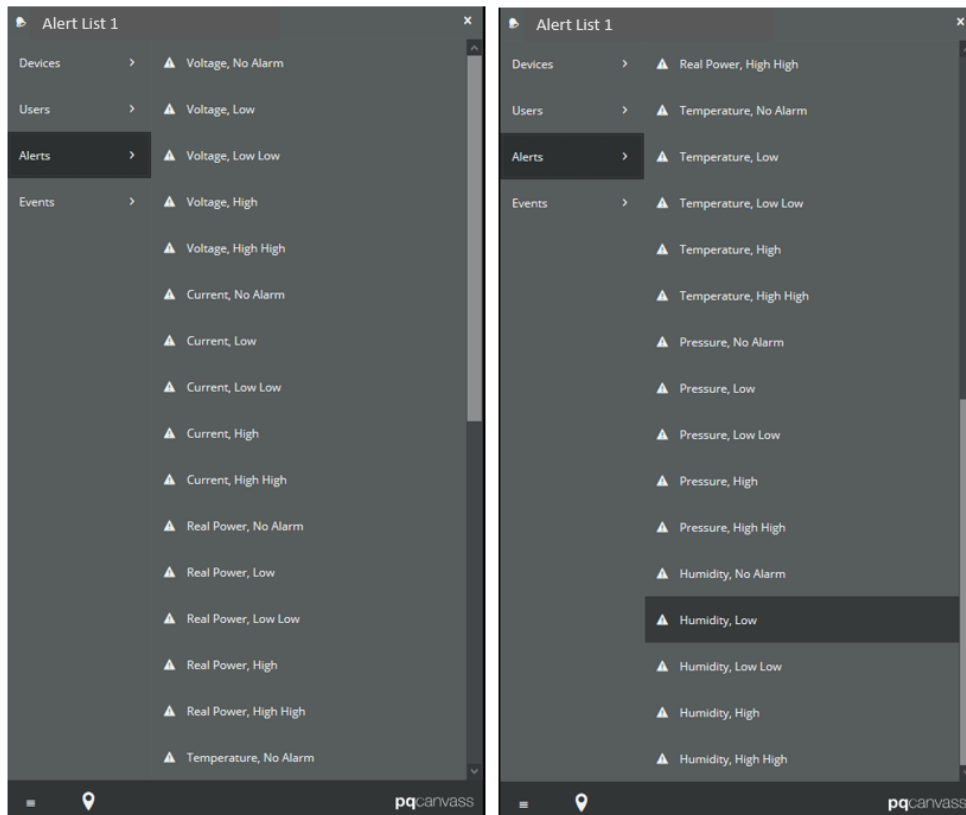
12. Next choose **[Users]** and select the **[Add Users]** button on the bottom right of the page  
NOTE: If alerts are for SMS (Text) alerts, another PQ Canvass user will need to be created with the appropriate user's phone settings. The default is for email alerts to be sent to the user's PQ Canvass login email account.  
SMS user example (check with your provider): 555-666-7788@vtext.com , 5556667788@tmomail.net



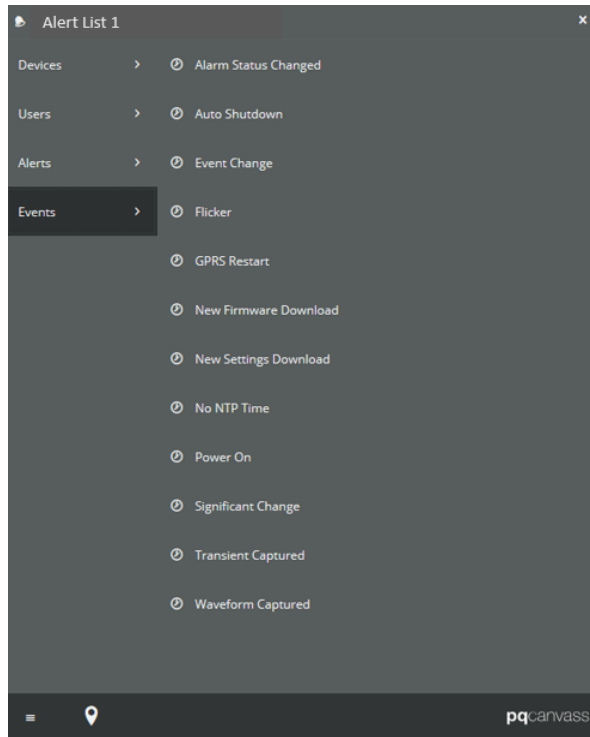
13. Select one or multiple users that will receive the alerts
- A check mark will appear on the right margin of each selected User
  - When all Users are selected, click **[Done]** on the bottom right of the page
  - The selected Users will be listed



14. Next select **[Alert]** and choose one or many alerts. A check mark will appear for each selected alert.  
An Alert email will contain the graph showing the alert



15. Click on **[Events]** - A check mark will appear for each selected event.  
An Event email is a notification that the event occurred  
When finished, select the **[X]** in the upper right corner

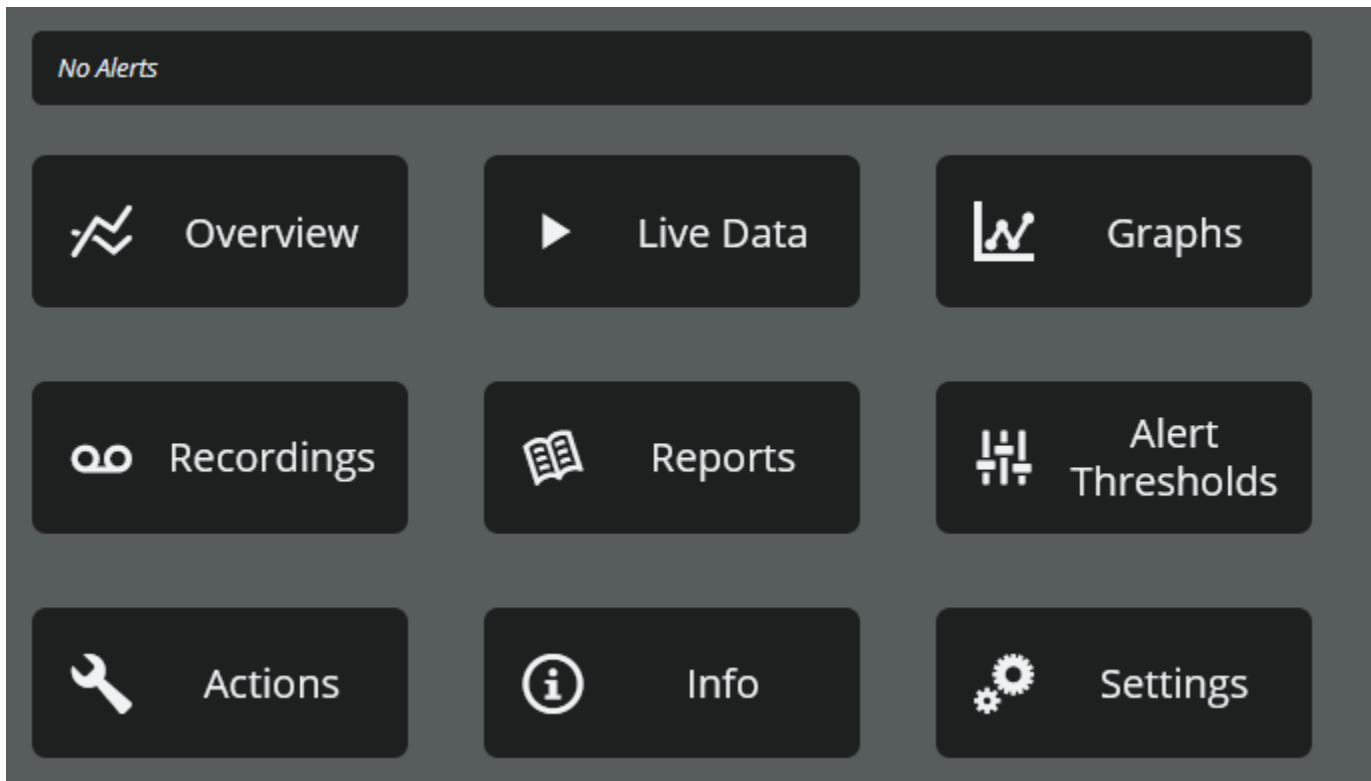


## Alert Trigger Thresholds

For a device to send an alert, each device will need their trigger thresholds set. Thresholds may need modifying when moving device to a new location

### To set Device Trigger Thresholds in PQ Canvass:

1. Trigger Thresholds are set according to the range that meets you or your companies' procedures
2. Login into PQ Canvass
3. Select the *Devices Quick Access View* page



4. Select *Alert Thresholds*

This will pull and display the settings from the selected recorder

5. Set the specific trigger levels, then save settings by selecting [**Set Thresholds**]

- a. The settings should match the Alerts set previously in the Notification List
- b. Averaging Window - Defines the number of seconds over which the input values will be averaged before they are used to test against the threshold values. [**Disabled - 1800 seconds**]
- c. Holdoff Time - Defines the number of seconds over which the input values will be averaged before they are used to test against the threshold values. [**Disabled - 1800 seconds**]
- d. Hysteresis - The hysteresis value does not have any units associated with it. It is a numeric value ranging from **0-100** that will assume the units of each individual threshold. It is used as a pad value that defines a narrow band above and below each threshold. A measurement must

exceed the programmed threshold plus (or minus) the hysteresis value in order for that measurement to be used for alert triggering.

- e. Low-Low, Low, High, High-High - Set one or all to limit the range of the alert

The screenshot displays the 'Set Thresholds' configuration window in the PQ Canvass software. It features a dark grey background with white text and input fields. At the top right, there are icons for help, refresh, and close. The main configuration area is divided into three sections: 'RMS Voltage', 'RMS Current', and 'Real Power'. Each section contains a table with columns for 'Channel', 'Low-Low', 'Low', 'High', and 'High-High' thresholds. The 'RMS Voltage' section has numerical values (100, 110, 130, 140) for all channels and thresholds. The 'RMS Current' and 'Real Power' sections have 'disabled' text for all channels and thresholds. A 'Set Thresholds' button is located at the bottom center of the window.

