POWERSIDE®

All our energy, in your power

PQube® 3 Power Analyzers

Operation and Reference Manual

Revision 5

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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 dieses Instrument anschließen, müssen Sie die Anleitung lesen und verstanden haben.

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Symbol	Meaning
	Caution. Consult this manual in all cases where this symbol is marked, in order to find out the nature of the potential hazards and any actions which have to be taken to avoid them.
	Caution. Risk of electric shock.
	Alternating current.
	Alternating current (AC) or direct current (DC).
	Double or Reinforced insulation.
	Functional earth terminal not relied on for safety.

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1 Introduction

Please note that for most users, the PQube 3 Installation Manual covers all the necessary information for installing the PQube 3, its accessory modules, CTs, wiring, and configuring. The PQube 3 is easy to use with an intuitive interface and is shipped preconfigured to cover the majority of use cases.

If more information is required, this Operation and Reference Manual addresses user controls, setting up emails, upgrading firmware, maintenance, operating modes, specifications, and other detailed references for the PQube 3 family. It also contains detailed error codes and commands for email as well as a list of industry-standard sag curve specifications for reference.

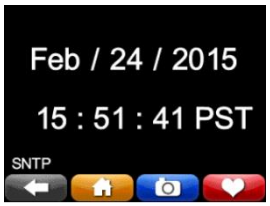
2 PQube 3 Operation

2.1 User Controls

2.1.1 Navigating the Touchscreen Display

Use the touchscreen on your PQube 3 to navigate the display. You can view live meters, recent events, system information, and perform actions like ejecting removable media and rebooting the unit.

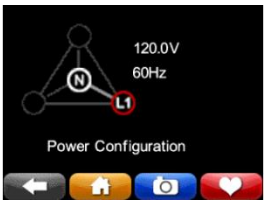
System



Date/time: You can change the time and day manually unless you are configured to synchronize on SNTP or NTP, or your PQube 3 is connected to GPS.

Your PQube 3 will automatically set the correct date and time upon configuring the **Setup.ini** files or connecting to a network.

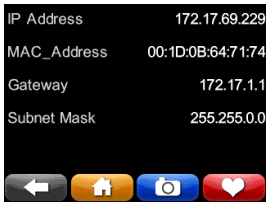
If SNTP or NTP has been enabled in the **Setup.ini** file, the PQube 3 will synchronize to UTC time. All measurements will be time tagged with the local time zone.



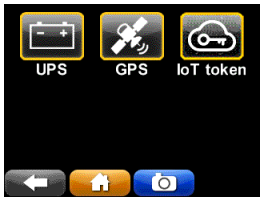
Power configuration: This screen shows you the power configuration, nominal voltage, and nominal frequency that your PQube 3 is using.

Information: Look up your PQube 3's firmware version, serial number.

Language: Select the language for the user interface on your screen. By default, the language is English-US.



Network: Your PQube 3's IP address and MAC address can be found on this screen. This is useful if you have a dynamic IP address. It is also useful for troubleshooting connectivity issues. An external network cable must be plugged in.

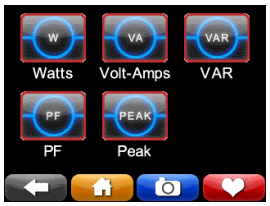


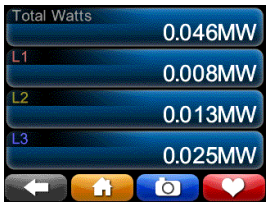
Advanced: UPS battery status, GPS synchronization status, and IOT Token number are available here.

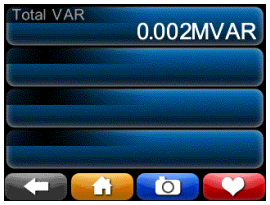
Meters

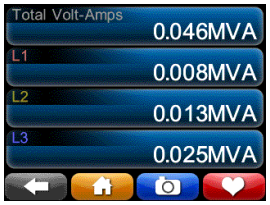
Voltage and Frequency: These are line-to-line, line-to-neutral, and neutral-to-earth true-RMS voltmeters. Different meters will show on these screens, depending on your power configuration. (For example, if the power configuration is "delta," there will not be any L-N meters, because there is no neutral conductor.) If you have set a potential transformer ratio in your **Setup.ini** file, the values will reflect this ratio.

Current: These meters show the true-RMS current. If you have set a current transformer ratio in your **Setup.ini** file, then these meters will use that ratio, so these meters will sometimes show their values in kilo-amps or even mega-amps. Different meters will show on this screen, depending on your power configuration. (For example, if the power configuration is "delta," this screen will not show a neutral current meter, because there is no neutral conductor in delta power.)
Note: The **PQube 3v** measures ***voltage only*** and will not show any readings for current or power.

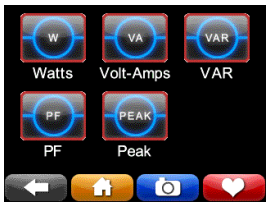


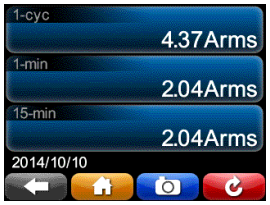




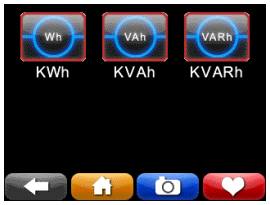


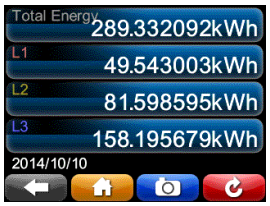
Power: These are the true power, apparent power, and reactive power readings, and they correctly handle harmonics (distorted voltages and distorted currents). If you have set a current transformer ratio or potential transformer ratio in your **Setup.ini** file, then these meters will reflect those ratios.



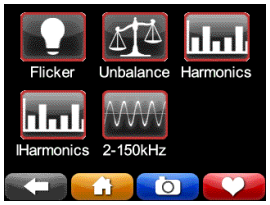


Peaks: These meters show the peak values on Load, Watts and VARS reached. The Peak accumulators can be reset by pressing the Reset button .

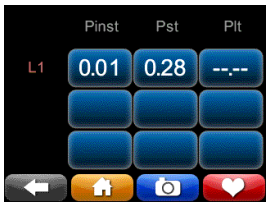




Energy: These three meters show the total energy, apparent energy, and reactive energy. The energy accumulators can be reset by pressing the reset button .

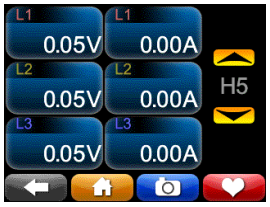


Class A: You will find additional power quality parameters as defined in IEC 61000-4-30 Class A, the international standard for power quality measurement methods.

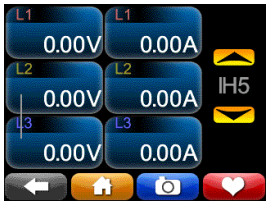


Flicker: These meters show flicker according to IEC 61000-4-15 Edition 2 methods. P_{inst} is the instantaneous flicker value for Incandescent Flicker. P_{st} is the short-term flicker, a statistical analysis of P_{inst} after 10 minutes, synchronized to real-time clock. P_{lt} is the mean value of P_{inst} over previous 2 hours, synchronized to real-time clock.

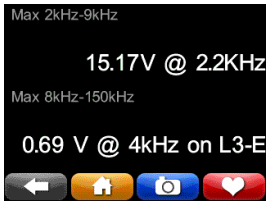
Unbalance: These meters show the voltage unbalance and the current unbalance. You can choose whether your PQube 3 calculates unbalance using the ANSI C84.1 method, IEC method, or GB method in your **Setup.ini** file.



Harmonics: Use this screen to view every harmonic up to the 50th for both voltage and current. Select one harmonic at a time. The selected harmonic applies to all channels. (Harmonic values up to the 50th are recorded in your PQube 3's CSV files.)



Interharmonics: Use this screen to view every Interharmonic up to the 50th for both voltage and current. Select one harmonic at a time. The selected Interharmonic applies to all channels. (Harmonic values up to the 50th are recorded in your PQube 3's CSV files.)



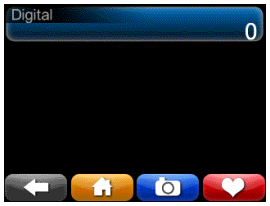
2 to 150 kHz: Use this screen to view the conducted emissions in the 2 to 150 kHz range. Useful for monitoring noise due to interference sources including solar inverters.

More meters: Additional meters can be found here.

Analog Channels: The Analog meters show the RMS voltage (equivalent to DC voltage for DC signals). You can view the Analog-to-Earth channels (common mode) and the Analog-to-Analog channels (differential mode).

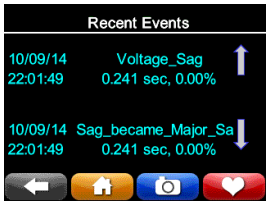
The internal pull-up voltage is 2.5 Vdc floating. It will zero out once you connect something to these terminals.

Environmental Meters: If you have ENV2 environmental probes, you can view your temperature, humidity, barometric pressure, acceleration, thermocouple input, and solar irradiance input here.



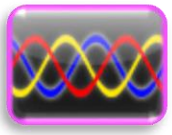
Digital Input: The DIG1 meter shows the average value of the DIG1 digital input averaged over one cycle—useful when the DIG1 signal is changing rapidly, because it will show the duty cycle of the DIG1 signal.

Recent Events



Your PQube 3 displays the 10 most recent events. For each event, you get a date/time, event type, and magnitude/duration if applicable. Use the up/down arrows to navigate the list.

Actions



Snapshot: You can trigger a Snapshot (waveform capture) event at any time using this button.

Trend: Trigger a partial daily trend for today. The data will begin at midnight and end at the time you pressed the button.

Reboot: Use this button to initiate a soft reboot. A confirmation message will appear, choose YES to reboot.

Eject: Use this button to safely remove any flash media (USB or microSD) that you have plugged into your PQube 3.

Clear: Use this button to clear all events and trends from your PQube 3.

Save Files

USB: Use this button to save your recorded data to the USB drive.

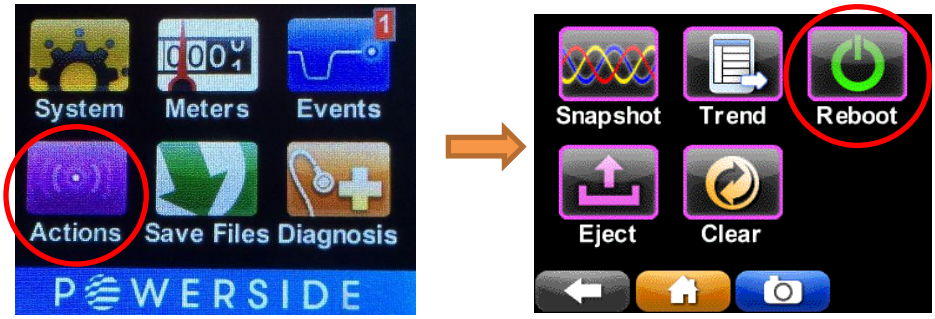
Optional SD: Use this button to copy data to the removable microSD card.

