

Cx Monitor™ User Manual

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Statements, Notices and Liability information

FCC Part 15 Class B

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against interference in a residential installation.

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the affected equipment and the panel receiver to separate outlets, on different branch circuits.
- Consult the dealer or an experienced radio/TV technician for help.

STATEMENT OF FAULTLESSNESS:

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Definitions

- **WARNING**

This statement is to reinforce the practice of certain conditions may cause physical bodily harm or loss of life.

- **CAUTION**

This statement is to reinforce the practice of certain conditions may cause physical damage to the Cx Monitor, accessories, equipment or property.

- **NOTE**

General information for simplifying the user experience.

Abbreviations

CT's : Current Transducers
Rope Probes : Rogowski coil current transducers
Cx : Power Monitor
Monitor : Power Monitor (Cx)

Wireless Probes: Wireless add-on's for power monitor
EWE: External Wireless Extensions
Site: Cx Monitor data set.

Symbols

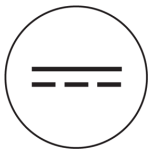
The following are (IEC) symbols are used on this document or on the power monitor, and their definitions.



This symbol indicates AC or DC voltage or current



This symbol indicates that caution is necessary when operating the device or control close to where the symbol is placed, or to indicate that the current situation needs operator awareness or operator action in order to avoid undesirable consequences.



This symbol indicates DC only voltage or current



This symbol indicates high voltage. It calls your attention to items or operations that could be dangerous to you and other persons operation this equipment. Read the message and follow the instructions carefully.



This symbol indicates AC only voltage or current



This symbol indicates safety ground conductor.



This symbol indicates earth ground conductor.



To avoid electrical shock or fire:

Review the entire manual before using the Power Monitor and its accessories and observe all warnings and cautions.

- Before using the power monitor inspect wireless probes, voltage probes, current probes, leads and accessories for mechanical damage or broken plastic and call Rx Monitoring Services Inc. for replacements.
- Wear proper Personal Protective Equipment, including safety glasses and insulated gloves when making connections to power circuits.
- Use only current probes, test leads, and adapters supplied with the power monitor and wireless probes.
- Remove unnecessary voltage leads or accessories that are not in use.
- Make sure the power monitor is properly connected through the power cord to protective earth ground.
- Do not insert foreign objects into connectors, only use approved accessories.
- Never open the power monitor, there are no customer replaceable parts.
- Never use power monitor outside or when condensing water is present.
- Use supplied safety kit and properly lockout circuits under test.
- Hands, boots and the working area must be dry when making connections to power system.
- Do not operate the Power Monitor or probes around volatile gas or vapor.

******* WARNING DO NOT EXCEED CAT RATINGS *******

Voltage Ratings:



Power Monitor	: CAT III - 600V	Pollution Degree 2
Rope CT's	: CAT III - 1000V	Pollution Degree 2
Clamp CT's	: CAT III - 600V	Pollution Degree 2
Wireless DC	: CAT II - 600V	Pollution Degree 2
Wireless DCx	: CAT II - 150V	Pollution Degree 2

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Cx Monitor™ with Rogowski Coil 24" CT's

The Cx Monitor Power Monitor was designed with one function in mind, bringing usability and simplicity to the power quality market.

Throughout this documentation the Cx Monitor will be referred more simply as “Monitor”.

Some of the key features:

- **15 Channels:**
The fifteen channels consist of 10 Voltage channels (3 Ph-Ph, 3 Ph-G, 3 Ph-N, N-G) and 5 Current channels (L1, L2, L3, N, G). The voltage is sampled at two rates, 256 samples per cycle (15.36Khz @ 60 Hz) and a high speed module operating at 1.66Mhz / channel.
- **Easy Setup:**
No setup is needed, the power monitor self-identifies the incoming power and can configure and adjust to the conditions that it faces, making setup in the field obsolete.
- **Cross Triggering:**
Voltage or current triggers on any single channel cause all 15 channels to capture data.
- **Event and Time based Triggers:**
Waveforms can be captured on a fixed time interval and/or on changes to incoming voltage and current readings.
- **Minimum Maximum Average Logging:**
Voltage readings are calculated at half cycle intervals (8ms @ 60hz) with current at full cycle. With a min/max/avg log files generated from 1 Second to 30 minutes.
- **External Wireless Extensions (EWE) :**
External wireless extension capabilities include the ability to capture 100 wireless probes consisting of Temperature & Humidity, 0-600V DC, DC current, High Temperature (up to 300 F) and a 10 channel battery monitor.
- **Communications:**
Communication and download is simple using either, 10/100 Ethernet, USB stick download or WiFi.
- **Internal Uninterruptible Power Supply:**
The (UPS) secures your data and makes sure that the power monitor always shuts down safely with adjustable time up to 15 minutes, protecting data regardless of incoming power conditions.
- **Software:**
The packages used with the Cx Monitor, Live-View™ and U-View™ are free for life. On a release cycle of 2 months they are written and developed at Rx Monitoring Services and are constantly being improved.

Monitor Hardware Overview

Volts:

Displays real time input voltage.
 Three phase format :
 L1-L2 / L2 -L3 / L3-L1
 Two pole single phase format:
 L1-L2
 Single phase format:
 L1-G

Date Time:

Current Cx Monitor™ Date and Time

ENET / WiFi:

Displays current IP address that can be used to communicate with the power monitor.
 (Changes to WiFi when USB WiFi is inserted)

Curr:

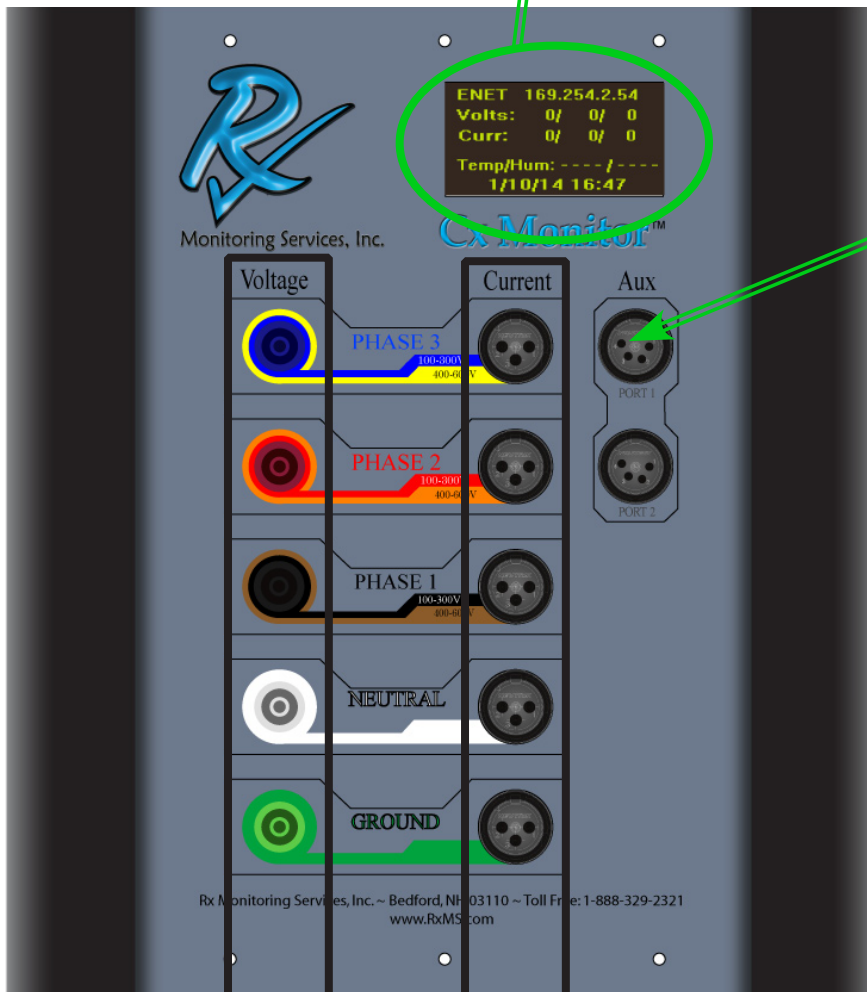
Displays real time input Current.
 Format :
 L1 Irms/ L2 Irms/ L3 Irms

% Used:

Displays percent storage used.

```

ENET 169.254.2.54
Volts:  0/  0/  0
Curr:   0/  0/  0
Temp/Hum: ---- / ----
1/10 16:47 12%
    
```



Aux Ports:

Used for external peripheral communication as well as powering external probes.



Plug only Rx Supplied Parts into Aux ports.
 12V - 500mA Max / Port

AC/DC Voltage input connections
 CATIII 600V Max



AC/DC Current input connections
 Use only Approved current transducers supplied by Rx Monitoring Services.





10Vp-p Max



Front View



Power Monitor Serial Number

10/100 Ethernet port
Supports: Auto IP
(169.254.x.x)
& DHCP
FTP, SMTP, HTTP, HTTPS,
SSL, SSH

USB Host Port:
Supports: Wifi and USB Stick down-loads.
 
USE ONLY Rx Monitoring Services
supplied WiFi sticks.
5V - 500mA max draw.

Input Power Port:
24V - 300mA
 
USE ONLY Rx Monitoring Services
supplied power supply.

Side View

Powering / Grounding Unit

Powering Unit



Caution - Always use a grounded receptacle

1. Plug power cord into grounded receptacle
2. Plug the supplied IEC cord into the external DC power supply.
3. Plug the male external DC power supply plug into the Power Monitor.
4. System powers up in 15 seconds.



DC Power Supply



2. Connect IEC



3. Plug In Barrel

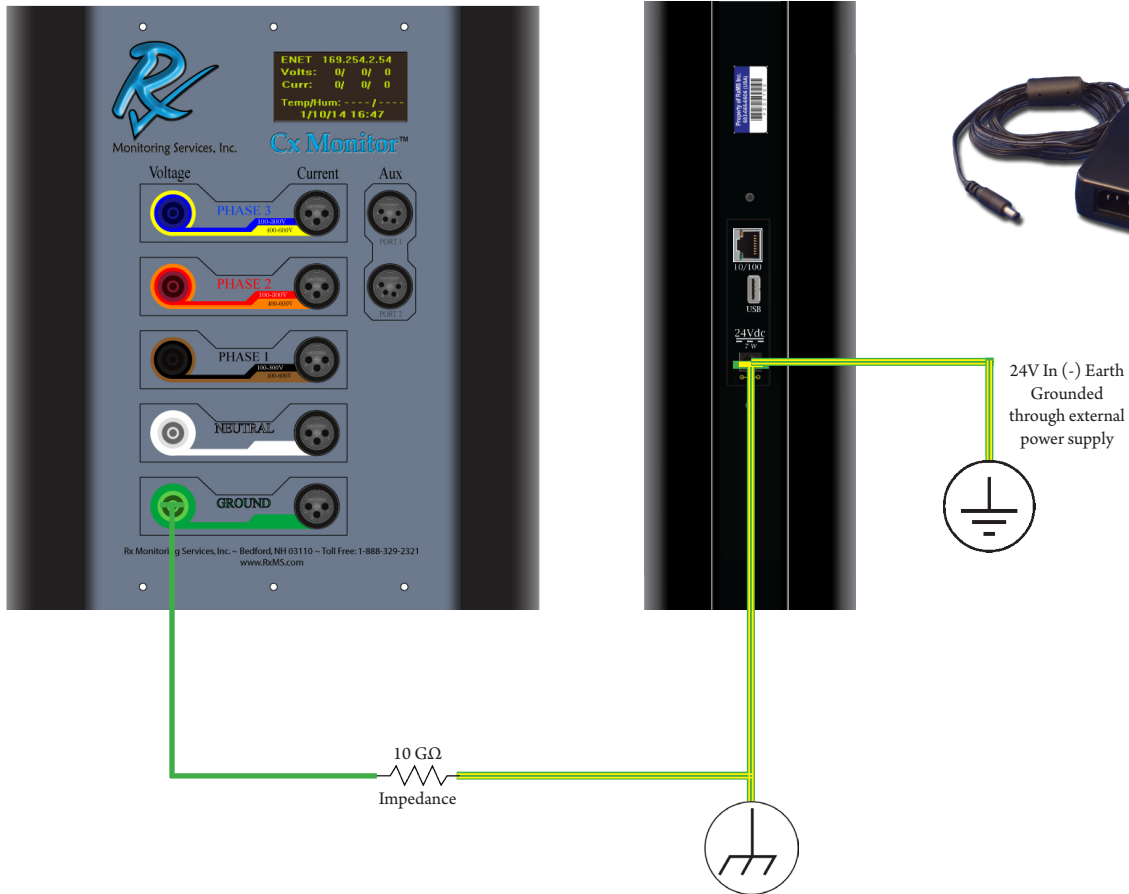


Grounding Unit

Safety earth ground is supplied by the external power supply's IEC320 connector.



The unit must be powered from a grounded receptacle. Failing to do so could cause voltages on the metal components.



Live-View™

Description:

Live-View™ software is used to actively communicate with the monitor. Some of the abilities include capturing and displaying of waveforms, as well as phasor diagrams to ensure that the power monitor is connected properly. Setup is also included in this package giving the ability to configure log rate and waveform capture parameters. Site management (multiple data sets) are added and deleted with this software. Downloading data sets from the power monitor is also done with the Live-View™ program.

Download Software:

Live-View™ is always available on our website at,

www.RxMS.com/Live-View.html

Click the button like the one below to start the download.



After downloading the file “LiveView-Setup.exe”, run the program to start the installation.