**Average Window (s)** 1

**Holdoff Time (s)** 1

**Hysteresis** 1

**RMS Voltage**

Channel	Low-Low	Low	High	High-High
Ch 1	100	110	130	140
Ch 2	100	110	130	140
Ch 3	100	110	130	140

**RMS Current**

Channel	Low-Low	Low	High	High-High
Ch 1	disabled	disabled	disabled	disabled
Ch 2	disabled	disabled	disabled	disabled
Ch 3	disabled	disabled	disabled	disabled

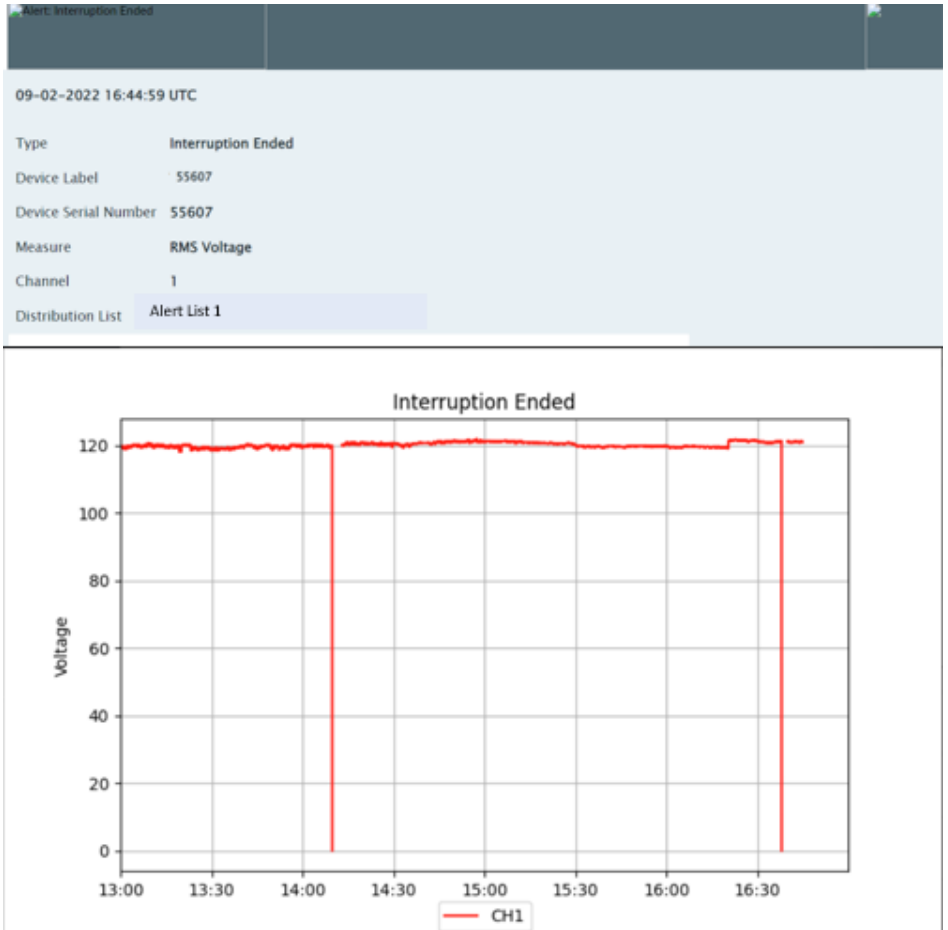
**Real Power**

Channel	Low-Low	Low	High	High-High
Ch 1	disabled	disabled	disabled	disabled
Ch 2	disabled	disabled	disabled	disabled
Ch 3	disabled	disabled	disabled	disabled

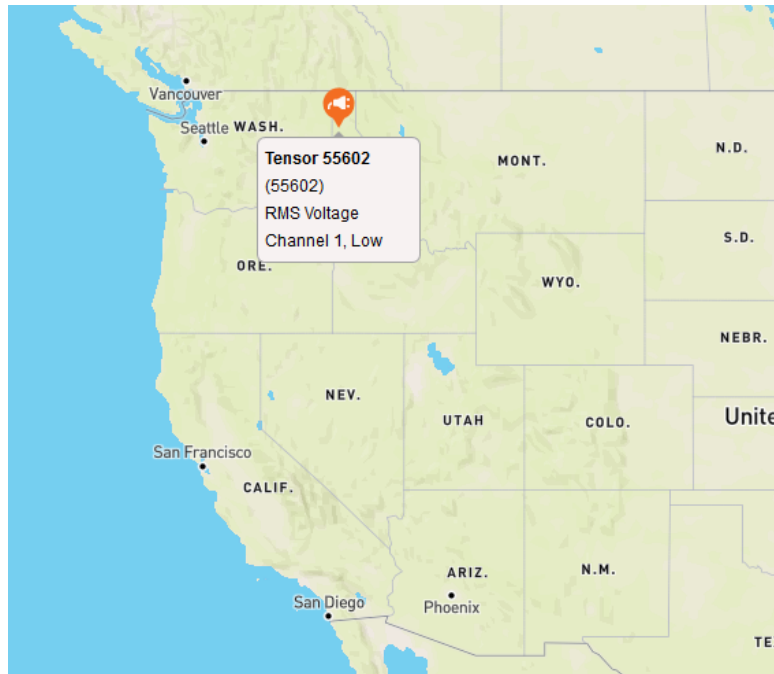
**Set Thresholds**



# PQ Canvass Alert Example



The device icon will turn amber when in an alert state




# Data File Administration

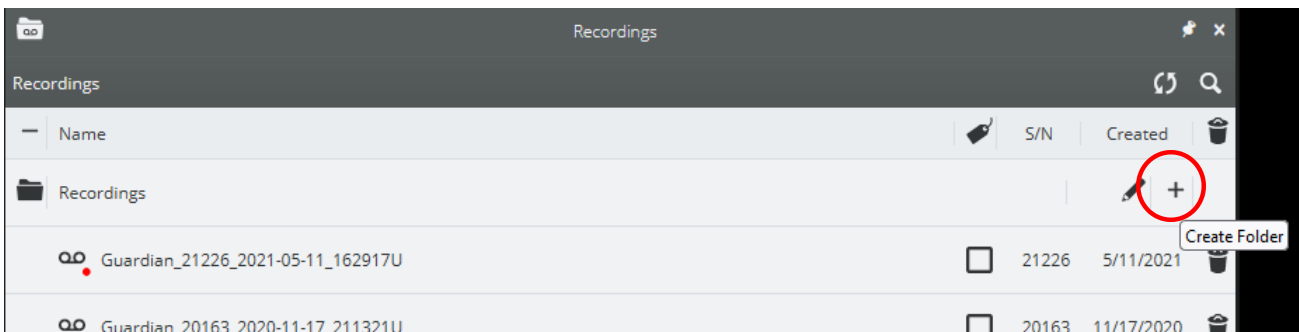
The default view of data files, lists the files by date of the recording. To manage the files, you can create folders or use smart tags.

## Creating File Folders

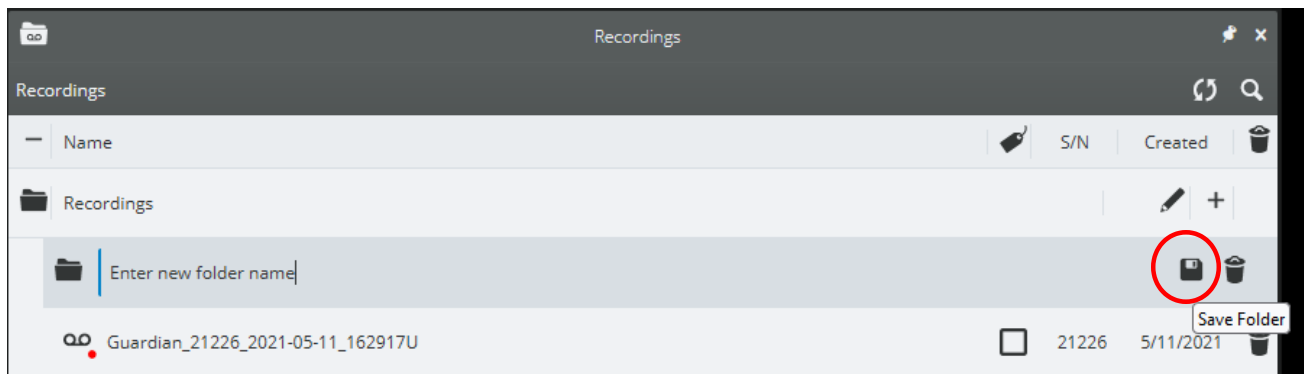
Creating Folders and subfolders with or without using Smart Tags. Folders will be seen by all users.



Select the Recordings icon 

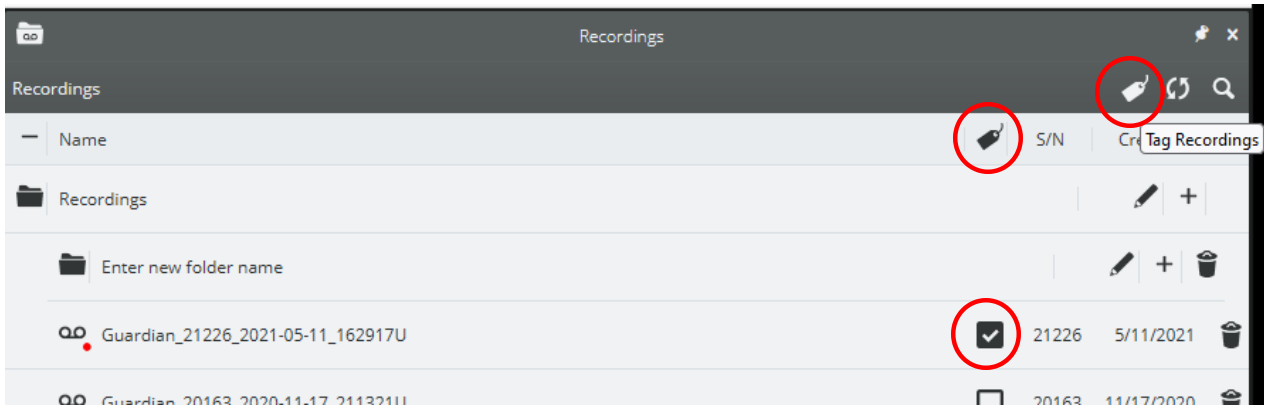
Select the + sign  icon to create folders or subfolders.