2.2 Rebooting the PQube 3

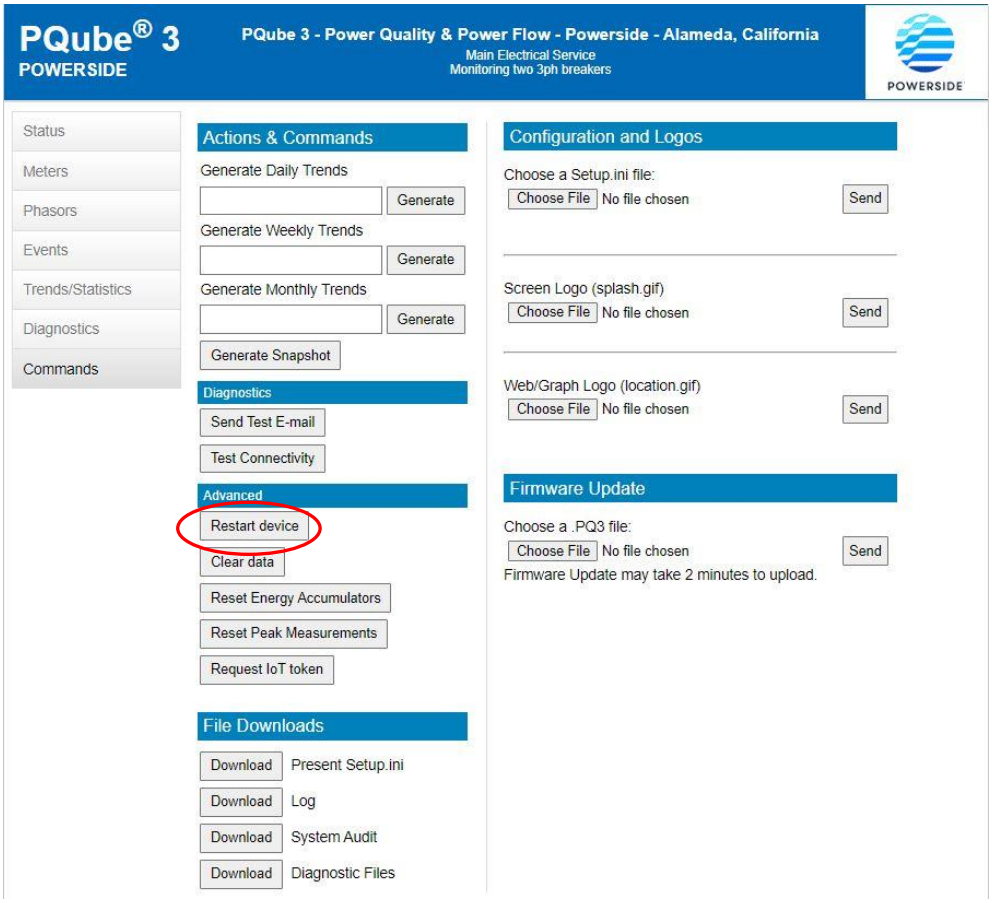
2.2.1 To perform a software reboot

You can perform a software reboot on your PQube 3 using two methods:

1. Touchscreen—From the main menu, go to Actions, then Reboot.



2. Web server—Commands page



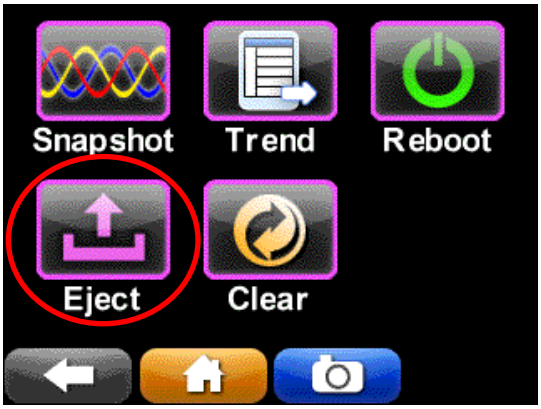
2.2.2 To perform a hardware reboot

If you cannot perform a software reboot, press the reset button located just above the microSD card slot with a paperclip.

2.2.3 Ejecting your USB thumb drive or microSD card

You can insert a USB thumb drive or microSD card into your PQube 3. Your PQube 3 will automatically detect it.

To remove the USB drive or microSD card, go to the Actions screen and press the Eject button. After the progress bar is complete, you can remove the drive from your PQube 3.



2.3 Accessing the FTP Server on Your PQube 3

Your PQube 3 has a built-in plain FTP server which you can access using any standard FTP client.

There are 5 different FTP accounts available.

- **ftp_user_1**, **ftp_user_2**, **ftp_user_3**
  Use these accounts to access events, trends, and logs.

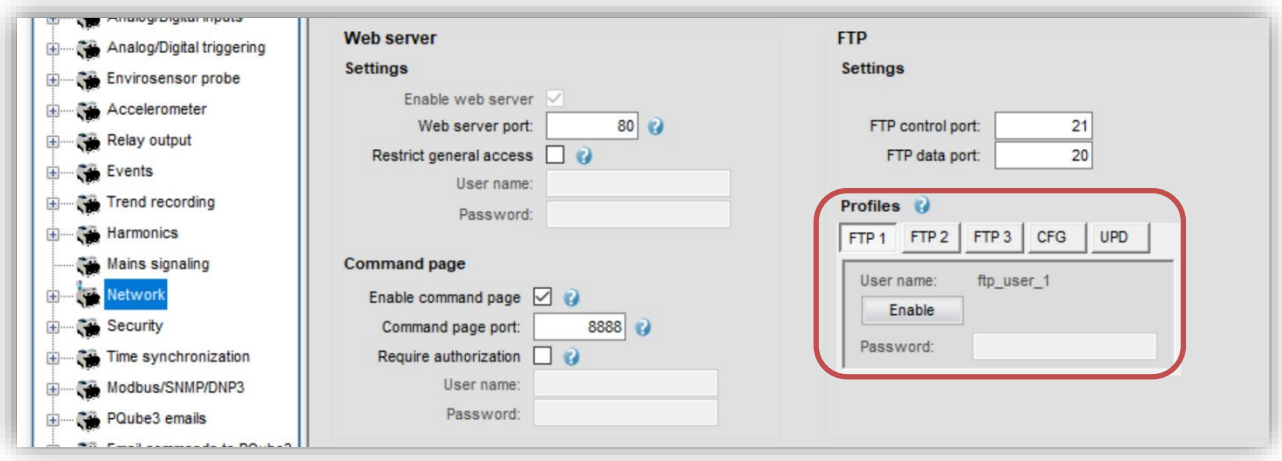
- **ftp_config**
  Use this account to upload a new setup file. After the upload is complete, your PQube 3 will automatically reboot and load your new settings. You can also retrieve your PQube 3's existing setup file using this account.

- **ftp_updater**
  You can upload new firmware to your PQube 3 using this account. After the upload is complete, your PQube 3 will automatically reboot and install the new firmware.

By default, each FTP account is disabled. To enable access for a particular account, you will need to specify a password for that account.

In the PQube 3 Configurator program, go to the Network Setup tab and locate the FTP Profiles section.

Select the FTP account you would like to use, then select the Enable button. Specify a password (at least 8 characters long) and save your setup file. Once your setup file is uploaded, then that FTP account will be available for you to use.

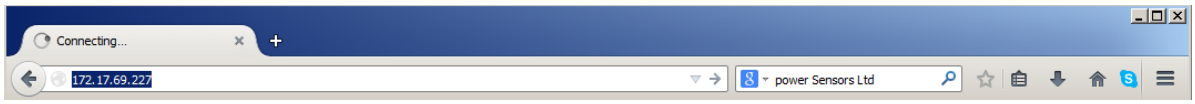


2.4 Accessing the HTTP Web Server on the PQube 3

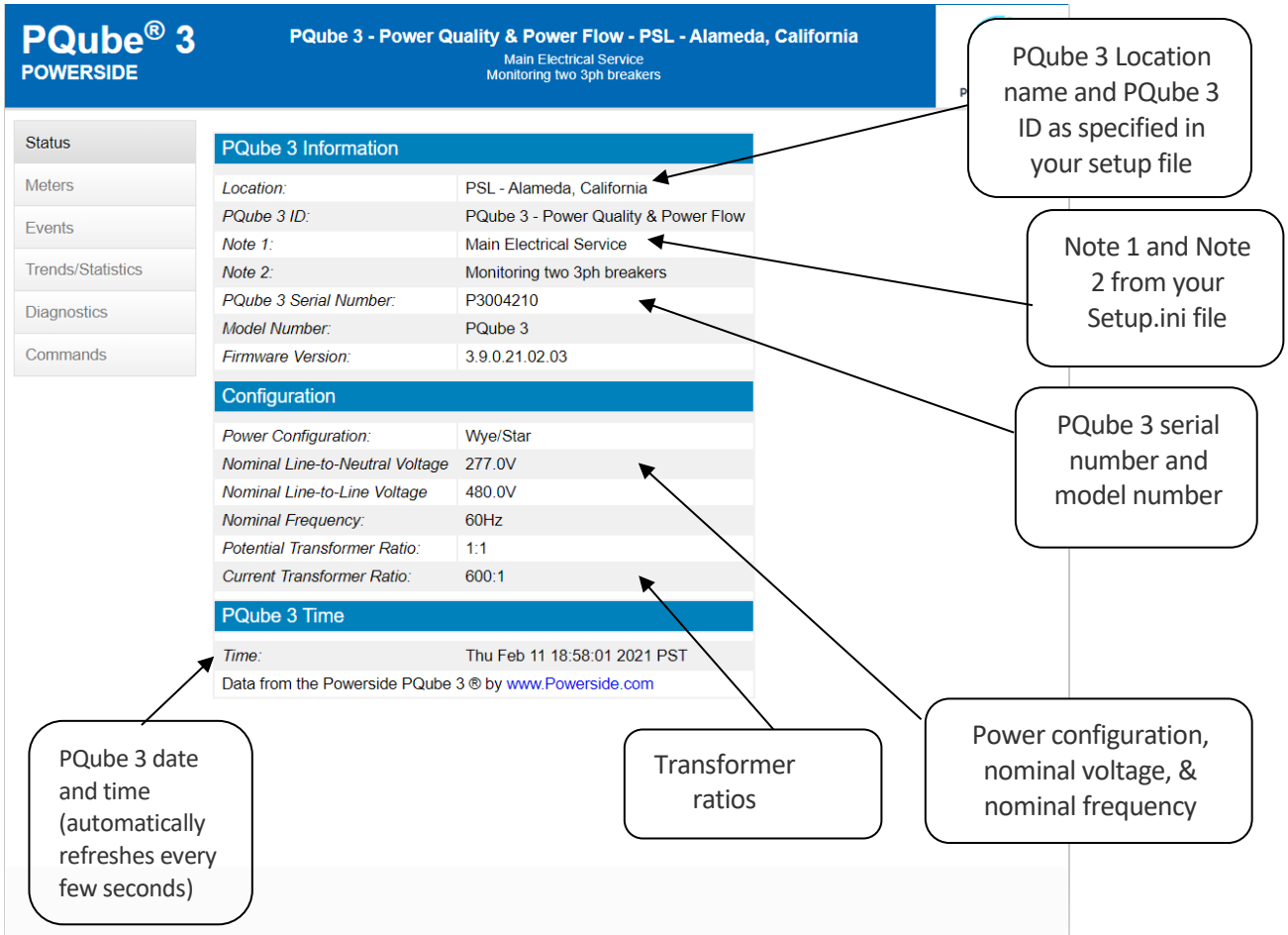
To access the web server on your PQube 3, ensure that your PQube 3 has:

- A Connection to a network
- A valid IP address assigned to it (assigned by DHCP or fixed IP)

To access your PQube 3 online, enter the IP address of the PQube 3 into your Internet Browser.



Your browser will automatically direct you to the main Status page.



2.4.1 Meters

The page refreshes the various meters regularly. The meters list depends on the power configurations, channels configured to be recorded, and environmental probes connected.