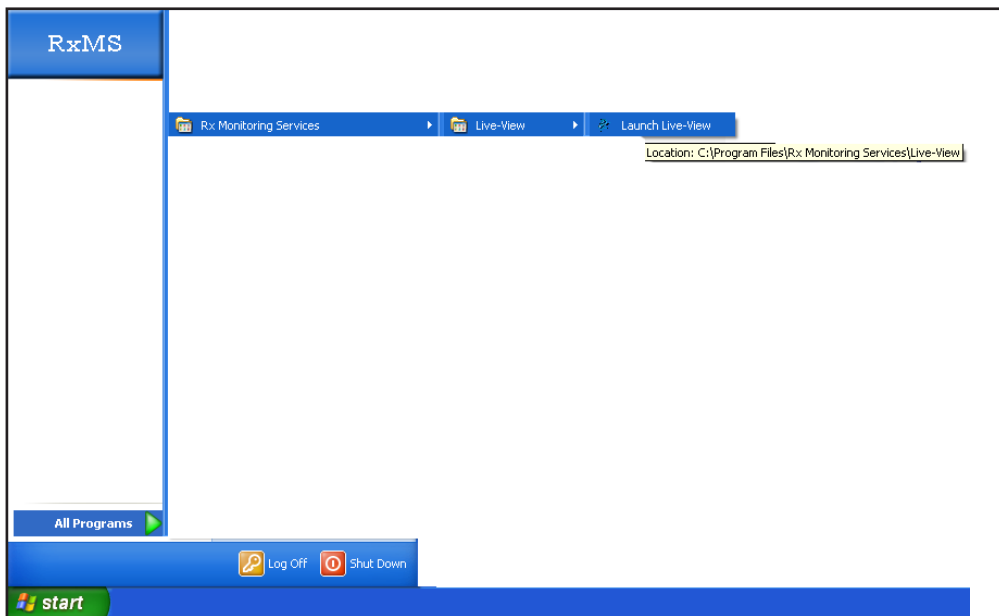
Download Instructions:

Instructions for usage of the Live-View™ software package is maintained in a separate document. This document link can be found on the **www.RxMS.com/Live-View.html** website under the download icon. Click on the hyperlink “here” of the line “Instructions are here”.

To Start Live-View™:

Default installation is placed at,

Start Menu » All Programs » Rx Monitoring Service » Live-View » Launch Live-View



Updates:

Updates are common place and should be expected.

Updates are always free and can be found in the same location as above.

Download and run “LiveView-Setup.exe” to install the newest release.

Upon Starting Live-View™ if a internet connection is present Live-View™ will confirm the installed version is up to date. If the installed version is not current, a window will appear with directions on how to obtain the newest release.

Description:

U-View™ software is used to interpret the output files from the power monitor after downloading. Some of the abilities include graphical representations and exporting of log files. The package include waveform analysis tools for power, RMS, frequency, (%) deviation and harmonics. There are multiple solutions to make the data more manageable including global zoom capabilities and on-graph annotations. The output of U-View™ is in picture form directly from what is on the PC screen, so it is easy to understand what the output will contain.

Download Software:

U-View™ is always available on our website at,

www.RxMS.com/U-View.html

Click the button like the one below to start the download.



After downloading the file “UView-Setup.exe”, run the program to start the installation.

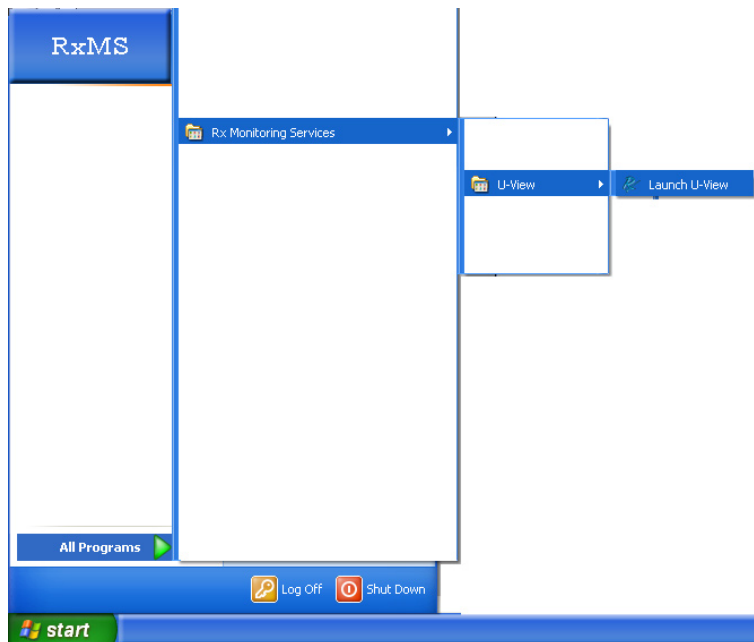
Download Instructions:

Instructions for usage of the U-View™ software package is maintained in a separate document. This document link can be found on the “**www.RxMS.com/U-View.html**” website under the download icon. Click on the hyperlink “here” of the line “Instructions are here”.

To start U-View™:

Default installation is placed at,

Start Menu » All Programs » Rx Monitoring Service » U-View » Launch U-View



Updates:

Updates are common place and should be expected.

Updates are always free and can be found in the same location as above.

Download and run “UView-Setup.exe” to install the newest release.

Upon Starting U-View™ if a internet connection is present U-View™ will confirm the installed version is up to date. If the installed version is not current, a window will appear with directions on how to obtain the newest release.

To use the Live-View™ program, an ethernet or Wi-Fi connection must be established to the device.

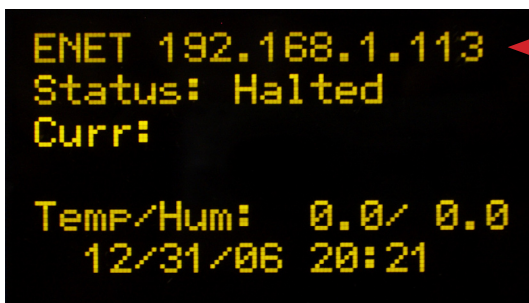
There are 3 different connection types

1. Ethernet through DHCP network.
2. Direct Ethernet connection with Cross-Over Cable.
3. Wi-Fi Ad-hoc (Windows XP & 7 only).



Ethernet through DHCP network

1. Unplug Cx Monitor™ wait for shutdown.
2. Plug Ethernet cord into side panel.
3. Plug DC power supply connector in to Cx Monitor™.
4. System will get IP address from DHCP server upon startup (10-15 seconds).
5. Monitor will display valid IP address on the first line of screen display.
6. Computer should now be able to talk using IP address on the display of the Cx Monitor™. Connect using this IP address in Live-View™.



IP Address of Cx Monitor™ used to connect with Live-View™.



Ethernet connection with Cross-Over Cable & Automatic Private IP

```
ENET 169.254.157.253
Status: Halted
Curr:

Temp/Hum: 0.0/ 0.0
12/31/06 20:01
```

IP Address of power monitor in Auto-IP mode is in the range of 169.254.xxx.xxx

1. Unplug Cx Monitor™ wait for shutdown.
 2. Plug **Crossover Ethernet** (Generally red) cord into side panel.
 3. Plug opposite end of crossover cable into computer running Live-View™.
 4. Plug power DC power supply in to Cx Monitor™.
 5. System will power up within 10-15 seconds.
 6. System will wait 30 seconds before setting automatic IP address. Ex: 169.254.157.253
 7. Computer running Live-View™ will need to time-out of its old network (If configured for DHCP) which can take up to 2 minutes.
 8. Computer should obtain an IP Address in the range 169.254.xxx.xxx (Automatic IP Range if set to DHCP). If it is not see Microsoft document for windows XP:
http://www.microsoft.com/resources/documentation/windows/xp/all/proddocs/en-us/sag_tcpip_pro_autoconfig.mspx?mfr=true
 9. Static IP's can also be set on the Live-View™ Computer in the range (As long as it's not the same IP as the Cx Monitor™).
- IP: 169.254.0.2 – 169.254.255.250
Subnet: 255.255.0.0
10. Computer should now be able to talk using IP address on the display of the Cx Monitor™.
 11. Connect using this IP address in Live-View™.

Wifi Ad-hoc Mode With Automatic Private IP

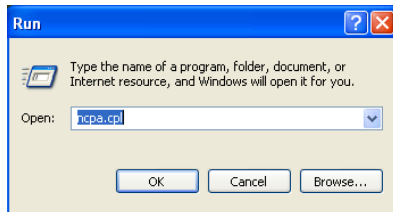


```
WiFi 169.254.147.253
Status: Halted
Curr:

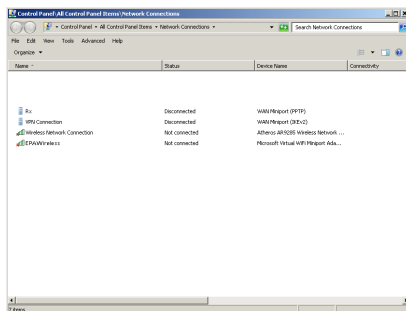
Temp/Hum: 0.0/ 0.0
12/31/06 20:03
```

1. Unplug Cx Monitor™ wait for shutdown.
2. Unplug all ethernet wires from device.
3. Plug WiFi Stick into side panel.
4. Plug DC power supply connector into Cx Monitor™.
5. Monitor will power up within 10-15 seconds.
6. IP address should appear within 10 seconds after boot.
7. If IP address doesn't show in this range reinsert USB stick.
8. On computer running Live-View™ attach to EPAWIRELESS network
9. Click on Start.

10. Select Run.
11. Type ncpa.cpl and press Enter.



12. Click wireless connect and choose View Available Wireless from networks from the pop up menu.



13. Press Connect.



14. You are now connected to the EPAWireless network.
15. Computer running Live-View will need to time out of its old network (If configured for DHCP) which can take up to 2 minutes.
16. Computer should obtain an IP Address in the range 169.254.xxx.xxx (Automatic_IP Range if set to DHCP). If it is not see Microsoft document for windows XP:

http://www.microsoft.com/resources/documentation/windows/xp/all/proddocs/en-us/sag_tcpip_pro_autoconfig.msp?mfr=true

17. Static IP's can also be set on the Live-View Computer in the range (As long as it's not the same IP as the Cx Monitor™).

IP: 169.254.0.2 – 169.254.255.250
Subnet: 255.255.0.0

18. Computer should now be able to communicate using the IP address on the display of the Cx Monitor™. Connect using this IP address in Live-View™.

Wireless with Access Point and WiFi

Rx Monitoring Services, Inc. supplies all Access Points and WiFi adapters described in this section.

There are two different types of WiFi adapters:



The AP & Wifi (Red) gives the user a way to attach to the wireless network using a computer equipped with IEEE 802.11N connectivity. This unit will also provide an Ethernet to WiFi connection for the Cx Monitor™, that is connected to it.

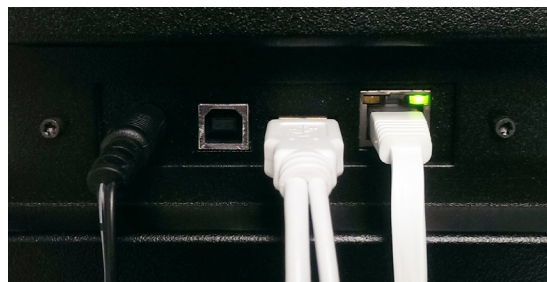
The second type is a Ethernet to WiFi (Blue) adapter that converts the wired 10/100 Ethernet to a 802.11N network for the Cx Monitor™.

Power up the (Red) Access Point & WiFi adapters before the WiFi only adapters.

1. Plug the Ethernet and USB into the AP & WiFi adapter. (RED)



2. Plug Ethernet and USB into Cx Monitor™
3. Plug Power supply into Cx Monitor™.



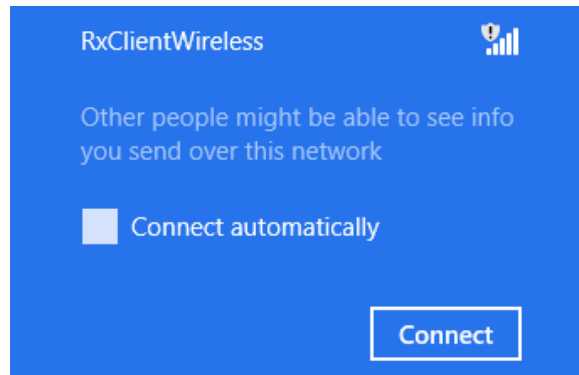
- Cx Monitor will power up, wait 30-40 seconds for configuration of the Access point, when the adapter attaches the display will show ENET: 192.168.1.xxx.

WiFi only adapters (BLUE): Repeat for each Cx Monitor™

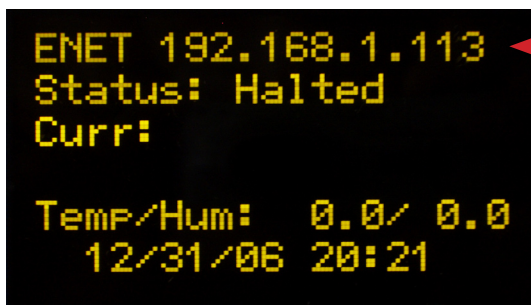
- Plug the Ethernet and usb into the WiFi only adapter. (BLUE)
- Plug Ethernet and USB in to Cx Monitor.
- Plug Power supply into Cx Monitor



- Cx Monitor will power up, wait 30-40 seconds for WiFi to attach to the Access point, when the adapter attaches the display will show ENET: 192.168.1.xxx.
- Using a Computer or device with 802.11N connectivity attach to the Wireless Network “RxClientWireless” This is an unsecured wireless connection, use at your own risk.



- Computer should now be able to talk using IP address on the display of the Cx Monitor™. Connect using this IP address in Live-View™.



IP Address of Cx Monitor™ used to connect with Live-View™.

