a-eberle

Operating manual

Power Quality Analyser PQ-Box 100

Power Quality Software

GB

Type PQ-Box 100

Note:

Please note that this operating manual cannot describe the latest version of the device in all cases. For example, if you download a more recent firmware version from the internet, the following description may no longer be accurate in every point.

In this case, either contact us directly or refer to the most recent version of the operating manual, available on our website (www.a-eberle.de).

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Content

1. User Guidance

1.1 Warnings

Types of Warnings

Warnings are distinguished according to the type of risk through the following signal words:

→ **Danger** warns of a risk of death

→ **Warning** warns of physical injury

→ **Caution** warns of damage to property

Structure of a warning

Signal word

Nature and source of the danger

✋ Actions to avoid the danger.

1.2 Notes

Notes on appropriate use of the device

1.3 Other Symbols

Instructions

Structure of instructions:

✋ Guidance for an action.

→ Indication of an outcome, if necessary.

Lists

Structure of unstructured lists:

→ List level 1
- List level 2

Structure of numbered lists:

1) List level 1
2) List level 1
    1. List level 2
    2. List level 2

2. Safety information

Please read this section carefully for important safety information.

Do not use the device for any other purpose than for measuring voltage and currents within the specified ranges and categories including the voltage to ground.

If the analyzer is not used according the manual and safety instructions, the protection provided may be impaired.

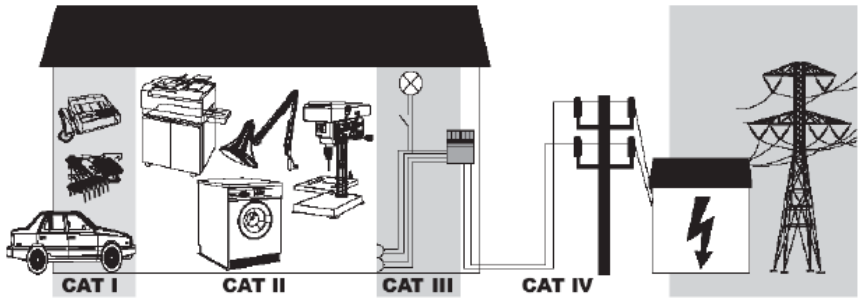
- **The measuring input voltages must not exceed the rating of the network analyzer.**
- **Pay attention to the power supply voltage range of the PQ-Box 100. This is, compared with the measuring voltage input, limited.**
- **The maximum voltage of the current inputs must not exceed 30 V rms to earth. (Especially when you are using current shunts)**
- **Check the power supply, measuring voltage and current leads for damage before use.**
- **Use integrated voltage probes with integrated fuses, if you want to connect the device to power networks with high short-circuit current ratings.**
- **When connecting or removing current clamps or voltage probes, first deenergise the circuit , or use appropriate protective clothing and equipment.**

Caution

Damage to the PQ-Box 100 by short circuits

For measurements in network with a big short circuit power, ensure that the voltage leads and power supply are used with integrated Power Fuses. Please use our fuse adapter set.

2.1 Measurement categories (CAT)



2.2 PQ-Box 100 Measurement voltage / Power supply

Measurement voltage:

While use on 110V and 240/415 V systems is common, the PQ-Box 100 can be directly connected up to 690 V rms systems, such as found in industrial and wind farm applications.

The upper “nominal” voltage recommendations are:

- 690 V rms line-to-line, 400 V rms line-to-earth

As any ‘nominal’ voltage system may exhibit over-voltages, the following maximum permissible ratings should not be exceeded:

- The PQ-Box 100 is rated for a maximum input voltage to earth, of 600 V rms (CAT III), but with a maximum of 300 V rms in CAT IV locations
- The maximum of the L-L measurement range is 1,100 V rms

The use of 111.7014 Safety Fused Leads are highly recommended for all applications (500 mA/1000 V /50 kA fuses).

Power supply:

To operate the PQ-Box 100, a power supply should be used in the range of:
100 V AC to 280 V AC (50/60 Hz) or 140 V to 220 V DC

The power supply leads may be connected to the measuring circuit if the voltage is within the above acceptable power supply limits. Note that if powering the PQ-Box 100 from a high impedance supply, such as VT secondary, the PQ-Box 100 power supply switch mode power supply may introduce a small harmonic voltage distortion. Power from an alternative source if desired.

If the supply voltage is:
lower than 100 V AC (140 V DC) the unit will shut off
higher than 280 V AC (220 V DC), the switched-mode power supply can be damaged

3. Hardware PQ-Box 100

3.1 General Technical Data

The PQ-Box 100 network analyser is suitable for analyses in low, medium and high-voltage networks. It fulfils all the requirements contained in IEC61000-4-30 for measurement instruments, Class A.

Functions:

- Voltage quality measurements according to EN50160, IEC61000-2-2 and IEC61000-2-4 for low and medium voltage networks
- Fault recorder functions (“expert” version only)
- Load analysis; energy measurements
- Ripple signal analysis

PQ-Box 100 (4U/4I)

4 voltage inputs:	L1, L2, L3, N, E
Maximum measuring voltage:	565V AC/800V DC L-N 980V AC/1380V DC L-L

Current inputs:	4 with a maximum of 700 mV rms., 1000 mV peak). Mini clamp, Rogowski clamps and adapter sets available

Maximum voltage of the power inputs to ground = 30 V rms

Data storage:	2 GByte
Interfaces:	USB 2.0
Display:	Illuminated, 6 lines x 30 characters
Dimensions:	220 x 146 x 57 mm
Weight:	1.7 kg
Power consumption:	< 8 VA; < 4.7 W (without backlight)
Degree of protection:	IP 65
IEC 61000-4-30:	Class A
Converter:	24 bit A/D
Power supply:	100 V to 280 V AC or 140 V to 240V DC
Emergency power supply (power failure):	NiMH battery (20 seconds)
Installation category	300 V CAT IV or 600 V CAT III
Accuracy of voltage inputs:	< 0.1 % from 10 % to 150 % of nominal voltage

Accuracy of current inputs:

(PQ-Box 100 delivered up to 12/2010 = 230 mV rms / PQ-Box 100 delivered from 01/2011 = 700 mV rms)

Uc (50 Hz)	0.85 mV ≤ Ue < 5 mV	5 mV ≤ Ue < 50 mV	50 mV ≤ Uc ≤ 700 mV
Accuracy	0.01 % v. E.	1 % v. M.	0.2 % v. M.

3.2 Reference conditions

Reference temperature	23°C ± 1 K
Input parameters	$U = U_n \pm 10\%$ I= In ± 10%
Auxiliary voltage	$H = H_n \pm 1\ \%$
Frequency	$= f_{nom} \pm 1\%$
Other	IEC 60688 - Part 1

3.3 Environmentalconditions

Temperature range

Function	-20 ... +60°C
Transport and storage	-30 ... +80°C

Humidity

No condensation	< 95 % rel.

Dry, cold

IEC 60068-2-1	-15°C / 16 h

Dry, hot

IEC 60068-2-2	+55°C / 16 h

Constant humid heat

IEC 60068-2-3	+ 40 °C / 93 % / 2 days

Cyclical humid heat

IEC 60068-2-30	12+12h, 6 cycles, +55°C/93%

Toppling

IEC 60068-2-31	100 mm drop, unwrapped

Vibration

IEC 60255-21-1	Class 1

Impact

IEC 60255-21-2	Class 1

3.4 Operating conditions

Measurement quantity	Error limits according IEC 61000-4-30, Class A
Fundamental oscillation: r.m.s.	±0.1% of U_{din} over 10% ~ 150% of U_{din}
Fundamental oscillation: Phase	± 0.15° over 50% ~ 150% of U_{din} over f_{nom} ±15%
2nd ... 50th harmonic	±5% of display over U_m = 1% ~ 16% of U_{din} ±0.05% of U_{din} over U_m < 1% of U_{din}
2nd .... 49th interharmonic	±5% of display over U_m = 1% ~ 16% of U_{din} ±0.05% of U_{din} over U_m < 1% of U_{din}
Frequency	± 5mHz over f_{nom} ±15% (f_{nom} = 50 Hz / 60 Hz)
Flicker, Pst, Plt	±5% of display over 0.02% ~ 20% of ΔU / U
Dip residual voltage	±0.2% of U_{din} over 10% ~ 100% of U_{din}
Dip duration	±20 ms over 10% ~ 100% of U_{din}
Swell residual voltage	±0.2% of U_{din} over 100% ~ 150% of U_{din}
Swell duration	±20 ms over 100% ~ 150% of U_{din}
Interruption duration	±20 ms over 1% ~ 100% of U_{din}
Voltage asymmetry	±0.15% over 1% ~ 5% of display
Ripple control voltage	±5% of display over U_m = 3% ~ 15% of U_{din} ±0.15% of U_{din} over U_m = 1% ~ 3% of U_{din}

Operating conditions and magnitude of additional error

Temperature in range 0°C to 45°C	35ppm / 1K
Humidity	< 95%
Instrument supply voltage and related series interferences	< 1ppm
common-mode interference voltage between earth connection of the instrument and input circuits	Current: 50Hz / 1,5µA/V; 1kHz / 50µA/V Voltage: 50Hz / 85dB; 1kHz / 60dB Isolated inputs

EMC

CE- conformity Interference immunity – EN 61326 – EN 61000-6-2 Emitted interference – EN 61326 – EN 61000-6-4	
ESD – IEC 61000-4-2 – IEC 60 255-22-2	8 kV / 16 kV
Electromagnetic fields – IEC 61000-4-3 – IEC 60 255-22-3	10 V/m
Burst – IEC 61000-4-4 – IEC 60 255-22-4	4 kV / 2 kV
Surge – IEC 61000-4-5	2 kV / 1 kV
HF conducted disturbances – IEC 61000-4-6	10 V, 150 kHz … 80 MHz
Voltage dips – IEC 61000-4-11	100 % 1min
Housing at a distance of 10 m AC supply connection at a distance of 10 m	30...230 MHz, 40 dB 230...1000 MHz, 47 dB 0,15...0,5 MHz, 79 dB 0,5...5 MHz, 73 dB 5...30 MHz, 73 dB

- **Four versions of the PQ-Box 100 are available:**

1) PQ-Box 100 basic
This version is made for data logging and load analysis.

2) PQ-Box 100 light
This device is suitable for performance analyses and voltage quality analyses according to EN50160 and IEC61000-2-2 (2-4).

3) PQ-Box 100 expert
This version has additional comprehensive trigger functions, which can record 10 ms rms. values.

4) PQ-Box 100 expert with ripple signal analysis
Recorder for ripple signal voltage is activated.

You can upgrade any PQ-Box 100 to “light”, “expert” or “expert + ripple signal” version via license code.

Performance			
PQ-Box 100	**basic**	**light**	**expert**
Statistic EN50160 / IEC61000-2-2		x	x
PQ events	x	x	x
Free interval:	x	x	x
Voltage: min. max. average	x	x	x
Current: min. max. average	x	x	x
Power: P, Q, S, PF, cos phi	x	x	x
Distortion power D	x	x	x
Energy: P, Q, P+, P-, Q+, Q-	x	x	x
Flicker (Pst, Plt)	x	x	x
Unbalance	x	x	x
Voltage, current harmonics		50.	50.
THD	x	x	x
Interharmonics- voltage, current		DC to 5kHz	DC to 5kHz
Ripple signal		x	x
Frequency	x	x	x
10/15/30 min interval - P, Q, S, D, cos phi …	x	x	x
Online mode including	x	x	x
Oscilloscope mode	x	x	x
Phasor diagram & Power triangle	x	x	x
Voltage, current harmonics	x	x	x
Interharmonics (U, I)	x	x	x
Direction of harmonics	x	x	x
Trigger functions			
manual trigger		x	x
10ms RMS recorder (U, I)			x
Oscilloscope recorder (U,I)			x
Option ripple signal voltage - possible	X	x	x

3.5 Brief description of the PQ-Box 100

Design:

The rugged mechanical design, protection class IP65 and the lack of rotating parts such as fans or hard disks make the device suitable for use in the field under the severest of conditions.

The PQ-Box 100 is equipped with a large memory capacity of 2 GB. This allows measurement values to be recorded over long periods of time, up to 12 months. In the event of a power failure, an internal UPS provides power to the network analyser for 20 seconds. The device can withstand such events several times in succession, because the battery capacity has been designed to last several minutes.

Power can be supplied in the form of AC or DC voltages via the measurement circuit or via an independent power supply.

The device runs using the free operating system FreeRTOS, version 4.7.3. The current source code of the operating system is available at www.FreeRTOS.org.

Display:

The device's display provides information about whether the measurement cables and current clamps are properly connected and it shows the real-time data of the voltage, current, THD and power.

The number of events that have occurred and the recorded time period are displayed to the user.

Keys:

Measurements are started via the "start/stop" key. The user can record multiple measurements without having to read out the device beforehand.

A "manual trigger" key allows oscilloscope and a "10 ms RMS" recording data to be captured on demand. This is ideal for taking a snapshot of network parameters.

Two additional keys allow the user to scroll through the screens and make/change basic device settings (e.g. CT and VT factors for medium or high-voltage networks)

Introduction to data recording features:

The PQ-Box 100 combines multiple simultaneous recording functions to provide overview and detailed data via PC for reporting and analysis:

- The average values[(1)] over a user defined "measuring interval" (1 second to 30 minutes) are stored and available displayed via the PC as line graphs, using the software "Permanent Recording" display functions. In addition during each measuring interval, the maximum and minimum 10 ms rms values are recorded for frequency, voltage, current and power.
- "Events" are captured when values exceed a user selected threshold:
    - "Limit events" are recorded as time stamped text records for slow voltage changes, fast voltage changes, frequency shifts, flicker, voltage unbalance, voltage THD or specific voltage harmonic limits

- "Oscilloscope Records" are high speed waveform recordings of voltage and currents similar to a fault record. These events can be triggered by voltage and/or current change events (selectable upper/lower threshold and step limits). Pre-triggering and recording time are user adjustable
- "10 ms RMS" records provide an alternative view to Oscilloscope Records. The half cycle rms value of voltage and current are recorded and reported in a line graph. "10 ms RMS" events have separate threshold settings and separate pre-triggering and recording settings
- As an option, Ripple control signals can be recorded as high speed data

(1) Over the user defined measuring interval each half cycle rms value (10 ms value) is measured, the average of which is recorded at the end of each interval.

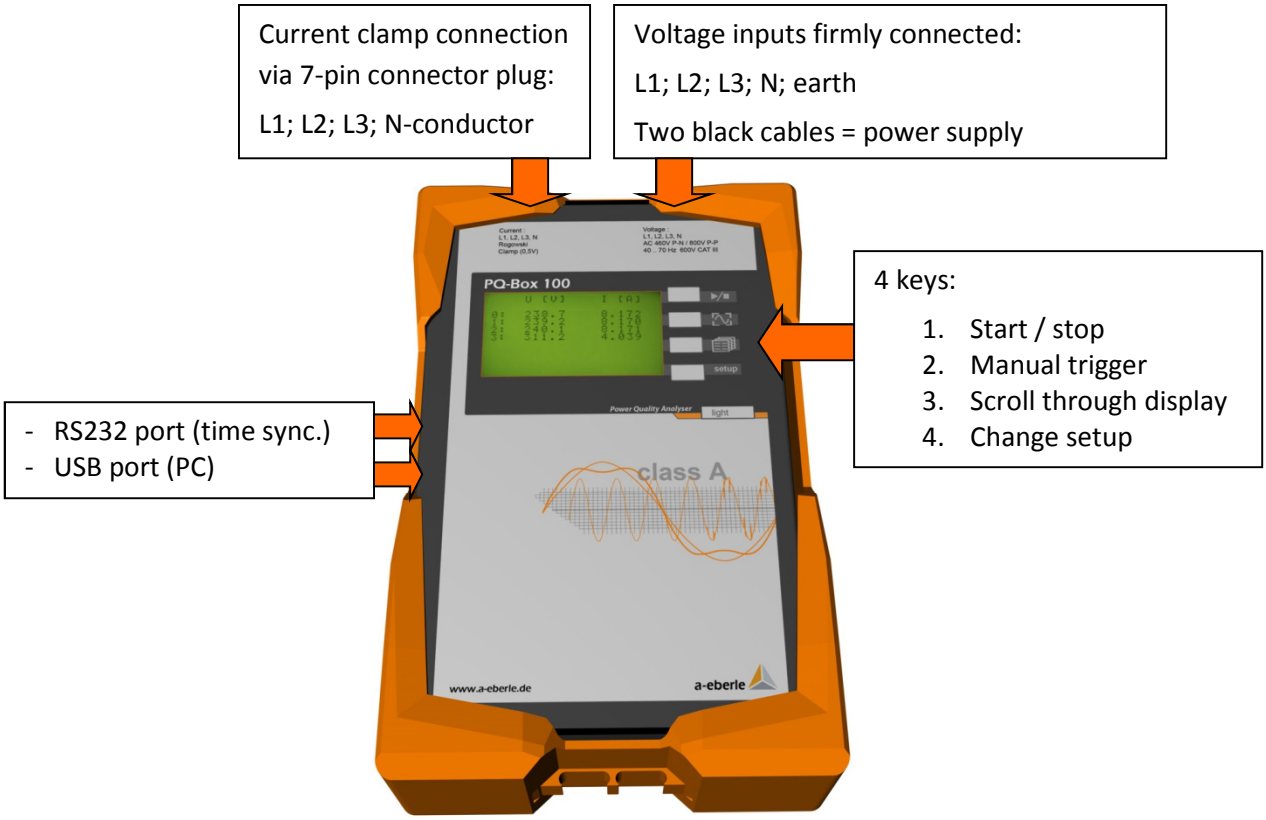
Evaluating measurement data:

Recorded data can be transferred to the analysis PC via the USB interface. For the data read-out, it is possible to power the device via the PC's USB interface, an external power supply is not required. The device is provided with comprehensive and user-orientated analysis software which can be installed on any number of PCs. Updates are also provided via our website (www.a-eberle.de) at no cost.

The software offers many display and analysis options permitting load analysis, fault detection in a network and comprehensive real-time analysis. Automatic standard reports according to EN50160 and IEC61000-2-2/2-4 are provided.

3.6 Overview of the PQ-Box 100 Network Analyser

Overview of the front panel of the device:



3.7 PQ-Box 100 Connection

Connect the 7-pin plug connector of the desired current clamp set to the PQ-Box 100. Standard current clamps are automatically detected and the measurement range is automatically set correctly.

Ensure that the measurement cables and current clamps are properly connected i.e. firmly closed and in the correct direction. The direction is indicated by arrows on the clamps. The direction of the arrow should point from the power source to the consumer/load to result in “positive” power readings.

Connect the voltage measurement cables to the desired measurement point.

- **The following connection versions are possible:**

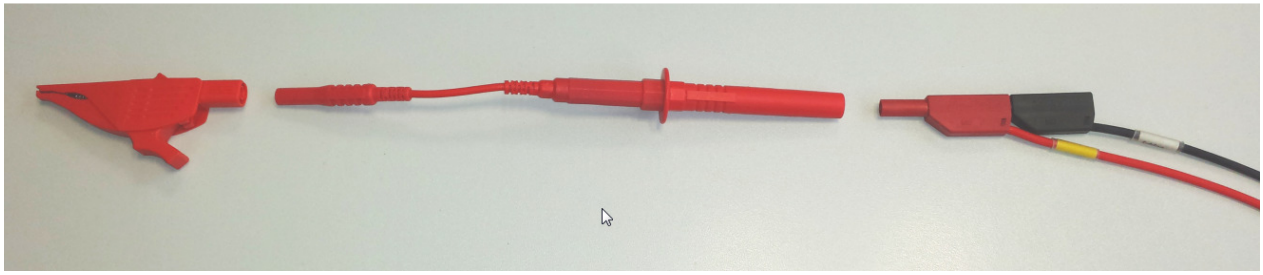
3.7.1 Voltage Connection for Low-Voltage 3 Phase grid

Caution

Damage to the PQ-Box 100 by short circuits

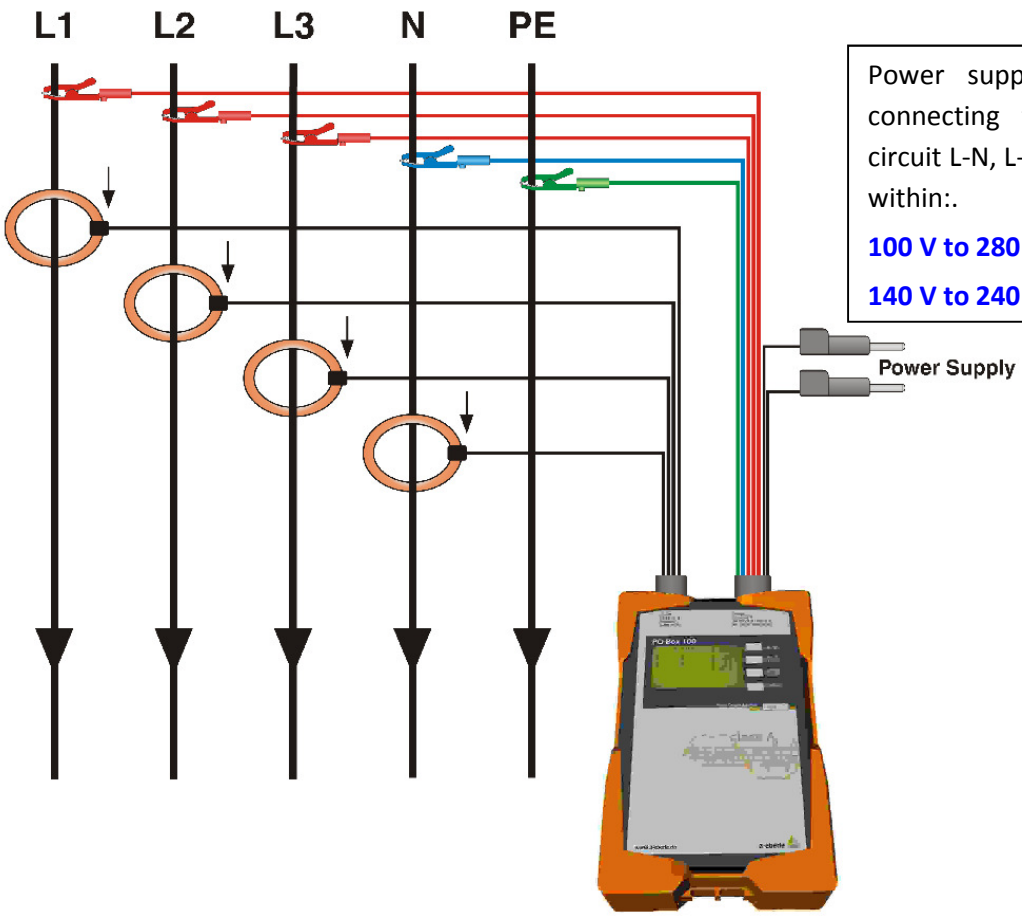
For measurements in network with a big short circuit power, ensure that the voltage leads and power supply are used with integrated Power Fuses. Please use our fuse adapter set.

Fuse voltage probe: Nr. **111.7014**



Use one fuse adapter per phase with power fuse. The power supply (black cable) can be stacked on the measurement line. Thus, short-circuits on the lines as well as in the instrument are proteced.

Connection in a 4-conductor, 3-phase grid:



Power supply possible by connecting to measuring circuit L-N, L-L (or external) if within:.

100 V to 280 V AC

140 V to 240 V DC

Important: This version has four voltage inputs and therefore measures the voltage of the neutral conductor to earth. The PE connection (green measurement cable) must be connected for each measurement. If no PE conductors are available at the measurement point, both the “N” and “PE” connections of the network analyser must be connected together to the N-conductor.

The measurement device can be supplied with power in a 400 V AC system via the conductor-earth voltage.

Power Supply PQ-Box 100

Caution

Damage to the power supply PQ-Box 100 by using wrong voltage

- supply device only with 100-280 V AC voltage.
- supply device only with 140-240 V DC voltage.
- do not supply the device directly from highly disturbed voltages. (for. example, a frequency inverter output / caution at high transients or high sampling frequency)

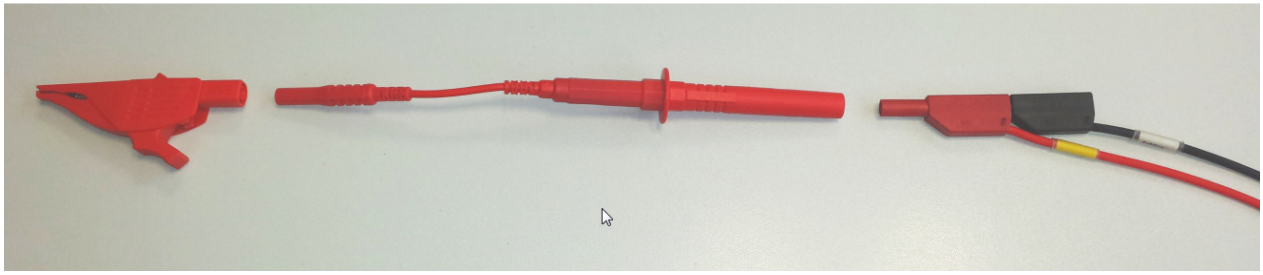
3.7.2 Voltage Connection for Low Voltage Single Phase

Caution

Damage to the PQ-Box 100 by short circuits

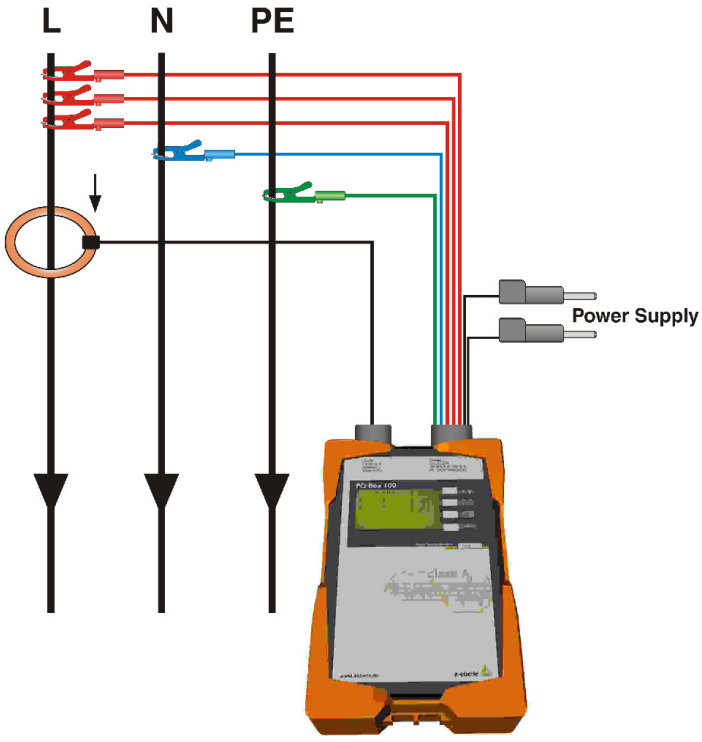
For measurements in network with a big short circuit power, ensure that the voltage leads and power supply are used with integrated Power Fuses. Please use our fuse adapter set.

Fuse voltage probe: Nr. **111.7014**



Use one fuse adapter per phase with power fuse. The power supply (black cable) can be stacked on the measurement line. Thus, short-circuits on the lines as well as in the instrument are protected.

Connection for single phase measurements:



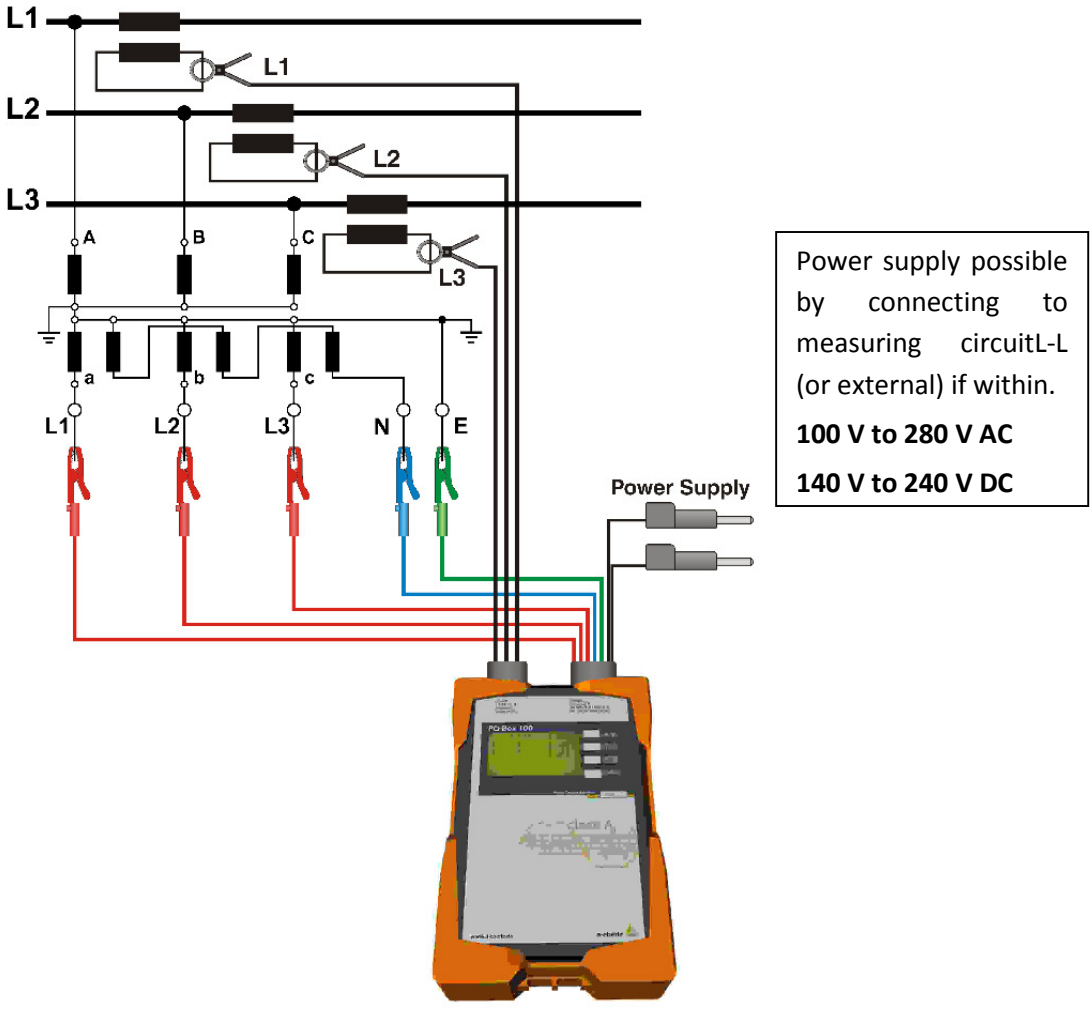
- For single phase measurements, change setting to 1-wire System
- Connect voltage leads L1, N and PE
- Not necessary to connect phases L2 and L3 for voltage and currents in single phase measurement
- If no PE is available, put N and PE together

3.7.3 Voltage Connection to Secondary Transformers in Medium and High-Voltage Networks

Select the type of network to be measured in the device setup (3-conductor network or 4-conductor network). The device now automatically sets all of the measurement parameters and trigger settings to this type of network. In a 3-conductor network, all conductor-to-conductor power-quality parameters are evaluated. In a 4-conductor network, the measurement device monitors the values of the voltage quality conductor-to-earth.

Connect the voltage measurement cables to the VT secondary's. In setup, enter the correct nominal primary voltage and correct transformer ratios for current and voltage transformers.

The PQ-Box 100 can also be powered via the voltage transformer secondary voltage. However, to avoid any feedback effects on the measurement values by the measurement device's power supply, it is recommended that you supply the device from an external power source.



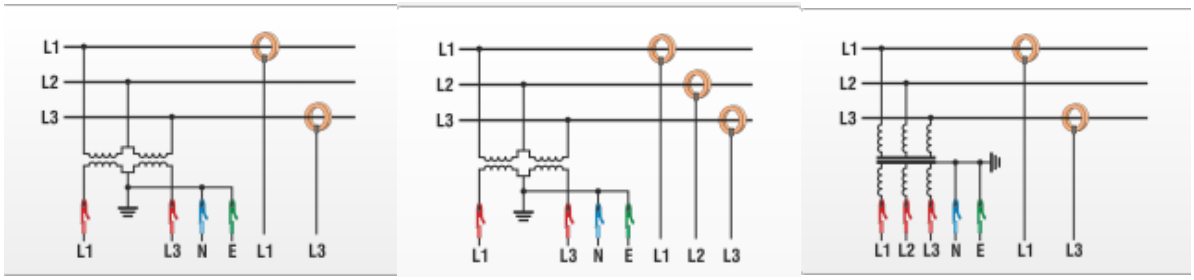
The input impedance of a measuring input is 1 mega ohms.

If the high-resistance ground connection is not desired, it is also possible to interconnect the terminals E and N and to hang open. (No connection to any ground)

In 3-wire connection the 4th voltage channel and the 4th current channel will be calculated from the device. (Voltage Neutral to Ground and current of the star point)

VT - CT connections:

For voltage transformers with open-delta connections or if using a two-wattmeter connection (Aron circuit) via current transformers select the appropriate configuration in the setup of PQ-Box 100.

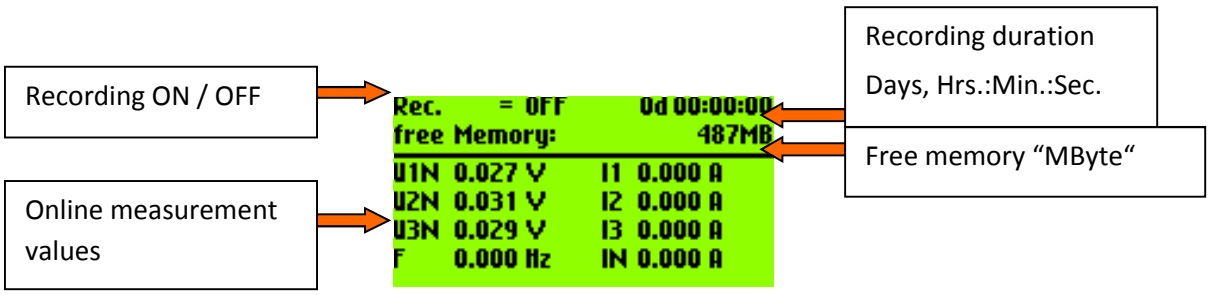


3.8 Start of the Measurement

Once everything is connected, start the recording using the  key.
The display “Rec. = OFF” changes to “Rec. = ON“ and the duration of the recording increments in second intervals.

The display should be checked to confirm if the voltage and current measurement cables are connected properly. Are the correct primary values being displayed? If the arrows of the current clamps were pointed in the direction of the consumer/load, the power values will be displayed with a plus sign on the display.

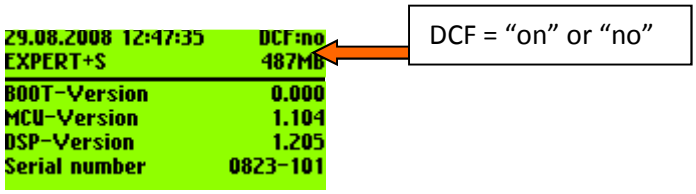
Start screen:



3.9 Time Synchronisation at the RS232 Port

The RS232 port is designed for connecting a DCF77 receiver or GPS time clock supplied from A. Eberle. If the network analyser detects that a time-receiver is connected, the measurement device automatically synchronises to this time pulse. If no time receiver is detected, the PQ-Box 100 uses an internal quartz clock.

The synchronisation of the measurement device to the external signal is displayed on the 6th page of the device's screen.



3.10 Manual Trigger Key

The  key of the PQ-Box 100, can be used to record the current status of the network. During permanent recording, if the key is pressed, an oscilloscope record and an “10ms RMS” record are taken with the duration that was specified in the setup.

The total number of event recordings (manual and automatically triggered) is displayed on the device's display. Note this may take a couple of seconds to update.

Example 1/2:

2 fault records were triggered while 1 fault record been stored on the SD card.

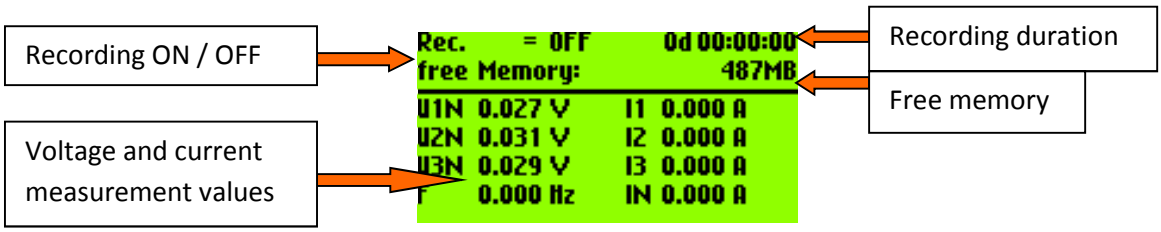
Example application:

What network feedback effects are caused by a drive in the network that is regulated by a frequency converter?

Manually record an oscilloscope record while the drive is switched off, then manually record again with the drive connected to the network. Both records can later be compared to each other using the analysis software and the feedback effects of the drive can be determined.

3.11 PQ-Box 100 Display

3.11.1 Start screen



- **If no key is pressed, the screen illumination switches off after 15 minutes.**

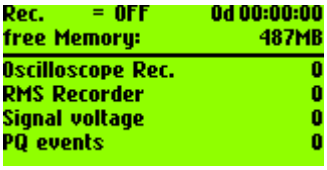
Note to reduce the flicker of digits if CT clamps are not connected, and display of values substantially below minimum clamp specifications, the LCD will show zero values if the measurement is below a minimum threshold:

- < 10 mA for 20 A mini clamps
- < 1 A for 3000 A Rogowski clamp

3.11.2 Scrolling Through the Screens

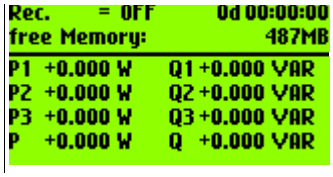
Using the  key, you can move through the different pages of the real-time rms. values in a circular fashion.