Meter	Value
L1-N	284.1V
L2-N	283.3V
L3-N	284.8V
N-E	0.07V
L1-L2	490.7V
L2-L3	492.0V
L3-L1	493.6V
L1 Amp	28.0A
L2 Amp	22.0A
L3 Amp	20.6A
N Amp	11.0A
L6 Amp	12.9A
L7 Amp	11.5A
L8 Amp	8.2A
Frequency	59.977Hz
L1-N Voltage Fundamental	284.1V
L1 Voltage Fundamental Angle	0.00deg
L2-N Voltage Fundamental	283.3V
L2 Voltage Fundamental Angle	240.31deg
L3-N Voltage Fundamental	284.8V
L3 Voltage Fundamental Angle	120.33deg
L1 Current Fundamental	27.5A
L1 Current Fundamental Angle	2.68deg
L2 Current Fundamental	21.9A
L2 Current Fundamental Angle	236.78deg
L3 Current Fundamental	20.6A
L3 Current Fundamental Angle	109.67deg

ClassA

Meter		Value
Flicker (L1-N)	P_{inst}	0.01
	P_{ST}	0.07
	P_{LT}	0.08
Flicker (L2-N)	P_{inst}	0.00
	P_{ST}	0.06
	P_{LT}	0.08
Flicker (L3-N)	P_{inst}	0.00
	P_{ST}	0.06
	P_{LT}	0.07
Max 2kHz-9kHz		0.19V @ 2.2kHz(L1-E)
Max 8kHz-150kHz		0.27V @ 8kHz(L1-E)
THD-V L1-N		1.06%
THD-V L2-N		0.97%
THD-V L3-N		0.95%
TDD-A L1		2.09%
TDD-A L2		0.69%
TDD-A L3		0.84%
V Unbal Zero Seq		0.03%
V Unbal Neg Seq		0.34%
I Unbal Zero Seq		13.16%
I Unbal Neg Seq		9.59%

Harmonics

Meter	L1-N	L2-N	L3-N	L1 Amp	L2 Amp	L3 Amp
H3	0.6V	0.8V	0.4V	3.8A	1.1A	1.5A
H5	1.1V	1.6V	1.3V	1.0A	0.1A	0.1A
H7	2.1V	1.3V	1.9V	0.9A	0.6A	0.6A
H9	0.3V	0.4V	0.2V	0.4A	0.3A	0.2A
H11	1.6V	1.5V	1.1V	0.4A	0.3A	0.3A
H13	0.5V	0.5V	0.7V	0.0A	0.1A	0.1A
H15	0.2V	0.2V	0.1V	0.2A	0.1A	0.1A
H17	0.3V	0.2V	0.3V	0.3A	0.1A	0.0A

Energy/Power

Meter		Value
Power	Total	24.58kW
	L1	8.882kW
	L2	7.738kW
	L3	7.956kW
Apparent Power	Total	25.45kVA
	L1	9.128kVA
	L2	7.871kVA
	L3	8.451kVA
True Power Factor	Total	0.965
	L1	0.973
	L2	0.983
	L3	0.941
Reactive Power	Total	6.61kVAR
	L1	2.102kVAR
	L2	1.444kVAR
	L3	2.049kVAR
Energy (since 2018/7/31)		378.656952MWh
Energy Imported (since 2018/7/31)		378.656982MWh
Energy Exported (since 2018/7/31)		-0.030042kWh
Apparent Energy (since 2018/7/31)		418.009MVAh
Reactive Energy (since 2018/7/31)		158.855MVARh
Positive Reactive Energy (since 2018/7/31)		158.855MVARh
Negative Reactive Energy (since 2018/7/31)		-0.037kVARh
Peak RMS Current (since 2018/8/13)	1 cycle	164.0Arms
	1 minute	96.7Arms
	15 minute	89.5Arms
Peak Power (since 2018/8/13)	1 cycle	107.1kW
	1 minute	65.14kW

Floor_Seismic

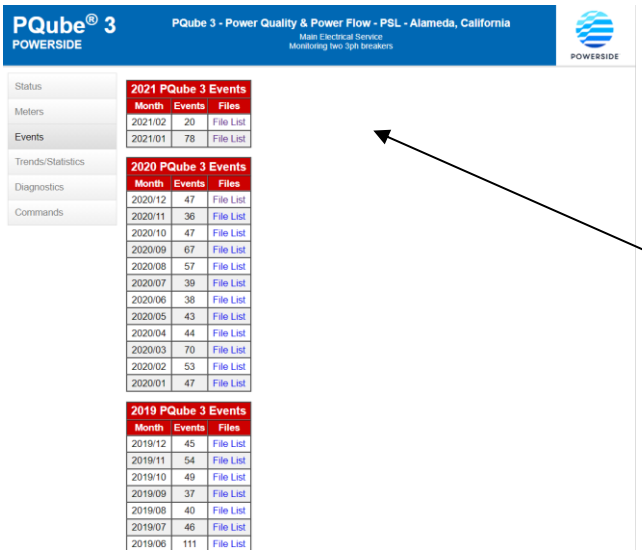
Meter	Value
Temperature	20.0°C
Humidity	42.9%RH
Pressure	1029.32hPa
Probe A X Acceleration	-0.010m/s²
Probe A Y Acceleration	0.000m/s²
Probe A Z Acceleration	0.000m/s²
Probe A Vector Acceleration	0.017m/s²

Inside_Box

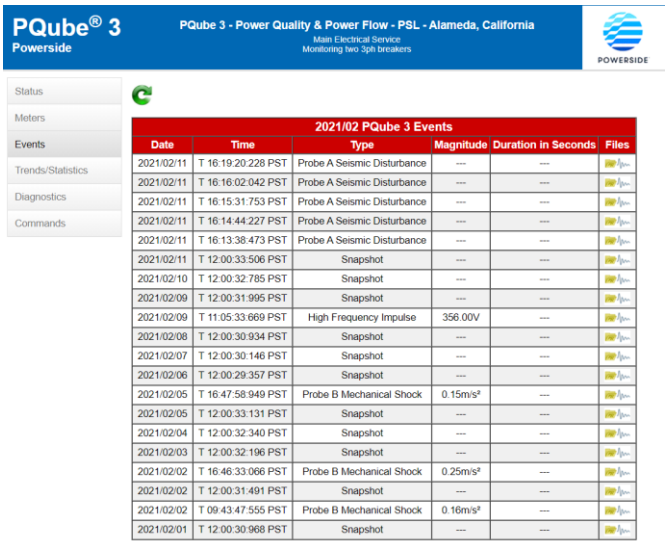
Meter	Value
Temperature	27.5°C
Humidity	26.6%RH
Pressure	1029.18hPa
Probe B X Acceleration	-0.019m/s²
Probe B Y Acceleration	-0.019m/s²
Probe B Z Acceleration	-0.010m/s²
Probe B Vector Acceleration	0.021m/s²

2.4.2 Events

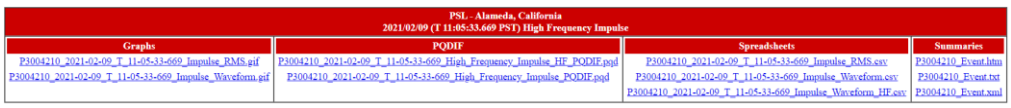
The page displays the list of events organized around years and months. Clicking the links provides access to the data files and graphs for each of the events. You can refresh the events listing at any time by pressing the refresh button.



Links to the details of the events for a given month

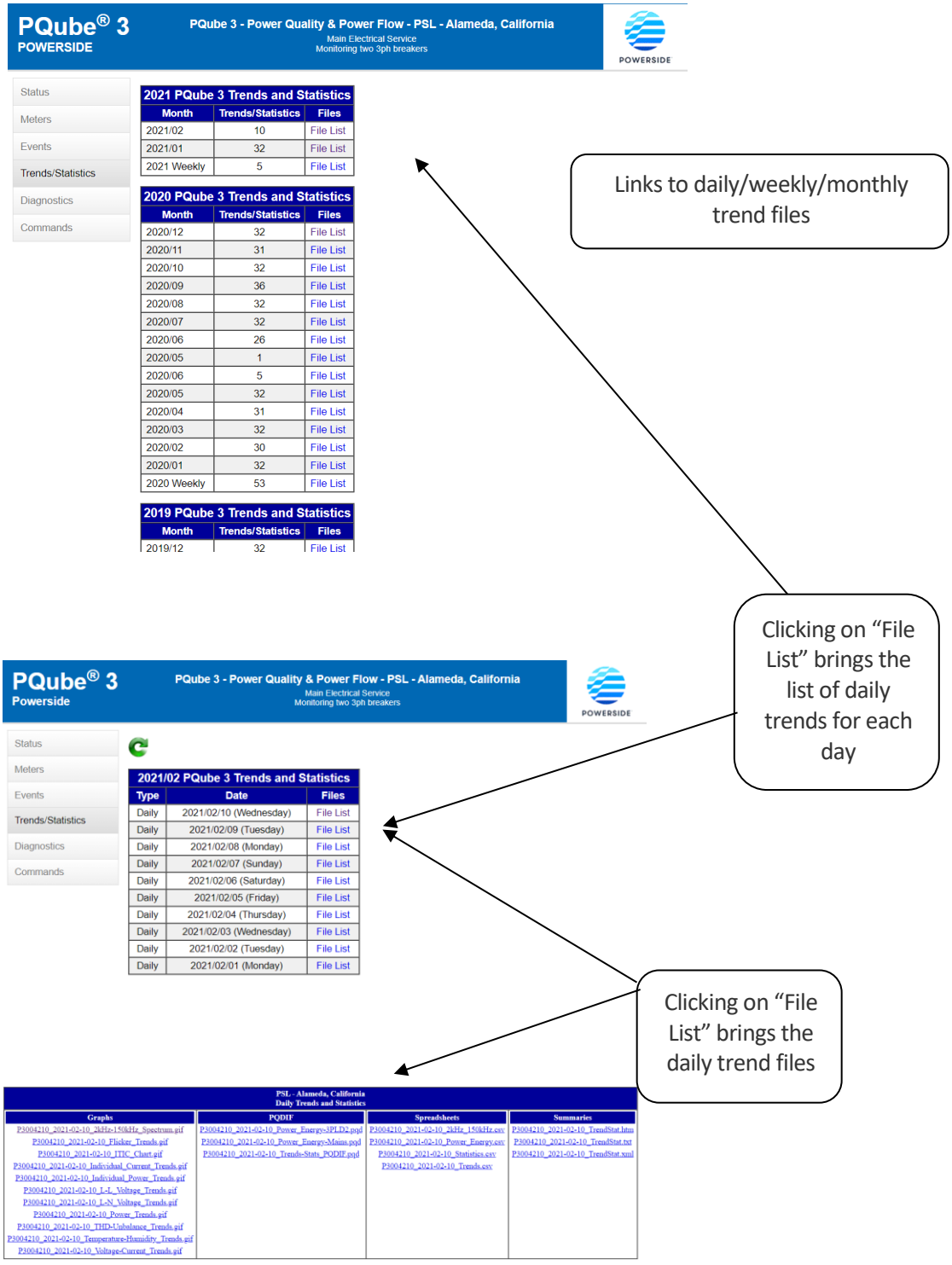


Links to the data files and waveform and RMS graphs for each event



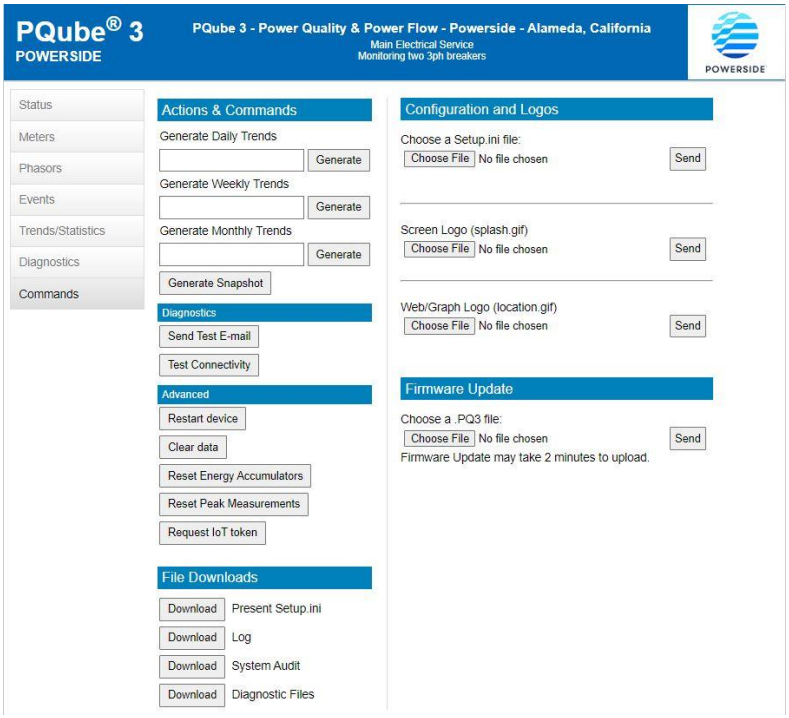
2.4.3 Trends

You can refresh the trends listing at any time by pressing the refresh button.