Notes:

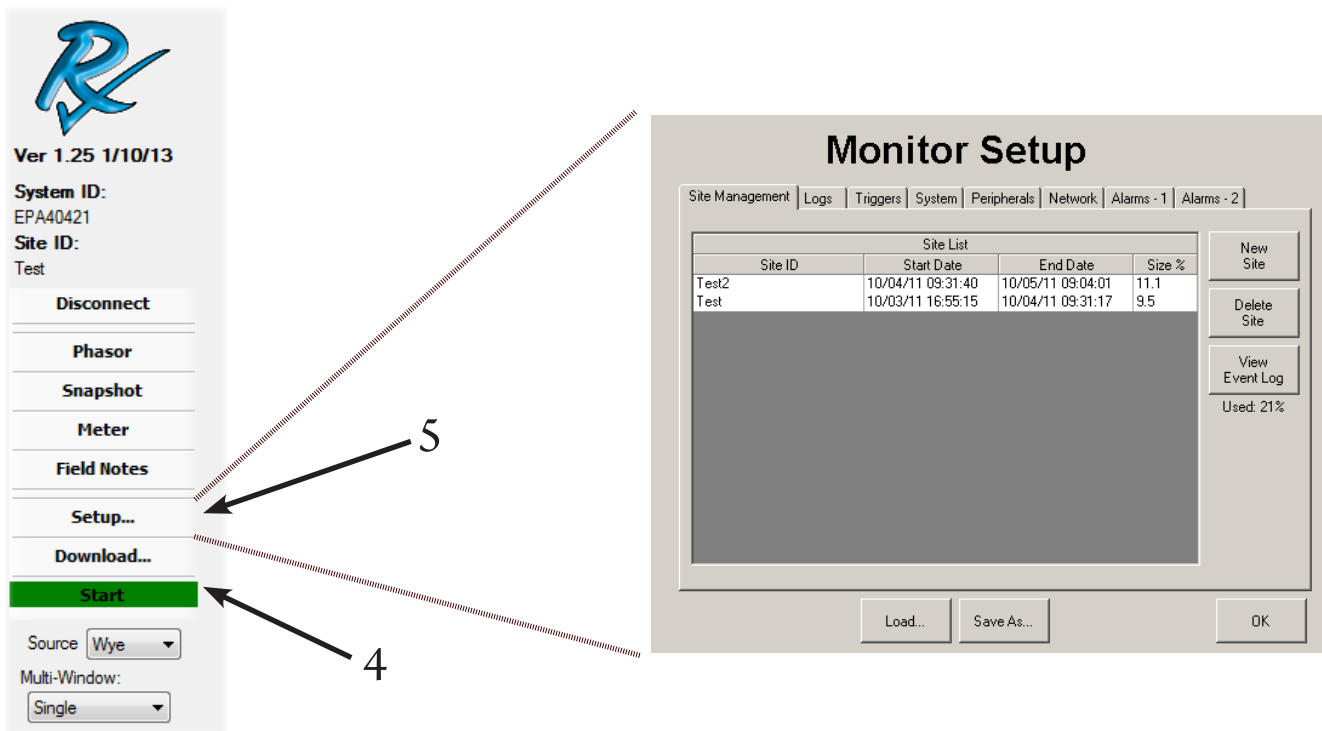
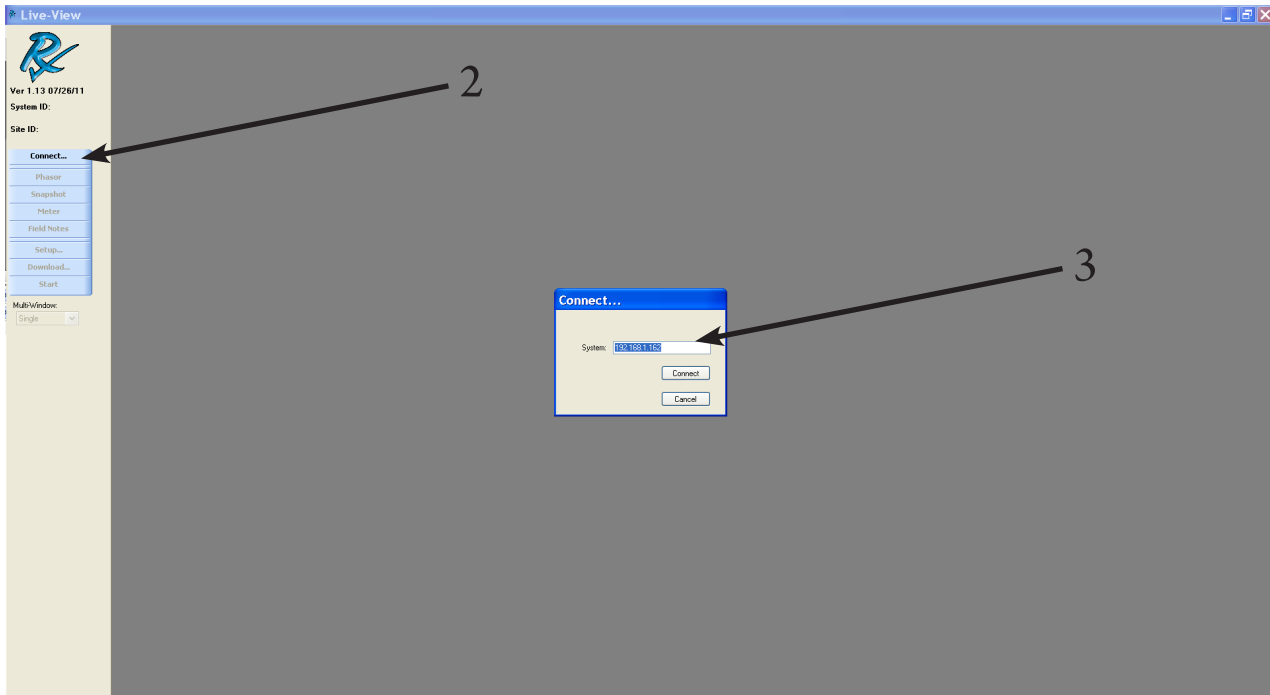
The WiFi only adapters will blink the “WiFi Activity” LED when they are connected to the wireless access point. If this LED is not blinking check to see if the access point is powered up.

The “Ethernet Activity” will also blink, if not blinking ensure connection to USB and Ethernet at both ends.

Monitor Configuration

All power monitor configuration is done within the Live-View™ software.

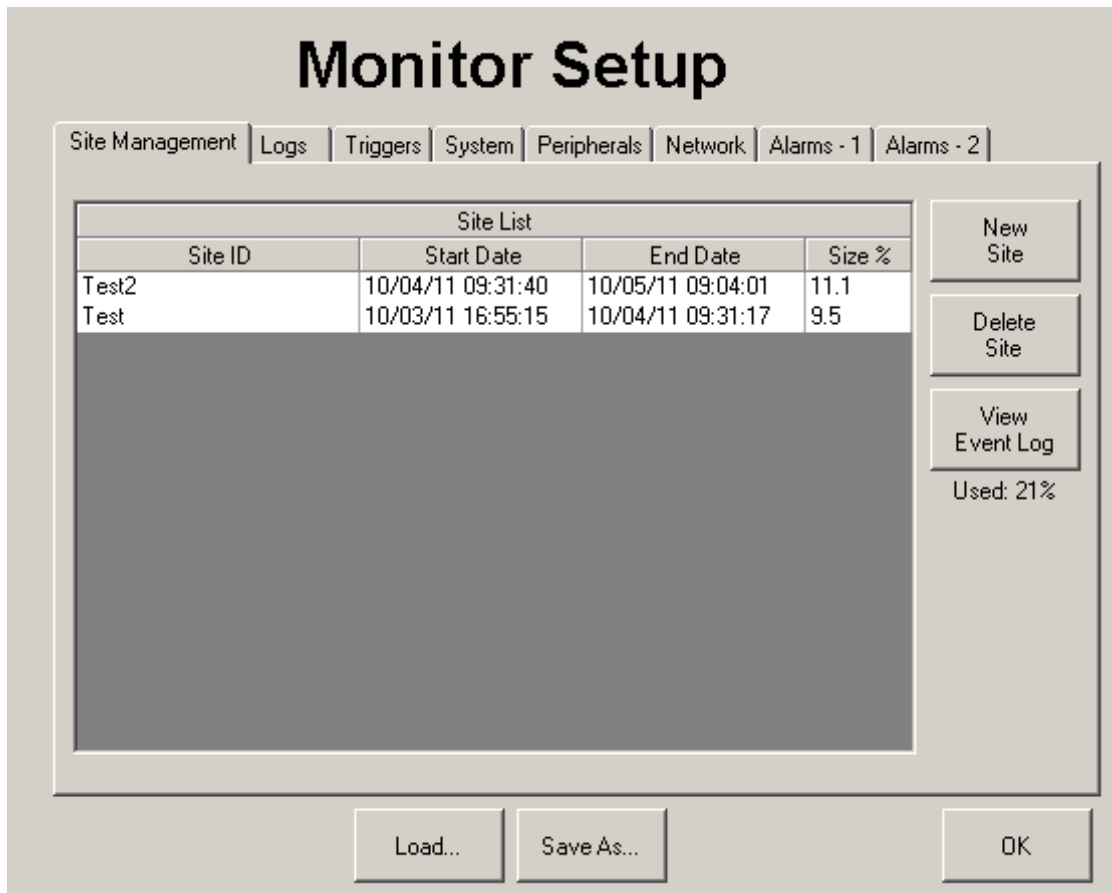
1. Start the Live-View™ program
2. Press the Connect button
3. In the “Connect...” pop-up box, enter the IP address of the power monitor and press connect.
4. Press the Stop/Start button to halt the monitor
5. Click the “Setup” button to enter the configuration setup menu.



Site Management (Data Sets)

Site Management is the first tab in the “Setup” section of Live-View™. Site Management is the screen in Live-View™ that provides all of the information on the data sets that are currently stored on the Cx Monitor™. It gives a interface to create new data sets as well as deleting old ones.

This is the only way that data can be removed from the power monitor.



Site Management lists the sites on the monitor, the Start and End dates, as well as the percentage of total storage used. The total storage used is displayed below the View Event Log button.

The **New Site** button creates a new site folder and configures the monitor to store all logs to this folder. Site names are limited to 20 characters in length.

The **Delete Site** button deletes the selected site folder.

Please refer to the Live-View™ documentation to go through “Monitor Setup”

Installation Instructions:

Detailed step by step instructions are maintained in three separate documents. The documents are split by the types of accessories and current probes that are provided with the power monitor kit.

For the different types of current probes:

For Rogowski (rope) CT's:

http://www.rxms.com/downloads/instructions/cx/Cx_Monitor_Rope_Install.pdf

For Clamp-On CT's:

http://www.rxms.com/downloads/instructions/epa1500/Cx_Monitor_Clamp_Install.pdf

For the wireless add-on system (EWE- External Wireless Extensions) probes:

Wireless Installation:

http://www.rxms.com/downloads/instructions/cx/Cx_Wireless_Instructions.pdf

Voltage Lead and Current Probe Installation Points

This section of the manual will show the basic guidelines on where to connect the voltage leads and current probes. For complete step by step startup procedure, there are separate installation documents covering that process.

The following sections show the installation points for these items based on different power sources.

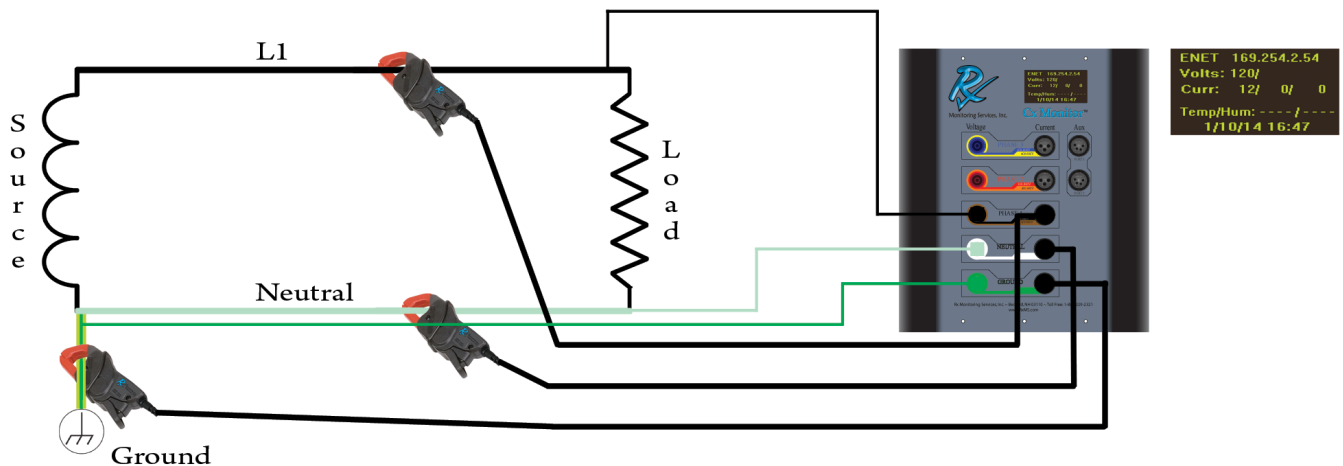
Note:

Because of the power monitor's ability to calculate and log power for delta, wye and single phase at the same time. There is no setup needed in Live-View™ to specify the type of source coming into the power monitor.

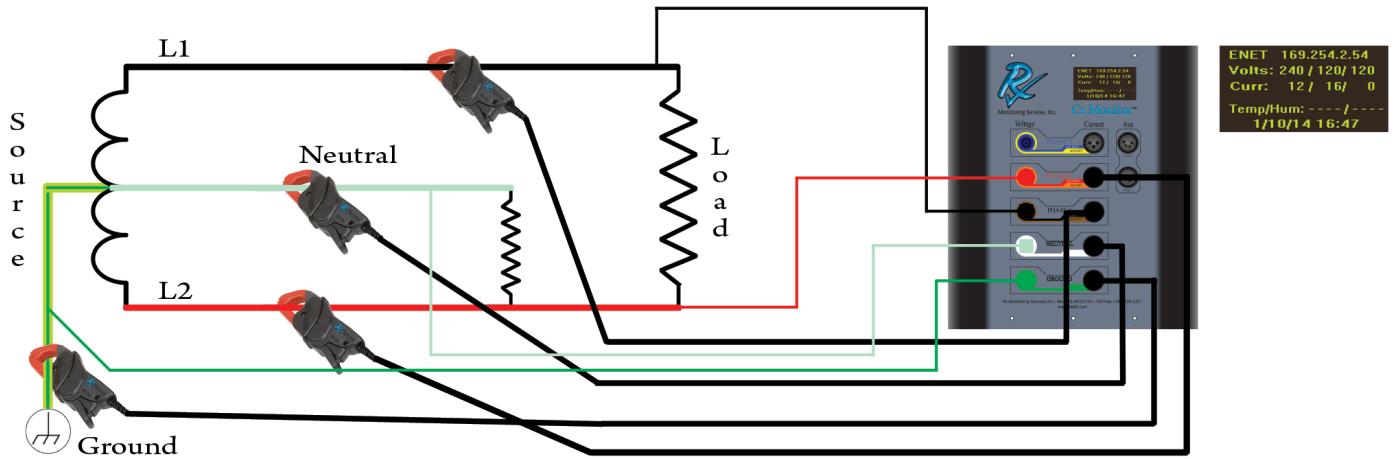
Note:

To ensure that the voltage and current transducers were installed and reading properly it is recommended to use the “Phasor” diagram in the Live-View™ software. See **Appendix E** for an overview of the phasor system.

