

MicroPMU Quick Start Kit

First Steps

Revision 14



If the equipment is used in a manner not specified by the manufacturer, the protection provided by

WARNING: Death, serious injury, or fire hazard could result from improper connection or operation of the instruments of this kit. Carefully read and understand manual before connecting this instrument.

AVERTISSEMENT: Si l'instrument est mal connecté, la mort, des blessures graves, ou un danger d'incendie peuvent s'en suivre. Lisez attentivement le manuel avant de connecter l'instrument.

WARNUNG: Der falsche Anschluß dieses Gerätes kann Tod, schwere Verletzungen oder Feuer verursachen. Bevor Sie die Instrument von dieses Start Kit anschließen, müssen Sie die Anleitung lesen und verstanden haben.

ADVERTENCIA: Una conexión incorrecta de los instrumentos de esta Start kit puede producir la muerte, lesiones graves y riesgo de incendio. Lea y entienda el manual antes de conectar.

the equipment may be impaired. Installation, service, and maintenance of your MicroPMU must only be done by qualified personnel for electrical installations.

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IMPORTANT: It is HIGHLY recommended that the Quickstart Kit (server, MicroPMUs, network switch) is backed up by and uninterruptable power supply (UPS) in the event of a power surge or failure. This will greatly reduce the likelihood of damage caused to any of the hardware or potential data corruption as a result of a power outage or fluctuation. A recommended UPS model is the **APC-SMT750**.

Document Release Date: April 2017

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1 MicroPMU Quick Start Kit

1.1 What Is the MicroPMU Quick Start Kit?

Microsynchronphasors measurement is a new technology. It involves continuous monitoring and recording of phenomena on the distribution or micro grids. The MicroPMU Plotting Application software has been developed specifically to assist researchers and engineers to manage and navigate through the large amount of measurements generated by the MicroPMU's. The Quick Start Kit serves as a convenient way to start a measurement campaign in just a few hours. It includes instruments, cables, connectors, software and a basic communication infrastructure: all is provided in a single pack to give you a head start!

1.2 Requirements prior to installation

IMPORTANT: It is HIGHLY recommended that the Quickstart Kit (server, MicroPMUs, network switch) is backed up by an uninterruptable power supply (UPS) in the event of a power surge or failure. This will greatly reduce the likelihood of damage caused to any of the hardware or potential data corruption as a result of a power outage or fluctuation. A recommended UPS model is the **APC-SMT750**.

The following is a list of requirements before installing any MicroPMUs.

- Monitor with a VGA display port and a VGA cable
- **Google Chrome Browser** (Windows, Linux, Mac OSX) or **Safari** (iOS and Mac OSX), or Microsoft Internet Explorer (Windows)
- Laptop with an Ethernet port and an Ethernet cable
- Minimum 7 available power outlets

1.3 MicroPMU Quick Start Kit Contents

Linux Server

- 1x Linux server (hosts the MicroPMU Plotter Application)
- 1x Power cord for Linux server

MicroPMUs

- 4x MicroPMU packages: each package includes a MicroPMU and its PM1, MS1, GPS1 and UPS1 modules
- 4x DIN rails
- 4x single phase voltage cables
- 4x current transformers

Networking

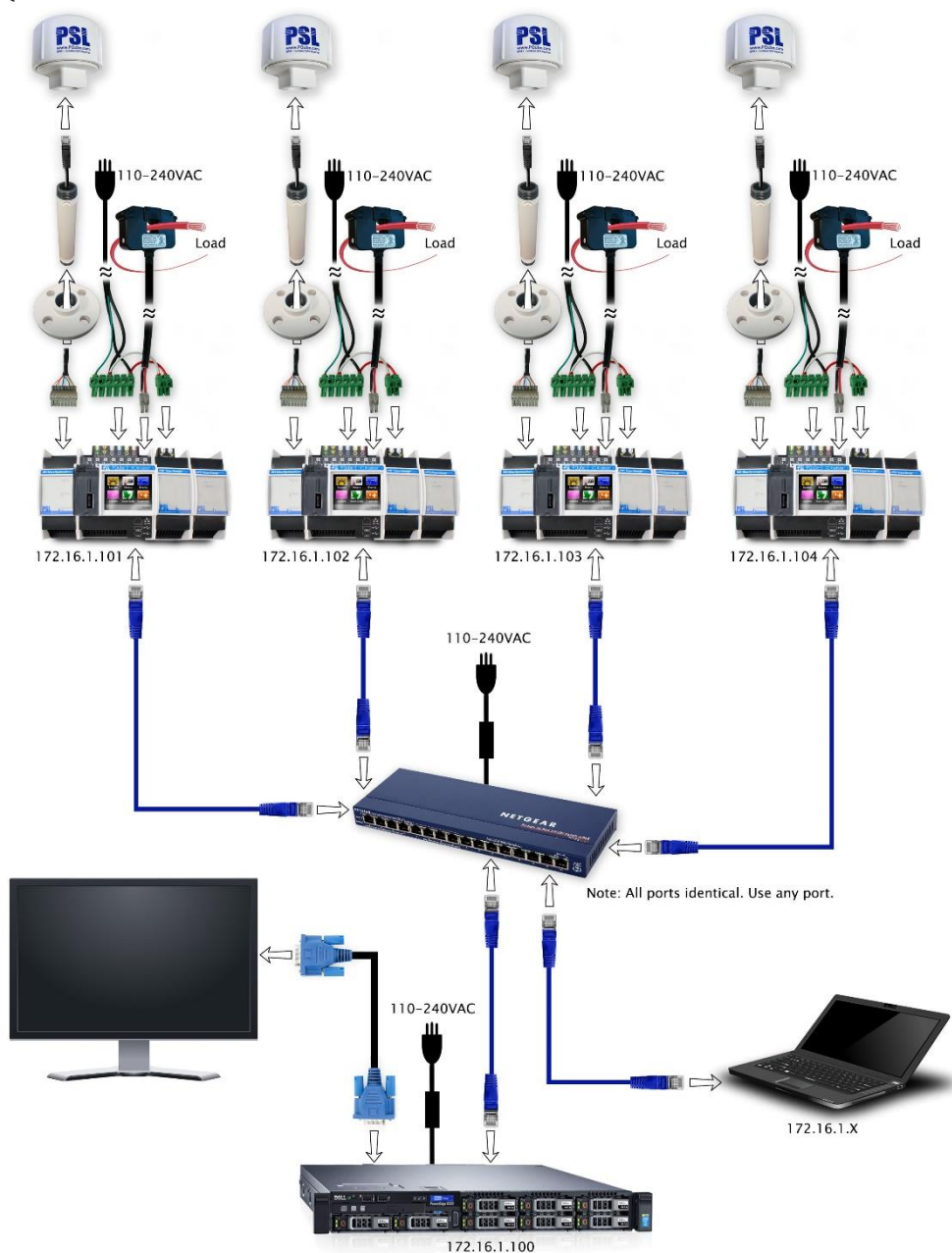
- 5x 10-meter Cat 5e patch cables (Ethernet)
- 1x 16 port 10/100 Desktop switch

The Quick Start Kit comes preconfigured as follows:

Server:	172.16.1.100
Subnet:	255.255.255.0
uPMU_1:	172.16.1.101
uPMU_2:	172.16.1.102
uPMU_3:	172.16.1.103
uPMU_4:	172.16.1.104

2 Connecting and setting up the MicroPMUs

The following top level diagram illustrates the entire physical setup and connections for the Quickstart Kit.