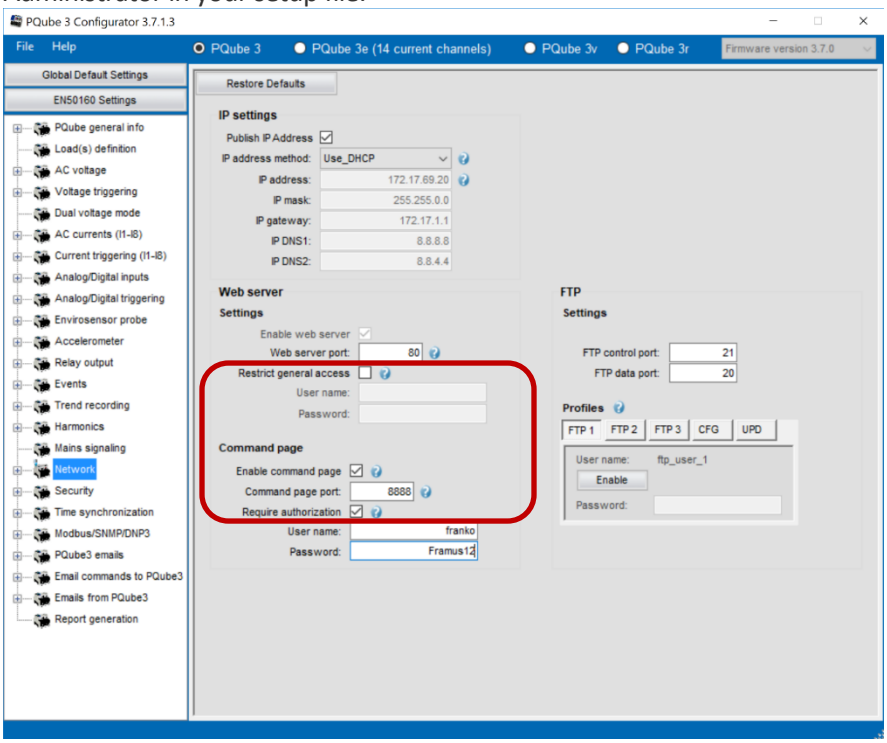


2.4.4 Commands

From the Commands page, you can trigger snapshots or daily trends, send test emails, or reset your PQube 3. You can also apply new setup files and firmware updates from here.



You can restrict access to this page by specifying a username and password for the HTTP Administrator in your setup file.



2.5 PQube 3 Email Setup

You can configure your PQube 3 to send you an email if there is any system activity, and whenever new data is available. The PQube 3 can send an email when there is a power quality event, such as a voltage sag or high frequency impulse. There is also an option to send your PQube 3 emails by configuring it with the Gmail email service provider. You can execute commands by entering the command name in the subject line. All you need to do is provide a dedicated email account for your PQube 3 and define a list of authorized email recipients.

2.5.1 Setting Up an Email Account on the PQube 3

Your PQube 3 needs its own email account. All emails from your PQube 3 will be sent from this email address.

Powerside provides an email account for your PQube 3 by default. If you want to use an email account using your own company's domain, go to the PQube 3 Email Setup section of your Setup file and enter the following information below. You will need to obtain this information from your IT or System Administrator.

Please tell your System Administrator that:

- Your PQube 3 is a standard email client.
- For outgoing mail, your PQube 3 supports plain-text authentication, SSL, Cram-MD5, or MD5-Digest login protocols.
- For the incoming mail option, your PQube 3 will need to be configured with a Gmail email. Plain-text authentication, SSL, Cram-MD5, MD5-Digest, USER-PASS, or APOP login protocols are supported.
- Ask your System Administrator to set up an email account, and get the following information from them:

  SMTP Server: _____ Port: _____ Auth method: _____

  POP Server: _____ Port: _____ Auth method: _____

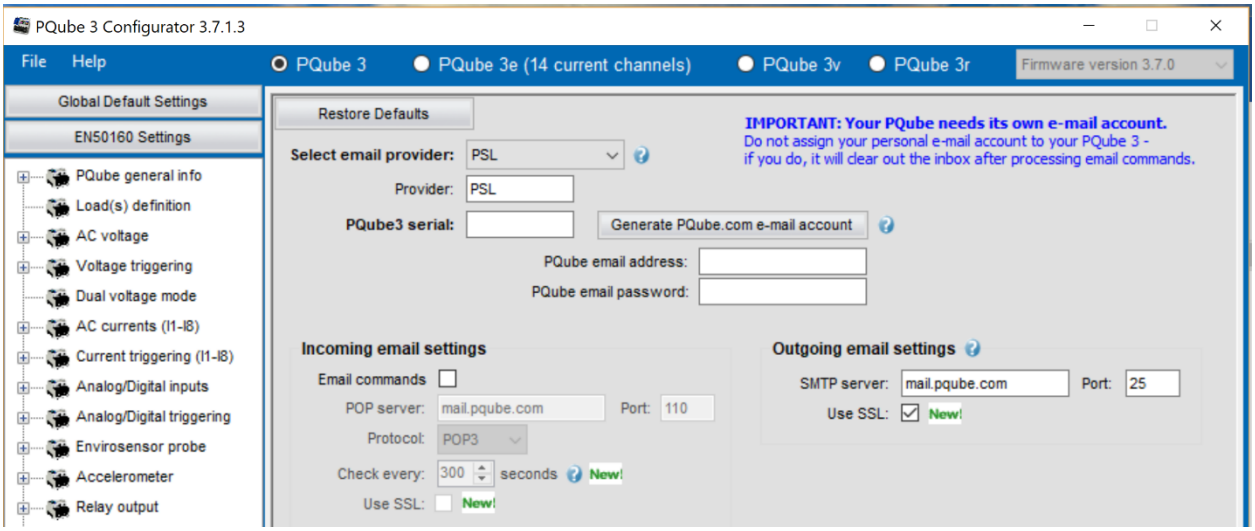
  PQube 3 email address: _____

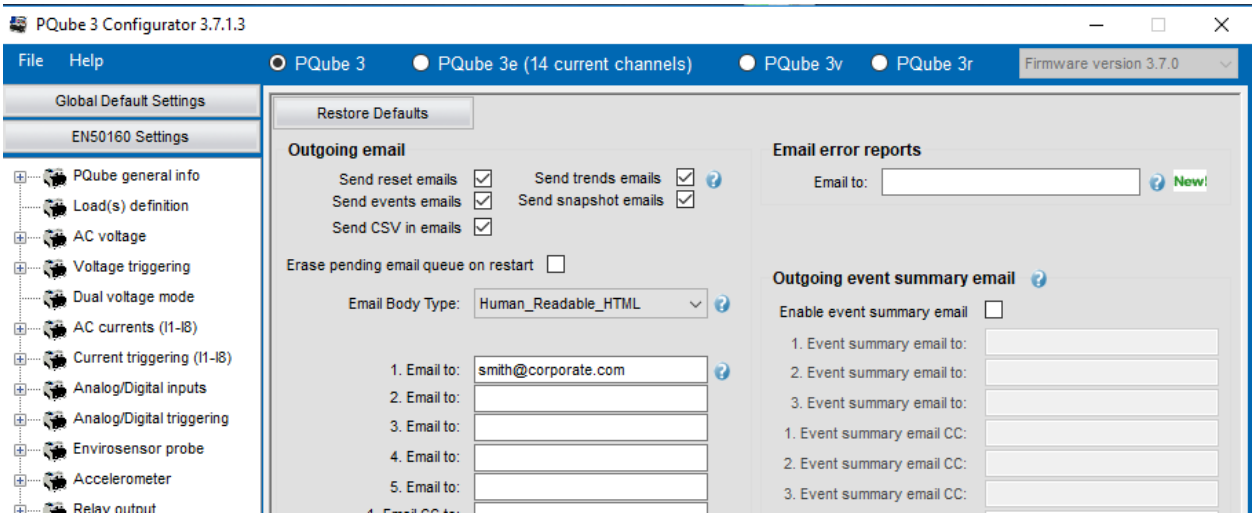
  PQube 3 email username: _____

  PQube 3 email password: _____

- Use this information to fill in your **Setup.ini** file in the PQube 3 Email Setup tab.

Use the PQube 3 Email tab to setup how often it checks for email and whether you wish to use SSL for added security.





WARNING

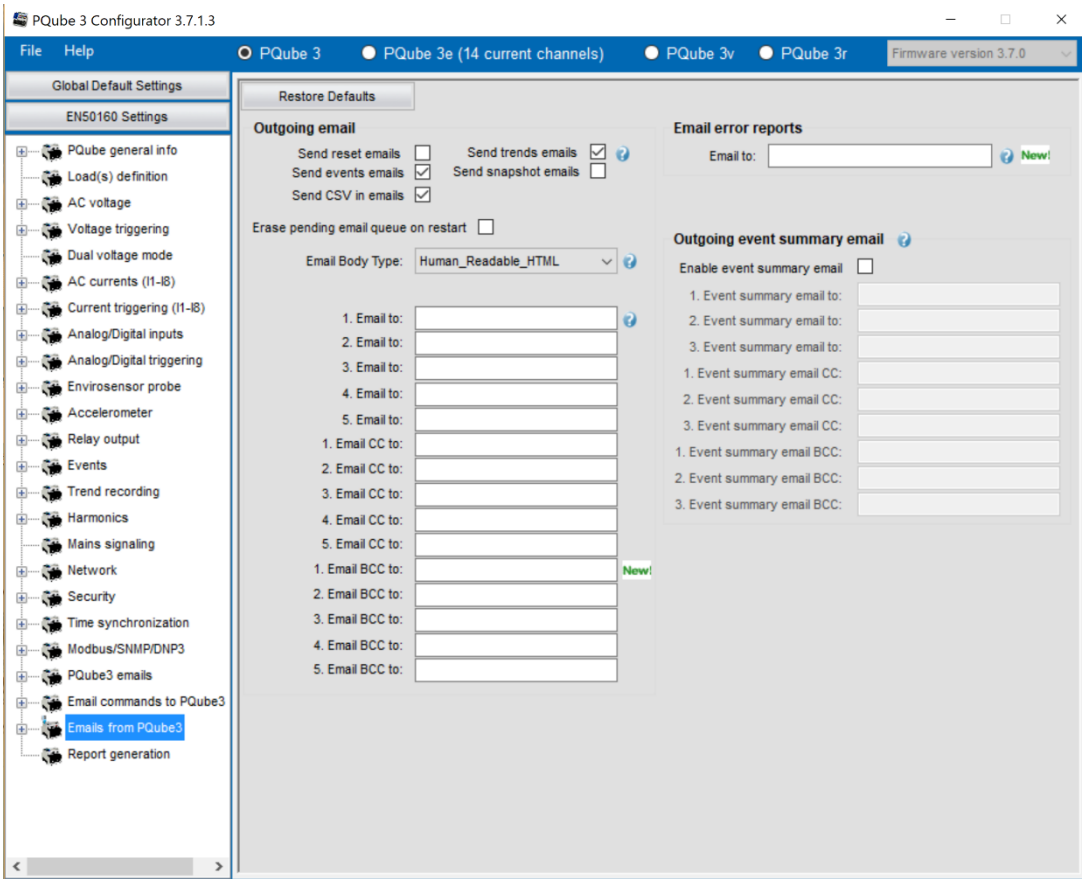
Do not assign your personal email address to your PQube 3. Your PQube 3 must have its own dedicated email address that it can use to send and receive email. Powerside is not responsible for any loss of data.

2.5.2 Getting event notifications and trend data from the PQube 3 by email

You can choose the type of data you would like to receive from your PQube 3 using the From_Email Commands including Event data, Trend data, Reset emails, and can include output files as attachments where appropriate.

You can specify who will receive these emails by selecting up to five Email_To recipients, five Email_CC_To recipients, and five Email_BCC_To recipients.