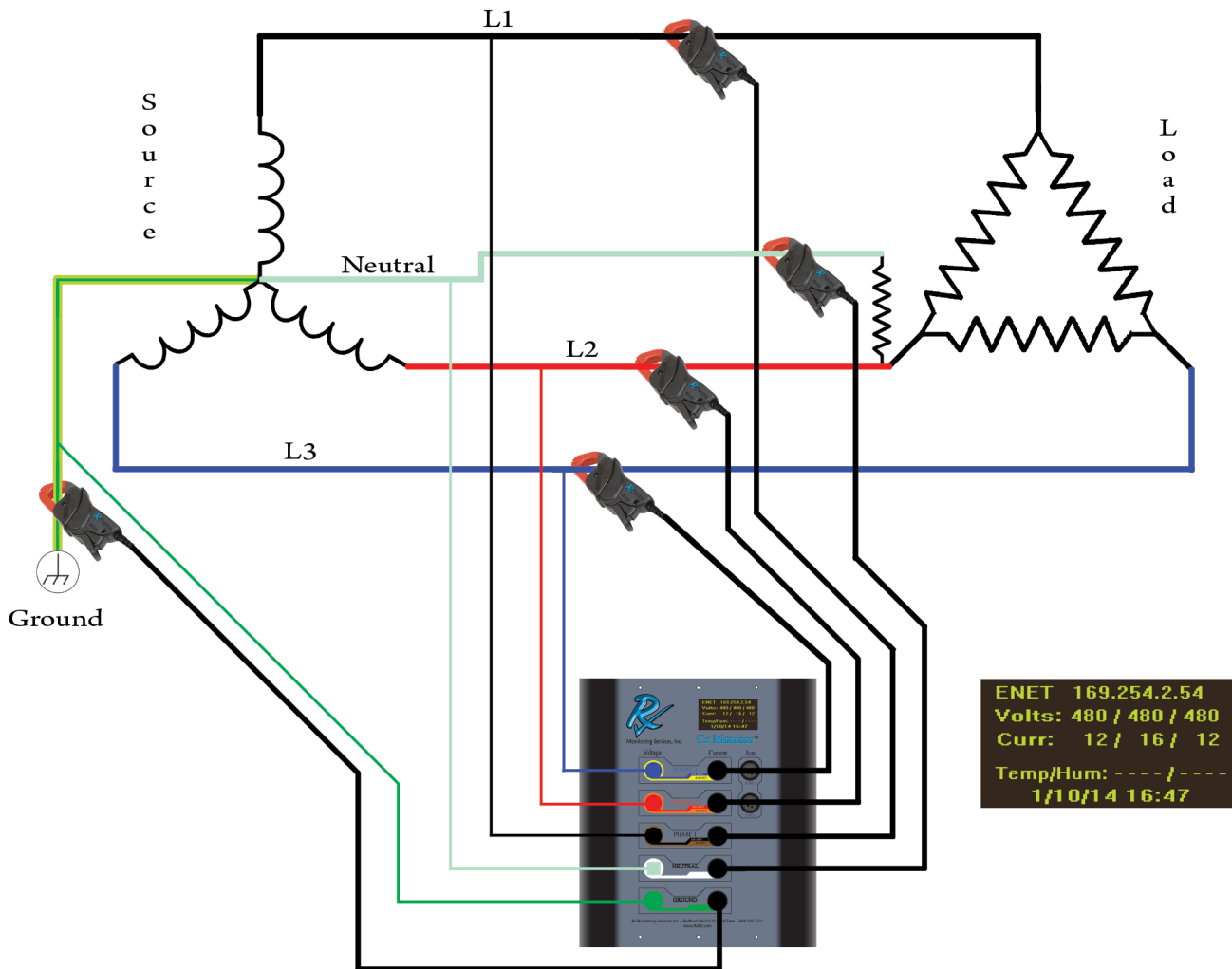
Single Phase Connection (L1 - N - G)



2 Pole Single Phase Connection (L1 - L2 - N - G)



3 Phase WYE / Delta Connection (L1 - L2 - L3 - N - G)



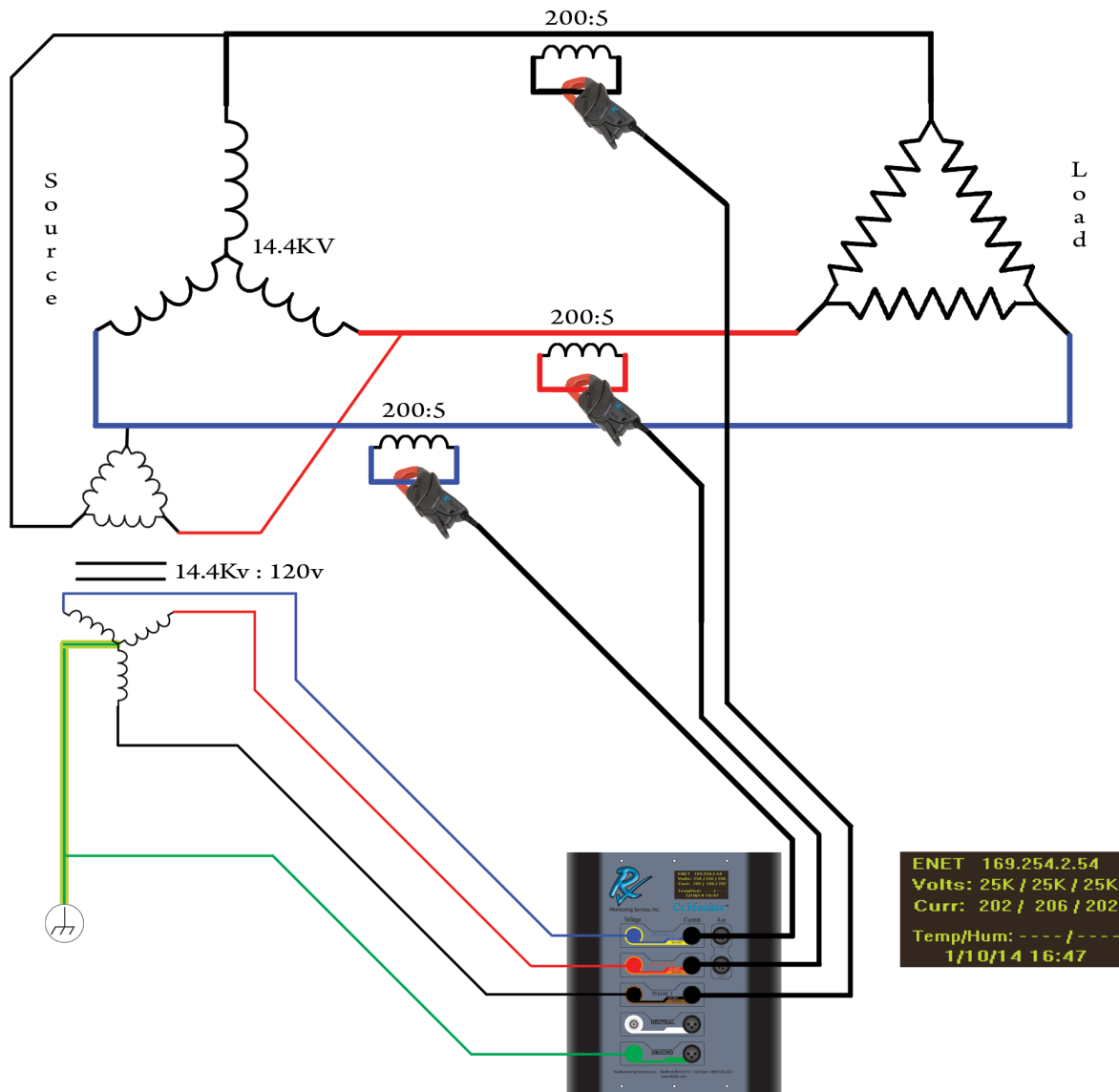
3 Element PT / CT Connection



WARNING



WARNING: Connecting to PT's and CT's can contain hazardous voltages and can exceed the CAT rating on the monitor and probes. Be knowledgeable about the location of the power monitor before energizing any circuits.



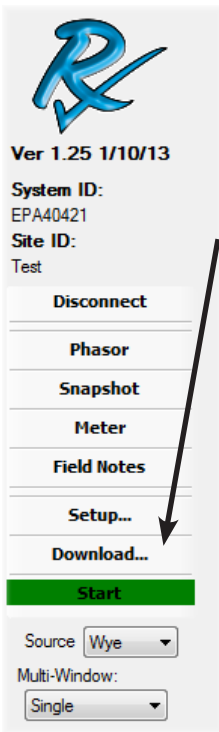
Note: Medium voltage multipliers are set in “Live-View™ -> Setup -> System -> Medium Voltage” .
The Voltage multiplier for the above example would be $14400/120 = 120$.
The Current multiplier would be $200/5 = 40$.

Note:

It is not a requirement to halt the system from sampling to retrieve your data through the Live-View™ Method. **The USB download will stop logging while it completes the download.**

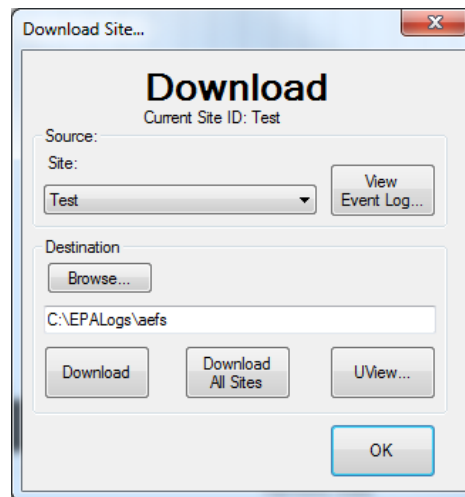
Live-View™ Download

Downloading data through direct ethernet or a network is the fastest way to retrieve data from the monitor.



To download through Live-View:

1. Start the Live-View™ program
2. Press the Connect button
3. In the “Connect...” pop-up box, enter the IP address of the power monitor and press connect.
4. Click the “Download...” button to enter the download menu.
5. Select a site from the Site combo-box
6. Specify a destination folder on the PC, either by typing the path, or using the Browse... button and selecting the destination.
7. Click the Download button to download the data.



Note: If data files are already in the directory, it will prompt if you want to overwrite or cancel the download. If the folder does not exist, it will prompt to create the folder.

Note: Download All Sites button allows you to download all of the site data on the monitor. A folder with the site name will be created in the destination folder for each site downloaded.

Once the download is complete, use the U-View™ button to launch U-View™.

USB Download

The power monitor has the ability to download to a USB storage device through the mass storage class driver. Only certain USB sticks properly identify themselves and only USB sticks provided from Rx Monitoring Services are guaranteed to work.

Note: Sandisk USB devices have the most reliable track record and are recommended.

There are multiple modes that the monitor can be operating in for USB downloads.

- **If the monitor is running in "Normal" mode, nothing is changed upon USB download.**
- **If the monitor is running in "Reset on USB" mode, when the USB stick is inserted and data downloaded, the old "Site" is renamed with the date appended and a new data set is started.**

Regardless of setup , data is never deleted when downloading using USB method. All data is stored on the power monitor.



Steps to perform USB download:

1. Power up monitor
2. Insert USB stick, wait 15 seconds for enumeration.
3. Monitor will automatically begin downloading data. Display will show "Downloading..." ****DO NOT REMOVE USB STICK****
4. When USB download is done, this amount of time is dependant on the data download size. The display will show "---Complete---".
5. It's now safe to Remove USB Stick from Monitor.

```
Downloading...
Test_0406
Curr:
Temp/Hum: 0.0/ 0.0
12/31/06 20:13
```

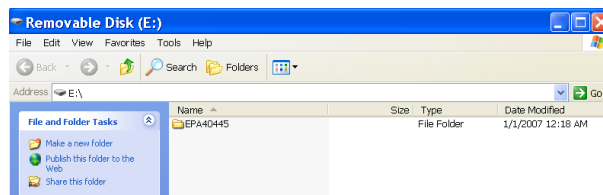
```
Downloading...
---Complete---
Curr: 0/ /
Temp/Hum: 0.0/ 0.0
12/31/06 20:18
```

After Download:

Insert the USB stick into your computer and explore to the contents of USB stick.

In root directory of stick will be the power monitors serial number in format EPA****

Depending on the configuration of the power monitor the data will either be a single zip file or a duplicate copy of data inside that directory.



U-View™

Description:

U-View™ software is used to interpret the output files from the power monitor after downloading. Some of the abilities include graphical representations and exporting of log files. The package include waveform analysis tools for power, RMS, frequency, (%) deviation and harmonics. There are multiple solutions to make the data more manageable including global zoom capabilities and on-graph annotations. The output of U-View™ is in picture form directly from what is on the PC screen, so it is easy to understand what the output will contain.

