User's Guide

PQA-300™ 8 Channel Power Quality Auditor

With PQ Firmware

Radian Research, Inc.
Table of Contents

Introduction .................................................................................................................. 1
Safety ........................................................................................................................... 2
Quick Start ................................................................................................................. 3
Hookup Configurations ............................................................................................... 4
Hookup Diagnostic Warnings .................................................................................... 5
PQA-300™ Firmware Features ............................................................................... 7
   RMS and Waveform Data Storage ................................................................. 7
   Harmonics ........................................................................................................... 7
   Interharmonics ................................................................................................... 7
   Power Calculations .............................................................................................. 8
   Frequency ........................................................................................................... 8
   Event Capture ..................................................................................................... 8
      Under/Over Voltage Events (U/OV) .............................................................. 8
      High Speed Voltage Transients (SPIKE) ..................................................... 8
      Current Inrush (CI) ....................................................................................... 8
   Voltage and Current Unbalance ........................................................................ 9
PQA-300™ Back Panel .............................................................................................. 9
PQA-300™ Front Panel ............................................................................................. 10
PQA-300™ Operation ............................................................................................... 11
   Turning On and Off ......................................................................................... 11
   Memory Card ..................................................................................................... 11
   Setup ................................................................................................................. 12
      Phase CT Range ........................................................................................... 12
      CH 4 CT Range ............................................................................................ 12
      Connection .................................................................................................... 13
         1P2W - 1 Phase 2 Wire .............................................................................. 13
         1P3W - 1 Phase 3 Wire (Edison circuit) ...................................................... 13
         3P3W - 3 Phase 3 Wire (Delta circuit) ....................................................... 13
         3P4W - 3 Phase 4 Wire (Wye circuit) ......................................................... 13
         2.5E - 2½ Element ....................................................................................... 13
   Data Storage ........................................................................................................ 14
      Storage Rate ................................................................................................ 14
      Recording Mode ............................................................................................ 14
         Stop When Full ......................................................................................... 14
         Restart When Full .................................................................................... 15
      Interharmonics .............................................................................................. 15
      Voltage Spike Waveforms .......................................................................... 15
      Under/Over Voltage Waveforms ............................................................... 15
      Current Inrush Waveforms ....................................................................... 15
      RMS Capture ................................................................................................. 15
   Trigger Levels ..................................................................................................... 16
      Event Enable ................................................................................................ 16
      Phase Current Inrush ................................................................................... 16
      Channel 4 Current Inrush .......................................................................... 16
      Phase Voltage Nominal ............................................................................... 16
      Channel 4 Voltage Nominal ....................................................................... 16
      Voltage Spike ............................................................................................... 17
      Phase Voltage Over .................................................................................... 17
      Phase Voltage Under .................................................................................. 17
      Channel 4 Voltage Over ............................................................................ 17
      Channel 4 Voltage Under .......................................................................... 17
      Ext PT/CT ..................................................................................................... 17

03-15 944410.01 User's Guide for PQA-300
Radian Research, Inc.
Table of Contents

System Freq ................................................................. 17
Clock ........................................................................... 18
Bluetooth ..................................................................... 18
Calibrate ........................................................................ 18
Language ....................................................................... 18
Setup Lock ..................................................................... 18
Display .......................................................................... 19
AC/DC Voltage, Current and Frequency ......................... 19
Waveforms ..................................................................... 19
Harmonic Bar Chart ..................................................... 19
Vector Diagram ............................................................ 19
System Information ....................................................... 19
Record ........................................................................... 20
Specifications ............................................................... 21
Abbreviations ............................................................... 22
Notes ............................................................................ 22
Introduction

The PQA-300™ is a power quality auditor developed for the measurement of power quality and for power system diagnostics. From the instrument’s front panel, or for more detail use Radian’s PV II™ software, you can view:

- AC and DC Voltage, Current, Power and Frequency
- Waveforms, harmonics and vector diagrams for both voltage and current
- Three phase voltage and current unbalance
- Voltage sags and swells
- High speed voltage transients
- Current inrush
- Flicker (IEC 61000-4-15)
- Power Quality (IEC 61000-4-30)

The PQA-300™ is an 8 channel power quality auditor/data recorder. It monitors three phases of voltage and current as well as a fourth channel of voltage and current. Measured parameters are updated every ½ cycle to ensure that nothing is missed. Most measurements can be viewed on the front panel LCD in the field and recorded data can be transferred to a computer using the removable memory card or wirelessly if the Bluetooth option is installed. The instrument is powered from the V1 voltage measurement input, or if V1 is a weak source, an auxiliary power supply may be used. The PQA-300™ has an internal rechargeable battery that can power the instrument for up to 4 hours in the event of a power outage. The entire unit is enclosed in a rugged weather proof case for use in harsh environments.
Safety

Although this instrument is designed to be as safe as possible, safety is ultimately the responsibility of the operator. This instrument should only be operated as specified by the manufacturer and by authorized personnel.