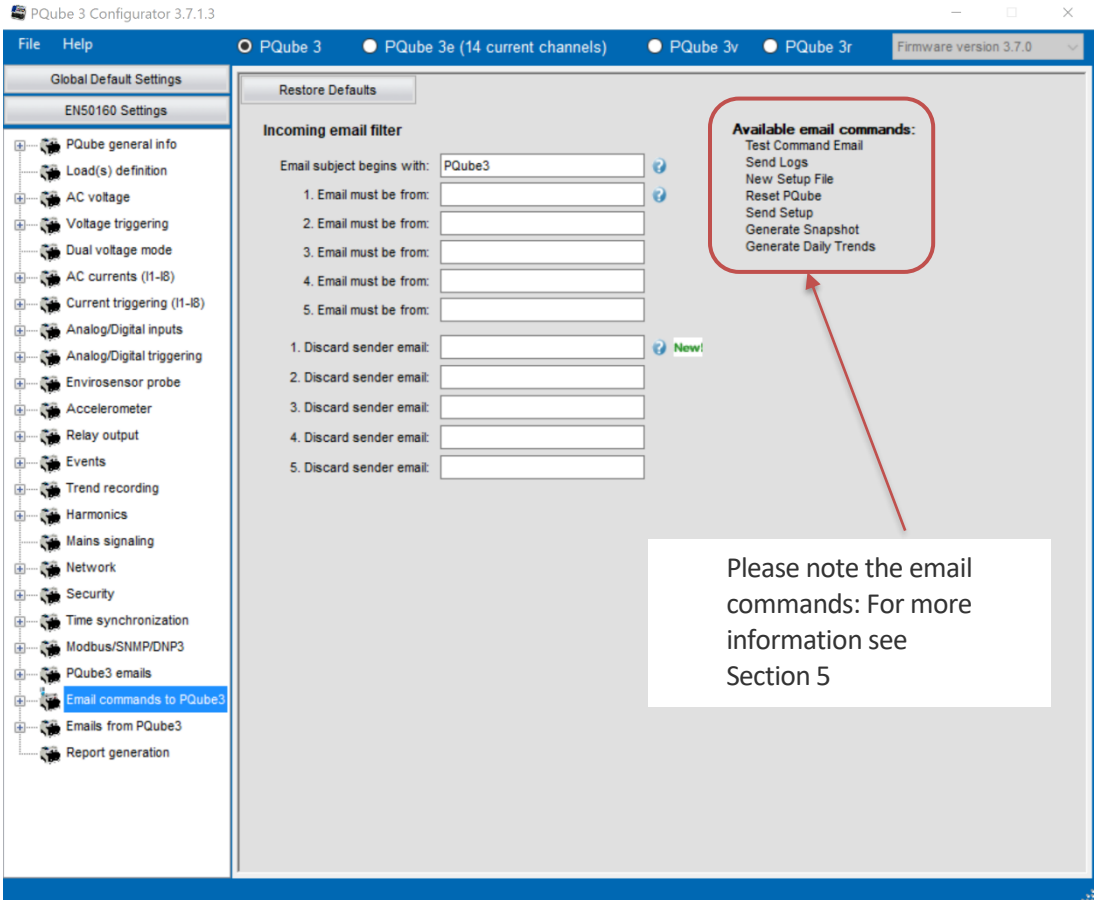
You can also set up to nine total recipients for outgoing event summary emails for quick notifications that an event has occurred, rather than detailed waveforms and graphs.



2.5.3 Sending commands to the PQube 3 using Gmail

Using Gmail email service provider, incoming emails can be enabled by checking the appropriate boxes in the Email Commands tab.

For added security you may want to specify a subject keyword and add names to the email whitelist. Only those emails on the whitelist with the first word in the subject will be successfully processed.



2.6 Modbus Setup

Your PQube 3 has a built-in Modbus-over-TCP server that you can use to read meters in real time and determine when new event or trend recordings are available.

You can set the following parameters in your PQube 3's **Setup.ini** file:

Modbus Base Address: The global base address from which all registers are offset. Default is 0x7000.

Modbus Query Port: The TCP/IP port on which the Modbus server listens. Default is Port 502.

Modbus Byte Order: Data values spanning multiple registers (such as floats) can be reported in BIG ENDIAN or LITTLE ENDIAN. Default is BIG_ENDIAN.

Modbus Slave ID: The PQube 3 can be assigned a slave ID required in queries. Default value is 0x1.

2.6.1 Scan Rates, Client Load, and Limitations

The Modbus protocol limits single query register results to 125 registers per scan. The client, PQube 3, and network speeds determine the scan rate of the register sets. **However, the PQube 3 Modbus register values only update at the internal meter update rate, which is around 2 Hz.** Therefore, if higher scan rates are supported, they will be limited to 2 Hz.

The PQube 3 supports multi-client, multi-session Modbus, with conventional limits to 10 clients at a time. This value can be changed internally in software.

2.6.2 Supported Clients

The PQube 3 supports the **Powerside Modbus Client**, third party free Modbus clients, or any software conforming to the Modbus protocol.

2.6.3 Register List (refer to Modbus Reference Manual)

Refer to the **PQube 3 Modbus Reference Manual** for the register tables.

2.6.4 Downloads

The **Powerside Modbus Client** and **PQube 3 Modbus Reference Manual** are available for download on the powerside.com website.

3 Upgrading the Firmware on your PQube 3

The process to perform firmware updates is similar to the application of new setup files.

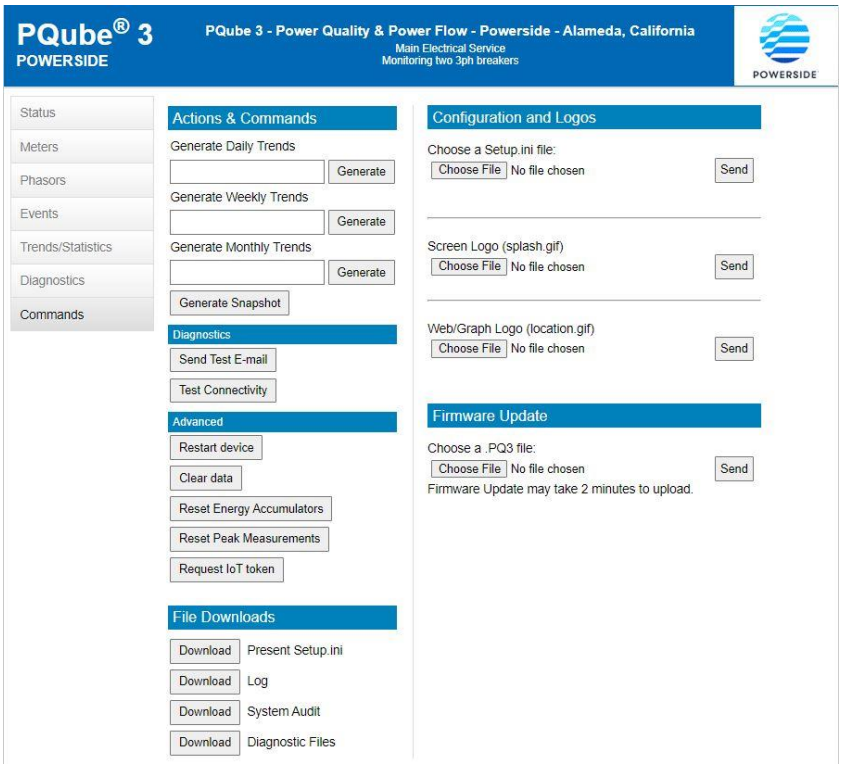
3.1 Apply Firmware Updates Locally

Copy the firmware (with .pq3 filename extension) onto a USB thumb drive, then insert it into your PQube 3. The update process will begin automatically, and the device will restart after several minutes. Powerside provides the firmware updates as compressed files. Make sure you unzip the file when you copy it to your flash drive.

After successful update and reboot, your PQube 3 automatically appends the firmware filename with YYYYMMDDHHMMSS so it does not repeatedly initiate the firmware update process. Look at the filename to verify that your PQube 3 successfully processed the firmware update.

3.2 Apply Firmware Updates Over the Web

You can also update the firmware through the Web page <Commands> by selecting the file with the [Choose File] button, and then pressing [Send]. Although the browser states that the file is sent, it may take up to 15 minutes for the PQube 3 to update its firmware and reboot, depending on the firmware file size and network connection speeds.



Web page for sending a configuration or updating the firmware.

3.3 Apply Firmware Update over Network

Log into your PQube 3's FTP server with the username **ftp_updater**. Upload the firmware (*. PQ3) into the folder and your PQube 3 will automatically reboot and apply the update.

For instructions on how to access your PQube 3's FTP server, refer to Section 2.

4 Maintenance

4.1 Turning Off Your PQube 3

Your PQube 3 is designed to be a permanently installed monitor. It does not have an on/off switch because it is designed to run continuously. If you need to turn off your PQube 3, remove your PQube 3's instrument power (either the power screw terminal block on your PQube 3, the optional PM1 Power Supply Module, or PoE).

If you have a UPS module installed, your PQube 3 will continue to run for the allotted amount of time. To immediately power down the device while on backup power from the UPS module, go to the Actions screen and press Reboot. With no permanent power source available, your PQube 3 will simply turn off.

4.2 Replacing Your PQube 3's Clock Battery

Your PQube 3 uses a user-replaceable, non-rechargeable lithium-manganese coin cell battery to back up the system clock in the event of the instrument's power loss. Powerside recommends replacing this battery every 10 years. When you order a replacement battery, always remember to power off the device first, disconnect mains connections, and verify disconnections.

To remove and replace the battery, insert a small flat-head screwdriver to pry up the label near the USB port and microSD card slot. Remove the old battery and install the new one. It is not possible to install the battery with the wrong polarity.

Follow all applicable federal, state, and local regulations when disposing of the used battery.

Disconnect power to the device before replacing the battery.

Replace battery with a Powerside-supplied battery only. Use of another battery may present a risk of fire or explosion. This part must be supplied only by Powerside or Powerside agents.

4.3 Life Expectancy of the PQube 3 and the PM1/PM2 module

The estimated life expectancy of a PQube 3 and its PM1/PM2 module is 10 years (estimation based on operating temperature at 23º C).

4.4 UPS Life Expectancy and Long-Term Storage Instructions

As the UPS1 lithium-ion battery inside the module ages, its capacity will decline. Depending on operating conditions and requirements, it is recommended to replace your UPS1 Module every 4 years or 500 cycles, whichever comes first. The UPS1 operating temperature range is 0 to 45 °C.

If you need to store your PQube 3 and modules on the shelf for 3 months or longer, remember to fully charge the batteries in your UPS1 module before placing them in storage. To fully charge the

batteries, turn on your PQube 3 with the UPS1 module plugged in, and let it run for at least 1 day. POWERSIDE recommends charging your UPS1 modules every 6 months while they are in storage. The UPS1 storage temperature range is -20°C to 35 °C.

The UPS2 and UPS3 allow for the addition of external lead-acid batteries that provide up to 1 hour of battery life. Depending on operating conditions and requirements, it may be necessary to replace your UPS2 or UPS3 battery every 10 years or 300 cycles, whichever comes first.

4.5 Cleaning Instructions

If necessary, wipe the accessible parts of your PQube 3 with a slightly damp cloth while it is powered off. Do not use abrasives or chemical cleaners and do not clean your PQube 3 while it is powered on.

4.6 Reasons for Reset

If your PQube 3 is configured to email you whenever system activity occurs, it will notify you whenever it has reset.

Reset reasons	Description
System Timeout reached	One of the processes of the PQube 3 is stuck or taking too much time to complete compared to expected time.
Setup File Sent	A new **Setup.ini** file has been sent.
Update Required Restart	A firmware update was sent and PQube 3 restarted.
User Triggered Display Reboot	The touchscreen <Action> <reboot> has been used.
Web Command Reboot	A reset has been requested from the web command page.
Battery Timeout Reached. Battery Percentage: XX%	The PQube 3 has shut down after reaching the configured autonomy of battery (see PQube 3 configuration).
Unspecified Reason	No reason identified (default).

4.7 Calibration Information for Your PQube 3

Every PQube 3 is calibrated and traced to NIST at the factory. You can download a free NIST trace certificate that contains the specific calibration information for your PQube 3 by entering your PQube 3's serial number at https://www.powerside.com/certificates.