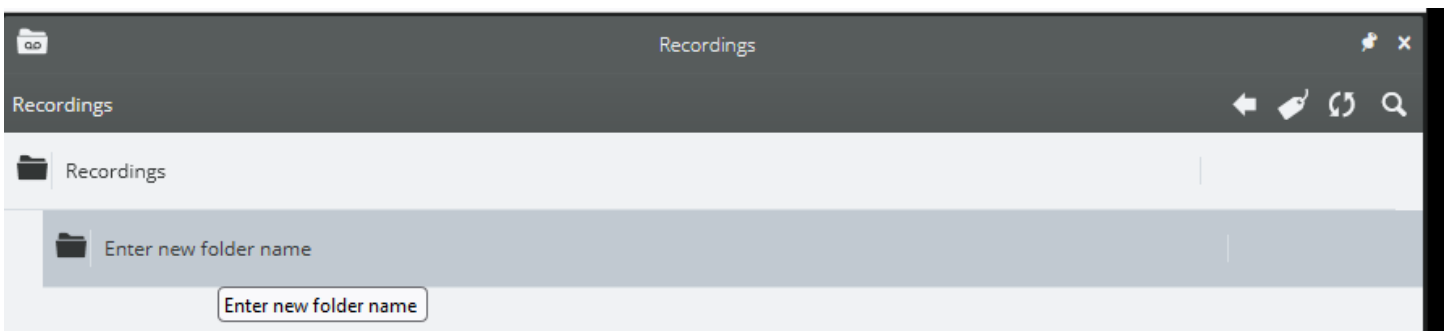
Once the folder is named, save the folder using the Diskette  icon, delete the folder using the Trashcan  icon or rename the folder using the Pencil  icon.




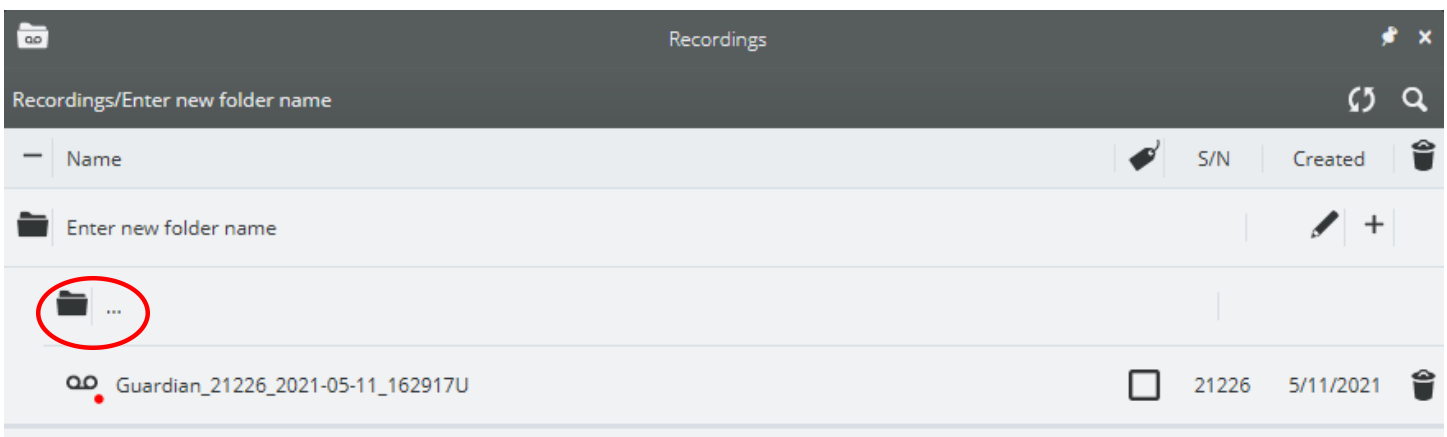
To move a file to the new folder, select the box listed after the file you are moving. The box is in the column under the Tag icon . When the box is selected a new Tag icon  appears at the top of the page.



Select the Tag Recording icon . On the new page that is displayed, select the folder or subfolder you are moving the recording to.





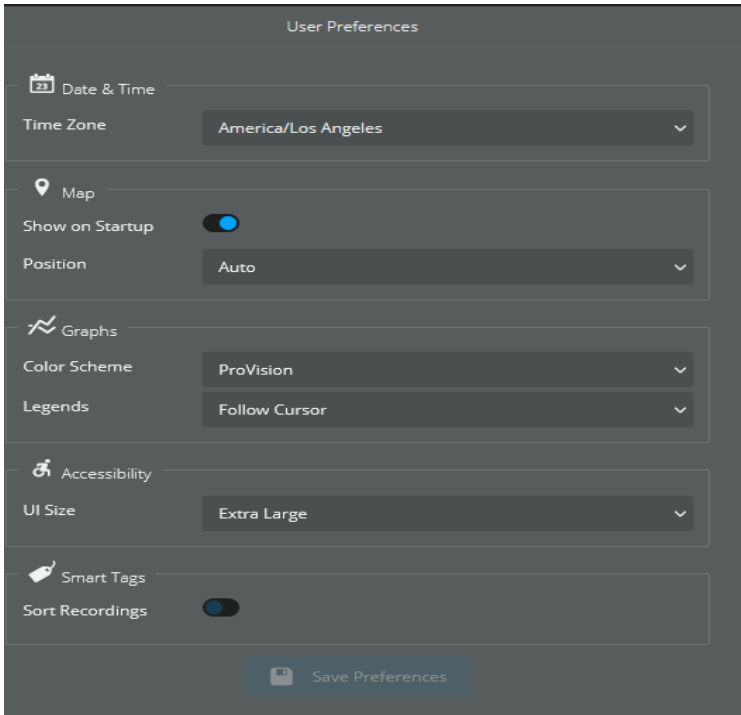
The Recording page will appear after the file is moved. Select the new folder to list the contents. Then use the previous folder icon  to move up one folder.



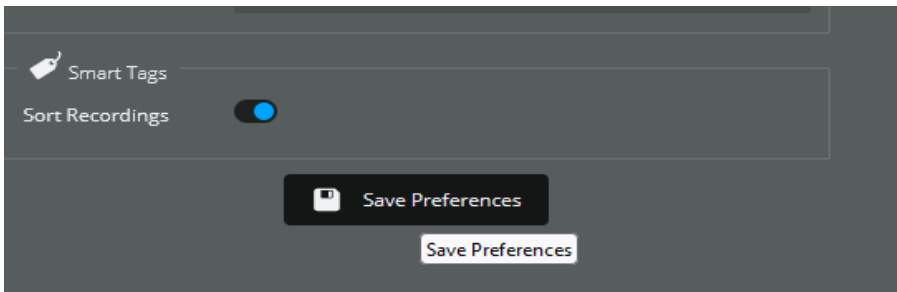
## Smart Tags

Smart tags can be used to automatically arrange your data file recordings by date.


To use Smart Tags, or view the Smart Tag setting, select the Settings icon , then select the Preferences icon , and slide the Sort Recording selection to the right-side and save.

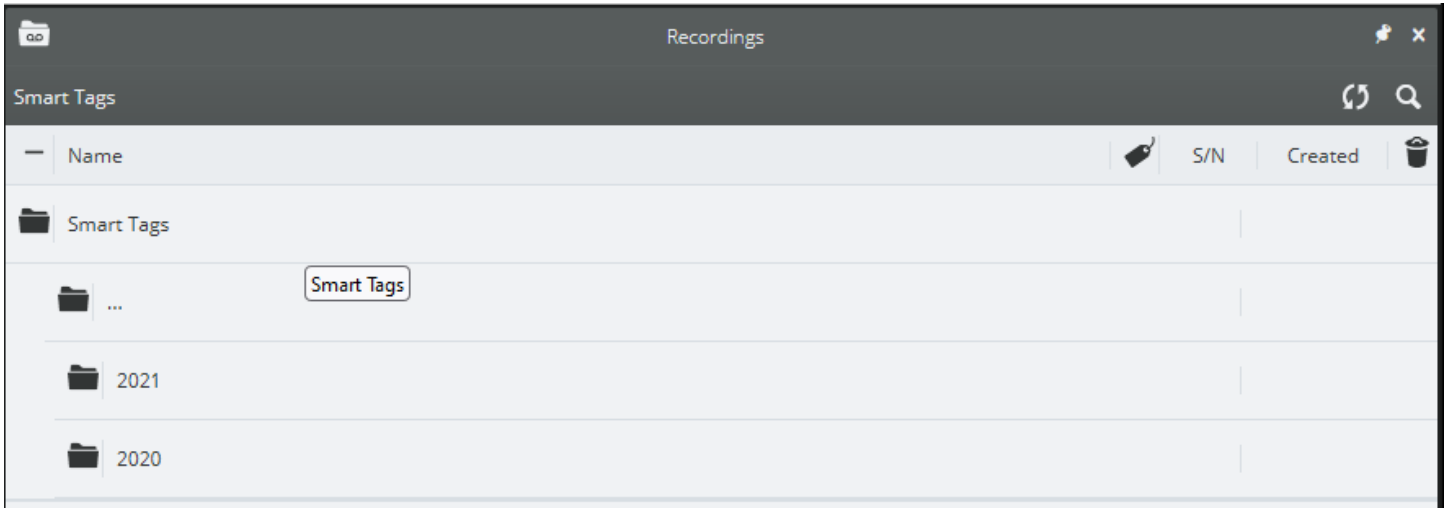



Smart Tags off



Smart Tags on

Select the Recordings icon  at the bottom of the PQ Canvass screen. Then select the Smart Tags icon to view the Smart Tags folders



The files will be listed according to Year and Month the files were recorded. Use the previous folder icon  to move up one folder or select another folder to view it's content.



## Types of Records

PMI recorders can record many different kinds of power quality data. The following refers mainly to configuring a recorder for recording a data file, but also refers to the live data and the streaming data in PQ Canvass.

The job of any power quality monitor is to record interesting or relevant data, while ignoring unexceptional data. The difficult part for a monitor is deciding which events are important. This is the primary problem of data reduction. A recorder that captured every 60 Hz waveform during a week's recording would never miss an event but would present the user with millions of useless cycles. Conversely, a recorder whose thresholds are set incorrectly may not record anything. Staying between these two extremes involves a balance of thresholds, settings, and record types. The monitor will see an enormous amount of data on its voltage and current inputs – the Recorder sees over 1 billion samples per day! Ideally, all this data is reduced to a small report which just shows the important events and measurements. The sifting of data into specific record types accomplishes this task.