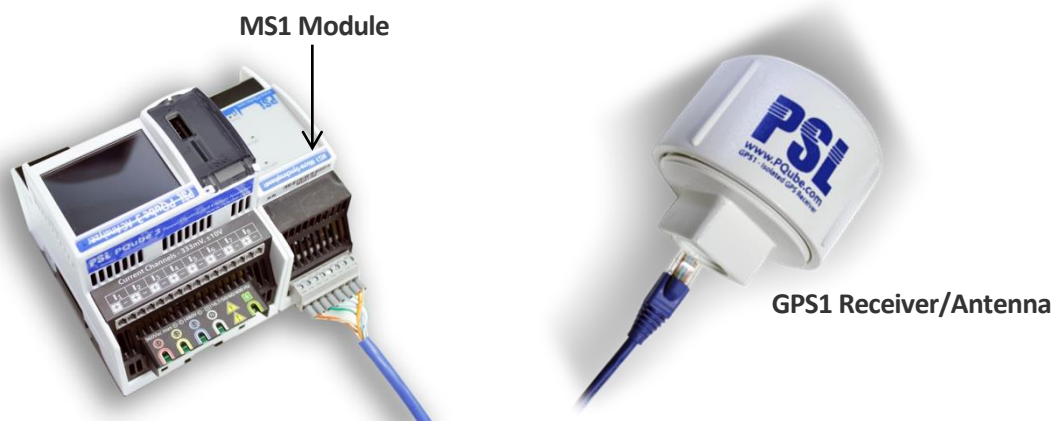
2.1 MicroPMU Setup

1. The MicroPMU, MS1, PM1 and UPS1 come preassembled on a DIN rail



2. Mount the GPS hardware

The GPS cable has an 8-pin terminal block on one end and an RJ-45 jack on the other end. The 8-pin terminal block plugs into the MS1 module, the other end plugs into the GPS1 receiver.



IMPORTANT: Do not plug the RJ-45 end of the GPS cable into a network switch or router.

Place the GPS1 antenna/receiver in an area with direct line of sight to the sky. For maximum exposure to satellites, mount it on the roof.

If necessary, the GPS cable can be extended using a standard RJ-45 coupler and a standard CAT5, CAT5E, or CAT6 Ethernet cable (to a maximum length of 500 feet / 150 meters).



3. Connect the MicroPMU to the network switch

Plug in one of the provided Ethernet cables between the MicroPMU and the provided 16-port Ethernet switch. Ethernet status lights will turn on when connection is established.



4. Connect wires to mains AC terminals and PM1

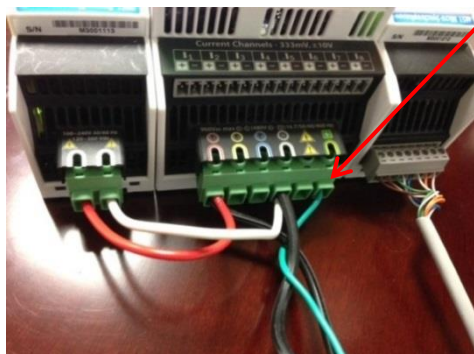


Make sure the power is OFF before servicing these terminals.

When installing microPMUs in the field, connect the wires to the high voltage terminal block on the MicroPMU. They will be labeled L1, L2, L3, N, and Ground.

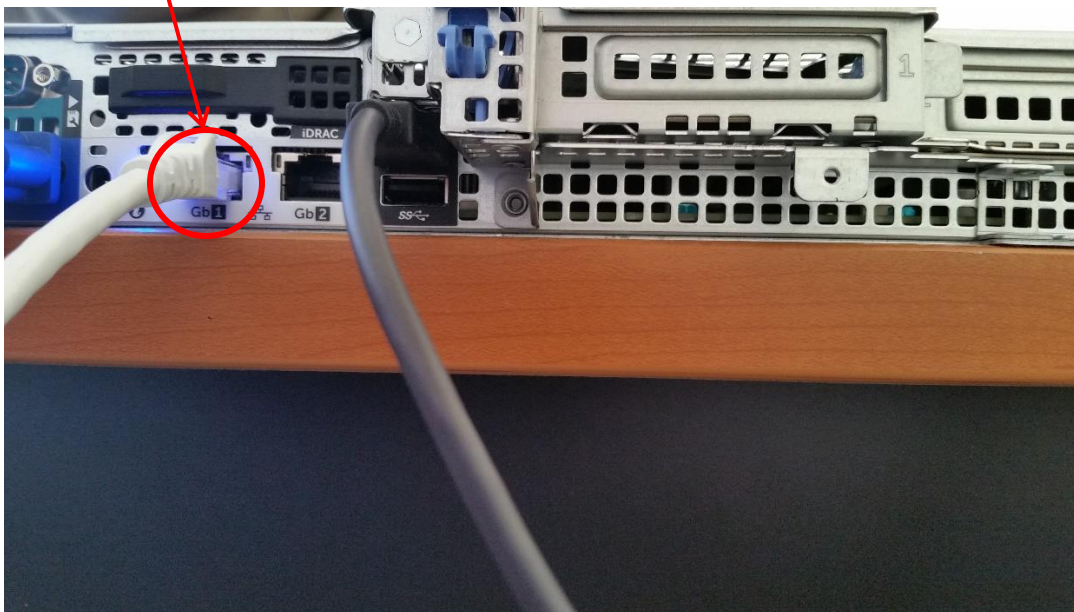
The power cable comes pre-wired to two terminal blocks in the Quick Start Kit. Plug the larger terminal block into the PQube 3 mains terminals and plug the smaller one into the power supply input of the PM1 module.

IMPORTANT: You **must** ensure that the ground wire is connected to the MicroPMU. This is critical for accurate phase angle measurements.



5. Connect the server to network and power

Once all of the MicroPMU units have been set up, use one of the provided Ethernet cables to connect the Gb1 interface of the server to the provided 16 port Ethernet switch.



Then, connect the server to a suitable power supply and press the power button next to the “Dell” icon on the top left corner of the front panel.



