HV Power hints and tips:
PQ-Box 100/150/200 Power Quality Recorder

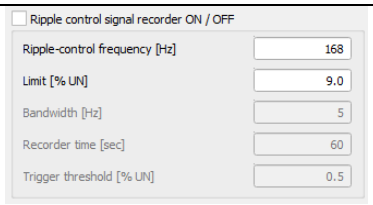
Issue 4g **Rewritten 27/1/2017**

WinPQ mobil 3.1.5

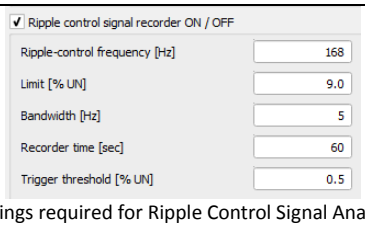
Ripple Control Signal Evaluation

The PQ-Box 100/150/200 can capture ripple control signal information and report via:

1) PQ Event "Signal detection [3sec-value]"
2) EN 50160 reporting
3) Permanent recording
4) Online measurement
5) "Ripple Control Signal Analysis" option



Settings required for PQ-Events, EN 50160 reporting and Permanent Recording



Settings required for Ripple Control Signal Analysis

Figure 1. Ripple control signal setup.

Setting	Maximum value*	Minimum value*
Ripple-control frequency [Hz]	100 Hz	3750 Hz
Bandwidth[Hz]	-	-
Recorder time [sec]	210 s	1 s
Trigger threshold [% UN]	100 %	0.1 %

Table 1. Permissible Ripple Control Setting ranges.

1) PQ-event "Signal detection (3 sec-values)"

As the PQ-Box's are Class A device, PQ-event "Signal detection (3sec-values)" is determined by evaluating the 10 cycle r.ms. value interharmonics bin, per IEC 61000-4-30 (Section 5.10.1).

That is, the PQ-Box completes an FFT analysis on each successive 200 ms of data to obtain harmonic and interharmonic information. The level of the FFT for the selected ripple control frequency is measured over a three second period to determine presence of a ripple control signal, and generate a PQ-event.

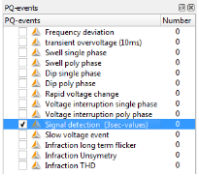


Figure 2. PQ-event "signal detection (3sec-values) listing.

Features and functionality may differ with other versions of software and/or firmware.

HV POWER MEASUREMENTS & PROTECTION LTD
8 Rongotai Road, Kilbirnie, Wellington
P O Box 14-385, Kilbirnie, Wellington 6241, New Zealand

TEL: +64-4- 387 7339
Fax: +64-9- 630 0674
email: info@hvpower.co.nz

Per IEC 61000-4-30, the interharmonic bin closest to the selected ripple control frequency is monitored. For example with 317 Hz setting, the closest four of the 5 Hz interharmonic bin values are monitored (310, 315, 320 and 325 Hz).

While in compliance with the standard, there is general agreement in the industry that this method to detect ripple control is **NOT** effective. This can be seen by comparing PQ-Events to permanent recordings. Measurement methods 3 & 4 (following) are outside of the scope of IEC 61000-4-30 defined measurements, and are provided by PQ-Box's as a more effective alternative.

2) EN 50160 Reporting

The set frequency is monitored over successive 3 second intervals. WinPQ mobil software EN50160 analysis function compares all the 3 second values, against the "Limit [% UN]" setting (see Figure 1). It displays via a normalised bar graph display if (the worst) 99 % and 100 % of these recorded values exceeded the set limit. *If that is the case the bar graph height will exceed the horizontal "limit" line.*

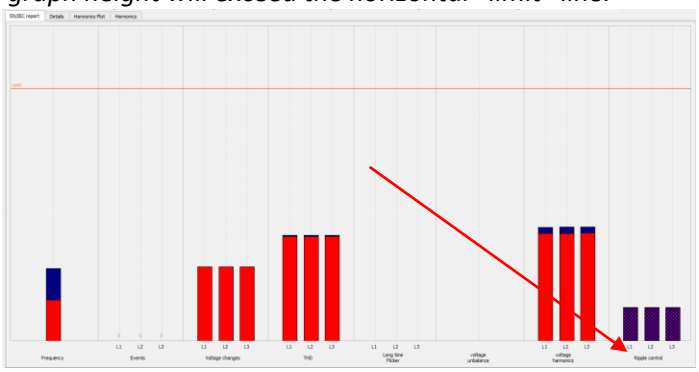


Figure 3. EN 50160 Analysis.

3) Permanent Recording:

The PQ-Box logs the ripple voltage (as a percentage of the set nominal-voltage). The frequency to be monitored must be set-up in the Ripple control signal set-up (see Figure 1).

