POWER AUTOMATION TECHNOLOGIES

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

Issue 4d **July 17th 2009**

General update 5/3/2010

WinPQ mobil

With release of Version 1.415 of the PC software for PQ-Box 100, the software has been renamed "WinPQ mobil".

To install V1.415, earlier versions of PQ-Box 100 PC software must first be removed from your PC.

PC Software and PQ-Box 100 firmware compatibility

To date, all new releases of PQ-Box 100 PC software (WinPQ mobil) have been able to open files downloaded and stored by earlier versions.

However, it is important that compatibility be maintained between the PQ-Box 100 firmware and PC software during USB connection (download, setting changes and online measurements). Data corruption may occur if the firmware and PC software versions are not compatible. This is most likely to occur when downloading data using V1.4 software from a PQ-Box 100 with (V1.3) firmware MCU 1.006 or earlier.

Table 1 indicates compatible Firmware and Software, and it is always recommend to upgrade firmware and PC software in parallel. However, limited testing has indicated that provided MCU is later than 1.006, more current versions of the V1.4xx software can be used.

If the PQ-Box 100 is using very old firmware (e.g. MCU 1.006) then V1.30 software must be used to download data. (Once data is download it will be able to be opened with V1.30 or V1.4x software)

PQ-Box 100 firmware version can be identified via LCD display screens.

PQ-Box 100 Firmware	Compatible PC software	Notes
MCU 1.119 **DSP V1.220**	**1.515**	
MCU 1.112 DSP V1.216	1.429	Any V1.4x software appears to work with earlier versions of firmware
MCU 1.111 DSP 1.216	1.426	
MCU 1.109 DSP 1.210	1.415 & V1.421	
MCU 1.106 DSP 1.208	1.40	
MCU 1.006 DSP 1.120	1.30	Do not use V1.4x to download data from these PQ-Boxes

Table 1. Firmware/software compatibility.

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Ripple Control Signal Evaluation

The PQ-Box 100 can capture ripple control signal information via:

1) PQ Event "Signal detection (3sec-value)
2) Permanent recording ("U eff R")
3) The new "Ripple Control Signal Analysis" option

1) PQ Event "Signal detection (3 sec-value)"

As the PQ-Box 100 is a Class A device, PQ Event "Signal detection (3sec-value)" 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 100 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 (e.g. Figure 1), is measured over a three second period to determine presence of a ripple control signal, and generate a PQ Event .

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).

For PQ-Events, the only set-up parameter used is the Ripple-Control frequency [Hz] setting. The other ripple control parameters (such as bandwidth etc) are not used.

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 "U eff R" permanent recordings. Measurement methods 2 & 3 (following) are outside of the scope of IEC 61000-4-30 define measurements, and therefore do not need to use this method. A.Eberle therefore use a more effective and proprietary method as follows.

2) Permanent Recording:

For the desired frequency, the PQ-Box 100 records a permanent recording of voltage (as a percentage of nominal-voltage) which is accessible as the "U eff R" data. The frequency to be monitored must be set-up in the Ripple control signal set-up (Figure 1). Only the Ripple-control frequency setting applies to Permanent Recording, the other settings apply to the Ripple Control Signal Analysis options (including Enable/Disable which does not affect Permanent Recording).

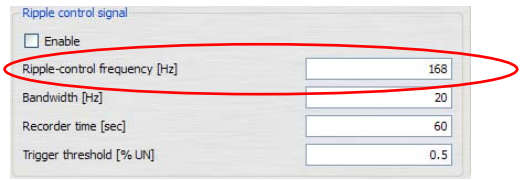

Figure 1. Frequency must be set up for Permanent Recording, all other settings do not apply

Using successive 200 ms evaluation windows, the PQ-Box 100 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

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four 5 Hz values to the selected frequency are monitored). At the end of the measuring interval (e.g. 10 minute measuring interval) the amplitude, time and date of the single largest 200 ms value is recorded. Note that therefore the "U eff R" data will not show if there have been several ripple controls during the measuring interval, or if they were of significantly lower amplitude.