2. Screen page:



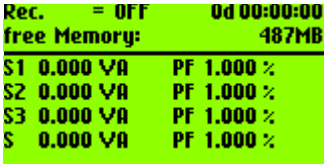
This page shows the number of recorded oscilloscope records, rms records, ripple signal records and power quality events.

3. Screen page:



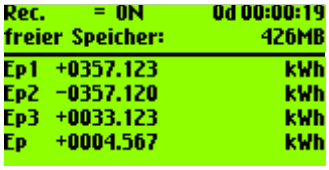
Active power and reactive power of the phases L1, L2, L3 and accumulated power, incl. the +/- prefixes.

4. Screen page:



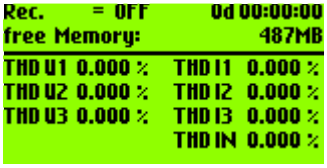
Apparent power and power factor of phases L1, L2, L3 and the sum.

5. Screen page:



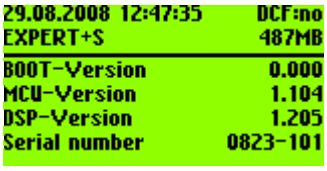
Real energy counter in kWh since start of measurement

6. Screen page:



THD of the voltages, currents and neutral circuits

7. Screen page:



Date, time, device version (light or expert) and current firmware version

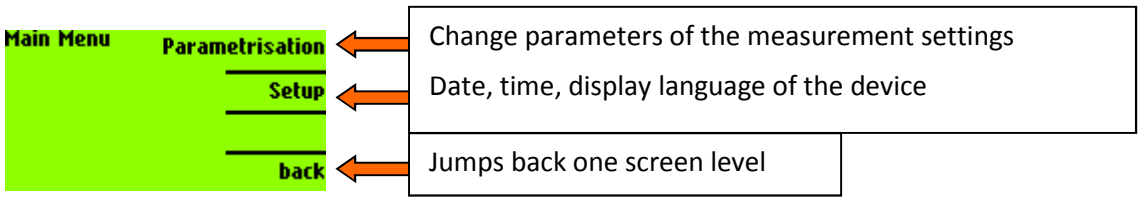
- **After screen no. 6, the initial screen reappears.**

3.12 Changing Settings in the PQ-Box 100 Setup

Using the 

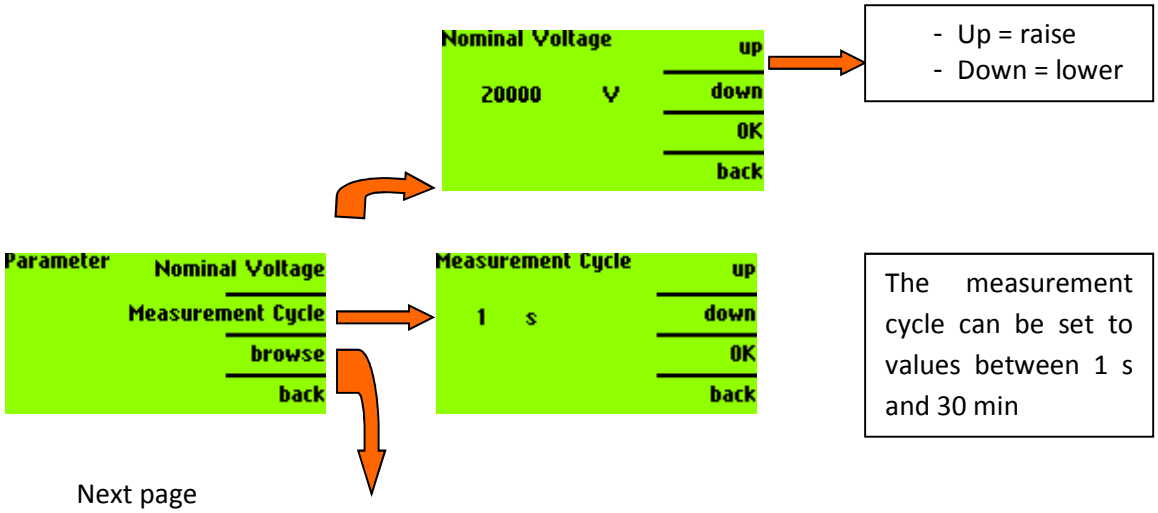
key, the menu opens in order to allow basic settings to be changed in the measurement device. The key is disabled during an ongoing measurement.

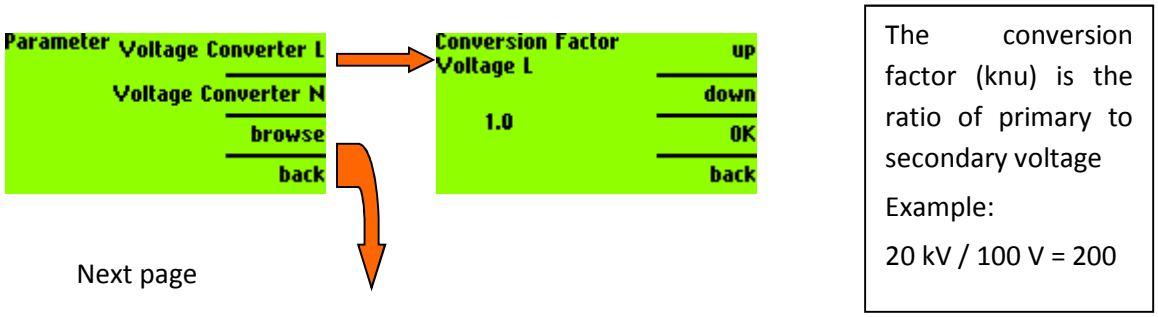
3.12.1 PQ-Box 100 Parameterisation

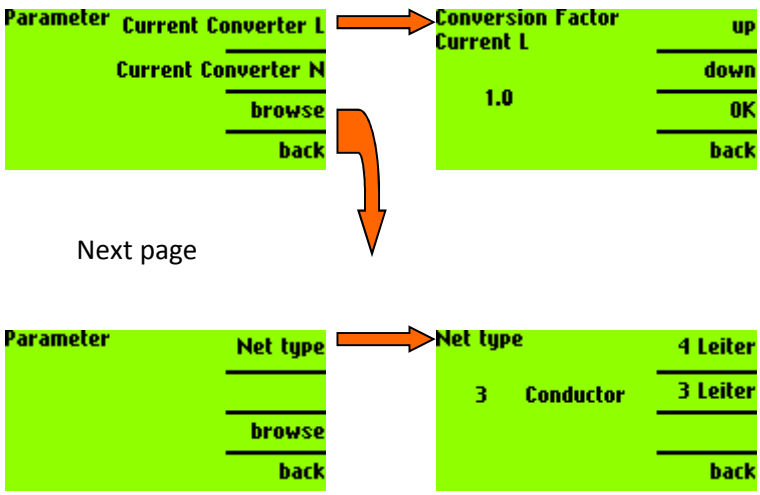


The **nominal voltage** always refers to the contractually agreed primary **conductor-conductor voltage**. All event recorders and standard analyses with their percentage values are relative to this value.

For low-voltage, e.g. 400 V, for medium voltage, e.g. 20.60 kV.







The conversion factor (kni) is the ratio of primary to secondary current

Example:

600 A / 5A = 120

Network configuration:

1-phase system

3-wire system

4-wire system

In one isolated 3-wire network, all evaluations according to standard EN50160 are calculated from the conductor-voltages. In a 4-wire network (earthed network), all PQ parameters are to be determined by conductor to earth voltages.

The selection of 3 or 4-wire network therefore affects the EN 50160 report, but also affects the LCD displayed values, some recorded data and Event trigger setups

	4-wire setting	**3-wire setting**
PQ-Box 100 LCD	Line-to-Earth voltages shown	Line-to-Line voltages shown
PQ-Box 100 Software EN50160	EN50160 reports show voltages as Line-to-Earth values	EN50160 reports show voltages as Line-to-Line values
Permanent Recorded Voltage [U eff, U eff max, U eff min, U eff R, THD, Phase angle, Short Term Flicker, Max flicker online output, Long term flicker, Divergence & PWHD]	L-L, L-E and N-E values recorded	
Permanent Recorded Individual Voltage Harmonics Even harmonics (H2-H50) Odd harmonics (H1-H490) Interharmonics (IH0-IH49)	L-E and N-E values recorded	L-L values recorded

Oscilloscope & "10ms RMS" recorder (also see Note 1)	L-L, L-E and N-E values recorded	
Online data		
Oscilloscope	L-L, L-E and N-E	L-L, L-E and N-E
Spectrum	L-L, L-E and N-E	L-L, L-E and N-E
Harmonics	L-E and N-E	L-L
Inter-Harmonics	L-E and N-E	L-L
Direction	Valid	No reading

Note 1)

Oscilloscope and "10ms RMS" recorder triggers are set independently for L-E and L-L events, and can be enabled or disable for both 3-wire and 4-wire setups. By default (Basic Settings) only L-E triggers are enabled, therefore, **if measuring a true 3-wire system check if you need to turn off L-E triggers and turn on L-L triggers.**

3.12.2 Date, Time and Language Settings

In the menu item "Setup", you can change the date, time and language of the network analyser.

3.12.3 Disabling the Keys of the Measurement Device

If you want to lock the measurement device from unauthorised use during an ongoing measurement, you can disable the keys, this also restricts the LCD display to the currently selected screen. The keys can be locked from any screen.

Pressing the 

key > 5 seconds after the start of a measurement disables the keys.

When a key on the device is pressed, the following message appears.

"**key locked**"

The keys can be reactivated by pressing the 

key for 5 seconds.

3.12.4 Memory management PQ-Box 100

The PQ-Box 100 manages its memory automatically.

Memory Management behaviour:

The goal is that the PQ-Box 100 should not stop recording permanent recorded data if the trigger thresholds are not correct and the device records too many events. Therefore:

- One single measurement file is limited to 690MByte.
- Upon starting each recording the size of the memory of all event recorders is limited to a maximum of 50% of the available memory (to a maximum of 300MB).
  I.e. if the free memory is 500MB upon starting, in this case the event recorder memory will be limited to 250MB, reserving 250MB for permanent recorded data (a considerable amount)
- If the event recorder memory overflows, this is indicated by a * behind the number of records in the second page of the PQ-Box 100 LCD display
  I.e, Number of Oscilloscope recorders = 1034 *
- If there are limited recorder events, and the perment recorder memory fills its allocation, then the PQ-Box 100 automatically permits the remaining free event memory to be used for permanent recording.
- If the entire PQ-Box 100 memory is filled, recording will stop, and message “Memory full” will be shown in the display.

3.12.5 Delete memory of PQ-Box 100

It is possible to delete the PQ-Box 100 memory without a computer, using the front panel keys. and.

Press and hold the buttons  + 

while connecting the power supply to the device. A confirmation message will appear in the display: “Delete memory?”. Pressing “OK” will cause all recorded data to be deleted from the memory – it will not be recoverable. Note that this procedure does not affect PQ-Box 100 settings, which will remain without change.

4. Accessories for current measurement

The PQ-Box 100 automatically detects the current clamps and sets the correct measurement range using a code in the plug connector of compatible CT clamps. Note some CT's require the user to input a correction factor this is described below for the applicable devices.

4.1 Rogowski current clamps

- **Rogowski current clamp 4~: Ident-No. 111.7001**
- **Rogowski current clamp 4~: Ident-No. 111.7006**

Model 111.7006
6000 A measurement range
Adjustment of the power converter factor to x2

Model 111.7001/6

Model	**111.7001 Pro Flex 3000 4~**	**111.7006 Pro Flex 6000 4~**
Current range	3,000 A AC RMS	6,000 A AC RMS
Measurement range	0-3300 A AC RMS	0-6,600 A AC RMS
Output voltage	85 mV / 1000 A	42.5 mV / 1000 A
Frequency range	1 Hz to 20 kHz	10 Hz to 20 kHz
Isolation voltage type	600 V AC / DC CAT IV	600 V AC / DC CAT IV
Accuracy (20 °; 50 Hz)	<50 A/0.1 % of the full scale value 50-3000 A/1.5 % of the measured value	<100 A/0.1 % of the full scale value 100-6000 A/1.5 % of the measured value
Angle error (45-65 Hz)	<50 A/2.5 ° 50-3000 A/1 °	<100 A/2.5 ° 100-6000 A/1 °
Position accuracy	<50 A/0.2 % of the full scale value 50-3000 A/1.5% of the measured value	<100 A/0.1 % of the full scale value 100-6000 A/1.5% of the measured value
Long Rogowski coils	610 mm	910mm
Diameter clamp head	9,9mm	9,9mm

- **Mini- Rogowski current clamp 4~: Ident-No. 111.7030**

Current range: 2A to 1500A RMS; Accuracy: 1%
Rogowski clamp length = 400mm;
Diameter = 125mm; Rogowski clamp head = 8,3mm
Frequency range: 10Hz to 20kHz

4.2 Current clamps

The MU-metal clamp is especially applicable for small current measurements on secondary transformers in medium- and high-voltage networks. High accuracy and small angle errors are combined.

- **Mu-Metal Mini-Current clamps 3~: Ident-No. 111.7003**

Current range: 10mA to 20A

Frequency range: 40Hz to 20kHz

- **Mu-Metal Mini-Current clamps 4~: Ident-No. 111.7015**

Current range: 10mA to 20A/200A AC RMS (two ranges)

Frequency range: 40Hz to 20kHz

Model 111.7015

Measurement range	**20 A measurement range**	**200A measurement range**
Current range	23 A AC RMS	200 A AC RMS
Measurement range	100 mA to 23 A RMS	5 A to 200 A RMS
Output voltage	10 mV/A	1 mV/A
Frequency range	40 Hz to 20 kHz	40 Hz to 20 kHz
Isolation voltage type	600 V AC	600 V AC / DC
Accuracy	100 mA- 10 A/2 % of the measured value 10-20 A/1 % of the measured value >20 A/1 % of the measured value	10-40 A/<2 % of the measured value 40-100 A/<1.5 % of the measured value 100-200 A/<1 % of the measured value
Angle error	100 mA- 10 A/2° 10-20 A/2 ° >20 A/2 °	10-40 A/<2 ° 40-100 A/<1.5 ° 100-200 A/<1 °

200 A Measurement range (111.7015)

Adjustment of the power converter factor to x10

- **Mu-Metal Mini-Current clamp 0…5A 1~: Ident-No. 111.7043**

Current range: 5mA to 5A AC RMS

Frequency range: 40Hz to 20kHz

Free current adapter set necessary

▶ AC/DC Current clamp 1~: Ident-No. 111.7020

AC/DC hall sensor clamp. Set with power supply and 2 pcs. 4mm connectors

Current range 60A/600A (two ranges)

Model 111.7020

Measurement range	**AC/DC 60 A**	**AC/DC 600 A**
Current range	60 A AC/DC RMS	600 A AC/DC RMS
Measurement range	200 mA to 60 A RMS	0 to 600 A RMS
Output voltage	10 mV/A	1 mV/A
Frequency range	DC to 10 kHz	DC to 10 kHz
Isolation voltage type		
Accuracy	-0.5-40 A/<1.5 % +5 mV -40-60 A/1.5 %	-0.5-100 A/<1.5 % +1 mV -100-400 A/<2 % -400-600 A(DC only)/<2.5 %
Angle error	-10-20 A/<3 ° -20-40 A/<2.2 °	-10-300 A/<2.2 ° -300-400 A/<1.5 °

600 A Measurement range (AC/DC)

Adjustment of the power converter factor to x10

4.3 Accessories for current measurement

- **Free Adapter set for connecting 4 clamps: Ident-No.: 111.7004**

Adapter set for connecting 4 clamps or shunt with 4mm connectors. 2m length
The free adapter set can be used to connect other current clamps to the PQ-Box 100 provided they have a compatible voltage output. Note that the voltage input of the current channels is 0 – 700 mV rms (for PQ-Box 100's delivered from 01/2011. For PQ-Box 100's delivered prior to 01/2011 input voltage range is 0 – 330 mV rms). Do not exceed these ratings.

The PQ-Box 100 is designed for clamps with a 20 A to 200 mV scaling factor. If using clamps with a different ratio, you must apply a correction factor to the PQ-Box 100.

Example:

If you use a current clamp with a 200 A to 200 mV range , it is necessary to change the CT ratio in the set-up of the device to "10x".

Power conversion factor
Current conversion correction factor; the default is 1 A/10 mV

Caution

Damage to the device from external current clamps
- Do not use clamps with A or mA output
- Avoid input voltages at the current inputs greater than 30 V

- **Current clamp cable extension: Ident-No.: 111.7025**

Cable extension 5 m for current clamps or Rogowski coils.

- **Current-shunt 2A: Ident-No.: 111.7055**

Measurement of AC- and DC-currents. Current range = 2A / 200mV output signal

.

4.4 Ordering Details of the PQ-Box 100 and Accessories

CHARACTERISTICS	CODE
Fault recorder and network analyzer according to DIN EN 50160 and IEC 61000-3-40 class A Mobile power-quality-network analyzer and power-meter for low-, medium- and high voltage networks according to DIN EN-50160/IEC 61000-4-30 class A ● 2 GByte flash memory ● USB interface ● Display ● IP65; with uninterruptible power supply ● USB-cable set; Ethernet cable set ● Voltage connecting cable ● 2 power supply lines ● 5 Dolphin clips ● 3 pcs high current fuses for voltage leads ● Hardcase for current clamps and measurement cables incl. analysis software	**PQ-Box 100**
Version	
● PQ-Box 100 (4U/4I) basic	B0
● PQ-Box 100 (4U/4I) light	B1
● PQ-Box 100 (4U/4I) expert	B2
Operating manual and display	
● German	G1
● English	G2
● French	G3
● Spanish	G4
● Italian	G5
● Dutch	G6
● Czech	G7
● Russian	G8
● Polish	G9
UPGRADES	**IDENT-NO.**
Ausführung	
● Upgrade version „basic“ (B0) to „light“ (B1)	900.9090
● Upgrade version „light“ (B1) to „expert“ (B2)	900.9091
● Upgrade version „basic“ (B0) to „expert“ (B2)	900.9093
● Upgrade R0 to R1 (ripple control recorder)	900.9092
ACCESSOIRES	**IDENT-NO.**
● Voltage tap on insulated cable; contact support 1 ~, connected for 35-240mm ²	111.7037
● Cable set 4 phase, 1.5 mm ², 2m long, 4x 16A fuse, 4x 4mm safety plugs	111.7038
● Network adapter connector socket for 1 ~; 4mm safety plugs	582.0511
● Calibration set for PQ-Box 100/200; calibration software and adapter box	111.7039
● Lemp rubber case for fuse box	111.7012
● Silex Box, SX-3000GB; USB to TCP-IP converter	111.9030.43
● Kit of magnetic voltage taps	111.7008
● GPS radio clock (230V – RS 232)	111.9024.47
● CAT-Booster (600V CAT IV) voltage adapter for PQ-Box 100 / 200	111.7026

5. PQ-Box 100 Analysis Software

The analysis software “WinPQ mobil” supports the **PQ-Box 100, PQ-Box 150 and PQ-Box 200** mobile network analyser.

It was developed in collaboration with energy supply companies with the aim of producing an easy-to-operate and adaptable solution for evaluating network quality parameters in energy distribution networks.

The network analyser is suited for network analysis in **low, medium and high-voltage networks**.

The purpose of this program is to prepare the power quality measurement data and fault records for the user and to then suitably display this data on the PC screen. For this purpose, the program provides tools for efficiently selecting saved data and a series of graphic and tabular forms of display with the characteristics of the voltage quality according to standard ***EN50160*** **and** ***IEC61000-2-2*** **for public networks** or **IEC61000-2-4 for industry networks**

- ✓ Automatic reporting according to the compatibility levels of EN50160, IEC61000-2-2 or IEC61000-2-4
- ✓ Information on faults in the network via fault records (events)
- ✓ Management of multiple measurements
- ✓ Data acquisition of long-term data and events
- ✓ Statistical long-term analyses
- ✓ Correlation of events and various measurement data
- ✓ User-friendly and user-orientated evaluation

5.1 Software installation / uninstallation

System requirements:

Operating system: Microsoft XP (Service Pack 2)

Microsoft Windows NT

Microsoft Windows 7 (32bit / 64bit)

Microsoft Windows 8 and 10

Installing analysis software:

To begin the installation of **the analysis software**, place the Installation CD in your CD-ROM drive. If Auto-start is enabled the installation program will begin automatically. Otherwise, navigate to the root directory of your CD-ROM drive and start by double-clicking the 

file.

The software is installed as per any standard Windows application and can be deinstalled as normal via the Control panel functions. The installation location of the program (target folder) can be specified during installation.

Select a folder where the user has read and write permission!

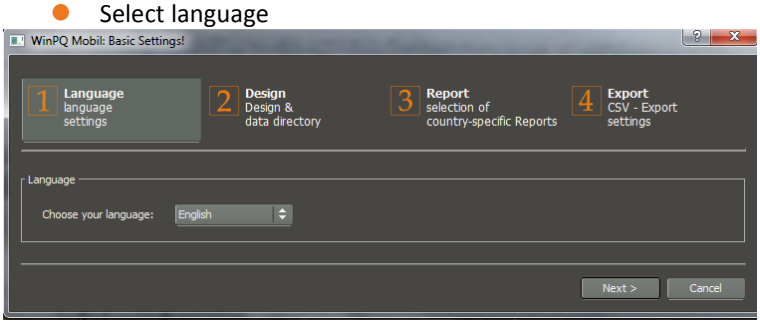
The start icon 

is automatically created on the desktop of the PC.

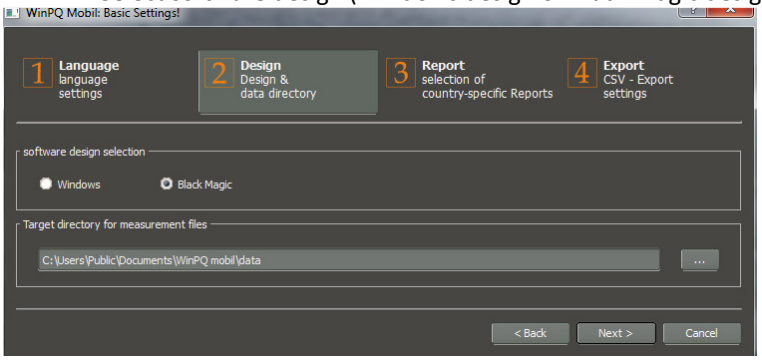
If you install the software on a new PC, after the first opening, a setup assistant will start. Customer and country-specific settings are automatically queried and copied into the software. All settings can be changed later in the Software General Settings.

Software Wizard:

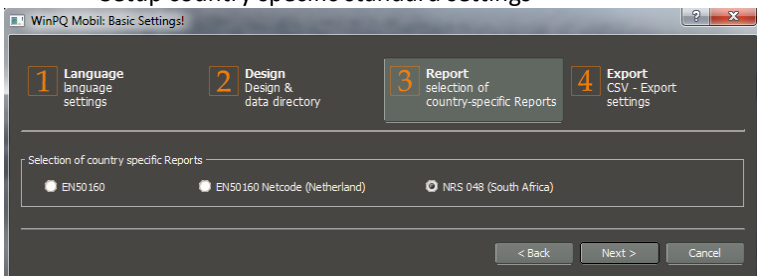
- Select language



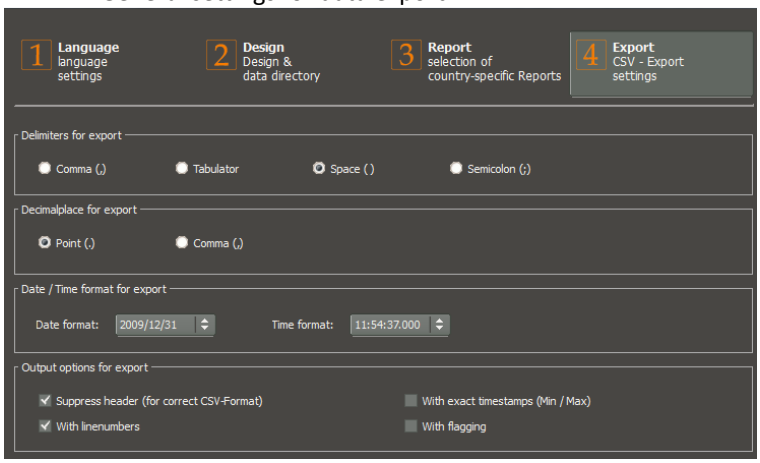
- Select software design (Windows design or Black Magic design)



- Setup country specific standard settings



- General settings for data export



Uninstalling the software via the control panel:

The removal of all components from the computer is done via the Windows “control panel.”

Under **“**Software“, click on “PQ-Box 100,” and click the "Remove" button to delete the analysis software**.**

All program components, including the links that were created, are completely removed by clicking the button once. Close any open program components before uninstalling the program. Note that user data (settings and data records) will not be removed, thus should be done manually if required.

Software updates

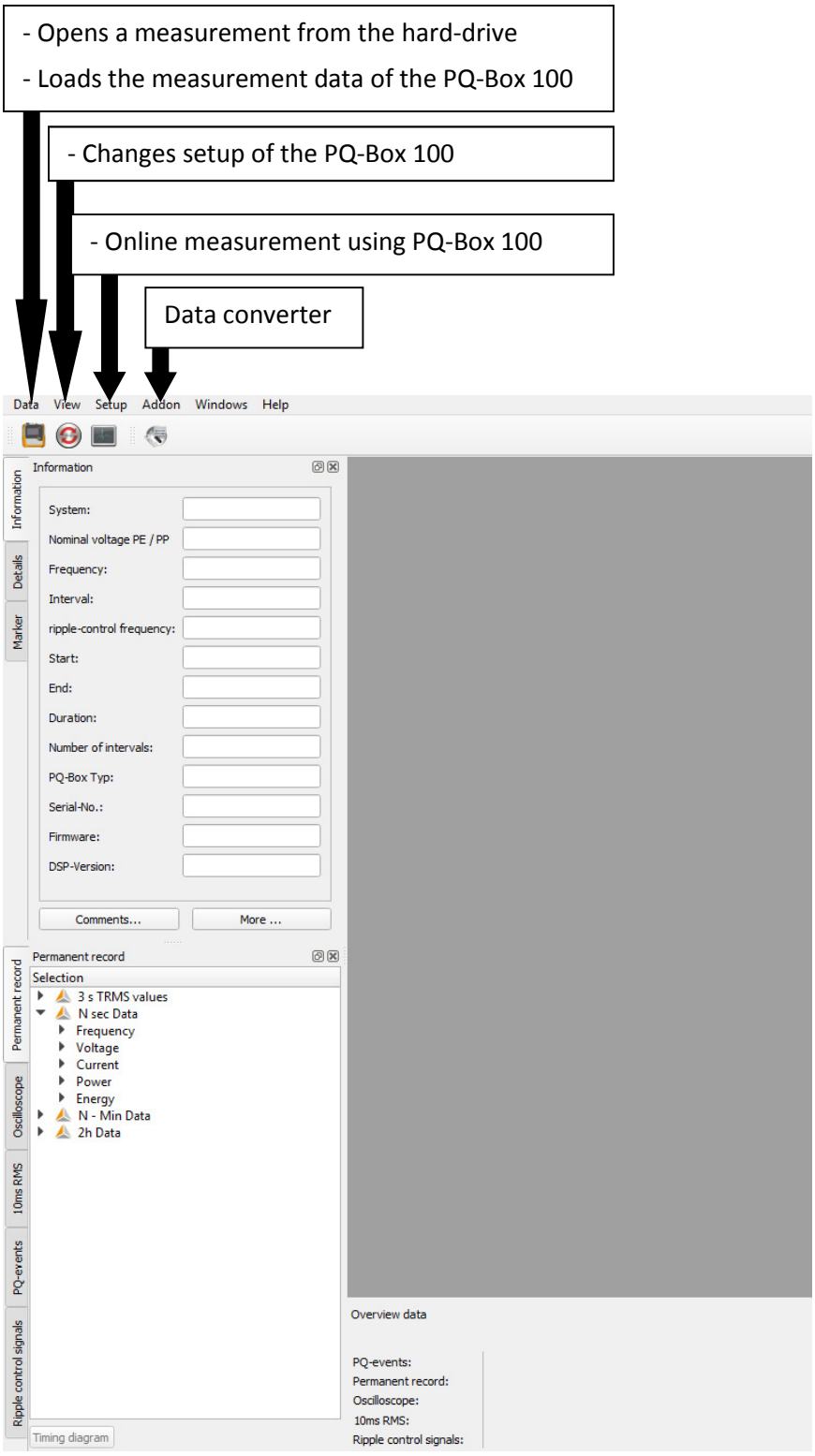
The software “WinPQ mobil” and updates can be found free of charge on our web page:

www.a-eberle.de.

Please update both, the software and the firmware of the PQ-Box 100, to avoid problems.

5.2 Start Screen of the PQ-Box 100 Software

Start screen of the PQ-Box 100 analysis software

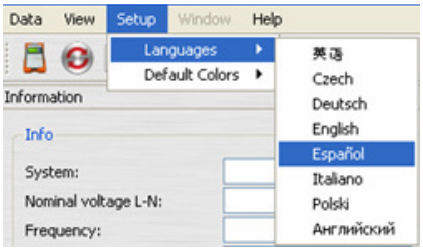


5.2.1 Common setup software

Changing the language:

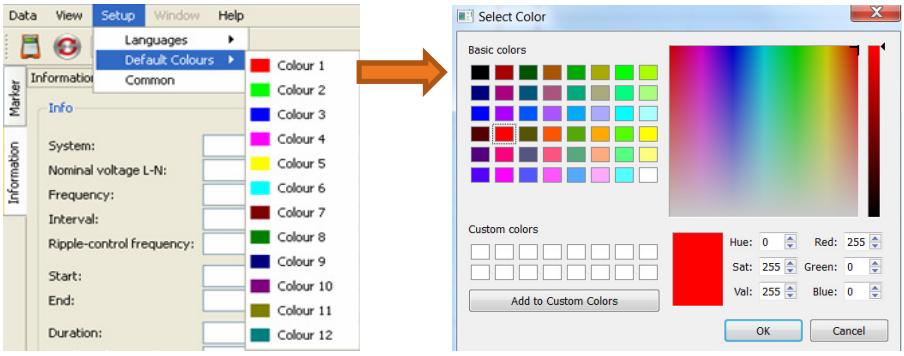
In the “Setup Languages”, you can change the language used for the analysis software.

After you change the language, the software must be restarted for the change to take effect.

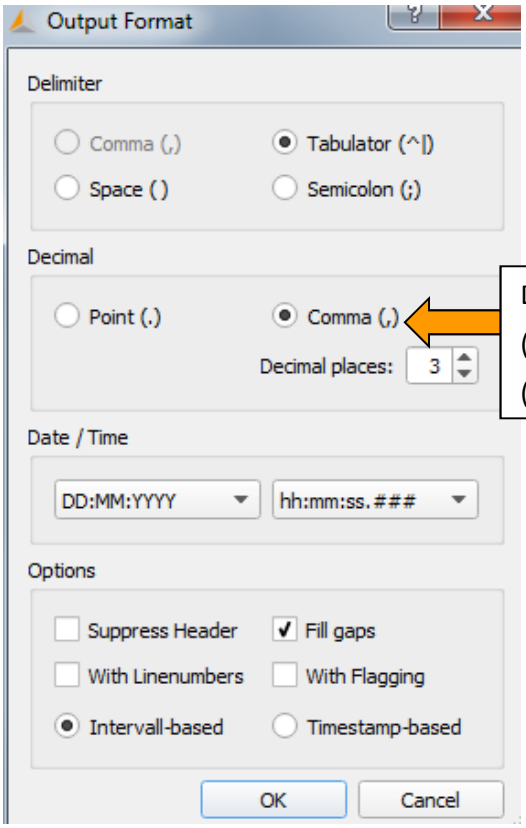


Changing colours

The colours of the different channels in all diagrams can be changed. There are two different settings possible: Windows native and Black magic. For print always the colours Windows native are used.



Data export – basic settings:

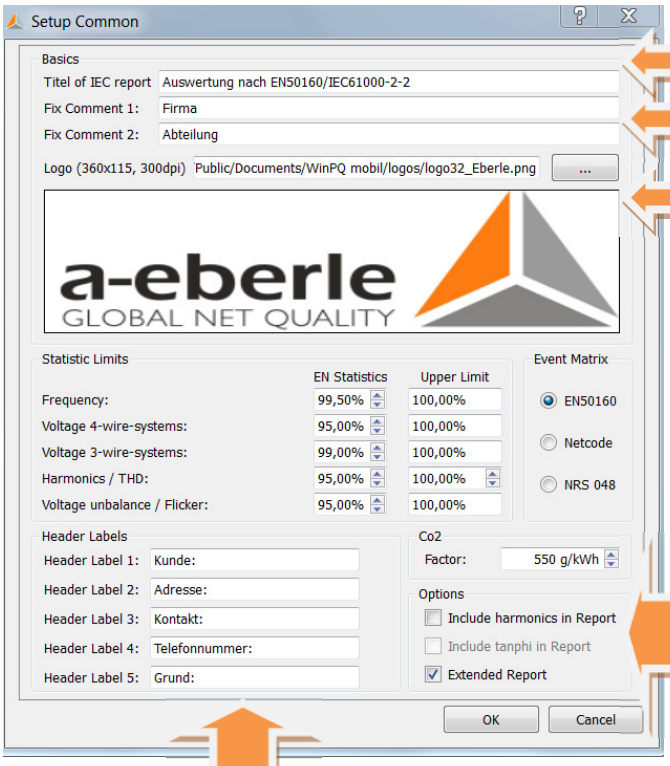


Decimal point separator:
(,) = German Windows
(.) = English Windows

Data export:

- Suppress Header – Information like device number, measuring interval and comments will be not in the header of the export file
- Fill gaps – gaps inside the measurement data based on interruption will be filled with 0.
- With flagging: show flagged data according IEC61000-4-30 in export data file
- With exact time stamp: all extreme values are stored with the exact time stamp in milli-seconds. For data export format it can be selected to receive the exact time stamp or one time stamp
- Export with exact time stamp: All ½ period extreme values are recorded by the meter with exact time stamps in milliseconds. For the data export it is now possible to choose whether the extreme values should be displayed in milliseconds in the export or whether all min, medium and maximum values should have a common time interval in the export.

Common settings WinPQ mobil



Title of the power quality report

Two fix comments will be printed on all reports and graphs.

Customer logo for reports and printings

1) Extended Report

This function extend the standard report with all PQ events and the ITIC graph

2) Include tanphi in report

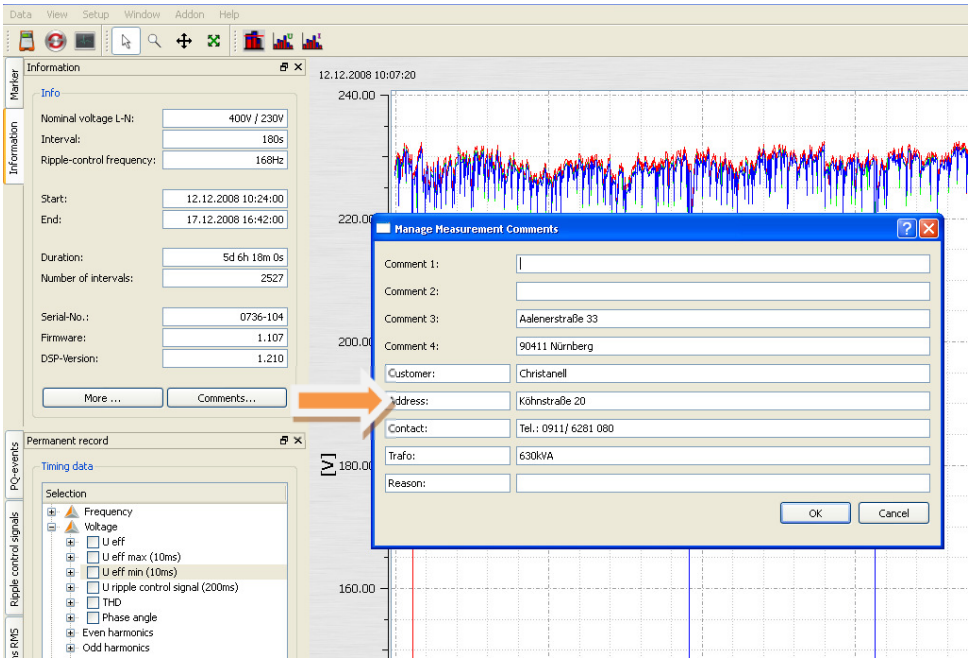
Here the information of tanphi can be activated or deactivated in the standard report

4 labels for the standard report and all printings can be changed here

Carbon dioxide calculation

The energy supply can be displayed in WinPQ mobil in carbon dioxide. The calculation factor can be set here.

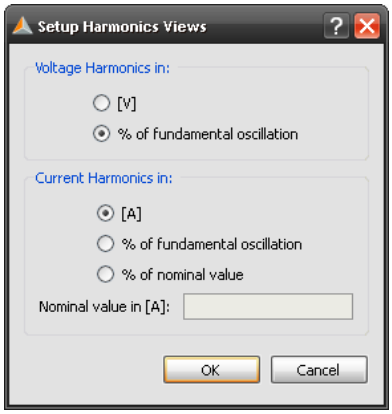
These 4 labels you will find under the icon “Comments...” and can be filled with information according the measurement.