Using successive 200 ms evaluation windows, the PQ-Box undertakes an FFT analysis of each and records the peak signal amplitude of the selected frequency. (The FFT resolution is 5 Hz, and the closest four 5-Hz values to the selected frequency are monitored). Refer to Table 2 for possible recorded information.

Data Class	Legend	Notes
200 ms Data	Ripple control signal (200ms) [UL x eff (200 ms)]	• Reports each 200 ms value. • Only on PQ-Box 150 & 200 with 200 ms data enabled.
3 s TRMS values	Ripple control signal (3s) [UL x eff (3s)]	• Reports the average ripple control signal using a fixed 3 second measuring period. • Recorded by PQ-Box 100/150/200. Does **not** required 3 second data enabled on PQ-Box 150/200.
N sec Data	U ripple control signal (200ms) [UL x R]	• Reports the single maximum 200 ms value during the measuring interval [**i.e. Peak**]. • Exact time of the peak is recorded. • The "UL x R" data will not show if there have been several ripple controls during the measuring interval, nor if they were of significantly lower amplitude. • Recorded by PQ-Box 100/150/200
	Ripple control signal [UL x eff]	• Reports the **average** ripple control signal from the each entire measuring interval [**i.e. Average**] • Recorded by PQ-Box 100/150/200

Table 2. Permanent Recorded Ripple Data.

HV POWER MEASUREMENTS & PROTECTION LTD
8 Rongotai Road, Kilbirnie, Wellington
P O Box 14-385, Kilbirnie, Wellington 6241, New Zealand

TEL: +64-4- 387 7339
Fax: +64-9- 630 0674
email: info@hvpower.co.nz

Figure 4. Example of the permanent recorded data (UL x R).

Note:

- The 200 ms evaluation window tends to give an averaging effect, reducing the effect of non-repetitive signals. However, the 200 ms recording may still capture non-repetitive signals such as network voltage disturbance events which contain components of the monitored frequency. Therefore during the analysis of the "U eff R" data it is recommended to check to see if other disturbance events coincide.
- The "On/Off" check box (see Figure 1) does not need to be checked to allow Permanent Recording. Permanent Recording will occur regardless of check box status. The Ripple Control Frequency (see Figure 1) should be set to appropriate frequency to be monitored.

4) Online measurement:

The online mode of the PQ-Box's has been updated to include "Ripple control" values, where the instantaneous ripple voltage is displayed (as a percentage of the set nominal voltage).

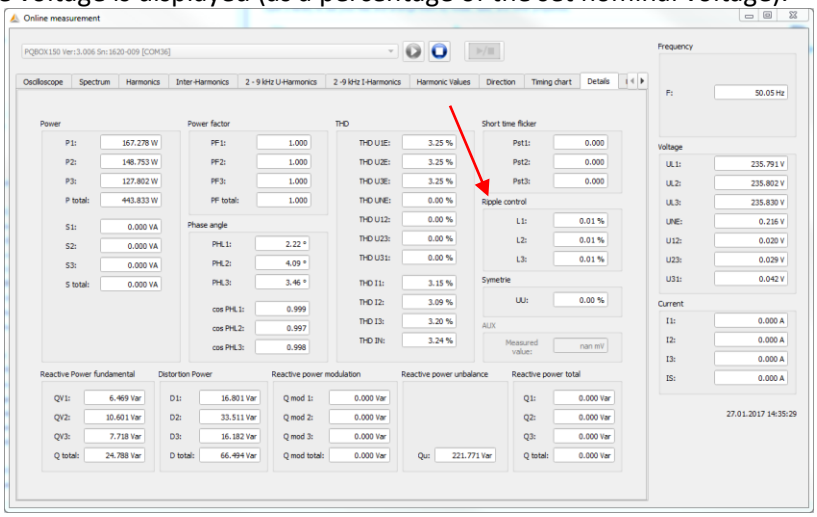


Figure 5. Online measurement – instantaneous ripple voltage.

HV POWER MEASUREMENTS & PROTECTION LTD
8 Rongotai Road, Kilbirnie, Wellington
P O Box 14-385, Kilbirnie, Wellington 6241, New Zealand

TEL: +64-4- 387 7339
Fax: +64-9- 630 0674
email: info@hvpower.co.nz

5) Ripple Control Signal Analysis:

PQ-Box's that have the Ripple Control Signal Analysis Option enabled (+S versions) have a dedicated high speed recorder for monitoring ripple control signals. The resolution of which is sufficient to show the pulse encoding of the ripple signal. Triggering options are powerful and flexible, allowing the PQ-Box to be used for a variety of ripple control analysis applications. Note that this method also records the ripple control signal current – which can be of use for ripple plant evaluation.