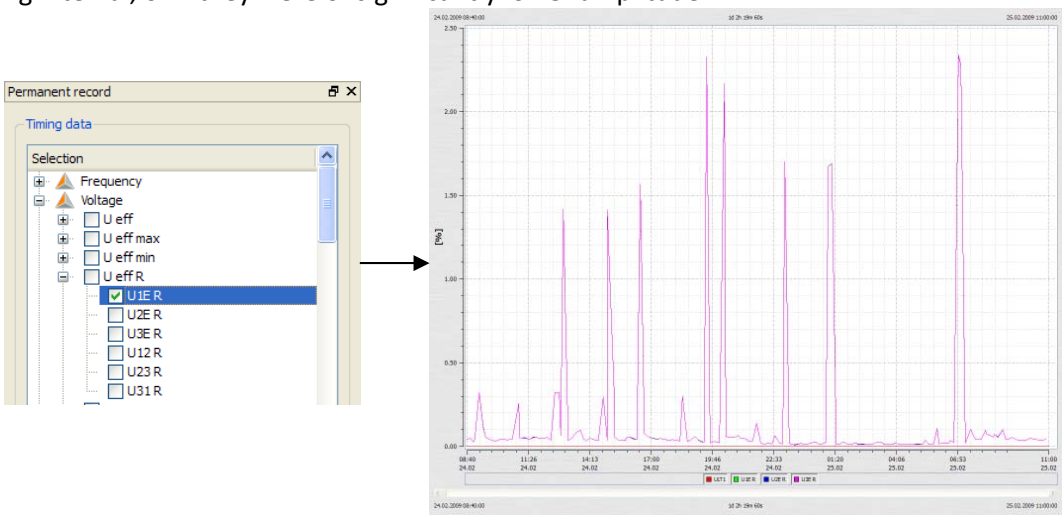

Figure 2. Example of the permanent recorded data (U eff R).

If greater detail of ripple control signal is required, a shorter measuring interval could be considered at the cost of larger data files and potential reduction in total recording time. Alternatively, implement the Ripple Control Signal Analysis option on your PQ-Box 100.

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 "Enable" check box (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 (Figure 1) should be set to appropriate frequency to be monitored.

3) Ripple Control Signal Analysis:

PQ-Box 100'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 100 to be used for a variety of ripple control analysis applications.

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.

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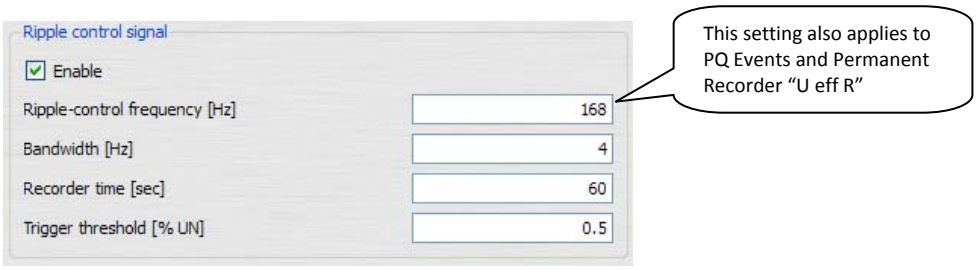

Figure 3. Ripple Control Signal setup dialog section of PQ-Box 100 Set-up "Basic settings".

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 "U eff R" data).

