a-eberle

Operating Manual

Network Analyzer / Transient Recorder
PQ-Box 200 & PQ-Box 300

Power-Quality Evaluation Software

GB

Model PQ-Box 200 & 300

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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Table of Contents

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:

✋ Indication 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 Instructions

2.1 Safety instructions

- Follow the operating instructions.
- Keep the operating instructions with the device.
- Ensure that the device is operated only in a perfect condition.
- Never open the device.
- When opening the battery compartment, disconnect the power supply.
- Ensure that only qualified personnel operate the device.
- Connect the device only as specified.
- Ensure that the device is operated only in the original condition.
- Connect the device only with recommended accessories.
- Ensure that the device is not operated outside the design limits. (See the technical data)
- Ensure that the original accessories are not operated outside the design limits.
- For measurements in short circuit resistant systems, ensure that voltage taps with integrated fuses are used.
- Do not use the device in environments where explosive gases, dust or fumes occur.
- Clean the device only with commercially available cleaning agents.

 If the device is used in a way not specified by the equipment producer, the device protection will be impaired.

2.2 Meaning of the symbols used on the device

Nature and source of the danger! Read the safety instructions inside the manual!

Voltage ground

USB-interface

TCP-IP interface

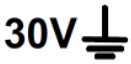
CE marking guarantees compliance with the European directives and regulations regarding EMC.

The unit is fully protected by double or reinforced insulation.

IP65 **6X** = Protection against dust
Protection against water **X5** = Protection against water jets from any angle

AC voltage

DC voltage



Maximum allowed RMS voltage against earth potential

CAT IV Category IV

2.3 Declaration of Conformity

Hereby, A. Eberle GmbH & Co. KG declares that the radio equipment type PQ-Box 300 is in compliance with Directive 2014/53/EU. The full text of the EU declaration of conformity is available at the following internet address:
https://www.a-eberle.de/en/company-profile/certificates

3. Scope of Delivery/Order Codes PQ-Box 200 & 300

3.1 Scope of Delivery

- PQ-Box 200/300
- User Manual
- Case
- 3 red dolphin clips, 1 blue dolphin clip, 1 green dolphin clip
- 3 high-load fuses integrated in voltage leads
- USB cable, Ethernet cable
- Adaptor cable for AUX input
- AC socket adapter with country-specific adapters
- Wide range power supply with 2 x 4 mm safety plugs and integrated high-load fuses
- 2 pcs. 4mm safety connectors (to staple power supply and voltage leads to one dolphin clip)

3.2 Order Codes

Option only for PQ-Box 200:

- Transient measuring board (hardware circuit board)

- 4 MHz sampling rate; +/- 5,000V measurement range; 14-bit resolution

The transient measuring board must be installed by the manufacturer.

Option only for PQ-Box 300:

- WLAN / Wi-Fi Interface S1 (license code)

- Wireless communication between measurement device and PC via WLAN / Wi-Fi

The WLAN / Wi-Fi Interface can be enabled with a license code subsequently.

Option for PQ-Box 200 and 300:
Ripple control signal analysis (License Code)

- Used for triggering and recording ripple control signals for voltages and currents.

With a license code, the PQ-Box 200 can be upgraded with ripple control recorder.

ACCESSOIRES PQ-Box 200 & 300	IDENT-NO.
● Voltage tap on insulated cable; contact support 1 ~, connected for 35-240mm ² ● Cable set 4 phase, 1.5 mm ², 2m long, 4x 16A fuse, 4x 4mm safety plugs	111.7037 111.7038
● Calibration set for PQ-Box 100/150/200/300; calibration software and adapter box	111.7039
● Kensington lock - Lock for PQ-Box 200/300, 1.8 m length	111.7032
● Temperature sensor, air temperature -20…80°C	111.7041
● Combination sensor for lighting 0-1400W/m2 and temperature -30…70°C	111.7040
● Kit of magnetic voltage taps	111.7008
● DCF 77 radio controlled clock	111.9024.01
● GPS radio clock (230 V – RS 232)	111.9024.47
● CAT-Booster (600 V CAT IV) voltage adapter for PQ-Box 100 / 200	111.7026
● SD memory card, 4GByte industry-standard	900.9099.04
● SD memory card 8 GByte industry-standard	900.9099.08
● Replacement battery pack	570.0011

Measured Values / Functions	
PQ-Box 200	
Automatic standard analysis and event collection in accordance with: EN50160 (2011) / IEC61000-2-2 / IEC61000-2-12 /IEC61000-2-4 (class 1; 2; 3) / NRS048 / IEEE519 / own generating plants in the low-voltage network; MS Network	
Record free interval 1sec to 30 min (>2,600 measurement parameter permanent parallel):	
Voltage: Average. Min. Max. Value	
Power, Average, Max. Value	
Power: P, Q, S, PF, cos phi, sin phi	
Distortion power D; Fundamental oscillation power	
Energy: P, Q, P+, P-, Q+, Q-	
Flicker (Pst, Plt, Ps5)	
Unbalanced current and voltage; reactive system,	
Voltage harmonics according to IEC61000-4-30 Class A	up to 50
Voltage harmonics 200 Hz frequency bands	2 kHz to 9 kHz
Current harmonics	up to 50
Current harmonics 200 Hz frequency bands	2 kHz to 9 kHz
Phase angle of current harmonics	up to 50
THD U and I; PWHD U and I; PHC	
FFT calculation of voltages and currents	DC to 20 kHz
Ripple control signal 100 Hz to 3 kHz	
Frequency, 10 sec, average. Min. Max. Value	
10/15/30 min Interval power value P, Q, S, D, cos phi, sin phi	
Online Mode:	
Oscilloscope image	40.96kHz
3D power triangle for active, reactive, apparent power and distortion power	
Voltage, current harmonics	DC to 20 kHz
Inter-harmonic groups (U, I)	DC to 20 kHz
Direction of harmonics and current harmonics phase angle	
Trigger functions (Rec A / Rec B)	
Manual trigger - trigger button	
RMS trigger on below, above threshold (U, I)	
RMS trigger jump (U, I)	
Phase shift trigger	
Envelope trigger	
Automatic trigger	
Trigger on binary input (0 – 250 V AC/DC; 10 V threshold)	
Ripple control signal analysis recorder for voltage and current – **Option R1**	100Hz to 3kHz
Transient Recorder programmable 200 kHz; 500 kHz; 1 MHz; 2 MHz – **Option T1**	2MHz

Measurement / Functions	
PQ-Box 300	
Automatic event detection and evaluation standards for: EN50160 (2015) / IEC61000-2-2 / IEC61000-2-12 / IEC61000-2-4 (Class 1; 2; 3) / NRS048 / IEEE519 / VDE N-4105 / IEC61000-4-30 Ed. 3 Class A / IEC61000-4-7 / IEC61000-4-15 / IEC62586-2 Ed. 2 / IEC62586-1	
Recording with user defined interval of 1sec to 30min (>3.900 parameters permanently measured):	
Voltage: min. max. average	
Current: min. max. average	
Power: P, Q, S, PF, cos phi, sin phi	
Distortion-, basic-, unbalance- and modulation reactive power	
Energy: P, Q, P+, P-, Q+, Q-	
Flicker (Pst, Plt, Pinst)	
Unbalanced voltage, current; positive-, negative- and zero-sequence	
Voltage harmonics according to EN 61000-4-30 Class A	Up to 50th
Voltage harmonics to 9kHz (200Hz frequency bands)	2kHz to 9kHz
Supra harmonics to 170kHz (2kHz frequency bands) (Mean values and 200ms min.- und max. values)	8kHz to 170kHz
Current harmonics	Up to 50th
Current harmonics to 9 kHz (200Hz frequency bands)	2kHz to 9kHz
Phase-angle of voltage and current harmonics	Up to 50th
THD voltage, current; PWHD, PHC	
FFT calculation of voltages and current	DC up to 20kHz
Ripple control signal	100 Hz to 3 kHz
Frequency, 10sec, min. max. average	
10/15/30 Min interval power values P, Q, S, D, cos phi, sin phi	
Online mode:	
Oscilloscope recorder	
3D power triangle for active, reactive, apparent power and distortion power	
Voltage, current harmonics (5Hz frequency bands)	DC to 20kHz
Supra harmonics of voltage to 170kHz (200Hz frequency bands)	8kHz to 170kHz
Direction of harmonics & phase angle of harmonics	
Trigger functions (Rec A / Rec B)	
Manual trigger – trigger button	
RMS level trigger (voltage, current)	
RMS jump trigger (voltage, current)	
Phase shift trigger	
Envelope trigger	
Automatic trigger	
Trigger on binary input (0 – 250V AC/DC; 10 V threshold)	

3.3 Technical Data PQ-Box 200 & 300

4 voltage inputs (TRMS): Maximum input voltage: Input Impedance:	L1, L2, L3, N, PE 565V AC/800V DC L-N 980V AC/1380V DC L-L 10 MΩ impedance
Voltage range AC adapter Power supply PQ-Box 200	100-400 V AC/DC; 47Hz – 63Hz / 15 V DC, 0,58A output
Voltage range of the current measurement channel - Mini current clamps / Adapter connection set - Rogowski coils - AUX input	 700 mV RMS; 1000 mV DC 330 mV AC 1000 mV RMS; 1400 mV DC
micro SD card memory	4 GB standard / up to 32 GB optional
Interfaces - USB 2.0 - TCP/IP - RS232 -WLAN / Wi-Fi *(option only for PQ-Box 300)*	 Communication Communication DCF77 connection or GPS synchronization unit Radio communication frequency band 2.4 GHz max. radiated output power 18 dBm EIRP max. conducted output power 15 dBm
Display	Illuminated
Dimensions	242 x 181 x 50 mm
Protection class	IP65 rated enclosure
Measurement methods	IEC 61000-4-30; class A
Temperature range	Operation: -20 °C …. 60 °C Storage: -30 °C …. 80 °C
USV	Li ion battery (bridging 6 Std.)
Insulation category	CAT IV / 300V L-E (CAT III/ 600 V L-E)
Converter	24 Bit A/D
Input impedance of the voltage measurement channel	1 MΩ
Accuracy current measurement channel - 0.85 mV ≤ Ue < 5 mV - 5 mV ≤ Ue < 50 mV - 50 mV ≤ Uc ≤ 700 mV	 0.01 % of end value 0,5 % of the measured value 0.1% of the measured value

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 inter-harmonic	±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}

Environmental conditions

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

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

4. External power supply

4.1 Requirement external power supply

Maximum power consumption incl. Backlight PQ-Box 200 – PQ-Box 300	Output power supply: Voltage: 15V DC Current: 0,58A

In order not to reduce the device protection class and surge strength of the network analyzer, the following requirements must be met by the external power supply. If these details are reduced, so the entire PQ-Box is reduced to this lower requirement.

IP protection	IP 65
Temperature	Function: -20° ….60°C Storage: -30°….70°C
Overvoltage category	EN61010-1 600V / CAT IV
surge	12kV 1,2/50 µsec
AC voltage	7,4kV 5 sec

Polarity of the external voltage supply with 15V DC

4.2 External power supply

Scope of Delivery PQ-Box

- AC socket adapter with country-specific adapters (582.0509)
- Wide range power supply with safety plugs and integrated high-load fuses (111.7069)
- 2 pcs. 4mm safety connectors (582.2037)

The PQ-Box is equipped with an extremely robust power supply unit. The power supply is designed for high noise immunity of 600V CAT IV and meets the IP65 protection class.

The PQ-Box can be supplied with energy directly at the measurement place and does not require a socket. The following voltage ranges for the power supply are possible: 100V to 440V AC or 100V to 300V DC.

In fuse carrier only 6.3mm x 32mm, 3 A, F, fuses are allowed, with a shut-off value of 50kA. Only fuses with the identical data must be used.

Suggestion: SIBA, Part.no. 7009463; 3AF

With two short adapter cables, the user has the option to tap into the wide range power supply and the voltage leads the network analyzer to one dolphin clip.

Socket adapter with 4 mm safety banana plugs for voltage measurement or connection of the wide range power supply at a socket.

Caution

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

- supply device only with 100-440 V AC voltage.
- supply device only with 100-300 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)

5. Accessories for current measurement

- Standard accessories are automatically recognized by the meter.
- The conversion factor is automatically adjusted for the connected accessory.

5.1 Rogowski current clamps

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

Model 111.7001/6

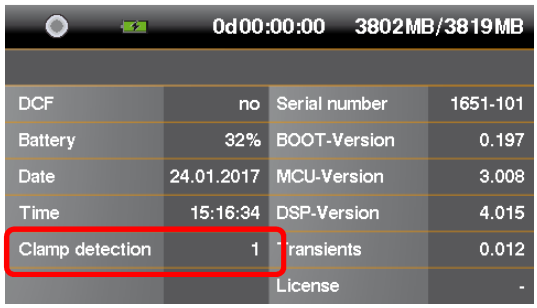
Model	**111.7001 Pro Flex 3000 4~**	**111.7006 Pro Flex 6000 4~**
Current range	3,000 A AC RMS	6,000 A AC RMS
Measurement range	0-3300 A AC RMS	0-6,600 A AC RMS
Output voltage	85 mV / 1000 A	42.5 mV / 1000 A
Frequency range	1 Hz to 20 kHz	10 Hz to 20 kHz
Isolation voltage type	600 V AC / DC CAT IV	600 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. 111.7085**

Current range: 500A RMS; Accuracy: 1%
Rogowski clamp length = 220mm;
Diameter = 70mm; Rogowski clamp head = 6mm
Frequency range: 10Hz to 50kHz

Automatic current clamp factor detection.