Setup Harmonics

In Setup Harmonics it is possible to change the displayed units of voltage- and current harmonics for all measurements:

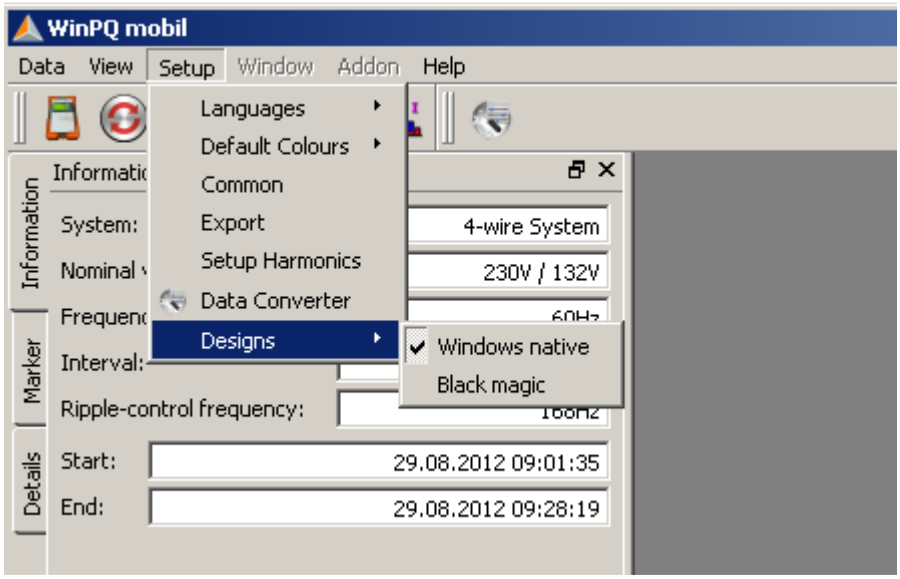
- **voltage harmonics can be displayed as “volts” or as “% of fundamental”**
- **current harmonics can be displayed as “amps” or as “% of fundamental” or as a “% of nominal value” where the user can enter the desired nominal current value**



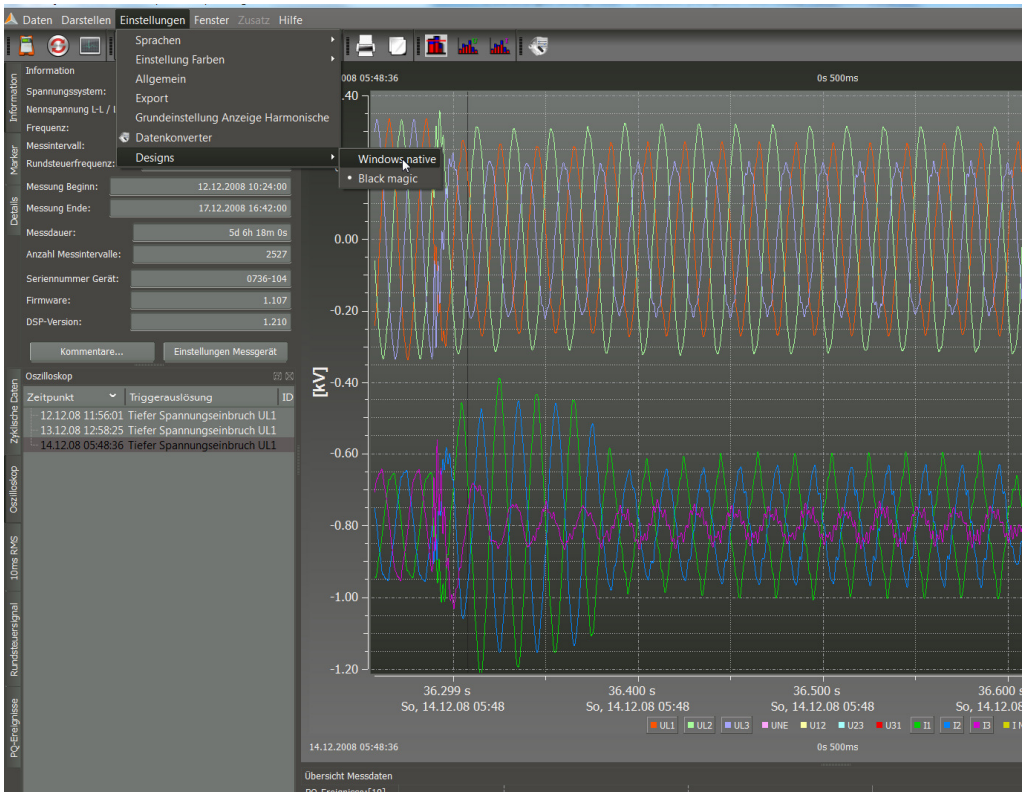
All diagrams and bar graphs in the software will use the selected units (volts or %; amps or % etc.).

Design of the software

WinPQ mobile offers two different designs for screen displays.



- Windows native
- Black magic



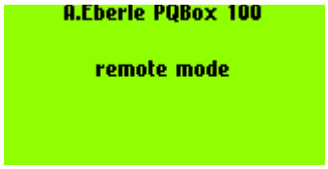
For print always the colours Windows native are used.

5.3 Loading the measurement file from the PQ-Box 100 to the PC

Connect the network analyser to the PC using the provided USB cable. The communication speed for USB is 10MB – 20MB per minute.

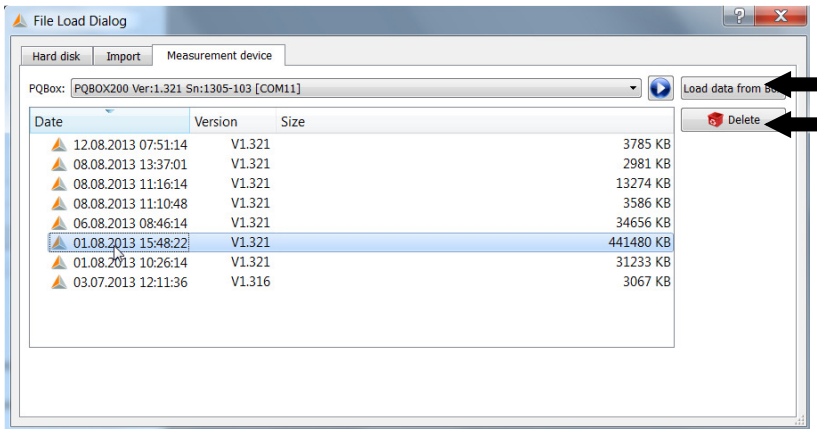
There is no need for the PQ-Box 100 to be powered by an auxiliary supply to download the measurement data from the PQ-Box 100 or upload/download settings as the PQ-Box can be powered via the USB port. Note that online measurements and recordings cannot be made while the PQ-Box 100 is powered by USB only.

The following display appears on the display of the PQ-Box 100 if the device is being powered via a USB port:



When the PQ-Box 100 is connected the  icon can be used to display all of the available measurement data within the PQ-Box 100 memory.

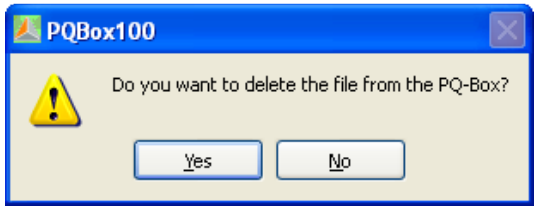
Press the icon  to read the memory of PQ-Box 100.



Loads measurement data from PQ-Box 100 to the PC

Deletes highlighted measurement data from PQ-Box 100

After the data has been imported, the analysis software automatically ask, if you want to delete the measurement data from the memory of PQ-Box 100.



Yes - the data will be removed from the memory of PQ-Box 100

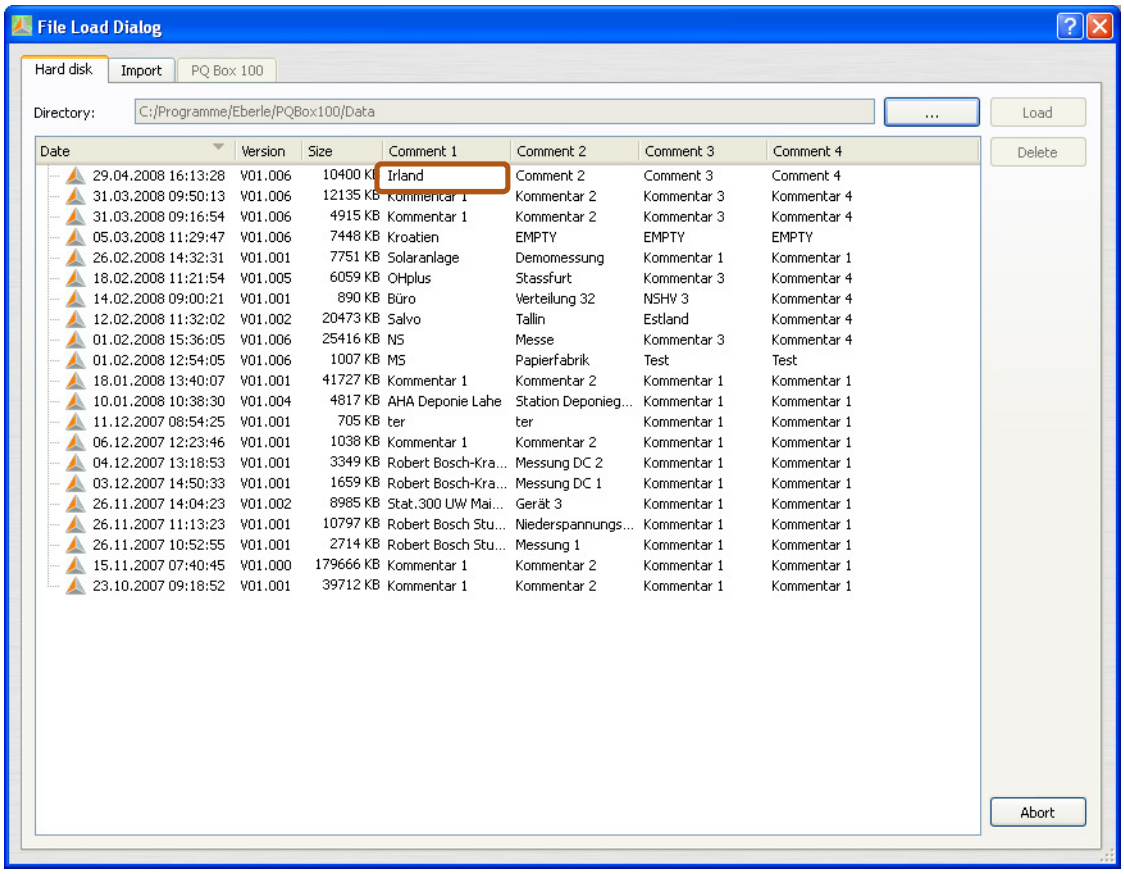
No - the data will stay on PQ-Box 100. The measurements can be loaded onto additional PCs.

Important: We recommend you to delete the measurement data from the PQ-Box 100 memory after the download in order to avoid filling up the memory of the measurement device unnecessarily.

Comments:

Four comments can be entered, with double mouse click, here for each measurement. If no comments have been entered, the word “Comment” appears in this field.

All comments (comment 1 – 4) will be written in each report and printing.



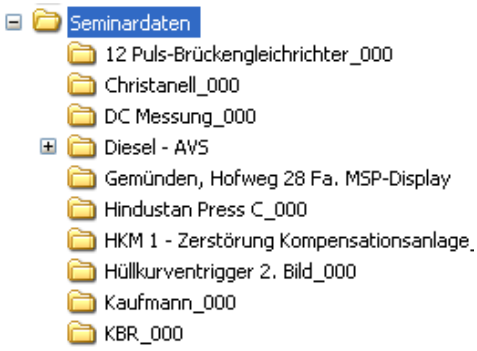
Date	Version	Size	Comment 1	Comment 2	Comment 3	Comment 4
29.04.2008 16:13:28	V01.006	10400 KB	Irland	Comment 2	Comment 3	Comment 4
31.03.2008 09:50:13	V01.006	12135 KB	Kommentar 1	Kommentar 2	Kommentar 3	Kommentar 4
31.03.2008 09:16:54	V01.006	4915 KB	Kommentar 1	Kommentar 2	Kommentar 3	Kommentar 4
05.03.2008 11:29:47	V01.006	7448 KB	Kroatien	EMPTY	EMPTY	EMPTY
26.02.2008 14:32:31	V01.001	7751 KB	Solaranlage	Demomessung	Kommentar 1	Kommentar 1
18.02.2008 11:21:54	V01.005	6059 KB	OHplus	Stassfurt	Kommentar 3	Kommentar 4
14.02.2008 09:00:21	V01.001	890 KB	Büro	Verteilung 32	NSHV 3	Kommentar 4
12.02.2008 11:32:02	V01.002	20473 KB	Salvo	Tallin	Estland	Kommentar 4
01.02.2008 15:36:05	V01.006	25416 KB	NS	Messe	Kommentar 3	Kommentar 4
01.02.2008 12:54:05	V01.006	1007 KB	MS	Papierfabrik	Test	Test
18.01.2008 13:40:07	V01.001	41727 KB	Kommentar 1	Kommentar 2	Kommentar 1	Kommentar 1
10.01.2008 10:38:30	V01.004	4817 KB	AHA Deponie Lahe	Station Deponieg...	Kommentar 1	Kommentar 1
11.12.2007 08:54:25	V01.001	705 KB	ter	ter	Kommentar 1	Kommentar 1
06.12.2007 12:23:46	V01.001	1038 KB	Kommentar 1	Kommentar 2	Kommentar 1	Kommentar 1
04.12.2007 13:18:53	V01.001	3349 KB	Robert Bosch-Kra...	Messung DC 2	Kommentar 1	Kommentar 1
03.12.2007 14:50:33	V01.001	1659 KB	Robert Bosch-Kra...	Messung DC 1	Kommentar 1	Kommentar 1
26.11.2007 14:04:23	V01.002	8985 KB	Stat.300 UW Mai...	Gerät 3	Kommentar 1	Kommentar 1
26.11.2007 11:13:23	V01.001	10797 KB	Robert Bosch Stu...	Niederspannungs...	Kommentar 1	Kommentar 1
26.11.2007 10:52:55	V01.001	2714 KB	Robert Bosch Stu...	Messung 1	Kommentar 1	Kommentar 1
15.11.2007 07:40:45	V01.000	179666 KB	Kommentar 1	Kommentar 2	Kommentar 1	Kommentar 1
23.10.2007 09:18:52	V01.001	39712 KB	Kommentar 1	Kommentar 2	Kommentar 1	Kommentar 1

Note that this process imports/downloads data from the PQ-Box 100 to the default/user selected hard disk location. To open and view the data, the file from the hard disk (using tab Hard disk) must then be selected and opened (loaded).

Each new measurement is downloaded to a new sub directory. The sub directory actually contains multiple data files. When dealing with “measurement data”, such as sending a colleague a copy of the data, you deal with the sub directory.

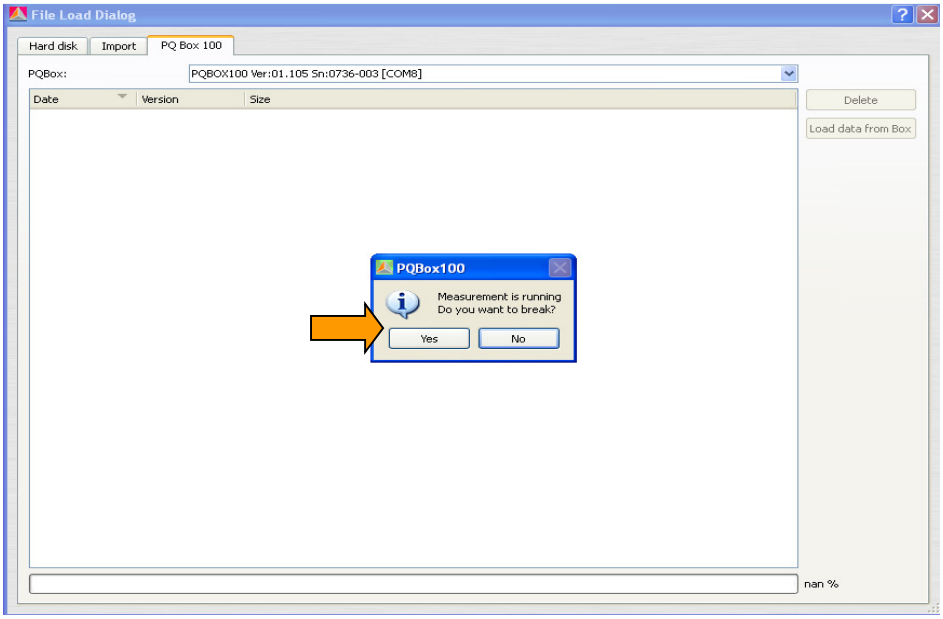
5.3.1 Data folder in Windows Explorer

If you change the text of comment 1 in the software, the name of the folder in Windows Explorer will receive the same name.

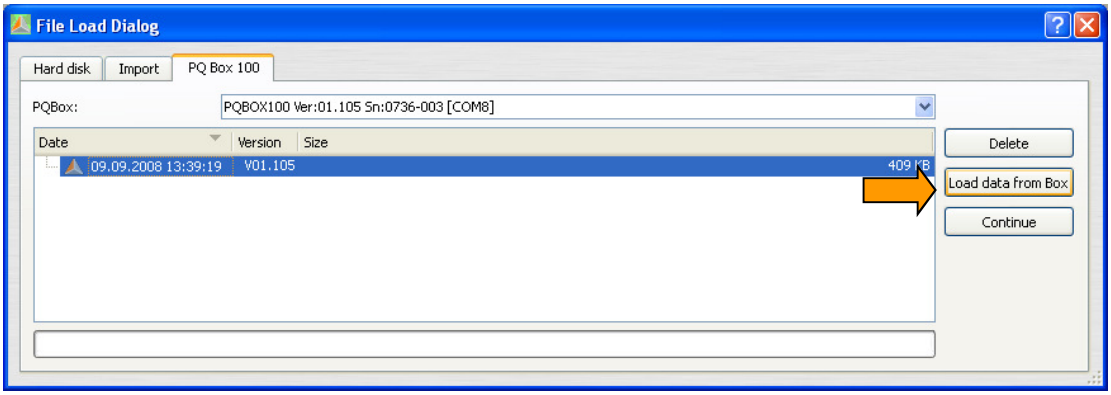


5.3.2 Download data during the PQ-Box 100 is running

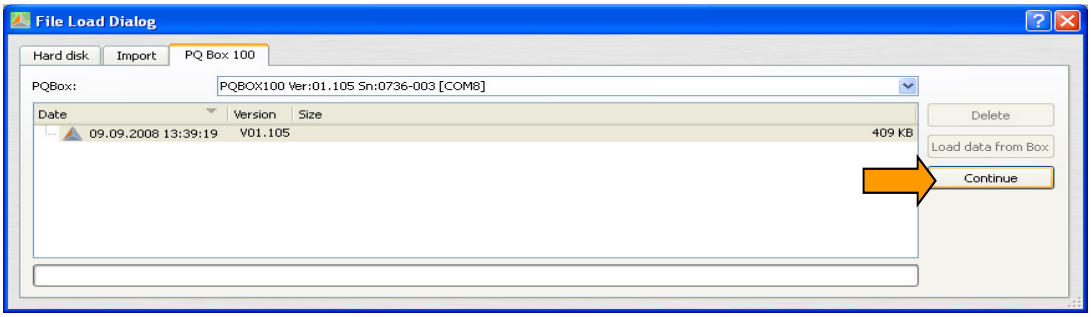
To download the data from PQ-Box 100 while the measurement is running, you have to stop the recording for the period of data transfer. An “break” function has been provided to automate this, and to continue recording data to the same file. To use this function press the icon “Yes” which will stop the recording for a short period.



Download the selected data file



Now you can continue the recording with the PQ-Box 100 by pressing the “Continue” button. The display of the PQ-Box will show the recorder “ON”.



5.4 Analysis of Measurements

All of the measurements that are available on the PC are listed under the hard-disk tab.

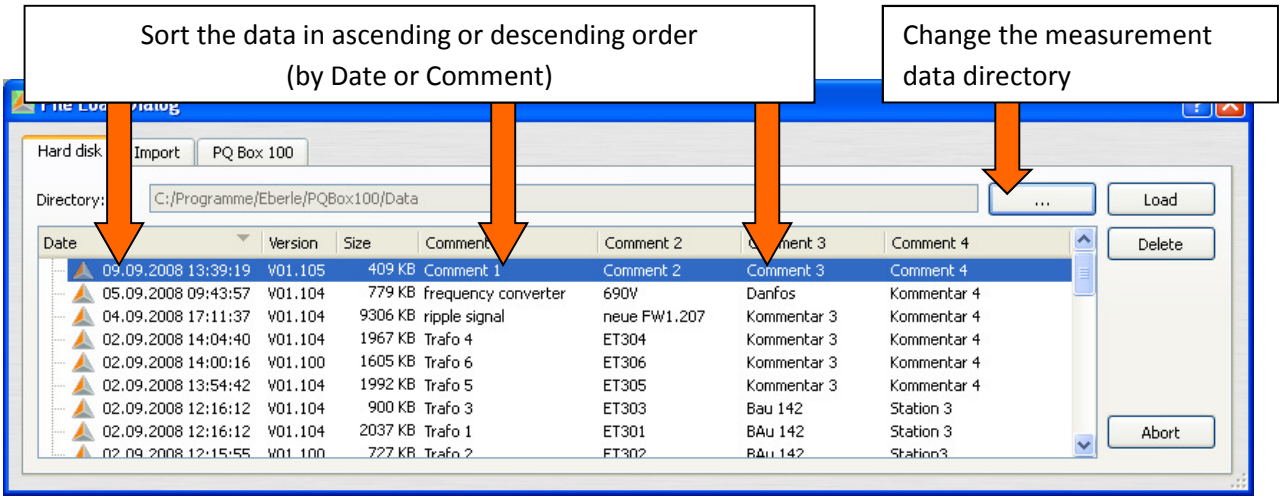
The measurement data can be sorted in ascending or descending order by “date,” “Comment 1” through to “Comment 4.”

The 

button opens the highlighted measurement for analysis.

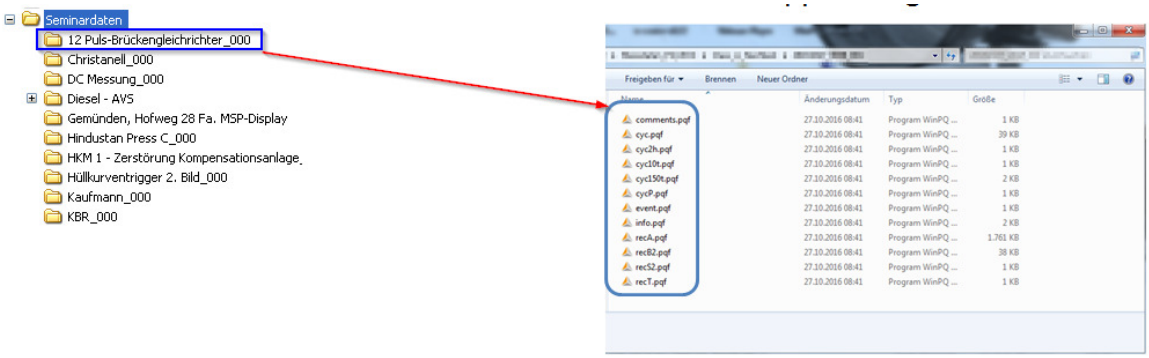
The 

icon deletes the measurement data from the PC’s hard-drive. Note that deleted records do not go to the Windows recycle bin, thus all deletions are permanent!



With double mouse click on “Comment” you can change the text for the measurement file.

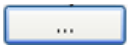
The measurement data can also be opened by double-clicking without the WinPQ mobile start via Windows Explorer. By opening the measurement data folder, you can load 12 Puls-Brückengleichrichter_000 by double-clicking on one of the icons as shown in the example below. The WinPQ mobile starts automatically and opens the selected measurement.

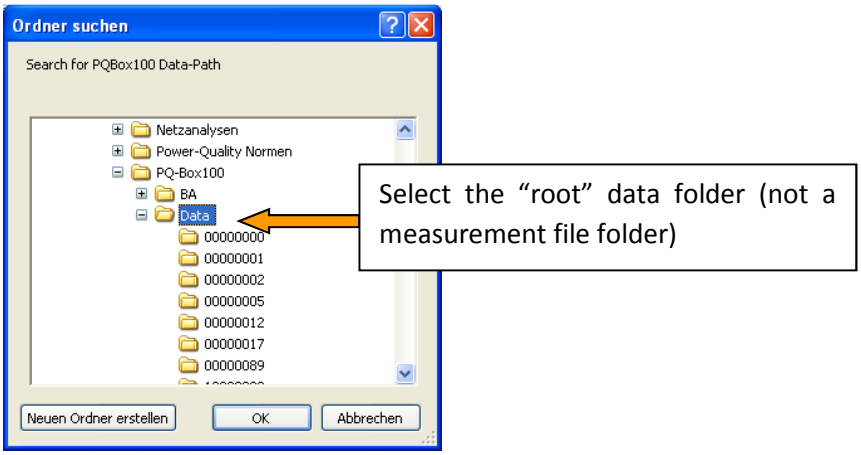


5.4.1 Change data folder

It is possible to change the default data folder for all measurements. The name of the folder can be re-named.

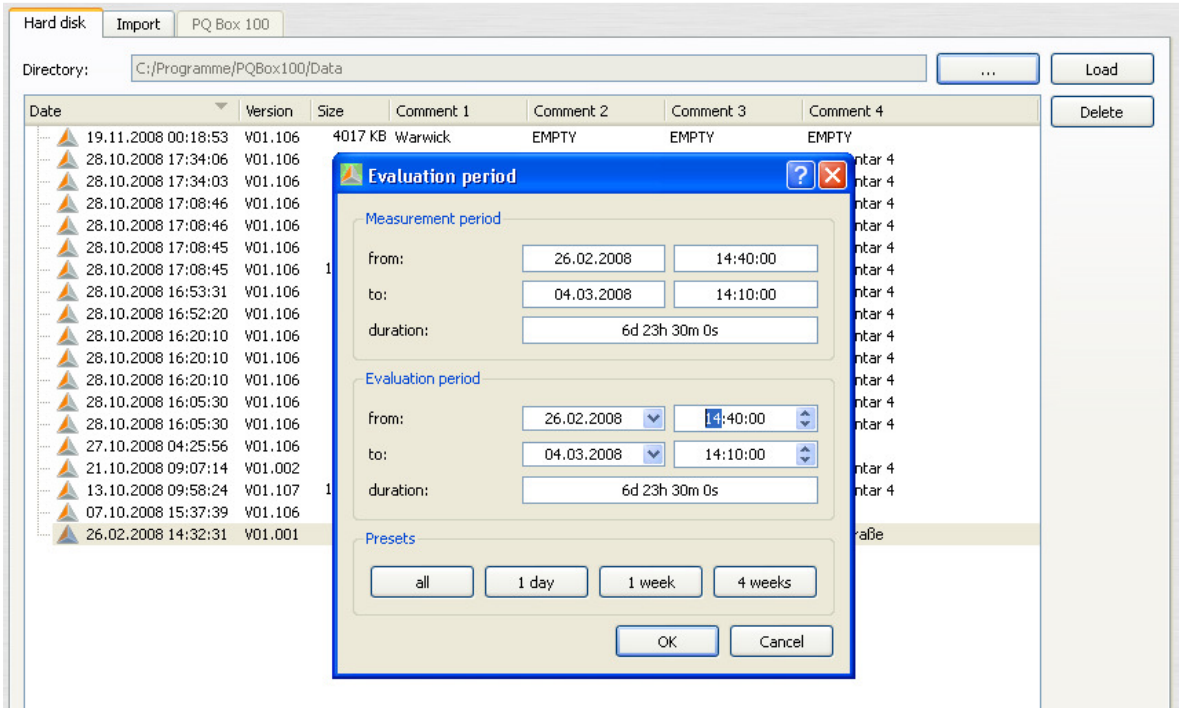
I. e. “measurements 2015”. The SW will automatically use this folder to open and store new data.

With the icon  you can change the folder.



After selecting on data file you wish to use, first displayed is the information about the total measurement period. In the field “Evaluation period” it is possible to select a subset of the data to be open by changing the values. Presets are also provide to select common/useful evaluation periods.

Example: You want to see exactly one week in the standard report, but the measurement contains 10 days. With the button “1 week” it is easy to cut the data exactly to one week.



With the button “OK” the selected measurement file will be opened using data from the selection evaluation period.

All of the following displayed measurement data and analysis were created using demo measurement data, which is included in every SW installation.

Start screen after loading the demo measurement.

Report acc. to EN50160/ IEC61000-2-2 or IEC61000-2-4

Spectrum of voltage and current harmonics and interharmonics

Marker for measured values

Information of the selected measurement

(trigger thresholds, VT, CT ratio ..)

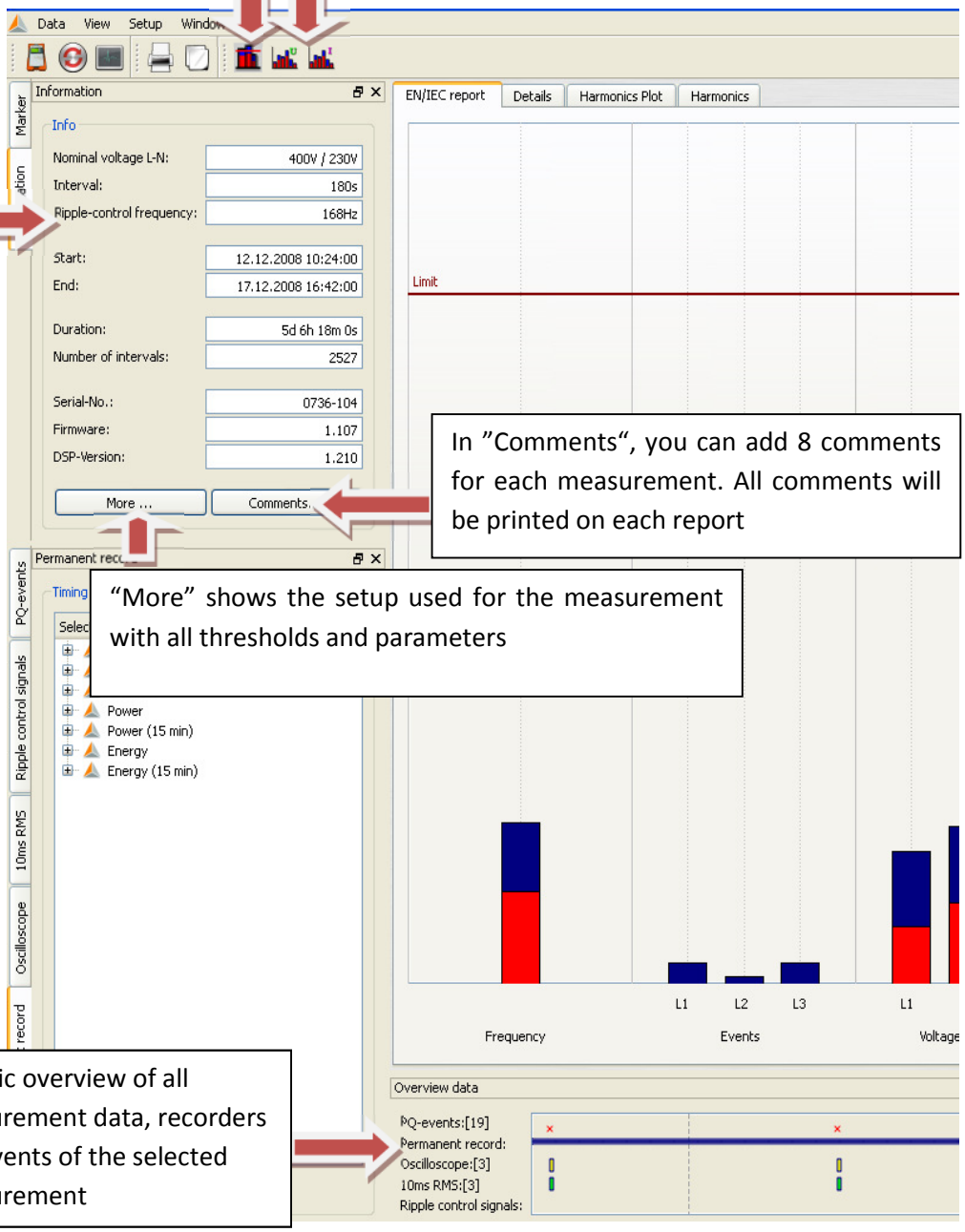
5 selections of the measurement recorders:

- Permanent record
- Oscilloscope
- 10ms RMS record
- PQ events
- Ripple contol signals

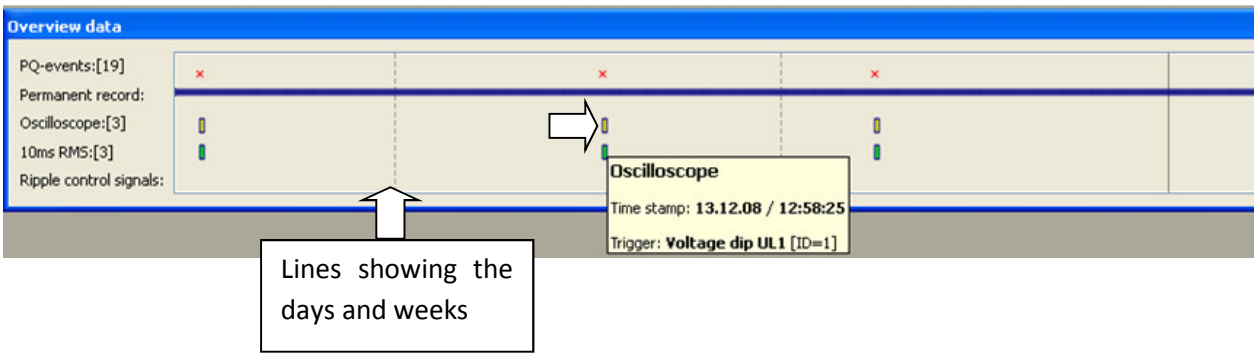
In ”Comments“, you can add 8 comments for each measurement. All comments will be printed on each report

“More” shows the setup used for the measurement with all thresholds and parameters

Graphic overview of all measurement data, recorders and events of the selected measurement



If the mouse pointer is over one Oscilloscope or “10ms RMS” record, the details of this record will be displayed.

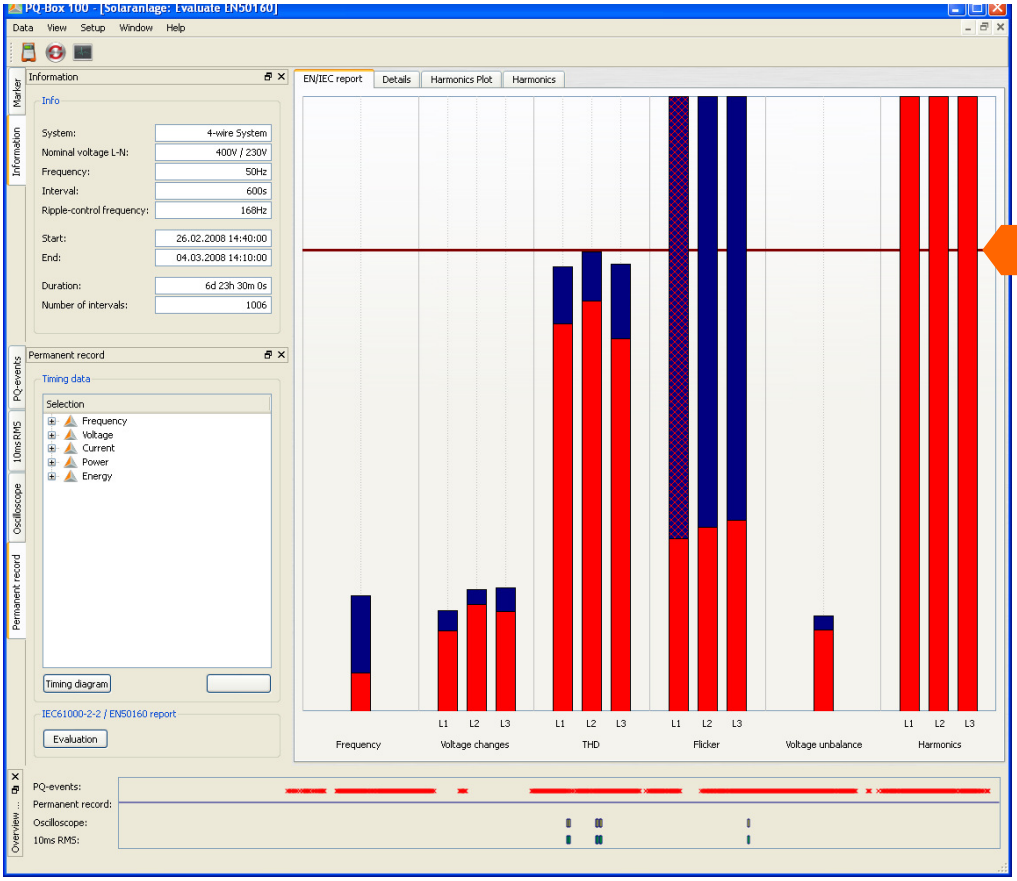


- **With a mouse click on one Oscilloscope or “10ms RMS” record you can open directly the disturbance record.**

5.4.2 Standard Analysis according to EN50160 and IEC61000-2-2

The button  gives a quick overview of all voltage measurement values, in relation to the compatibility levels of activated standard (in basic setting it is EN50160 and IEC61000-2-2). Depending on the amount of the measurement data, the creation of these statistics can take several seconds. In a one-week measurement, more than 300,000 measurement values are compared to the corresponding compatibility level and graphically displayed.