3 Using the MicroPMU Plotter

3.1 Accessing the MicroPMU Plotter

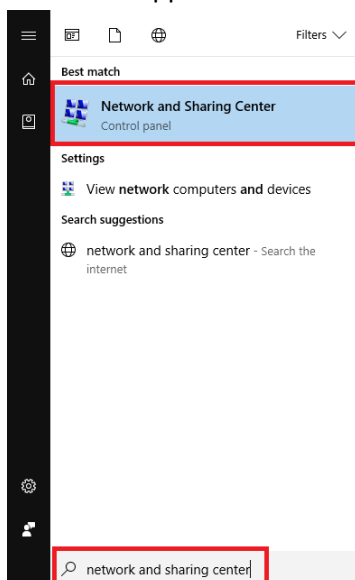
The Quick Start Kit server comes with a pre-installed data plotting web application, known as the MicroPMU Multiple-Resolution Plotter. The MicroPMU Plotter can be accessed using an internet browser and by typing the IP address of the Quick Start Kit server: <http://172.16.1.100>. This IP address is pre-configured with the Quick Start Kit. If this needs to be changed, refer to the MicroPMU Administrator Manual. In order to view the plotter from a client computer, the IP configuration of either the WI-FI or Ethernet adapter must be changed so that the adapter is on the same network as the Quickstart Server and microPMU units. Refer to the next two sections for instructions on the client connection from either a Windows or Mac computer.

The screenshot shows the MicroPMU Plotter web application interface. At the top, it displays 'PSL Power Sensors Ltd.' and 'BTDBG & uPMU Plotter developed by U.C. Berkeley'. Below the header, there are navigation options like 'Hide', 'MicroPMU Plotting Application v1.40', and 'Log in'. The main content area is divided into two panels. The left panel, titled 'Select Streams', shows a tree view of data streams under 'uPMU' and 'upmu'. The right panel shows a detailed view of the selected streams, including 'uPMU', 'uPMU_1', 'uPMU_2', 'uPMU_3', and 'uPMU_4'. A line graph is displayed on the right, showing 'Value' on the y-axis and 'Time (GMT+08:00, August 2015)' on the x-axis. The graph shows a fluctuating signal. Below the graph, there are two images of a mouse, with callout 4 pointing to the mouse buttons. At the bottom, there is an 'Export' section with buttons for 'Export Graph to CSV File', 'Export Graph to SVG Image', and 'Generate Permalink'. Numbered callouts 1 through 5 are overlaid on the interface: 1 points to the 'uPMU' folder in the left panel; 2 points to the 'uPMU' folder in the right panel; 3 points to the graph; 4 points to the mouse images; and 5 points to the 'Export' section.

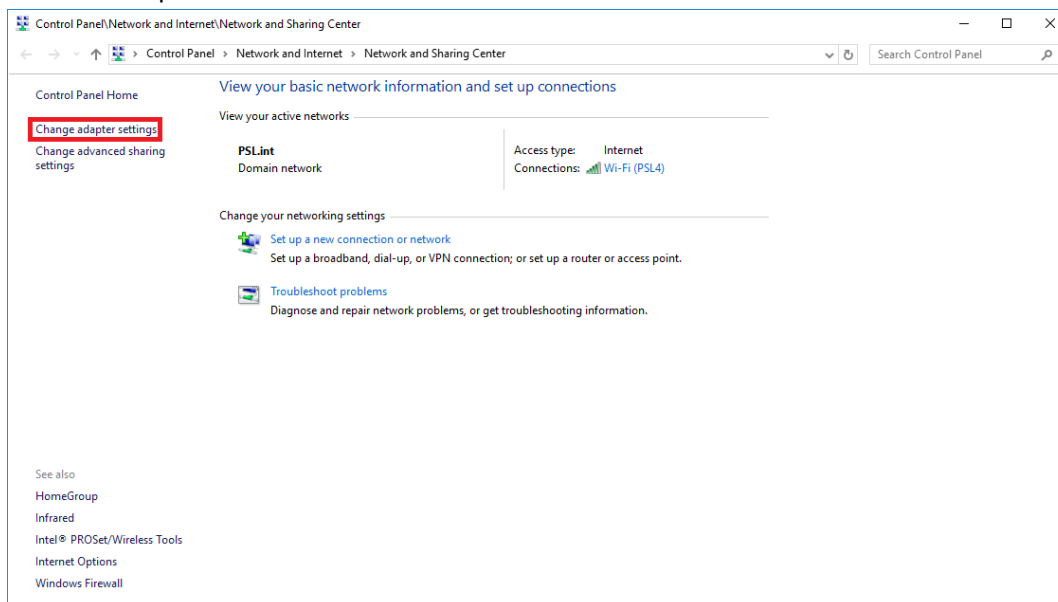
3.1.1 Client Connection via Windows

Go through the following steps to change network adapter settings on Windows.

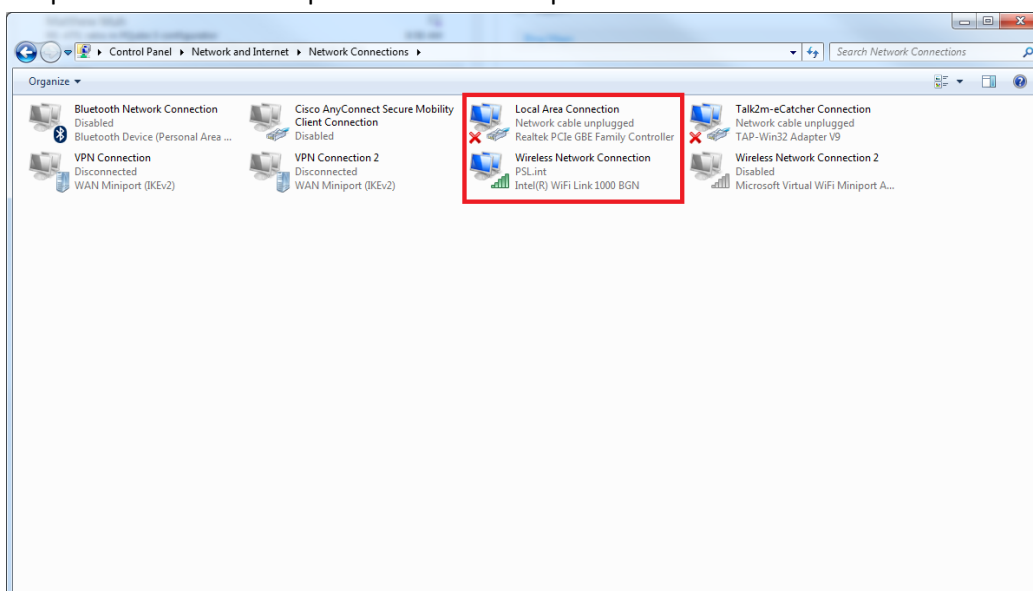
- 1) Open the start menu and type “network and sharing center” in the start menu search bar (if using Windows 10, just type and a search bar will automatically display), and click on the top result that appears which will open the Network and Sharing Center window.