Please read and UNDERSTAND the following information before operating this instrument

- The **PQA-300™** uses a membrane keypad that could be damaged if a sharp object is brought into contact with it.

- Frequently inspect the test leads and the instrument for damage. If the instrument shows any signs of physical damage or functions improperly, it should not be used.

- Never work alone. Ensure that a qualified observer is mindful of your activities.

- When performing any measurements, all connections should be made to the circuits while the power is off. To ensure personnel safety, the test leads and related connectors should not be handled while the circuit is energized.

- Do not attempt to measure any voltage higher than the maximum rating of 600V RMS. Failure to observe the maximum rating could result in damage to the equipment or personnel injury.

- Refer servicing of this instrument to qualified personnel only. Disconnect supply power before servicing. Potentially lethal voltages may be present inside the case. If any of the protective circuitry is improperly repaired, the safety of this product could be compromised.

- Do not expose the **PQA-300™** directly to outdoor elements.

- See explanation in manual to find out the nature of the potential HAZARD and any actions to be taken.

- On/Standby

- If the **PQA-300™** is used in a manner not specified by the manufacturer the provided protection of the instrument may be diminished.

- Clean with damp cloth only.

- The measurement category of a combination of the instrument and an accessory is the lower of the two measurement categories.

- CT inputs are voltage only. CTs must have an integrated burden resistor with 1VRMS output corresponding to rated current. CT connection is to pins 1 (+) and 2 (-).
Quick Start

Connecting the PQA-300™ to the circuit to be measured is a straightforward process.

1. Connect the voltage leads for each phase to be measured. For proper operation V1 must always be used. Three phase circuits can be connected in either a ‘wye’ or ‘delta’ configuration. Refer to the ‘Hookup Configurations’ section for the various methods of connecting the voltage leads.

2. Connect the clamp CTs or flex CTs. Channels 1, 2 and 3 must use the same type and rating of CT, channel 4 may use a different type and/or rating CT (Ensure that the correct CTs have been selected in the SETUP menu).

3. Turn the instrument on by pressing the On/Standby button.

4. Ensure a memory card is installed.

5. Use the ‘SETUP’ key and function keys to check and modify any of the setup parameters.

6. Press the ‘Record’ key and then F1 to start recording synchronized to the real time clock or, if the recording interval is 0.2 seconds, F2 to start recording immediately.

7. The measured values can be viewed from the instrument using the 'DISPLAY' key and function keys.

8. To stop recording press the ‘RECORD’ key and then F2 followed by F1 to confirm the stop command.

Note: Static discharges may occur when connecting leads or the memory card, depending on environmental conditions. This is not hazardous and will not damage the instrument. However it may affect the integrity of the data if the instrument is recording. Connection and disconnection of leads etc. should be done while the instrument is not recording. Before handling an instrument that is recording the operator should discharge any potential static by touching a grounded object.

9. Data is transferred to a computer using the memory card or wirelessly if the Bluetooth option is installed. When recording has been stopped the memory card can be removed from the instrument. The memory card can be inserted directly into an SD card reader. Run PV II™ and select ‘File’, ‘Open’ and then go to the drive that has been configured for the memory card. If there is data on the card you will then see a file that can be opened. After opening the file on the data card the file is processed and stored on the computer’s hard drive.
Hookup Configurations

The PQA-300™ can be used to monitor any single phase or three phase power configuration. Following are descriptions of the five most common field setups:

1 Phase 2 Wire (1P2W)

1 Phase 3 Wire (1P3W)

3 Phase 3 Wire (3P3W)

Optional: CT2 not used in Total Power Calculation
**Hookup Configuration** (continued)

3 Phase 4 Wire (3P4W)

2 1/2 Element (2.5E)

**Hookup Diagnostic Warnings**

From the ‘RECORD’ screen the operator can select ‘SYSTEM CHECK’. The instrument does a number of checks on the connected signals, if it detects a potential problem a message will be displayed in the RECORD screen. The operator can elect to ignore these messages and start anyway in which case these messages will not appear while the instrument is recording. If the operator makes changes to the instrument setup or the connections to the power system and the condition clears then the messages will clear when the operator selects ‘SYSTEM CHECK’ again.