5 Reference

5.1 List of Recorded Parameters

5.1.1 List of recorded voltage parameters

VOLTAGE		V_RMS (across 3-Phase)	V_RMS (both L-N and L-L)	V_RMS (N-E)	Frequency	Flicker Pinst	Flicker Pst	Flicker Plt	V_NegSeq_Unbalance	V_ZeroSeq_Unbalance	V_THD	V_Harm1	V_Harm2	V_Harm 50	V_InterHarm1	V_InterHarm2	..	V_InterHarrm49
10 sec	avg				x													
1 min	avg	x	x	x	x	x	x	x	x	x	x							
	min	x	x	x	x				x	x	x							
	max	x	x	x	x				x	x	x							
10 min	avg	x			x	x	x	x	x	x		x	x	x			..	x
	min	x																
	max	x										x	x	x	x	x	..	x
2 hour	avg	x			x	x	x	x	x	x	x	x	x	x	x	x	..	x
	max							x				x	x	x				

5.1.2 List of recorded conducted emission parameters

Supraharmonics														
VOLTAGE 2 kHz to 9 kHz emissions	2000 Hz	2200 Hz	2400 Hz	..	8800 Hz	9000 Hz		VOLTAGE 8 kHz to 150 kHz emissions	8 kHz	10 kHz	12 kHz	..	148 kHz	150 kHz
1 min avg	x	x	x	..	x	x		1 min avg	x	x	x	..	x	x
1 min max	x	x	x		x	x		1 min max	x	x	x		x	x

5.1.3 List of recorded current parameters

CURRENT		I_RMS	I_Neutral	I_GND	I_channel 6	I_channel 7	I_channel 8	I_channel 9 (PQube 3e)	I_channel 14 (PQube 3e)	I_NegSeq_Unbalance	I_ZeroSeq_Unbalance	THDi or TDD	I_Harm1	I_Harm2	I_Harm 50	I_InterHarm1	I_InterHarm2	I_InterHarrm49
10 sec	avg																	
1 min	avg	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	min	x	x	x	x	x	x	x	x	x	x	x						
	max	x	x	x	x	x	x	x	x	x	x	x						
10 min	avg	x								x	x	x	x	x	x	x	x	x
	min																	
	max																	
2 hour	avg	x								x	x	x	x	x	x	x	x	x
	max																	

5.1.4 List of recorded environmental parameters

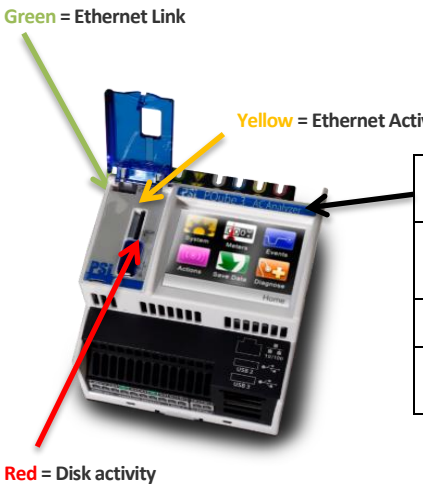
ENVIRONMENT (up to 2 probes)		Temperature	Humidity	Barometric pressure	Acceleration (X-axis)	Acceleration (Y- axis)	Acceleration (Z-axis)	Acceleration (vector)
1 min avg		x	x	x	x	x	x	x
1 min		x	x	x	x	x	x	x
1 min max		x	x	x	x	x	x	x

5.1.5 List of recorded analog channel parameters

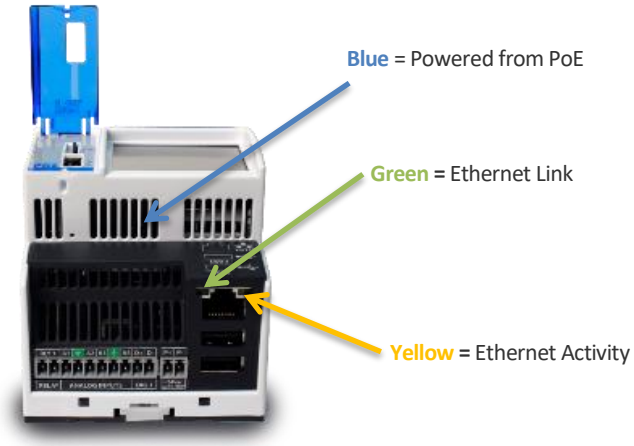
ANALOG CHANNELS	AN1_E magnitude	AN2_E magnitude	AN3_E magnitude	AN4_E magnitude	AN1-AN2 magnitude	AN3-AN4 magnitude	AN1XAN2 magnitude	AN3XAN4 magnitude	AN1XAN2 Energy	AN3XAN4 Energy
1 min avg	x	x	x	x	x	x	x	x	x	x
1 min	x	x	x	x	x	x	x	x		
1 min max	x	x	x	x	x	x	x	x		

5.2 PQube 3 Operating Modes

5.2.1 PQube 3 LED Blinking Modes



Purple = Seeking phase lock (still waiting to record data)
Green = Locked onto power configuration (recording has started)
Light Blue = Firmware update in progress
Orange = Seeking voltage to lock onto and measure



5.2.2 GPS-R — LED Indications

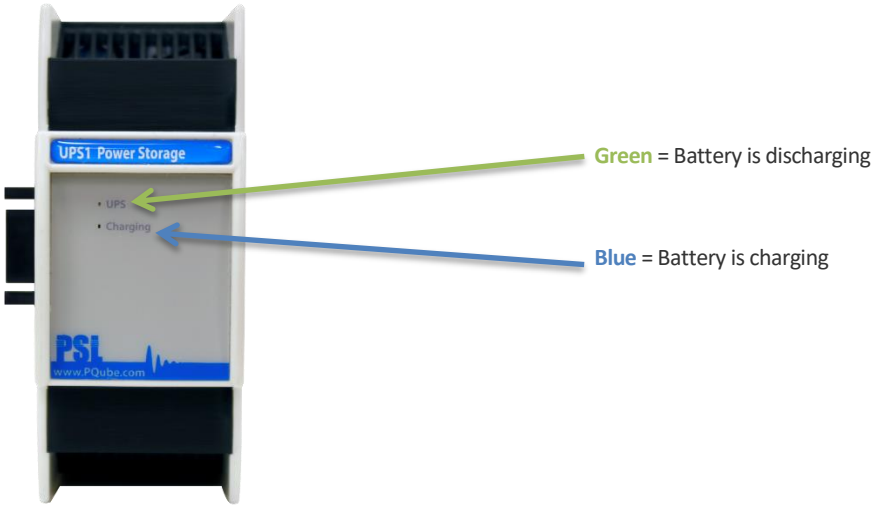
Green = PPS pulse (blinks at 1Hz)

5.2.3 PM1/PM2 — LED Indications

Green = AC input power detected

Blue = 24V auxiliary outputs are ON (PM2 only)

5.2.4 UPS1/2/3 — LED Indications



5.2.5 ENV2 — LED Indications

Green blinking at 1 Hz = Normal operation
Green blinking at 2 Hz = Acceleration event in progress
Red blinking = Powered, but not communicating with PQube 3
Red solid = Transmitting event data to PQube 3

5.3 List of Email Commands Using Gmail

Command (case sensitive)	Description
Test Command Email	This forces the PQube 3 to send a sample email.
New Setup File	Your new setup file name must start with "Setup" and have the ".ini" filename extension (e.g. **Setup.ini** or **Setupxxx.ini)**, and must be attached to the email. Your PQube 3 will send you two reply emails: One when it receives the new setup file, and another when the new setup file has been successfully installed.
Reset PQube	Resets PQube 3 upon receipt of email. This is useful when loading a new setup file or firmware via FTP.
Send Logs	You can ask your PQube 3 to send you its log files via email. The log files can help diagnose PQube setup problems, and they show the complete history of your PQube. For faster technical support, please include these files when contacting our technical support department.
Send Setup	Retrieve the existing setup file from your PQube 3.
Generate Snapshot	Takes a waveform recording of your power.
Generate Daily Trends	Generates the Daily Trends for today. The data ranges from midnight to the moment the email request is received.

Note: You can test emails using the PQube 3 screen. You can also send an email remotely from the PQube 3 Command Page by pressing the email test command.

5.4 List of Email Error Codes

Fail Codes	Description
1 No SMTP server address specified	There is no SMTP server address specified in the **Setup.ini**
2 No SMTP server port specified	There is no SMTP server port specified in the **Setup.ini**
3 Could not ping SMTP server	No ping response from SMTP server. Possible Reasons: • Network not available (no Ethernet connection or network down) • Router, DNS, or network configuration error • SMTP server address error (typo)
4 No To recipients specified	No To: Recipients are specified in the **Setup.ini**
5 SMTP Port connection refused	Could not connect to SMTP port specified Possible Reason: • Wrong SMTP port configured
6 Postfix front end error	Postfix didn't like the front-end request

Note: If PQube 3 is having trouble reaching the SMTP server, double-check that your PQube 3 was assigned an IP address as well as try pinging the SMTP server from the same LAN that your PQube 3 is connected to. If this works properly, check in with your network administrator to make sure there are no firewall rules blocking SMTP connections.

5.5 List of Error Messages

These codes (found in PQube log file) can be used to troubleshoot errors in setup when contacting technical support.

Error Codes	Error Message
64	command line usage error
65	data format error
66	cannot open input
67	addressee unknown
68	host name unknown
69	service unavailable
70	internal software error
71	system error
72	critical OS file missing
73	can't create (user) output
74	input/output error
75	temp failure; user is invited to retry
76	remote error in protocol
77	permission denied
78	configuration error

5.6 MS1 Module to GPS1 Receiver 8-pin Cable Pinouts:

MS1 Pin-Out with pin 1 on left while looking at module from the front				GPS1 Receiver Pin-Out based on standard RJ-45 Ethernet pin-out			
Pin#	**Net Name**	**Function**	**Wire Color***	**Pin #**	**Net Name**	**Function**	**Wire Color***
1	ANT_PPS -	Pulse per Second -	Orange/White	**1**	ANT_PPS -	Pulse per Second -	Orange/White
2	ANT_PPS+	Pulse per Second +	Orange	**2**	ANT_PPS+	Pulse per Second +	Orange
3	ANT_RX -	Received Data -	Green/White	**3**	ANT_RX -	Received Data -	Green/White
4	ANT_TX+	Transmitted Data +	Blue	**4**	ANT_TX+	Transmitted Data +	Blue
5	ANT_TX -	Transmitted Data -	Blue/White	**5**	ANT_TX -	Transmitted Data -	Blue/White
6	ANT_RX+	Received Data +	Green	**6**	ANT_RX+	Received Data +	Green
7	ANT_COM	Power Supply Return	Brown/White	**7**	ANT_COM	Power Supply Return	Brown/White
8	ANT_25V	Positive Power Supply	Brown	**8**	ANT_25V	Positive Power Supply	Brown

*Wire color is based on standard Ethernet cable used to interface between MS1 Module and GPS1 Receiver.

5.7 PQube3 Event Types

Your PQube 3 comes with an embedded library of event triggers. A trigger event is a condition that can be detected by the PQube 3. When triggering on an event, the PQube 3 will record and store an event summary. For certain types of events, the PQube 3 also records a waveform and an RMS evolution.

The PQube 3 can trigger on voltage amplitude deviations, such as sag (dips), swells, interruptions, wave shape changes, on frequency deviations, but it can also trigger on current amplitude exceeded (load current), or inrush currents.

The PQube 3 can also trigger on any of its 4-analog input channels or its digital input channel. If equipped with one or more ENV2 EnviroSensors, the PQube 3 can trigger on temperature humidity and even on external events such as mechanical shocks or seismic type of disturbances.

The chapter below describes the various types of events and what information is recorded:

EVENT TYPE	**Recordings**		
Voltage events	Event summary	Waveform	RMS
Voltage_Sags	X	X	X
Voltage_Swells	X	X	X
Voltage_Interruptions	X	X	X
Major_Sags (see annex 7 below)	X	X	X
Over-Frequency	X	X	X
Under-Frequency	X	X	X
RVC (Rapid Voltage Changes)	X	X*	X*
Wave Shape Changes	X	X	X
High Frequency Impulse	X	X*	X*
Current events			
Phase Over Current Trigger	X	X	X
Phase Under Current Trigger(**)	X	X	X
Analog channels Events			
ANx-E Sags	X	X	X
ANx-E Swells	X	X	X
EnviroSensor (ENV) events			
Probe A/B Low Temperature	X		
Probe A/B High Temperature	X		
Probe A/B Low Humidity	X		
Probe A/B High Humidity	X		
Probe A/B Mechanical Shock	X	X	
Probe A/B Seismic Disturbance	X	X	

Note: (*) with firmware 3.5.0 or above (**) acceleration signature
(**) with firmware 3.9.8 or above (**) acceleration signature

5.7.1 Triggering mechanism - general overview

Detection - state machine:

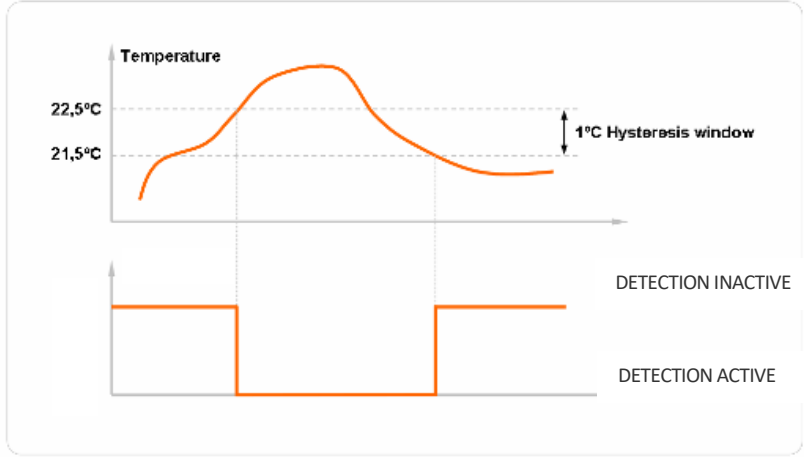
For most of the PQube 3 trigger events, the detection algorithm works with a state machine with one (upper) or two (lower and upper) threshold value(s), along with a hysteresis value.