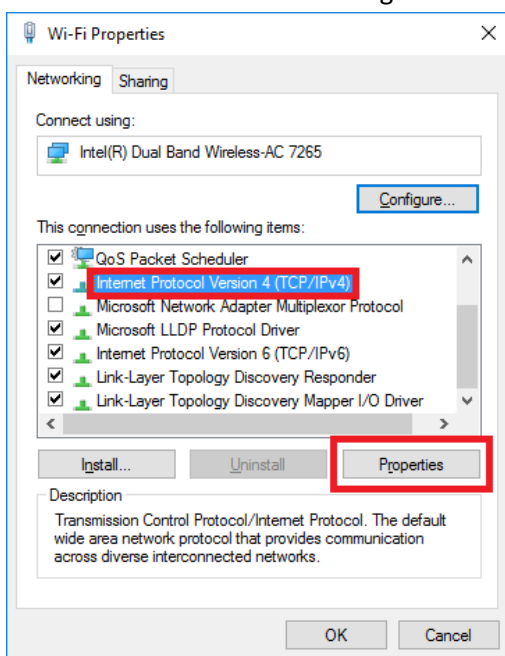
- 2) In the left hand pane of the Network and Sharing Center window, click on the link labeled “Change adapter settings” and another window will appear that displays all of the available network adapters.



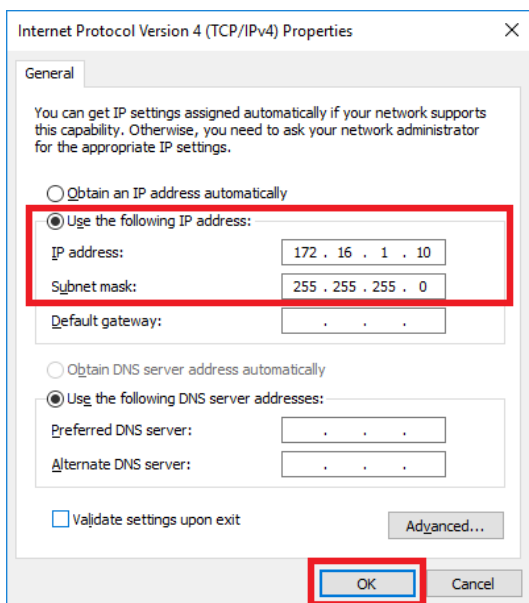
- 3) Find either the Wi-Fi or Ethernet adapter which should be labeled something similar to either “Wireless Network Connection” or “Local Area Connection” respectively, although these labels may vary depending on the exact hardware of the client machine. Next, right click on the adapter and click on “Properties” which will open another small window.



- 4) In the scroll box, scroll down to the entry labeled “Internet Protocol Version 4” and click on the text to highlight it, but do not uncheck the box to the left of the text. Now click the “Properties” button underneath the lower right corner of the scroll box.



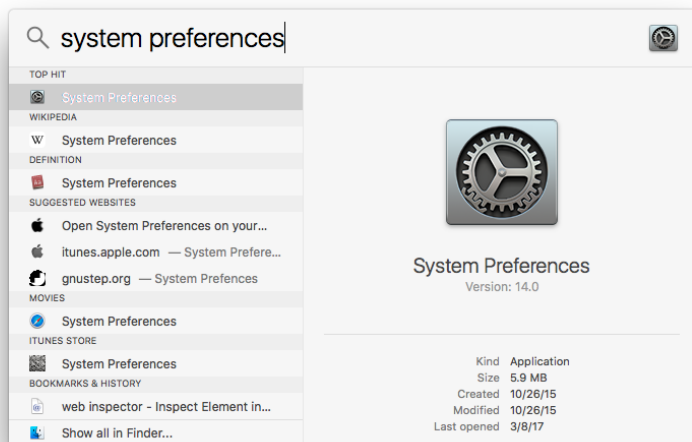
- 5) In the new window that appears, there will be two sections of radio button choices. Change the top radio button selection from “Obtain an IP address automatically” to “Use the following IP address”. Now set the IP address to an unused IP on the same network as the Quickstart server and microPMU units. For example, with the default network of “172.16.1.0”, a valid client IP could be “172.16.1.10”. Next, set the subnet mask to “255.255.255.0” then click the “OK” button on the bottom right corner of the window and close the other Network and Sharing Center windows.



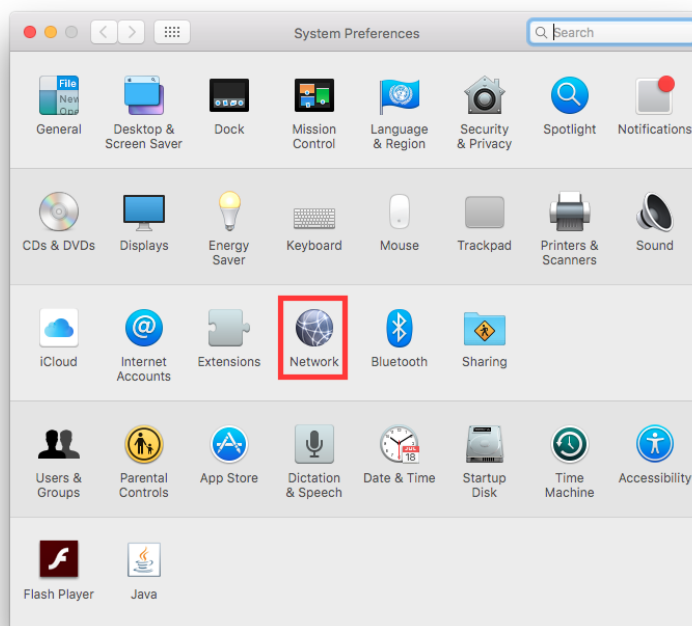
3.1.2 Client Connection via Mac OS

Go through the following steps to change network adapter settings on Mac OSX.

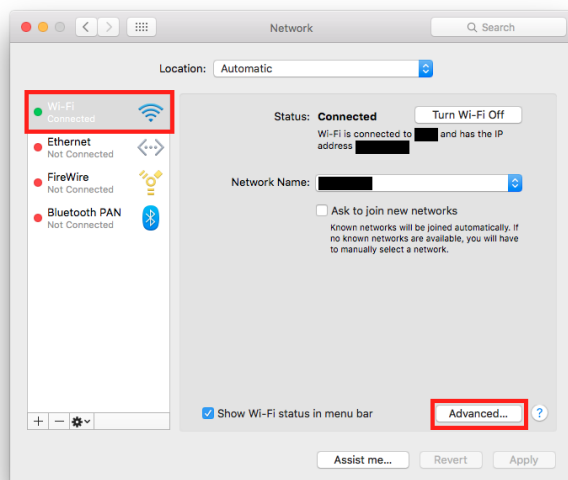
- 1) Open the spotlight search (Command (⌘)-Space bar), type “system preferences” and press the “enter” key.