Possible messages and descriptions:

- ‘CH1 VOLTAGE TOO LOW’
- ‘CH2 VOLTAGE TOO LOW’
- ‘CH3 VOLTAGE TOO LOW’

  Voltage being measured is less than 10V

- ‘CH1 VOLTAGE TOO HIGH’
- ‘CH2 VOLTAGE TOO HIGH’
- ‘CH3 VOLTAGE TOO HIGH’
- ‘CH4 VOLTAGE TOO HIGH’

  Voltage being measured is greater than 120% of rated value.
Hookup Diagnostic Warnings (continued)

‘CH1 CURRENT TOO HIGH’
‘CH2 CURRENT TOO HIGH’
‘CH3 CURRENT TOO HIGH’
‘CH4 CURRENT TOO HIGH’

Current being measured is greater than 120% of the CT rating.

‘-VE POWER CHECK CT1’
‘-VE POWER CHECK CT2’
‘-VE POWER CHECK CT3’
‘-VE POWER CHECK CT4’

This usually means that the relevant CT has been connected in reverse. To fix the problem remove the CT, rotate it 180 degrees, reconnect it and then press ‘SYSTEM CHECK’ again. In some cases this is not an error (i.e. when measuring a generator output).

‘VOLTAGE PHASE SEQ ERROR’

Voltage phase sequence is checked when voltage on channels 1, 2 and 3 are greater than 30V and error occurs when phase sequence is not A B C. To fix this problem, swap the voltage connections to channels 2 and 3 and then press ‘SYSTEM CHECK’ again.

‘CURRENT PHASE SEQ ERROR’

Current phase sequence is checked when currents on channels 1, 2 and 3 are greater than 5% of range and error occurs when phase sequence is not A B C. To fix this problem exchange CT’s for channels 2 and 3 and then press ‘SYSTEM CHECK’ again.

‘VOLTAGE OUTSIDE TRIG WINDOW’

This indicates that at least one of the four measured voltages is above the over voltage trigger level or at least one of channels 1, 2 or 3 voltage is below the under voltage trigger level. Note: Channel 4 under voltage is not included in the system check.

‘CURRENT GREATER THAN TRIG LEVEL’

This indicates that one or more currents are greater than the current inrush threshold.

‘CT TYPE ERROR - PHASE’

The type of CT(Flex or Clamp) connected to the phase CT inputs is not the same as selected.

‘CT TYPE ERROR - CHANNEL 4’

The type of CT(Flex or Clamp) connected to channel 4 inputs is not the same as selected.
PQA-300™ Firmware Features

RMS and Waveform Data Storage
The PQA-300™ stores RMS data at set intervals which can be adjusted from 0.2 (continuous) to 30 seconds or 1 to 30 minutes. The minimum, maximum and average values are stored at the end of each storage interval. The averaged values are calculated from the sum of the RMS values (updated every ½ cycle) over the preceding storage interval. The minimum and maximum values are updated every ½ cycle over the preceding storage interval.

The PQA-300™ has a Continuous Waveform storage mode which stores RMS minimum, maximum and average data every 200 milliseconds and waveform data continuously. During Continuous Waveform storage mode event capture functions are disabled, and Bluetooth communication is limited.

Data is stored in files with a maximum size of 458M. Data cards from 4G to 64G are supported.

There are two Storage modes that the user can select: Stop When Full and Restart When Full. Both modes refer to the space on the memory card. A 4G card will hold a maximum of eight 458M files and if configured for Stop When Full recording will automatically stop when there are eight files on the memory card (unless the user stops recording first). When configured for Restart When Full and there are eight files on a 4G card the oldest file will be overwritten and recording will not stop until the user stops recording.

Harmonics
The PQA-300™ displays up to the 41st harmonic on its display while the software displays up to the 128th harmonic. Total Harmonic Distortion (THD) is calculated as the ratio between the square root of the squared sum of the harmonic magnitudes (for harmonics 2…128) divided by the fundamental value. THD is calculated over a 200 millisecond window.

Interharmonics
Interharmonics are calculated by the software from waveform snapshots that are stored every storage interval. The Interharmonic calculation requires multiple cycles of waveforms. If Interharmonics are turned off only one cycle of waveforms is captured and the software can only calculate Harmonics. If Interharmonics are turned on 10 cycles (for 50 Hz systems), 12 cycles (for 60 Hz systems) or 40 cycles (for 400 Hz systems) are stored every storage interval. Interharmonics can be resolved to 5 Hz resolution from 10 cycles or 12 cycles and to 10 Hz resolution from 40 cycles.

In Continuous storage mode the 10 cycles, 12 cycles or 40 cycles of waveforms are stored continuously with no missing cycles. This enables the software to be able to calculate Interharmonics over a longer period. For example the software could use 120 cycles resulting in a resolution of 0.5 Hz (in 60 Hz systems) for Interharmonics. Note that in Continuous Waveform storage mode there is no option to turn Interharmonics On or Off.
Power Calculations
Power calculations are updated every ½ cycle. Average values of power are recorded every storage interval. Power factor displayed is true power factor (not displacement power factor which is determined from the phase angle shift between fundamental values of voltage and current) and is calculated as the ratio of real power (kW) divided by apparent power (kVA).