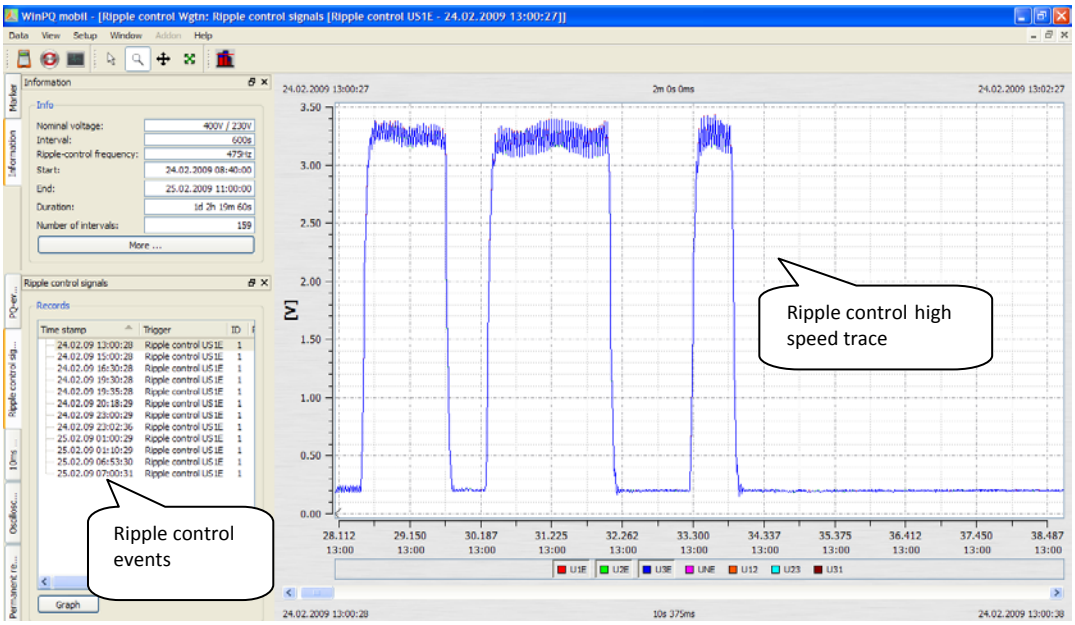

Figure 4. Example high speed ripple control signal data (10 ms resolution).

Setting	Maximum value*	Minimum value*
Ripple-control frequency [Hz]	5 Hz	3750 Hz
Bandwidth[Hz]	-	-
Recorder time [sec]	999,999 s	1 s
Trigger threshold [% UN]	100 %	0.1 %

Table 2. Permissible Ripple Control Settings.

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, is applied as +5Hz, - 5Hz to the set ripple control frequency.

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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.

Note:

- The WinPQ mobil software features the Ripple Control dialog box, even if the connected PQ-Box 100 does not have the Ripple Control Signal Analysis Option implemented. If the check box is enabled and setting uploaded to a PQ-Box 100 without Ripple Control Signal Analysis Option, the ripple control parameters are ignored (without warning).

  To confirm if a PQ-Box 100 has Ripple Control Signal Analysis enabled, check the PQ-Box 100 LCD for "+S" suffix on the 2nd line model description of the firmware reporting screen (e.g. LIGHT+S or EXPERT+S).

  Ripple Control Signal Analysis can be added to existing PQ-Box 100, by firmware and licence upgrades. (At time of writing NZ$1,100+GST to add this feature to Light or Expert versions).

- The PQ-Box 100 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 100 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 100 cyc.pqf files (http://www.freecommander.com/). Please backup data prior to splitting, and note that this procedure is unsupported.

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The “Only voltages” setting of the PQ-Box 100 is a method to reduce data **prior** to commencing recording. Enabling this reduces permanent recording size by approximately 40 %, by recording voltage /frequency based data only. Current and derived calculated information (e.g. W, VAr, pf etc) are not recorded (and are displayed as zero values).

Figure 5. “Only voltages” PQ-Box 100 set-up

Recommended practices

1 When connecting the PQ-Box 100, 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.

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 100 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 100 before disconnecting USB cable as USB communications can be buffered and delayed by the operating system.

Auxiliary Supply

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).

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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.

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

The PQ-Box 100 Measuring Interval is 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 is 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 is set to less than 60 seconds, P_{st} will not be calculated and zero values will be recorded (for P_{st} and P_{lt}).

This document was written referencing features of PQ-Box 100 firmware MCU 1.109, DSP 1.210 and PC software WinPQ mobil 1.415. Features and functionality may differ with other versions.

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