For voltage amplitude, current amplitude and analog input amplitude events, the detection algorithm is based on comparison of "half-cycle" RMS amplitudes against the thresholds, referenced as $U_{rms\,(1/2)}$. The $U_{rms\,(1/2)}$ values are computed as an RMS value over a window of 1 cycle commencing at the voltage signal zero crossing. The window slides by half a cycle for the next evaluation. Complete definition of $U_{rms\,(1/2)}$ is described in IEC 61000-4-30 Ed3.

Events such as RVC (rapid voltage changes) and HF impulse have a more complex triggering condition (RVC triggering method is described in IEC 61000-4-30 Ed3).

Hysteresis:

The detection (start of the event) occurs as soon as the parameter value crosses the threshold value (low or high). The end of the event occurs when the threshold and the hysteresis is crossed. The goal of a hysteresis is to avoid multiple (or bursts of) events when the parameter fluctuates around the threshold value.



The example here shows the use of hysteresis on a high temperature detection with a threshold of 22.5º C and a hysteresis of 1º C.

Duration:

The duration of an event is the time difference between its start time and end time.

Events with no duration:

The following events, are not characterized with an end portion, and therefore have no duration characteristic:

- Current events (phase current, neutral current, earth current)
- HF impulse events (they are characterized with more advanced parameters)
- Mechanical shocks and seismic disturbances
- Temperature/humidity events

3-phase voltage sags, swells, and interruptions events:

A full description of the algorithm is found in chapter 5.4.2 and 5.4.3 of the IEC 61000-4-30 Ed3.

A 3-phase sag starts as soon as one of the phase $U_{rms\,(1/2)}$ values amplitude crosses the sag (lower) threshold and ends when all 3 phase-voltage amplitudes are back within the threshold plus the hysteresis.

A 3-phase swell starts as soon as one of the phase $U_{rms\,(1/2)}$ values crosses the swell (upper) threshold and ends when all 3 phase $U_{rms\,(1/2)}$ are back within the threshold minus the hysteresis.

A 3-phase interruption starts when all 3 phase $U_{rms\,(1/2)}$ values cross the swell (upper) threshold and ends when at least one of the phase-voltage "half cycle" amplitudes are back within the threshold plus the hysteresis.

Frequency Events:

Frequency events are based on frequency measurements done based on counting of zero crossings on a given period. The frequency triggering method uses a frequency refreshed every cycle, and the value is computed on the window of 64 cycles.

> Note: The PQube 3 also computes frequency aggregated at a 10s interval as per IEC 61000-4-30 Ed3. This frequency aggregation, however, is not used for triggering, but is recorded in a specific 10s frequency file.

Inrush Current Events:

Inrush triggers have thresholds for magnitude and time. If the current increases by the Inrush Threshold value or more, within the specified time period or less, the PQube 3 will trigger an inrush current event.

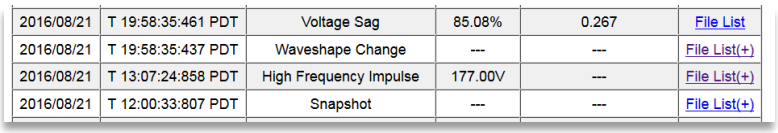
Wave Shape Change Events:

Your PQube 3 triggers a wave shape change when the voltage waveform changes abruptly. It uses the "floating window" algorithm to compare each cycle to the previous cycle. It is especially useful for detecting Power Factor Correction capacitor switching.
If the voltage changes from one cycle to the next exceeds the selected threshold and duration, your PQube 3 will trigger a Waveshape change.

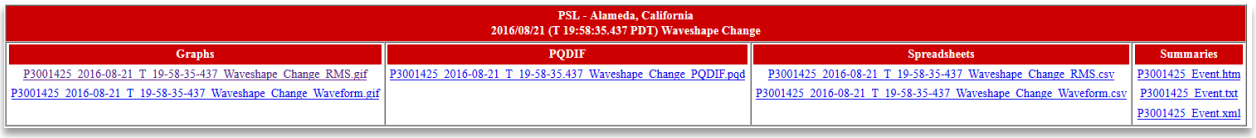
5.7.2 Event Parameters

The section below presents a list of recommended/default thresholds for events:

The event [name] is the name that can be seen in the web event list page and is part of the event filenames or email subjects (emails sent by the PQube 3).

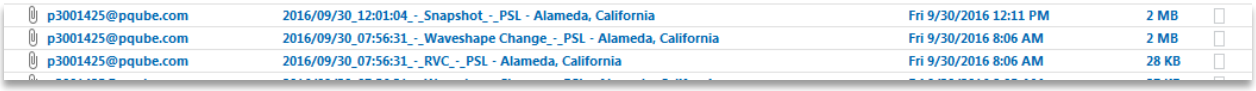


2016/08/21	T 19:58:35:461 PDT	Voltage Sag	85.08%	0.267	File List
2016/08/21	T 19:58:35:437 PDT	Waveshape Change	---	---	File List(+)
2016/08/21	T 13:07:24:858 PDT	High Frequency Impulse	177.00V	---	File List(+)
2016/08/21	T 12:00:33:807 PDT	Snapshot	---	---	File List(+)



PSL - Alameda, California
2016/08/21 (T 19:58:35.437 PDT) Waveshape Change

Graphs	PQDIF	Spreadsheets	Summaries
P3001425_2016-08-21_T_19-58-35-437_Waveshape_Change_RMS.gif	P3001425_2016-08-21_T_19-58-35.437_Waveshape_Change_PQDIF.pqd	P3001425_2016-08-21_T_19-58-35-437_Waveshape_Change_RMS.csv	P3001425_Event.htm
P3001425_2016-08-21_T_19-58-35-437_Waveshape_Change_Waveform.gif		P3001425_2016-08-21_T_19-58-35-437_Waveshape_Change_Waveform.csv	P3001425_Event.txt
			P3001425_Event.xml



p3001425@pqube.com	2016/09/30_12:01:04_-_Snapshot_-_PSL - Alameda, California	Fri 9/30/2016 12:11 PM	2 MB
p3001425@pqube.com	2016/09/30_07:56:31_-_Waveshape Change_-_PSL - Alameda, California	Fri 9/30/2016 8:06 AM	2 MB
p3001425@pqube.com	2016/09/30_07:56:31_-_RVC_-_PSL - Alameda, California	Fri 9/30/2016 8:06 AM	28 KB

Event Type/Name	Description	Threshold Default	Min/Max Threshold
Voltage events			
Voltage_Sags	Voltage Sags as per IEC 61000-4-30, on Ph-N channels and Ph-Ph channels	90.0% Un (remaining voltage)	99.0 to X% Un X=interruption threshold
Voltage_Swells	Voltage Swells as per IEC 61000-4-30, on Ph-N channels and Ph-Ph channels	110.0% Un	101.0 to 200% Un
Voltage_Interruptions	Voltage Interruptions as per IEC 61000-4-30, on Ph-N channels and Ph-Ph channels	10% Un (remaining voltage)	1 to 10% Un
Major_Sags (see annex below)	Voltage sag with minimum depth and minimum duration criteria (3 Phase, Ph-Ph)	See Annex	See Annex
Over-Frequency	Frequency above the upper threshold	100.5% (Nominal Frequency)	100.001% to 200.000%
Under-Frequency	Frequency below the lower threshold	99.5% (Nominal Frequency)	1.000% to 99.990%
RVC	Rapid voltage changes as per IEC 61000-4-30 Ed3 on Ph-N channels and Ph-Ph channels	6%Un	0.01% to 99.99%
Wave Shape Change	Wave shape change compared to the previous portion of the wave shape (see definition above)	20% 10 cycles	5% to 50% 0.5 to 30 cycles
High Frequency Impulse	Sub millisecond fast transients down to 250ns duration events.	2000 Vac	300 Vac to 6000 Vac

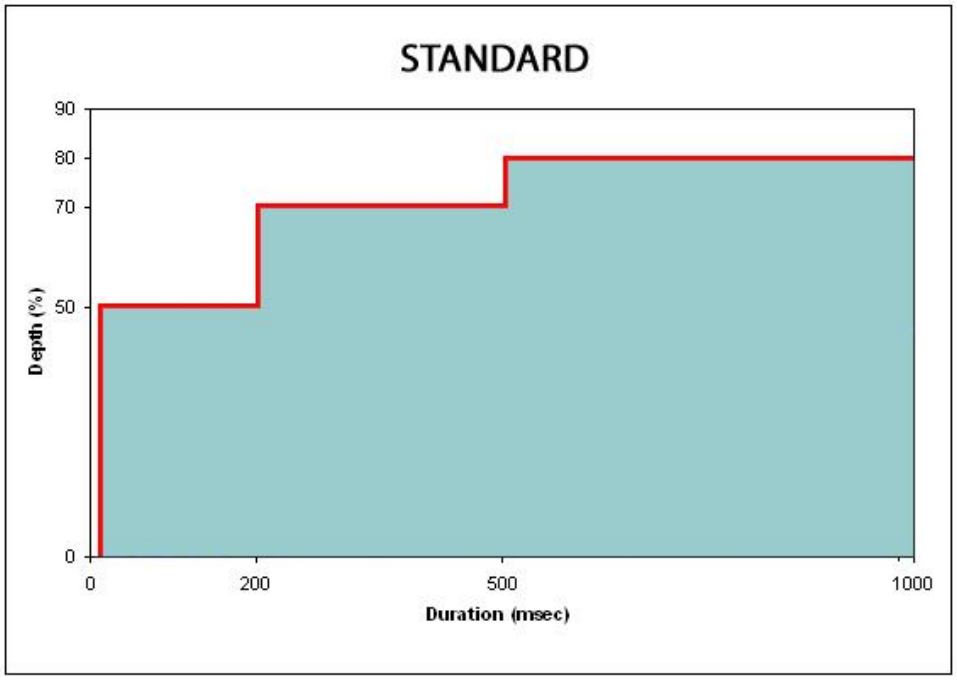
Event Type/Name	Description	Threshold Default	Min/Max Threshold
Current events			
Phase Over Current Trigger I1/I2/I3/.. /I8 channels(*)	RMS amplitude exceeds threshold	1 A	0.0001 A to no limit
Phase Under Current Trigger I1/I2/I3/.. /I8 channels(*)	RMS amplitude falls below threshold	0 A	0.0001 A to no limit
Phase Current Trigger I1/I2/I3/.. /I8 channels(*)	Inrush (current gradient) exceeds a gradient threshold	1 A 1 cycle	0.0001 A to no limit 1 cycle to no limit
Note: (*) 8 channels for PQube 3, 14 channels for PQube 3e			
Analog channels Events			
AN1/2/3/4 Sag	Analog Channel AN1 through AN4-E Sag (method as per IEC61000-4-30 Ed3)	2 V	No limits
AN1/2/3/4 Swell	Analog Channel AN1 through AN4-E Swell (method as per IEC61000-4-30 Ed3)	60 V	No limits
ENVIROSENSOR events			
Probe A/B Undertemperature	Temperature below the lower threshold	0º C	No limits
Probe A/B Overtemperature	Temperature above the upper threshold	50º C	No limits
Probe A/B Low Humidity	Humidity below the lower threshold	0%	No limits
Probe A/B High Humidity	Humidity above the upper threshold	90%	No limits

5.8 Major Sag (Dip) Curves

Your PQube 3 supports the following worldwide standards: STANDARD (IEC 61000-4-34), SEMI F47, Samsung Power Vaccine, ITIC, CBEMA, MIL STD 704E, and MIL STD 1399. These standards define ride-through curves based on the depth and duration of voltage dips. When the voltage dips below the ride-through curve, your PQube 3 will trigger a Major Dip event. You can specify which standard to use in your **Setup.ini** file.