Frequency
System frequency is measured from the signal on V1 input and is updated once per cycle. Frequency will not be measured if the voltage on channel 1 is below 10V.

Event Capture
Under/over voltage events, high speed voltage transients and current inrush events are stored when they occur. Trigger levels are set in the Setup menu under ‘TRIGGER LEVELS’. When an event is triggered data for all four voltage and current channels is stored, if configured for a 3 phase system, irrespective of which channel triggered the event.

Under/Over Voltage Events (U/OV)
Under/over voltage events are tagged as sags/swells if they are under 2 seconds in duration and under/over if they are longer. PV II™ software reports their duration in number of cycles, with ½ cycle resolution, for events less than 2 seconds and in seconds for longer events. The PQA-300™ uses a hysteresis value of 0.1% of full scale to determine when the event has finished. For example if the under voltage trigger level is set at 228.0 volts the instrument will start recording an event when the voltage goes under 228.0 volts and will stop recording the event when the voltage goes over 228.8 volts. For under/over voltage events both event waveforms and RMS data, with ½ cycle resolution, are recorded. Pre-trigger data is 25% of the event buffer for waveforms and 64 cycles for RMS data. The Event Waveform buffer is user adjustable between 4 and 100 cycles. Under/Over Voltage and Current Inrush events have the same Waveform and RMS buffer lengths.

High Speed Voltage Transients (SPIKE)
The PQA-300™ captures high speed voltage transients that are 20 microseconds (50Hz) / 16 microseconds (60Hz) / 39 microseconds (400Hz) or longer. When a transient is detected on any of the four voltages, high resolution (1024 samples/cycle for 50 and 60 Hz systems and 64 samples/cycle for 400 Hz systems) waveform data is stored. Waveform data for all voltage and current channels is stored with a user adjustable buffer of between 2 and 10 cycles. Pre-trigger recording is fixed to ½ cycle.

Current Inrush (CI)
Current inrush data for all voltage and current channels is stored when the current on any of the four channels exceeds the threshold setting. The trigger level setting for channel 4 can be set independently from channels 1, 2 and 3. Both event waveforms (256 samples/cycle for 50 and 60 Hz systems and 64 samples/cycle for 400 Hz systems) and RMS data, with ½ cycle resolution, are recorded. Pre-trigger data is 25% of the event buffer for waveforms and 64 cycles for RMS data. The Event Waveform buffer is user adjustable between 4 and 100 cycles. The Event RMS buffer is user adjustable between 120 and 3600 cycles. Under/Over Voltage and Current Inrush events have the same Waveform and RMS buffer lengths.
Voltage and Current Unbalance
This is for three phase systems. Unbalance is calculated as the ratio of the negative sequence component divided by the positive sequence component. Unbalance is calculated over a 200 millisecond window.

PQA-300™ Back Panel
The voltage and current connections are color coded according to phase and polarity (for voltage).

<table>
<thead>
<tr>
<th>Channel 1 or Phase A</th>
<th>Red</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel 2 or Phase B</td>
<td>Yellow</td>
</tr>
<tr>
<td>Channel 3 or Phase C</td>
<td>Blue</td>
</tr>
<tr>
<td>Channel 4 Current</td>
<td>Grey</td>
</tr>
<tr>
<td>Channel 4 Voltage</td>
<td>White</td>
</tr>
</tbody>
</table>

There is an auxiliary connector that is used to connect to an external DC power supply (for use when V1 is connected to a weak source).

When measuring less than 4 voltages V1 must always be used. V1 zero crossing is used to synchronize the data sampling and measure frequency. In the event of an outage on V1 the PQA-300™ has an internal digital phase lock loop that simulates the zero crossing until V1 is restored.
**PQA-300™ Front Panel**

The front panel of the PQA-300™ has a color graphics display, a 10 button keypad and a memory card interface.

The color graphics display is 270x480 pixels.

The keypad has two types of buttons. The bottom row of 4 keys are fixed function buttons and the top row of 6 keys are function keys that change function depending on the active screen on the display. In most screens the bottom line of the display is used to describe the functions associated with the six function keys.

The memory card interface is used to store recorded data on a memory card and also to load new firmware. The PQA-300™ will not begin a survey without a memory card installed. Once a survey has been started the memory card may not be removed until the survey has been stopped.
**PQA-300™ Operation**

**Turning On and Off**
The PQA-300™ has a dedicated On/Standby button 🔄. If the instrument is running on battery power, is not recording and there has been no key pressed or Bluetooth activity for five minutes the instrument will automatically turn off in order to conserve battery capacity. If the instrument is running on battery power and recording the instrument will not turn off until the battery capacity is below 15%. At that time the data file will be closed and the instrument will automatically turn off – no data will be lost.