This high speed recorder is independent of the permanent recorder measuring interval. This allows permanent recording to occur at speed appropriate for monitoring (such as 10 minute EN 50160 requirements or user desired time resolution/file size selection), yet allows detailed high speed ripple control analysis.

Enabling the Ripple Control Option causes the selected frequency range (frequency + bandwidth) to be monitored. If the signal exceeds the set minimum amplitude threshold, a high speed recorder is started for the "Recorder time" duration. The signal voltage is recorded as line-to-ground and line-to-line values, as a voltage (not as a "percentage-of-nominal voltage" like the permanent recorder data).

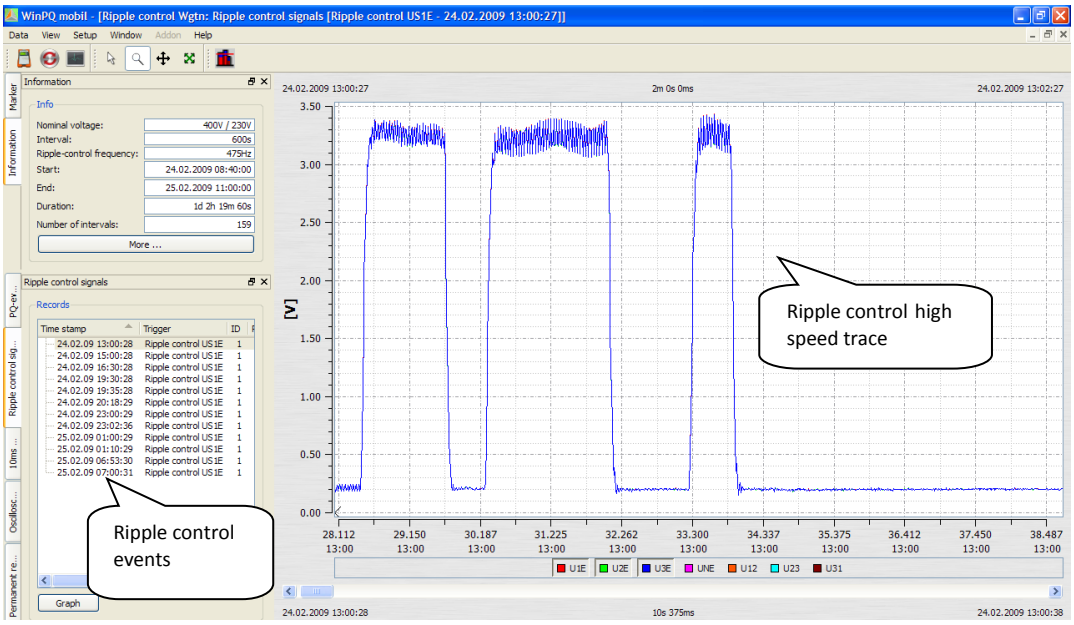


Figure 6. Example high speed ripple control signal data (10 ms resolution).

Unlike the IEC 61000-4-30 methods which are based on 200 ms sampling and evaluation of 4 x 5 Hz bins (or full interharmonics values), the PQ-Box 100 Ripple Control is based on 10 ms sampling and to the specific frequency + bandwidth. For example with frequency setting = 317 Hz and bandwidth = 10 Hz, the trigger threshold and recorded data is strictly monitoring 312 to 322 Hz signals only.

A bandwidth setting of 10 Hz for example, is applied as +5Hz, - 5Hz to the set ripple control frequency.

The bandwidth selected should match the specification of the ripple control relays being monitored. If bandwidth is not known, then 10 Hz is recommended. Care should be exercised where monitored frequencies are close to major harmonic signals. For example, with 317 Hz ripple control, a bandwidth of 10 Hz would be sufficient, and avoids the 7th harmonic (350 Hz) signal.

HV POWER MEASUREMENTS & PROTECTION LTD
8 Rongotai Road, Kilbirnie, Wellington
P O Box 14-385, Kilbirnie, Wellington 6241, New Zealand

TEL: +64-4- 387 7339
Fax: +64-9- 630 0674
email: info@hvpower.co.nz

Note:

- The WinPQ mobil software features the Ripple Control setup dialog box, even if the connected PQ-Box does not have the Ripple Control Signal Analysis Option implemented. If the check box is enabled and setting uploaded to a PQ-Box without Ripple Control Signal Analysis Option, the ripple control parameters are ignored (without warning).
- To confirm if a PQ-Box has Ripple Control Signal Analysis enabled, check the PQ-Box LCD. In the PQ-Box 100 look for "+S" suffix on the 2nd line of the firmware reporting screen (e.g. LIGHT+S or EXPERT+S).
- Ripple Control Signal Analysis can be added to an existing PQ-Box, by licence upgrade.
- The PQ-Box LCD "Signal Voltage" shows the number of recordings. The count is incremented at the completion of the signal voltage recording.
- Ripple control signal events require approx 165 kB of data storage per 60 seconds of recording. Data is stored in the RecS.pqf file.