To start a recording in PQ Canvass select *Recordings* then *New Recording* on the Recorder's *Quick Access View* page, set the Initialization parameters you want to settings you want to record. See *Initializations Settings* earlier in this manual.

Reports and Graphs can be selected from the Device *Quick Access View* page or from the Header report page of a PQ data file recording. There are also quick links that can be selected from the Header report page

## Triggered Record Types

Records can be divided into two classes: triggered and non-triggered. Triggered records are event driven. These record types are triggered by a combination of triggering logic and adjustable thresholds, usually voltage based. If a trigger never happens, nothing is recorded for that record type. As more triggers occur, the recorder collects more data for that record type. The advantage of this class is that nothing is recorded unless something happens. In the ideal case, no problems occur, so nothing is recorded, and no data analysis is necessary. If a trigger does occur, then the event is logged for later analysis. This is a powerful data-reduction tool and can reduce huge amounts of data into a few small records containing all the significant events. The disadvantage is that success completely depends on good thresholds and settings. A low threshold, such as 0.5%, may cause the recorder to log records that are not worth analyzing.

These extraneous records often hide the few important ones. Conversely, a higher threshold may cause the recorder to ignore important disturbances.

Although it is often possible to use regulatory limits or other known standards to set thresholds, choosing the proper thresholds can be a problem in itself: sometimes you need to know something about the disturbance before you can set proper thresholds to capture it. Despite these potential pitfalls, triggered record types are powerful tools in power line monitoring. They are most useful for capturing voltage disturbances and power quality problems.

The captured events are then presented in a text report. Triggered record types include power outage, abnormal voltage, event change (i.e., event capture), significant change, and waveform capture.

## Non-triggered Record Types

The second class of record types is not event driven. These record types are always logging data, regardless of how interesting, important, or unimportant the data may be. The classic example is a paper stripchart, which continuously logs data. There are no thresholds to set, although there may be a parameter to determine how often to collect data. The logged data is usually presented as a graph of data points. Although there may be a large amount of data, using a graph lets the eye pick out important data. Problems such as sags and swells are easy to see in the interval graphs. In addition to voltage quality studies, these record types are used for finding daily trends in current or power values, measuring power factor, etc. The advantage of not having thresholds to set is that there is no question about what data will be recorded. The disadvantage is that sometimes much of the recorded data is unimportant. For non- power quality data such as power factor measurement, there is no disadvantage. These record types include interval graphs, daily profiles, histograms, and energy usage.

## Understanding the Recorded Data

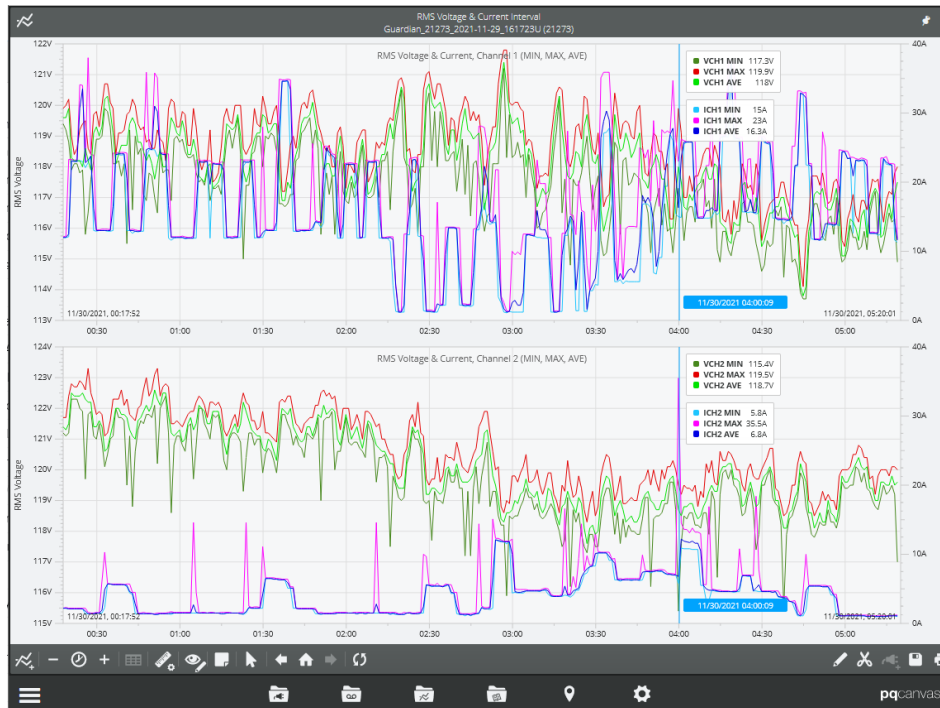
Many PQ Canvass recorders can record every available record type simultaneously. Thus, the choice usually is not which record types to record, but which record types to examine. To answer that question, a good understanding of each record type is required. The details of each record type, and potential uses, are described in the following subsections.

### Interval Graphs

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

### What is Recorded

This interval, which can be as small as one cycle to as large as four hours, determines how often the recorder takes an interval graph data point. During the interval period, the recorder keeps a history of the largest and smallest one-cycle values for each interval graph, as well as a running average. At the end of the interval, the maximum, minimum, and average values for that time period are recorded as an interval graph data point. For example, if the interval is set to one minute (a typical setting), at the end of each minute, the voltage interval graph will record the average root-mean-square (RMS) voltage, the minimum one-cycle RMS voltage, and the maximum one-cycle RMS voltage, all during that minute. All of the 3600 cycles that occur during that minute are used to calculate the average, and for maximum and minimum 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 interval graphs as a graph from a paper stripchart recorder. The maximum and minimum graphs, however, are unique. Each gives the worst-case value for every interval, with single-cycle measurement resolution.



The recorder itself has two options: it can either stop recording interval graphs or go into “wrap-around” mode. In “wrap-around” mode, the oldest interval graph data points are erased to make room for the new data. PQ Canvass data files are continuously recording even though the recorder memory may have overwritten or filled up.

The choice to overwrite is made by the user during the initialization setup. If the “Overwrite” box is checked in the PQ Canvass New Recording page, the recorder will go into “wrap-around” mode as needed, otherwise it will stop interval graph recording when memory is full

When creating an interval graph or report, any “gaps” in the data due to a power outage are filled with zeroes. This happens whenever a recorder loses power on its channel 1 input, and the internal ride-through battery discharges to its cutoff voltage.

## Typical Settings

The interval time setting determines how often the interval graph and report data are captured and displayed. Since the interval graphs always give worst case, one cycle maximum and minimum values, the interval can be set to any time value without a loss of measurement resolution. For example, even if the 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 90V RMS during an interval graph interval, with the interval set to 15 minutes, you are sure that voltage dipped that low for at least a cycle, but you do not know when or how often or how long it happened during that particular 15-minute period. A smaller interval, such as one minute, provides a finer time resolution. The smallest interval allowed for the recorder, one cycle, gives excellent time resolution, but consumes memory 3600 times faster than a one-minute setting. Often, the exact time of a voltage dip is not as important as the size - in that 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 startup current) are easily spotted in the interval graph. 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.

When setting the interval, keep in mind that any report will have one line for every interval data point recorded. When viewing an interval graph in PQ Canvass, the cursor position will display the data information at each interval data point, but the time will be the cursor position and the data will not change until the cursor moves to the next data point.

## Suggested Uses

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 interval. In this case, the recorder should not be left to record for days, since it will only hold the last few hours of interval graph data. The best use in this case is to set the interval graph to one second, cycle the load (such as the elevator) for a while in an attempt to reproduce the problem. 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 “Overwrite” mode or “wrap-around” mode, as we discussed earlier does not affect the data file in PQ Canvass. A new PQ Canvass data file will be created when the recorder is initialized and connected to AC power.

You will need to choose which interval data to record. The options are:

- RMS voltage
- RMS current
- Real power
- Apparent power
- Reactive power
- Phase angle
- Power factor
- Displacement power factor
- Voltage THD (total harmonic distortion)
- Current THD (total harmonic distortion)
- Frequency
- IFL (Instantaneous flicker level)
- PST (Perception-short-term flicker)

For quantities such as power factor, phase angle, THD, etc., often the average is much more important than the one cycle maximum and minimum values. The maximum and minimum traces on the graph may be turned off so that they do not obscure the average trace.

## Daily Profiles

Daily profiles are used to spot daily trends in voltage, current, power factor, etc. The entire recording session is combined to form an “average” 24-hour day, which is plotted in a format that resembles an interval graph. 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.



Daily Profile with Standard Deviation shown

## What is Recorded

Each measured quantity has only one daily profile per channel in a recording session. For example, there are four voltage daily profiles recorded for a recorder in a recording session, one per channel. The profile is averaged over the entire recording session. This average is created by dividing the 24-hour 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.

## Typical Settings

There are no settings for daily profiles, interval settings used for recording will reflect which Daily Profiles are available. In PQ Canvass, Daily Profiles viewed from a data file has less options than viewing the Daily profiles from the recorder information screen.

## 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 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 will 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 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 capacitor bank 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 capacitor bank 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.

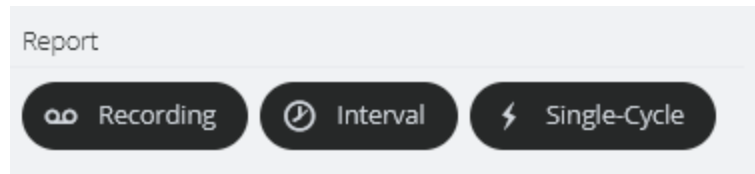
The more days recorded, the better the average created by the profile. A recording session that just lasts a single day does not incorporate any daily averaging at all. Since a profile starts with all zeros, a recording session that does not even last 24 hours will include some 15-minute blocks with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

An interval graph can also be used for profiling, but that is not ideal. The interval graph 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 graph only has enough memory for a week or two, limiting the averaging time; the daily profiles have no such limit. Most importantly, the interval graph does not divide the data into an average day period, so it can be difficult to spot daily trends in the graph.