Figure: Example of an EN50160 / IEC61000-2-2 analysis



Limit value line according to EN50160 / IEC61000-2-2 or IEC61000-2-4 for 95 % / 99.5 % values

The bars clearly show the 95 % measurement value (99.5 % value for frequency) in red and the highest "100 % value" that occurred in blue.

As shown in the example, the maximum value of the long-term flicker exceeds the compatibility level of the standard on phases L2 and L3. However, the 95 % value is far below the permitted limit values.

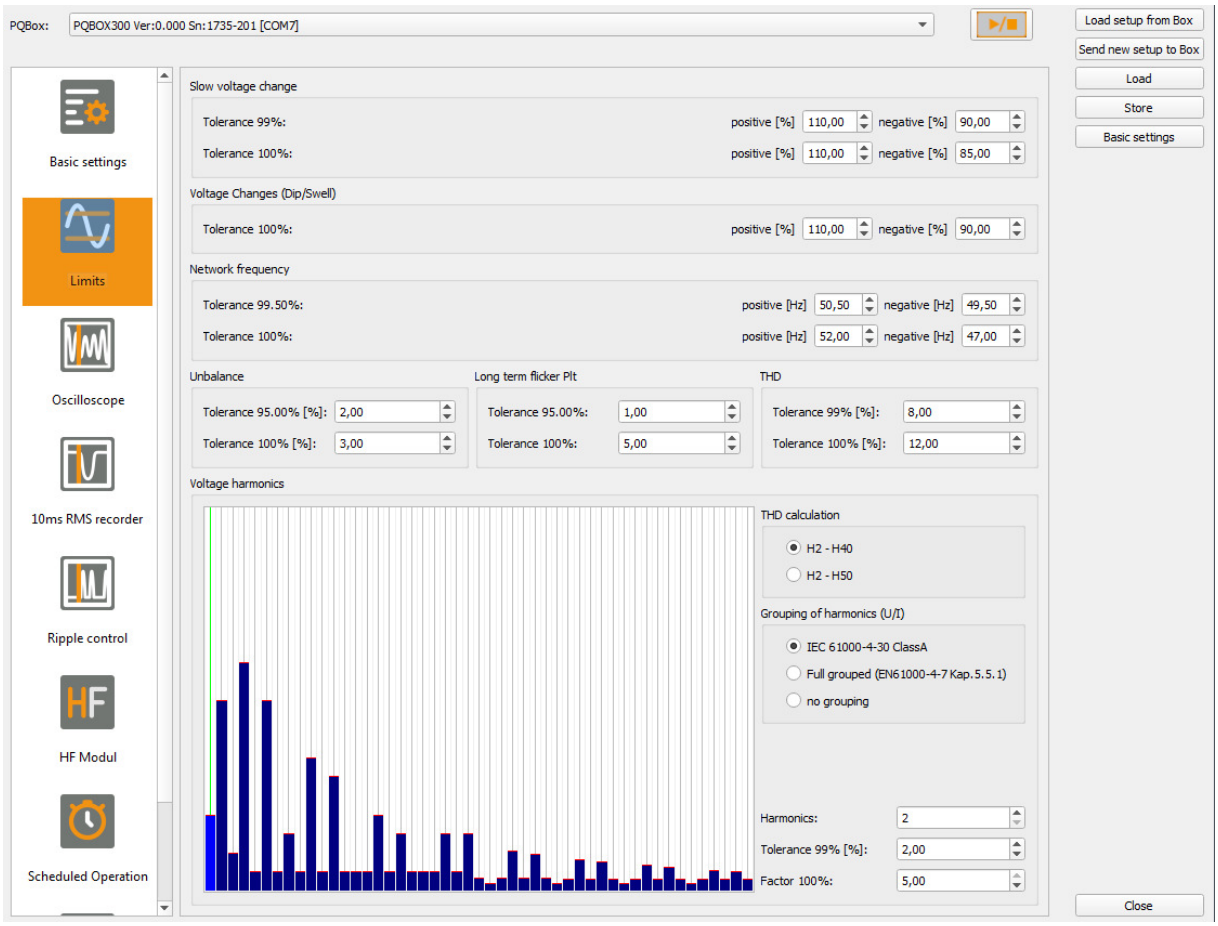
In the basic settings for the standard evaluation, you can set a 100 % limit for each value. If these limits will exceed, the blue bar will changed to squared red 

Harmonics:

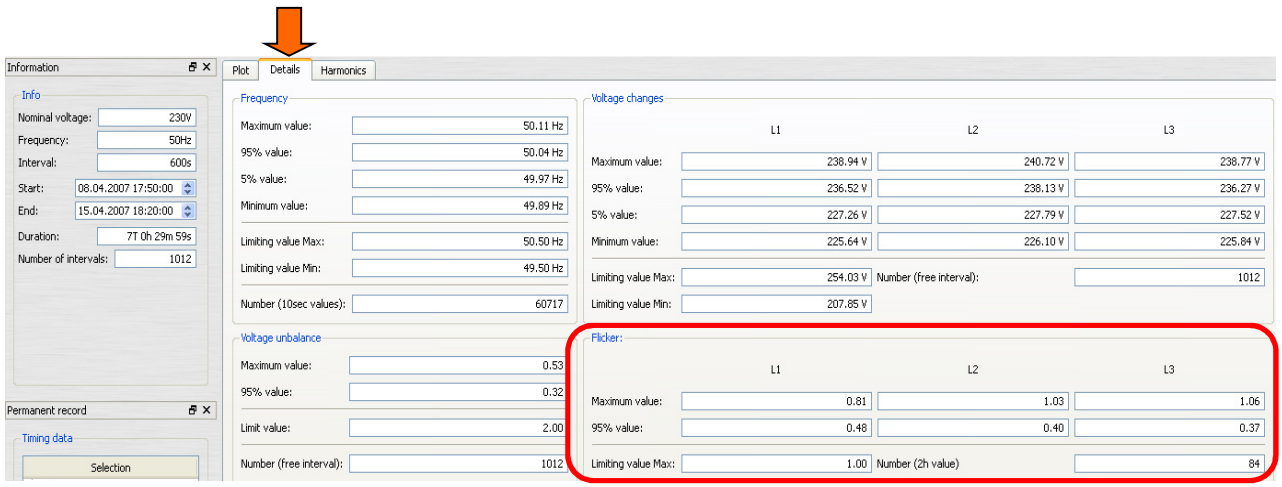
In the bars of the voltage harmonics, all of the measurement values of the 2nd to 50th harmonics are compared to the respective compatibility level of standards EN50160 and IEC61000-2-2. The maximum measurement value for each harmonic is displayed.

All standard limit values can be changed by the user as required in the “setup” menu of the PQ-Box 100 software.

Listing of the standard default settings of the network analyser:



In the “Details” tab of the EN report, you will see detailed data of the respective highest and lowest values and the reference to the standard limit value.



Example: Standard analysis flicker

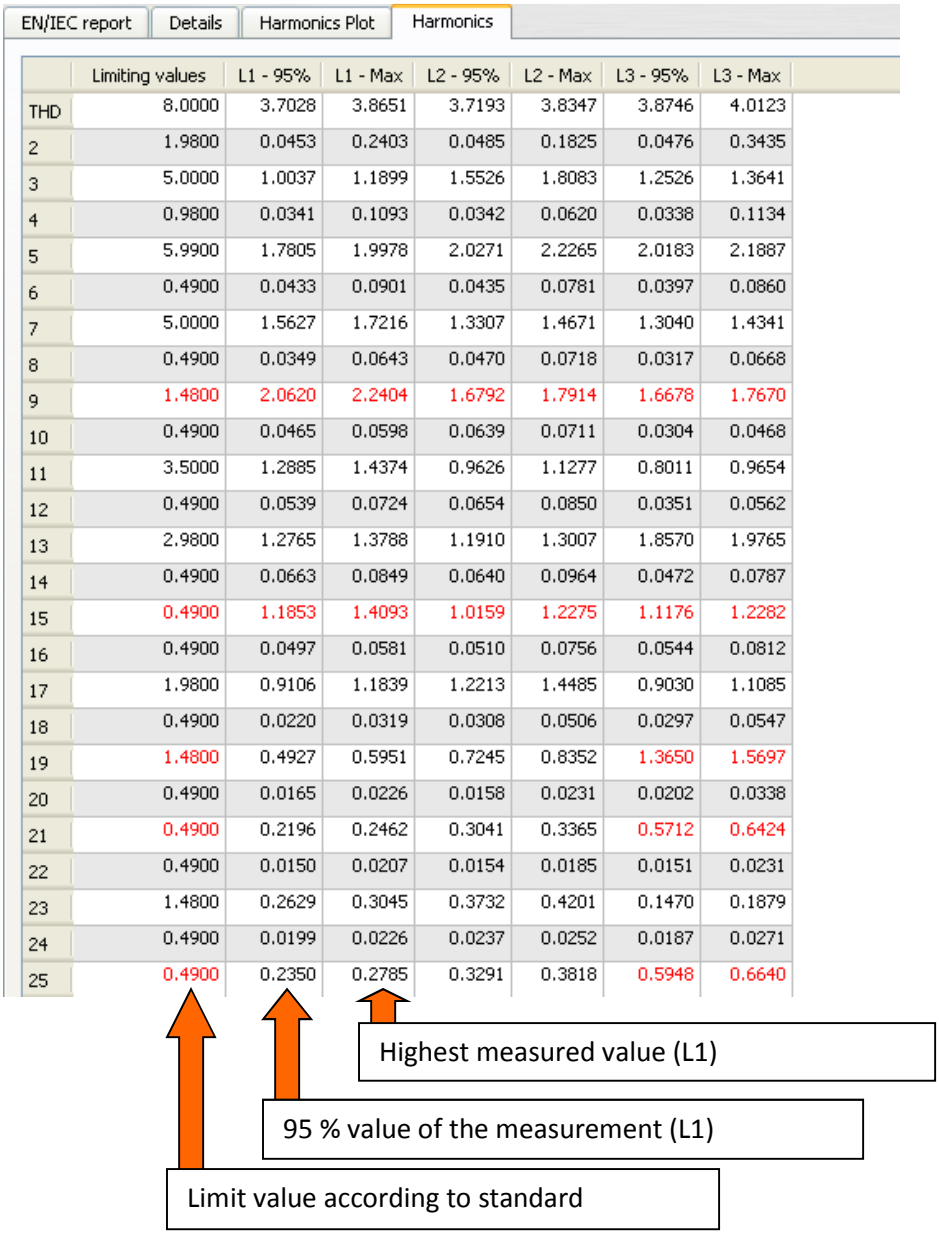
The maximum values of the phases are: L1 = 0.81; L2 = 1.03; L3 = 1.06. Because the limit value Plt is 1, the graphic bars of phases L2 and L3 exceeded the limit value line in the overview display.

The 95 % values (blue bars) are far below the limit value. L1 = 0.48; L2 = 0.4; L3 = 0.37
In the “Harmonic Plot” ” tab, the limit values of the standards, the 95 % values (red bar graph) and maximum values (blue bar graph) of the individual phases are listed.

Example: Detailed list of the 2nd to 50th harmonics and the respective compatibility levels.
In this example all harmonics are below the limits.

In the “Harmonics” tab, the limit values of the standards and the 95 % values and maximum values of the individual phases are listed in tables. If a harmonic exceeds the limit values, the values and targets will be highlighted in red.

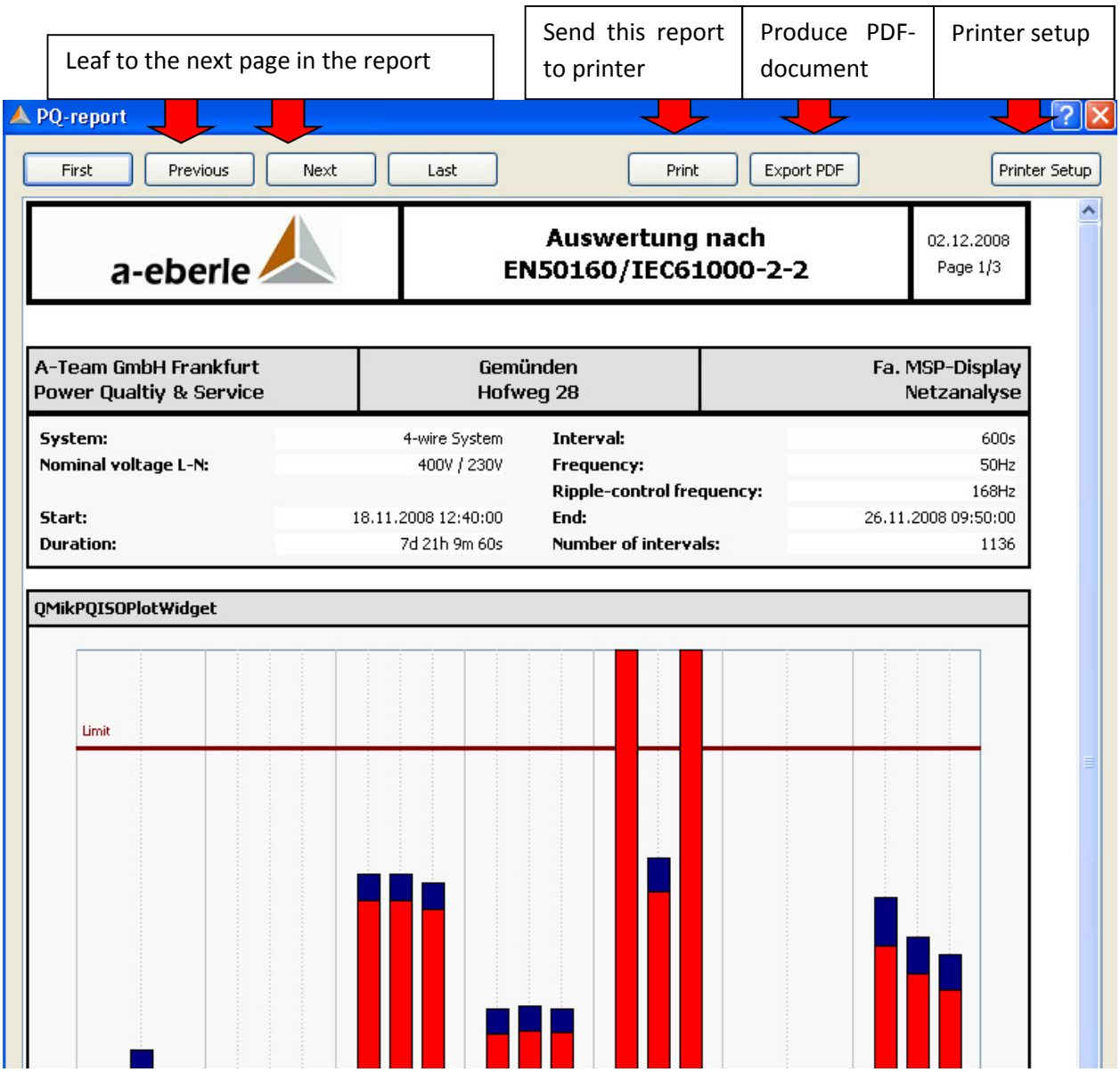
Figure: Detailed list of the 2nd to 50th harmonics and the respective compatibility levels.



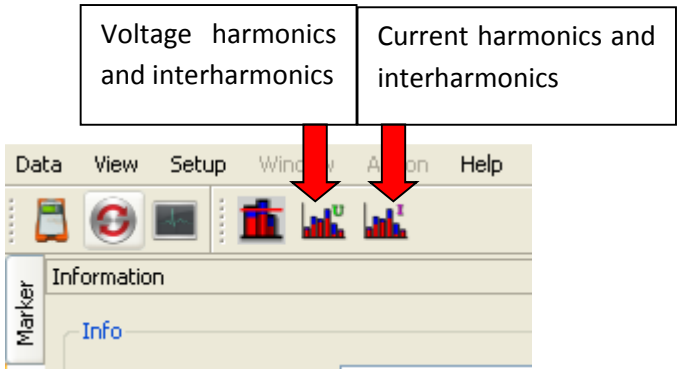
	Limiting values	L1 - 95%	L1 - Max	L2 - 95%	L2 - Max	L3 - 95%	L3 - Max
THD	8.0000	3.7028	3.8651	3.7193	3.8347	3.8746	4.0123
2	1.9800	0.0453	0.2403	0.0485	0.1825	0.0476	0.3435
3	5.0000	1.0037	1.1899	1.5526	1.8083	1.2526	1.3641
4	0.9800	0.0341	0.1093	0.0342	0.0620	0.0338	0.1134
5	5.9900	1.7805	1.9978	2.0271	2.2265	2.0183	2.1887
6	0.4900	0.0433	0.0901	0.0435	0.0781	0.0397	0.0860
7	5.0000	1.5627	1.7216	1.3307	1.4671	1.3040	1.4341
8	0.4900	0.0349	0.0643	0.0470	0.0718	0.0317	0.0668
9	1.4800	2.0620	2.2404	1.6792	1.7914	1.6678	1.7670
10	0.4900	0.0465	0.0598	0.0639	0.0711	0.0304	0.0468
11	3.5000	1.2885	1.4374	0.9626	1.1277	0.8011	0.9654
12	0.4900	0.0539	0.0724	0.0654	0.0850	0.0351	0.0562
13	2.9800	1.2765	1.3788	1.1910	1.3007	1.8570	1.9765
14	0.4900	0.0663	0.0849	0.0640	0.0964	0.0472	0.0787
15	0.4900	1.1853	1.4093	1.0159	1.2275	1.1176	1.2282
16	0.4900	0.0497	0.0581	0.0510	0.0756	0.0544	0.0812
17	1.9800	0.9106	1.1839	1.2213	1.4485	0.9030	1.1085
18	0.4900	0.0220	0.0319	0.0308	0.0506	0.0297	0.0547
19	1.4800	0.4927	0.5951	0.7245	0.8352	1.3650	1.5697
20	0.4900	0.0165	0.0226	0.0158	0.0231	0.0202	0.0338
21	0.4900	0.2196	0.2462	0.3041	0.3365	0.5712	0.6424
22	0.4900	0.0150	0.0207	0.0154	0.0185	0.0151	0.0231
23	1.4800	0.2629	0.3045	0.3732	0.4201	0.1470	0.1879
24	0.4900	0.0199	0.0226	0.0237	0.0252	0.0187	0.0271
25	0.4900	0.2350	0.2785	0.3291	0.3818	0.5948	0.6640

Create EN50160 / IEC61000-2-2 report:

With the function “Print” (right mouse click) the report can be printed on a printer or stored as a PDF document.



5.4.3 Bar chart of harmonics and interharmonics

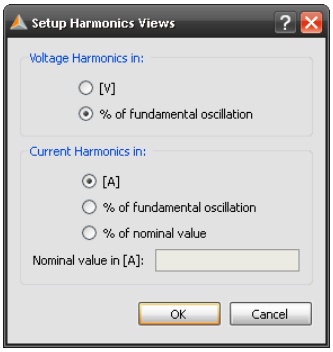


With these two icons  the software generates the statistic of all voltage and current harmonics and interharmonics.

In our example the main current harmonics are the 11^{th} , 13^{th} , 17^{th} and 19^{th} harmonic.

The two colours show the 95 % value (red) and the 100 % value (blue) of all harmonics. All current harmonics are scaled in “ampere” and the voltage harmonics in “%”.

The scaling can be changed in “setup harmonics” from absolute values to relative values.



The example shows the list of all current harmonics of the three phases and neutral. The ordinals 5 and 7, 11 and 13, 17 and 19 stand out. Red bar represents the 95% measured value, the blue bar represents the 100% value.

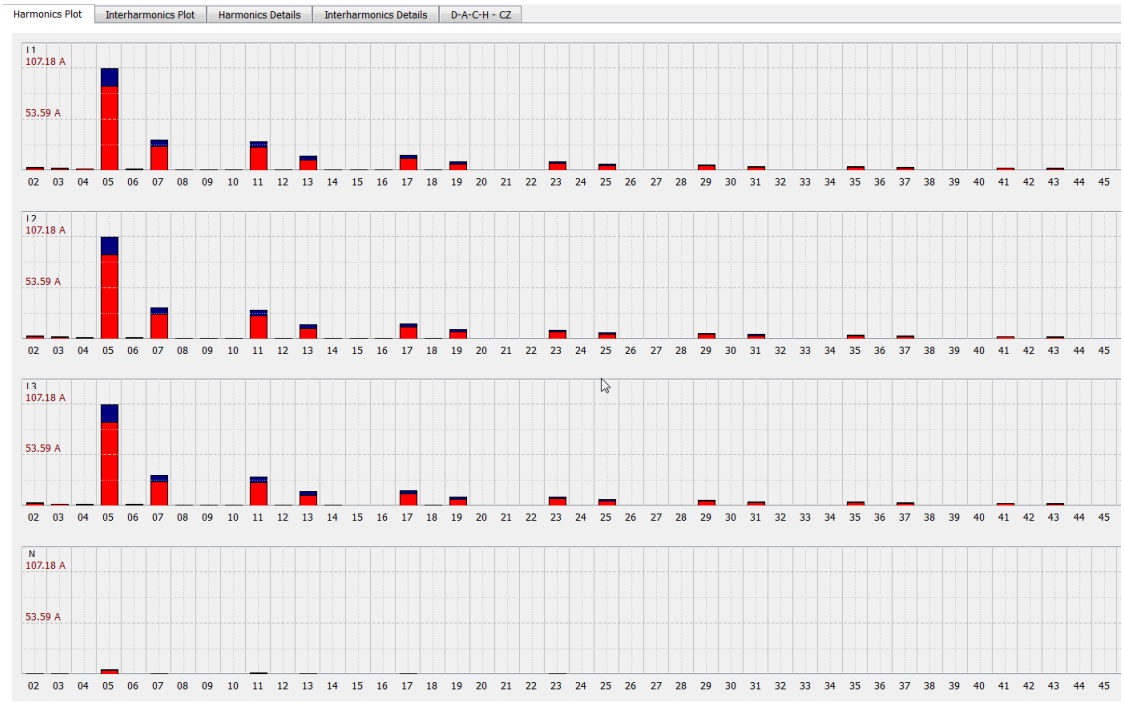


Table of harmonic values

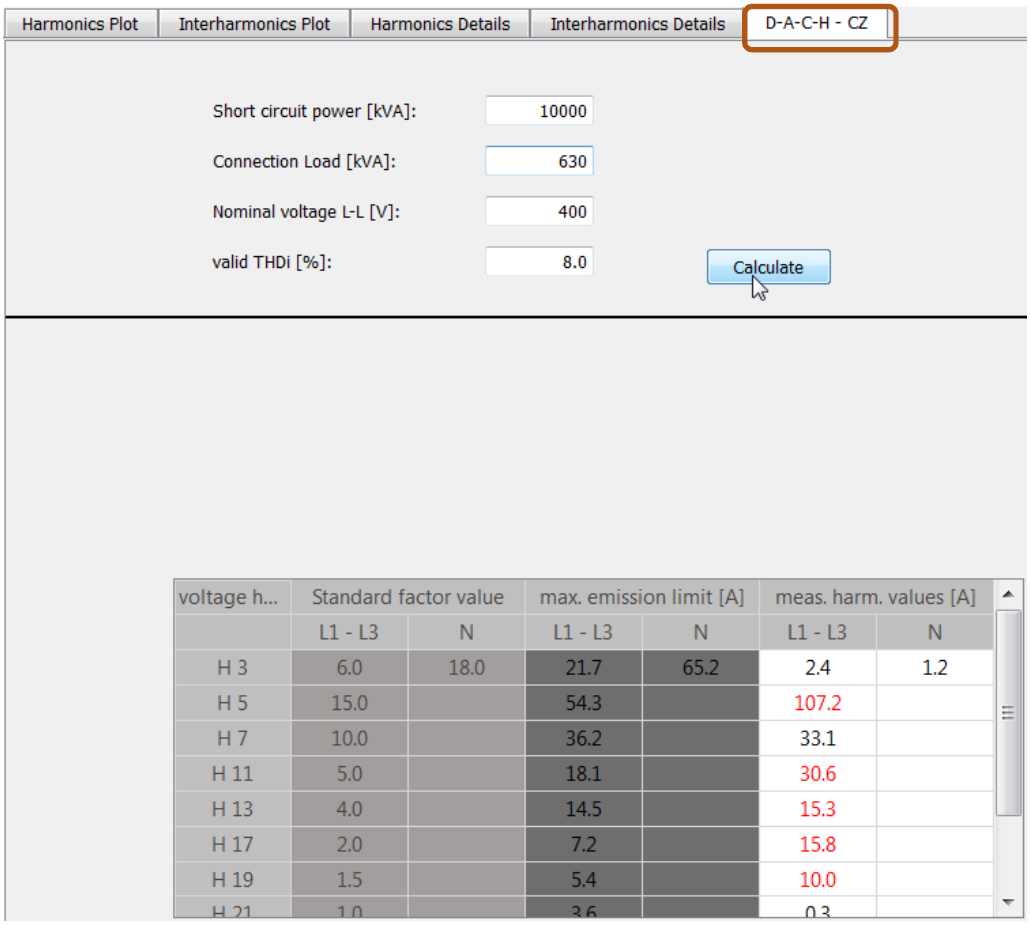
Harmonics Plot | Interharmonics Plot | Harmonics Details | Interharmonics Details | D-A-C-H - CZ

	L1 - 95%	L1 - Max	L2 - 95%	L2 - Max	L3 - 95%	L3 - Max
02	2.8521 [A]	3.4658 [A]	2.6505 [A]	3.5537 [A]	2.5926 [A]	3.2562 [A]
03	1.7764 [A]	2.2264 [A]	1.8707 [A]	2.3933 [A]	1.5029 [A]	1.9265 [A]
04	1.2930 [A]	1.6541 [A]	1.2510 [A]	1.8606 [A]	1.2403 [A]	1.6760 [A]
05	88.0763 [A]	106.7447 [A]	88.3021 [A]	107.1785 [A]	87.8084 [A]	106.6618 [A]
06	1.0791 [A]	1.4184 [A]	1.0394 [A]	1.4161 [A]	1.0252 [A]	1.4987 [A]
07	25.4768 [A]	32.0951 [A]	26.1785 [A]	33.0616 [A]	25.5559 [A]	32.1389 [A]
08	0.6486 [A]	0.9401 [A]	0.6441 [A]	0.8871 [A]	0.6309 [A]	0.8007 [A]
09	0.5818 [A]	0.7895 [A]	0.5549 [A]	0.7112 [A]	0.5185 [A]	0.7063 [A]
10	0.5378 [A]	0.7709 [A]	0.5205 [A]	0.7113 [A]	0.5028 [A]	0.7268 [A]
11	24.4563 [A]	30.5683 [A]	24.4522 [A]	30.5124 [A]	24.3625 [A]	30.4375 [A]
12	0.4965 [A]	0.6506 [A]	0.4973 [A]	0.7355 [A]	0.4640 [A]	0.6367 [A]
13	11.0046 [A]	14.7722 [A]	11.3741 [A]	15.3005 [A]	11.0889 [A]	14.8478 [A]
14	0.3423 [A]	0.4776 [A]	0.3570 [A]	0.4720 [A]	0.3331 [A]	0.4413 [A]
15	0.3337 [A]	0.4499 [A]	0.3349 [A]	0.4376 [A]	0.3039 [A]	0.3993 [A]
16	0.3181 [A]	0.4593 [A]	0.3323 [A]	0.4456 [A]	0.3126 [A]	0.4064 [A]
17	12.5913 [A]	15.7555 [A]	12.4908 [A]	15.6298 [A]	12.5218 [A]	15.7005 [A]
18	0.3317 [A]	0.4455 [A]	0.3349 [A]	0.4393 [A]	0.3082 [A]	0.4272 [A]
19	7.0123 [A]	9.5618 [A]	7.3320 [A]	10.0010 [A]	7.0974 [A]	9.5995 [A]
20	0.2396 [A]	0.3149 [A]	0.2420 [A]	0.3224 [A]	0.2352 [A]	0.3055 [A]
21	0.2378 [A]	0.3196 [A]	0.2341 [A]	0.3165 [A]	0.2211 [A]	0.2829 [A]
22	0.2334 [A]	0.3069 [A]	0.2334 [A]	0.3146 [A]	0.2301 [A]	0.2942 [A]
23	7.6396 [A]	9.3913 [A]	7.5836 [A]	9.2955 [A]	7.6189 [A]	9.3453 [A]
24	0.2514 [A]	0.3249 [A]	0.2534 [A]	0.3468 [A]	0.2290 [A]	0.3186 [A]
25	4.8823 [A]	6.5485 [A]	5.1987 [A]	6.9194 [A]	4.9771 [A]	6.5909 [A]
26	0.1842 [A]	0.2600 [A]	0.1909 [A]	0.2500 [A]	0.1801 [A]	0.2174 [A]

5.4.4 DACH-CZ report

The software produces an automatic report according the D-A-CH-CZ standard.

All current harmonics will be compared to the maximum allowed limit of this standard. You have to fill the “short circuit power” of the network, the connected load and the nominal voltage.



voltage h...	Standard factor value		max. emission limit [A]		meas. harm. values [A]	
	L1 - L3	N	L1 - L3	N	L1 - L3	N
H 3	6.0	18.0	21.7	65.2	2.4	1.2
H 5	15.0		54.3		107.2	
H 7	10.0		36.2		33.1	
H 11	5.0		18.1		30.6	
H 13	4.0		14.5		15.3	
H 17	2.0		7.2		15.8	
H 19	1.5		5.4		10.0	
H 21	1.0		3.6		0.3	

DACH-CZ report compare all current harmonics to the limits. Red values are above the thresholds.

Details

DACH-CZ: NOT COMPLIED

voltage harmonics	Standard factor value		max. emission limit [A]		meas. harm. values [A]	
	L1 - L3	N	L1 - L3	N	L1 - L3	N
H 3	6.0	18.0	21.7	65.2	2.4	1.2
H 5	15.0		54.3		107.2	
H 7	10.0		36.2		33.1	
H 11	5.0		18.1		30.6	
H 13	4.0		14.5		15.3	
H 17	2.0		7.2		15.8	
H 19	1.5		5.4		10.0	
H 21	1.0		3.6		0.3	
H 23	1.0		3.6		9.4	
H 25	1.0		3.6		6.9	

5.4.5 “Level-Time” Diagram of Permanent Recorded Data

All available permanently recorded measurement data are listed in the “Permanent Record” tab item. More than 2,250 measurement parameters are saved in each measurement (voltages, harmonics, inter-harmonics, currents and power etc).

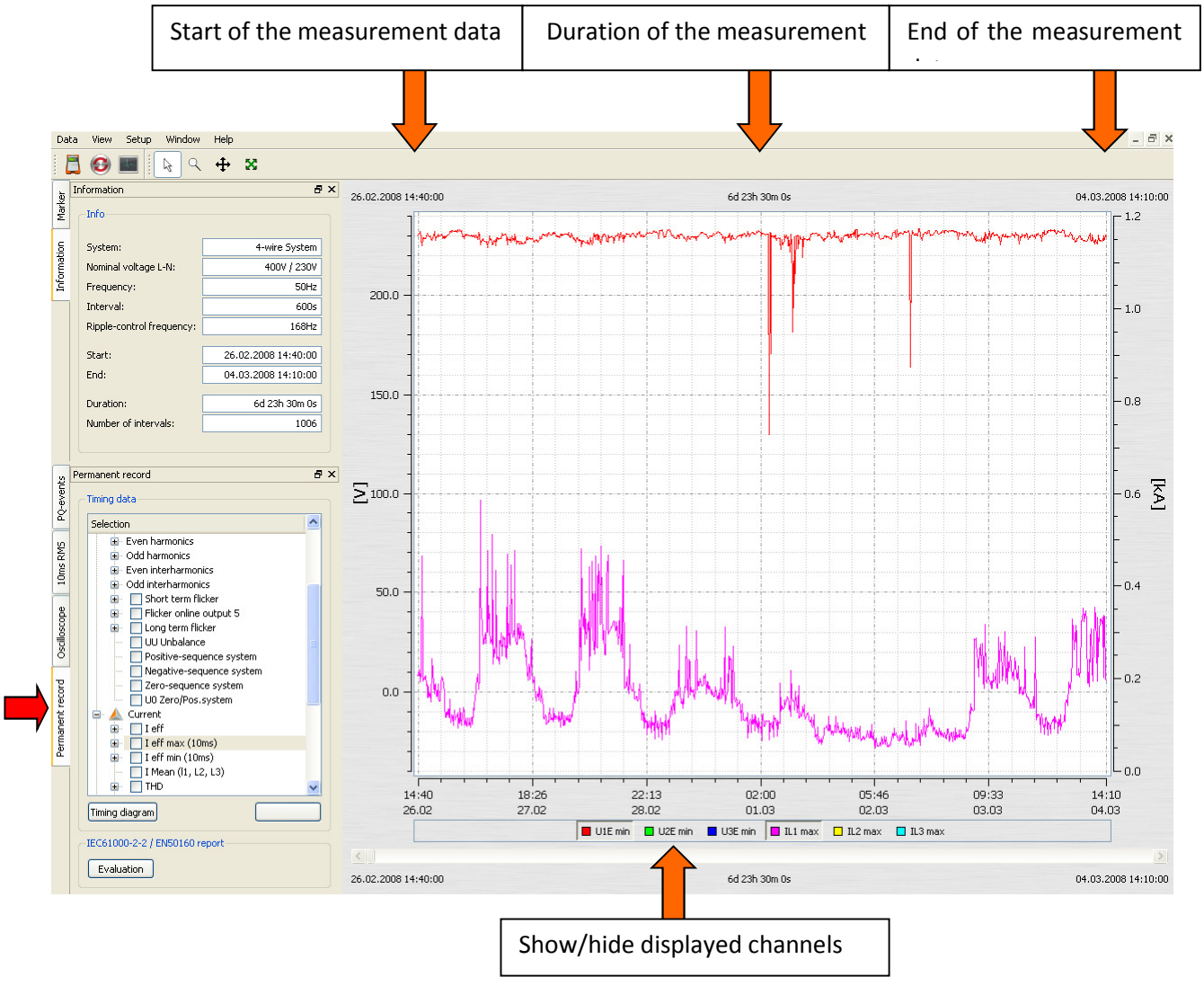
Any number of measurement values can be shown together in a level-time diagram. For example, it is possible to see the connection between voltage fluctuations, the resulting flicker levels and the consumers in the network, based on the corresponding changes in the current.

Highlighting the desired parameter (or several parameters) 

and pressing the 

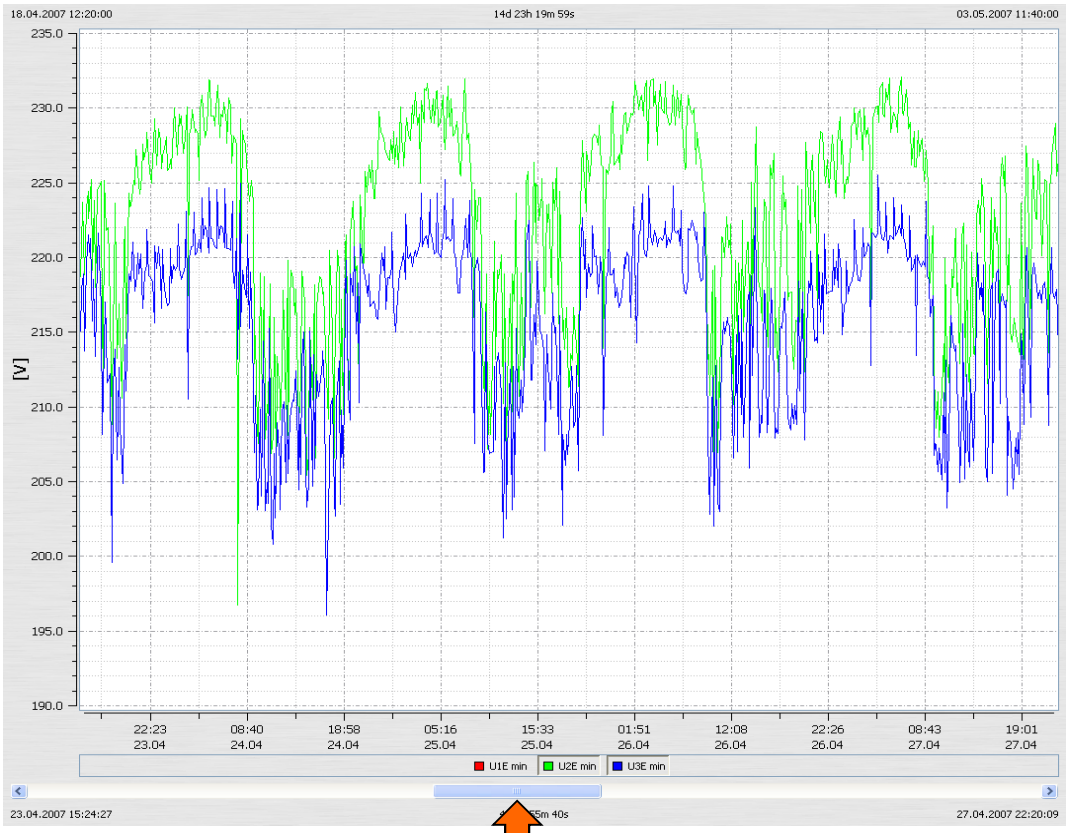
key displays the level-time diagram of the desired measurement values.

Figure: Level-time diagram of the 10 ms minimum value of voltages L1 and current L1



Zooming in the graphic:

To enlarge an area, press the left mouse key and drag a box from the top left to the bottom right. If the box is drawn in the reverse direction, the zooming is reset.



The sliding bar shows the area of zoom.

You can move this bar through the measurement.

Move graphic:

When the "Move" button is pressed, the graphic can be moved freely in the time axis and value axis.