Reducing size/time range of permanent recordings

Issue #2 of "HV Power hints and tips: PQ-Box Power Quality Recorder", detailed possible methods of reducing file size by deleting specific data types. It is also possible to use file splitting software to split permanent recording file (cyc.pqf) into smaller sections. For example a month of recording data can be split into four, to provide another user with just one week of data.

However, when splitting cyc.pqf files, note that relationships with Events, Oscilloscope and 10 ms r.m.s recording data may be affected – e.g. Oscilloscope recordings may appear at the wrong time, or not be accessible. It is recommended when splitting permanent recordings, to delete oscilloscope, r.m.s. and event data, to avoid possible confusion (refer Issue #2 for details).

Free Commander is a freeware program that can be downloaded and used to split PQ-Box cyc.pqf files (http://www.freecommander.com/). Please backup data prior to splitting, and note that this procedure is unsupported.

There are two other options for reduce data size **prior** to commencing recording. These can be used alone or in combination, using the 'Only voltages' and/or the 'Record "only" Basicdata' option. See Hints and Tips #12 for more information.

Recommended practices

1 When connecting the PQ-Box, if possible connect laptop and use online phasor diagram to determine correct phasing of CT/VT connections, correct CT polarity and correct scaling of current/voltages.

If laptop is not available, use the PQ-Box LCD display of voltage, current and check the direction of power.

Note that a partially closed CT mini-clamp will result in a lower current reading compared to other phases, and large phase angle difference.

HV POWER MEASUREMENTS & PROTECTION LTD
8 Rongotai Road, Kilbirnie, Wellington
P O Box 14-385, Kilbirnie, Wellington 6241, New Zealand

TEL: +64-4- 387 7339
Fax: +64-9- 630 0674
email: info@hvpower.co.nz

2 When starting recording, press the manual trigger key to take a snapshot recording. The oscillograph and RMS event data can be a useful reference of “normal” or “as connected” conditions. Repeat manual trigger again just before stopping recording to obtain snapshot of end conditions.

Wait several seconds after stopping recording, before removing power from the PQ-Box. It takes a few seconds for the PQ-Box to close the recorded file. For greater data security, use the Windows task bar “Safely remove hardware” to close USB connection between the PC and PQ-Box before disconnecting USB cable as USB communications can be buffered and delayed by the operating system.

Auxiliary Supply – PQ-Box 100

For PQ-Box 100’s manufactured prior to July 2010, the input range of the auxiliary power supply is 100-440 Vac or 100-260 Vdc. Using voltages below 100 V can cause the power supply to draw excessive current, overheating the input resistors. Short term under voltages can be withstood, but continuous under-voltage should be avoided.

If connecting the PQ-Box 100 power supply to measuring VT's (63.5 Vac L-E), then connect the PQ-Box 100 between phases (110 Vac).

For PQ-Box 100’s manufactured after July 2010, the power supply is protected against under voltages, but the range is 100-440 Vac or 220 Vdc (specifically note that 110 Vdc is no longer supported).

If powering the PQ-Box 100 from the circuit to be measured, although the power supply consumption is less than 8 VA, the power supply is of a switch-mode variety that may cause some harmonic distortion on the circuit to be measured. This should only be an issue where a very accurate measurement of low level harmonics is required. Power the PQ-Box 100 from a separate circuit if required.

Measuring Interval & Flicker

From DSP 1.247/MCU 1.144, the Flicker Measurement is fixed to time base of 10 minutes, regardless of the user set measuring interval.

Prior to these versions, the PQ-Box 100 Measuring Interval was also used as the time-base for P_{st} Flicker measurements. In the industry Short Term Flicker (P_{st}) is based on a 10 minute evaluation period, and Long Term Flicker (P_{lt}) a 2 hour period.

If the PQ-Box 100 Measuring Interval was set to a period other than 10 minutes, then Flicker measurements (P_{st} & P_{lt}) will be captured using non-standard time-bases.

If the Measuring Interval was set to less than 60 seconds, P_{st} will not be calculated and zero values will be recorded (for P_{st} and P_{lt}).

HV POWER MEASUREMENTS & PROTECTION LTD
8 Rongotai Road, Kilbirnie, Wellington
P O Box 14-385, Kilbirnie, Wellington 6241, New Zealand

TEL: +64-4- 387 7339
Fax: +64-9- 630 0674
email: info@hvpower.co.nz