## Cycle Histograms

The cycle histograms contain valuable power quality information as well as information for distribution line profiling. Questions such as “what were the absolute highest and lowest RMS voltage?”, “how many cycles was the voltage below 80V?”, 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 100V?” and “What high and low limits does the line voltage meet 99.99% of the time?” While 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.

Select Single-Cycle report from a PQ recording Header report page



## What is Recorded

A histogram divides a measurement range into many bins. For example, the voltage histogram divides the 150V voltage range into 150 bins, each one-volt wide, giving a bin for 0V, a bin for 1V, 2V, all the way to 150V. After each 60Hz cycle is measured, the voltage is rounded to the nearest volt and placed in the appropriate bin. The bins are counters that accumulate the number of cycles at each voltage value. If the 108V bin has a count of 45, then there have been 45 cycles with an RMS voltage of 108V sometime during the recording session. The histogram does not include time information: those 45 cycles could have occurred anytime during the recording session. There 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. To see extremes, use the voltage or current out of limits report.

RMS Voltage Single-Cycle Histogram Report  
0V - 127V

RMS Voltage	Cycles	
	Ch1	Ch2
116V	0	0
117V	256	0
118V	43,777	56,320
119V	16,779,598	20,652
120V	1,476,518,172	1,459,747,042
121V	16,780,525	33,586,889
122V	0	0
123V	0	0
124V	0	0

Note: List starts at 0v. Scroll down to the voltage range of your site

Every interval graph maximum and minimum value will have a non-zero count in the corresponding histogram. For example, if the voltage interval graph shows six sags to 108V sometime during the recording session, there should be a

count of at least six in the histogram at 108V. The count will probably be somewhat larger, unless each individual sag was only one cycle long.

## Typical Settings

There are no settings for histograms. All available histograms are always recorded, regardless of the settings for any other record types.

Memory does not run out for a histogram; measurements continue to be added to the bins (by incrementing the bin counters) as long as the recording session lasts.

## Suggested Uses

The power of the histogram is that every cycle is included in the report and is included in the count of one of the bins.

If the counts in a histogram are totaled, the result will represent the total number of cycles for the duration of the recording session (minus any time during a power outage).

Histograms are presented as a bar graph and a report. The report can be 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, you also know how many cycles the voltage was at those extremes, and by glancing at the nearby bins, you know how many cycles the voltage was near those extremes. For example, if all the bins below 110V are zero, then you immediately know that there was not even a single cycle of voltage below 110V anytime during the recording session. If the count at 111V is 1,352,200, then the voltage was at 111V for over 6 hours ( $1,352,200 = 6.26 (60 \cdot 60)$ ). By totaling the counts for all the bins in a voltage range (for example, 0 to 150V), you find 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, the user is generally 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 of the counts in the middle of the histogram range is the most significant and relevant data.

## Minute Histograms

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 is 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 Stripchart interval is also set to one minute, then the Stripchart voltage averages will match the Minute Histogram counts. All Recorders record a voltage Minute Histogram. Recorders that can measure current also record a current Minute Histogram. The voltage Minute Histogram graph is divided into a Nominal Voltage and Abnormal Voltage graph - voltage bins outside the nominal values as defined in the Abnormal Voltage report type are separated, so that baseline voltage and exceedance voltages may be graphed separately

### Typical Settings

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.

### 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 Stripchart, depending on the recording interval and amount of memory. Because the Stripchart 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 Stripchart, but not as easy to see.

## Energy Usage

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-ampere-hours, respectively.

## What is Recorded

For 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.

Negative power values are included in the accumulation. For example, if a load is absorbing and generating power (at different times, of course), then 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.

### **Accumulated Real Power (kWh)**

<u>Channel 1</u>	<u>Channel 2</u>	<u>Channel 3</u>	<u>Channel 4</u>
65.403	69.338	69.031	---

### **Accumulated Apparent Power (kVAh)**

<u>Channel 1</u>	<u>Channel 2</u>	<u>Channel 3</u>	<u>Channel 4</u>
72.108	75.887	76.146	---

### **Accumulated Reactive Power (kVARh)**

<u>Channel 1</u>	<u>Channel 2</u>	<u>Channel 3</u>	<u>Channel 4</u>
-30.045	-30.456	-31.754	---

## 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 significant change power in power factor studies. A revenue meter that does not total negative power, or does not include the effects of harmonics, may show readings that differ from this report.

## Significant Change

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, then 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 120V, 208V, 240V, 277V, or 480V). 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 maximum or minimum) that caused the trigger becomes the new “standard” until the next significant change. As an example, consider a “standard” voltage of 119V, and a threshold of 2V. After 40 seconds, the voltage drops to 118V. No significant change is recorded because the 1V change is smaller than the 2V threshold.



# Significant Change Report

Tensor\_100531\_2022-05-06\_091315U (100531)

Settings

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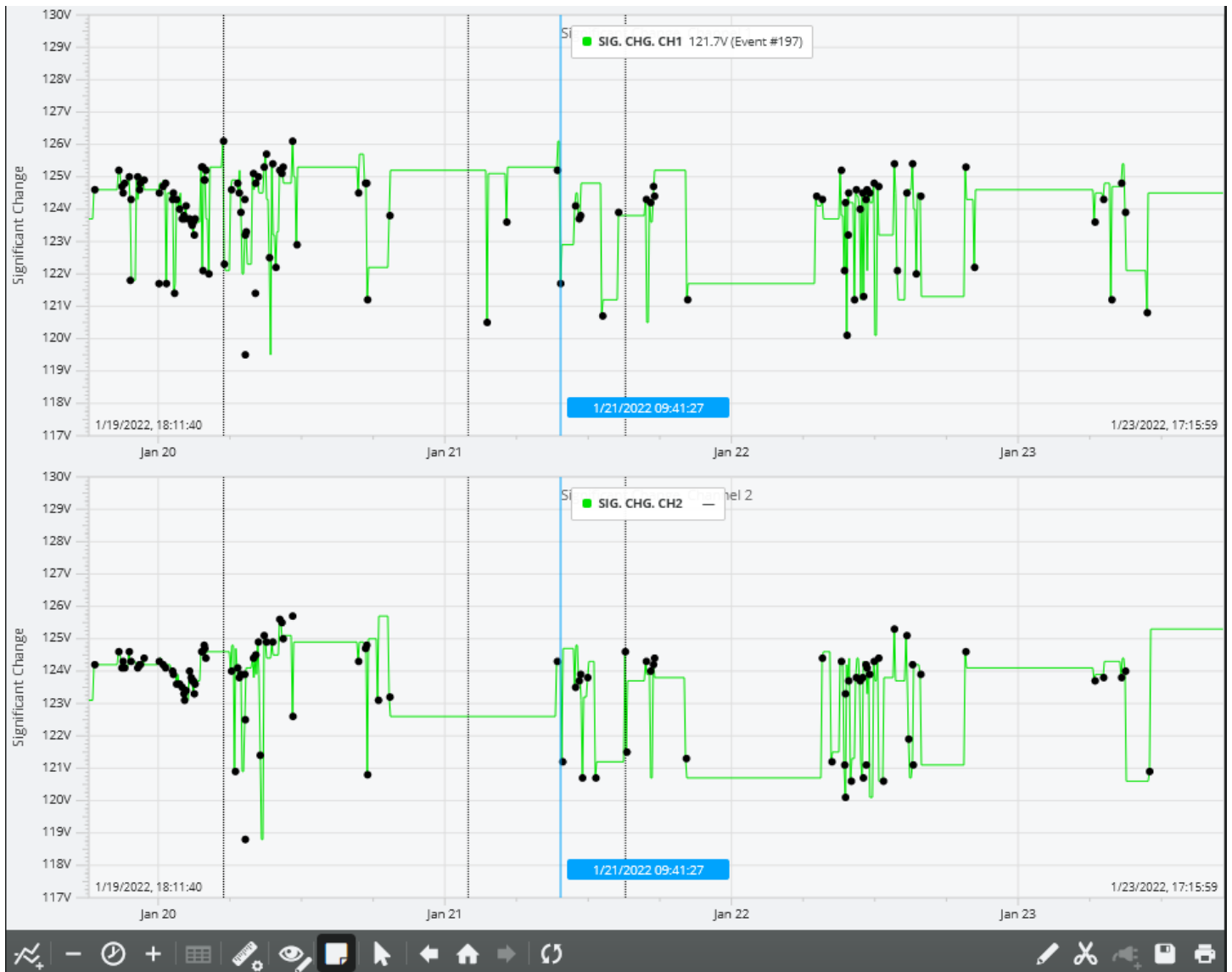
Channel Threshold

1	3V
2	3V

Events

---

#	Ch	Timestamp	Voltage
1	2	5/6/2022, 2:13 AM	0V
2	1	5/6/2022, 2:13 AM	123.3V
3	1	5/6/2022, 4:42 AM	119.9V
4	1	5/6/2022, 9:09 AM	123V
5	1	5/6/2022, 9:29 AM	119.4V
6	1	5/6/2022, 9:32 AM	123V
7	1	5/6/2022, 9:53 AM	119.4V
8	1	5/6/2022, 1:19 PM	122.5V
9	1	5/6/2022, 4:59 PM	118.4V
10	1	5/6/2022, 4:59 PM	122.8V
11	1	5/6/2022, 8:12 PM	119.6V



Significant Change Graph with Graph overlays set (shows date/ time Waveform Captures were captured)

After another 35 seconds, the voltage increases to 120V. The change is 2V, from 118V to 120V, but no significant change occurs because 120V is only 1V greater than the “standard” of 119V. After another 23 seconds, the voltage increases to 121V. A significant change is triggered because the 1V increase created a 2V difference between the 121 maximum voltages for that second, and the 119V standard. The standard voltage is now set to 121V, until the next significant change.

Only one significant change per second can be recorded per channel. If both the single-cycle maximum and minimum meet the threshold in the same second, the voltage that is furthest from the standard becomes the new standard.