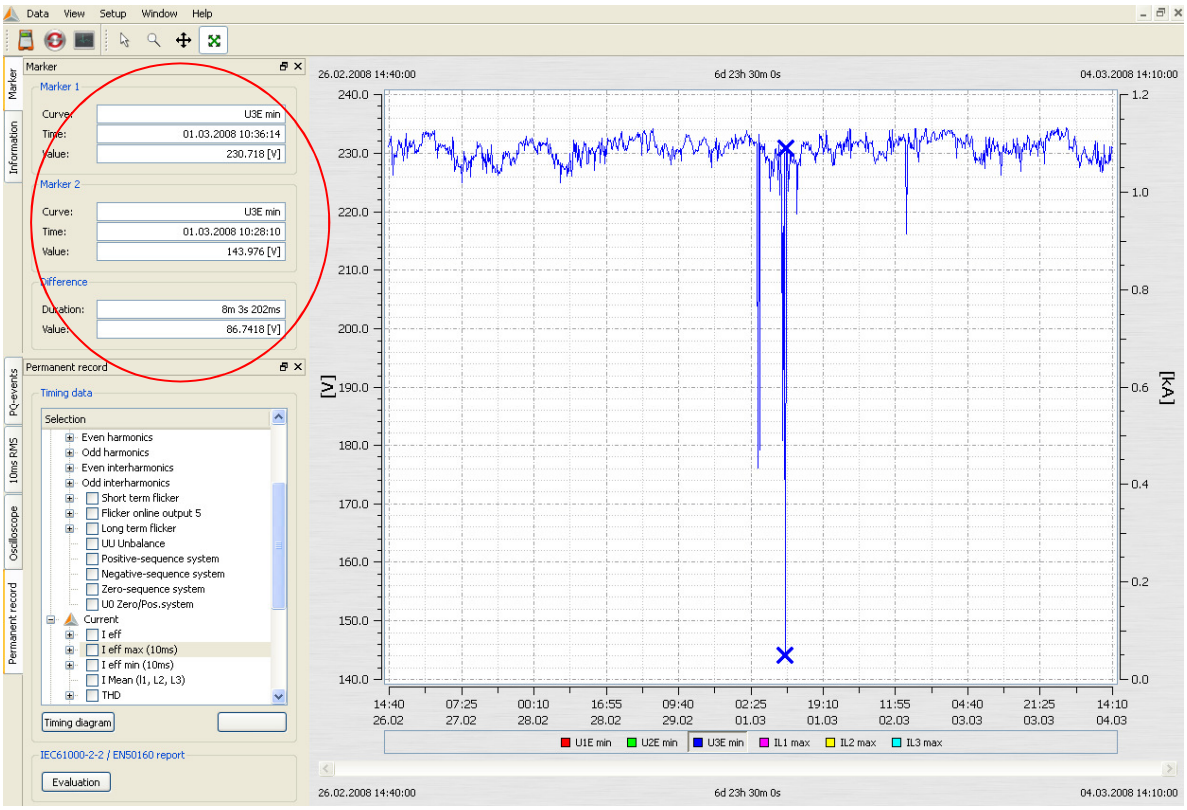
Place a marker:

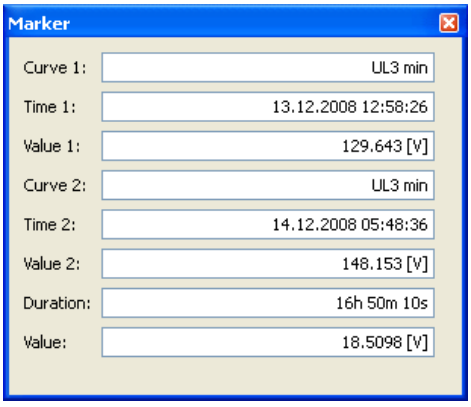
If the icon “Mark” is active, it is possible to set two markers in the diagram.

- **Marker No. 1** with the left mouse button and Shift
- **Marker No. 2** with the left mouse button and Control key

The marker selects automatically the next measuring point in the graphic.

The distance between the two markers is determined as an absolute value. The time interval is always calculated; the difference value is calculated only with identical units.





The time of the marker will show the precise time of each 10 ms value, even if the long time interval was adjusted to a long period, i. e. 10min interval.

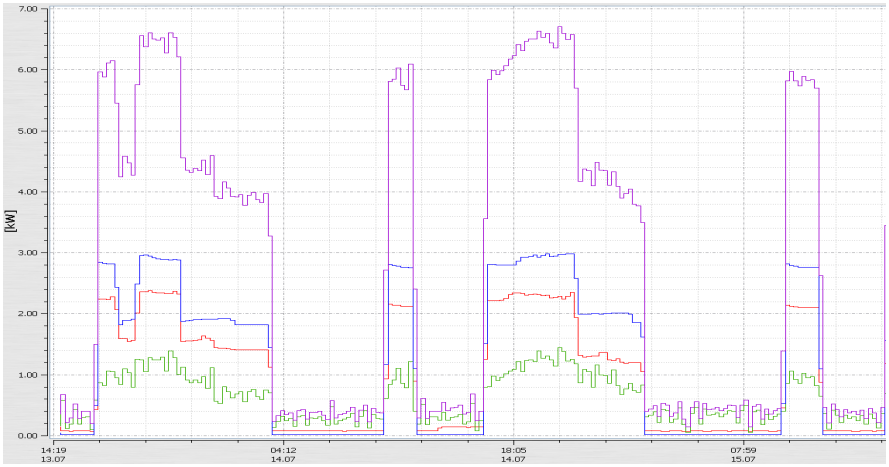
Representation of line styles

Four different kinds of styles for the lines are available.

1. All values will be linked point to point (basic setting for all diagrams)

2. Displays only the dots – no link

3. This level representation is particularly suitable for medium values, such as 15 minutes performance data. Here, the mean value over the measuring period is represented as a straight line.



4. The "inverted level representation" enables network interruptions to be clearly shown in the level-time diagram

Additional functions of the right mouse key in the menu:

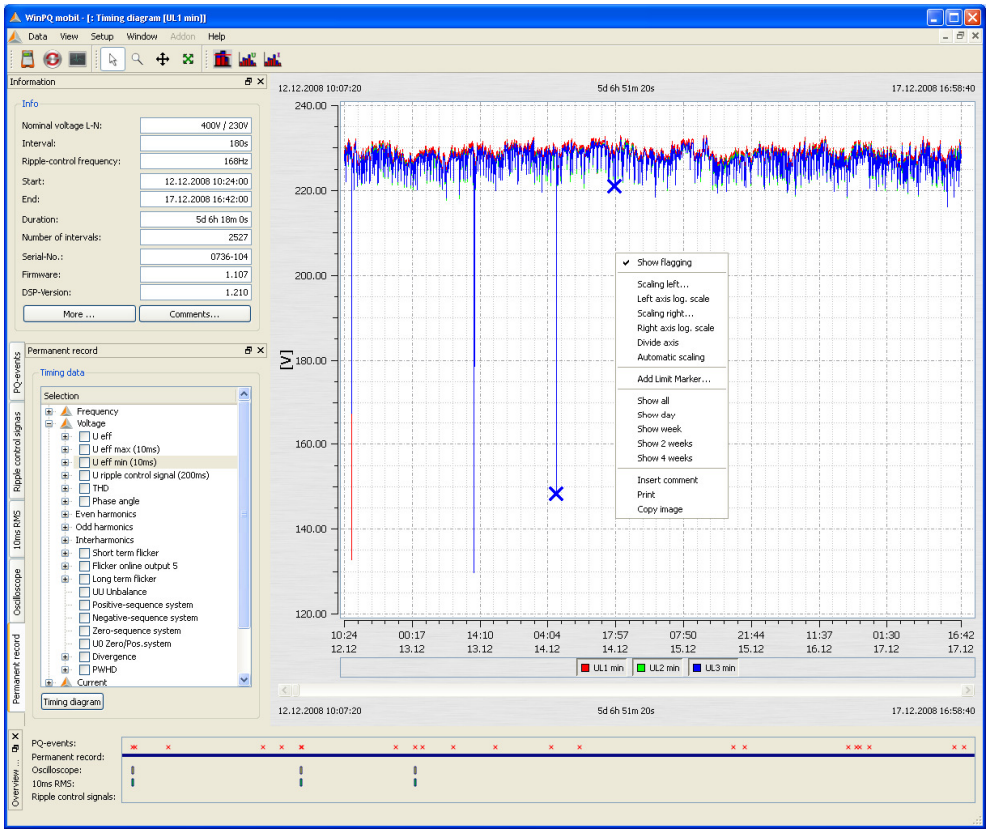
- **Delete marker** – If one marker is set, it is possible to delete the marker
- **Show flagging** = data measured during a voltage dip or swell will be flagged (according IEC61000-4-30 class A). You can mark all flagged data.

- **Left axis scale** = The left axis measurement values can be scaled manually
- **Right axis scale** = The right axis measurement values can be scaled manually
- **Divide axis** = Software automatically separates measurement values with a suitable scale
- **Automatic scaling** = Software automatically scales to maximum and minimum values

- **Add Limit Marker** = A threshold line can be defined here for each measurement value

- **Show all** = Time scaled to the complete measurement
- **Show day** = Time scaled to one day
- **Show week** = Time scaled to 7 days
- **Show 4 weeks** = Time scaled to 4 weeks

- **Insert comment** = You can insert a comment onto the diagram
- **Print** = current graphic is sent to the selected printer or produce PDF documents
- **Clipboard** = The graphical display is copied to the clipboard. Then, for example, the graphic can be pasted into an ***MS-WORD***™ document

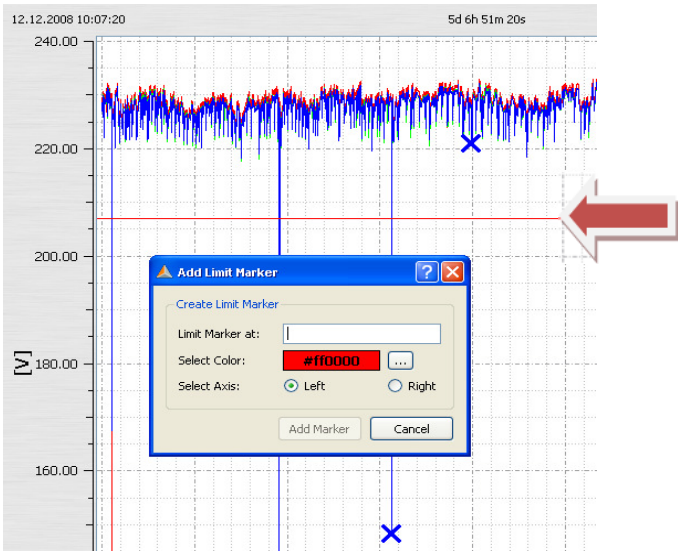


Add Limit Marker

In menu “Add limit Marker” it is possible to set several limit marker lines.

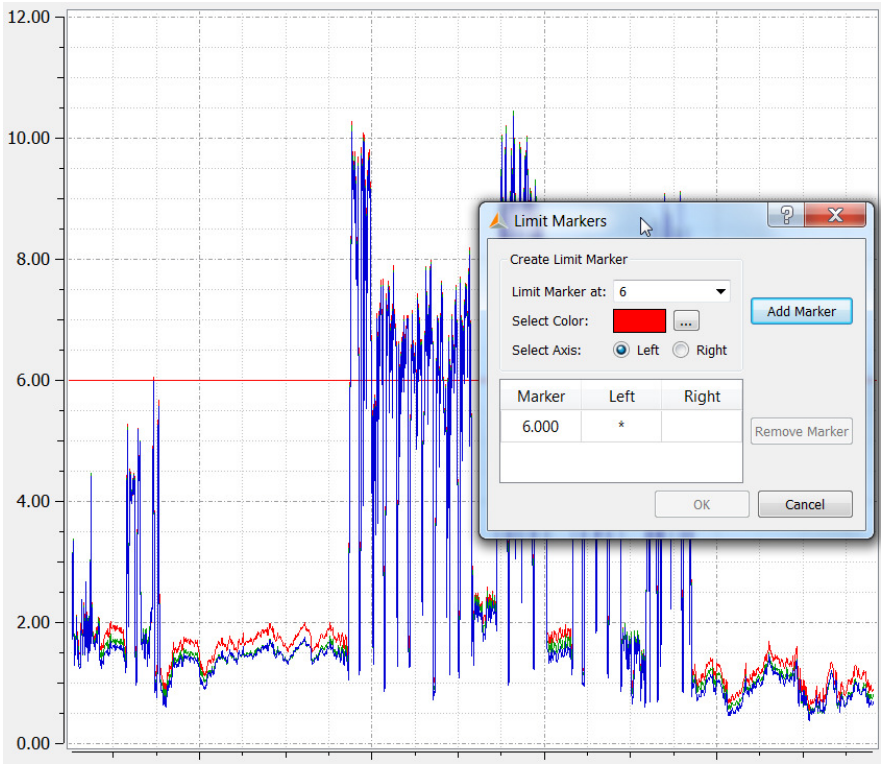
The colour and value (threshold) according to left or right axis values can be defined.

Example: Threshold line for the voltage; 207 V (Unom – 10 %)



Show limit marker harmonics

The software automatically suggests the thresholds for harmonics. The threshold can be a %-value or an absolute value, depending on the representation.



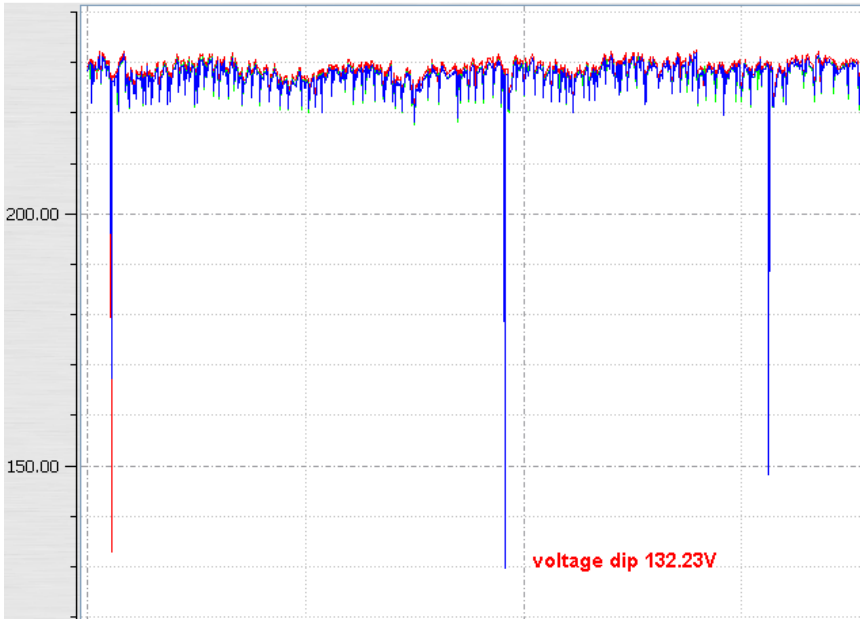
Insert comment in diagram

With the function: ”insert comment“, it is possible to implement several text comments in each diagram.

To delete or move this comment in the graphic, you can click the text with your mouse.

If the text changes to red, you can delete or move this comment on the screen. Comments are not saved to the recorded file, but are useful for adding comments to PDF reports and screen shots.

With double mouse click it is possible to edit the comment.

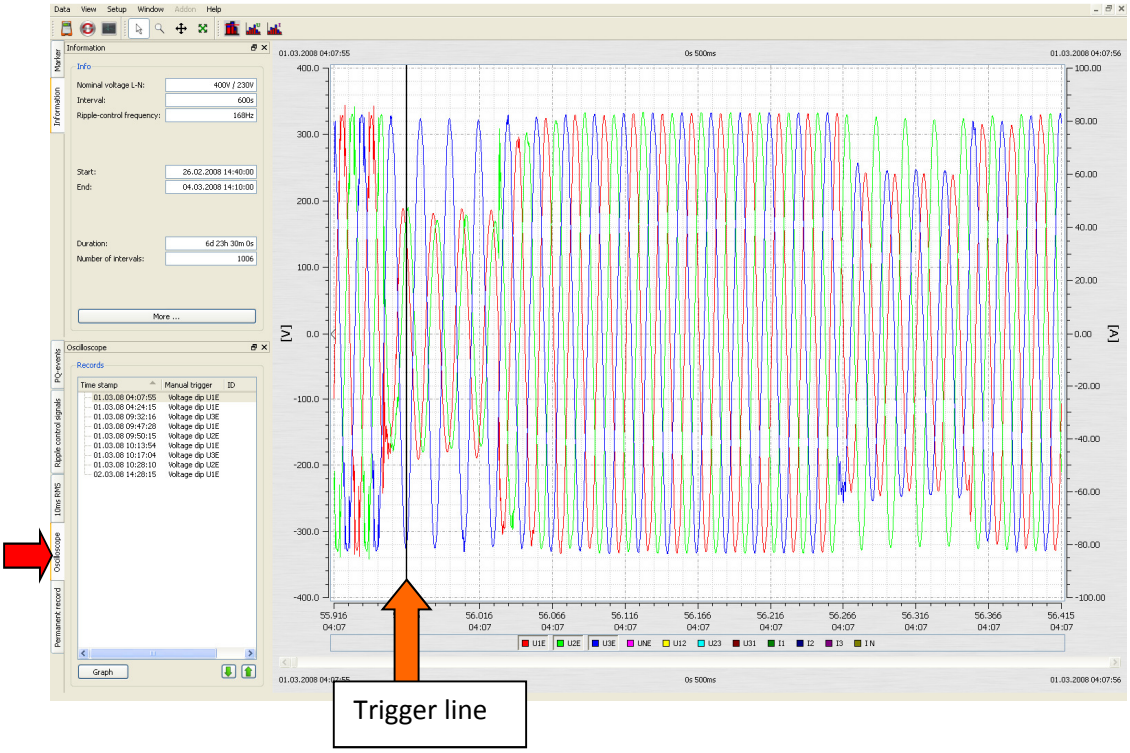


5.4.6 Oscilloscope Recordings

All of the Oscilloscope records (recorded manually and via trigger settings) are listed using the “Oscilloscope" tab. These records can be sorted by time or trigger condition.

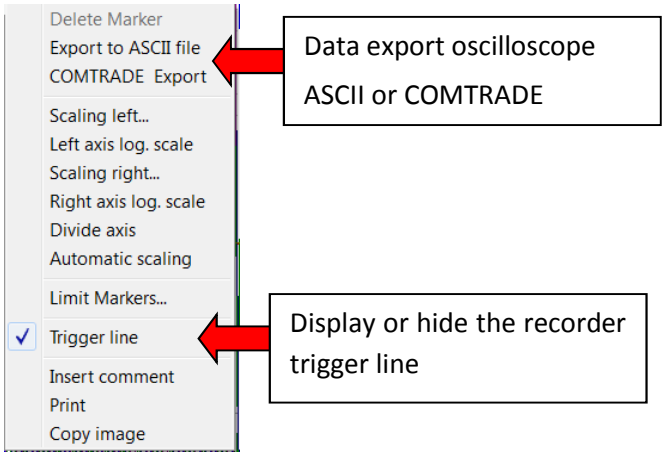
The corresponding Oscilloscope record is displayed by double-clicking on the line or clicking on the Graph button.

All of the voltages (conductor to conductor and conductor to earth) are recorded for every recording.

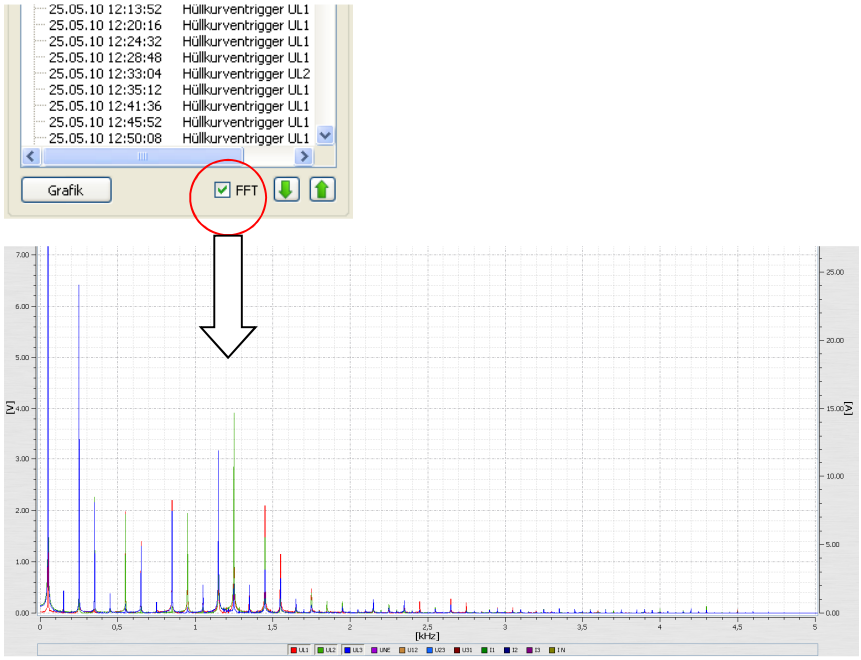


With these two icons  it is possible to scroll through the different recorders. The software automatically uses the same display settings from the picture before. (Example: if the current traces are deselected, all other records will show without the current traces)

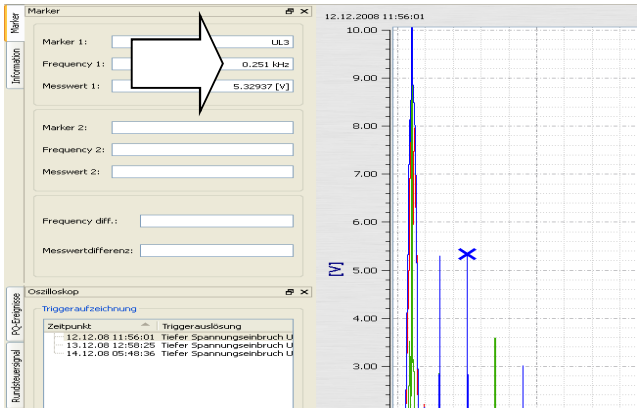
Right mouse click – menu:



The icon: ”FFT“, calculates from each oscilloscope record the spectrum of voltage and current harmonics and interharmonics from DC up to 5000 Hz in steps of 5Hz.



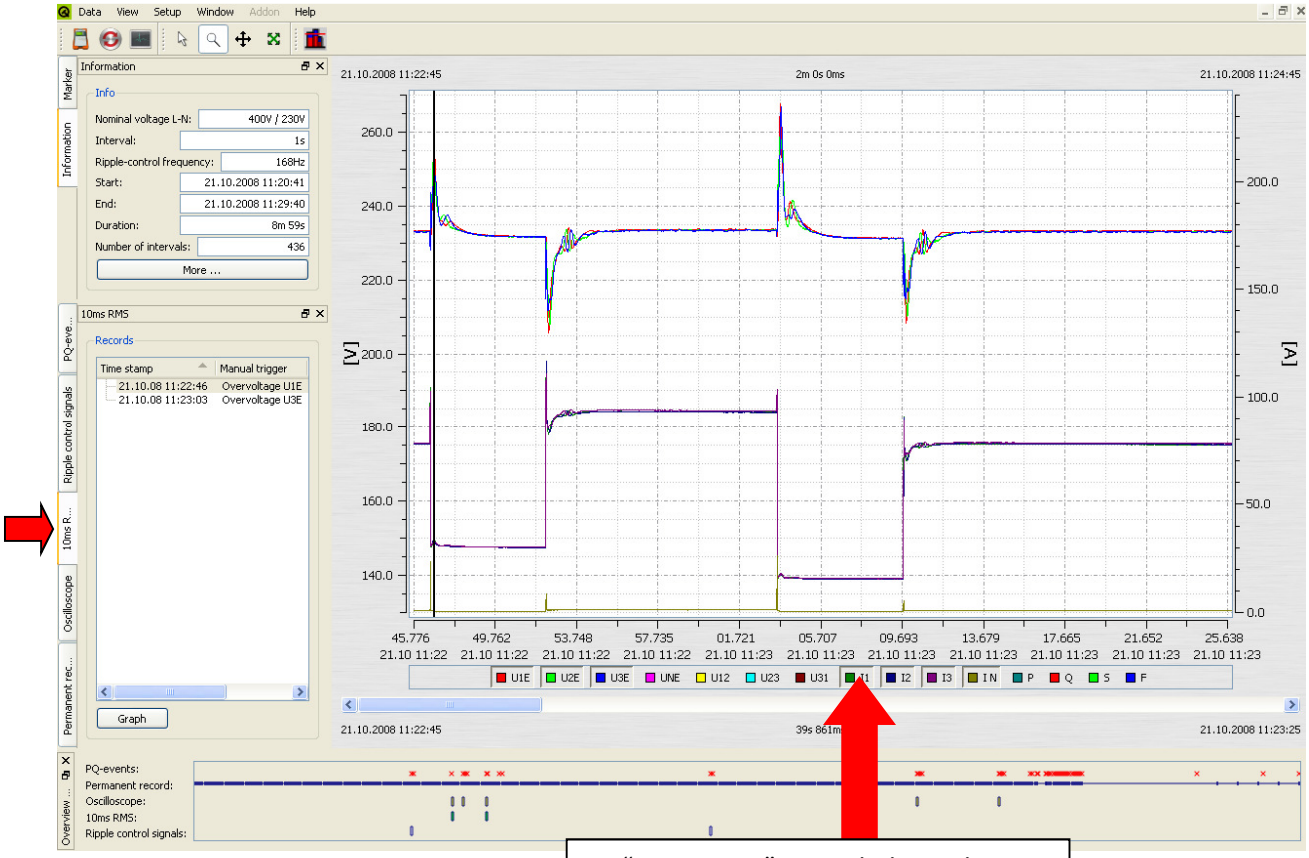
The “Marker“ will show the selected frequency and the amplitude.



5.4.7 “10ms RMS” Records

All of the “10ms RMS” records (recorded manually and via trigger settings) are listed using the “10 ms RMS" tab. These can be sorted by time or trigger condition.

The corresponding “10ms RMS” record is displayed by double-clicking on the line or clicking on the Graph button.



In “10ms RMS” record channels U1E, U2E, U3E, I1, I2, I3, N are preselected.

You can activate new channels for display by pressing the button i. e. U12, U23, U31 …

With these two icons  it is possible to scroll through the different recorders. The software automatically uses the same display settings from the picture before. (Example: if the current traces are deselected,, all other records will show without the current traces)

5.4.8 Ripple signal recorder

With the option “Ripple signal recorder” it is possible to trigger to the signal voltage and start a record especially for this frequency. The maximum length of the recorder is 210 seconds. There are recorded the voltages and currents

In this example the frequency of 180 Hz was recorded over 1 minute and 40 seconds.

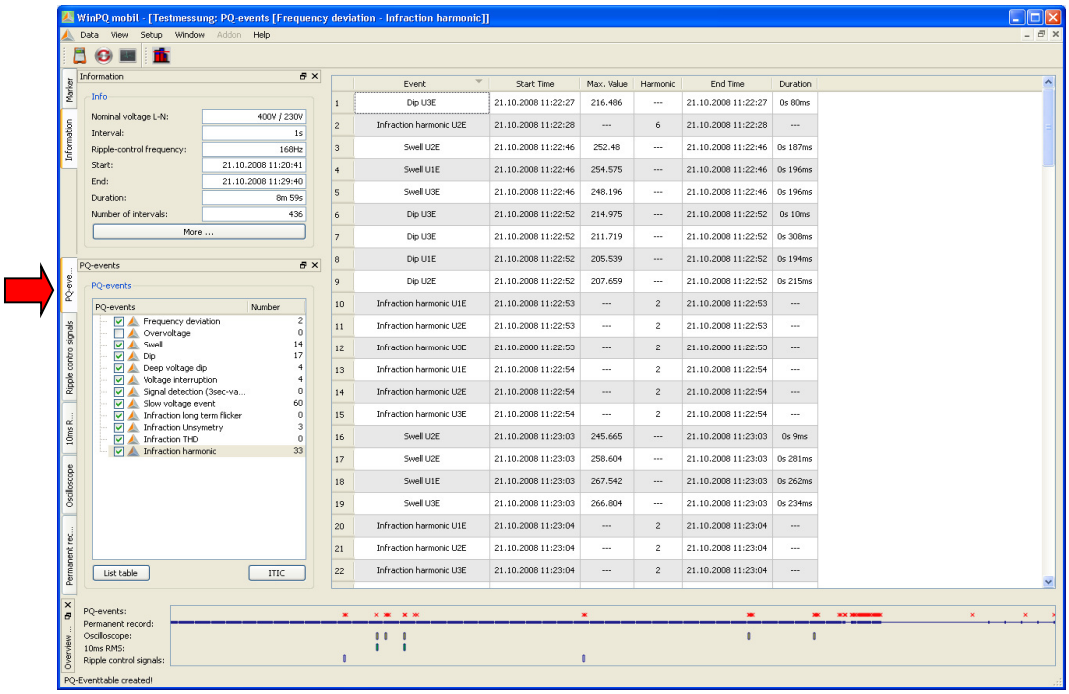
All ripple control records are shown in the recorder list and in the overview picture

With these two icons  it is possible to scroll through the different recorders

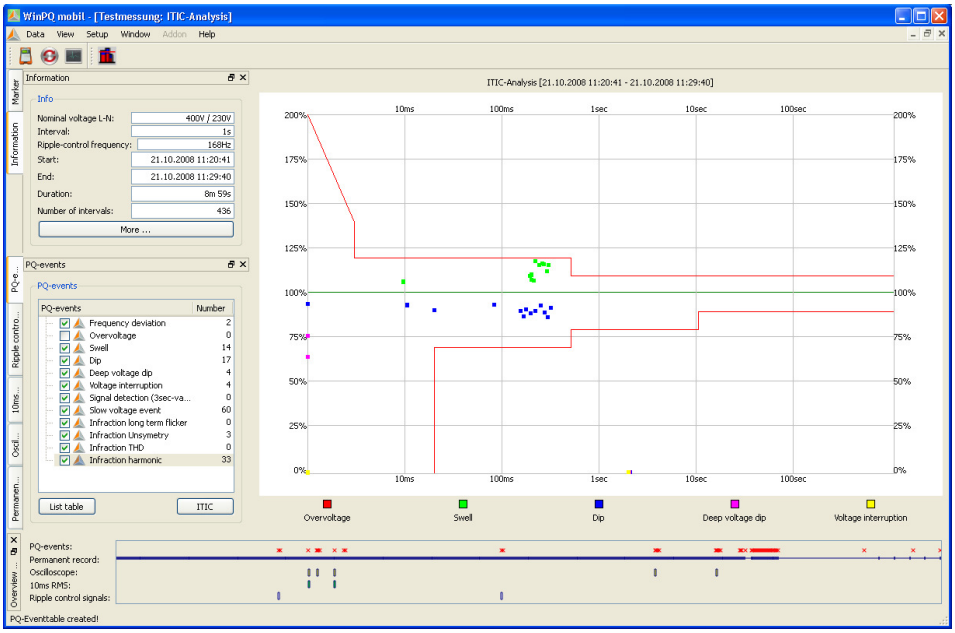
5.4.9 PQ Events

The “PQ events” tab shows all overshoots of the specified limit value.

The List table button gives you a detailed list of the PQ events with the time and extreme values.

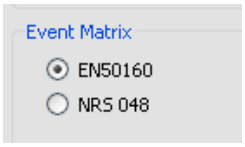


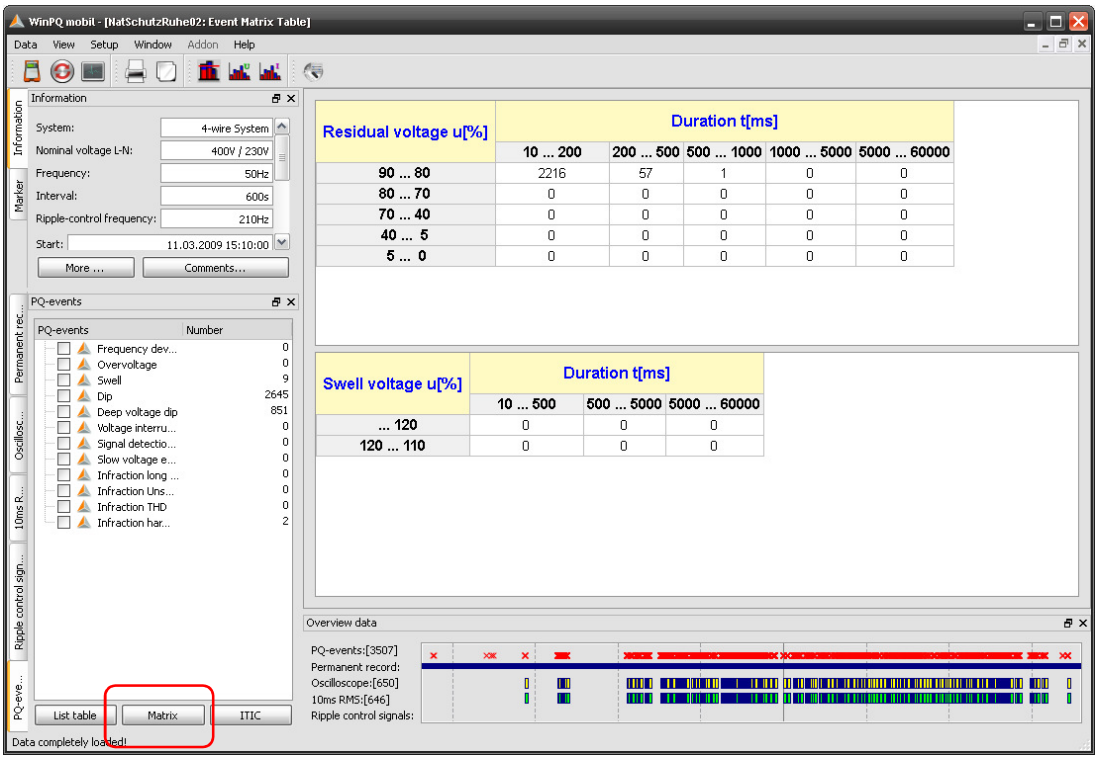
With the button ITIC it is possible to show all voltage dips, swells and interruptions in an ITIC graph. All events are scaled in % to the nominal voltage (=100 %) and duration of the event.



In PQ events additional to the ITIC graph the UNIPEDE statistic for voltage dips and voltage swells is available.

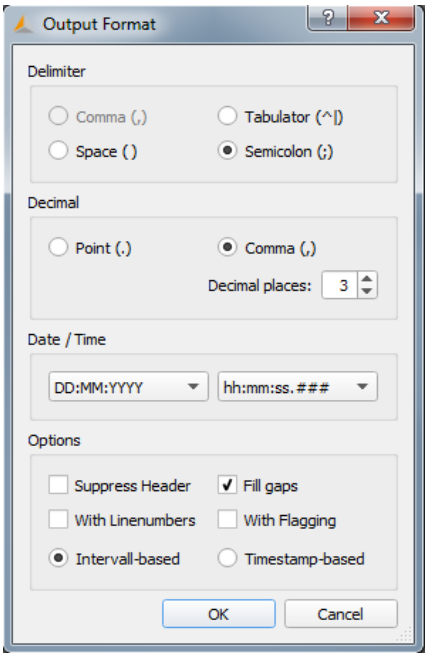
This matrix can be changed in WinPQ mobil/settings/common to the NRS 048 statistic.



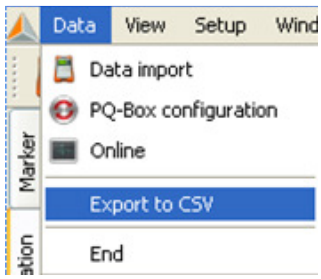


5.4.10 Data export function

In Setup/Export it is possible to configure the general settings of the data export function.

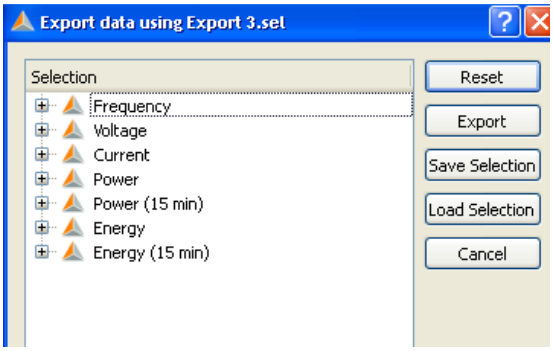


With “Export to CSV” you have the possibility to export all permanent data.

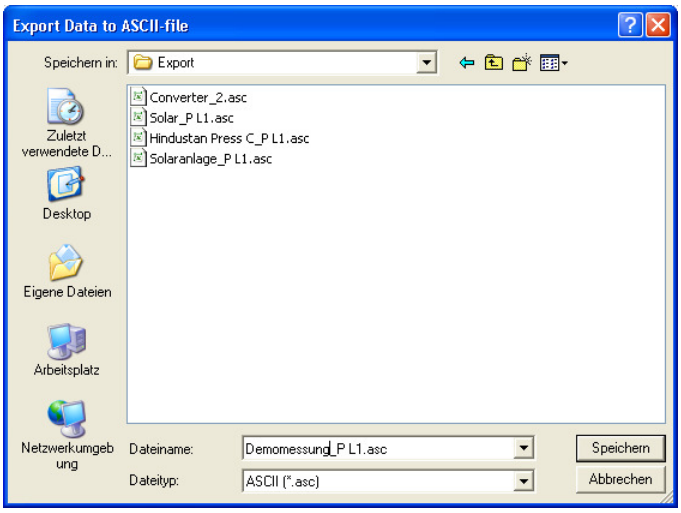


In the following menu you can select all parameters which you want to export.