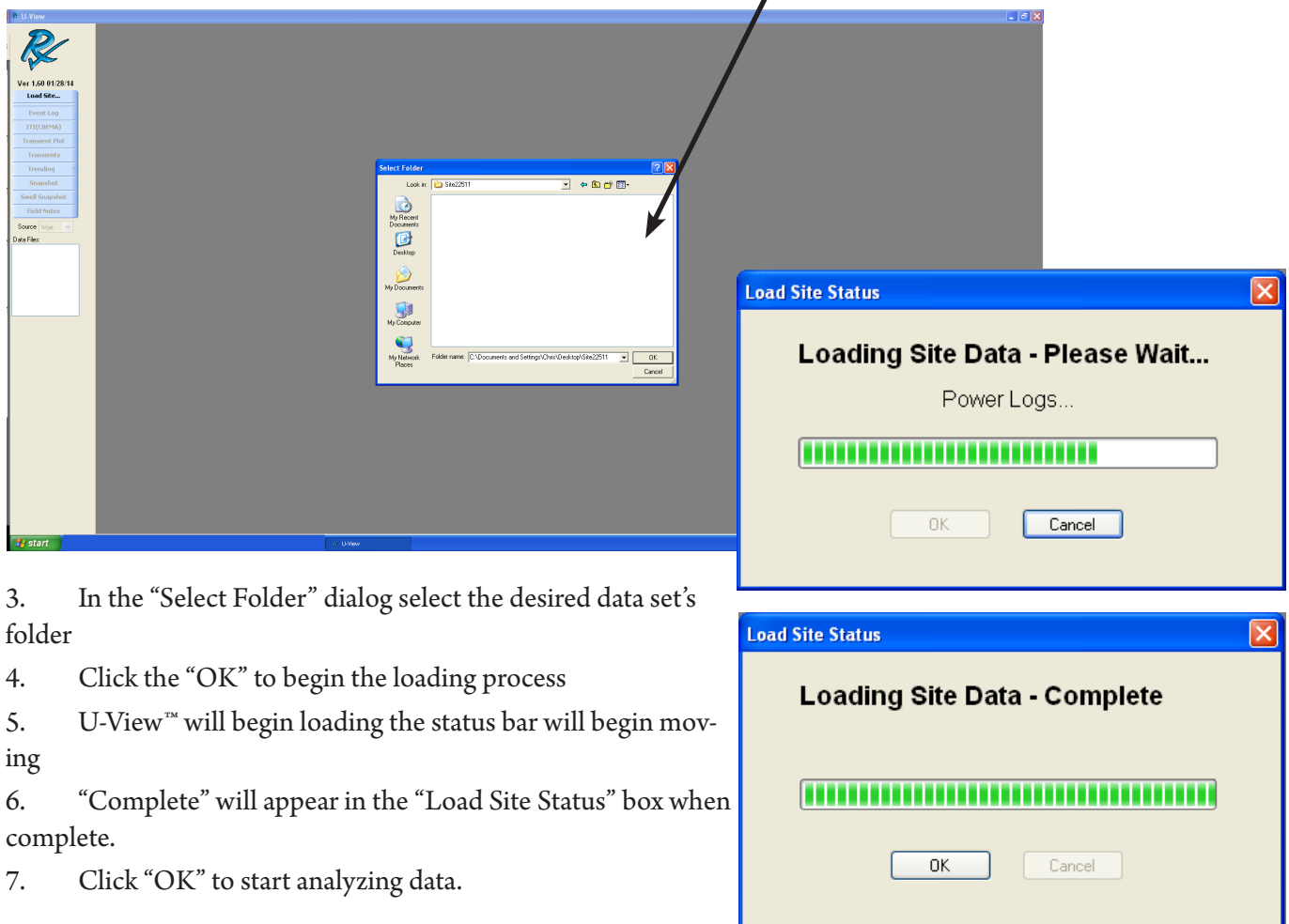
Instructions:

Instructions for usage of the U-View™ software package is maintained in a separate document. This document link can be found on the “www.RxMS.com/U-View.html” website under the download icon. Click on the hyperlink “here” of the line “Instructions are here”.

To Analyze downloaded data:

1. Start the U-View™ program
2. Press the “Load Site...” button

Note: The display will not show the files in the folder, it is to select the folder that contains all of the files.



The screenshot illustrates the process of loading data into U-View. It shows the main application window with the 'Load Site...' button highlighted. A 'Select Folder' dialog box is open, showing the 'C:\Documents and Settings\Cheri\Desktop\Site2011' folder. An arrow points from the 'Note' text to this dialog. Two 'Load Site Status' dialog boxes are shown: the first is titled 'Loading Site Data - Please Wait...' and the second is titled 'Loading Site Data - Complete'. Both status dialogs feature a green progress bar and 'OK' and 'Cancel' buttons.

3. In the “Select Folder” dialog select the desired data set’s folder
4. Click the “OK” to begin the loading process
5. U-View™ will begin loading the status bar will begin moving
6. “Complete” will appear in the “Load Site Status” box when complete.
7. Click “OK” to start analyzing data.

Appendix A - Theory Of Operation

Calculation types

This section will show the formulas for how the power monitor calculates the different logged values.

Min = Lowest calculated value over log period.

Max = Highest calculated value over log period

Average = Sum of all values divided by count of values.

<p style="text-align: center;">RMS Voltage (Ph-Ph, Ph-G, Ph-N, N-G)</p> $V_{rms}(Half\ Cycle) = \sqrt{\frac{1}{128}(x_1^2 + x_2^2 \dots x_{128}^2)}$	<p style="text-align: center;">RMS Current (L1, L2, L3, N, G)</p> $I_{rms}(Full\ Cycle) = \sqrt{\frac{1}{128}(x_1^2 + x_2^2 \dots x_{128}^2)}$
<p style="text-align: center;">Harmonics (Ph-Ph, Ph-G, Current L1, L2, L3)</p> <p>Harmonics are measured on a cycle by cycle basis. Every 256 samples a FFT (Fast Fourier transform) is performed. The harmonics are the calculated values from that transform. Logs contain: DC, fundamental and harmonics up to 31st.</p>	<p style="text-align: center;">RMS Current - Residual (L1+L2+L3 - N)</p> $Residual\ I_{rms}(Full\ Cycle) = \sqrt{\frac{1}{128}((L1_1 + L2_1 + L3_1 - N_1)^2 + \dots + (L1_{128} + L2_{128} + L3_{128} - N_{128})^2)}$
<p style="text-align: center;">Frequency (L1-G, L2-G, L3-G)</p> <p>Frequency is measured on a 20 cycle window. Every 5120 voltage samples a 20 cycle(5120 sample) a zero cross count is performed. The frequency is the calculated time from that zero count algorithm.</p>	<p style="text-align: center;">THD Even % (Ph-Ph, Ph-G, Current: L1,L2,L3)</p> $THD\ Even\ \%(Cycle) = \sqrt{\frac{(h_2^2 + h_4^2 + \dots + h_{30}^2)}{h_1^2}}$
<p style="text-align: center;">THD Odd % (Ph-Ph, Ph-G, Current: L1,L2,L3)</p> $THD\ Odd\ \%(Cycle) = \sqrt{\frac{(h_3^2 + h_5^2 + \dots + h_{31}^2)}{h_1^2}}$	<p style="text-align: center;">THD Total % (Ph-Ph, Ph-G, Current: L1,L2,L3)</p> $THD\ \%(Cycle) = \sqrt{\frac{(h_2^2 + \dots + h_{31}^2)}{h_1^2}}$
<p style="text-align: center;">THD Max % (Ph-Ph, Ph-G, Current: L1,L2,L3)</p> $THD\ \%(Cycle)_{max} = \text{Max THD\% calculated over log interval}$	<p style="text-align: center;">Phase Angle:(Ph-Ph, Ph-G) Calculated when $V_1 > 50V_{rms}$ & $I_1 > 2A_{rms}$</p> $Phase\ Angle\ \emptyset(Cycle) = (V_1 \angle \emptyset) - (I_1 \angle \emptyset)$ $Phase\ Angle\ \emptyset(Avg) = \sum (V_1 \angle \emptyset) - \sum (I_1 \angle \emptyset)$ <p>V= L1-L2, L2-L3, L3-L1 I= L1, L2, L3 V= L1-G, L2-G, L3-G I= L1, L2, L3</p>

Power: KVA - Three Phase (Min, Max, Avg)

$$KVA(Cycle)_{1,2,3} = V_{rms} * I_{rms}$$

$$V = L1-G, L2-G, L3-G \quad I = L1, L2, L3$$

Power: KW - Three Phase (Min, Max, Avg)

$$KW(Cycle)_{1,2,3} = \frac{1}{64} \sum_{n=1}^{64} ((V_1 * I_1) + \dots (V_{64} * I_{64}))$$

$$V = L1-G, L2-G, L3-G \quad I = L1, L2, L3$$

Power: PF - Three Phase (Min, Max, Avg)

$$PF(Cycle)_{1,2,3} = \frac{KW(Cycle)}{KVA(Cycle)}$$

$$KW = 1, 2, 3 \quad VA = 1, 2, 3$$

Power: KVAR - Three Phase (Min, Max, Avg)

$$KVAR(Cycle)_{1,2,3} = \sqrt{(KVA^2 - KW^2)}$$

$$V = L1-G, L2-G, L3-G \quad I = L1, L2, L3$$

Power: Total (KW, KVA, KVAR, PF)

Based on the Average values.

$$KVA(Cycle)_{total} = KVA_1 + KVA_2 + KVA_3$$

$$KW(Cycle)_{total} = KW_1 + KW_2 + KW_3$$

$$KVAR(Cycle)_{total} = KVAR_1 + KVAR_2 + KVAR_3$$

$$PF(Cycle)_{total} = PF_1 + PF_2 + PF_3$$

Power: Energy KVAh, kWh, KVARh

Based on the Average values.

$$x = \frac{3600}{Log Rate_{seconds}}$$

$$kWh = \frac{1}{(x)} \sum_{n=1}^{(x)} (KW(Total)_1 + \dots KW(Total)_{(x)})$$

$$KVARh = \frac{1}{(x)} \sum_{n=1}^{(x)} (KVAR(Total)_1 + \dots KVAR(Total)_{(x)})$$

$$KVAh = \frac{1}{(x)} \sum_{n=1}^{(x)} (KVA(Total)_1 + \dots KVA(Total)_{(x)})$$

Power: Demand KVA, KW, KVAR

Based on the Average values.

$$x = \frac{3600}{\text{Log Rate}_{seconds}}$$

$$y = \frac{x}{\text{Demand Interval}_{seconds}}$$

$$\text{Demand}_{KWh} = \frac{1}{(y)} \sum_{n=1}^{(y)} (KW(\text{Total})_1 + \dots KW(\text{Total})_{(y)})$$

$$\text{Demand}_{KVARh} = \frac{1}{(y)} \sum_{n=1}^{(y)} (KVAR(\text{Total})_1 + \dots KVAR(\text{Total})_{(y)})$$

$$\text{Demand}_{KVAh} = \frac{1}{(y)} \sum_{n=1}^{(y)} (KVA(\text{Total})_1 + \dots KVA(\text{Total})_{(y)})$$

Power: KW - Single Phase (Min, Max, Avg)

$$KW(\text{Cycle})_1 = \frac{1}{64} \sum_{n=1}^{64} ((V_1 * I_1) + \dots (V_{64} * I_{64}))$$

V= L1-L2

I= L1

Power: KVA - Single Phase (Min, Max, Avg)

$$KVA(\text{Cycle})_1 = V_{rms} * I_{rms}$$

V= L1-L2

I= L1

Power: PF - Single Phase (Min, Max, Avg)

$$PF(\text{Cycle})_1 = \frac{KW(\text{Cycle})}{KVA(\text{Cycle})}$$

V= L1-L2

I= L1

Power: KVAR - Single Phase (Min, Max, Avg)

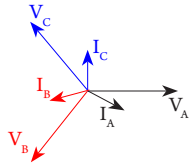
$$KVAR(\text{Cycle})_1 = \sqrt{(KVA^2 - KW^2)}$$

V= L1-L2

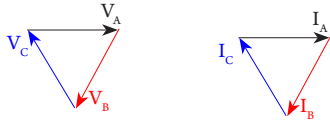
I= L1

Symmetrical Components

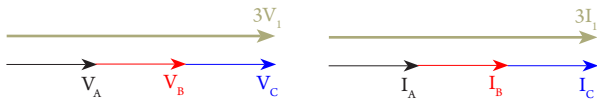
Given: Fundamental Voltage Vectors V_A, V_B, V_C , either Phase-Ground or Phase-Phase and Current Vectors I_A, I_B, I_C .



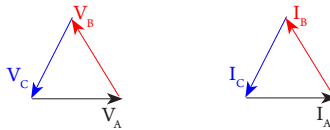
Zero Sequence: $V_0 = 1/3(V_A + V_B + V_C)$ $I_0 = 1/3(I_A + I_B + I_C)$



Positive Sequence: $V_1 = 1/3(V_A + V_B(+120^\circ) + V_C(+240^\circ))$
 $I_1 = 1/3(I_A + I_B(+120^\circ) + I_C(+240^\circ))$



Negative Sequence: $V_2 = 1/3(V_A + V_B(+240^\circ) + V_C(+120^\circ))$
 $I_2 = 1/3(I_A + I_B(+240^\circ) + I_C(+120^\circ))$



Symmetrical Components: Imbalance

$$\text{Voltage Imbalance \%} = V_1 / V_2$$

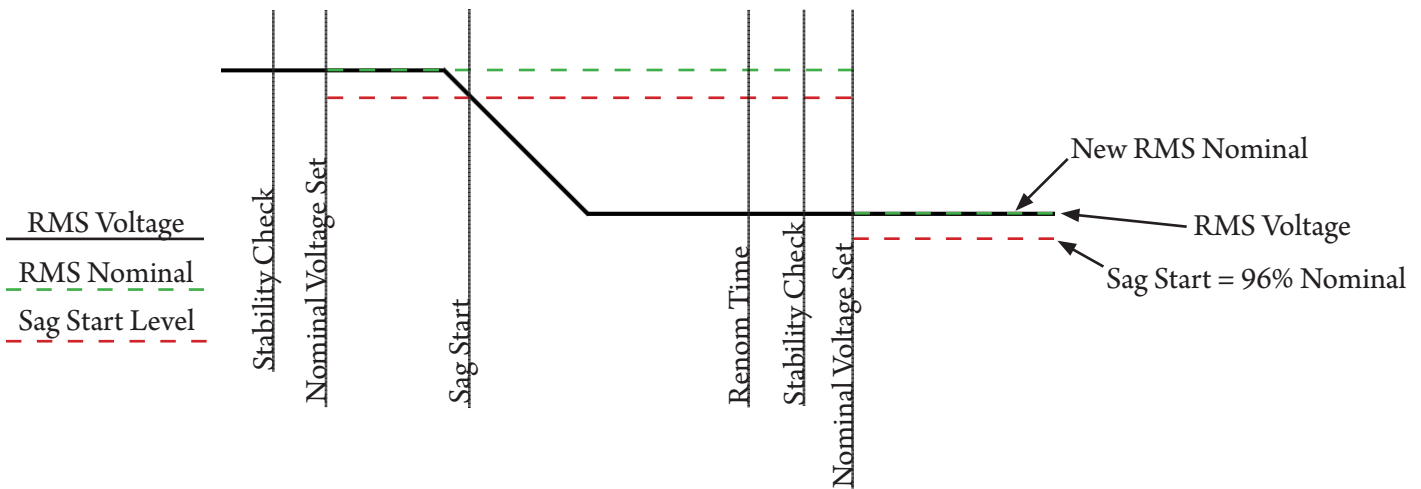
$$\text{Current Imbalance \%} = I_1 / I_2$$

RMS Nominal:

The RMS nominal is the voltage level that the power monitor “normalizes” to either on sampling start (first 5 seconds) or after renominaling based on the parameter set in the “Live-View™ -> Setup -> Triggers -> Volts -> (Renom)” time. The system will re-normalize the RMS voltage if there is a voltage sag or surge that is outside the set “Live-View™ -> Setup -> Triggers -> Volts -> (Sag Start)” or “Live-View™ -> Setup -> Triggers -> Volts -> (Surge Start)” and lasts longer than the Renom time.