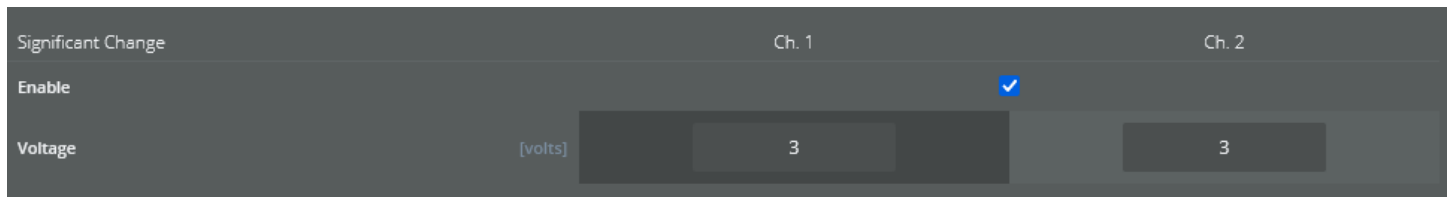
## What is Recorded

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. Both voltage channels use the same significant change memory. Every recorder can record over one thousand records.

## Typical Settings and Suggested Uses

The default setting for the significant change threshold is 3V. This setting can be as small as 1V or as large as 8V. Normally, a threshold between 2V and 5V 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 to its previous level.



The screenshot shows a settings panel for 'Significant Change' with two columns for 'Ch. 1' and 'Ch. 2'. The 'Enable' row has a blue checkmark in the 'Ch. 1' column. The 'Voltage' row has input fields for both channels, both containing the value '3'. A '[volts]' label is positioned to the left of the 'Ch. 1' input field.

Significant Change	Ch. 1	Ch. 2
Enable	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Voltage	<input type="text" value="3"/>	<input type="text" value="3"/>

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 graph by using its timestamp. Find the same time period in the interval graph 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 that occur during a graph interval period will be included in a single interval data point, consisting of a maximum, minimum, and average value. For example, if the interval is one minute, and six significant changes occur within one minute, they may all fall into the same interval graph data point. (They are still reported individually in the significant change report).

The significant change report provides more detail than the interval graph 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 single-cycle response. If event change 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 more detail waveform capture can be used (if enabled). If the disturbance triggers waveform capture, the raw waveforms of each voltage and current channel can be displayed. Again, the significant change timestamp is used to find the waveform in the list of captured waveforms.

## Event Change

The event change report provides detailed cycle-level information about each voltage disturbance. This is the most detailed report available, excluding waveform capture. An event is triggered when the voltage moves past any of a series of trip points. Maximum and minimum voltages and currents during the event, the event duration (in cycles), and the current before and after the event are all recorded.

### Event Change Report

Guardian\_29003\_2022-07-26\_120824U (29003)

Settings

Channel	Nominal Voltage	Thresh. Bands	Min. Event Time (Cycles)
1	120V	+/- 6V	10
2	120V	+/- 6V	10

Events

#	SE	Ch	Timestamp	Cycle Duration	S	Voltage		Current			
						Min	Max	Min	Max	Prev	Post
1	1	1	7/26/2022, 5:16:55 AM	1	—	113.8V	116.3V	0A	0A	0A	0A
						112.2V	115V	0A	0A	0A	0A
						5.7kV	4.2kV	0A	11.3kA	37.4kA	0A
						73.1V	25.6V	0A	46.2kA	319A	0A
2	1	2	7/26/2022, 5:16:55 AM	1	—	113.8V	116.3V	0A	0A	0A	0A
						112.2V	115V	0A	0A	0A	0A
						2.5kV	4.2kV	0A	16.2kA	146A	0A
						5.6kV	100mV	0A	21.7kA	16.1kA	0A
3	1	1	7/26/2022, 5:32:25 AM	1	—	113.8V	115.2V	0A	0A	0A	0A
						112.1V	113.9V	0A	0A	0A	0A
						5.7kV	4.2kV	47.9kA	46.6kA	0A	16.4kA

## 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 voltage. For example, a nominal voltage of 120V and a threshold of 6V would create trip points at 102V, 108V, 114V, 126V, 132V, 138V, etc.

The voltage region around the nominal voltage, but before any trip points (115V to 125V in the above example) is called 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 6V in the above example) from 0V to 600V (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, Minimum Event 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.

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

## What is 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 as a minus for a sag and a plus for a swell. While the event is occurring, the recorder keeps track of the maximum and minimum current and voltage values. When the event ends, the maximum and minimum 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 117V, use 117V as the nominal, not 120V. 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. To disable event change on a channel, set its threshold to something exceptionally large, like 500V.

Event	Ch. 1	Ch. 2
Nominal Voltage [volts]	120	120
Threshold Bands [±volts]	6	6
Minimum Time [cycles]	10	10
Hysteresis	0	0

The minimum event time is not as critical. Ideally, this is set to a value 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 minimum event time is 7 cycles. This will prevent multiple event changes from the same voltage sag. Otherwise, as the voltage drops lower and lower, past voltage trip points, events will 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 shows up only as a single point on the interval graph can be analyzed in the event change report. Usually, event change is not the first report to analyze in a recorder recording, due to its complexity. Check the voltage interval graph for minimum or maximum 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 maximum and minimum 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 if they occurred within 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 cycles 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 maximum 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 inrush 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, then the current rose to its normal level also. ProVision group 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 they 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 PMI recorders, but most recorders can record over one thousand records.

## Power Outage

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 80V, lasting for at least one third of a second. Only channel 1 voltage is used to trigger an outage. The beginning and end of the outage are time-stamped. In the report, the duration is also given, along with the total number of outages and the total outage time.

# Power Outage Report

Tensor\_55620\_2022-08-11\_214231U

[Settings](#)

Channel	Min. Time	Min. Volts
1	0s	0V
2	0s	0V

[Events](#)

#	Ch	Start Time	Stop Time
1	1	8/11/2022, 2:43:03 PM	8/11/2022, 2:44:11 PM
2	1	8/11/2022, 2:43:03 PM	8/11/2022, 2:44:11 PM
3	1	8/11/2022, 2:43:03 PM	8/11/2022, 2:44:11 PM
4	1	8/11/2022, 2:43:03 PM	8/11/2022, 2:44:11 PM
5	1	8/11/2022, 2:43:03 PM	8/11/2022, 2:44:11 PM

Most recorders have a battery or super-cap for ride-through capability, and will continue to record histograms, interval graphs, etc. for a period of time during a power outage. A power outage often triggers waveform capture, which may help reveal the cause of the outage.

## Flicker

The flicker record type is designed to show voltage variations that cause lights to flicker. The default threshold of irritation curve is based on the 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 flicker 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 differ 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.

**Flicker Report**  
 Tensor\_S5620\_2022-08-11\_214231U (55620)

Settings

Level	Percent	Limit
1	0.9%	5
2	1.2%	10
3	2.1%	10
4	2.5%	10
5	3%	10
6	4.6%	10
7	5.6%	10
8	5.9%	10
9	6.8%	10

Events

Channel 1

#	Timestamp	Tolerance	Duration	Freq. Limit	Events
1	8/12/2022, 3:20:28 AM	—	1s	—	6

Channel 2

#	Timestamp	Tolerance	Duration	Freq. Limit	Events
1	8/12/2022, 3:20:26 AM	—	1s	—	7
2	8/12/2022, 3:20:29 AM	—	10s	—	12
3	8/12/2022, 3:20:36 AM	—	1s	—	12
4	8/12/2022, 3:20:46 AM	—	1s	—	10
5	8/12/2022, 3:20:56 AM	—	1s	—	9

## What is 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 that 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 that shows no flicker according to a standard curve may lessen the complaint by showing that the voltage variations are within standard limits. If flicker memory is filled, flicker recording stops. The amount of memory used for flicker is different for various PMI recorders, but every recorder can record over one



thousand records.

Flicker is not meaningful on neutral to ground voltage channels: only channels that are used to power lighting generate useful Flicker data. 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, and in any case no lighting is being powered from the neutral. On most recorders Flicker is always enabled for recording.

## Abnormal Voltage

The abnormal voltage record type shows if the average line voltage moved past a low or high threshold from the nominal voltage. When the trigger occurs, the event is time stamped to the nearest second.

### Abnormal Voltage Report

transient\_waveform.nsf (14696)

Settings

Ch	Duration	Low-Low	Low	Nominal	High	High-High
1	5s	108V	114V	120V	126V	132V
2	5s	108V	114V	120V	126V	132V
3	5s	108V	114V	120V	126V	132V
4	5s	108V	114V	120V	126V	132V

Events

#	Ch	Timestamp	Range
1	1	12/31/1969, 4:00 PM	low
2	1	12/31/1969, 4:00 PM	high
3	2	12/31/1969, 4:00 PM	low
4	2	12/31/1969, 4:00 PM	high
5	3	12/7/2017, 8:20 AM	low
6	3	12/7/2017, 8:20 AM	high
7	4	12/7/2017, 8:20 AM	low
8	4	12/7/2017, 8:20 AM	high

## 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.

Recorders are initialized with a list of potential nominal voltages (such as 120V, 240V, 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 nominal voltages; the closest one becomes the nominal

voltage for the entire recording session.

There are five standard nominal voltages in the software setup (120V, 208V, 240V, 277V, and 480V), and two custom nominal voltages. The custom nominal voltages can be set to any voltage. It is also possible to enable and disable the standard and custom nominal voltages. For example, if you want to force the recorder to use 230V as the nominal, the standard nominal voltages should be disabled, and both custom nominal voltages set to 230V.

If the standard nominal voltages were not disabled, there would be a chance for the recorder to pick 240V during the two-minute countdown if the line voltage happened to be running closer to 240V than 230V at that time.

The nominal voltage 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 voltage is selected by the recorder after the two-minute countdown. Voltage channels are handled separately; there is a complete set of nominal voltages and thresholds for each. The recorder will automatically select the correct nominal and threshold voltages for 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 voltage 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 creates two trip points, one above the nominal and one below. For example, consider a setup where the nominal is 120V, the low threshold is 6V, and the high 12V. The low trip points become  $120 \pm 6$ , or 114V and 126V. The high trip points are  $120 \pm 12$ , or 108V and 132V. If the one-second average voltage rises above 126V or falls below 114V for longer than the trigger duration, the low abnormal voltage trigger occurs. 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.

## What is 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. Typically, the abnormal voltage report is used to get a quick read of whether there was any line voltage drift; if so, other record types such as the interval graph and significant change are used for more information.