After turning off due to low battery voltage the battery will have enough capacity to keep the real time clock functioning for over a month.

**Memory Card**
The PQA-300™ continually checks the memory card interface to see if a card has been inserted or removed. When it detects a card being inserted (or a card in the socket immediately after power up) the instrument checks the card size and the number of files on the card. The PQA-300™ supports from 4GB to 64GB SD memory cards. Each file is allocated approximately 0.5GB on the card so that a 4GB card can hold up to 8 data files and a 64GB card can hold up to 128 data files.

When the instrument detects a card being removed it changes the screen to the initial screen if the instrument was not recording. If the instrument was recording when the memory card is removed recording is stopped and an error message is displayed:

```
MEMORY CARD REMOVED WHILE RECORDING
RECORDING STOPPED
RE-INSERT CARD TO CLOSE FILE PROPERLY
```

If the memory card is not re-inserted the data file on the card will have the name Q999xxxx.TSQ and PV II™ software may be able recover the trend and event data.

The Memory card should NEVER be removed while recording is on, ALWAYS stop recording before removing the Memory card.

The Memory card offers a fast and convenient method to transfer recorded data to a computer. To transfer data from the memory card to a computer, remove the card from the logger and insert into an SD card reader. Run PV II™ and select 'File', 'Open' and then go to the drive that has been configured for the memory card. If there is data on the card you will then see a file that can be opened. After opening the file, the processed file can be saved on the computer’s hard drive. If the Bluetooth option has been installed recorded data can be downloaded wirelessly.
**PQA-300™ Operation - Setup**

**Setup**
Pressing the ‘SETUP’ button calls up the main setup screen. From the main setup screen you can select:

- PHASE CT RANGE
- CH 4 CT RANGE
- CONNECTION
- DATA STORAGE
- TRIGGER LEVELS
- EXT PT/CT
- SYSTEM FREQ
- CLOCK
- BLUETOOTH
- CALIBRATE
- LANGUAGE
- SETUP LOCK

**Phase CT Range**
User selects the clamp CT or flex CT that is being used on channels 1, 2 and 3. The same type and rating is used for all three channels.

The flex CT interface is inside the **PQA-300™**. Calibration is done digitally and for best accuracy the flex CTs should be used with the unit that they were calibrated for and on the correct channel. Each flex CT has a serial number that matches the unit serial number and is color coded for the correct channel.

For correct polarity the arrow on the Flex connector should be pointing towards the load. The Flex CTs are slightly position dependant (up to +/- 1% of reading). For best results the Flex plane should be perpendicular to the current carrying cable and the Flex connector should be on the opposite side of the loop with respect to the current carrying cable:

Position dependency of Clamp CTs is insignificant.

Clamp CTs are not restricted for use with a specific unit or channel however they are color coded for convenience.

**CH 4 CT Range**
User selects the clamp CT or flex CT that is being used on Ch 4. The type and rating can be different from the phase CT.
**PQA-300™ Operation – Setup (continued)**

**Connection**
User selects the type of phase connection, in the 3P4W and 2.5E configurations channel 4 voltage and current is recorded:

1P2W - 1 Phase 2 Wire
The three phase CTs are associated with V1 so that three individual loads can be monitored in this configuration.

1P3W - 1 Phase 3 Wire (Edison circuit)
Channels 1 and 2 for voltage and current are used for monitoring a residential type split phase service.

3P3W - 3 Phase 3 Wire (Delta circuit)
Line to line voltages \( V_{ab}, V_{bc} \) and \( V_{ca} \) and line currents \( I_a, I_b \) and \( I_c \) are measured directly. Only \( I_a \) and \( I_c \) are required for three phase power calculations.

3P4W - 3 Phase 4 Wire (Wye circuit)
Line to neutral voltages \( V_{an}, V_{bn} \) and \( V_{cn} \) and line currents \( I_a, I_b \) and \( I_c \) are measured directly

2.5E - 2½ Element
Line to neutral voltages \( V_{an} \) and \( V_{cn} \) and line currents \( I_a, I_b \) and \( I_c \) are measured directly. Line to neutral voltage \( V_{bn} \) is calculated from \( V_{an} \) and \( V_{cn} \).
PQA-300™ Operation – Setup (continued)

Data Storage
User can configure various data store parameters:

STORAGE RATE
RECORDING MODE
INTERHARMONICS
VOLT SPIKE WVFRM (Voltage Spike Event Waveforms)
VOLT U/O WVFRM (Under/Over Voltage Event Waveforms)
CURR INRSH WVFRM (Current Inrush Event Waveforms)
RMS CAPTURE (RMS Event Capture)

Storage Rate
The storage rate has the following settings:

0.2, 1, 5, 10, 15, 30 seconds
1, 5, 10, 15, 30 minutes

RMS calculations are updated every ½ cycle using a sliding one cycle window. At each storage interval the minimum, maximum and average RMS values based on the ½ cycle updates are stored.