Stability Check = Power monitor confirms less than 20% deviation in RMS voltage for 5 Seconds after sampling start.

Nominal Voltage Set = Power monitor Sets nominal voltages and the Sag/Surge Thresholds.



Input Frequency PLL

The AC Frequency setup in “Live-View™ -> Setup -> System -> AC Frequency” configures the power monitor on how to detect input frequency, there are three options.

Fixed Mode

The monitor uses only the configured AC Frequency either 50.0 or 60.0 Hz.

Auto 50/60 Mode

The monitor selects either 50.0 or 60.0 Hz if the input frequency on channel L1-L2 is within the configured Band setting. (Ex. If Band = 2Hz, if signal is 58Hz-62Hz Monitor sets to 60Hz) The Time setting is used as a hysteresis band, it waits that amount of time after AC frequency is in the Band range before setting the master sample frequency.

Auto Mode

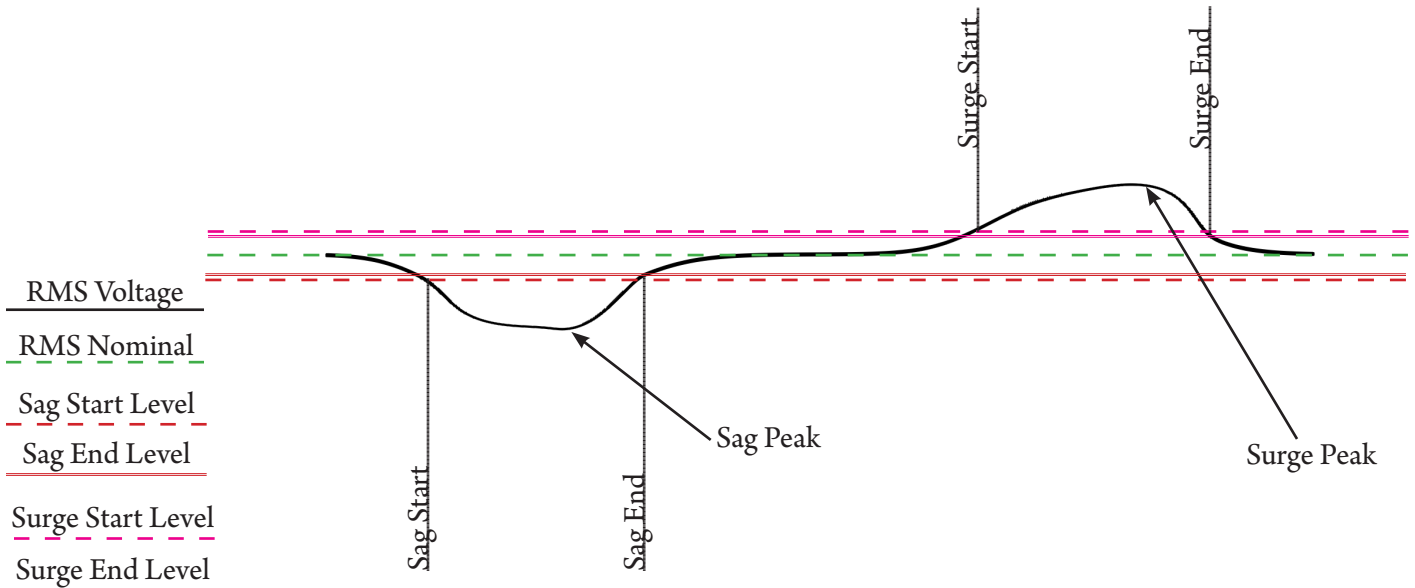
The monitor “Syncs” to the incoming frequency on channel L1-L2, Time is used as the amount of time the signal must be stable and out of band before setting a nominal frequency. Band is used as the amount of frequency deviation from the nominal sample frequency before a new nominal frequency is calculated. Time can be set from 10 seconds to 30 minutes. Auto Mode should only be used if frequency is known to change, such as a transfer to generator set. Sites with large THD or wave shape faults can be unstable and cause problems in this mode.

Sag / Surge Voltage Triggers

The Sag or Surge events occur when the RMS Voltage falls outside the set “Live-View™ -> Setup -> Triggers -> Volts ->(Sag Start)” or “Live-View™ -> Setup ->Triggers -> Volts -> (Surge Start)” and lasts until the RMS returns to “Live-View™ -> Setup -> Triggers -> Volts ->(Sag End)” or “Live-View™ -> Setup -> Triggers -> Volts -> (Surge End)” value.

Duration = The total time that the RMS voltage was outside of the set parameters.

Peak = The highest (surge) or lowest (sag) RMS voltage that was calculated during the event.



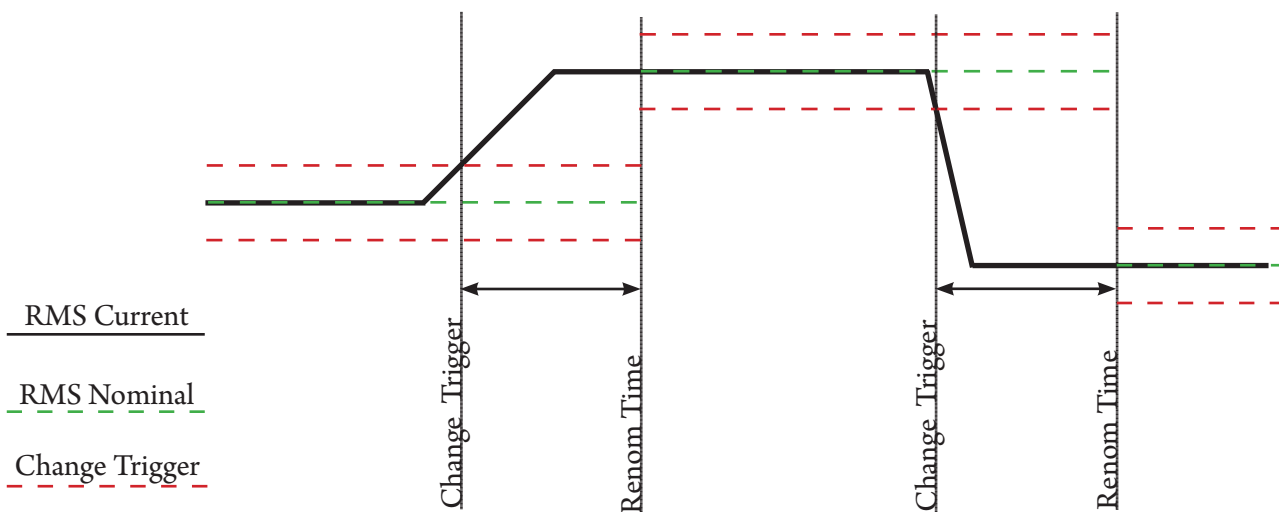
Current Trigger

The Current Trigger starts when power monitor calculates a deviation from the nominal RMS Current falling outside the set “Live-View™ -> Setup -> Triggers -> Phase Current ->(Change)”, “Live-View™ -> Setup -> Triggers -> Neu Current -> (Change)” or “Live-View™ -> Setup -> Triggers -> Gnd Current -> (Change)”.

The Current Trigger ends when the RMS Current stabilizes for “Live-View™ -> Setup -> Triggers -> Current Triggers ->(Settle)” cycles, or the “Live-View™ -> Setup -> Triggers -> Phase Current ->(Renom)” value is reached. **Change** = Change from RMS nominal that causes a Current Trigger Event. Phase, Neutral and Ground current triggers are configured in Lieve-View independently.

Settle = Time in cycles the RMS current must stabilize before ending the Current Trigger event.

Renom = Maximum time in seconds the monitor will wait for the RMS Current to stabilize before ending the Current Trigger and forcing a Renominal. The power monitor will then take a 4 cycle average and use that as its new RMS nominal.



Waveform Capture

Waveform capture can be started from either the Sag/ Surge Voltage Triggers or the Current Triggers. Upon start, they record 10 voltage and 5 current channels at 64 samples/cycle.

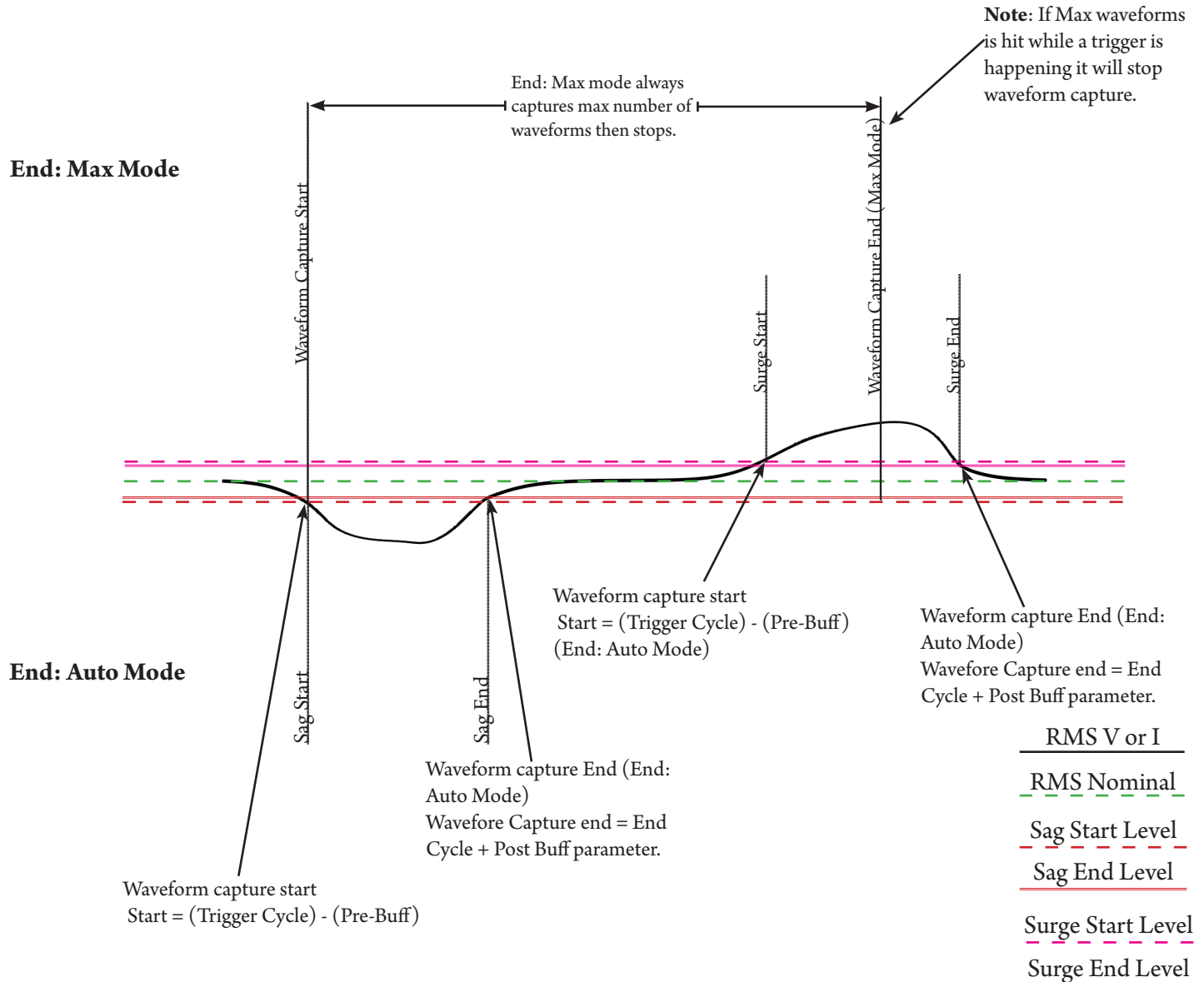
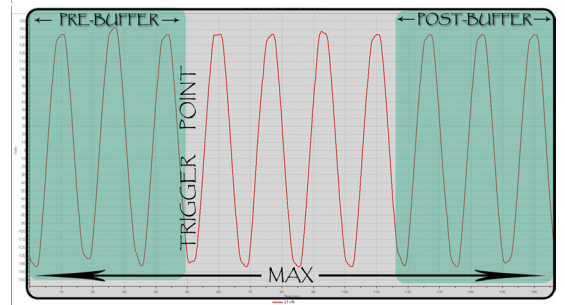
There are 4 parameters that can be set for the Waveform captures.

Pre-Buff = Amount of cycles captured before the triggering event occurred.

Post-Buff = For Auto End, number of cycles captured after all triggering events have cleared. Any triggers occurring during this time will reset the Post-Buff time and cause the waveform capture to continue recording.

Max = Total amount of cycles that will be captured during a event.