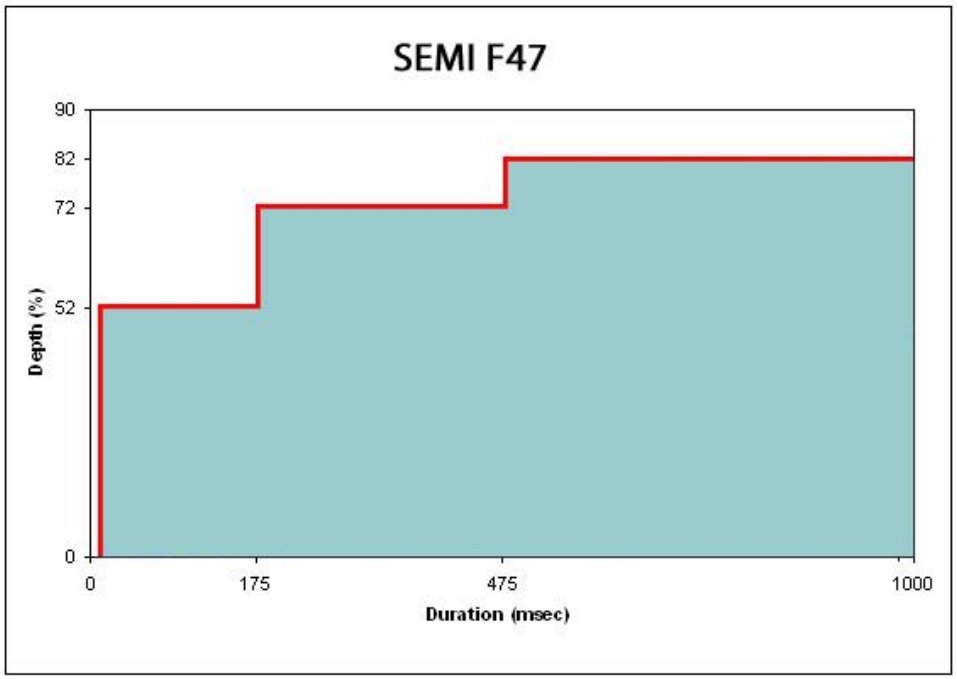
This is especially useful for electrical systems manufacturers, who must design their equipment to withstand voltage sags that do not dip below the ride-through curve.

5.8.1 STANDARD



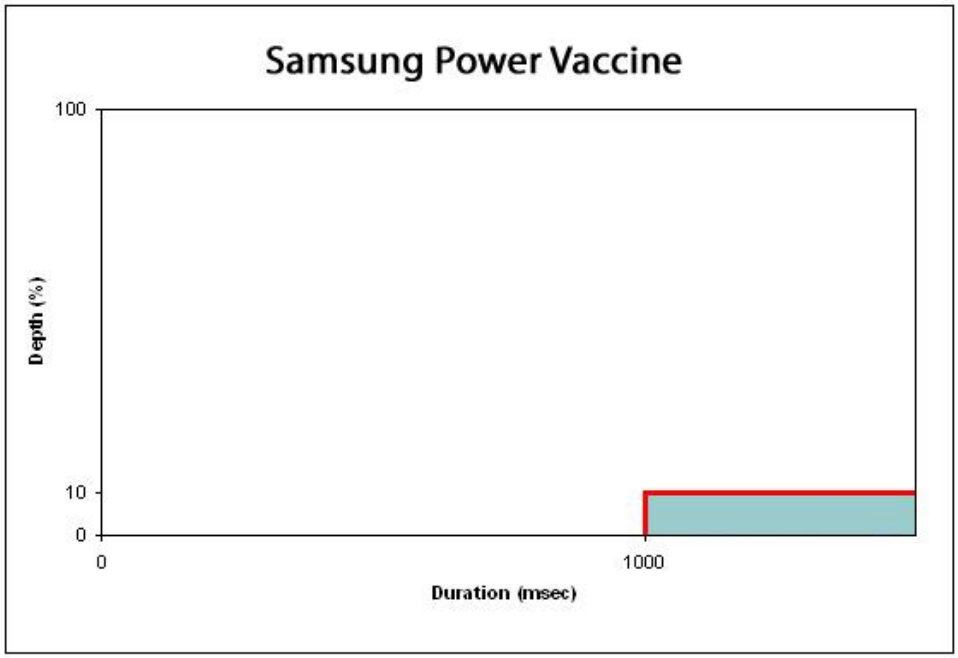
NOTE: Use this curve to detect only events that lie outside the SEMI F47 boundary.

5.8.2 SEMI F47

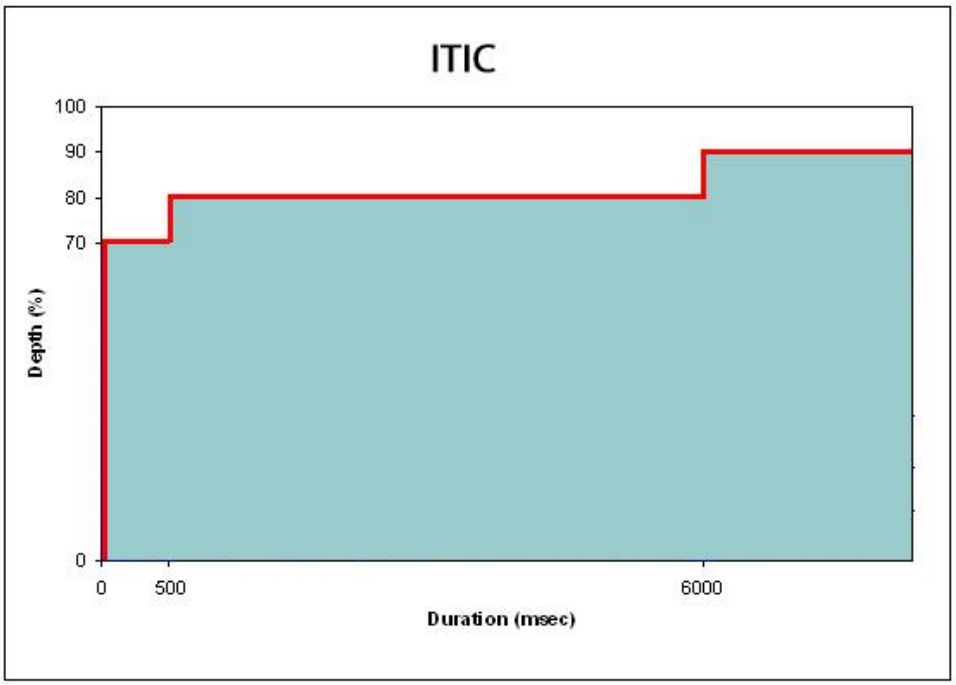


NOTE: Use this curve to guarantee that a Major Dip is detected for events that lie directly on the SEMI F47 boundary.

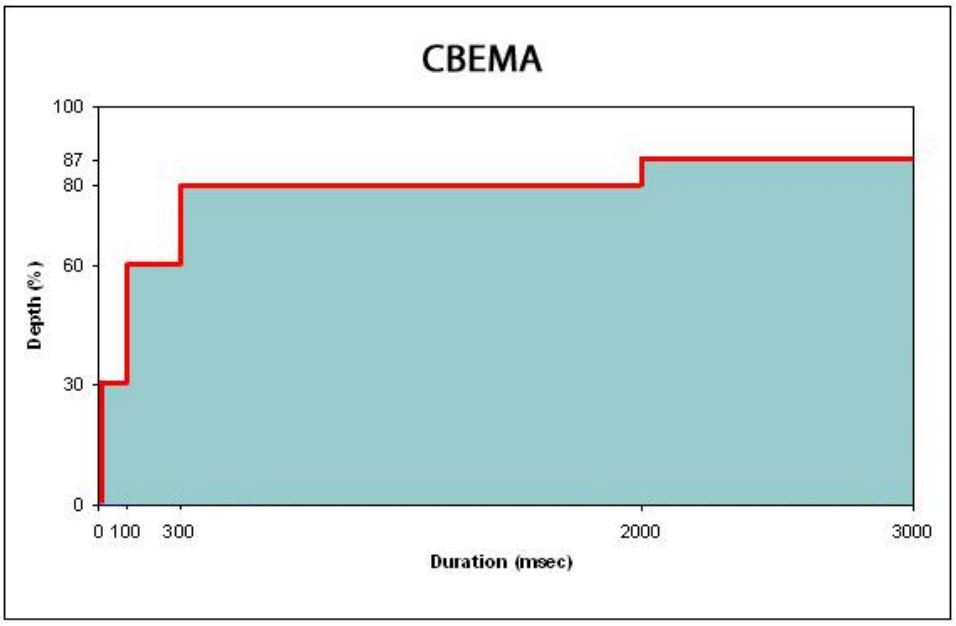
5.8.3 Samsung Power Vaccine



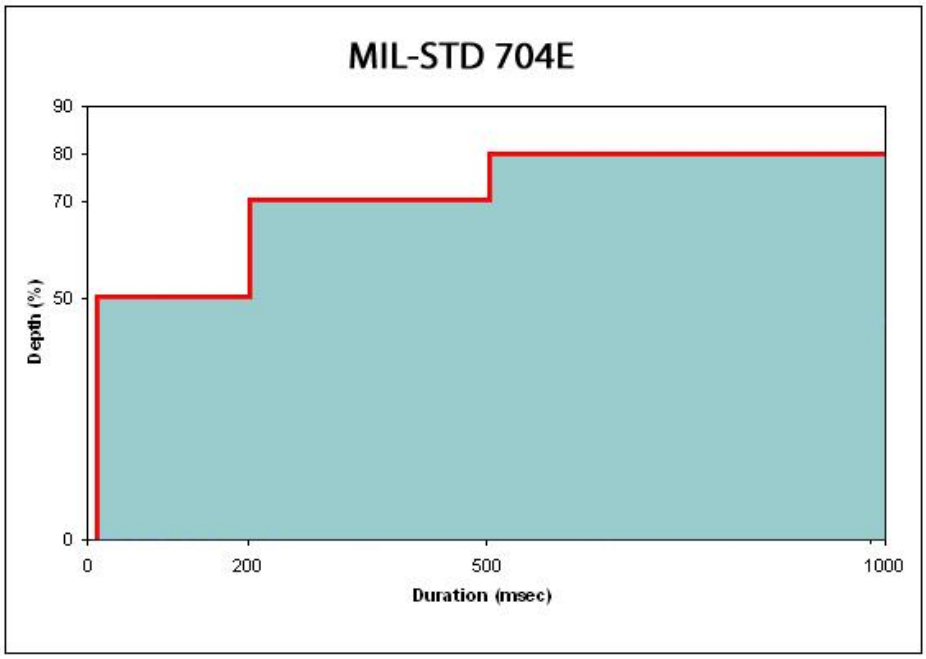
5.8.4 ITIC



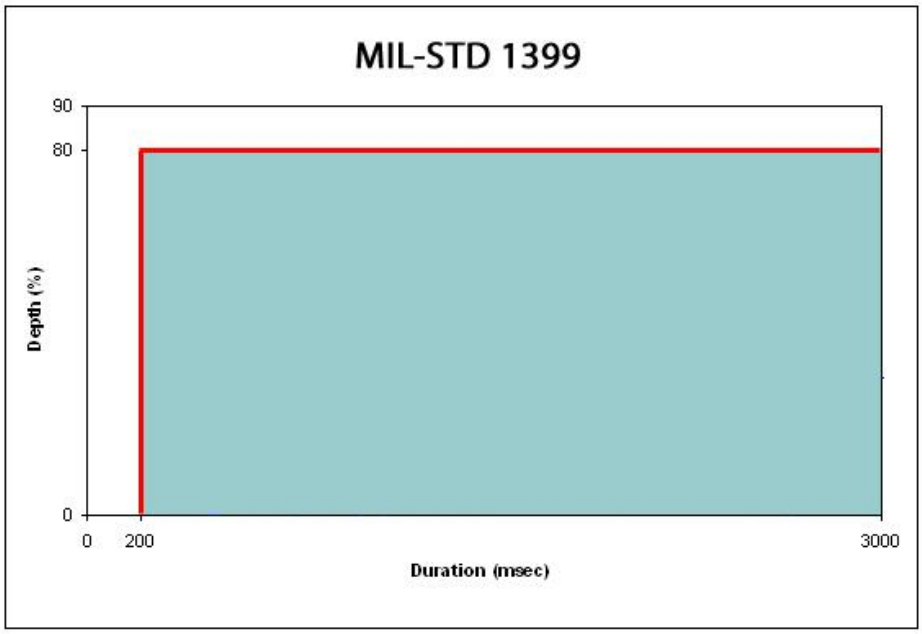
5.8.5 CBEMA



5.8.6 MIL STD 704E



5.8.7 MIL STD 1399



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