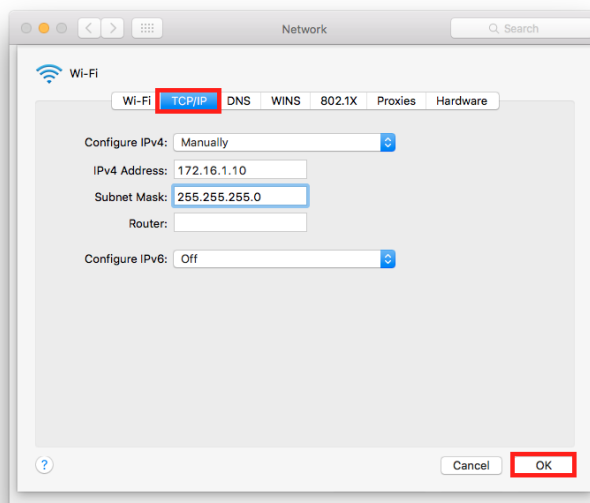
- 2) Click on the “Network” icon



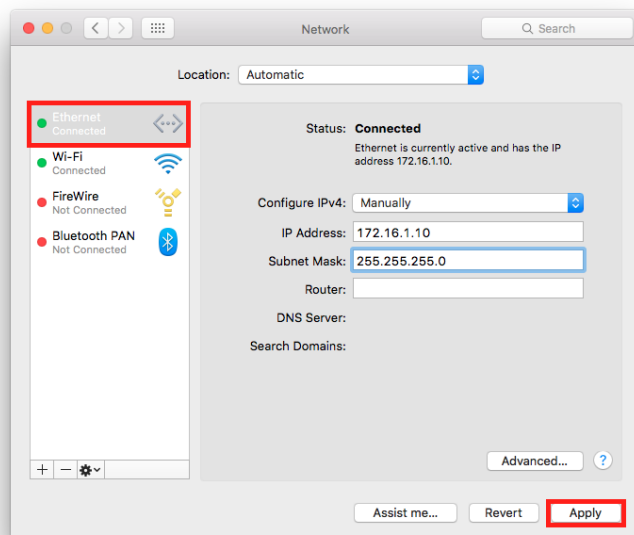
- 3) For instructions on adjusting the Wi-Fi adapter, go to step 3a. For instructions on adjusting the Ethernet adapter, go to step 3b.
- a) Select “Wi-Fi” in the left hand pane of the Network window and click the “Advanced” button toward the bottom right corner.



- i) Click the “TCP/IP” tab, set the “Configure IPv4” selection to “Manually” and enter an unused IP on the same network as the Quickstart Server and microPMU units. For example, with the default network of “172.16.1.0”, a valid client IP could be “172.16.1.10”. For the subnet mask, enter “255.255.255.0” then click “OK” toward the bottom right corner and click “Apply” after the “Advanced” window closes.



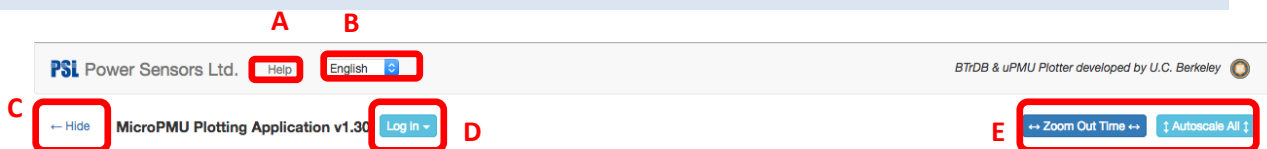
- b) Select “Ethernet” in the left hand pane of the Network window, set the “Configure IPv4” selection to “Manually” and enter an unused IP on the same network as the Quickstart Server and microPMU units. For example, with the default network of “172.16.1.0”, a valid client IP could be “172.16.1.10”. For the subnet mask, enter “255.255.255.0” then click “Apply” toward the bottom right corner.



The different areas of the plotter interface are indicated in the following figure:



3.2 Plotter Header

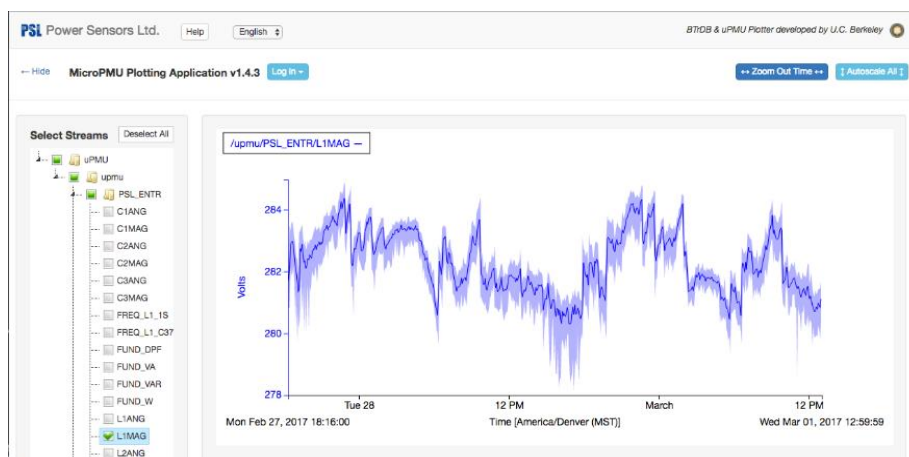


- A. Click help to open a PDF of this document (Quick Start Kit First Steps).
- B. Set the language for the plotter interface.
- C. Click to hide or show the left-hand panel containing the list of microPMUs and datastreams.
- D. Log in to a user account. User accounts can control which users have access to each microPMU. By default there are no user accounts, so data from all microPMUs is visible. Refer to the Quick Start Kit Administrator manual for instructions on setting up user accounts.
- E. The “Zoom Out Time” button autoscales the X-axis (time) to fit all recorded data into the graph. The “Autoscale All” button autoscales the Y-axis (measurement values) to fit all recorded values within the time scale.

3.3 Selecting Streams

A stream is a parameter recorded over time by the MicroPMUs, e.g. phasor amplitude. To view a stream:

1. Click the dropdown arrow to the left of “uPMU” in “Select Streams” section
2. Click the dropdown arrow to the left of “upmu” (database collection name) to show MicroPMUs
3. Expand by clicking the dropdown arrow to the left of a MicroPMU name
4. Select a MicroPMU stream to display (ex. L1MAG or FREQ_L1_1S) by check marking the box to the left of the stream name
5. Data will appear in the graphing canvas.



The server disk usage is displayed in between the streams tree and time parameter options.