End = How the waveform capture ends, this can be set to Max (The capture ends when the Max parameter cycle count is reached) or Auto (When the triggering event ends)



Appendix B - Monitor Specifications

General Specifications:

- Clock: Leap Year, 24-Hour, with time zone info
- Real-time Clock Accuracy: +/- 1 sec / day max.
- Synchronize time between Cx Monitors to +/- 10 mSec / day.
- Internal Memory: Minimum 512Mbytes high speed NAND Flash
- Wireless 802.11g Integration (Ad-hoc mode)
- 10/100Mbit Ethernet; FTP, SMTP, HTTP, HTTPS, SSL, SSH, NTP.
- USB Mass storage class support
- Remote access through secure remote Ethernet tunneling
- Max number of events: Only limited by internal memory
- Power Requirements: 100V-240V ACrms +/-10% 47-63 Hz
10Watts 24Vdc 0.5Arms Center positive barrel
- UPS standby time: Programmable Max time 10 Minutes
- Dimensions: 11.5 x 10.25 x 4 Inches.
(Height x Width x Depth)
- Weight: 5.55lb

Environmental & Safety

- Operating environment: Indoors (Pollution degree 2)
- Storage Temperature: -20°C to 50°C
(-4F-122F)
- Operating Temperature: 0°C to 40°C
(32F-104F)
- Max Changes per hour temp: 30°C
- Operating Humidity: 80% Max
Non-Condensing
- Conforms to IEC61010 CAT III 600V

Synchronization & Sampling:

Low Frequency:

- Sampling Frequency: 256 samples/cycle
- A/D Resolution: 16 bit oversampled
voltage 2X ; current 4X
- Auto 50/60 Hz ; or locked to input
- Voltage & Current RMS triggers ; Cross triggering
- Adaptable trigger thresholds

High Frequency:

- 1.666Msample/sec per channel.
- A/D Resolution: 12 bit

Voltage and Current Measurement:

Low Frequency

- Voltage Measurement Range: 0-600Vrms
- Voltage input impedance: 1.2Mohm

High Frequency

- Voltage Measurement Range: 0-2,500V
- Measurement type: AC coupled digital threshold trigger 500 sample buffer per channel
- Voltage input impedance: 1.2Mohm

Current Measurement Range (Probe dependant)

- Current input type: AC/DC +/- 6Vdc Input impedance
120K, 1M to gnd.

Voltage Current & Time Accuracy:

V/I Calibrated at 72° f. TC = 0.003%/°F

+/- ((% of reading) + (% of range))

Low Frequency

- A/D Measurement type: True RMS calculated every half cycle
- A/D Measurement Uncertainty: AC +/- 0.1% reading +/- 0.1% full scale above 50Vrms
DC +/- 0.1% reading +/- 0.1% full scale above 50V dc Offset Error: AC/DC: 0.05Vrms

High Frequency

- A/D Measurement type: Sampled Threshold cross 500 sample buffer per channel
- A/D Measurement Uncertainty: AC +/- 5% reading Offset Error: AC: 5V

Current:

- A/D Measurement type: True RMS calculated every cycle
- A/D Measurement Uncertainty System:
AC +/- 0.1% reading +/- 0.1% full scale above 50Arms
DC +/- 0.1% reading +/- 0.1% full scale above 50Adc
Offset Error: AC/DC: 1Arms

Time:

- 10mSec/day calibrated at 72° f. TC = 100ppb/°F

Log rates and Types

RMS Voltage / Current:

- 1 Second to 30 Minutes
- 10 Voltage Channels Ph-Ph, Ph-G, Ph-N & N-G
- 5 Current Channels { L1, L2, L3, N & G }
- 1 Residual Current {L1+L2+L3+N}
- RMS Voltage Imbalance

Frequency:

- 10 Seconds to 30 Minutes
- 3 Voltage {L1-G, L2-G, L3-G}

Peripherals:

- 4 Seconds to 30 Minutes
- Up to 100 Probes
- Wireless DC Voltage +/- 0-600V AutoRanging
- Wireless DCx Voltage {10Ch - 60dc}
- Wireless DC Current {2,000A, 4,000A}
- Wireless Temperature / Humidity
- Wired Temperature / Humidity

Power:

- 10 Seconds to 30 Minutes

3 Phase Delta

{Min/Max/Average} Apparent Power(KVA), Real power(KW), Reactive (KVAR) Power Factor (PF).

Total KVA, Total KW, Total KVAR, Total PF, Total KVAH, Total KWH, Total KVARH, Total Demand(KVA) and Total Demand(KW)

3 Phase Wye - Split Phase - Single Pole Single Phase

{Min/Max/Average} Apparent Power(KVA), Real power(KW), Reactive (KVAR) Power Factor (PF).

Total KVA, Total KW, Total KVAR, Total PF, Total KVAH, Total KWH, Total KVARH, Total Demand(KVA) and Total Demand(KW)

2 Pole Single Phase

{Min/Max/Average} Apparent Power(KVA), Real power(KW), Reactive (KVAR) Power Factor (PF).

Total KVA, Total KW, Total KVAR, Total PF, Total KVAH, Total KWH, Total KVARH, Total Demand(KVA) and Total Demand(KW)

Harmonics:

- 10 Seconds to 30 Minutes
- 3 Ph-Ph, 3 Ph-G & 3 Current channels to the 31st.

THD:

- 10 Seconds to 30 Minutes
- 3 Ph-Ph, 3 Ph-G & 3 Current{Odd, Even, Total & Max}

Phase Angle:

- 10 Seconds to 30 Minutes
- 3 Ph-Ph, 3 Ph-G

Symmetrical Components:

- 10 Seconds to 30 Minutes
- Voltage & Current : Magnitude, Angle & Imbalance

Appendix C - Current Probe Specifications

10A Clamp-On 0.75" Diameter



Clamp-On 10 Arms medium -Wire Length 12ft

- Measuring range: 0.01A- 12Arms AC
- Max Working Voltage: 600Vrms
- Basic probe accuracy: Of reading

0.1A-0.5A:	2.5%
0.5A-1A:	2.5%
1A-12A:	1.0%
12A-24A:	4.0%

- Linearity: 0.1% + accuracy
- Conductor sensitivity: none
- Frequency Response 40Hz – 10 kHz
- Phase Shift:

0.1A-0.5A:	< 5.0 degrees
0.5A-1A:	< 3.0 degrees
1A-12A:	< 2.5 degrees
12A-24A:	< 5.0 degrees

- Total System Accuracy: +/- 2.6% rms with offset errors of +/- 0.05Apk
- System Gain: 0.002A/Count (16bit a2d)
- Output voltage: 100mV/Amp
- Total Range: +/- 30Apk

200A Clamp-On 0.75" Diameter



Clamp-On 200 Arms medium -Wire Length 12ft

- Measuring range: 0.5A- 240Arms AC
- Max Working Voltage: 600Vrms
- Basic probe accuracy: Of reading

0.5A-10A:	3.0%
10A-40A:	2.5%
40A-100A:	2.0%
100A-240A:	1.0%
240A-350A:	8.0%

- Linearity: 1% + accuracy
- Conductor sensitivity: none
- Frequency Response 40Hz – 10 kHz
- Phase Shift:

0.5A-10A:	Not Specified
10A-40A:	< 5.0 degrees
40A-100A:	< 3.0 degrees
100A-240A:	< 2.5 degrees
240A-350A:	< 5.0 degrees

- Total System Accuracy: +/- 4% rms with offset errors of +/- 0.5Apk
- System Gain: 0.02A/Count (16bit a2d)
- Output voltage: 10mV/Amp
- Total Range: +/- 600Apk

3,000A Rope
24" & 36" Lengths



3,000A Rope:

-Wire Length 8ft

- Measuring range: 5A- 3,200Arms AC
- Max Working Voltage: 600Vrms
- Basic probe accuracy: $\pm 1\%$ of reading $\pm 1A$
- Linearity: $\pm 0.2\%$ of reading
- Conductor position sensitivity: $\pm 1\%$ of reading
- Frequency Response: 10Hz to 10 kHz (-1dB)
- Phase Shift: < 1 degrees

- Total System Accuracy: $\pm 2\%$ RMS with offset errors of $\pm 2.5A_{pk}$

- System Gain: 0.2A/Count (16bit a2d)
- Output voltage: 1mV/Amp
- Total Range: $\pm 6,000A_{pk}$ probe limited to 4,500A_{pk}

- DC offset on startup can be significant for approximately 10 sec.

Powered from power monitor or 2xAA

10,000A Gen2 Rope
36", 48" & 60" Lengths



10,000A Gen2 Rope:

-Wire Length 12ft

- Measuring range: 20A- 10,000Arms AC
- Max Working Voltage: 600Vrms
- Basic probe accuracy: $\pm 1\%$ of reading $\pm 20A$
- Linearity: $\pm 0.2\%$ of reading
- Conductor position sensitivity: $\pm 1\%$ of reading
- Frequency Response: 40Hz to 7 kHz (-1dB)
- Phase Shift: < 1 degrees

- Total System Accuracy: $\pm 2\%$ RMS with offset errors of $\pm 20A_{pk}$

- System Gain: Frequency dependant
- Output: 0.122mV/ARMS @ 60Hz
- Total Range: $\pm 50,000A_{pk}$ at 60Hz to $\pm 60,000A_{pk}$ at 50Hz

- DC offset on startup can be significant for approximately 2 sec.

Self-powered no external source needed

Appendix D - Advanced Network Configuration

Network options:

The network parameters are set up in
“Live-View™ -> Setup -> Network”

The ethernet port can be configured either for Automatic, using Dynamic Host Configuration Protocol (DHCP), or as a static IP address.

To configure the monitor to use DHCP, just select Automatic.

To configure the monitor for a static IP address, select Static and fill in the IP Address, Net Mask, and Gateway from a network administrator.

The screenshot shows the 'Monitor Setup' dialog box with the 'Network' tab selected. The 'Ethernet' section has 'Automatic' selected. The 'Wireless' section has 'Ad-Hoc' mode selected, with 'EPAWireless' network and 'Static' configuration. The 'Network Time Protocol (NTP)' section has 'Enable' checked with a server of '192.168.2.208' and a timeout of '30' seconds. A note at the bottom states: 'At this time, only Wireless Ad-Hoc mode is supported. EPA-1500 systems have NO Wireless support.'

Section	Option	Value
Ethernet	Mode	Automatic
	IP Address	
	Net Mask	
	Gateway	
Wireless	Mode	Ad-Hoc
	Network	EPAWireless
	WEP Key	
	Mode	Static
Wireless (Static)	IP Address	169.254.147.230
	Net Mask	255.255.0.0
	Gateway	169.254.1.1
NTP	Enable	Checked
	Server	192.168.2.208
	Timeout	30 secs

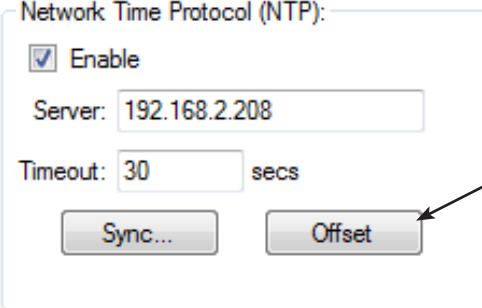
Reset a mis-configured system's network settings:

If a power monitor's settings had been configured in a unknown state, it is possible to reset using the USB stick interface.

1. On the base directory of a USB stick, place a file called “resetnetconfig” with no file extension.
2. Insert the USB stick into the power monitor
3. After the USB stick is recognized there will be a message on the power monitor saying “Network Reset Complete”.
4. Remove the USB stick
5. Ethernet will now be in default settings
6. Reboot Cx Monitor™ to save ethernet settings

NTP:

The NTP parameters are set up in
“Live-View™ -> Setup -> Network”



Use “Offset” to check if Cx Monitor’s time is in sync with server.

Theory of operation:

The Cx Monitor™ can act as a client to an NTP server (either local or internet based) or as a server. This gives the ability for Cx Monitor™ to sync to each other, or to a time server. When enabled the Cx Monitor™ automatically synchronizes the time under three conditions, upon system boot up (if enabled), when “Start” is pressed in Live-View™ and using the “Sync...” button in the NTP section of network setup.

The NTP Server/Client can operate in any Ethernet configuration shown in the “PC Connection Methods” section of this manual.

1. Auto-IP Direct cross over Ethernet (Between two Cx Monitors, Cx Monitor™ as server)
2. Auto-IP with multiple Cx Monitors on a network switch (One Cx Monitor™ server multiple client Cx Monitors)
3. AD-Hoc mode with USB stick (One Cx Monitor™ server multiple client Cx Monitors)
4. DHCP/WiFi AP with multiple Cx Monitors on a network (One Cx Monitor™ server multiple client Cx Monitors)
5. DHCP/WiFi AP with multiple Cx Monitors on a network (External NTP Server)

Server Mode:

The Cx Monitor™ upon boot up will get the time from the RTC time clock (This has a 1 second resolution) it will lock it’s NTP server to the RTC time at this point.

The Cx Monitor™ will then use it’s internal clock with a 10mSec/day accuracy to synchronize it’s NTP server time.

If you check “Enable” in the NTP section of Live-View™ this mode starts.

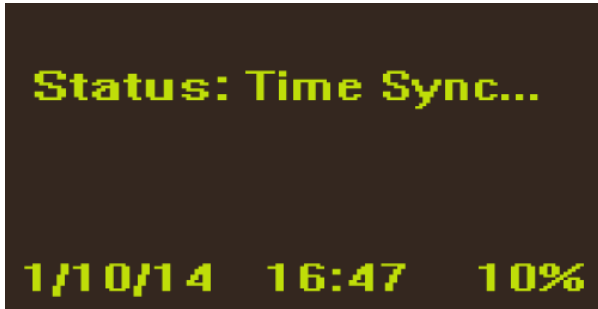
Client Mode:

The Cx Monitor™ will synchronize it’s clock using the settings in the NTP section of Live-View™. NTP is automatically run on boot up when enabled, and when the “Start” button is pressed in Live-View.

The “**Server:**” setting is the server that will be attempted to synchronize to using the NTP protocol. This time will be trusted so ensure it’s a server that has a valid time.

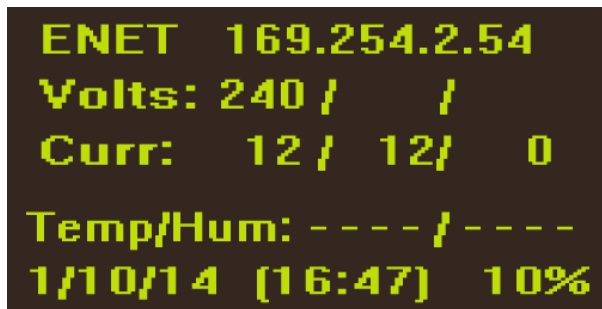
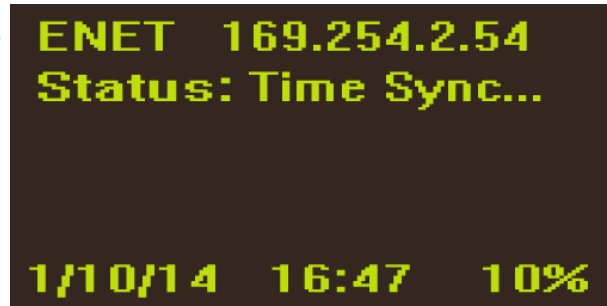
The “**Timeout:**” setting in Live-View™ gives the amount of seconds to wait while requesting a time from the configured NTP server. If unable to connect to the server the monitor will begin sampling after this time-out. (un-synchronized)

Display when Cx Monitor's time is synchronizing with time server.