In this example the PQ-Box set the clamp factor to 1



5.2 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	20 A AC RMS	200 A AC RMS
Measurement range	100 mA to 20 A RMS	1 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
Accuracy	100 mA- 10 A/1.5 % 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. For the clamp with two ranges the automatic factor detection of the PQ-Box does not work for the second.

▶ 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 DC / 40A AC RMS	600 A DC / 400A AC RMS
Measurement range	200 mA to 60 A RMS	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

5.3 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 and 2m in length

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 5m 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

6. Intended use

The product is exclusively for the measurement and evaluation of voltages and currents. The current inputs are in fact mV-inputs.

7. Description

The Network Analyzers PQ-Box 200 & 300 are suitable for analysis in low, medium and high-voltage networks. They meet all the requirements of the measurement equipment standard IEC61000-4-30 Ed. 3 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

→ Load analysis; energy measurements

→ Ripple control signal analysis

→ Transient analysis

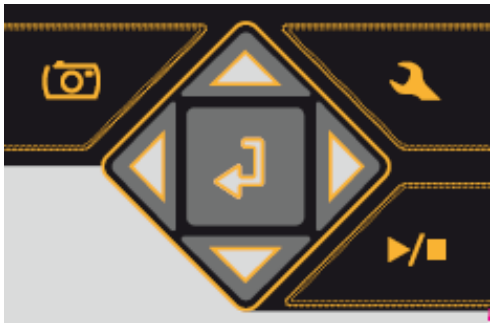
8. Hardware PQ-Box 200 & 300

PQ-Box 200 & 300 overview

Top panel view

1) Securely connected voltage inputs
   L1 (red + label L1)
   L2 (red + label L2)
   L3 (red + label L3)
   N (blue + label N)
   Measurement ground (green + label E)
2) Binary input (0 – 250V AC/DC; threshold 10V)
3) AUX input (1 V AC / 1.4 V DC)
4) Current clamp connection (7-pin plug)

Front panel - keypad



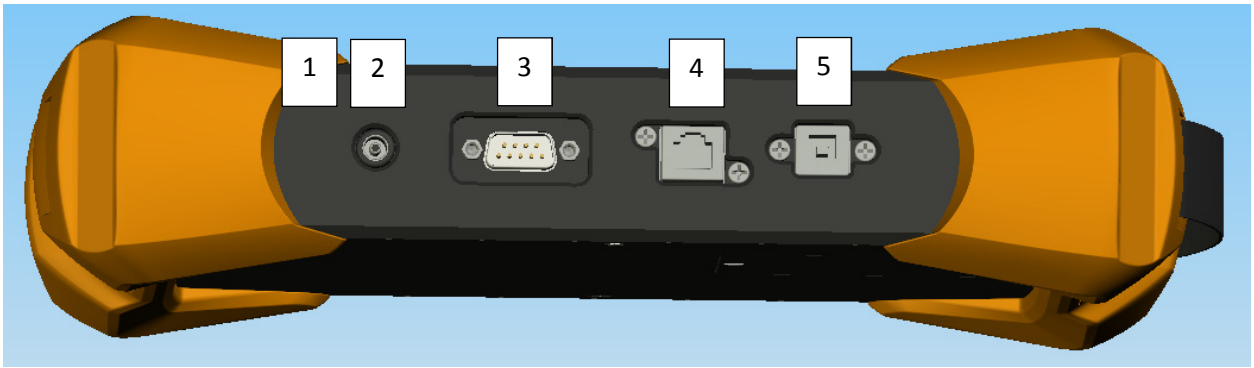
Measurement Start / Stop

Manual trigger

Setup

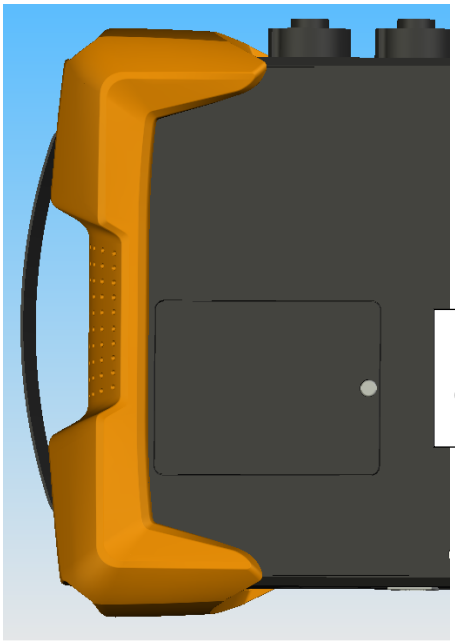
Panel with 5 keys for scrolling and changing setup parameters

Bottom view



1) Kensington lock
2) 15 V DC power supply
3) RS232 interface – for connecting a DCF77 or GPS radio clock
4) TCP/IP interface
5) USB 2.0 interface

Rear view



Under the cover you find a battery pack and a card slot for a micro SD card (1 Gb to 32 Gb)

9. Battery management and micro SD card

9.1 Micro SD card

To replace the microSD card, please note the following:

- The PQ-Box support microSD cards up to a maximum size of 32 GB.
- We recommend the use of an industrial micro-SD card, to reach the temperature range from -20 ° C to +50 ° C of the PQ Box200.

- Insert the micro SD card into the appropriate slot in the correct direction. The correct direction is defined by a notch on the microSD card.

9.2 Accumulator

The PQ Box is equipped with a lithium-ion battery and intelligent charging electronic.
The aim is to achieve a long battery life time. At 80% capacity, the PQ-Box can run approximately 6 hours without mains supply.
The Li-ion battery is first charged to 100% when the threshold (75%) is reached. This has a very positive effect on the total life time of the batteries.
Aging: At high temperature and when the battery is full, the cell oxidation developed particularly rapidly. This condition may occur, f. e. in notebooks when the battery is fully charged and at the same time, the device is in operation. The optimal charge level is between 50% and 80% during storage.

- Charging stops when exceeding a battery temperature of 50 ° C
- Start charging only when the battery temperature is less than 45 ° C
- Warning Battery capacity below 7%
- PQ-Box shutdown when battery capacity <5%

▶ **Display state of charge battery:**

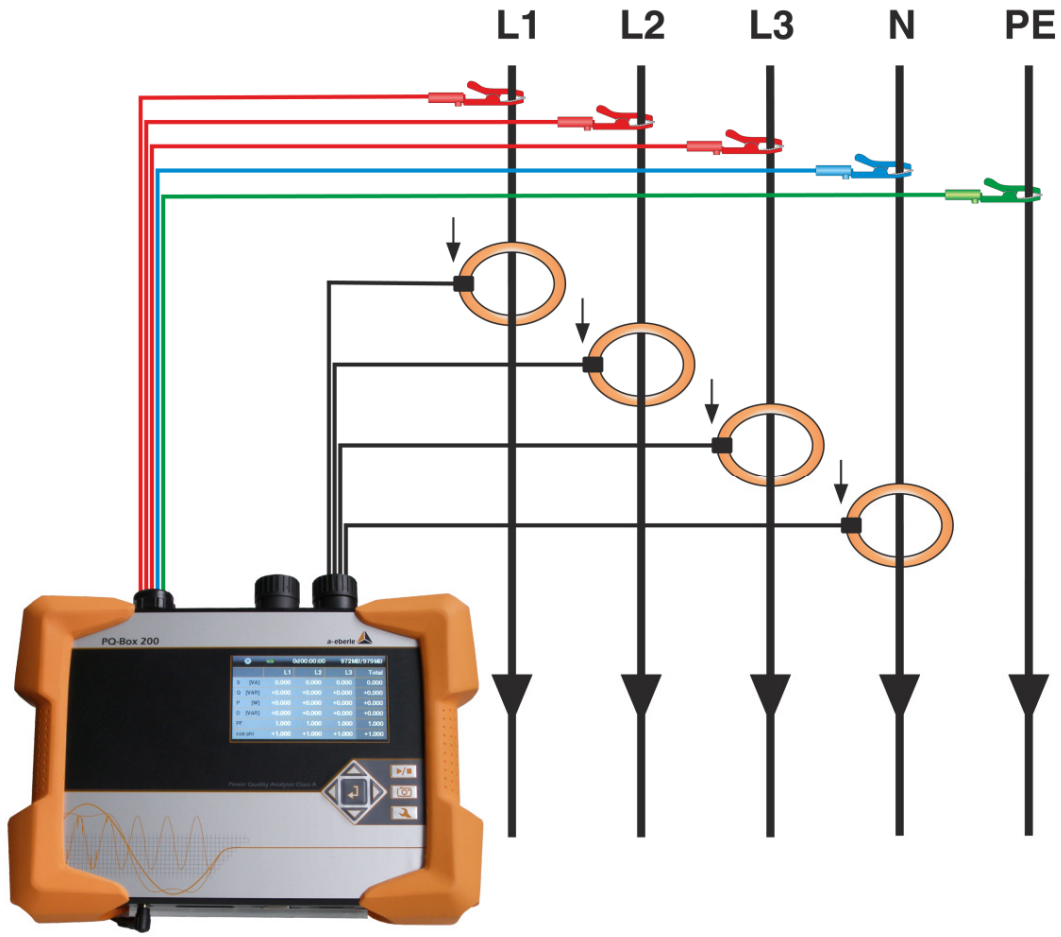
state of charge >= 100% --> four green bars
state of charge >= 75% --> three green bars
state of charge >= 40% --> two green bars
state of charge >= 20% --> one red bar
state of charge < 20% --> empty

We recommend storing the battery of the PQ-Box at 15 ° C with a charge of 60% - this is a compromise between accelerated aging and self-discharge. The battery of the PQ-Box should be recharged to approximately 55-75% every six months, due to the natural self-discharge, in order to ensure a long-term service life.

10. Network connection PQ-Box 200 & 300

10.1 Direct connection to a 3-phase low voltage network

Connection in a 3-phase 4-wire AC network



Voltage connection

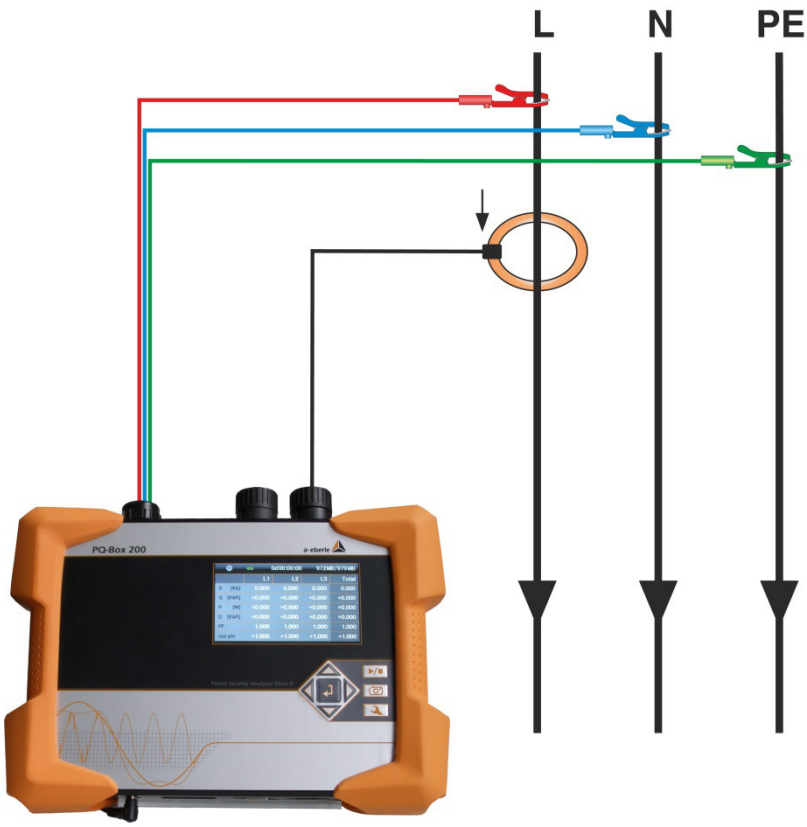
- Ensure that voltage measurement cable PE is connected for every measurement.
- If no PE connection is available, connect E and N together.
- Ensure that switching (4-wire) is selected. (Setting via display or software)

PE conductor current measurement

The PQ Box offers the possibility to use the AUX input to measure the PE conductor current in parallel with the L1, L2, L3 and N conductor currents.