For 0.2 second storage rate the RMS values are stored every 200 milliseconds (50 or 60 Hz systems), or every 100 milliseconds (400Hz systems). Event capture is disabled and Bluetooth communication is limited.

Waveforms for each channel are stored every storage interval. For storage rates 1 second or longer one cycle of waveforms are stored if interharmonics are turned off and 10 cycles (50 Hz systems), 12 cycles (60 Hz systems), 40 cycles (400Hz systems) if interharmonics are turned on.

For 0.2 second storage rate 10 cycles (50 Hz systems) or 12 cycles (60 Hz systems) of waveforms are stored every 200 milliseconds. For 400 Hz systems and 0.2 second storage rate 40 cycles of waveforms are stored every 100 milliseconds. This results in continuous waveform storage –*with no gaps*.

Recording Mode
There are two different recording modes: *Stop When Full* and *Restart When Full*.

Stop When Full
When a data file is full (458MB) the file is closed and a new file is automatically started. For storage rates 1 second or longer the file will start on an even minute boundary so there could be a gap of up to a minute between the end of one data file and the start of the next one. For 0.2 second storage rate the new file will start immediately with no gap between the end of one data file and the start of the next one.

When the memory card is full recording will automatically stop.
**PQA-300™ Operation – Setup (continued)**

**Restart When Full**
When a data file is full (458MB) the file is closed and a new file is automatically started. For storage rates 1 second or longer the new file will start on an even minute boundary so there could be a gap of up to a minute between the end of one data file and the start of the next one. For 0.2 second storage the new file will start immediately with no gap between the end of one data file and the start of the next one. When the memory card is full the oldest file will be deleted and a new one will be started. Recording will continue until the user stops recording.

**Interharmonics**
Interharmonics are calculated by the software from the waveform snapshots that are stored every storage interval. If Interharmonics are turned off one cycle of waveforms are stored every storage interval and the software can only calculate Harmonics. If Interharmonics are turned on then multiple cycles of waveforms are stored every storage interval, 10 cycles (for 50 Hz systems), 12 cycles (for 60 Hz systems) or 40 cycles (for 400 Hz systems). For 50 and 60 Hz systems Interharmonic resolution will be 5 hertz and for 400 Hz systems Interharmonic resolution will be 10 hertz.

Interharmonics use a lot of memory and should only be used if required. For example, in a 60 Hz system at 1 minute storage it will take 45 days to fill one data file with Interharmonics off and 5.0 days with Interharmonics on. On power up Interharmonics are off and the user must turn on Interharmonics if desired.

**Voltage Spike Waveforms**
For high speed voltage transients (>20 microseconds for 50 Hz systems >16 microseconds for 60 Hz systems or >39 microseconds for 400 Hz systems) you can adjust the number of waveform cycles stored from 2 to 10 cycles. There will be ½ cycle of pre-trigger data.

**Under/Over Voltage Waveforms**
For Under/Over Voltage transients that are ½ cycle or longer the user can adjust the number of waveform cycles stored from 4 to 100 cycles. Pre-trigger data is 25% of the waveform buffer. Both Under/Over Voltage and Current Inrush waveform buffers will be set to the same length.

**Current Inrush Waveforms**
For Current Inrush transients that are ½ cycle or longer the user can adjust the number of waveform cycles stored from 4 to 100 cycles. Pre-trigger data is 25% of the waveform buffer. Both Under/Over Voltage and Current Inrush waveform buffers will be set to the same length.

**RMS Capture**
This setting affects the RMS transient data stored for both under/over voltage transients and current inrush. The pre-trigger buffer size is fixed at 64 cycles. User can adjust the total length of the RMS storage from 120 to 3600 cycles. The resolution of the RMS data is ½ cycle.
Trigger Levels
The event trigger levels are set here. The options are:

- EVENT ENABLE
- PHASE CURRENT INRUSH
- CH4 CURRENT INRUSH
- PHASE VOLT NOMINAL
- CH4 VOLT NOMINAL
- VOLTAGE SPIKE
- PHASE VOLT OVER
- PHASE VOLT UNDER
- CH4 VOLT OVER
- CH4 VOLT UNDER

Note: This menu is not accessible if the storage rate is set to 0.2 seconds.