2% used (29GB of 2TB)

The Quickstart Server comes with a two terabyte solid state drive for database storage. When the drive reaches about 98% capacity, the server will stop accepting data and a message will display below the disk usage gauge stating “No longer accepting new data. Drive is full”. A new drive will need to be used or the existing data will need to be backed up and a fresh database instance will need to be created on the existing drive. This procedure will need to be done by the Quickstart Server administrator or instructions on these procedures may be found in the Administrator manual.

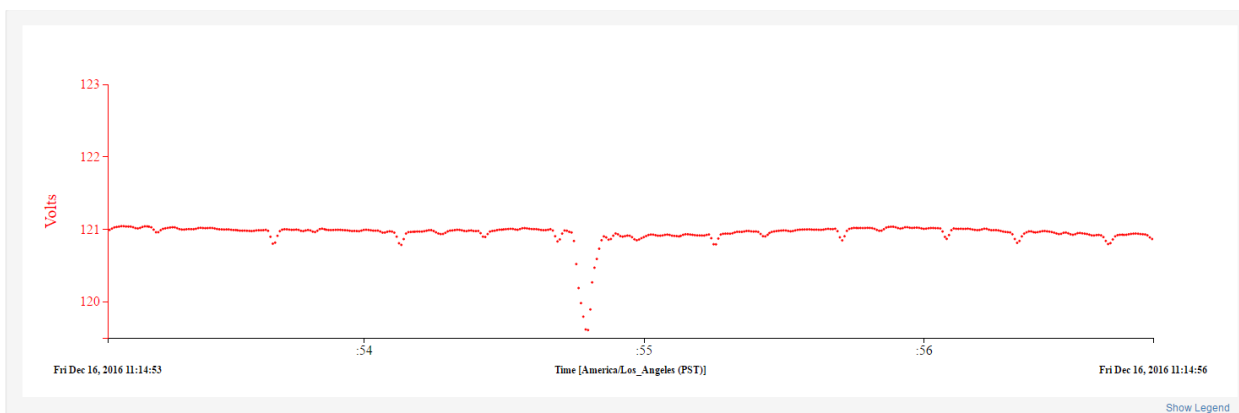
3.4 Setting the min and max range of the X-axis and Y-axis

3.4.1 To set the X-axis

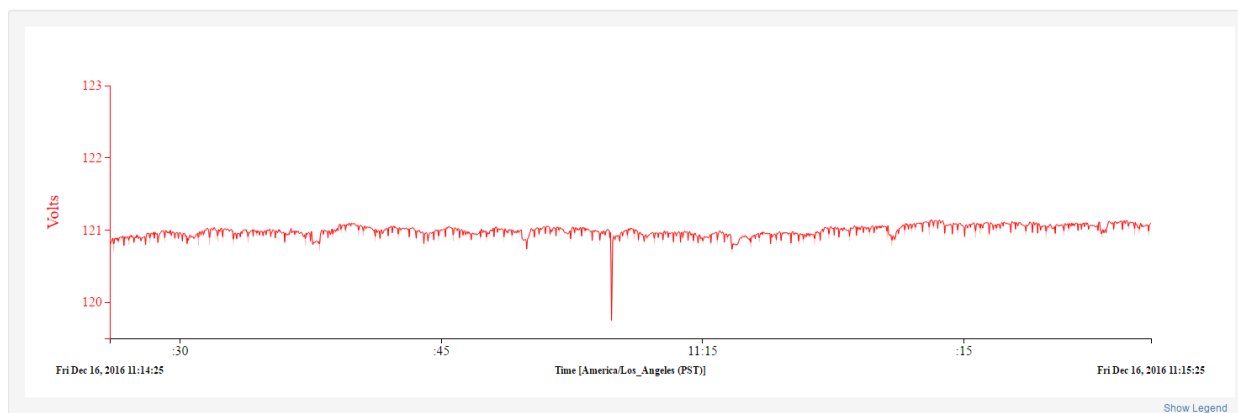
Use the scroll wheel on the mouse to zoom in and out of the X-axis.

Click and drag the mouse to pan left or right along the X-axis.

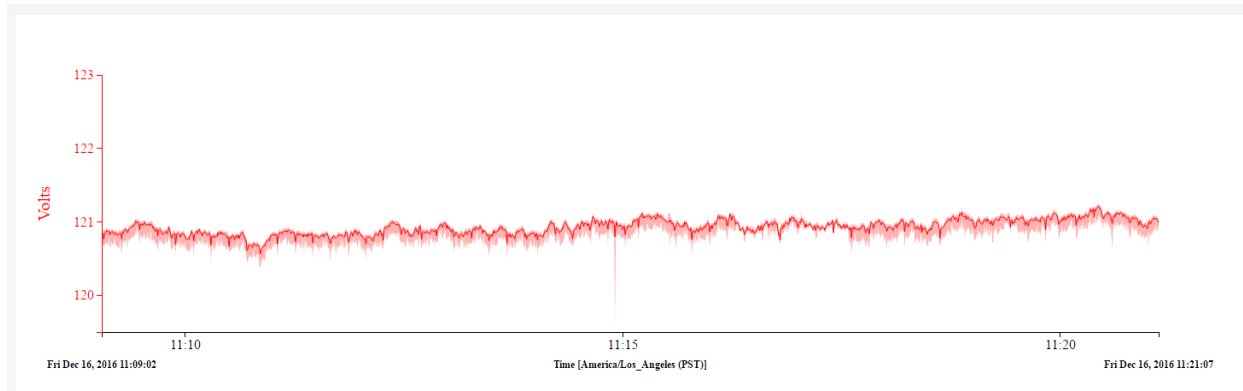
Each microPMU records data at a rate of 120 times per second. When zoomed in close enough, each individual measurement point can be seen.



When zooming out, the plotter software will automatically average the data points before displaying them.



When zooming out even farther, the data will appear as a line inside of a shaded area. The line represents the average value. The upper/lower boundaries of the shaded area represent the maximum and minimum values, respectively.



Show Legend
Axes
Time

Manual Zoom

Start Date: Fri Feb 03, 2017 03:15:46 -1Y

End Date: Tue Feb 07, 2017 11:09:24 Now

[← Manual Zoom →](#)

Timezone

America/Los_Angeles DST

[Autodetect](#)

The minimum and maximum X-axis value may also be manually set. Click the Time tab underneath the graph and set the Start Date and End Date fields.

Shortcut buttons are available for Start Date (past 1 year) and End Date (now).

Set the time zone using the dropdown menu on the right, and check the DST box to set Daylight Savings Time if necessary.

Click the “Manual Zoom” button to refresh the plotter graph.

3.4.2 To set the Y-axis

Under the Axes tab, clicking “Autoscale” fits the Y-axis to the data presently in the graph.

If necessary, the minimum and maximum Y-axis values may also be entered manually.