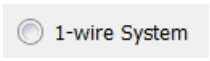
10.2 Connection to a single-phase low voltage network

Connection for single-phase measurements



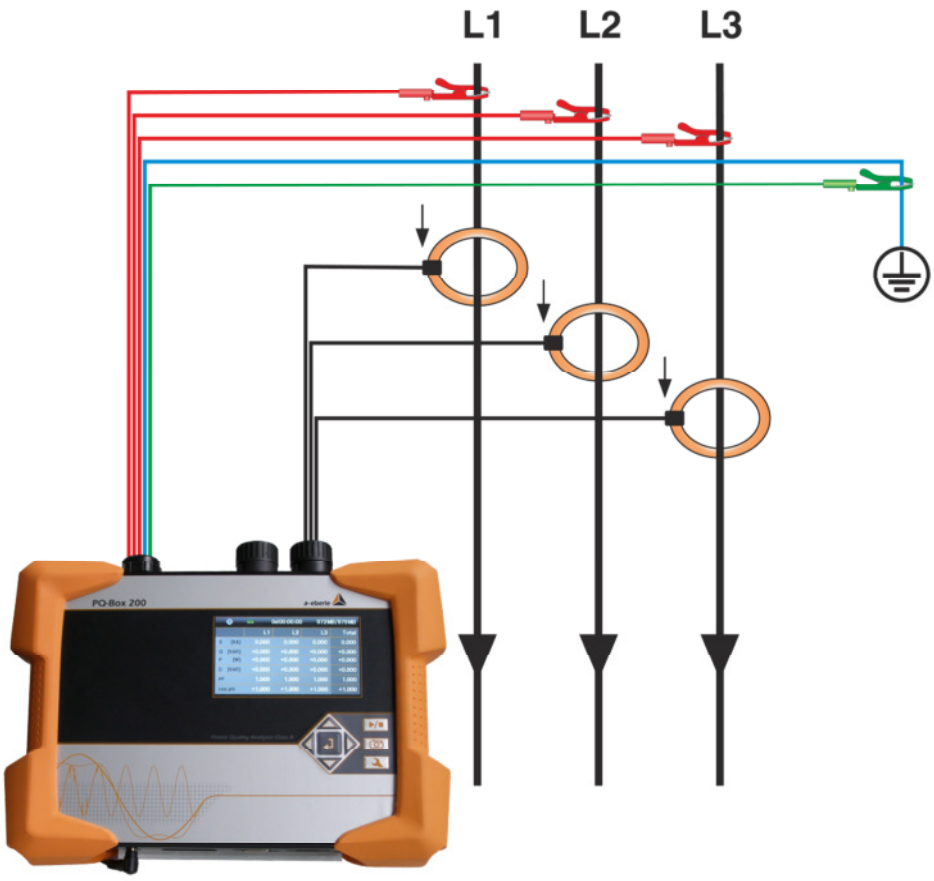
Voltage connection

- Ensure that voltage measurement cable E is connected for every measurement.
- If no PE connection is available, connect E and N together.
- Ensure that switching “1-wire system” is selected. (Setting via display or software)



- Not necessary to connect phases L2 and L3 for voltage and currents in single phase measurement.

10.3 Connection to an isolated network



Connections

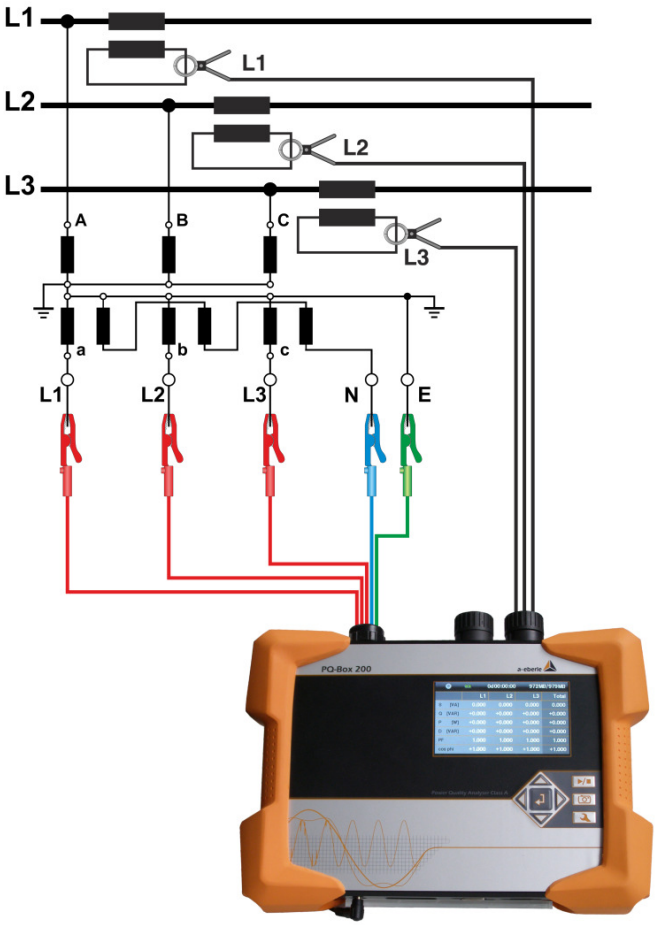
- Connect terminals E and N together and connect it to a ground potential.
- Ensure that switching (3-wire) is selected. (Setting via display or software)

The input impedance of a measuring input is 10 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)

10.4 Connection to secondary transformer



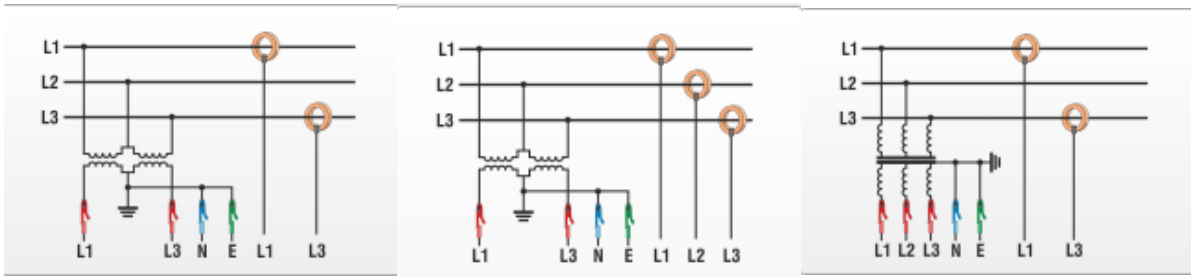
Connections

- Ensure that voltage measurement cable E is connected for every measurement.
- If no PE connection is available, connect E and N together.
- Ensure that switching (3-wire) is selected. (Setting via display or software)
- Set the voltage transformer ratio
- Enter the nominal conductor-conductor voltage
- Set the current transformer ratio

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)

10.5 Special circuit types

Configurations such as a V connection or Aron connection can be set-up.



- V connection (set-up through the evaluation software or device setup)
- Aron connection (set-up through the evaluation software or device setup)

Isolated networks

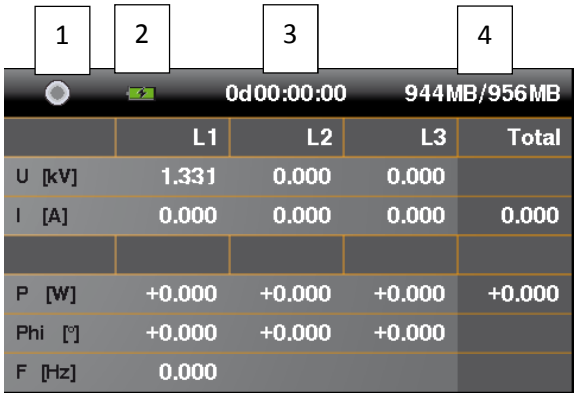
Connections

- Connect voltage measurement conductors E and N to ground
- If this is not desired in the plant due to isolation monitoring, the E and N connections can be connected together and remain free without connection.
- Ensure that switching (3-wire) is selected.
- Set the voltage transformer ratio
- Enter the nominal conductor-conductor voltage
- Set the current transformer ratio

11. Display

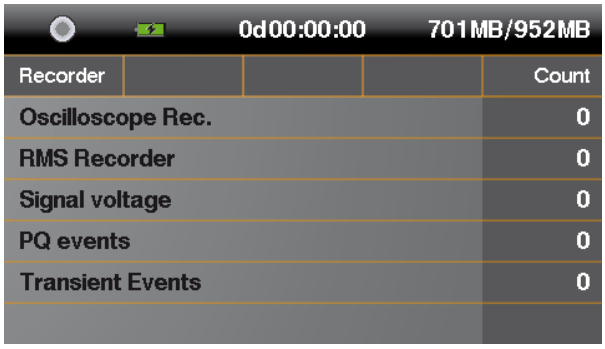
Pressing the right and left arrows on the directional pad  changes the page of the Display.

Display page 1



1) Recording "On" is indicated by a flashing red light 
2) Display state of charge battery
   state of charge >= 100% --> four green bars
   state of charge >= 75% --> three green bars
   state of charge >= 40% --> two green bars
   state of charge >= 20% --> one red bar
   state of charge < 20% --> empty
3) Current recording duration
4) Free space for recording / SD card size

Display page 2



→ Display the number of PQ events and fault recorder during the current measurement

Display page 3

	L1	L2	L3	Total
S [VA]	0.000	0.000	0.000	0.000
Q [VAR]	+0.000	+0.000	+0.000	+0.000
P [W]	+0.000	+0.000	+0.000	+0.000
D [VAR]	+0.000	+0.000	+0.000	+0.000
PF	1.000	1.000	1.000	1.000
cos phi	+1.000	+1.000	+1.000	+1.000

→ Display of the apparent, active and reactive power with sign prefix (individual phases and total performance)

Display page 4

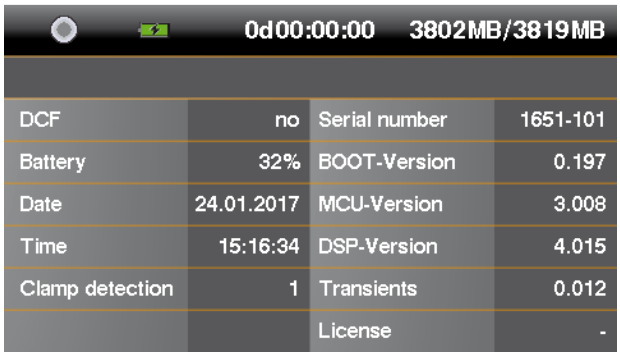
	L1	L2	L3	N
THD [k%]	2.408	0.000	0.000	0.000
THD I [%]	0.000	0.000	0.000	0.000
	L12	L23	L31	
U [kV]	1.337	0.000	1.337	
Ep [Wh]	−0.000	0.000	0.000	−0.000
Eq[VARh]	0.000	0.000	0.000	0.000

→ Display of the current and voltage THD (individual phases, neutral conductor)

→ Display of the conductor-conductor voltages

→ On the last two lines, the active and reactive power are displayed from the start of the measurement.

Display page 5



DCF	no	Serial number	1651-101
Battery	32%	BOOT-Version	0.197
Date	24.01.2017	MCU-Version	3.008
Time	15:16:34	DSP-Version	4.015
Clamp detection	1	Transients	0.012
		License	-

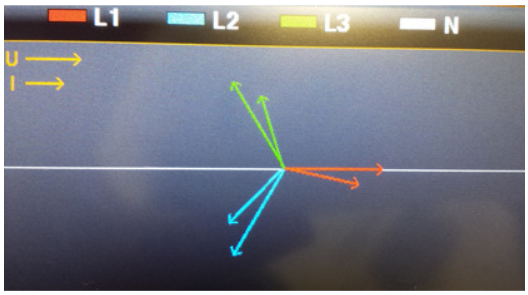
→ Date, time, version, current firmware version and time synchronization display.

→ After changing display pages once more, display page 1 appears again.

Graphic display PQ-Box

With the keypad by pressing, "up" or "down" you get into the graphic screens.

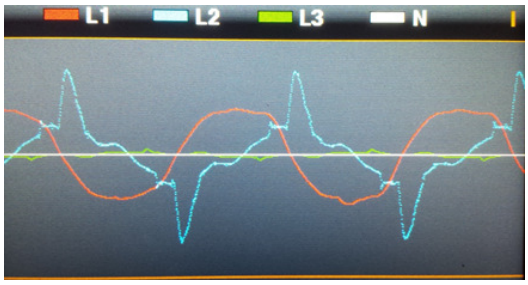
Graphic display 1: Phasor diagram voltage and current



.

Scroll to the right or to the left with the keypad  to reach the oscilloscope pictures.

Graphic display 2: oscilloscope voltage and current
Graphic display 3: oscilloscope voltage
Graphic display 4: oscilloscope current



With the “Enter” key it is possible to get back to the value view.

11.1 Starting a measurement

✋ Press the  key to stop or start measuring.

- Recording "On" is indicated by a flashing red light 

For a positive display of the active power

Ensure that the arrows on the current clamps point towards the consumer.

11.2 Manual Trigger

✋ Press the  key to set manual trigger.

→ Store the current voltages and currents with:

- Oscilloscope recorder
- 10ms RMS recorder
- Transient recorder (only PQ-Box 200 with option Transient)

The recording length and sampling frequency from transient measurement depends on the recorder configuration selected in the software.

Example 3/4:

4 fault records were triggered while 3 fault records been stored on the SD card.

1) The number of the Oscilloscope record increases by 1.

2) The number of the RMS record increases by 1.

3) Transient events increased by 1.

Example:

To evaluate the network perturbation of a consumer in the network:

✋ Before starting the consumer, activate manual trigger.

✋ After starting the consumer, activate manual trigger.

It is possible to compare all the images in the software. The images provide information about the cause of the network perturbations

11.3 Time synchronisation using the RS232 interface

→ The RS232 interface is equipped as standard for a DCF77 or GPS receiver connection.

- Automatic synchronization of the measurement equipment after connecting receivers. If synchronization is lost, the PQ-Box 200 runs with an internal quartz clock.

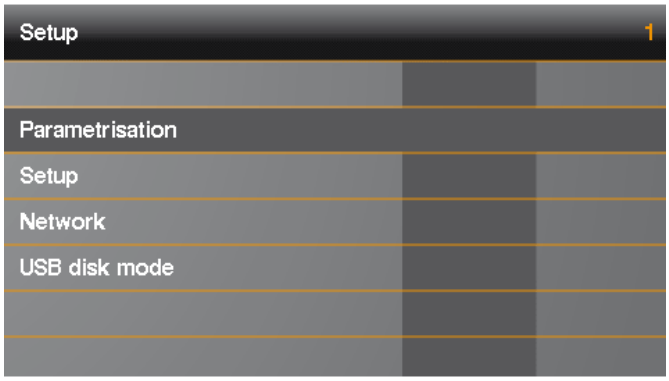
- A detected external clock is shown on the equipment display on display page 5.