Event Enable
The three events types (Voltage Spike, Under/Over Voltage and Current Inrush) can be individually disabled. On power up all events are automatically enabled. All events are disabled if the storage Interval is set to 0.2 seconds.

Phase Current Inrush
This trigger level is an RMS value. If any of the three phase currents (channels 1, 2 or 3) exceeds this level then a Current Inrush Event is triggered.

Channel 4 Current Inrush
This trigger level is an RMS value. If the current on channel 4 exceeds this level then a Current Inrush Event is triggered.

Phase Voltage Nominal
This is the expected nominal voltage for channels 1, 2 and 3. If measuring Line – Neutral this is the line to neutral nominal voltage, If measuring Line – Line this is the line to line nominal voltage. This is used as a reference for channels 1, 2 and 3 voltage event trigger levels.

Channel 4 Voltage Nominal
This is the expected nominal voltage for channel 4. This is used as a reference for channel 4 voltage event trigger levels.
**PQA-300™ Operation – Setup (continued)**

**Voltage Spike**
Trigger setting for the high speed voltage transient capture function.

**Phase Voltage Over**
The RMS over voltage trigger level for channels 1, 2 and 3.

**Phase Voltage Under**
The RMS under voltage trigger level for channels 1, 2 and 3.

**Channel 4 Voltage Over**
The RMS over voltage trigger level for channel 4.

**Channel 4 Voltage Under**
The RMS under voltage trigger level for channel 4.

**Ext PT/CT**
For use when measuring on the secondary sides of external PTs and CTs. Entering these values enables user to view voltage, current and power as they are on the primary side of the external PTs and CTs. With the ratios set 1:1 user would see them as they are on the secondary side. The maximum voltage ratio that can be entered is 999,999:1. The maximum current ratio that can be entered is 99,999:1. These ratios can also be modified later when viewing the data in software.

**System Freq**
User can select one of three frequencies. These frequencies are factory set. In most cases these frequencies will be 60 Hz, 50 Hz, and 400 Hz but could be different for special cases.

The frequency setting will affect the operation of some of the instrument functions. These functions are:

i) Flicker calculation. The **PQA-300™** calculates flicker according to the IEC 61000-4-15 standard which has different requirements for 50 Hz and 60 Hz systems. For frequencies other than 50 Hz and 60 Hz flicker is not calculated.

ii) Interharmonic calculation. **PV II™** calculates Interharmonics according to the IEC 61000-4-30 standard which has different requirements for 50 Hz and 60 Hz systems. For both frequencies a 200 millisecond window is used which corresponds to 10 cycles at 50 Hz and 12 cycles at 60 Hz resulting in an Interharmonic resolution of 5 Hz. For 400 Hz systems a 100 millisecond window is used which corresponds to 40 cycles resulting in an Interharmonic resolution of 10 Hz

iii) 0.2 second storage rate, for 50 and 60 Hz systems the **PQA-300™** stores RMS data every 200 milliseconds and waveforms, with 256 samples/cycle, continuously. For 400 Hz systems the **PQA-300™** stores RMS data every 100 milliseconds and waveforms, with 64 samples/cycle, continuously
Clock
This enables the user to set the PQA-300™ internal clock from the front panel. The internal clock can also be set from a computer using PV II™ software and a Bluetooth interface. The clock resolution is 0.01 seconds.

Bluetooth
User can turn off the internal Bluetooth radio transmitter. This is an optional feature and if installed Bluetooth communication is automatically enabled on power up.

Calibrate
Calibration factors are stored internally in the PQA-300™. Any user can view the calibration factors without the ability to modify them. Qualified personnel can modify the calibration factors by first entering a six digit password. Please consult the factory (radian@radianresearch.com) to receive the password.

Language
User can change the language used by the PQA-300™ display. Presently only English and Spanish are supported.

Setup Lock
When the Setup Lock is on the setup parameters cannot be changed from the front panel. The password ‘4123’ is used to turn the lock on and off.
PQA-300™ Operation – Display

Display
Pressing the ‘DISPLAY’ button calls up the main display screen. The main display shows the real time values of AC voltage, current and power. The main display is formatted depending on the connection configuration.

From the main display screen you can select:

**AC/DC Voltage, Current and Frequency**
AC and DC voltage and current for all four channels are displayed independent of the connection configuration. For 1 phase 2 wire connection the power shown is for the channel current referenced to the voltage on channel 1.

**Waveforms**
Voltage and current waveforms can be viewed in real time.

**Harmonic Bar Chart**
Voltage and current harmonic magnitudes up to the 41st harmonic can be viewed in real time. When data is recorded and viewed with PV II™ software harmonic magnitudes up to the 128th can be viewed.