The screenshot shows the 'Axes' configuration panel in the PSL software. The panel has tabs for 'Hide', 'Legend', 'Axes', and 'Time'. A green 'Add a Y-Axis' button is in the top right. Below is a table with columns: Axis Name, Stream, Units, Axis Position, Axis Scale, and Remove.

Axis Name	Stream	Units	Axis Position	Axis Scale	Remove
Degrees			← × →	↑ Autoscale ↓	to
Amps			← × →	↑ Autoscale ↓	to
Volts	/ upmu/ PSL_ENTR/ L1MAG	Volts	← × →	↑ Autoscale ↓	278 to 285
Hertz			← × →	↑ Autoscale ↓	to
Watts			← × →	↑ Autoscale ↓	to
VA			← × →	↑ Autoscale ↓	to
VAR			← × →	↑ Autoscale ↓	to
DPF			← × →	↑ Autoscale ↓	to
bitmap			← × →	↑ Autoscale ↓	to

3.5 Setting line color and labels for each data stream



In the “Legend” tab underneath the graph, the color and label for each data stream in the graph may be changed.

To set the color, click the box under the Color column to reveal a color palette.

To set the label, click the dropdown menu under the Axis Name column.

Click the Stream name to highlight the individual channel on the graph. This can be useful when viewing many streams on the same graph.

In addition, clicking the name of the stream also displays a number on the graph that describes the density of data points per pixel and any gaps in data recording are indicated on the graph.

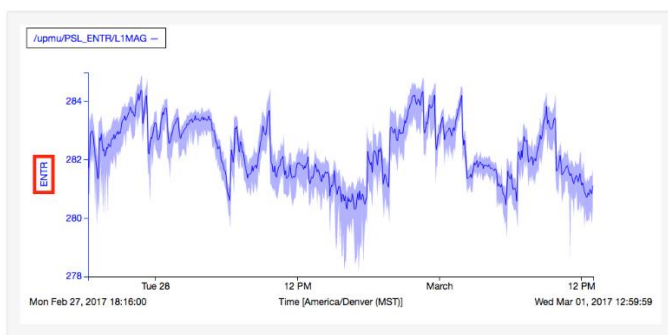
3.6 Custom Axis Labels

Axis labels for each parameter can be set to a custom value. For example, if comparing power input vs power output, it can be helpful to set the units to Watts (in) and Watts (out), respectively.

To create custom units:

1. Under the Axes tab, click Add a Y-axis. A new entry will be added to the bottom of the list.
2. Enter a new axis label in the Axis Name field
3. Under the Legend tab, choose a stream and click the dropdown menu under the Axis Name column and select the newly created Axis Name.

To remove a custom axis, go to the Axes tab and click the red X button next to the custom axis in the list.



Hide Legend Axes Time

Color	Stream	Axis Name	Progress
■	uPMLU/upmu/PSL_ENTR/L1MAG	ENTR	

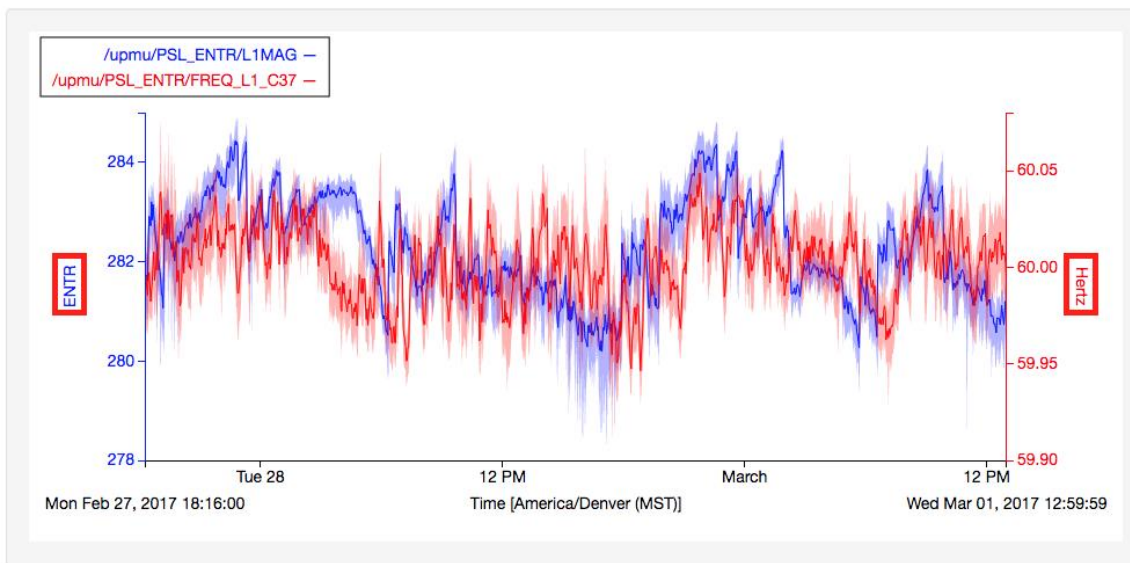
Hide Legend Axes Time

Add a Y-Axis

Axis Name	Stream	Units	Axis Position	Axis Scale	Remove
Degrees			← X →	Autoscale 1	
Amps			← X →	Autoscale 1	
Volts	/upmu/PSL_ENTR/L1MAG	Volts	← X →	Autoscale 2 278 to 285	
Hertz			← X →	Autoscale 2	
Watts			← X →	Autoscale 1	
VA			← X →	Autoscale 1	
VAR			← X →	Autoscale 1	
DPF			← X →	Autoscale 1	
Bitmap			← X →	Autoscale 1	
ENTR			← X →	Autoscale 2	X

3.7 Y-axis Positions

For each stream, the Y-axis can be moved to the left or right of the graph. This is useful for two graphs with different units (volts and degrees, for example). Under the Axes tab, use the left or right buttons to move the Y-axis. Clicking on the “X” hides the axis.



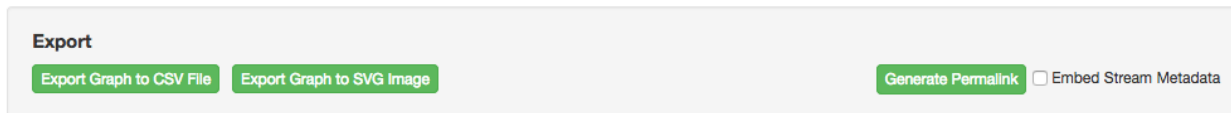
Hide Legend
Axes
Time

Add a Y-Axis

Axis Name	Stream	Units	Axis Position	Axis Scale	Remove
Degrees			← X →	↑ Autoscale ↓	to
Amps			← X →	↑ Autoscale ↓	to
Volts			← X →	↑ Autoscale ↓	278 to 285
Hertz	/ upmu/ PSL_ENTR/ FREQ_L1_C37	Hertz	← X →	↑ Autoscale ↓	59.9 to 60.08
Watts			← X →	↑ Autoscale ↓	to
VA			← X →	↑ Autoscale ↓	to
VAR			← X →	↑ Autoscale ↓	to
DPF			← X →	↑ Autoscale ↓	to
bitmap			← X →	↑ Autoscale ↓	to
ENTR	/ upmu/ PSL_ENTR/ L1MAG	Volts	← X →	↑ Autoscale ↓	278 to 285 X

3.8 Export Tools

Generate Permalink



Graphs can be shared with others using the “Generate Permalink” button. It creates a URL shortcut that opens the MicroPMU Plotting Application and displays the measurements with the associated time, axes, and parameters selected at the time of permalink generation.