11.4 PQ-Box Setup

Press the  key to open Setup.

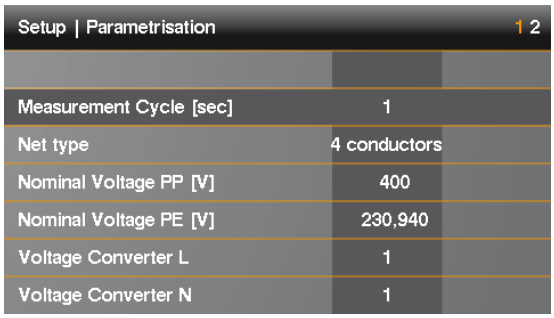
Press this key again to exit the Setup Menu.

→ Display page changes to the Main Menu.



1) Change the network data parameters (measurement interval, nominal voltage, conversion factors)
2) Basic equipment settings (display language, date, time)
3) TCP-IP interface settings
4) Change USB interface of PQ-Box 200 to mass storage (very fast USB data transfer to PC)

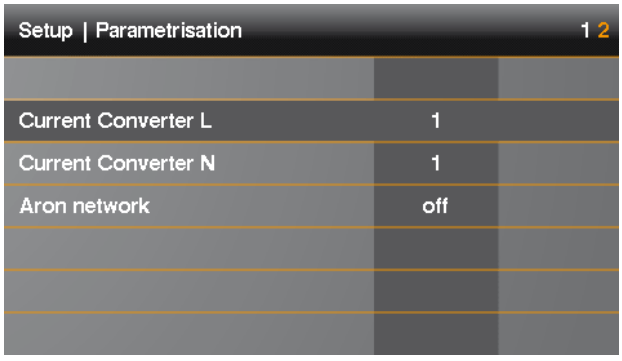
Parameterisation page 1



1) Freely adjustable measurement interval: 1 sec to 30 min (default interval setting = 600 sec)
   Settings < 1 min should only be used for short measurements.
2) Switch between 1~; 3~ and 4~ conductor networks.
   In a single phase network, only phase L1, neutral and earth will be measured.
   In a 3-conductor system, all evaluations of the standard reports are calculated from the phase-phase voltages.
   In a 4-conductor system, all evaluations of the standard reports are calculated from the phase-ground voltages.
   Additional network types are: V-connection, split phase and delta high leg
3) Nominal voltage refers to the contractually agreed phase-to-phase voltage.
   All recorders refer to this value as a percentage.
   For the low voltage: 400 V applies.
4) Voltage converter corresponds to the ratio between the primary and secondary voltage.

scroll with the left/right control keys

Parameterisation page 2



1) Current converter corresponds to the ratio between the primary and secondary current.
2) Switch Aron connection for 2-current converter measurement on and off

Changing parameters

Setup | Parametrisation	1 2
Measurement Cycle	0600
Nominal Voltage	400
Voltage Converter L	1
Voltage Converter N	1
Current Converter L	1
Current Converter N	1

Press  .

→ the color of the selected parameter changes to orange

Select position

→ the value can now be changed with the up and down arrows

Press  to accept the changed value

→ the new value appears in the Menu

Settings page 1

Setup | Setup	1 2
Language	English
Date	25.09.2017
Time	17:48
Continuous mode	off
Memory limitation (680MB)	active
Interface Lock	off

1) Change the display language
2) Change the date
3) Change the time
4) Continuous mode (active = PQ-Box run permanent)
5) Memory limitation to 680 MB – active or no limitation of memory (Memory management)
6) Password protection for interfaces and display of PQ Box (see chapter password protection)

11.5 Keypad Lock

Press and hold the Setup key for > 5 sec while a measurement is in progress.

→ Keypad lock active.

Then press and hold > 5 sec.

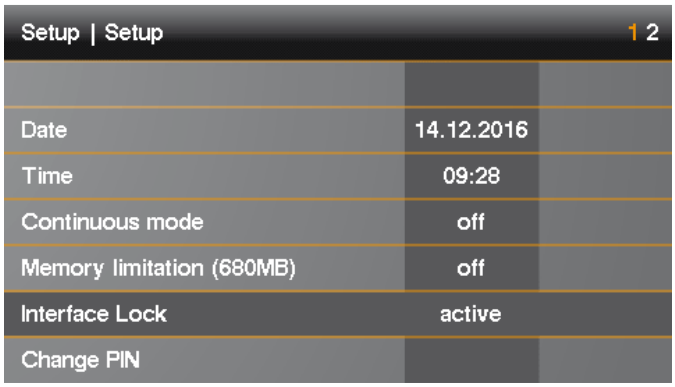
→ Keypad lock inactive.

It is possible to see the measurement readings when the keypad is locked.

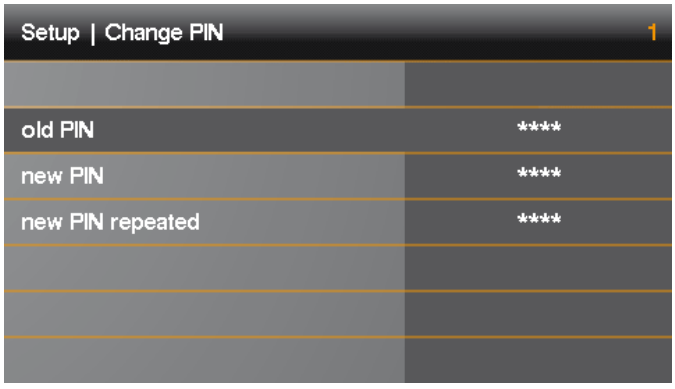
The Setup menu and screen pages are locked.

11.6 Password Protection and Interface Lock

In order to protect the PQ-box from unauthorized access and manipulation during measurement task the device provides an interface lock mode with password (PIN) protection. The interface lock can be activated in the setup menu and is protected with a corresponding four-digit numerical password, a PIN consisting of any combination from 0000 to 9999.



The PIN (default factory setting is 0000) is set in the menu item Change PIN.



If the interface lock is active, the password protection locks the device automatically one minute after starting a measurement. With the keypad lock function (see description above) the device can be locked with password protection manually. In locked mode the USB and Ethernet interface are deactivated and a display lock is active.

In active interface lock mode the device can only be unlocked with the correct PIN. After more than eleven incorrect PIN entries, user access is locked permanently and the device has to be sent to the A. Eberle support address.

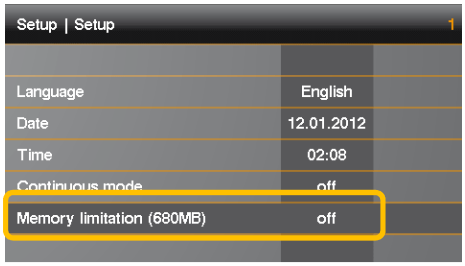
11.7 Memory management

So that the recorder data does not fill the whole memory when a too sensitive or incorrect trigger level is set and thus the long-term recording is stopped, at the start of the measurement the PQ Box 200 reserves a maximum size of the free space for all fault records. If this memory size is reached, this can be seen in the display by an asterisk * after the number of fault records.

e.g. Display: Oscilloscope recorder = 1312*

If the memory of the SC card is filled 100%, the message "**Memory full**“, appears in the display.

Two possibilities to run the memory management:



- **Memory limitation (680MB) = off**

  On single data file can get up to the maximum size of 3,41GB. If the data size is reached then the PQ Box automatically starts a new measurement file. This will be repeated until the maximum size of the microSD memory card is reached (f. e. 32 GByte). The size of all recorders is limited to 1GB in one 3,41GB file.

  Warning: This type needed for evaluating the 64bit WinPQ mobile software.

- **Memory limitation (680MB) = active**

  The PQ-Box memory size for one measurement file is limited to 680 MByte, to avoid problems with Windows 32bit systems. If the data size is reached then the PQ Box automatically starts a new measurement file. This will be repeated until the maximum size of the microSD memory card is reached (f. e. 32 GByte).

  The size of all recorders is limited to 300 MB in one 680 MB file.

The data converter provides the opportunity to connect several measurements to one measurement file, if needed. (see chapter “Data Converter”)

11.8 Delete device memory

It is possible to clear the device memory of the PQ-Box using the front panel keys while the PQ-Box is booting up.

✋ Connect the power supply

✋ If “A. Eberle logo” appears hold enter key  for some seconds

→ Message appears: "Please press start button to clear the device memory"

✋ Press record button 

→ Device memory is formatted
→ PQ-Box is starting

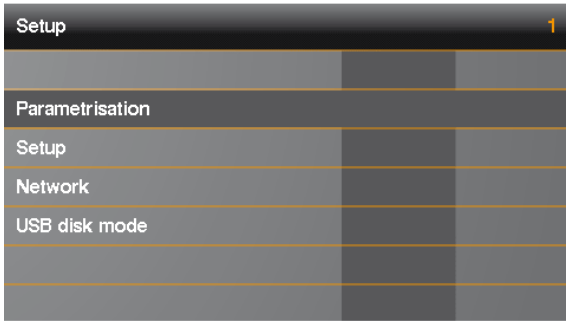
11.9 Continuous mode without power supply

If the function „continuous mode“ is active, the PQ box does not stop running if the power supply is off momentarily. The PQ Box can work up to 6 hours with battery supply. You can start and stop records or measure in online mode.
At 7% capacity, about 10 minutes before turning off, a warning message appears on the display.

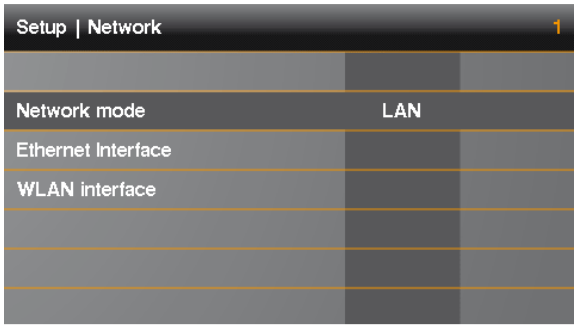
Deactivate battery mode via the setup menu "Off".

11.10 Interface and TCP/IP settings

In “Setup/Network” you can change the configuration for TCP/IP interface and WLAN interface.

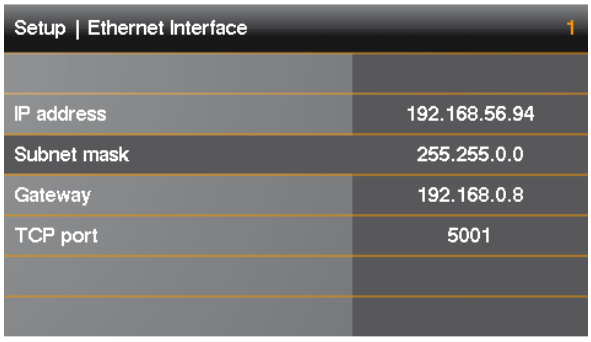


In “Network mask” it is possible to switch between WLAN and LAN communication. Both ways of communication can´t run at the same time.



Ethernet settings

This example shows the basic settings for the PQ Box Ethernet interface.
All parameters can be changed with the control keys on the box.



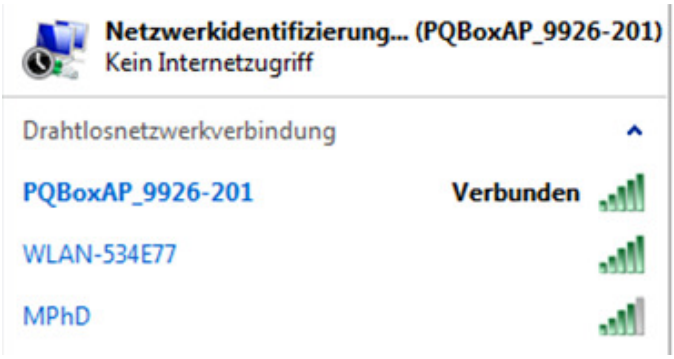
To accept the changed parameters, the device must be restarted.

WLAN settings (Option for PQ-Box 300)

This example shows the basic settings for the PQ Box WLAN interface.
All parameters can be changed with the control keys on the box.

Setup | WLAN interface	1
SSID	PQBoxAP_1731-101
WPA2-Key	PQBoxAP_1731-101
IP address	192.168.2.5
Subnet mask	255.255.255.0

The name of the WLAN router shown in the network for PQ Box 300 is: „PQBoxAP_*serial number*“
For connection you have to enter the WPA2 Key on your PC. The current WPA2-Key is displayed on the WLAN interface setup screen as shown above.



12. Evaluation software WinPQ mobile

The evaluation software WinPQ mobile supports the PQ-Box 100, PQ-Box 150, PQ-Box 200 and PQ Box 300 **portable network analyzers.**

It was developed in collaboration with power supply companies with the goal of creating an easy-to-use and adaptable solution for the evaluation of power quality parameters in energy distribution networks.

The network analyzer is suitable for network analyses in low, medium and high voltage networks.

The purpose of the program is to process the stored power quality measurement data and fault records for the viewer and display them on the PC screen in an appropriate manner. To this end, the program provides tools for the efficient selection of stored data and a set of graphical and tabular presentations of the parameters of power quality according to European standard ***EN50160, IEC61000-2-2 or the standard for industrial networks IEC61000-2-4.***

- ✓ Automatic reporting according to the compatibility levels of EN50160, IEC61000-2-2 or IEC61000-2-4.
- ✓ Information about faults in the network by means of fault records
- ✓ Management of many measurements
- ✓ Data acquisition of long-term data and events
- ✓ Statistical long-term analyses
- ✓ Correlation of events and different measurement data
- ✓ User-friendly, user-oriented evaluation

12.1 SW – Installation / Removal / Update

System Requirements:

Operating system: Microsoft Windows 7 (32-bit & 64-bit)

Microsoft Windows 8

Microsoft Windows 10

Memory, at least 2 GB

The WinPQ mobile software is available free of charge in 32-bit and 64-bit versions.