**Vector Diagram**
Voltage and current vectors can be viewed in real time.

**System Information**
User can view the PQA-300™ serial number, the firmware revision, installed options, the recording status (on or off), the battery status (charging or discharging and capacity) and memory card usage.
**PQA-300™ Operation - Record**

**Record**
Pressing the ‘RECORD’ button calls up the recording screen. From this screen user can:

i) (F3) Run a system check that checks over range voltage and current, reverse CT connections, reverse phase sequence and voltage and current outside trigger levels.

ii) (F2) Start recording immediately. This is only available if the storage interval is 0.2 seconds.

iii) (F1) Start recording synchronized to the internal clock. Recording starts on an even minute. User can adjust the start time to be the next even minute or delayed as much as 24 hours. When delayed start is initiated the display will show ‘RECORD DELAY’. When the delay is over this will change to ‘RECORD ON’ and the first record will be written to the data file.

The Record screen also shows the memory usage in terms of number of records available/used in the current file and the number of files available/used on the card.

When recording is started ‘F2’ becomes the stop recording button.

If events are active messages in red will be printed above the function keys.
## Specifications

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Specifications</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1, V2, V3</td>
<td>0 - 600 VAC 0 - 400Hz</td>
<td>0.1% of full scale + 0.1% of reading</td>
</tr>
<tr>
<td>V4 0 - 80VAC / 110VDC Or 0 - 600VAC / 850VDC 0 - 400Hz</td>
<td>0.1% of full scale + 0.1% of reading</td>
<td></td>
</tr>
<tr>
<td>I1, I2, I3</td>
<td>0 - 1VAC/DC (Clamp) 0 - 100mVAC (Flex)</td>
<td>0.1% of full scale + 0.1% of reading + Flex position error</td>
</tr>
<tr>
<td>I4 0 - 1VAC/DC 0 - 100mVAC (Flex)</td>
<td>0.1% of full scale + 0.1% of reading + Flex position error</td>
<td></td>
</tr>
<tr>
<td>Sampling</td>
<td>1024 samples/cycle every cycle</td>
<td>16 - 100Hz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>164 samples/cycle every cycle</td>
</tr>
<tr>
<td>Internal Clock</td>
<td>Initial Accuracy</td>
<td>±0.05 seconds</td>
</tr>
<tr>
<td></td>
<td>Drift</td>
<td>±0.5 sec/day</td>
</tr>
<tr>
<td>Recording</td>
<td>Storage Rate</td>
<td>1, 5, 10, 15, 30 sec</td>
</tr>
<tr>
<td></td>
<td>Memory</td>
<td>4G - 64G removable memory card</td>
</tr>
<tr>
<td>Power Supply and Battery Charger</td>
<td>Internal Power Supply</td>
<td>50VA 100 - 600VAC ± 10% 0 - 400 Hz</td>
</tr>
<tr>
<td></td>
<td>External Power Supply</td>
<td>Input: 100-240 VAC ± 10% 47-63Hz, 400mA 12VDC, 1.25A</td>
</tr>
<tr>
<td></td>
<td>Battery Run Time</td>
<td>4 hours</td>
</tr>
<tr>
<td>Communication</td>
<td>Bluetooth</td>
<td>Bluetooth 2.0</td>
</tr>
<tr>
<td></td>
<td>GPS</td>
<td>Timing GNSS – 1PPS Time Pulse &lt;15 nsec @130 dBm</td>
</tr>
<tr>
<td>Environmental</td>
<td>Operating Temperature</td>
<td>-20°C to 60°C</td>
</tr>
<tr>
<td></td>
<td>Humidity</td>
<td>Max 80% relative non condensing</td>
</tr>
<tr>
<td></td>
<td>Altitude</td>
<td>Max 2000m</td>
</tr>
<tr>
<td>Safety</td>
<td>Approval</td>
<td>CAN/CSA-C22.2 No. 61010-1-04</td>
</tr>
<tr>
<td></td>
<td>Pollution Degree 2</td>
<td>Normally only non-conductive pollution occurs. However, temporary conductivity caused by occasional condensation must be expected.</td>
</tr>
<tr>
<td></td>
<td>600V CAT-IV</td>
<td>Measurement category IV is for measurements performed in the building installation.</td>
</tr>
</tbody>
</table>

*Specifications may change without notice.*
Abbreviations

- Iac – AC current
- kW – Kilowatts
- PF – Power Factor
- PLT – Flicker Perception Long Term
- PST – Flicker Perception Short Term
- THDI – Total Harmonic Distortion Current
- THDV – Total Harmonics Distortion Voltage
- VacLL – AC Voltage Line to Line
- VacLN – AC Voltage Line to Neutral

Notes