With “save selection” you have the possibility to save different exports templates, which can be recalled using the Load Selection.



When exporting the data file, you can change the name of the data file, and location.

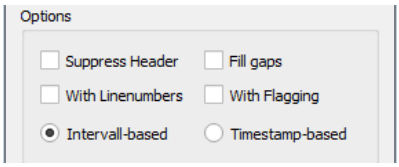


Example of a file exported and opened MS-Excel:

	A	B	C	D	E	F	G	H	I	J	K
1	**PQ Box 100**		**Serial-No.: 0804-004**								
2											
3	Measurement: Solar plant, Hofweg 28,										
4											
5	Interval: 600 sec										
6	Voltage: 230 V										
7											
8											
9	**Date/Time: 18.11.2008 12:40:00 - 26.11.2008 09:50:00**										
10											
11	Date	Time	P L1	P L2	P L3	P total	S L1	S L2	S L3	S total	Q L1
12	18.11.2008	12:40:00	28970.9	29141.8	28623.1	86735.7	33268.4	32337.8	32861.8	98529.4	16354.6
13	18.11.2008	12:50:00	35467.8	35369.3	35821.7	106659	38617.5	36427.2	38791.4	113940	15275.8
14	18.11.2008	13:00:00	37027.4	36698.5	37197.9	110924	39811.1	37975.3	39840.5	117718	14625.3
15	18.11.2008	13:10:00	30077.2	30896.3	30015.8	90989.1	33151.5	32195	32980.1	98415	13942.7
16	18.11.2008	13:20:00	28710.2	29336.5	29443.2	87489.9	30632.4	30212.2	31295.6	92214.9	10680.1
17	18.11.2008	13:30:00	36482.6	37915.5	36829	111227	39502.6	39227.4	39710.5	118495	15148.7
18	18.11.2008	13:40:00	29710.6	30129.8	29647	89487.3	33692.9	31855.7	33216.9	98892.1	15890.1
19	18.11.2008	13:50:00	39636.2	40203.4	39142	118982	42011.7	41812.8	41045.9	124953	13926.7
20	18.11.2008	14:00:00	32961.5	32672.7	31729.8	97364	35817.4	34063.2	34084.7	104121	14015.2
21	18.11.2008	14:10:00	24075.5	24809.9	23199.5	72085	26868	25623.7	25789.5	78576.4	11927.1
22	18.11.2008	14:20:00	30752.7	31526.1	30099.9	92378.7	33938.8	32864.1	32846.5	99826	14356.6

The order of the selected data in data export is automatically the order of columns in the export file.

In CSV export you will have the minimum - and maximum - RMS output with the exact time stamps.

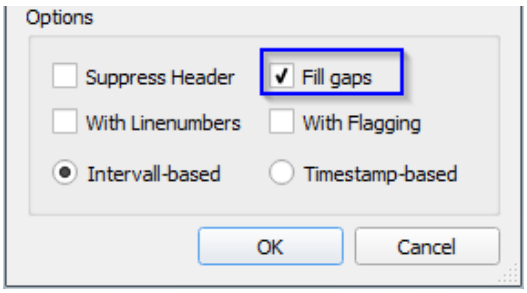


The time format for CSV Export can be changed in general settings for export data

Also, the Short Time Flicker (PST) and the Long time Flicker (PLT) has it's own time stamps regardless of the programmed measurement interval as 10 min interval is issued.

Datum/Zeit:	17.10.2013 09:30	06:50:00								
Datum	**Zeit**	**UL1**	**UL2**	**UL3**	**UL1 max**	**UL2 max**	**UL3 max**	**UL1 min**	**UL2 min**	**UL3 min**
07.10.2013	09:30:00	232,56	232,539	233,323						
07.10.2013	09:35:39					233,004				
07.10.2013	09:35:44						233,999			
07.10.2013	09:38:16				233,124					
07.10.2013	09:39:01							230,728		
07.10.2013	09:39:01								230,506	231,44
07.10.2013	09:40:00	232,572	232,487	233,394						
07.10.2013	09:40:27						233,874			
07.10.2013	09:43:50								231,299	232,322
07.10.2013	09:49:00				233,116					
07.10.2013	09:49:00					233,107				
07.10.2013	09:49:30							231,209		
07.10.2013	09:50:00	232,51	232,412	233,318						

With the feature "Fill gaps" measurement interruptions will be filled with zero values.

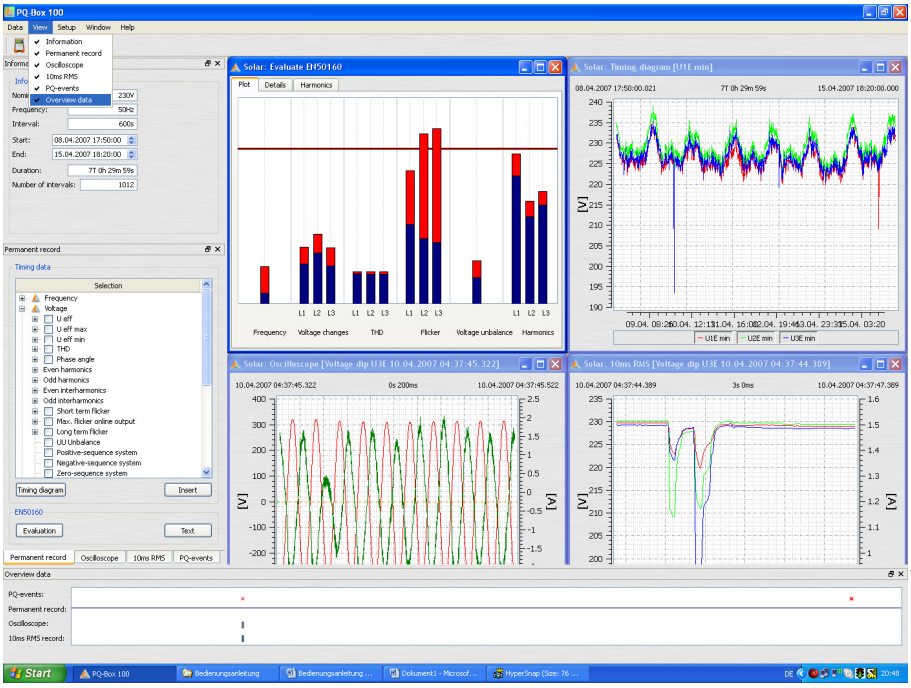


Datum	Zeit	'UL1 [V]'	'UL2 [V]'	'UL3 [V]'	'UL1 max [V]	'UL2 max [V]	'UL3 max [V]	'UL1 min [V]'	'UL2 min [V]'	'UL3 min [V]'	'IL1 [A]'	'IL2 [A]'	'IL3 [A]'	'I Neutral [A	'IL1 Max [A]'	'IL2 Max [A]'	'IL3 M
01.04.2016	05:10:00.000	271.283	275.863	270.185	271.919	276.491	270.827	269.174	274.863	268.923	483.327	511.903	475.153	2.532	489.030	520.794	4
01.04.2016	05:20:00.000	271.176	275.864	270.134	272.041	276.776	270.911	266.244	271.936	264.533	483.976	512.775	476.001	2.584	507.876	540.824	4
01.04.2016	05:30:00.000	272.163	276.583	270.990	272.676	277.101	271.544	269.445	275.224	269.690	483.283	510.335	473.954	2.574	489.797	525.497	4
01.04.2016	05:40:00.000	272.324	276.556	271.203	272.900	287.965	276.910	175.906	262.996	258.264	483.457	509.221	474.873	2.559	701.583	895.008	6
01.04.2016	05:50:00.000	272.216	276.055	270.999	276.221	279.873	274.843	257.461	260.527	256.539	478.912	504.267	472.828	2.590	810.285	849.971	8
01.04.2016	06:00:00.000	274.798	279.002	273.612	275.324	279.678	274.152	273.097	277.789	272.422	367.563	385.975	359.205	2.002	382.301	402.349	3
01.04.2016	06:10:00.000	274.875	278.879	273.465	275.364	279.403	274.052	273.792	277.889	272.460	367.464	384.099	357.608	2.001	371.021	387.841	3
01.04.2016	06:20:00.000	273.572	277.434	271.984	274.937	278.942	273.517	258.707	262.495	256.860	454.392	474.790	443.088	2.428	971.944	1.011.982	9
01.04.2016	06:30:00.000	273.935	277.786	272.189	274.357	278.254	272.611	273.290	277.178	271.608	484.630	506.019	471.180	2.578	488.557	509.808	4
01.04.2016	06:40:00.000	273.603	277.804	271.985	274.187	278.434	272.504	273.104	277.079	270.531	483.665	506.959	469.497	2.573	492.795	510.591	4
01.04.2016	06:50:00.000	273.318	277.704	271.789	274.863	278.241	272.271	271.649	275.464	269.279	483.641	508.505	469.488	2.583	495.022	519.829	4
01.04.2016	07:00:00.000	272.719	277.356	271.312	274.428	279.222	273.166	267.584	274.644	265.968	483.577	510.151	470.616	2.568	509.982	532.637	4
01.04.2016	07:10:00.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
01.04.2016	07:20:00.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
01.04.2016	07:30:00.000	271.370	276.053	270.290	272.101	276.797	271.214	268.478	274.057	266.689	485.299	511.619	472.537	2.575	499.676	529.348	4
01.04.2016	07:40:00.000	271.203	275.780	269.894	271.855	276.450	270.460	269.144	274.073	268.600	486.857	511.288	472.643	2.573	492.777	524.878	4
01.04.2016	07:50:00.000	271.833	276.470	270.451	273.298	277.945	271.870	268.370	273.023	268.168	485.391	510.938	471.766	2.552	496.792	523.589	4
01.04.2016	08:00:00.000	272.188	276.863	270.839	272.829	277.586	271.501	269.882	275.163	268.022	483.957	509.124	470.683	2.516	494.502	520.687	4
01.04.2016	08:10:00.000	272.631	277.394	271.318	274.412	279.321	273.401	262.514	267.480	261.272	455.861	479.871	443.723	2.339	802.930	841.529	8
01.04.2016	08:20:00.000	273.252	278.387	272.129	274.491	279.595	273.301	270.917	276.895	269.314	365.707	386.118	354.603	1.907	373.335	390.746	3
01.04.2016	08:30:00.000	272.364	277.592	271.256	273.230	279.464	272.320	215.401	267.423	266.888	370.111	391.976	359.718	1.945	452.832	552.734	4
01.04.2016	08:40:00.000	271.453	276.559	270.260	272.904	277.958	271.591	270.356	275.560	269.245	371.568	393.983	361.710	1.974	386.928	408.464	3
01.04.2016	08:50:00.000	272.355	277.624	271.147	272.829	278.079	271.616	269.892	276.400	269.976	370.809	391.864	359.285	1.961	375.008	402.604	3
01.04.2016	09:00:00.000	272.348	277.488	271.108	272.814	277.939	271.609	271.506	274.913	270.548	371.115	391.664	359.167	1.939	373.925	394.946	3
01.04.2016	09:10:00.000	271.936	276.954	270.820	272.751	277.968	271.806	268.822	275.860	269.619	371.944	391.588	360.324	1.947	375.136	406.871	3
01.04.2016	09:20:00.000	271.860	276.784	270.721	272.351	277.231	271.250	269.976	275.709	268.667	370.965	390.672	359.837	1.939	378.106	396.025	3
01.04.2016	09:30:00.000	271.655	276.642	270.668	272.369	277.249	271.430	268.689	274.576	267.302	371.617	391.268	360.750	1.945	383.970	403.924	3
01.04.2016	09:40:00.000	271.898	276.897	270.987	276.420	281.923	275.758	264.022	269.337	263.041	353.857	372.914	343.972	1.902	605.231	636.503	6

5.4.11 Additional Functions

Using the "Window / Split" menu item it is possible to display all previously selected evaluations together in an overview.

The various command/control windows such as the "Measurement data overview" windows can be closed in order to make more room for the analysis graphics. It is possible to reactivate these via the “View” menu.

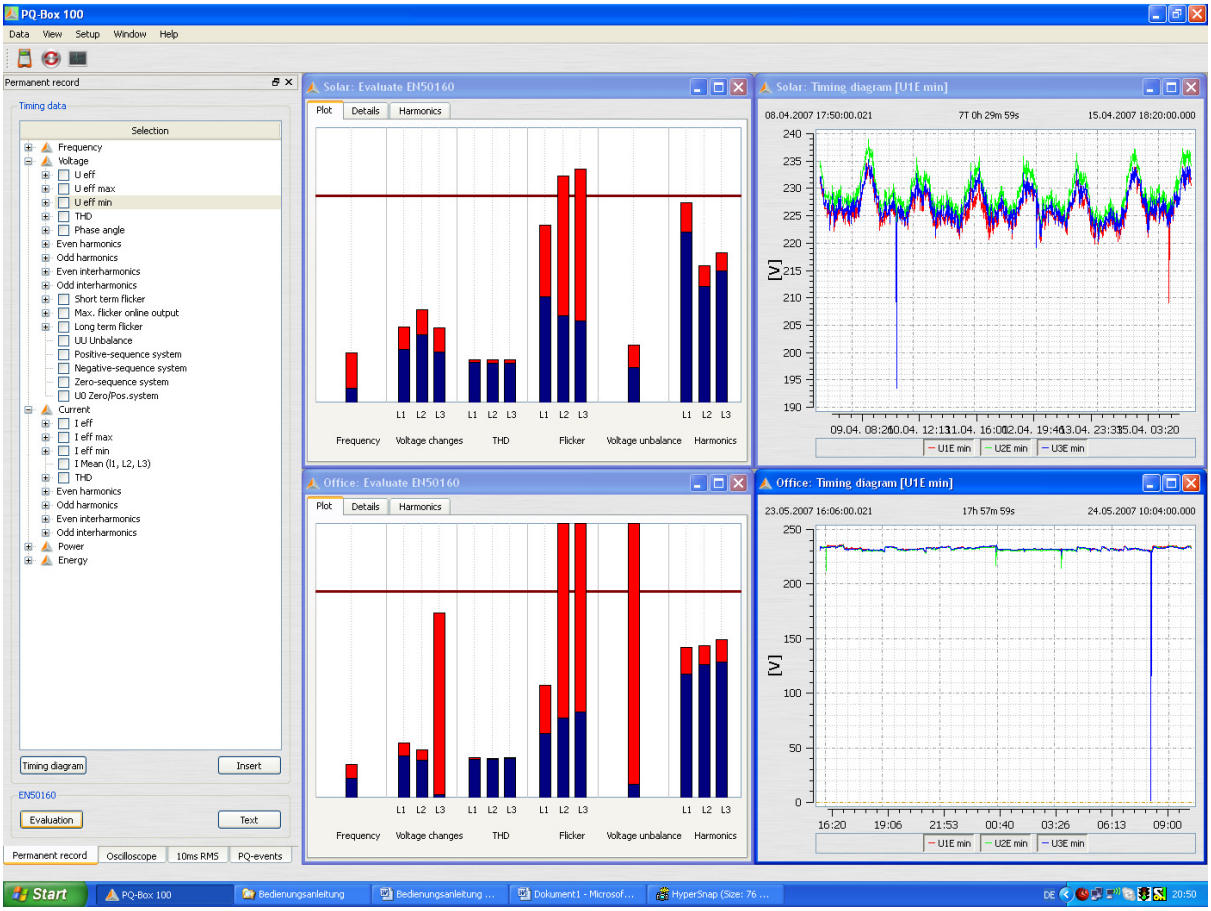


Close “Data overview” window

Comparing two different measurements to each other.

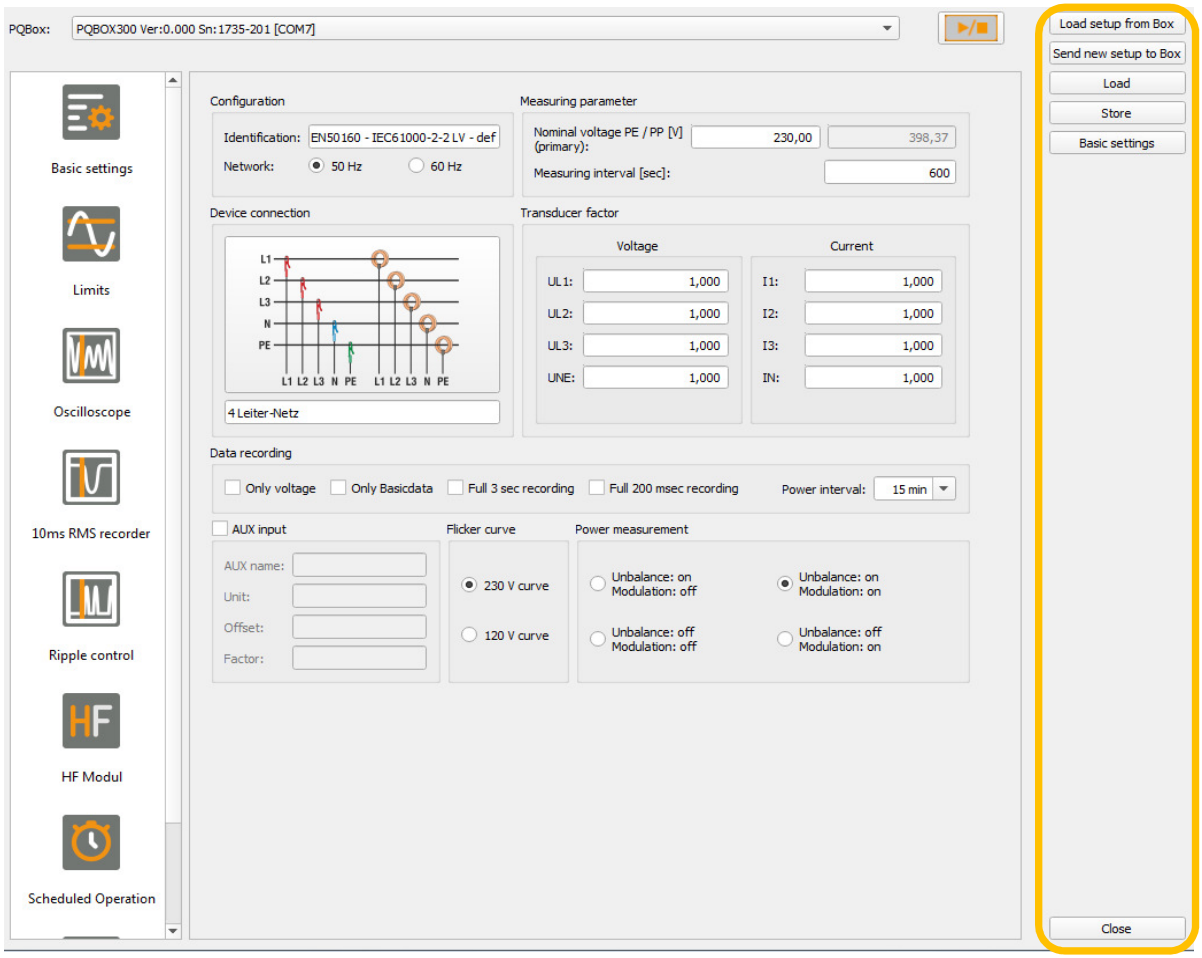
During an analysis, it is possible to open an additional measurement record, create another level-time diagram and/or standard EN analysis, and using the “Window-> Segmenting” menu item to compare these to each other on one screen (next to each other).

Figure: Two different measurements displayed together.



6. Changing Limit Values and PQ-Box 100 Settings

The “Setup” icon  , enables device parameters, trigger conditions and limit values of the PQ-Box 100 to be changed.



Load setup from Box Loads the current settings from the network analyser to PC screen

Send new setup to Box Sends currently displayed settings to the PQ-Box 100

Load Opens a template file of settings, which has previously been stored on the PC

Store Saves a setup file to the PC

Basic settings Resets displayed settings to default values. (Please note these still need to be “sent” to the PQ-Box 100 to take effect). The Basic settings button loads all settings from the stored file “PQBox_Param_defult.ini” This file can be overwritten if you desire to create your own default settings. Note that each setting file contains all the “Basic Settings”, “Limits”, “Oscilloscope” & “10ms RMS recorder” setting values. These are not stored individually.

 This function can start and stop a measurement on the meter from the software.

6.1 Setup – Basic Settings

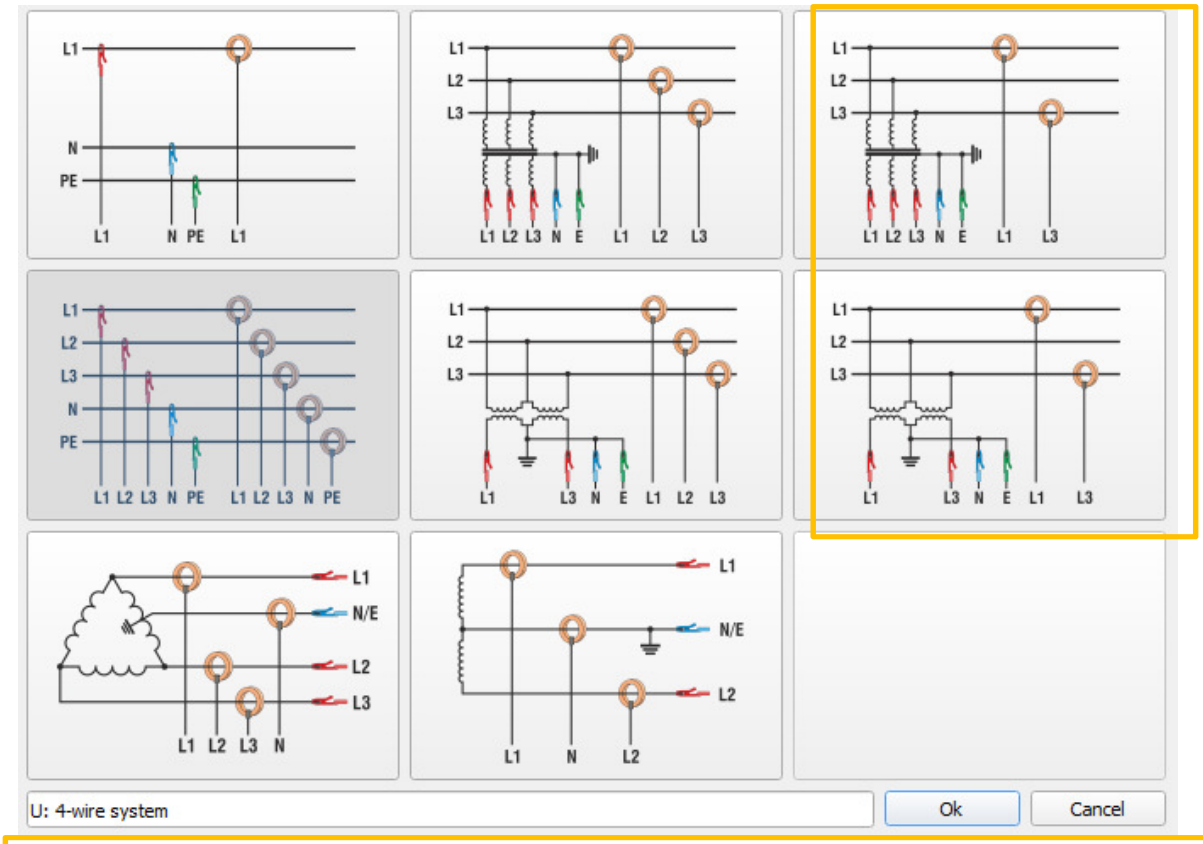
Basic settings

Settings such as network configuration, nominal voltage and transformer ratio of current and voltage transformers are carried out in the basic settings menu.

Voltage configuration:

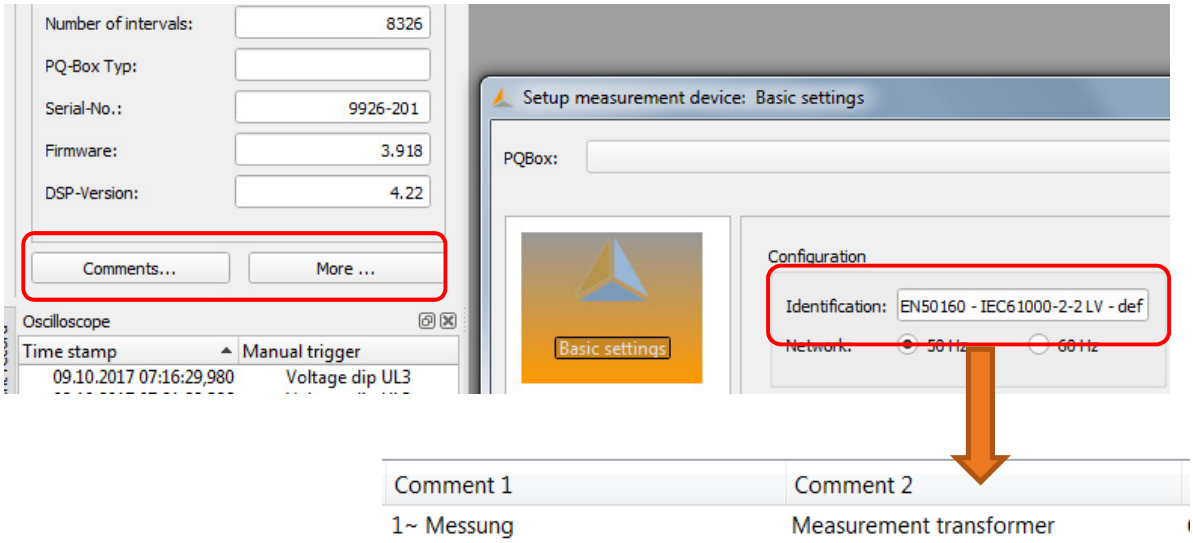
- 1 wire system (single phase L1)
- 3 wire system (insolated network)
- 4 wire system (L1, L2, L3, N, earth)
- V-circuit (This should be used if the voltage transformers are connected in open delta)
- Delta high leg network
- Split phase network

With the 3-wire or 4-wire the device distinguishes the configuration of the network to be measured. In an isolated 3-wire network, all ratings from the EN50160 standard are calculated from the wire voltages. In a 4-wire network (grounded network) all Power-Quality parameters are derived from the phase voltages. For single phase measurement only phase L1, N and PE will be recorded.



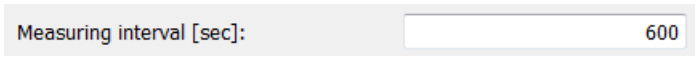
This function is activated if the secondary current transformer in the medium or high-voltage network is connected in an Aron-connection. The current L2 is not connected and calculated by the PQ-Box.

It is possible to describe the measurement/setup with user defined text (up to 32 characters). After the measurement is done, this text can be found in “Comment 2”.



The PQ-Box 100 bases all trigger thresholds and PQ events on the set “Nominal voltage”.

The contractually agreed voltage should be specified as the nominal voltage in all network configurations, e.g. 230 V or 20500 V



The measurement interval of the PQ-Box 100 can be freely set, between 1 and 1800 seconds. The default setting is 10 minutes, because this is the duration of the interval specified in EN50160 and IEC61000-2-2.

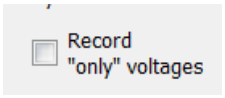
Note - Data Quantity

Setting the measurement interval to values less than 60 seconds is only suitable for short measurement periods (a few hours), since large amounts of data are recorded by the measurement device.

Examples of the data size of the long-term data; the fault records also increase the memory:

- a measurement interval of **10 minutes** produces a data size of about **10 MB in a week**
- a measurement interval of **1 second** produces a data size of about **10 MB in 30 minutes**

The resulting data size can be limited in two ways.

a) 

In this setting, no currents and power values are recorded. The amount of data reduced to about 40%.

b) 

In “Basicdata” are no harmonics, interharmonics or phase angle of harmonics recorded.

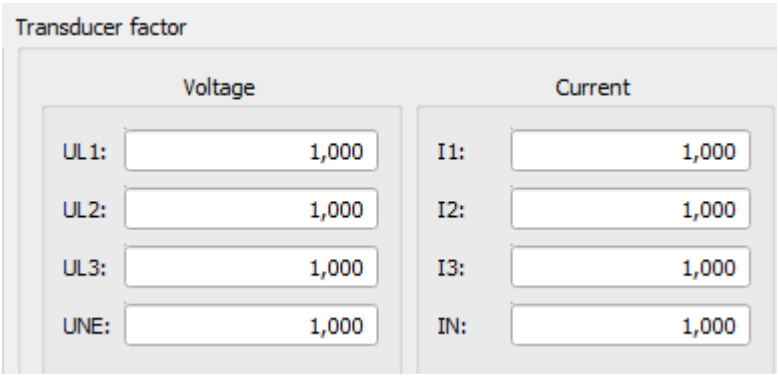
All recorders are still active.

Status, Events, Flagging
Frequency values (mean, extreme)
Voltage values (mean, extreme)
Flicker
Current values (mean, extreme)
Power values (mean, extreme)
Ripple signal voltage
THC, K-Factor, Phaseangle, symmetrical components
Distortion power, Power factor
Spannungsabweichung, Symmetrie, PWHD
PWHD, PHC current
cosPhi, sinPhi, tanPhi, power values fundamental
Reactive power fundamental
10/15/30-minutes interval
Power values (mean, extreme)
Distortion power, Power factor
cosPhi, sinPhi, tanPhi, power values fundamental
Reactive power fundamental

A measurement with 1 sec intervall produced about 6,6 MB data per hour.

1 GB memory will be filled in 6,6 days.

Transducer factor voltage and current



The transformer ratio of the current and voltage transformers to which the network analyser is connected must be entered in the transformer settings.

Example:

Medium voltage: primary = 20000 V; secondary = 100 V; transducer factor U = 200

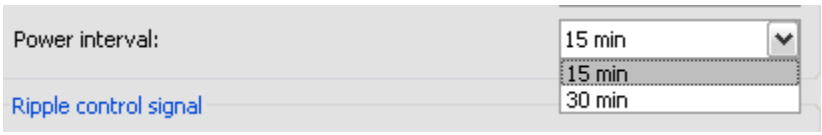
Current: primary = 600A; secondary = 5A; transducer factor I = 120

Note the CT ratios also need to be adjusted for certain CT clamps.

Power interval:

All power values will be recorded parallel to the free adjustable interval with a 10, 15 or 30 minutes interval as set. These intervals start always in sync with the full hour.

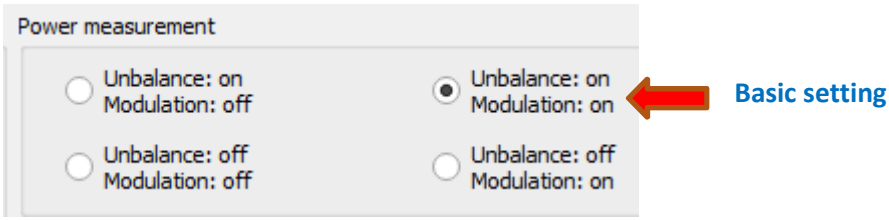
Example: If recording is started at 14:37, and 15 minute interval has been selected, the first valid power date interval will be 14:45 to 15:00.



Power measurement

The calculation of the power values can be changed in two different settings:

- according DIN40110-2 – with calculation of the unbalance reactive power (basic setting of the Box)
- Simplified power calculation - without the unbalance power.



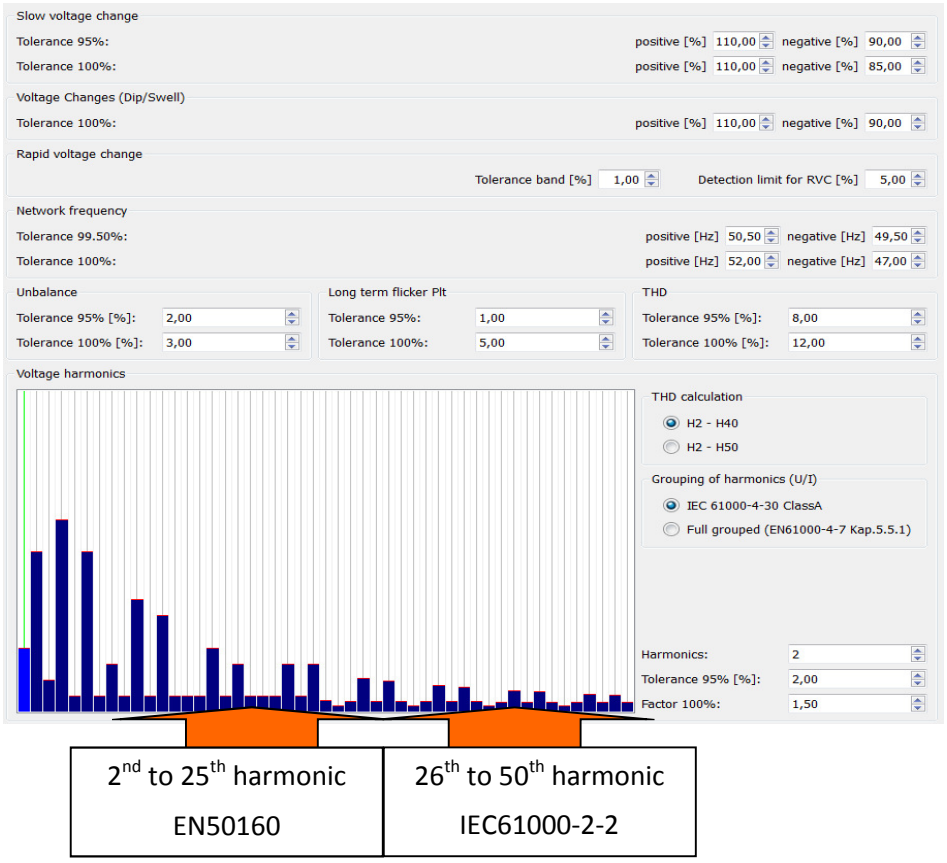
This setting has also an effect on the power values in the display of the PQ-Box.

6.2 Setup – Limit Values EN50160 / IEC61000-2-2 / IEC61000-2-4

Limits

In this menu item, all of the compatibility levels can be changed by the user.

The limit values can be reset to the default values using the Basic settings button.



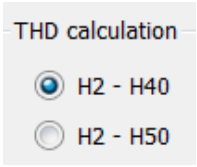
2nd to 25th harmonic	26th to 50th harmonic
EN50160	IEC61000-2-2

Because EN50160 only specifies limit values up to the 25th harmonic, the compatibility levels of IEC61000-2-2 are used as the default settings for the 26th to the 50th harmonics.

With the icon Load it is possible to load setting files bases on different standards. In the folder you will find many standards for industry networks (IEC61000-2-4 for category 1, 2 and 3) or the standards NRS 048 for Africa.

If you desire you can save any setting file using the icon Store.

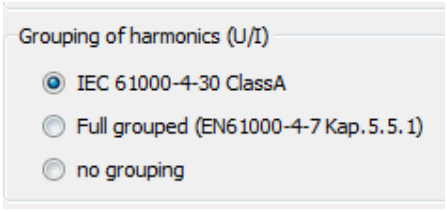
THD calculation



The THD calculation of voltage and current can be changed in the settings:

- 2 – 40th according EN50160
- 2 – 50th according IEC61000-x-x

Calculation of harmonics



The calculation method for the harmonic groupings can be adjusted depending on the application (PowerQuality measurement or equipment testing).

- IEC61000-4-30 class A calculation
- Full grouping according IEC61000-4-7 section 5.5.1 (IEC 61000-3-X)

  Harmonic calcualtion (f. e. 2. Harm. = 75Hz bis 125Hz).

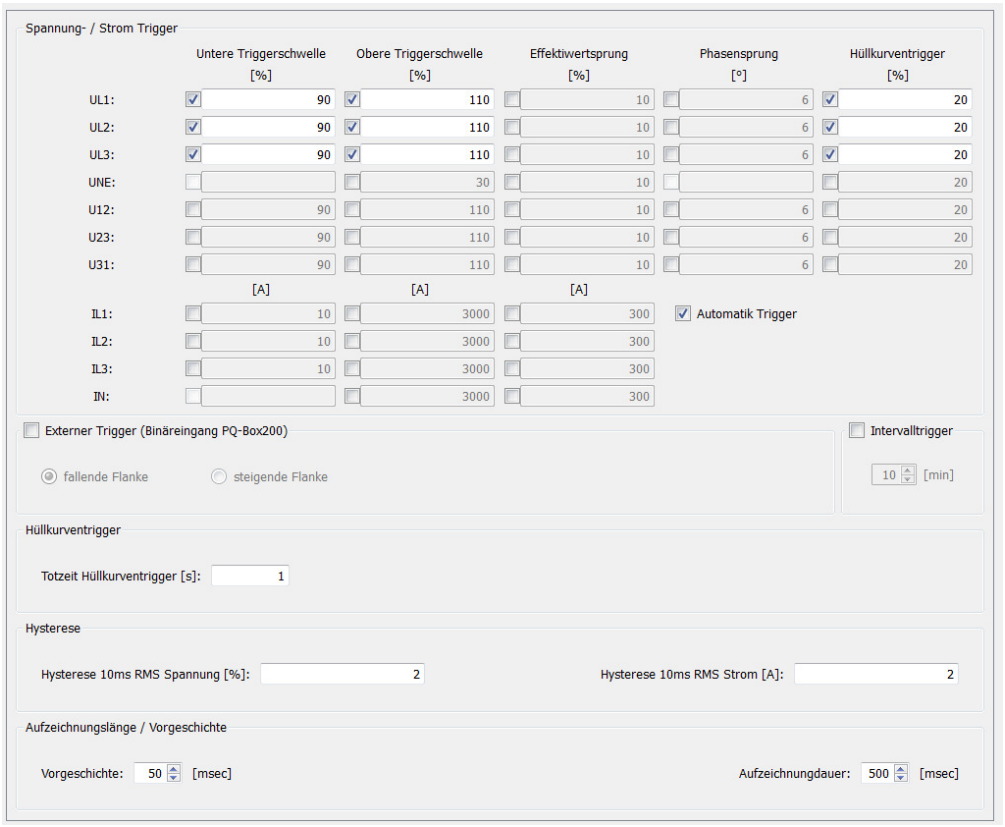
  Interharmonics. (f. e. IH1 55Hz bis 95Hz)
- No grouping – single frequency

6.3 Trigger Settings for the Oscilloscope Recorder

Oscilloscope

In the “Oscilloscope” menu item, you can set trigger criteria for Oscilloscope recordings. A rms value threshold of +10% and -10% of the nominal voltage is set in the default basic setting.