Installation of the evaluation software:

To start the installation of the evaluation software, place the installation CD in your CD-ROM drive. If the Autostart function is activated, the installation program starts automatically. Otherwise, go to the root directory of your CD-ROM drive and start the program by double-clicking the file 

.

The installation complies with the Windows standard including uninstalling the program using the "software" system control. The installation location of the program (target directory) can be freely selected during installation.

Install the software in a directory in which you also have read and write rights.

The start icon 

is created automatically on your PC's Desktop.

Uninstalling the software using the system control:

The components are removed from the PC using the Windows "System control“.

Under "Software“, select "WinPQ mobile“ and delete the evaluation software with the "Remove“ button.

All parts of the program, including the generated links, are completely removed after a single confirmation. Before uninstalling the program, the components launched must be closed.

Software Update

The evaluation software and all updates are available free of charge on our website under the category "Power Quality":

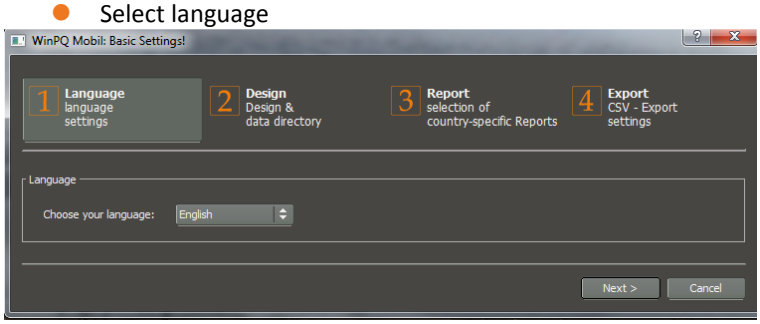
www.a-eberle.de

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

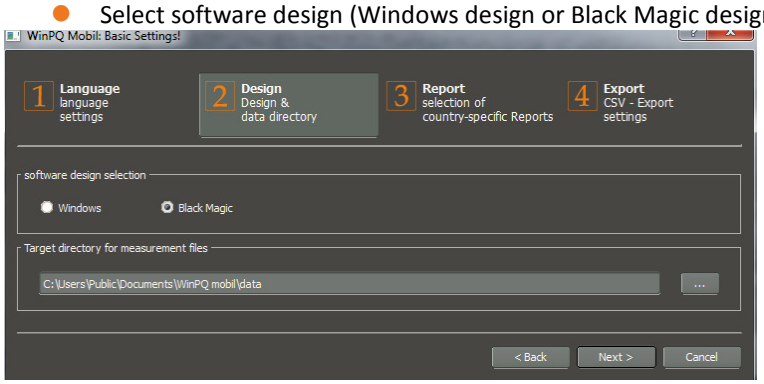
12.2 Software Wizard

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.

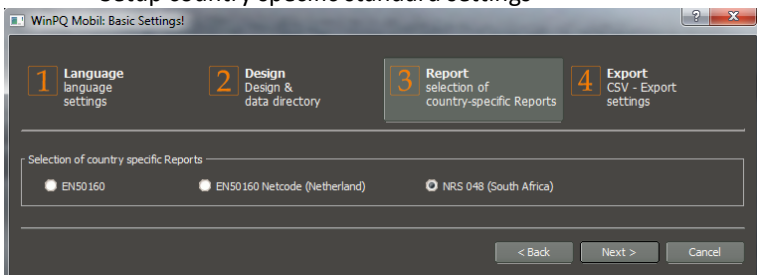
- Select language



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



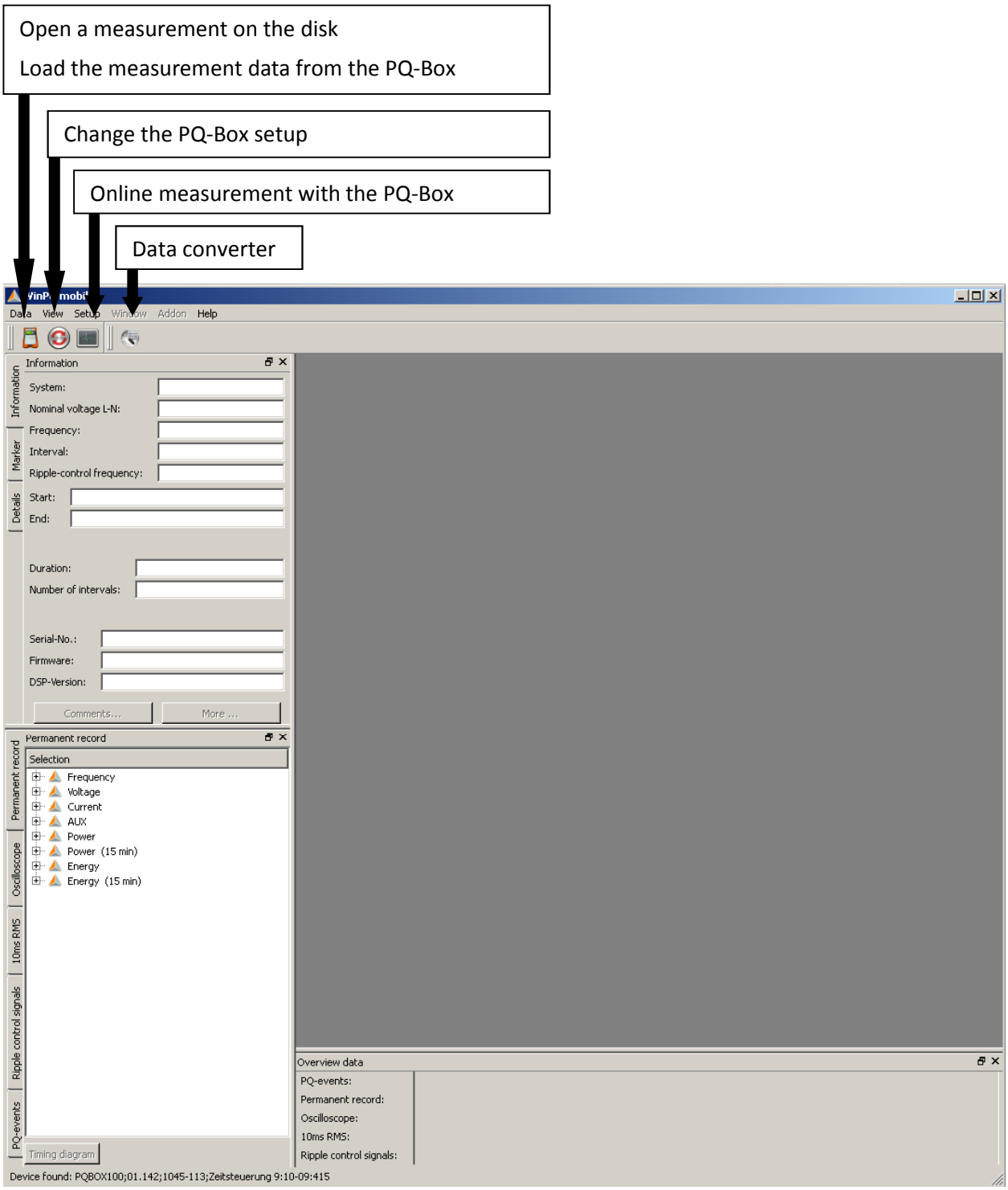
- Setup country specific standard settings



- General settings for data export

12.3 WinPQ mobile start screen

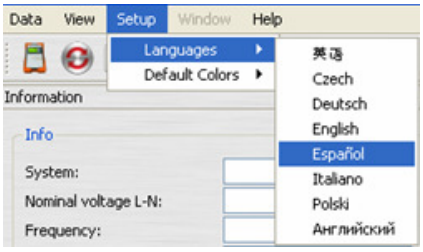
Start screen of the evaluation software WinPQ mobile



12.4 General Software Settings

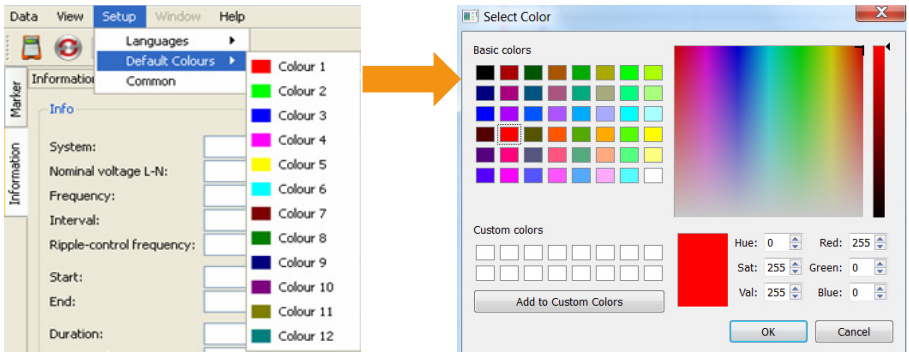
Changing the language

The evaluation software language can be changed in the "Settings“ menu. After changing to a new language, the software must be restarted for the change to take effect.



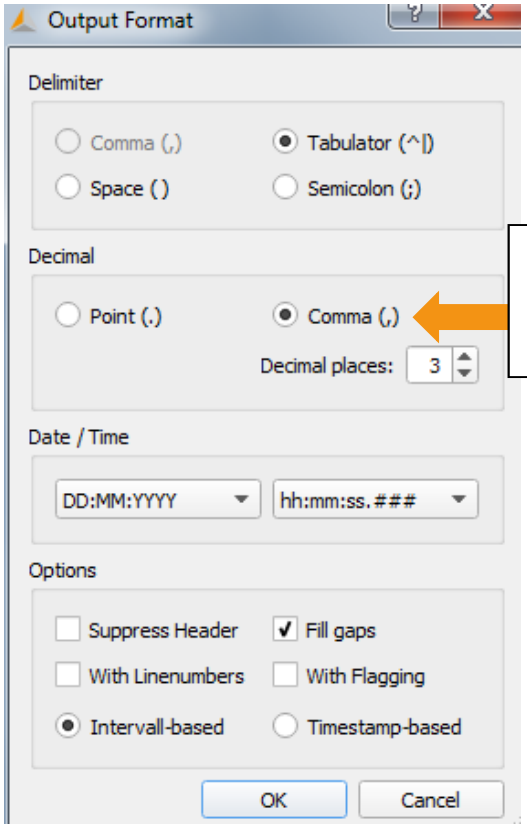
Changing the colors of lines

Here, each measuring channel can be assigned a specific color. There are two different settings possible: Windows native and Black magic. For print always the colors Windows native are used.



Export Preferences:

Here the basic settings for data export are set.



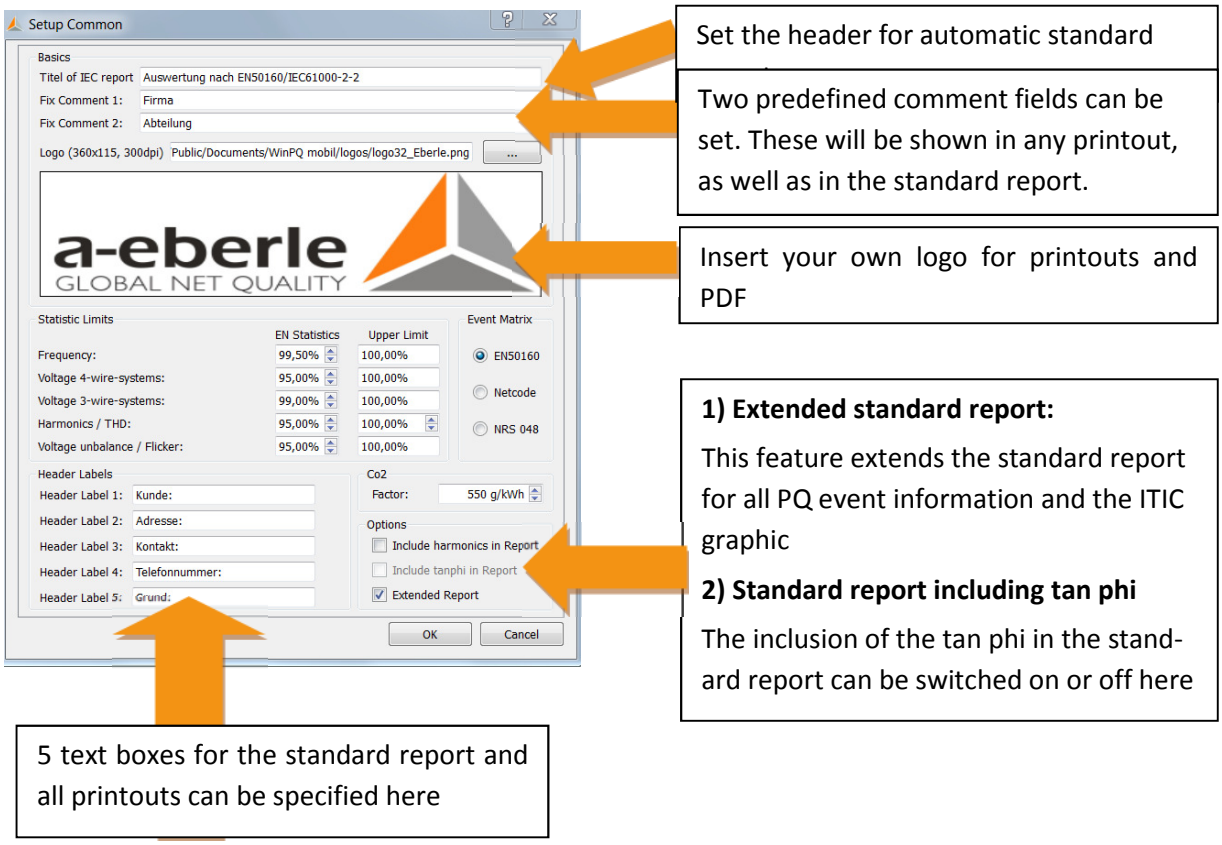
Decimal point separator:
(,) = German MS Windows
(.) = English MS Windows