1) Ethernet not established Cx Monitor™ waiting for IP address.
Cx Monitor™ waits 60 seconds in this mode before skipping NTP sync.

2) Ethernet link connected and Cx Monitor™ waiting for response from NTP server.



3) After successful sync parenthesis (xx:xx) appear around the time. This ensures the time is synchronized to the server's and time-out was not reached.

If this is not shown, check cabling and either re-boot system or re-synchronize with Live-View™.

NTP NOTES:

The Cx Monitor™ does not re synchronize time after the initial start, if the server's time is changed, the clients will have to be rebooted or re synchronized using Live-View™.

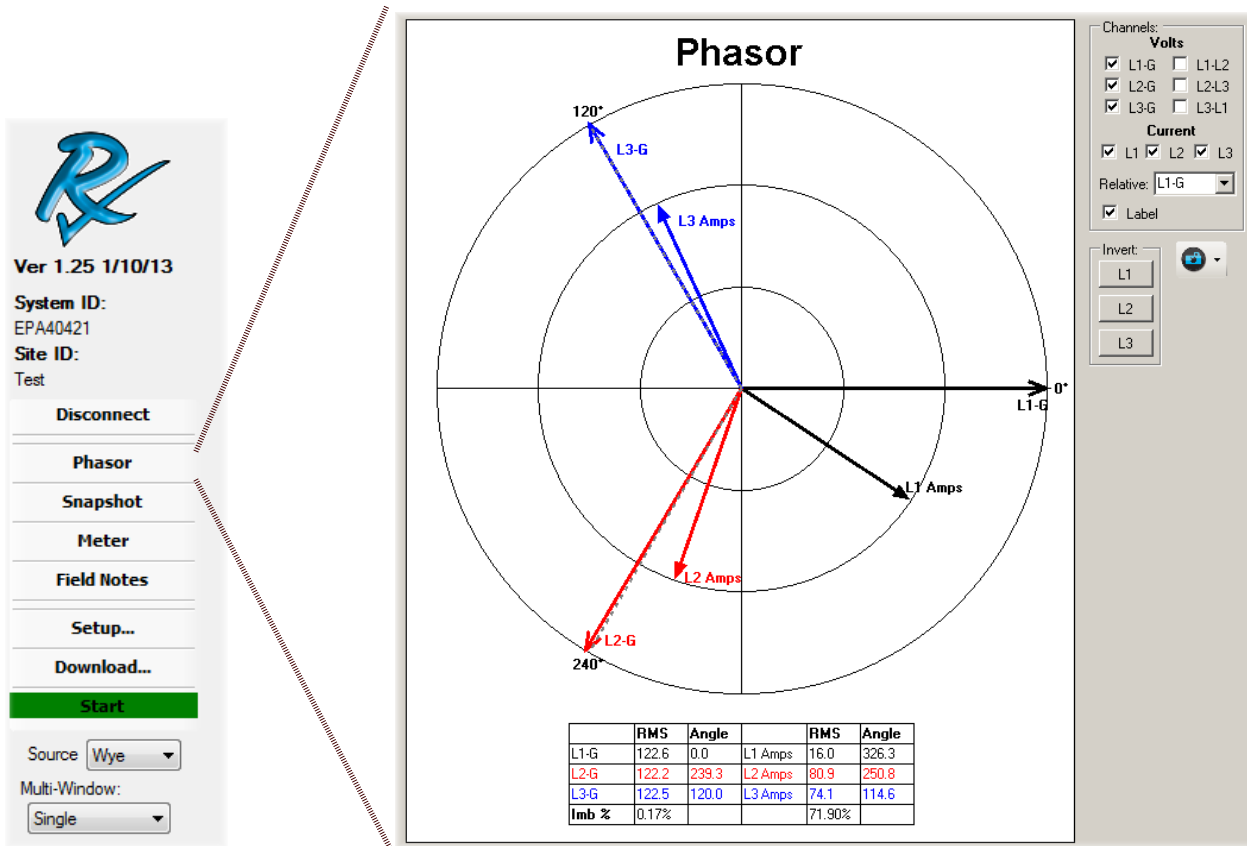
The Cx Monitors time will drift after the initial synchronization point, up to ten milli-seconds per day.

Temperature can effect time keeping ability see the Cx specification sheet for drift rates under different temperature conditions.

When NTP is enabled, the "Set" time functionality of the Cx Monitor™ to the computer running Live-View™ is disabled.

Appendix E - Phasor Diagram

The Phasor Diagram in Live-View™ displays the phase angles and magnitudes of the incoming voltage (Ph-Ph and Ph-G) and current values (L1, L2, L3).



The phasor diagram in Live-View™ is a powerful tool to be sure that the Voltage and Current signals coming into the power monitor are properly connected and configured.

The relative phase angle (0°) is changed by using the “Relative” drop down menu. It can be either L1-Ground or L1-L2.

The displayed voltage and current can be disabled / enabled by marking the corresponding check boxes.

Suggested Settings:

- Single Phase (L1 - N - G) : Relative: L1-G (Channels Enabled: L1-G, Current L1)
- 2 Pole Single (L1 - L2 - N - G) : Relative: L1-L2 (Channels Enabled: L1-L2, Current L1, L2)
- 3 Phase (L1 - L2 - L3 - N - G) : Relative: L1-G (Channels Enabled: L1-G ,L2-G, L3-G Current L1, L2, L3)

Note: If a delta source is provided select “Delta” from the Source drop down box in the left Live-View™ panel.

The phase angle of each Voltage channel extends to the outer circle while the current channel is represented by a shorter line with a closed arrow head.

The Phasor Diagram gives the user the option to invert each of the phase current channels. If the current is hooked up backwards, it will display 180 degrees relative to it’s corresponding voltage. To correct for this, click the L1, L2, or L3 buttons to invert the current signal.

Appendix F - Cx Emulator

The Cx_Emulator is a program that is designed so you can simulate the usage of the Cx Monitor™ and its software without having to have the hardware available.

Download Cx Emulator.

Go to Website:

<http://weborders.rxms.com/>

Under Software -> Select Cx Emulator -> Add to Cart

Go to Checkout

If you do not have an account you will have to set one up.

Finish the checkout

No Shipping Required - Free

Pick today as delivery date

Free Checkout - Agree to terms and conditions.

Confirm order.

You can now go to the download section in your account and download the software.

Install Cx Emulator

Install “Cx Emulator” by running the installer package after download.

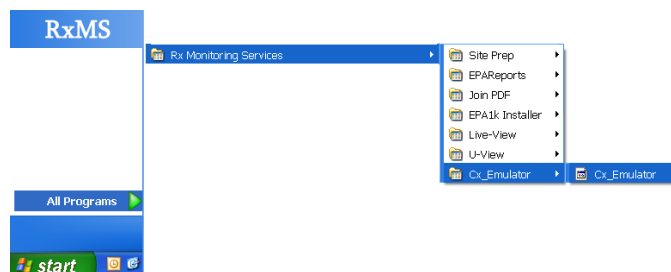
Follow the instructions through the installer process.

Windows® XP / Windows® 7, 8
Compatible



Run Cx Emulator

Go to Start Menu » All Programs » Rx Monitoring Service » Cx_Emulator » Launch Cx_Emulator
Or other location if default was changed during installation.

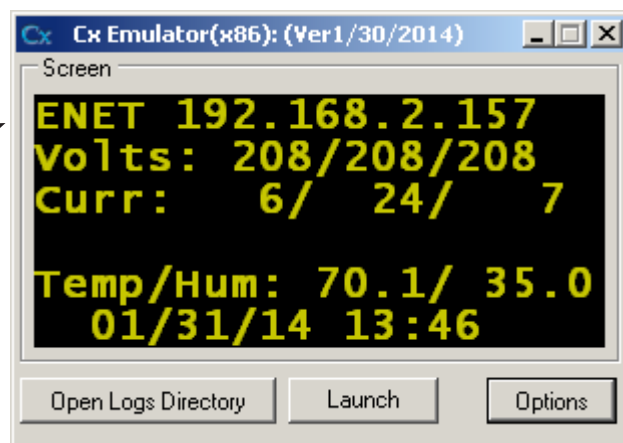


NOTE:

Windows may pop-up a “Windows Security Alert”. Press **Unblock** for the program to operate properly.

Get IP address to connect with Live-View™ from Cx Emulator display

IP address of Cx_Emulator is displayed in the
Cx_Emulator window



Appendix G - EWE (External Wireless Extensions)

The EWE (External Wireless Extensions) is a system that extends the capabilities of the Cx Monitor™. It adds wireless communications to 100 external probes. Adding additional functionality including, DC Voltage (600V single) ,DC Current (2000A & 4000A), Temperature and Humidity and a battery voltage tester (10 Channel 60V).

This section will give specifications for those devices.

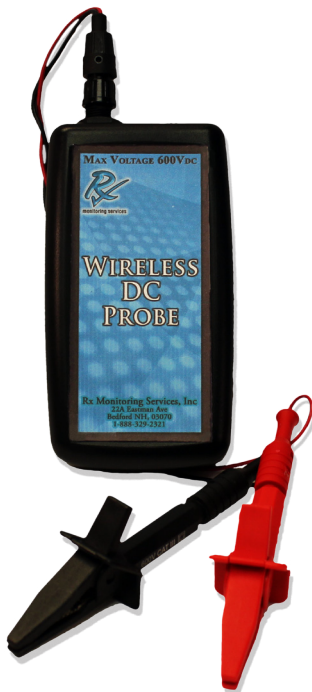
For use, see the “Installing Monitor” section of this manual for obtaining installation instructions for the wireless system.

Features:

- **Individual log file created for each probe**
- **Programmable log rate of 4 seconds to 30 minutes**
- **Up to 100 probes per Cx monitor™, mix and match probe types**
- **Range: Indoor up to 100 ft**
- **Range: Line of sight up to 1 mile**

Battery Operated : 600V DC Single

Full Spec. Sheet: https://reports.rxms.com/image/data/spec_sheet/Wireless_battery_Specsheet.pdf



Auto Dual Range:

+/- 24Vdc

- Uncertainty: +/- 0.5% +/- .01% Full scale
- Resolution: 0.001 V

+/- 600Vdc

- Uncertainty: +/- 0.5% +/- .01% Full scale
- Resolution: 0.005 V

DC Probe Specifications:

- 1 Sample per second minimum
- 4 Readings per log entry {Min, Max, Avg}
- Dimensions: 3” x 4.5” x 1.5” (L/H/W)
- Battery life between 20wks - 50wks dependant on log rate



Temperature Probe Specifications:

- Range: 0° - 122° Fahrenheit
- Resolution: 0.02° Fahrenheit
- Accuracy: ±1.5° Fahrenheit
- 1 Reading per log entry

Humidity Probe Specifications:

- Range: 0%-100% Relative Humidity Non-Condensing
- Resolution: 0.03% Relative Humidity
- Accuracy: ±2% (10%-90%) Relative Humidity ±5% Full Range
- 1 Reading per log entry

Temperature and Humidity Probe Specifications:

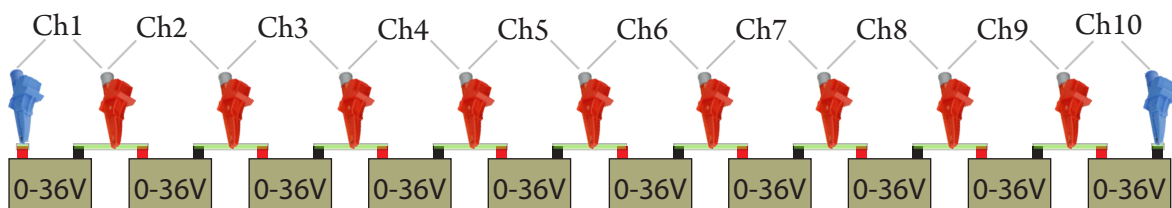
- 1 Sample per 15 second
- Dimensions: 3" x 4.5" x 1.5" (L/H/W)
- Battery life between 20wks - 50wks dependant on log rate



DCx Voltage Probe Specifications:

- 10 Channel
- +/- 60 Vdc
- Accuracy: ±0.1%
- Noise: +/-2mV
- TC = 1.63ppm/°F
- 1 Sample per second minimum
- 4 Readings per log entry {Min, Max, Avg}
- Operating Temperature: 0°C to 40°C (32F-104F)
- Operating Humidity: 80% Max - Non-Condensing
- Conforms to CAT II 150V

Only 11 Connections for 10 Batteries





Dual Range

+/- 2,000A

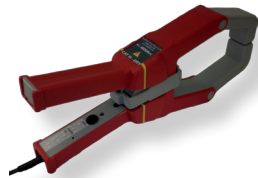
- Resolution: 0.017 A
- Uncertainty: +/- 0.5% +/- .01% Full scale

+/- 4,000A

- Resolution: 0.035 A
- Uncertainty: +/- 0.5% +/- .01% Full scale

DC Current Probe Specifications:

- 12V DC powered
- Sample speed 1 second
- Min, Max, Avg logging
- Hall effect probe powered from system, no batteries required



4,000A 4.5”x2.5” ID Probe Specifications:

- Range: 40-4,000 ADC / 28 -2,800 AAC
0-5,000 Hz
- Operating Conditions: 14-122 ° F / Max 600V

Accuracy:

- Noise: +/- 2ADC
- 1.5% from 400-4,000ADC
- 2% from 40-400ADC
- 4% from 8-40ADC



2,000A 2” ID Probe Specifications:

- Range: 20-2,000 ADC / 14 -1,400 AAC
0-5,000 Hz
- Operating Conditions: 14-122 ° F / Max 600V

Accuracy:

- Noise: +/- 1 ADC
- 1.5% from 200-2,000ADC
- 2% from 20-200ADC
- 4% from 4-20ADC