The default threshold settings are at 5% and 10% of the nominal voltage (for example, 6V and 12V for the 120V nominal). The high threshold must be larger than the low threshold. The two custom nominal voltages are preset at 106V and 230V but should be changed if a different nominal voltage 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

The loose neutral report shows whether the typical symptoms of a loose neutral have occurred. This report is intended for single phase services, such as those measured by the recorder with only two channels in use, with voltage channels 1 and 2 connected from line to neutral.

### Loose Neutral Report

Eagle 330 LooseN.nsf (56394)

#### Settings

Duration	Range	Difference
5 sec	12V	16V

#### Events

Timestamp	Duration	VCH1	VCH2	VCH3
9/17/2013, 5:18:35 PM	9 sec	214V	26.5V	0V

The primary 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 119V and 121V, then move to 105V and 135V, a loose neutral is a likely cause: one leg went up, one went down, and the sum is close to twice the nominal (240V). This happens whenever 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, with a loose neutral where the difference is 16V; there must be at least a 16V 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 voltage. For example, a range of 12V means that the sum of the two legs must be within 12V 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 five seconds, then the difference and range conditions must be met for five 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 120V in a single-phase hookup. As an example, assume the difference parameter is 16V, and the range 12V, with 5-second duration. The two-line voltages are 119 and 121V. Then one leg moves to 128V, and the other to 110V. The difference between the two legs is 18V, which meets the difference threshold. The sum of the two voltages is 238V, which is within the required 12V (specified by the range value) of twice the nominal (240V).

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 119V and 121V, then a heavy load to channel 1 causes it to drop to 105V, with the other leg still at 121V, the difference condition is met ( $121 - 105 > 12$ ), but the range condition is not met:  $105 + 121 = 226$ , and 226V is not within 12V of the 240V nominal.

## What is Recorded

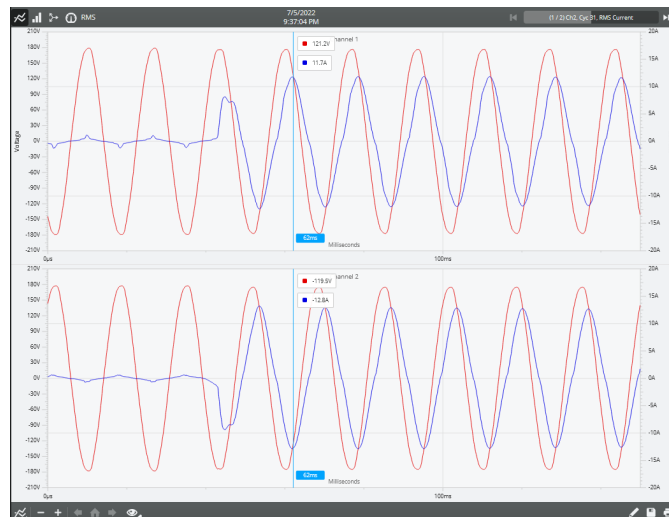
The date and time of the loose neutral triggering is recorded, along with the voltage on the two channels. Only the first occurrence of a loose neutral is recorded; if the conditions are met again, nothing further happens. The loose neutral report shows whether the neutral may have a bad connection, 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

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 nonlinear loads, and the voltage wave shapes show the distortion due to harmonic currents and transformer

loading.

## Trigger Logic

Waveform capture is triggered when the change in voltage or current exceeds one of the user settable thresholds. This threshold can be set as a percentage change in voltage or current, or a change in terms of absolute volts. 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 5V to trigger. If a trigger occurs, the waveform data is recorded.

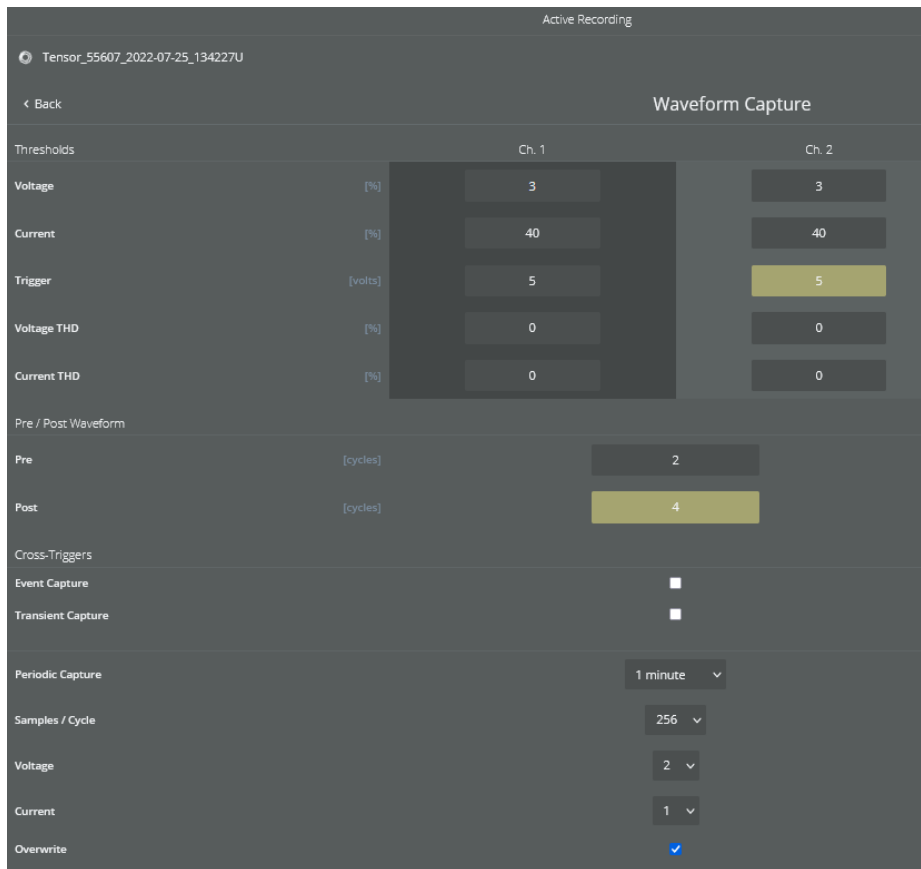
The trigger test is repeated every cycle, so if the RMS voltage keeps changing, waveform capture will continue to be triggered, until the voltage stabilizes.

## What is 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. The user can also customize how many pre and post waveform cycles are recorded. Whenever a waveform is triggered, 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. Many users choose to record two cycles prior to the triggering cycle and six cycles after the triggering cycle, recording nine cycles total (including the triggering cycle). This provides a good depiction of what happened just before the triggering cycle and what happened immediately after. 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 waveform capture one cycle after the triggering stops. 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

The default setting for triggering a voltage waveform capture is 3%. With this threshold, the RMS voltage must change by at least 3% in a single cycle. If the threshold is too tight, waveform capture will trigger so often that useless events overwrite the important waveforms. You may also choose to trigger a waveform capture using a voltage value, rather than a percentage. The default trigger setting for the voltage is 5 volts. To use this, simply set the percentage setting for waveform capture higher than the voltage setting. For example, if you would like the trigger threshold to be 5 volts rather than 3%, simply set the percentage trigger threshold to a value such as 100%, and the waveform capture will then be triggered by the threshold of 5 volts, as that is the tighter constraint.



The default setting for triggering a current waveform is 40%. If you wish to capture more or less current waveforms, simply set this value higher or lower. If you do not wish to capture any waveforms based on variations in current, simply set this percentage to a very high level, so that it is unlikely that a waveform will ever be triggered by a current variation (the highest allowed trigger threshold is 900%).

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 arrester. 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 minimum or maximum voltage is usually in the interval graph 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, because some harmonics do not 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.

## Transient Capture

In addition to measuring and recording many types of instantaneous and momentary voltage and current disturbances, the recorder can capture a class of events shorter in duration than instantaneous sags and swells called transients. These disturbances are classified as impulsive transients, usually attributed to lightning and load switching, and oscillatory transients usually caused by capacitor bank switching.








### Transient Capture Report

2139-5336-0 VAN ALLEN TIM.nsf

Settings

	Ch 1	Ch 2	Ch 3	Ch 4
Threshold Volts	1kV	1kV	1kV	1kV
Threshold Percent	200%	200%	200%	200%

Transients

#	Timestamp	Cycle	Duration	
1	11/5/2019, 2:28:40 AM	1	1ms	
2	11/5/2019, 2:28:40 AM	2	1ms	
3	11/5/2019, 2:28:40 AM	2	1ms	
4	11/5/2019, 2:28:40 AM	2	1ms	
5	11/5/2019, 2:29:03 AM	8	1ms	
6	11/5/2019, 2:29:11 AM	6	1ms	
7	11/5/2019, 2:29:11 AM	6	1ms	

Impulse transients occur as high peak magnitude, fast rise time, uni-polar (either positive or negative) disturbances. Since they are non-power frequency related events, they can occur at any point in the fundamental power voltage waveform and can add to or subtract from the voltage peak magnitude.

Oscillatory transients occur as a result of capacitor switching for power factor correction, one of the most common switching events on utility systems. When switched, these capacitors react with the inductance of the power system to create a resonant circuit which rings at the natural frequency of the L-R-C system. This event produces a voltage transient with a peak magnitude between 1.0 and 2.0 per unit depending on the damping, or resistive component, of the system. The frequency of the ringing or oscillating waveform varies with the VAR rating of the capacitor, and usually falls between 300 and 900 Hz.