Options:

- 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

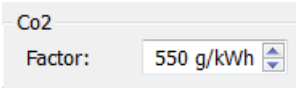
General setup

Change the logo in printouts and headers

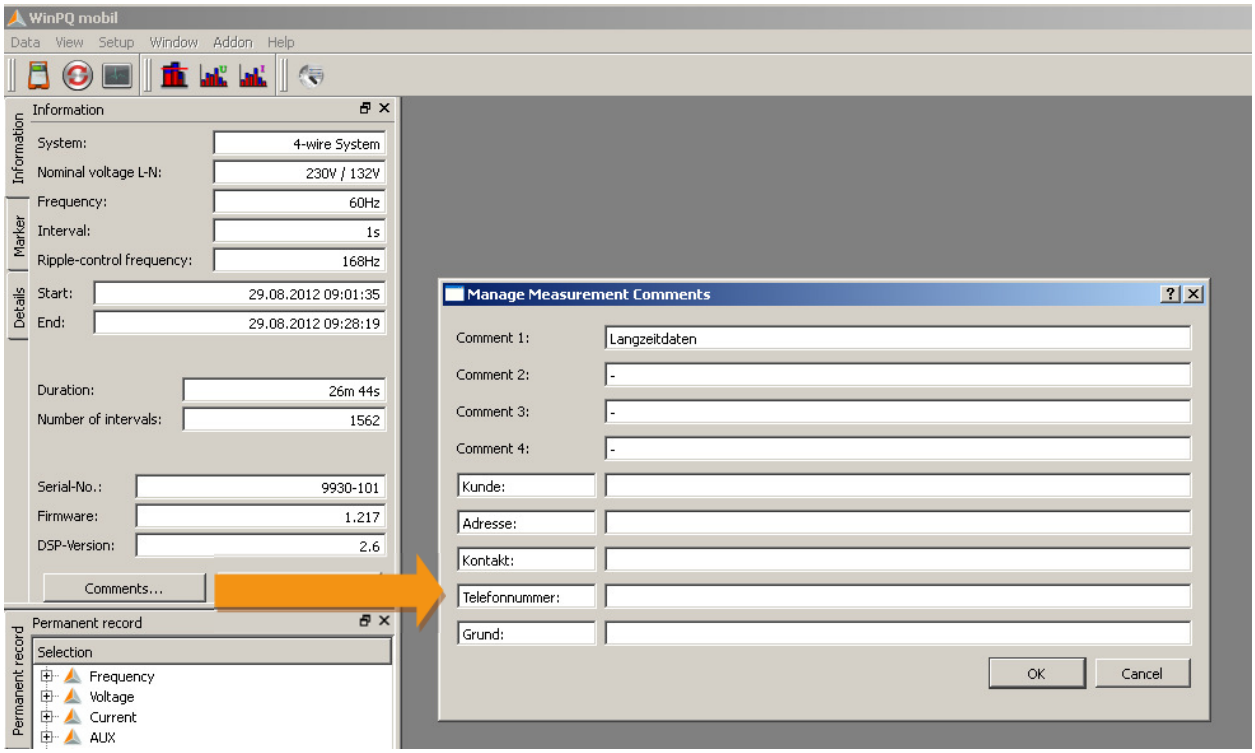


These text boxes appear below the "Comment" icon as template text and can be filled here with Information about the measurement.

Carbon dioxide calculation



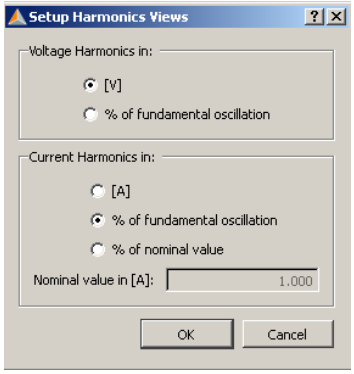
The energy supply can be displayed in WinPQ mobil in carbon dioxide. The calculation factor can be set here.



Harmonics settings

Under "Settings / Harmonics Settings“ the type of presentation can be set.

- Voltage harmonics: Display as “Volt” or “% of the fundamental oscillation”
- Current harmonics / THD, TDD current:
  Display as “Ampere”, “% of the fundamental oscillation” or “% of the nominal current“

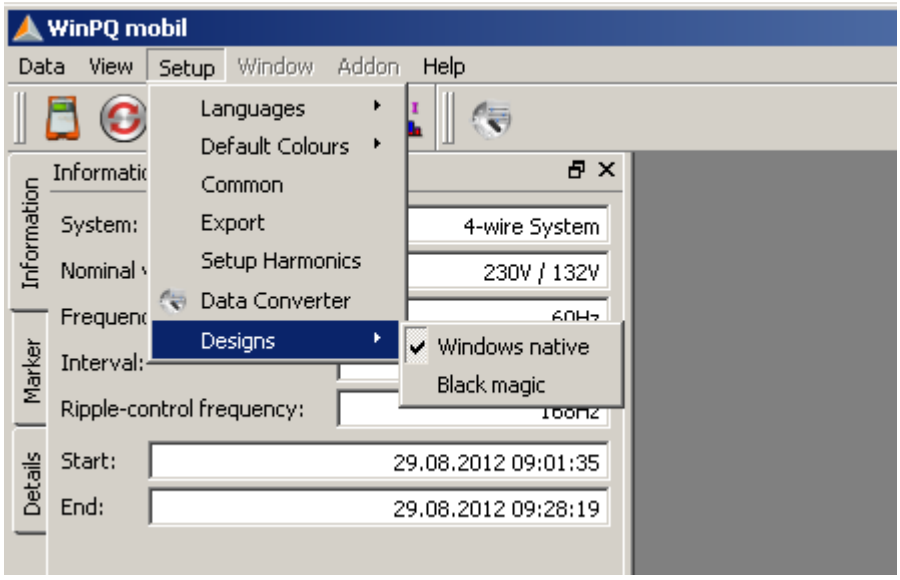


All diagrams and bar graphs in the software will use the selected units (volts or %; amps or % etc.).

Changing the WinPQ mobile design

WinPQ mobile offers two different designs for screen displays**.**

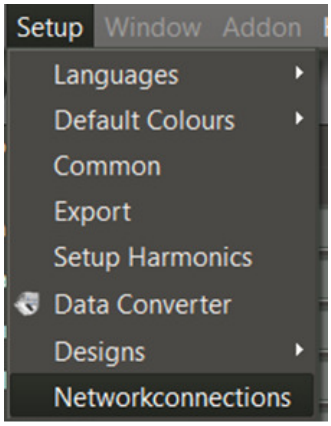
- Windows native
- Black magic



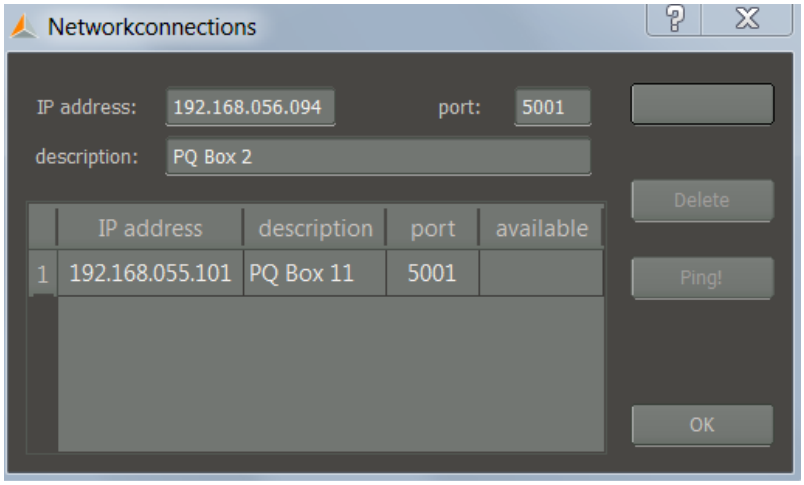
Example: "Black magic“ design with a black background

With the "Black magic“ setting, all print tasks are printed in "Windows native“.

12.5 TCP-IP Settings in WinPQ mobile



In the analysis software in "Settings / Network Connections", multiple network connections from PQ-Box devices are stored.



1) IP address, port number, and a free name of the analyzer can be stored.
2) Pick up with "Add" this connection to the software menu.
3) "Delete data" deletes the selected IP address from the drop-down menu.
4) With "Ping" an IP data connection can be tested.

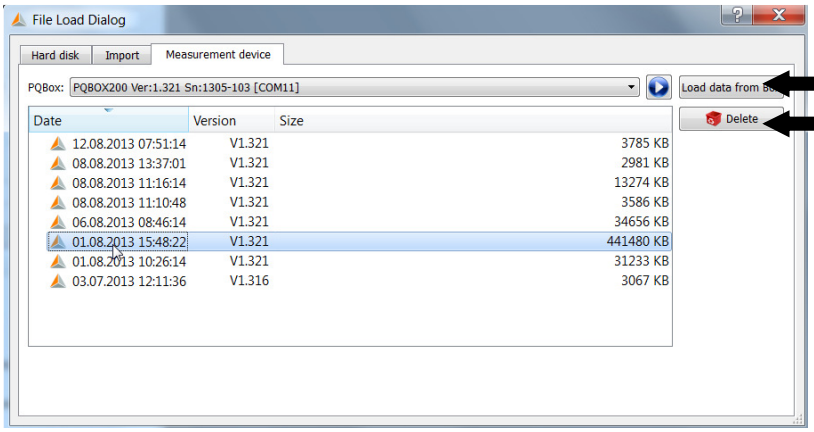
WinPQ software tries to connect always to existing connections. In the software in setup, online data or read out measurement data available devices are selectable.

12.6 Transferring measurement data from the PQ-Box to the PC

Connect the power quality analyzer to the PC with the USB cable or TCP-IP connection.

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

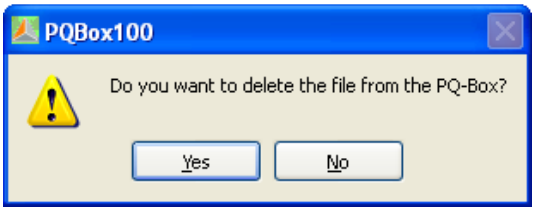
Press the icon  to read the memory of the device.



Loads measurement data from PQ-Box to the PC

Deletes highlighted measurement data from PQ-Box

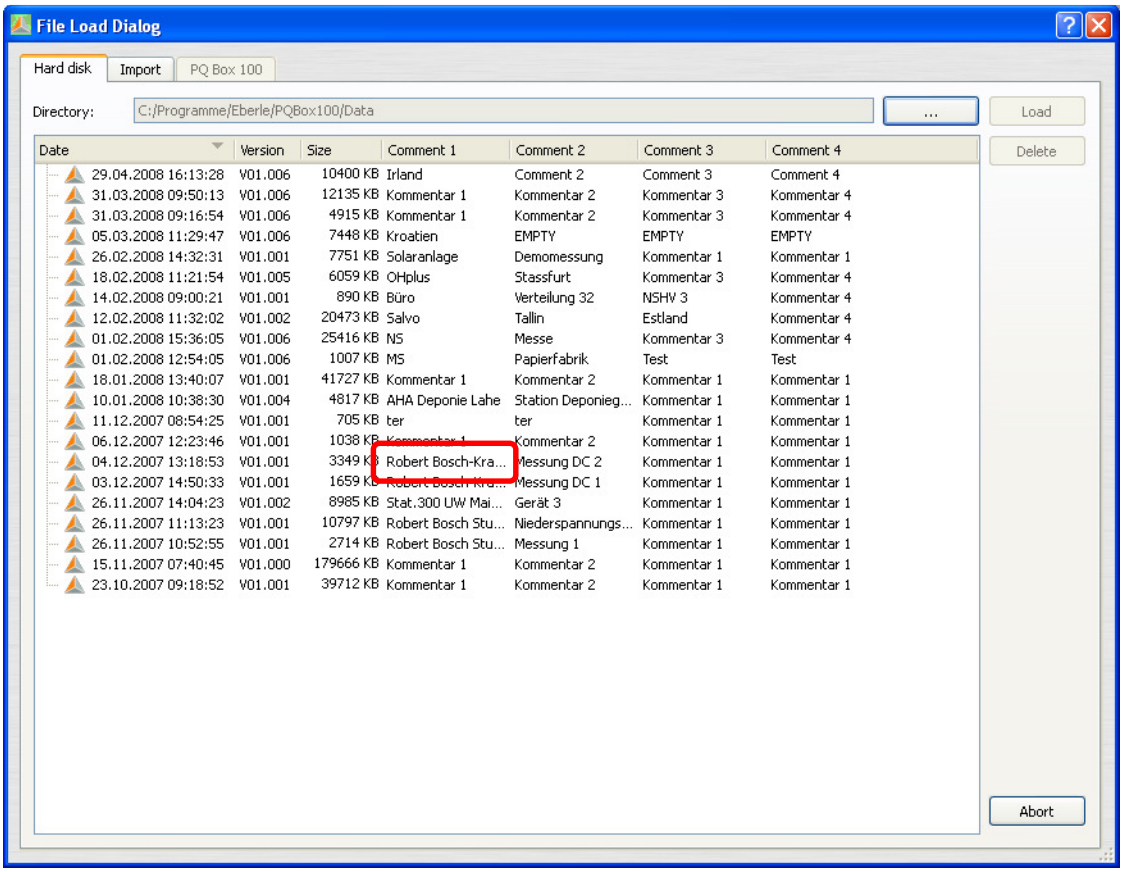
After reading the data from the device to the PC hard drive, the message "Should the measurement data in the PQ-Box now be deleted?" is displayed.