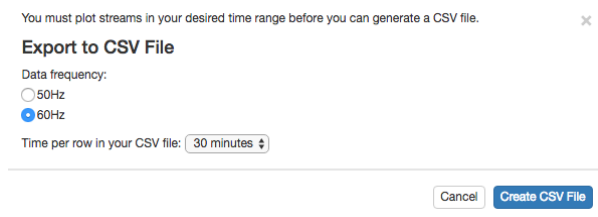
The link can be copied, saved, or emailed. Clicking the link will display the exact same graph.

Export to SVG Image

Click “Export Graph to SVG Image” to generate a picture of the graph. Click “Download Image” to save it to the client computer.

Export Graph to CSV Files

The “Export Graph to CSV File” button is used to create a CSV (comma separated values) file of the plotter graph’s data for the values seen within the current graphing canvas.



First, select the correct power frequency for the data in the graph. This frequency sets the data interval in the CSV, so it is important to choose the correct frequency or the resulting CSV file will have inaccurate sample data. MicroPMUs on 50Hz systems will record 100 measurements per second. MicroPMUs on 60Hz systems record 120 measurements per second.

After clicking “Export Graph to CSV File”, a prompt to set the CSV file time interval will appear. The available time intervals to choose from are 1 day, 1 hour, 30 minutes, 5 minutes, 1 minute, 1 second, 1 cycle and ½ cycle. The CSV file contains minimum, average, and maximum values for each parameter.

Click “Create CSV File” to create a csv file which will be saved to the downloads folder by default.

Below is a sample CSV export file.

	A	B	C	D	E	F	G	H	I
1	Time[ns]	Time	uPMU/ upmu/ uPMU	uPMU/ upmu/ uPMU_5/	uPMU/ upmu/ uPMU	uPMU/ upmu/ uPMU_5	uPMU/ upmu/ uPMU	uPMU/ upmu/ uPMU	uPMU/ upmu/ uPMU
2	1481915682726600000.00	14:42.7	129	120.824318	121.003723	121.036087	129	59.99189	59.99651
3	1481915683800350000.00	14:43.8	128	120.744331	120.951002	121.00885	128	59.98978	59.99651
4	1481915684874090000.00	14:44.9	129	120.830063	121.007603	121.052856	129	59.99076	59.99685
5	1481915685947830000.00	14:45.9	129	120.815857	120.962761	121.024643	129	59.99106	59.99659
6	1481915687021570000.00	14:47.0	129	120.827072	120.969933	121.037949	129	59.99217	59.99842
7	1481915688095310000.00	14:48.1	129	120.832947	120.997668	121.046928	129	59.99521	59.99877
8	1481915689169050000.00	14:49.2	129	120.683647	120.934873	121.027084	129	59.99545	59.99965
9	148191569024280000.00	14:50.2	128	120.845345	121.013445	121.05584	128	59.99656	60.00053
10	1481915691316540000.00	14:51.3	129	120.881027	120.996742	121.04821	129	59.99427	59.99944
11	1481915692390280000.00	14:52.4	129	120.817802	121.005727	121.045639	129	59.99273	59.99917
12	1481915693464020000.00	14:53.5	129	120.783745	120.970856	121.011147	129	59.99329	59.99899
13	1481915694537760000.00	14:54.5	129	119.60791	120.87103	121.015205	129	59.92365	59.9949
14	1481915695611510000.00	14:55.6	129	120.795418	120.970242	121.034714	129	59.98822	59.99482
15	1481915696685250000.00	14:56.7	129	120.785278	120.937713	120.974312	129	59.98708	59.99297
16	1481915697758990000.00	14:57.8	128	120.77063	120.950664	120.991058	128	59.9861	59.99201
17	1481915698832730000.00	14:58.8	129	120.768166	120.936498	120.989639	129	59.98597	59.99118
18	1481915699906470000.00	14:59.9	129	120.768456	120.916374	120.987747	129	59.98605	59.991
19	1481915700980210000.00	15:01.0	129	120.657997	120.886401	120.993767	129	59.98119	59.989
20	1481915702053960000.00	15:02.1	129	120.731773	120.896657	120.940506	129	59.98404	59.98896
21	148191570312770000.00	15:03.1	129	120.730286	120.939378	120.981712	129	59.98136	59.98915
22	1481915704201440000.00	15:04.2	129	120.767555	120.946361	120.983238	129	59.98359	59.98954
23	1481915705275180000.00	15:05.3	128	120.763824	120.93255	120.965706	128	59.98466	59.99032
24	1481915706348920000.00	15:06.3	129	120.789543	120.983137	121.051872	129	59.98468	59.99111
25	1481915707422670000.00	15:07.4	129	120.82531	121.003409	121.043381	129	59.98325	59.99142

The first column displays a Unix time stamp (number of nanoseconds elapsed since January 1, 1970 00:00:00 UTC) for the beginning of the time interval.

The second column displays local time (according to plotter settings) when the CSV file was generated.

Columns following after will display data for each stream in the graph. Each stream will have four columns to display “cnt”, “min”, “mean” and “max”.

The “cnt” column displays the number of ½ cycles in the chosen time interval (row).

The “min”, “mean”, and “max” columns display, respectively, the minimum, average, and maximum values recorded in the chosen time interval.

4 Troubleshooting

Symptom:

A “No longer accepting new data” message is displayed underneath the data usage gauge on the plotter website.

Solution #1:

The Quickstart Server comes with a two terabyte solid state drive for database storage. When the drive reaches about 98% capacity, the server will stop accepting data and a message will display below the disk usage gauge stating “No longer accepting new data. Drive is full”. A new drive will need to be used or the existing data will need to be backed up and a fresh database instance will need to be created on the existing drive. This procedure will need to be done by the Quickstart Server administrator or instructions on these procedures may be found in the Administrator manual.

Symptom:

No data is shown on the plotter or no new data is appearing on the plotter for one or more microPMUs.

Solution #1:

Consult with the Quickstart Server administrator or refer to the troubleshooting section of the Quickstart Kit Administrator Manual.

For technical assistance or the latest version of this document, please call 1-510-522-4400 or email: support@powersensorsltd.com with any further questions.