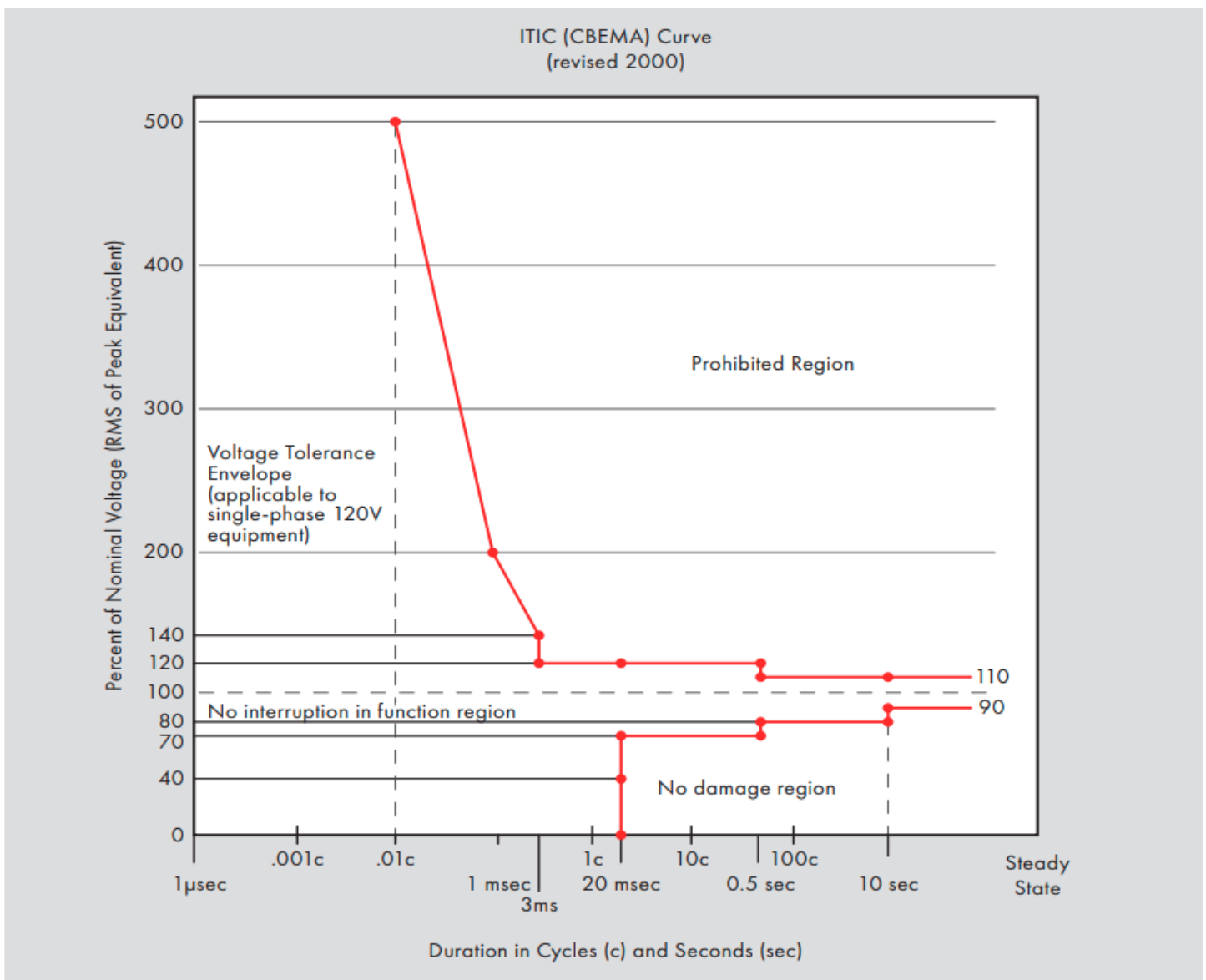
The recorder uses a voltage channel sampling rate of 1MHz (16,666 samples/cycle) to detect and measure voltage transients up to 5kV peak magnitude. Current channels are sampled at 250kHz or 4,166 samples/cycle.

In order to detect and record transients, the recorder measures the peak (or instantaneous) voltage. Whenever the absolute instantaneous voltage exceeds the limit selected by the user during initialization, a transient will be detected

and recorded.

## CBEMA Report and Graph


The CBEMA and ITIC 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





## CBEMA Report

Guardian\_21253\_2022-09-02\_053523U (21253)

 Open Graph

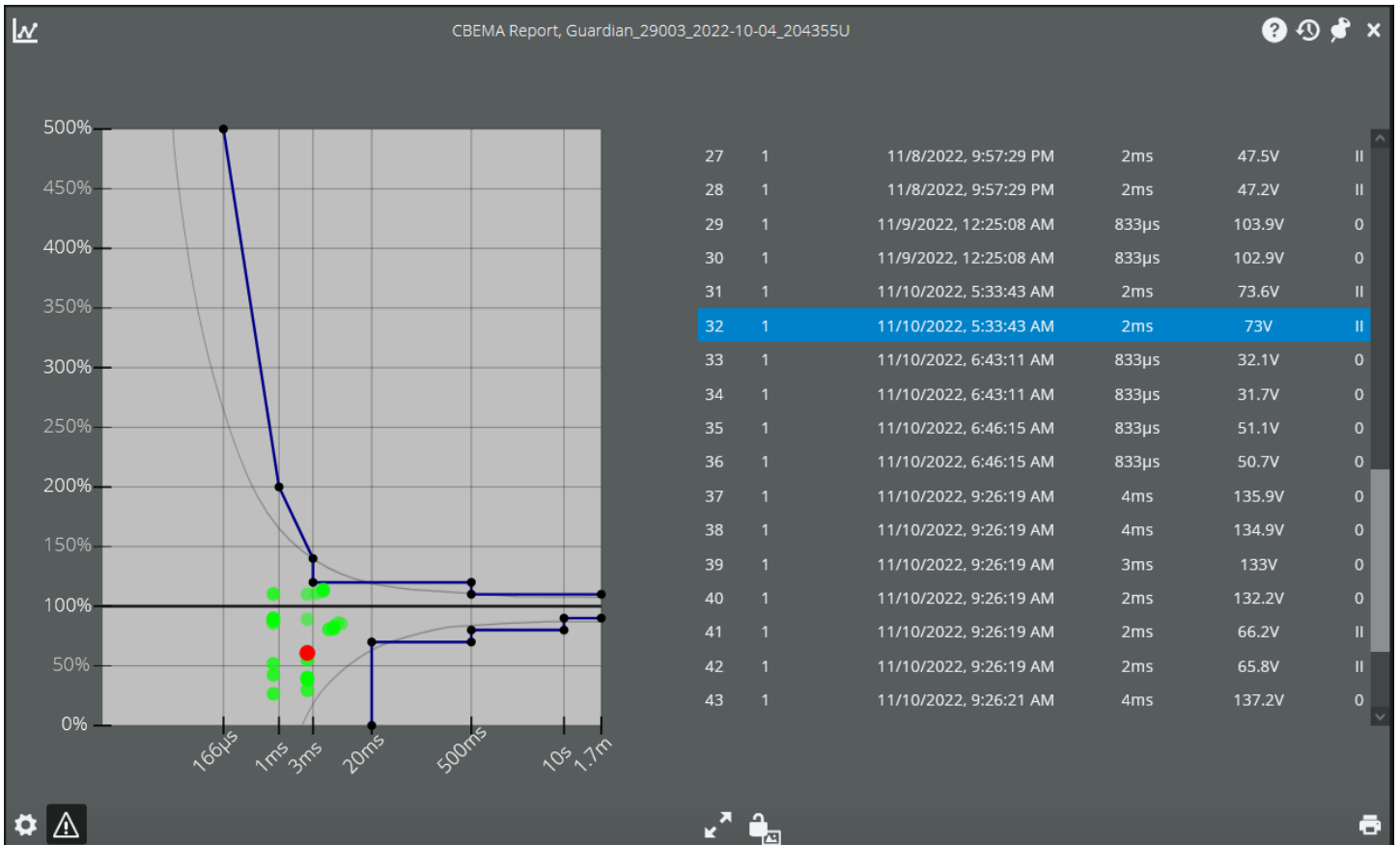
Settings

Nominal Voltage	Channels
120V	3

Events

#	Ch	Timestamp	Duration	Voltage	Type
1	1	9/6/2022, 4:54:58 AM	8ms	146.2V	I
2	1	9/6/2022, 4:54:58 AM	8ms	146.3V	I
3	1	9/6/2022, 4:56:19 AM	25ms	3.6V	II
4	1	9/6/2022, 4:56:19 AM	25ms	3.5V	II

The ITIC and CBEMA curves define an input voltage region based on 100% of the nominal RMS voltage and increasing time durations. Voltage events that fall into this defined region can typically be tolerated by most IT equipment. The curves are not intended to be used as design specifications for products or for voltage distribution systems. However, events plotted on the graph do show a general overview of the existing voltage acceptability. The curves define both steady-state and transitory regions for events.



Select Graph Event or Event in List to highlight both

The ITIC and CBEMA curves define an input voltage region based on 100% of the nominal RMS voltage and increasing time durations. Voltage events that fall into this defined region can typically be tolerated by most IT equipment. The curves are not intended to be used as design specifications for products or for voltage distribution systems. However, events plotted on the graph do show a general overview of the existing voltage acceptability. The curves define both steady-state and transitory regions for events.

# Recorder Hookup Diagrams

<p><b>Three Phase WYE</b></p> <p>Set circuit type to "wye"</p>	<p><b>Three Phase Delta</b></p> <p>Set circuit type to "3 wire delta"</p>	<p><b>Open Delta</b></p> <p>Set circuit type to "3 wire delta"</p>
<p><b>Four Wire Delta</b></p> <p>Set circuit type to "4 wire delta"</p>	<p><b>Two Element Delta</b></p> <p>Set circuit type to "3 wire delta"</p>	<p><b>2½ Element WYE</b></p> <p>Set circuit type to "2.5 el. wye"</p>
<p><b>2 Wire Single Phase</b></p> <p>All Other Channels Optional Set circuit type to "wye"</p>	<p><b>Notes:</b></p> <ul style="list-style-type: none"> <li>• Directional arrows on CTs should point TOWARDS the load.</li> <li>• 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.)</li> <li>• Do not exceed 600 volts RMS channel-to-channel or channel-to-common.</li> <li>• Disable unused channels in software for more recording time.</li> <li>• Phase-to-Phase voltages are measured in 3-wire delta hookups.</li> <li>• Line-to-neutral voltages are measured in wye hookups.</li> </ul>	<p><b>3 Wire Single Phase</b></p> <p>All Other Channels Optional Set circuit type to "wye"</p>

## Conclusion

PQ Canvass provides a cloud-based system for power quality data analysis, storage, and real-time display to recorders in the field. Browser and tablet friendly interfaces allow for graph and report generation, live readings, email and SMS alerts, and recorded data management. All collected data up to the present is immediately available in a web browser. This eliminates the need to wait for a recording session to finish or go back in the field to see what has been collected so far. The combination of always-connected recorders and PQ Canvass makes gathering and analyzing power quality data easier and faster.

# 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](mailto: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**