Yes – The data will be deleted and the occupied memory in the device is freed.

No – The measurement data remain stored in the device and can be downloaded from other PCs.

 We recommend deleting the measurement data from the device's memory after downloading so that the memory is not filled unnecessarily.

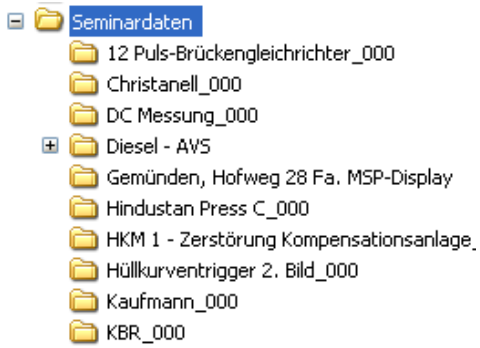


In this view, four comments can be attached to each measurement. If no comment has been entered yet, this field contains "-". Double-click a comment field to edit it.

All four comment fields appear in the printed reports.

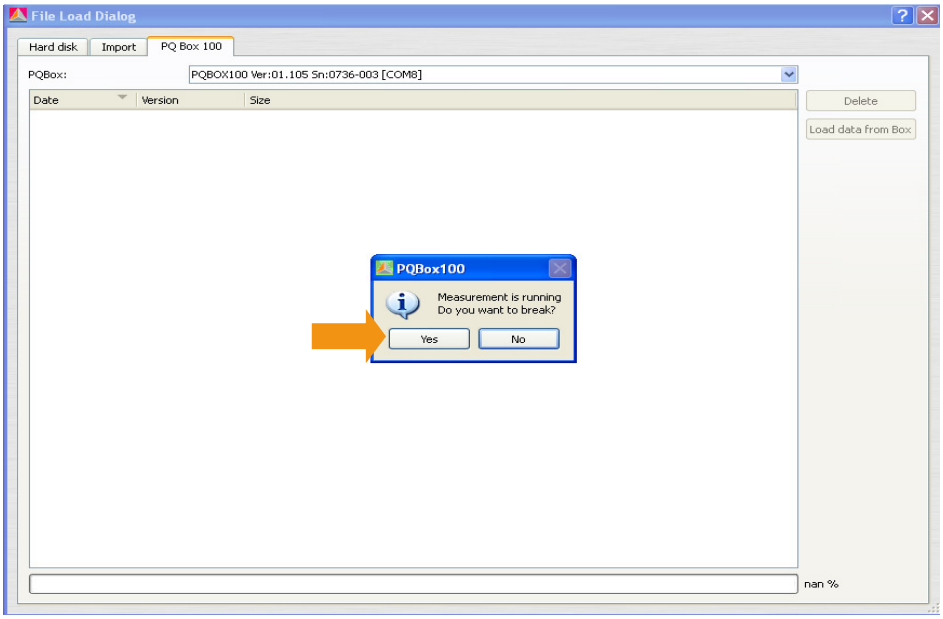
12.6.1 Data folder in Windows Explorer

If a text is entered in the first comment field of a measurement file, the folder containing the measurement data will also be called this in Windows Explorer.

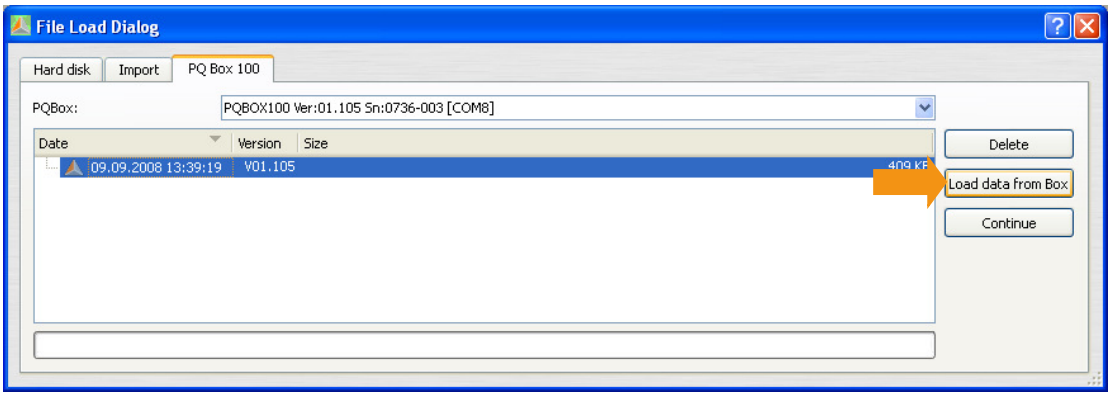


12.6.2 Transferring measurement data while a measurement is in progress

To transfer measurement data from the device after a measurement has been started, the measurement is stopped briefly during the data transfer. Confirm the question "Should the recording be stopped?" with "Yes"

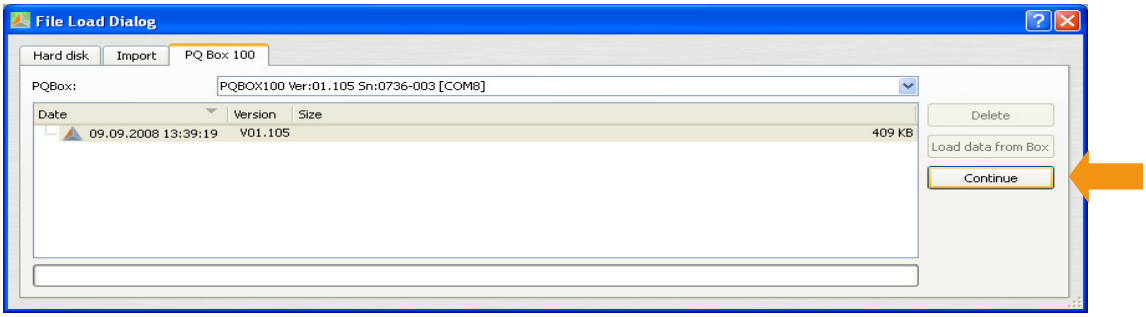


Select the measurement data and press the "Transfer data" icon.



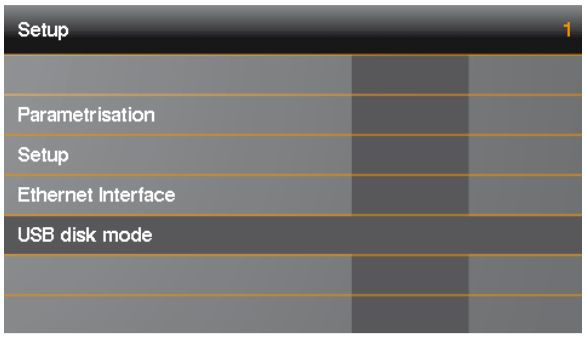
The measurement is resumed by pressing the "**Continue**" button.

All of the measurement data are available at the end of the recording in a complete measurement file.

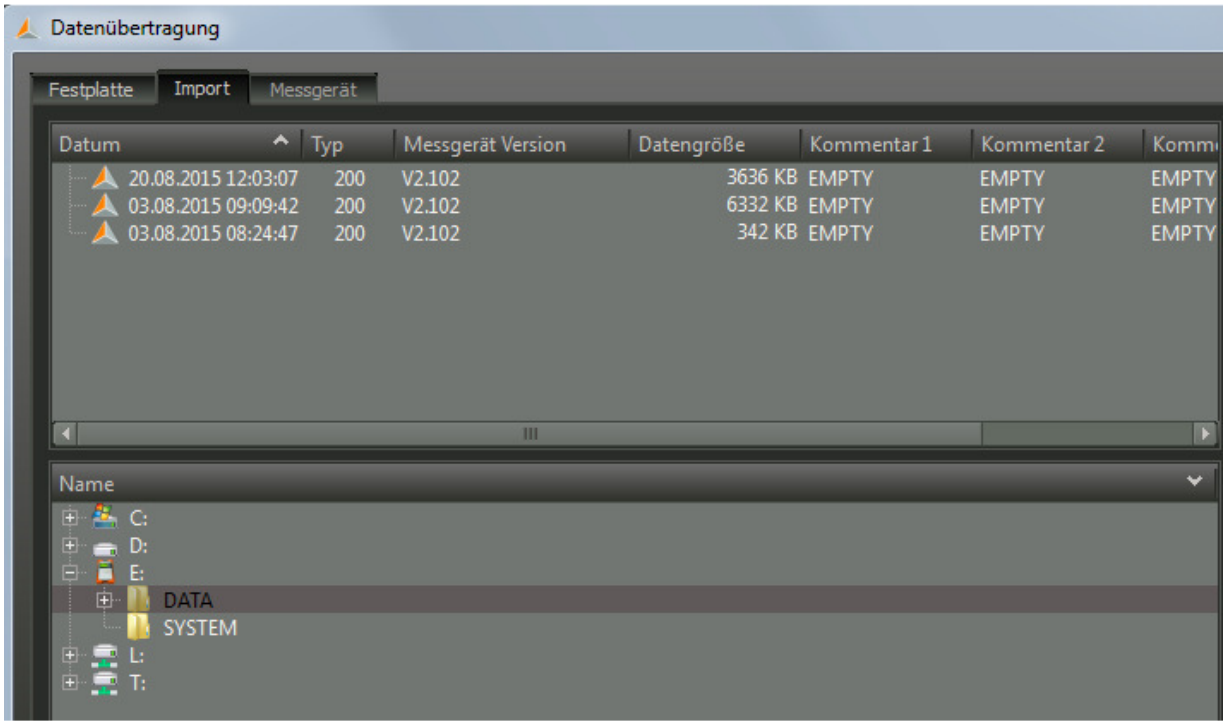


12.6.3 Fast data transfer in USB disc mode

If PQ Box 200/300 is in the setting "USB disc mode", huge data files can be transmitted very quickly to the PC.



Use the tap "Import" the PQ-Box appears as a disk. In the folder "DATA" are all measured data of the device. Select one or more measurement files and copy them via the icon "Import" on the PC.

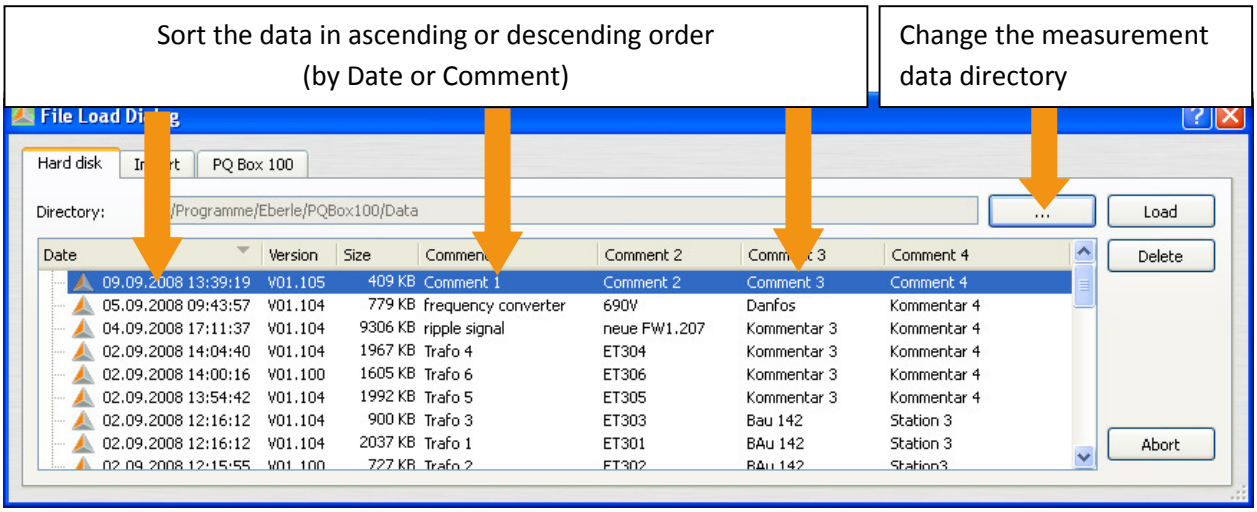


12.7 Evaluation of Measurement Data

All measurements available on the PC are listed in the "Hard disk" folder.