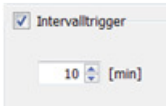
If a field has a grey background  and is not marked  , the trigger criterion is not active. All trigger conditions can be operated in parallel and are “OR-linked.”



The “recording length” is the total recording time for the Oscilloscope recording in milliseconds (including the pre-event time).

The time that is recorded before the event trigger condition is defined as the “pre-event” time.

The length and pre-event time can have any value between 20 ms and 4000 ms.



If enabled, an oscilloscope recorder is recorded according to the interval of time. With WinPQ mobil it is possible to calculate the spectrum of the recorder with the integrated FFT functionality.

Trigger Settings for the Oscilloscope:

All trigger settings are depending on the nominal voltage “ Nominal voltage [V]: 400 ”.

lower threshold [%] The record starts, if the 10 ms rms value remains under the threshold

upper threshold [%] The record starts, if the 10 ms rms value exceeds the upper threshold

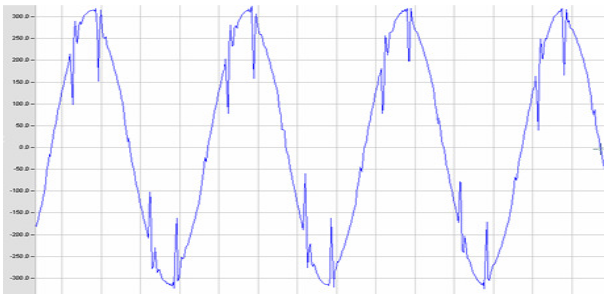
step [%] The record starts, if one 10 ms rms value to the next 10 ms rms value is greater than selected percentage.

phase step [°] The record starts, if the phase angle between successive 10 ms rms values exceeds the threshold step. „ ° „

envelope [%] This is a “wave shape” trigger where the record starts, if one sampling value (10.240 Hz) is outside of the wave shape threshold of the voltage sine wave.

(Typical threshold setting for wave shape trigger is 20 – 30 %)

Example: Commutation dip produced from frequency converter.



Envelope-Trigger Hold:

This setting only applies when the envelope trigger is used. The envelope trigger (wave shape trigger) is very sensitive and can produce many records in a short time period. The “Envelope Trigger Hold” time setting limits the number of records by applying the stop time between consecutive records.

All other triggers working without any hold off time between different records.

Hysteresis:

According to the standard IEC61000-4-30 all “Events” have to be recorded by using a hysteresis. The hysteresis defines the difference between begin of an event and end of an event.

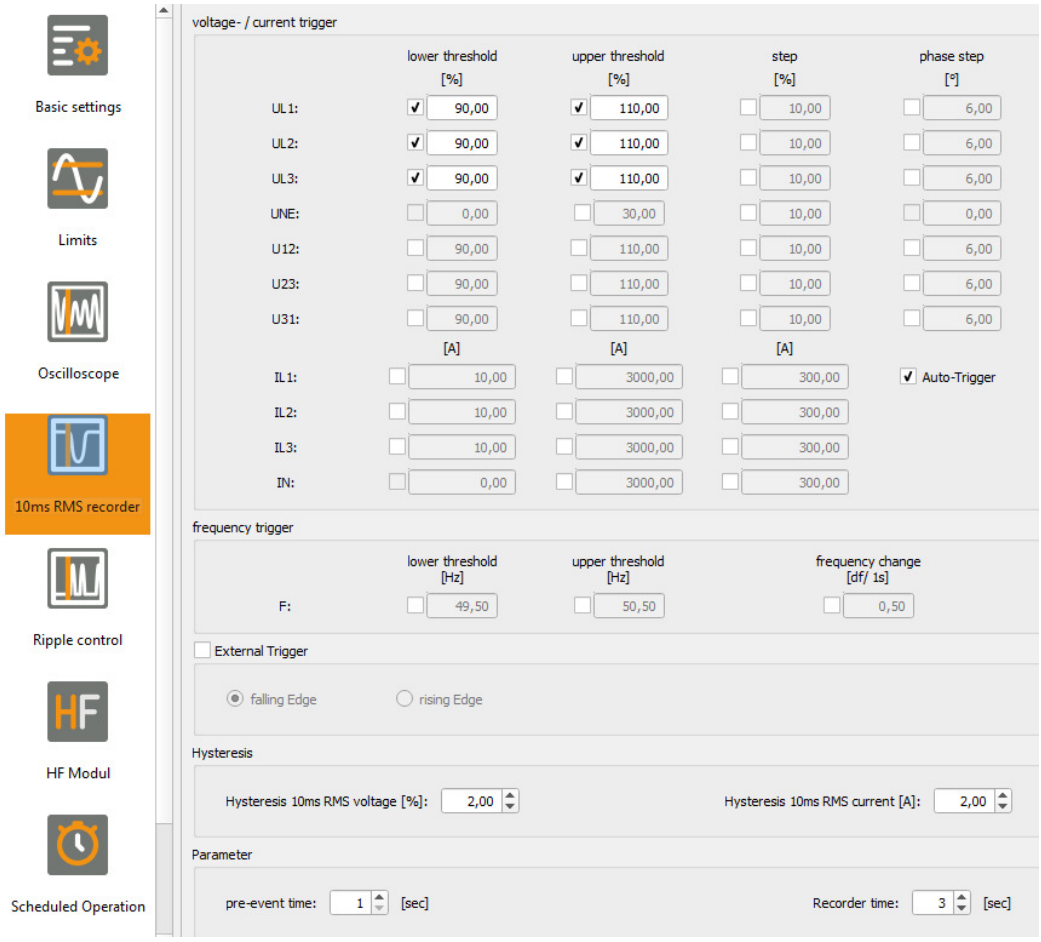
Example: Trigger voltage dip = 90 %; Hysteresis = 2 %

The voltage dip begins at -10 % of the nominal voltage and ends at 92 % of the nominal voltage (2% higher).

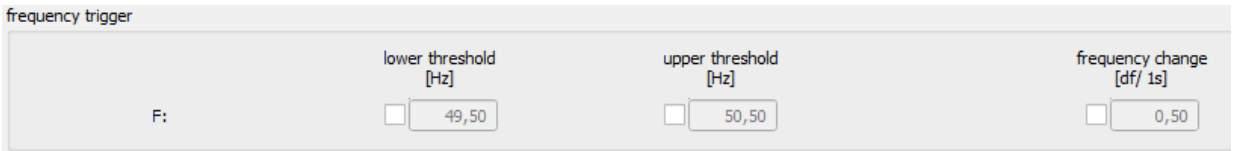
6.4 ½ periode rms Recorder

10ms RMS recorder In the "rms (1/2 period)" menu item, trigger criteria can be set for the rms recorder. In the default setting an rms value threshold of +10% and -10% of the nominal voltage is set.

Only the threshold values with a tick are active, trigger conditions without ticks are not switched on.



Explanation of the trigger conditions additional to oscilloscope trigger 6.3:



The ½ period rms recorder can be triggered on lower or upper threshold of the frequency or a frequency change within one second.

The "Recorder Time" is the total recording time for the oscilloscope in seconds.

As "pre event time", the time is defined that was recorded before the occurrence of the event.

The length of the recording, and the history can be set to any value between **1 sec and 600 sec.**

6.5 Automatic Trigger

The automatic trigger function for the oscilloscope recorder and half period recorder can be separated enabled or disabled.

If enabled, the PQ-Box changes independently for all enabled trigger thresholds, in case of a too sensitive threshold. This prevents the recording of unnecessarily large amounts of data.
The "automatic trigger" acts for each threshold selectively and can increases all these limits (e.g. the upper and lower threshold, the step, the phase shift or the wave shape trigger)

Should a power failure occur, which leads to a continuous violation of the lower trigger threshold, the limit is automatically reset to a preset value.

Implementation of the automatic trigger:

Three timers act to decrease the sensitivity of the affected trigger level. The trigger levels for the upper threshold, lower threshold, step, phase shift and wave shape triggers are each adjusted independently.

- **Expansion threshold:**

This timer acts to decrease the trigger sensitivity based on an exponential function. The larger the difference between the actual trigger condition and the setting, the longer (and larger?) a decreased sensitivity is applied.

- **Hold threshold**

If a new trigger condition occurs that is just slightly higher than the last trigger level, that new trigger level is used as the threshold for the next 600 seconds (the 'hold threshold').

- **Approximation threshold**

At the end of the ‘hold threshold’, the 'approximation threshold' timer adjusts exponentially the threshold back to the setting value.

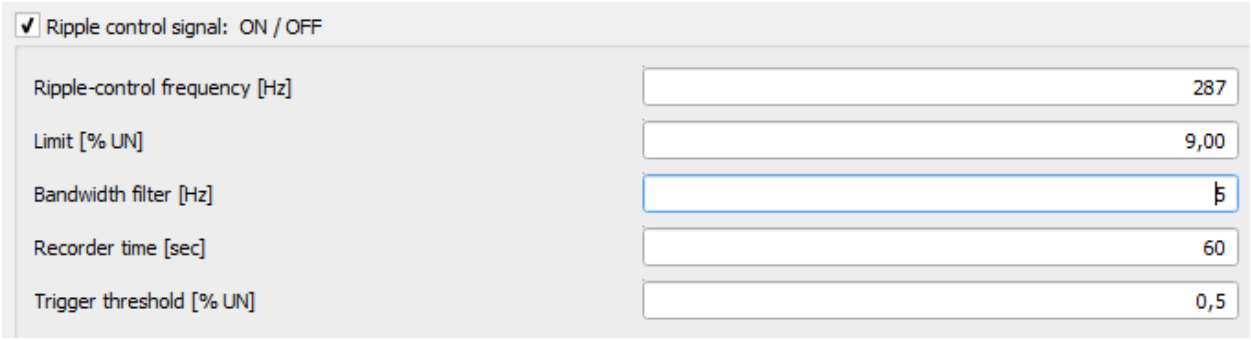
Using the automatic trigger function the user can ensure that the highest interference will be recorded always.

 For short measurement tasks or with custom trigger thresholds, please turn the automatic trigger function always off.

Do you want to capture measurement data over a long period (> 5 days) and you do not know the exact conditions of the network? Then the auto-trigger function helps when the thresholds are set too low to not fill immediately the device memory.

6.6 Ripple control signal analysis

Ripple control



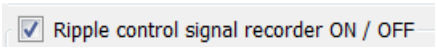
In the ripple control signal frequency field any frequency can be entered in the range from 100 Hz to 3,750 Hz. This frequency now will be permanently recorded as a maximum value of 200ms interval in the cyclic data. If the frequency will be set smaller than 100Hz, the 3 sec. recordings for this signal stop.

At this point, the limit value of the standard evaluation for the ripple control frequency can be changed.

Option ripple signal recorder (R1)

If the option “ripple signal recorder” activated in the PQ-Box, it is possible to start a high speed recorder that monitors this frequency.

You can setup the frequency of the signal, the bandwidth of the filter, the recorder time length and the trigger threshold voltage. The maximum recorder length is 210 seconds.



It is possible to enable or disable this recorder

PQ-Box with licensed/active optional “Ripple Signal Recorder” can be identified by the LCD display (6th Screen) showing “+S” after the PQ-Box 150 type.

- **The ripple control recorder can generate large amounts of data and should be turned on only when specifically a disturbance in the waveform is searched.**

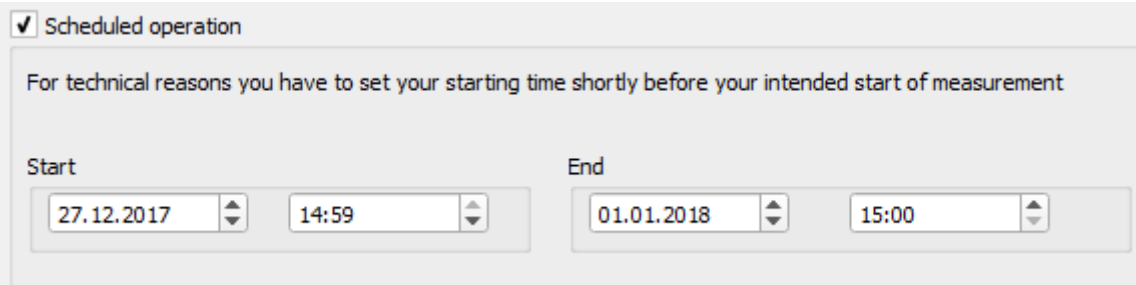
6.7 Scheduled Operation

Scheduled Operation

Programming the PQ-Box through a time command

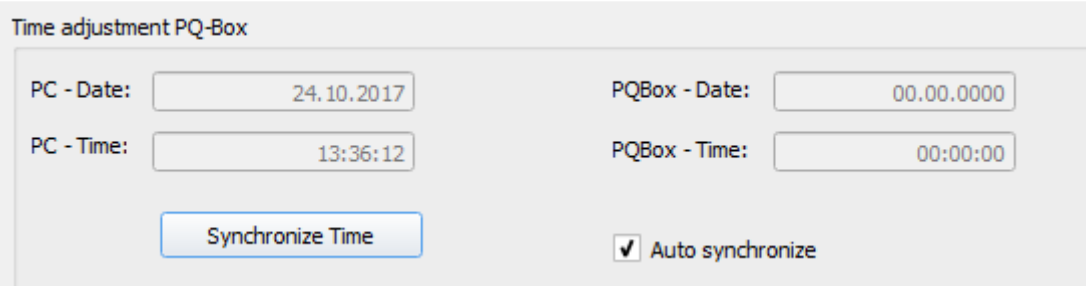
It is possible to start and stop the PQ-Box using a predefined time command.

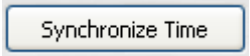
Example: The PQ-Box should switch on at the 27th Dec. 2017 at 15:00 o´clock and strop at 1st Jan. 2018 at 15:00 o´clock.



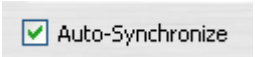
- If the start button on the PQ-Box is pressed before the measurement job, the PQ-Box starts recording immediately.
- If the stop button of the PQ-Box is pressed before the end of the measurement job, the measurement is stopped immediately.

Setting the PQ-Box date and time:





Synchronizes the PQ-Box time with the PC time at the moment when the button is pressed. The PQ-Box time will not hereafter be permanently shown on the PC screen.



If this option is activated, the PC automatically synchronizes the PQ-Box as each setup is sent.

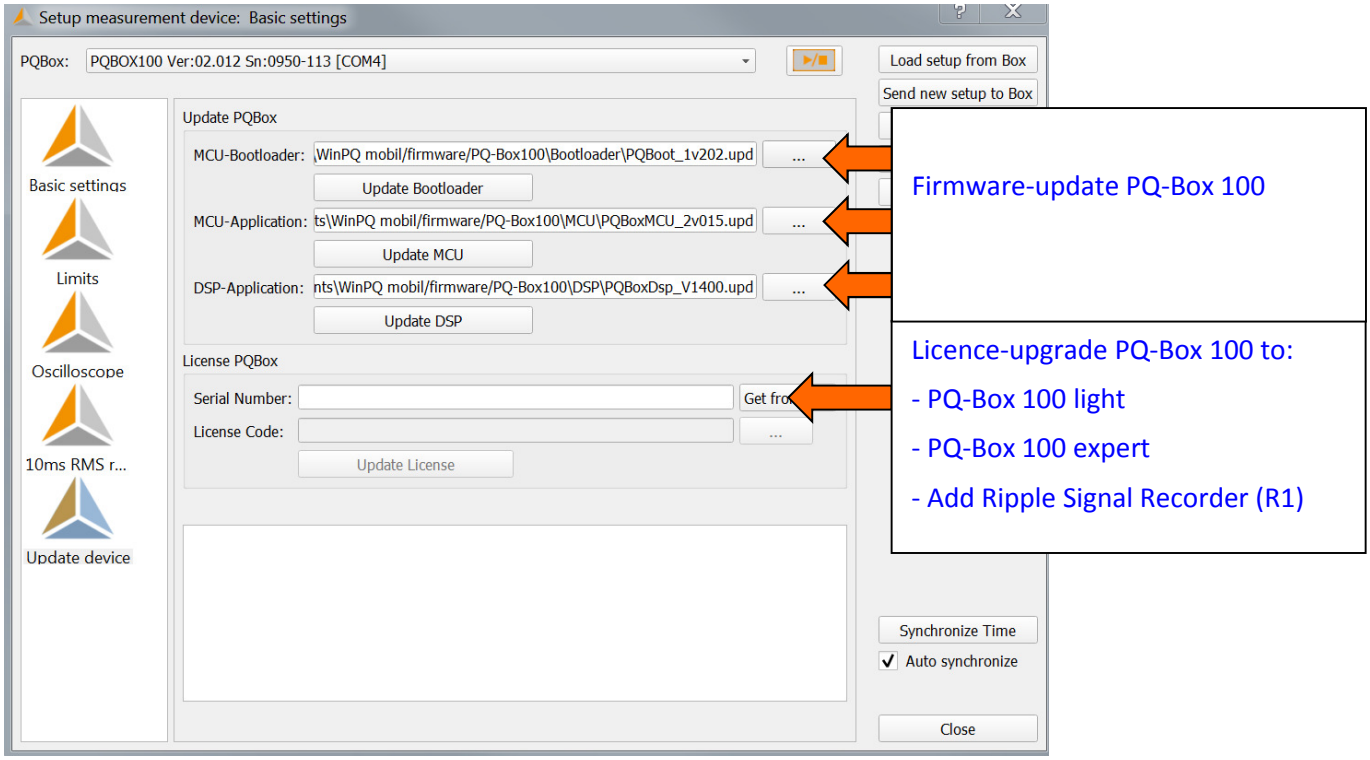
6.8 PQ-Box 100 Firmware Update

Update device

In the “Update” menu item, you can update the firmware of the network analyser or you can upgrade the device to have more functions via a license code. This menu item will only appear if a PQ-Box 100 is connected to the PC

Sequence for updating a PQ-Box 100:

1) Disconnect the PQ-Box 100 from the power supply (also disconnect USB)
2) Press and hold the “Start/Stop” and “Page” keys simultaneously (1st and 3rd key of PQ-Box 100)
3) Connect the PQ-Box 100 to a power supply (or USB)
   Device display show: “Waiting for Download”
4) Open the PQ-Box 100 Setup/update dialog box in the software
5) Load update file “PQBoot” to the measurement device
6) Load update file “MCU Application” to the measurement device
7) Load update file “DSP Application” to the measurement device
8) Disconnect the PQ-Box 100 from the power supply (also disconnect USB)
9) Next time the PQ-Box starting, the new firmware will be installed.



6.9 License Upgrade

The Get from Box button displays the serial number of the connected PQ-Box 100. In the “License code” field, enter the provided license upgrade code via the keyboard or by specifying a directory where supplied upgrade file has been located. If the license code matches the serial number of the device, the “Update license” field becomes active, permitting the connected PQ-Box 100 to be upgraded.

7. Data Converter

If the setting of the PQ-Box 100 were wrong, it is possible with the program tool ”Data Converter“, to correct some of the data in a stored measurement file:

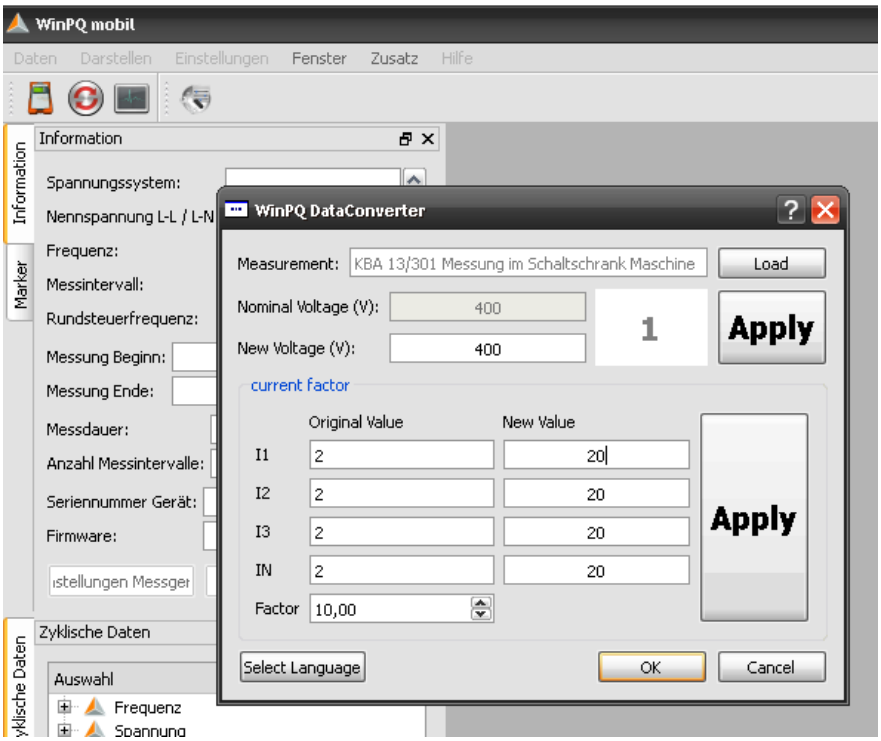
- **Changing the nominal voltage (i. e. 400 V to 20,800 V)**
- **Change the current transducer factor (i. e. from 2 to 20)**

1) Start the Data Converter (Setup/Data Converter)

2) Open the desired file using ”Load”

2) Change the nominal voltage or the current transducer factor

3) With “Apply“, a new measurement file with the correct values will be calculated. This new file will get the name “new“, in column no. 4



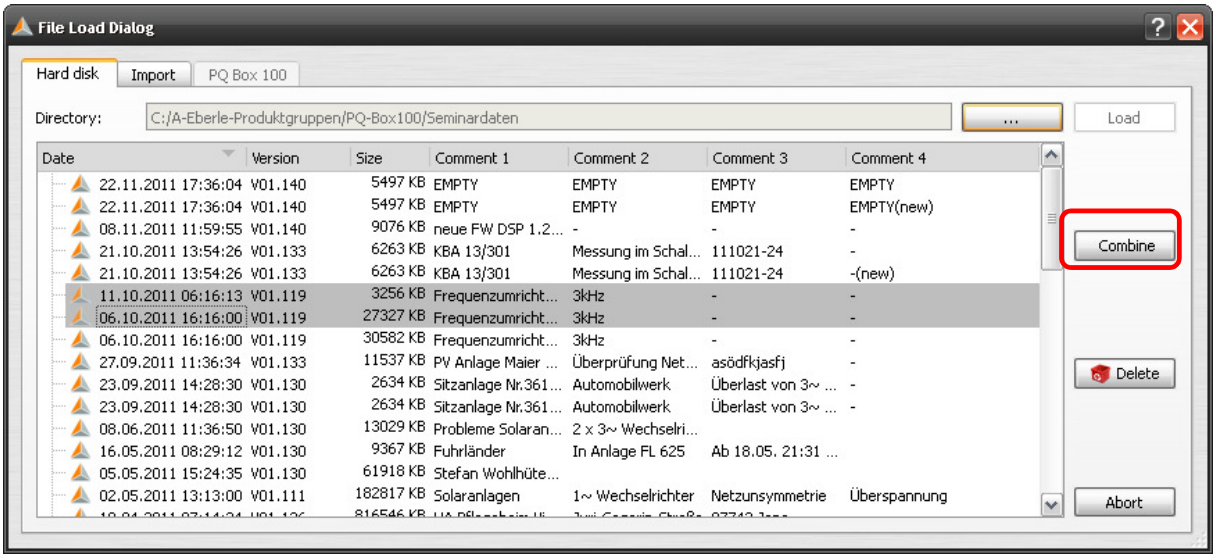
Merging partial measurements into a combined measurement

With the program “**Data Converter**” it is also possible to combine two or more measurement files to one single file.

1) Open the files with “Load”

2) Select two or more files

3) With the button “Combine“, the selected files will be combined to one file



8. Real-Time Analysis; PQ-Box 100 with PC

The “Online measurement” function displays rms. values, oscilloscope images, harmonics and interharmonics in real-time on the screen of a PC or laptop. The displayed data is refreshed every few seconds. It is possible to carry out a real-time measurement during an ongoing measurement, before a measurement has been started and after a measurement has been ended.

All real time data screens can be started and stopped with the icons: 

8.1 Real-Time Oscilloscope Image

Real-time oscilloscope images of all measurement channels are displayed on the screen via the “Oscilloscope” tab.

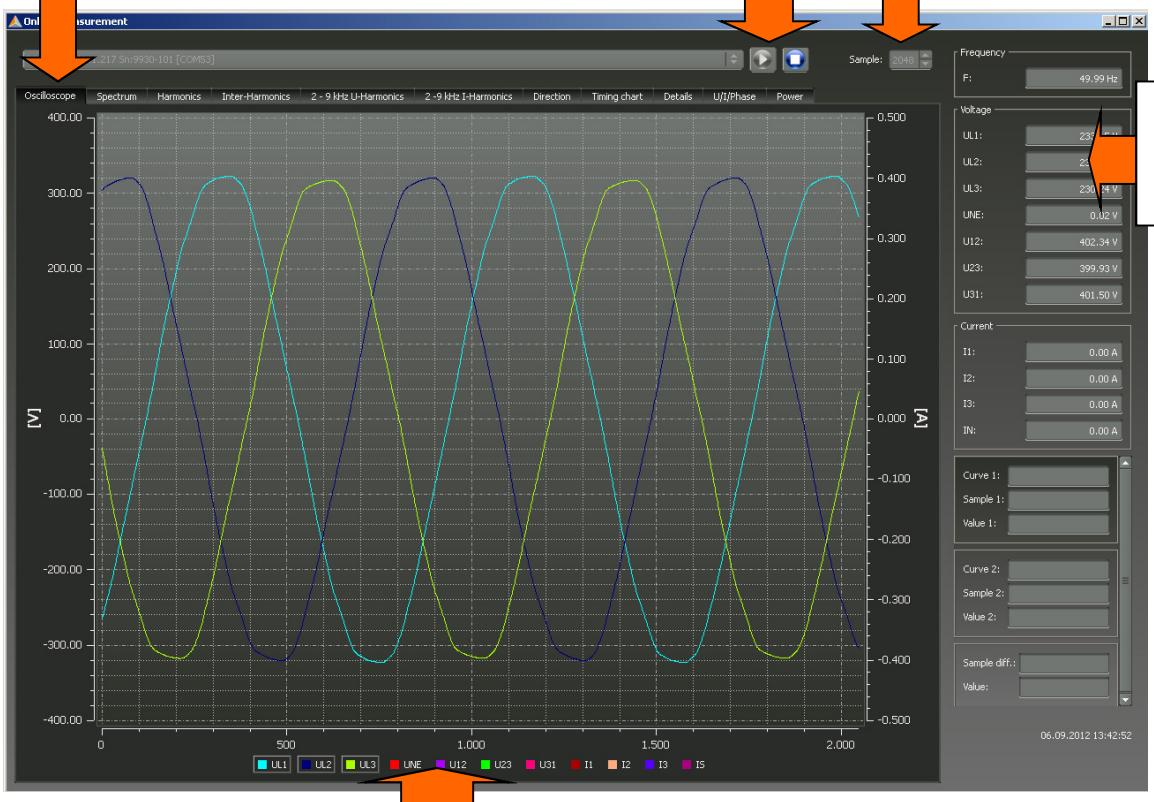
Tab – Oscilloscope display

Start = Data is overwritten in 1 sec intervals

Stop = current image freezes

Length of the oscilloscope image in sampling points

e.g. 1024 = 100 ms

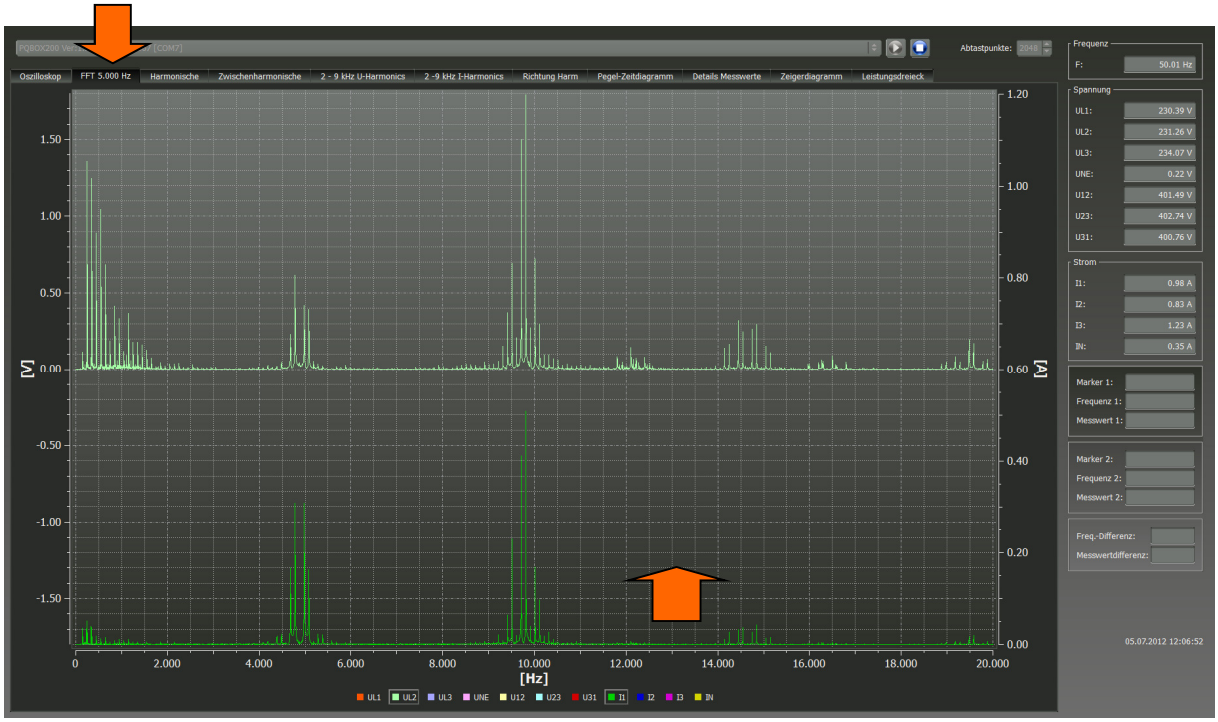


Basic real-time RMS values

Show and hide channels with click on the legend

8.2 Online FFT DC – 5000 Hz

In online function “Spectrum” you can analyse the voltage and current spectrum from DC to 5000 Hz in steps of 5 Hz.

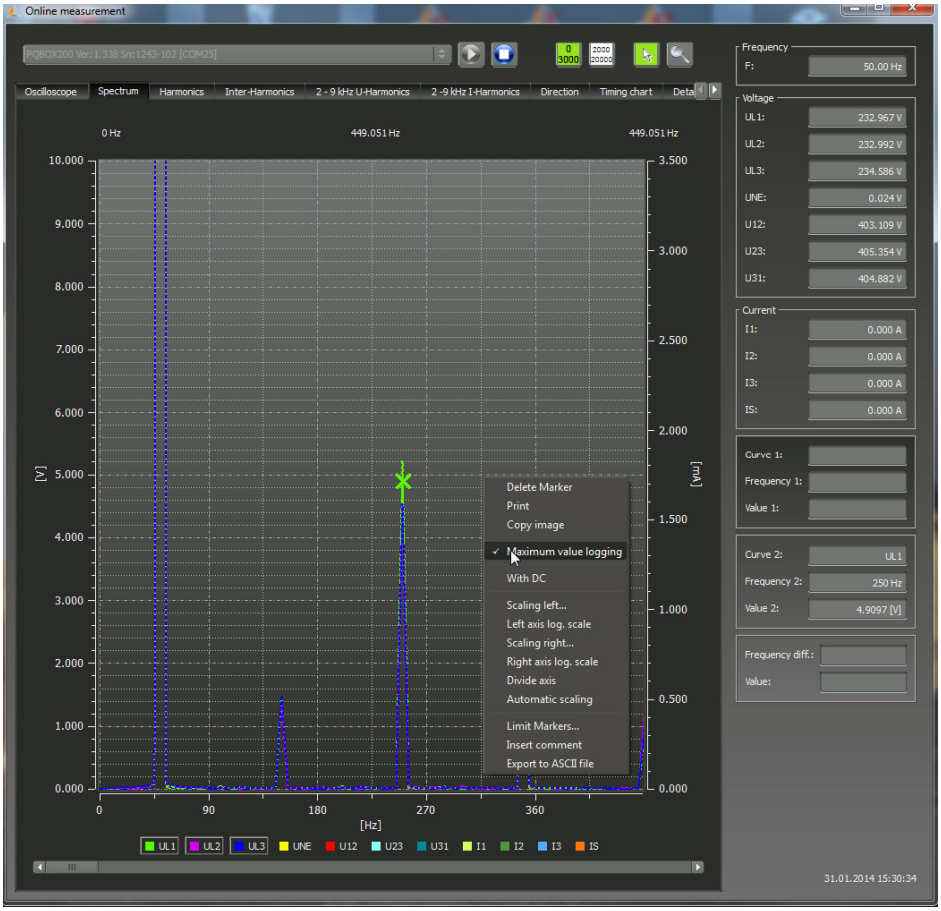


In right mouse click menu you find these possibilities:

Print	Picture will be sent to printer
Copy image	Copies the graphic to the clipboard. The illustration can then be used as a diagram in a *MS WORD*™ document (for example)
With DC	The spectrum includes the DC component
With fundamental	The spectrum is displayed with the fundamental frequency

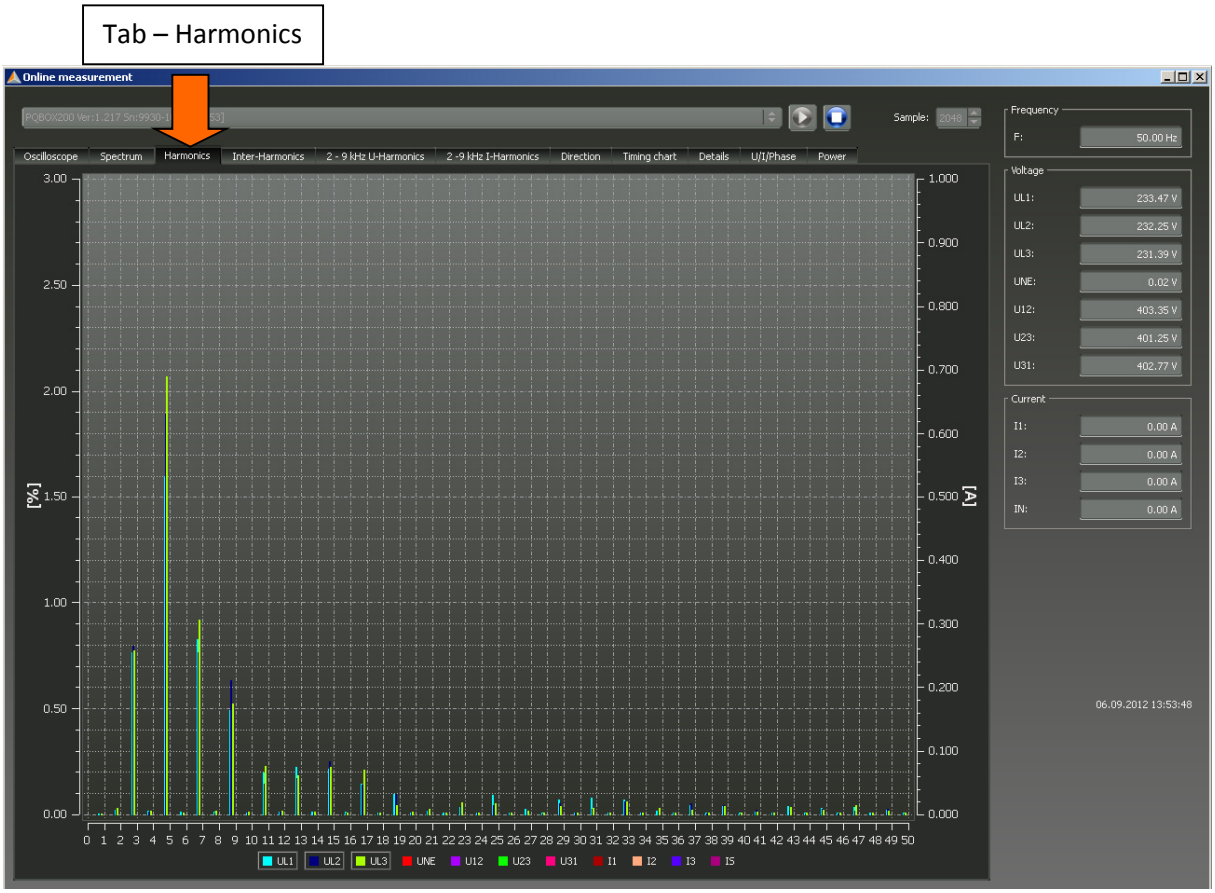
Maximum values logging FFT

Using this function it is possible to hold the maximum value of the spectral lines of online FFT. (Dashed line). With this function it is possible to determine direct in online view which maximum values of harmonics exists direct at the measurement point.

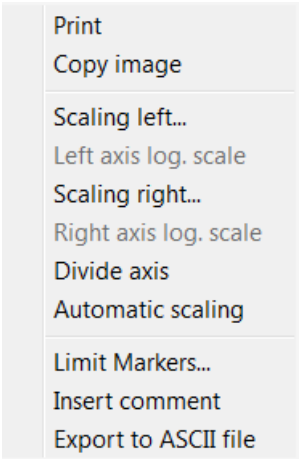


8.3 Online - Harmonics

All of the current and voltage harmonics (2nd to 50th) are displayed in real-time via the “Harmonics” tab. The measurement data is calculated by PQ-Box 100 according to IEC61000-4-30 Class A and then transferred to the PC.

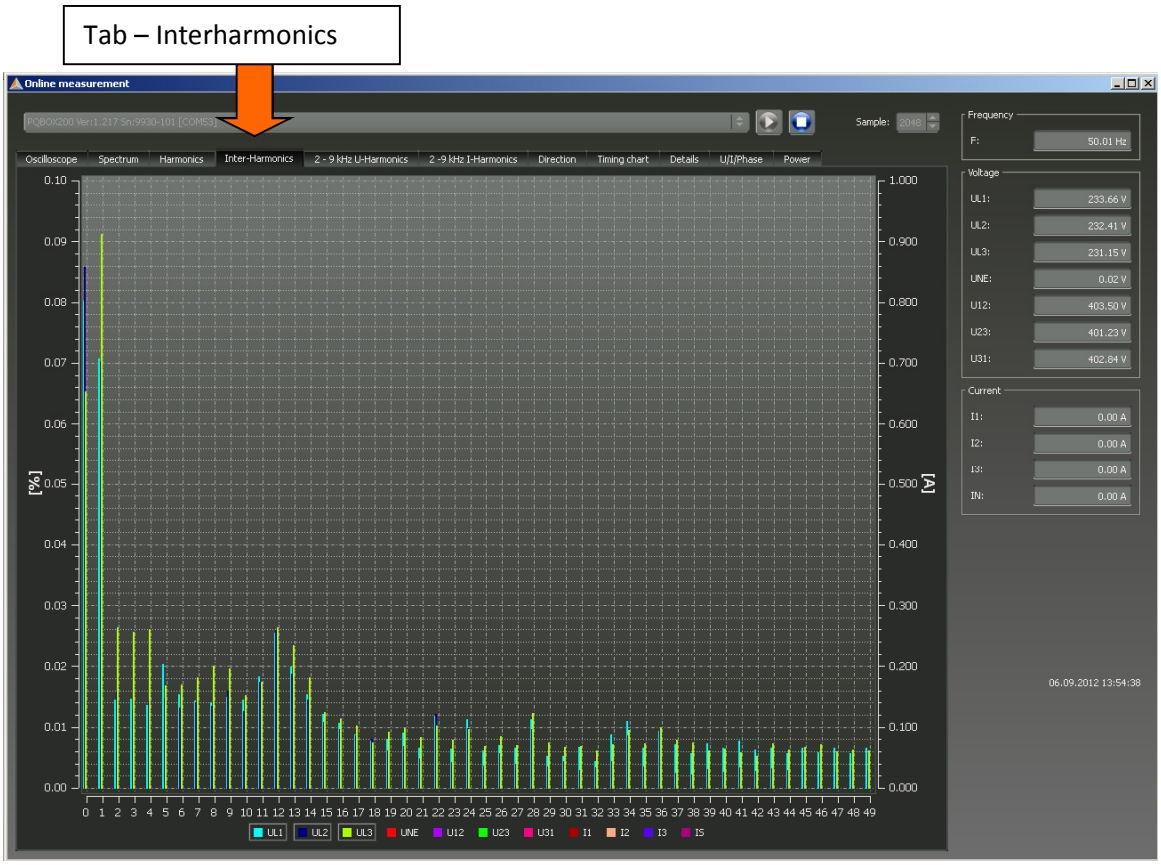


Different functions are possible in the “right mouse menu” (Data export, manual scaling, split axis)



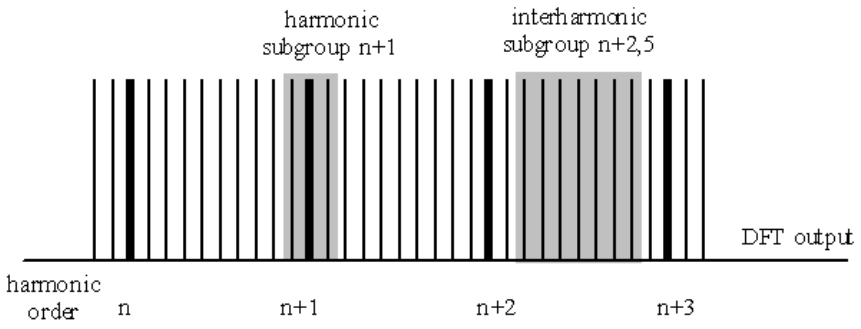
8.4 Online Interharmonics

All of the current and voltage interharmonics up to 2500 Hz are displayed in the “Interharmonics” tab. The measurement data is calculated by the measurement device according to IEC61000-4-30 Class A according to the grouping procedure.



Explanation of grouping procedure according to IEC:

Subgroups are formed for evaluating the interharmonics in the network. All interharmonics between two harmonics are compiled into a subgroup.



Example:

All interharmonics from 5 Hz to 45 Hz are in the interharmonic subgroup no. **IH0**.

8.5 Direction of harmonics

The direction of the current and voltage harmonics are displayed in the “Direction” tab.

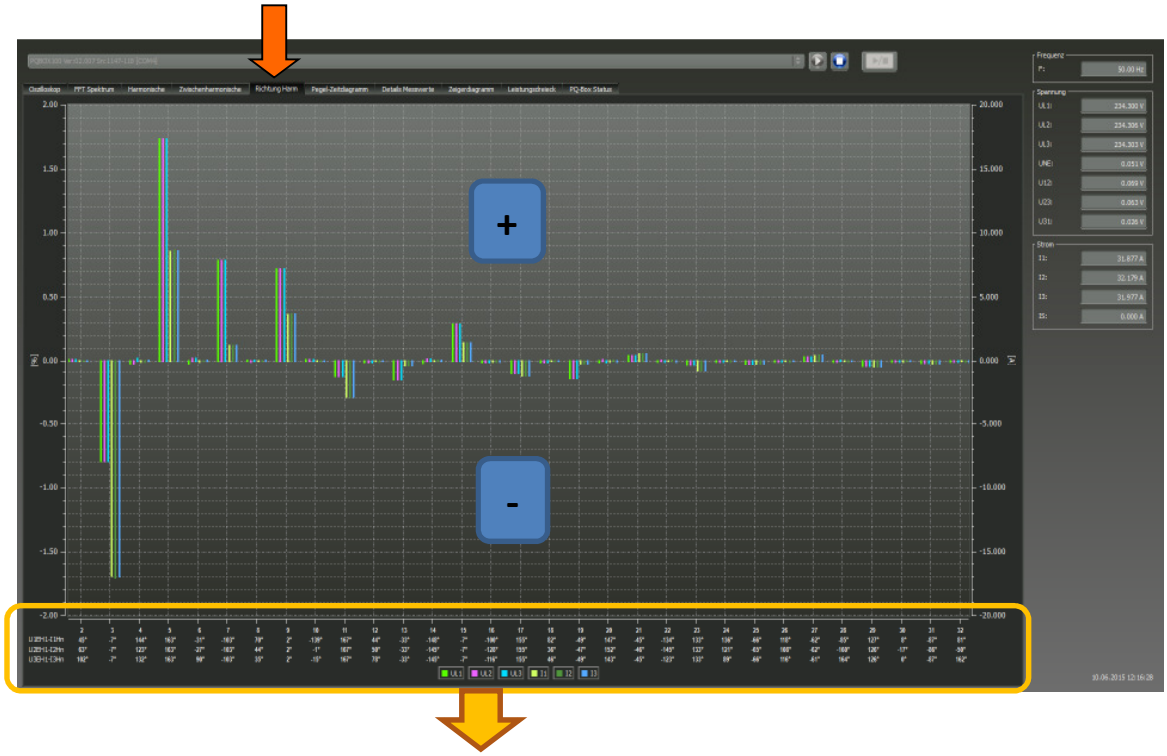
Harmonics appearing in the top half of the display means: the sign of the real power of this harmonic is positive (+) and this harmonic power coming from the network to the load.

Harmonics appearing in the bottom half of the display means: the sign of the real power of this harmonic is negative (-) and this harmonic power will be delivered from the load to the network.

Determining the direction of harmonics

The direction of power flow of harmonics is determined by the **sign** of the active power.

$$P_2 = U_2 \cdot I_2 \cdot \cos\varphi_2$$

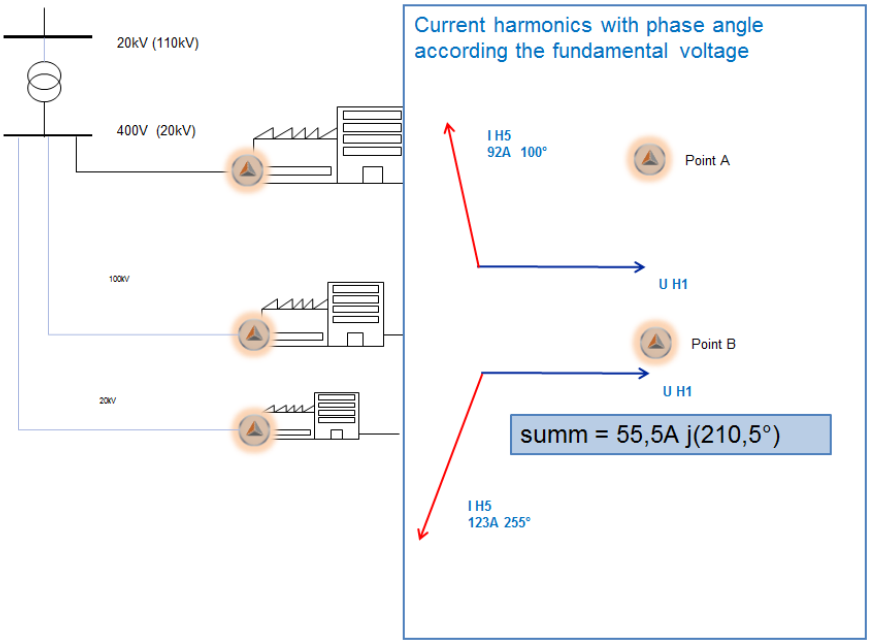


Phase angle of current harmonics:

The measured values at the bottom of the graph show the angle of the current harmonics with respect to each fundamental of the voltage.

Example:

At one connections point with several consumers should be analyzed, whether the 5th harmonic will be added or subtracted. In our example customer A has 92A and customer B has 123A 5th harmonic current. Together with the phase angle of the current harmonic, it is possible to calculate complex the result with 55,5A.



8.6 Online Level-Time Diagram

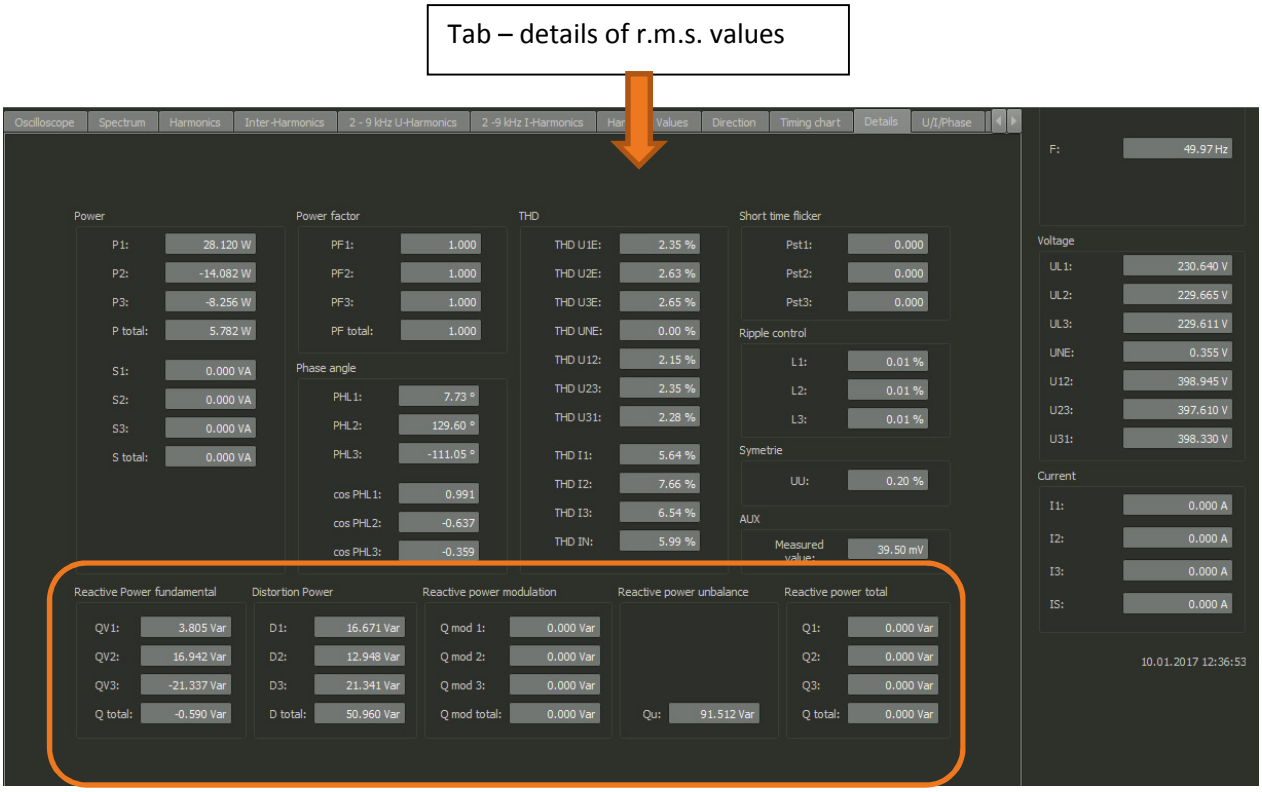
This diagram shows the timing chart for 1, 3, 5 or 10 minutes time window. Voltage, Current and power values are available.

Clear curves - clear the sreen for a new measurement.

 It is possible to start and stop the recording.

8.7 Real Time - Details of Measurement Values

The “Details” tab displays active power, reactive power and apparent power of the 1-phase and 3-phase values in real-time and the power factor and phase angle of the fundamental frequency of the network.



Description of power values in online “Details”

- P = real power values
- S = apparent power values
- Q = total reactive power

The total reactive power will be calculated from:

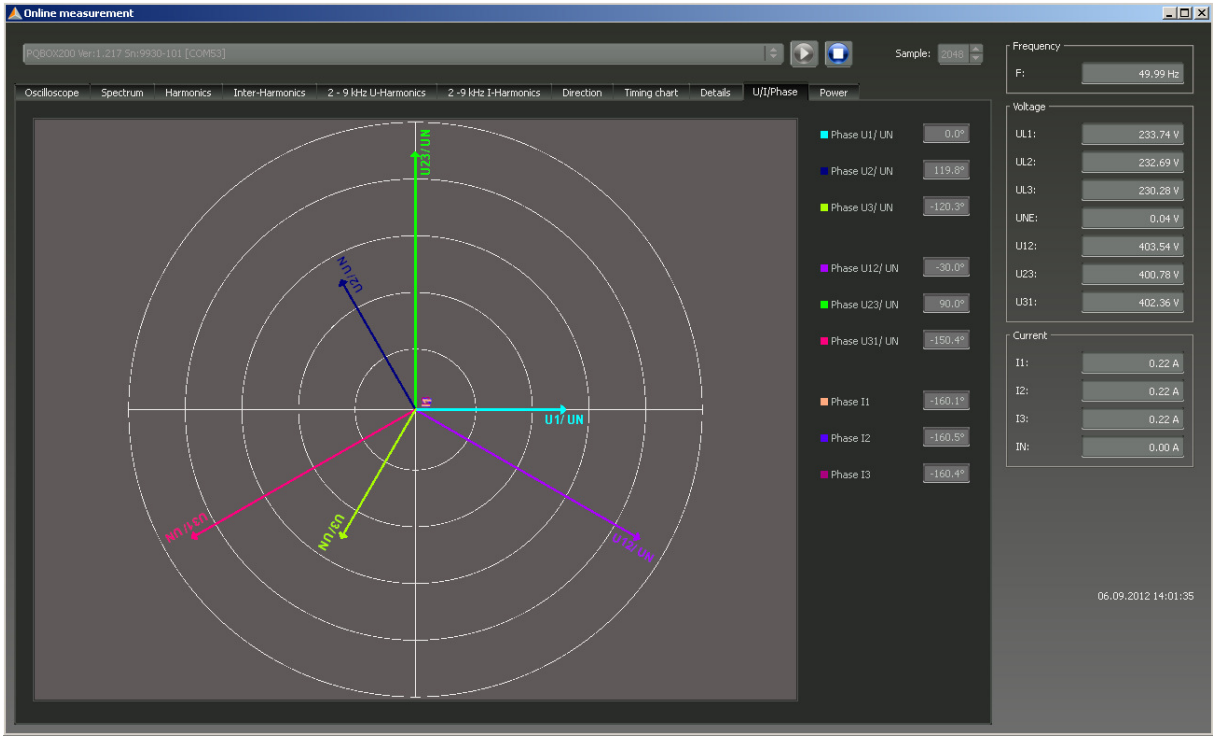
- QV = reactive power of fundamental frequency
- D = distortion power
- Qmod = modulation power
- Qu = unbalance power

$$Q_{\mathrm{tot},\Sigma} = \sqrt{Q_{\mathrm{l}}^2 + Q_{\mathrm{u}}^2 + Q_{\mathrm{h}}^2 + Q_{\mathrm{d}}^2 + Q_{\mathrm{m}}^2}$$

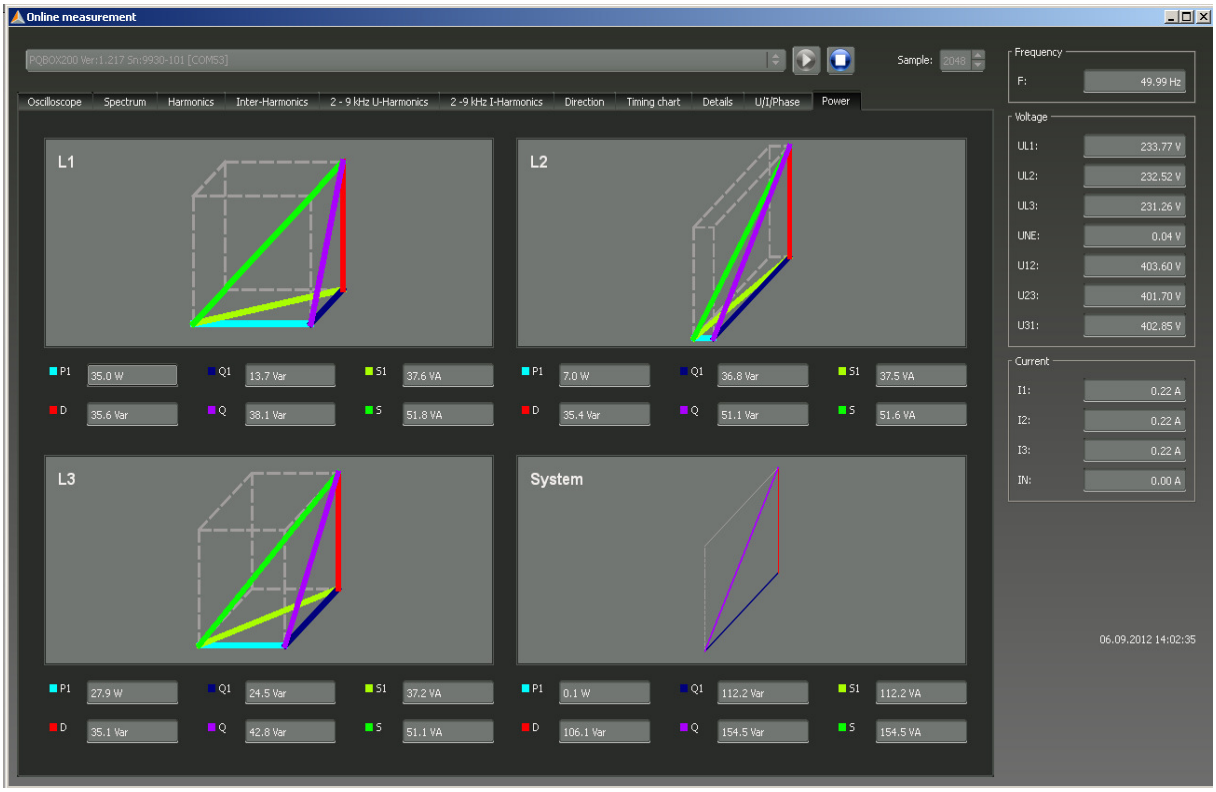
8.8 Online – phasor diagram

In this diagram you can analyse all phasors of voltages and currents with all phase angles.

You can also see the rotating field of your voltage connection.



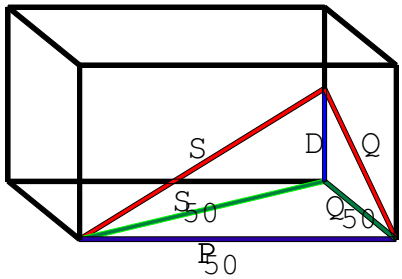
8.9 Power flow – Online graphic



On this screen the real power, apparent power, reactive power and distortion power are displayed in a three dimensional graphic. There is one screen for each phase and one screen for the three phase system power.

Distorted reactive power (disharmony) is::

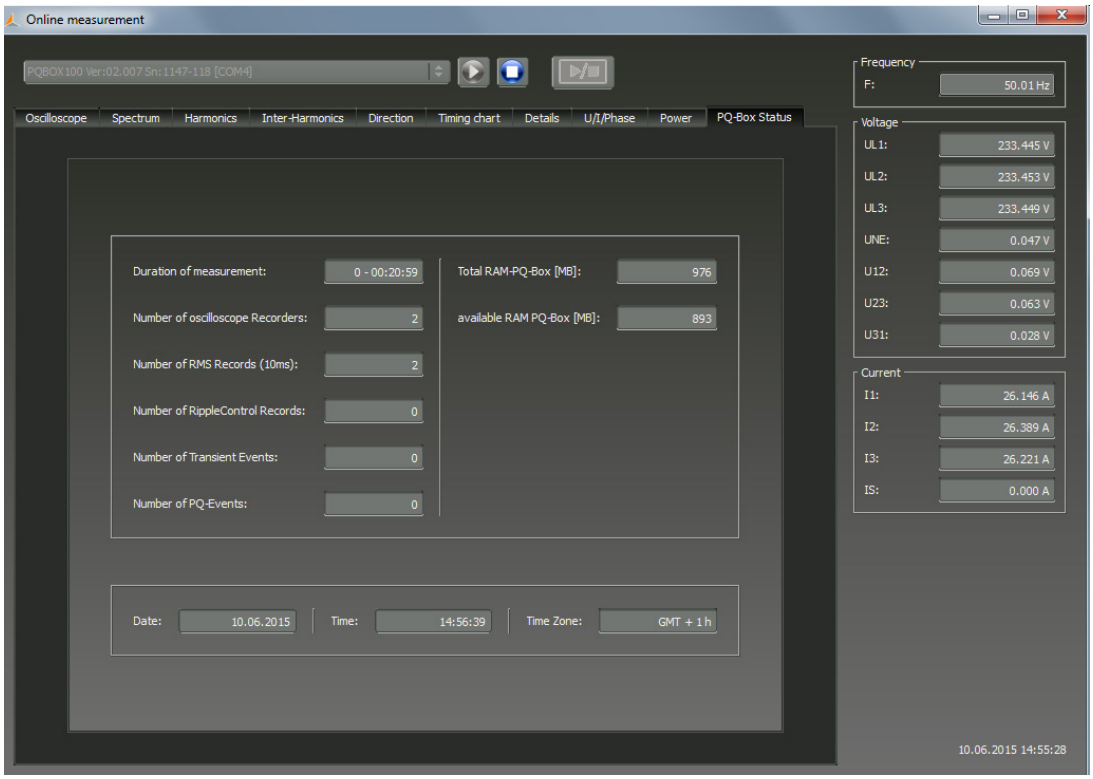
$$D := \sqrt{S^2 - P^2 - Q^2}$$



8.10 Online Status PQ-Box

In “Online status PQ-Box” the state of the power quality analyzer can be queried via a remote connection.

- Duration of the current measurement
- Number of fault records in the current measurement
- Used memory of the device
- Free memory of the PQ-Box
- Local date and time of the device



9. Methods of measurement / formulas PQ-Box 100

Signal sampling:

All voltage and current inputs are filtered with an antialiasing filter and digitized with a 24-bit A/D converter.

The sampling frequency is 10,240 samples/s at nominal power frequencies of 50 Hz or 60 Hz. All measurement values will be calculated from this data.

The time aggregation of the measurement values is according the standard IEC61000-4-30 for class A devices.

9.1 Voltage / Current rms values; Min / Max values

U eff / I eff

The average value of all 10 ms rms values that occurred during the measuring interval (the standard setup interval is 10 minutes)

U min / max; I min / max

The extreme values (Min / Max values) are derived from the half cycle (10 ms) rms values. During each measuring interval (free interval) the PQ-Box 100 store the maximum and minimum values including the exact time of each.

9.2 Ripple signal voltage

U ripple signal (200ms)

The frequency of the ripple signal voltage of the local utility can be entered into the setup of the PQ-Box 100. The FFT results are used to obtain the 200 ms maximum value of the ripple signal.

9.3 Flicker Pst / Plt

The **Short term flicker levels P_{st}** (10 min) and **Long tern flicker levels P_{lt}** (2 h) are calculated for the star and delta voltages. P_{st} and P_{lt} are defined in EN 61000-4-15: 2010.

The short term flicker **P_{st}** (10min) and the long term flicker **P_{lt}** (2h) will be calculated phase to ground. In a isolated network (3 wire network) the flicker is calculated phase to phase.

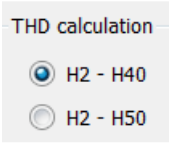
- **The measuring interval of the Pst is set to 10 minutes fix and is independently from the free intervall.**

Formula for calculation of Plt:

$$P_{lt} = \sqrt[3]{\frac{1}{12}\sum_{i=1}^{12} P_{st,i}^3}$$

9.4 THD – PWHD – K Factor

All calculations are based on a 10/12 cycle averaging interval (50 Hz = 10 cycles / 60 Hz = 12 cycles), according the formula of IEC61000-4-7 (exactly 2024 sample values will be used for calculation)



The THD calculation of voltage and current can be changed in the settings: 2 – 40th or 2 – 50th

THD Total harmonic distortion voltage:

$$THD_u = \frac{\sqrt{\sum_{v=2}^{40} U_v^2}}{U_1}$$

THD Total harmonic distorting current in %:

$$THD_i = \frac{\sqrt{\sum_{v=2}^{40} I_v^2}}{I_1}$$

THD(A) current in ampere:

$$THC = \sqrt{\sum_{n=2}^{40} I_n^2}$$

PWHD - Partial weighted harmonic distortion

This THD calculate the harmonics from the 14th. till the 40th. harmonic.

$$PWHD = \frac{\sqrt{\sum_{n=14}^{40} n \cdot C_n^2}}{C_1}$$

PHC - Partial Odd Harmonic Current

The PHC will be calculated only from the odd numbers of the current harmonics (n = 21..39)

$$PHC = \sqrt{\sum_{n=21,23}^{39} C_n^2}$$

K-Factor

The K-factor will be calculated from the current harmonics C_n n = 1..40.

Losses in transformers are due to stray magnetic losses in the core and losses in windings.

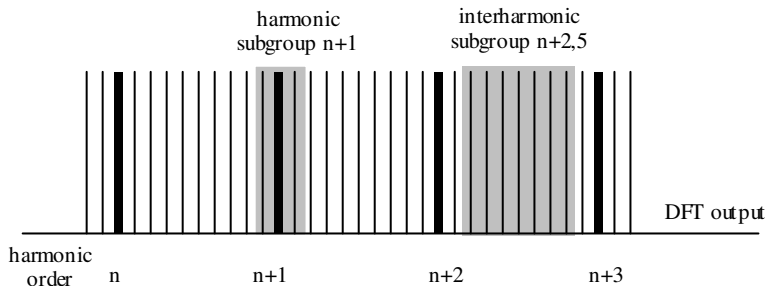
Of these eddy current losses are of most concern when harmonics are present, because they increase approximately with the square of the frequency.

K-factor is a unit measuring a transformer's ability to withstand the harmonics content of a system. Transformer manufacturers can offer K=4, K=13, K=20 and K=30 transformers.

$$K = \frac{\sum_{n=1}^{40} (n \cdot C_n)^2}{\sum_{n=1}^{40} C_n^2}$$

9.5 Harmonic / interharmonic

All calculations are based on a 10/12 cycle averaging interval (50 Hz = 10 cycles / 60 Hz = 12 cycles), according the formula of IEC61000-4-7 (exactly 2024 sample values will be used for calculation)
The PQ-Box 100 calculates all harmonics of voltage and currents from the 2nd to the 50th harmonic.
For interharmonics the IEC standard build interharmonic subgroups. (IH0 to IH49)



"IH0" is the first interharmonic subgroup and calculates the frequencies from 5 Hz to 45 Hz.

Voltage harmonics (10/12 periods):

$$\left|U_{n-10/12}\right| = \frac{\sqrt{\frac{1}{2} \cdot \sum_{k=n\cdot N-1}^{n\cdot N+1} \left|C_k\right|^2}}{U_{nom}}$$

Current harmonics:

$$\left|I_{n-10/12}\right| = \sqrt{\frac{1}{2} \cdot \sum_{k=n\cdot N-1}^{n\cdot N+1} \left|C_k\right|^2}$$

9.6 Reactive power

In the setup of the PQ Box 200 two variants of the power calculation are adjustable

a) Simplified power calculation

Reactive power without unbalanced reactive power calculation:

$$Q = \sqrt{Q_V{}^2 + D^2} \qquad Q\,\Sigma = Q\,L1 + Q\,L2 + Q\,L3$$

b) **Reactive power calculation according DIN40110 part 2**

Reactive power calculation with unbalanced power:

Reactive power:

$$Q_{L-10/12} = Sgn\left(\varphi_{L-10/12}\right) \cdot \sqrt{S^2_{L-10/12} - P^2_{L-10/12}}$$

$$Q_{10/12} = Sgn\left(\varphi_{1-10/12}\right) \cdot \sqrt{S^2_{10/12} - P^2_{10/12}}$$

Reactive energy:

”Reactive energy consumption“ inductive energy +EQ:

$$Q_S(n) = \left|Q_{L-10/12}(n)\right| \qquad Q_{L-10/12}(n) \geq 0$$

$$Q_S(n) = 0 \qquad Q_{L-10/12}(n) < 0$$

“Reactive energy supply“ capacitive energy -EQ:

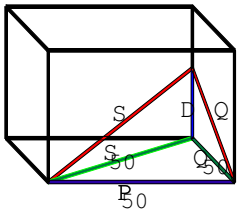
$$Q_S(n) = \left|Q_{L-10/12}(n)\right| \qquad Q_{L-10/12}(n) < 0$$

9.7 Distortion power - D

$$D := \sqrt{S^2 - P^2 - Q^2}$$

The product of the voltage with all the harmonic currents results in the distorted reactive power D:

$$D = U \cdot \sqrt{\sum_{\nu=2}^{\infty} I_\nu^2}$$



9.8 Power factor PF

The power factor is calculated from the real power and apparent power.

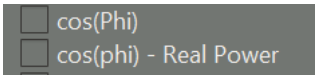
The formula is $\text{power factor PF } \lambda = P / S$

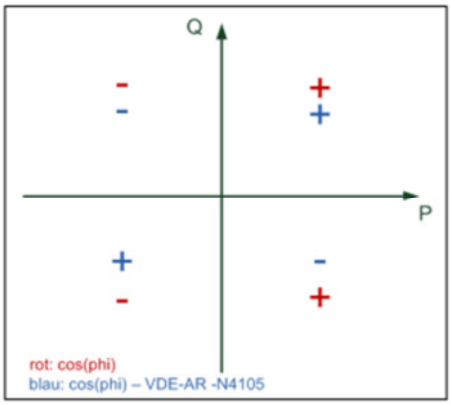
The power factor contains the sign of the real power.

9.9 Cos phi

The PQ-Box calculates the cos phi in two versions:

a) Cos phi – standard
b) Cos phi – VDE N4105





On device display and in online measurement data, the standard cos phi (version a) is shown.

In the long-term measurement data both versions are available.

9.10 Apparent power - S

In the setup of the PQ Box 200 two variants of the power calculation are adjustable

a) Simplified power calculation

$$S = \sqrt{P^2 + Q^2}$$

b) power calculation according DIN40110 part 2

Apparent power phase-ground in a 4-wire-system :

$$S_L = U_{LNrms} \cdot I_{Lrms}$$

Apparent power phase to ground in a 3-wire-system :

$$S_L = U_{L0rms} \cdot I_{Lrms}$$

Consumption apparent power DIN40110 :

$$S_\Sigma = U_\Sigma \cdot I_\Sigma$$

$$U_\Sigma = \frac{1}{2} \cdot \sqrt{U_{12rms}^2 + U_{23rms}^2 + U_{31rms}^2 + U_{1Nrms}^2 + U_{2Nrms}^2 + U_{3Nrms}^2}$$

4-wire network :

$$I_\Sigma = \sqrt{I_{1rms}^2 + I_{2rms}^2 + I_{3rms}^2 + I_{Nrms}^2}$$

3-wire network, I1 + I2 + I3 ≠ 0 :

$$U_\Sigma = \frac{1}{2} \cdot \sqrt{U_{12rms}^2 + U_{23rms}^2 + U_{31rms}^2 + U_{1Erms}^2 + U_{2Erms}^2 + U_{3Erms}^2}$$

$$I_\Sigma = \sqrt{I_{1rms}^2 + I_{2rms}^2 + I_{3rms}^2 + I_{Erms}^2}$$

Fundamental Apparent power :

$$\underline{S}_G = 3 \cdot [\underline{U}_{1\_PS} \cdot \underline{I}_{1\_PS}^* + \underline{U}_{1\_NS} \cdot \underline{I}_{1\_NS}^* + \underline{U}_{1\_ZS} \cdot \underline{I}_{1\_ZS}^*]$$

9.11 Real power - P

The sign of the power (“+“ or “-“) shows the direction of fundamental frequency.

+ = power consumed

- = power feed to the network

$$P_{L-10/12} = \frac{\sum_{n=1}^{2048} p_L(n)}{2048}$$

(200 ms values)

The power consumption of the 4-wire network is calculated:

$$P_\Sigma = P_1 + P_2 + P_3 + P_E$$

The power consumption of the 3-wire network is calculated:

$$P_\Sigma = P_1 + P_2 + P_3$$

Fundamental real power (network):

$$P_G = \mathrm{Re}\{\underline{S}_G\}$$

$\underline{S}_G$ = Fundamental apparent power (network)

9.12 Unbalance – symmetrical components

The imbalance is calculated from the symmetrical components, based on IEC61000-4-30 class A.

Positive system:

$$\underline{U}_{1\_PS} = \frac{1}{3} \cdot \left(\underline{U}_{1N-1} + \underline{a} \cdot \underline{U}_{2N-1} + \underline{a}^2 \cdot \underline{U}_{3N-1} \right)$$

$$\underline{I}_{1\_PS} = \frac{1}{3} \cdot \left(\underline{I}_{1-1} + \underline{a} \cdot \underline{I}_{2-1} + \underline{a}^2 \cdot \underline{I}_{3-1} \right)$$

Negative system:

$$\underline{U}_{1\_NS} = \frac{1}{3} \cdot \left(\underline{U}_{1N-1} + \underline{a}^2 \cdot \underline{U}_{2N-1} + \underline{a} \cdot \underline{U}_{3N-1} \right)$$

$$\underline{I}_{1\_NS} = \frac{1}{3} \cdot \left(\underline{I}_{1N-1} + \underline{a}^2 \cdot \underline{I}_{2N-1} + \underline{a} \cdot \underline{I}_{3N-1} \right)$$

Zero system:

$$\underline{U}_{ZS} = \frac{1}{3} \cdot \left(\underline{U}_{1N-1} + \underline{U}_{2N-1} + \underline{U}_{3N-1} \right)$$

$$\underline{I}_{ZS} = \frac{1}{3} \cdot \left(\underline{I}_{1N-1} + \underline{I}_{2N-1} + \underline{I}_{3N-1} \right)$$

10. Maintenance/Cleaning

Cleaning:
The PQ-Box 100 should not be opened for cleaning purposes. Do not use solvents for cleaning nor immerse the device in liquid.
Caution:
Don´t open the meter under any circumstances! The opening can result in electric shock.
The PQ-Box 100 contains no user-serviceable parts. The maintenance and battery replacement must be performed by qualified service personnel.

Danger

Danger of electric shock!

- Do not open the unit.
- Maintenance of the equipment can only be carried out by A-Eberle.

For service, contact A-Eberle.

Service address:

A. Eberle GmbH & Co. KG
Frankenstraße 160
D-90461 Nuremberg

11. Calibration

We recommend a calibration interval of three years for the network analyzer PQ-Box 100 to maintain the high accuracy of a-IEC61000-4-30 Class A instruments.

12. Product Warranty

- A-Eberle guarantees that this product will remain free of defects in material and workmanship for a period of three years from the date of purchase.
- For accessories like current clamps and the battery the period is one year.
- This warranty does not cover damage caused by accident, misuse or abnormal operating conditions.

To obtain service during the warranty period, please contact A-Eberle GmbH & Co KG in Nuremberg

A. Eberle GmbH & Co. KG

Frankenstraße 160
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http://www.a-eberle.de

No. 584.0771

Vers. PQ Box 100 – 16.06.2017

PQ Box 100 – 21/03/2018