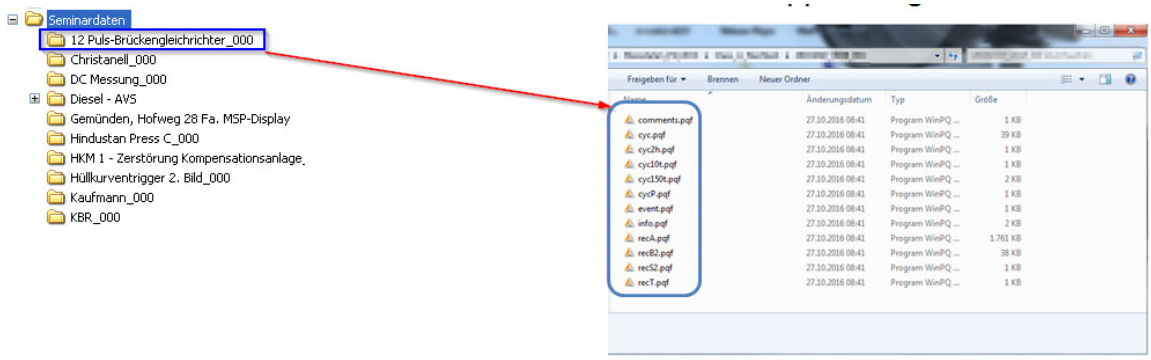
The various measurement data can be sorted by "Date" and "Comment" in ascending or descending order. The Load button opens the selected measurement for analysis.

The Delete icon removes the measurement data from the PC´s hard disk. More than one measurement can be selected. You will be asked for confirmation before the data is deleted.

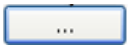


With double mouse click on “Comment” you can change the text for the measurement file.

The measurement data can also be opened by double-clicking without the WinPQ mobile start via MS 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.

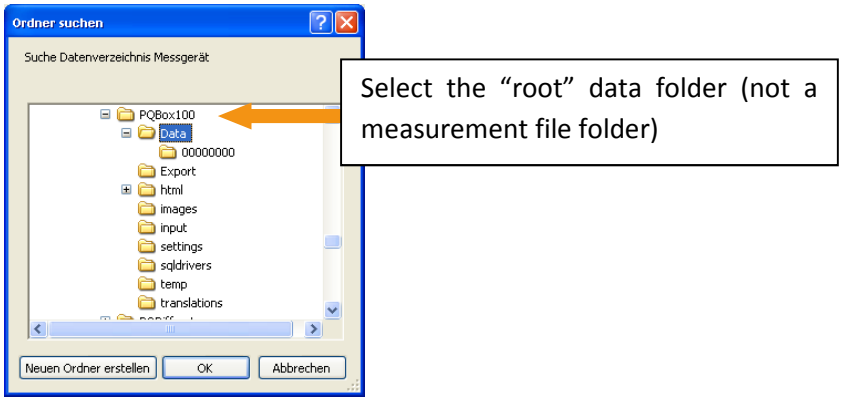


12.7.1 Change the measurement data directory

The button  opens an Explorer window. Here the folder is assigned in which the measurement data are located.

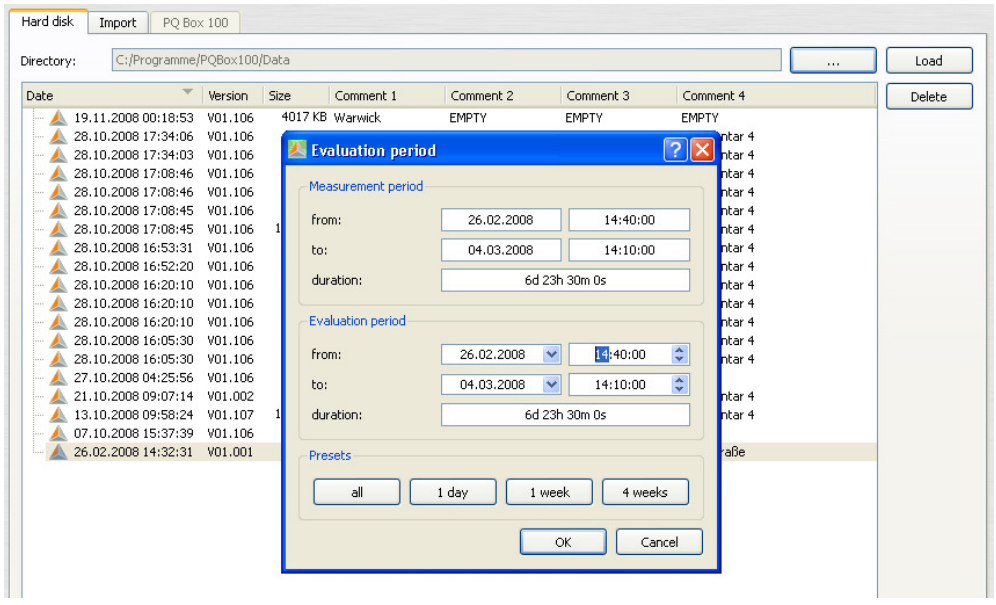
Do not select the measurement data folder directly but only the parent folder.

Any number of folders with measurement data can be created. These can be located anywhere in the network. Example: A folder for "Measurement data 20kV 2011“.



After opening a data file, the information for the whole measuring period is displayed. In the "Evaluation Period" field you can select a specific time period within the measurement and only evaluate this.

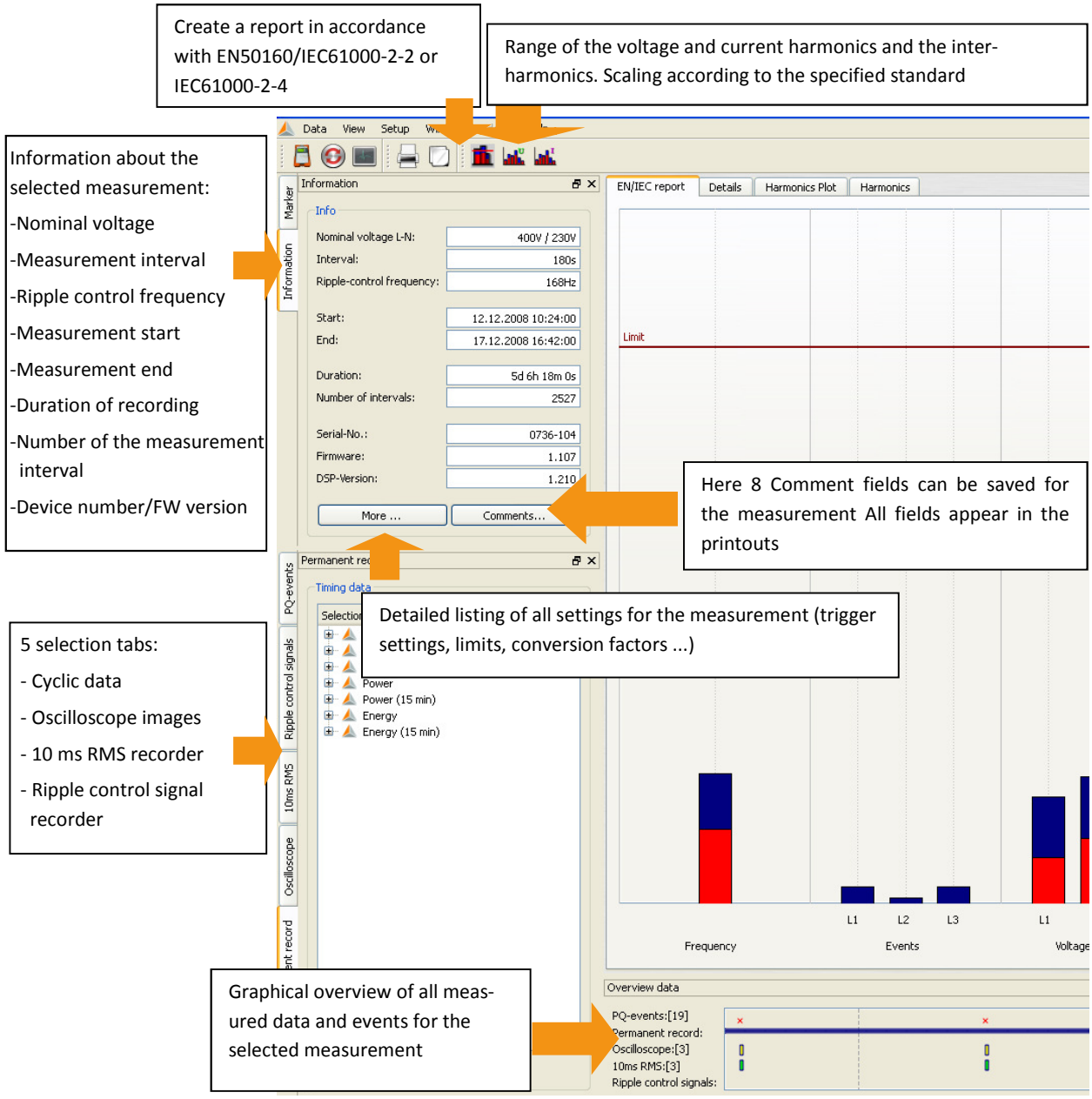
Example: A measurement was carried out over 10 days. The standard report is however to be created over a week. By pressing the "1 week" button, the measurement data is limited to one week.



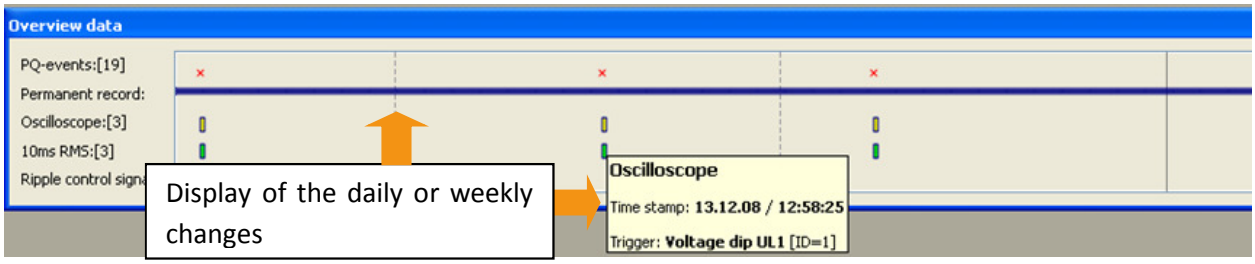
After pressing the "OK" button, the specified period of the selected measurement is opened.

All of the measurements and analyses shown below have been prepared with demo data, which are included in every installation.

Start screen after loading one measurement:



When the mouse pointer is over an icon for the oscilloscope or RMS recorder, information will be displayed for this event.

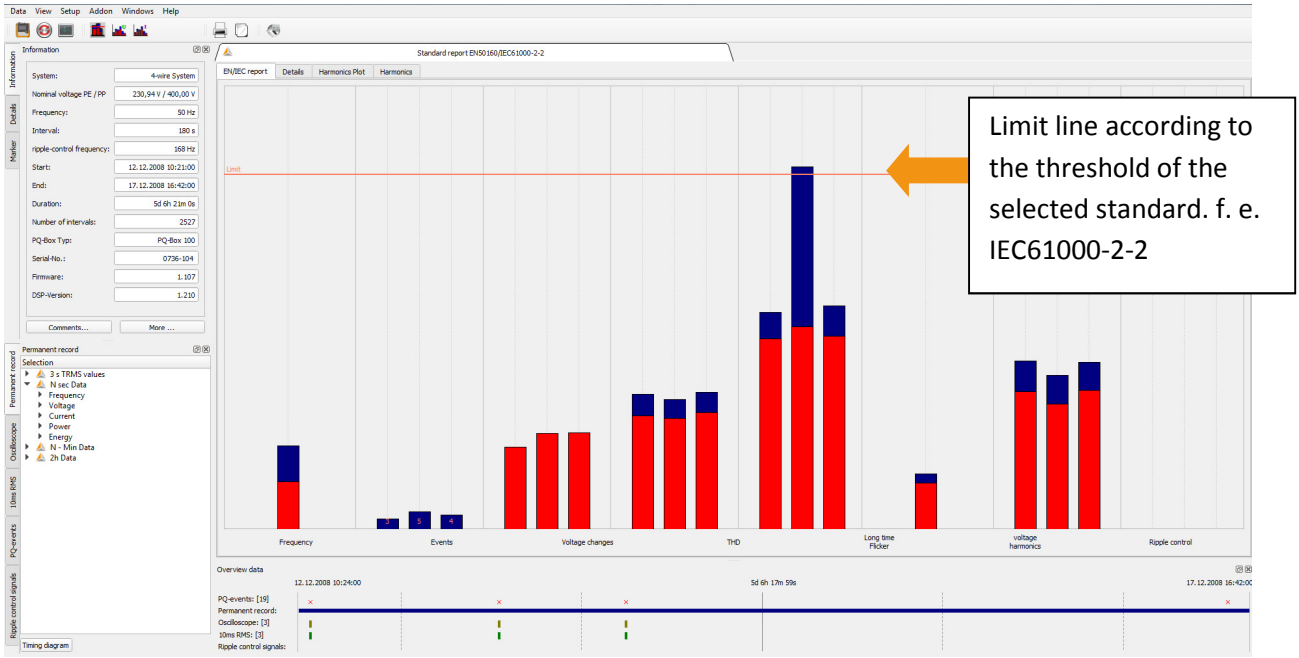


Clicking on a sign of an oscilloscope recorder, RMS recorder, ripple signal recorder or transient recorder automatically opens the corresponding fault description.

12.7.2 Standard evaluation for EN50160 and IEC61000-2-2

The  button gives you a quick overview of all voltage measurement value, with regard to the compatibility levels of the specified standard. In the basic settings, this is the EN50160 and IEC61000-2-2 combined. Depending on the size of the measurement data, the creation of these statistics may take few seconds. In a week of measurements, more than 300,000 measurement values are compared with the corresponding performance level and displayed graphically.

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



The bars show in a clear format the 95% reading in red and the highest "100% value" measurement value occurring in blue.

In the example shown, the maximum value of the long term flicker Plt exceeds the standard performance levels in all phases. The 95% value however is far below the permitted limits.

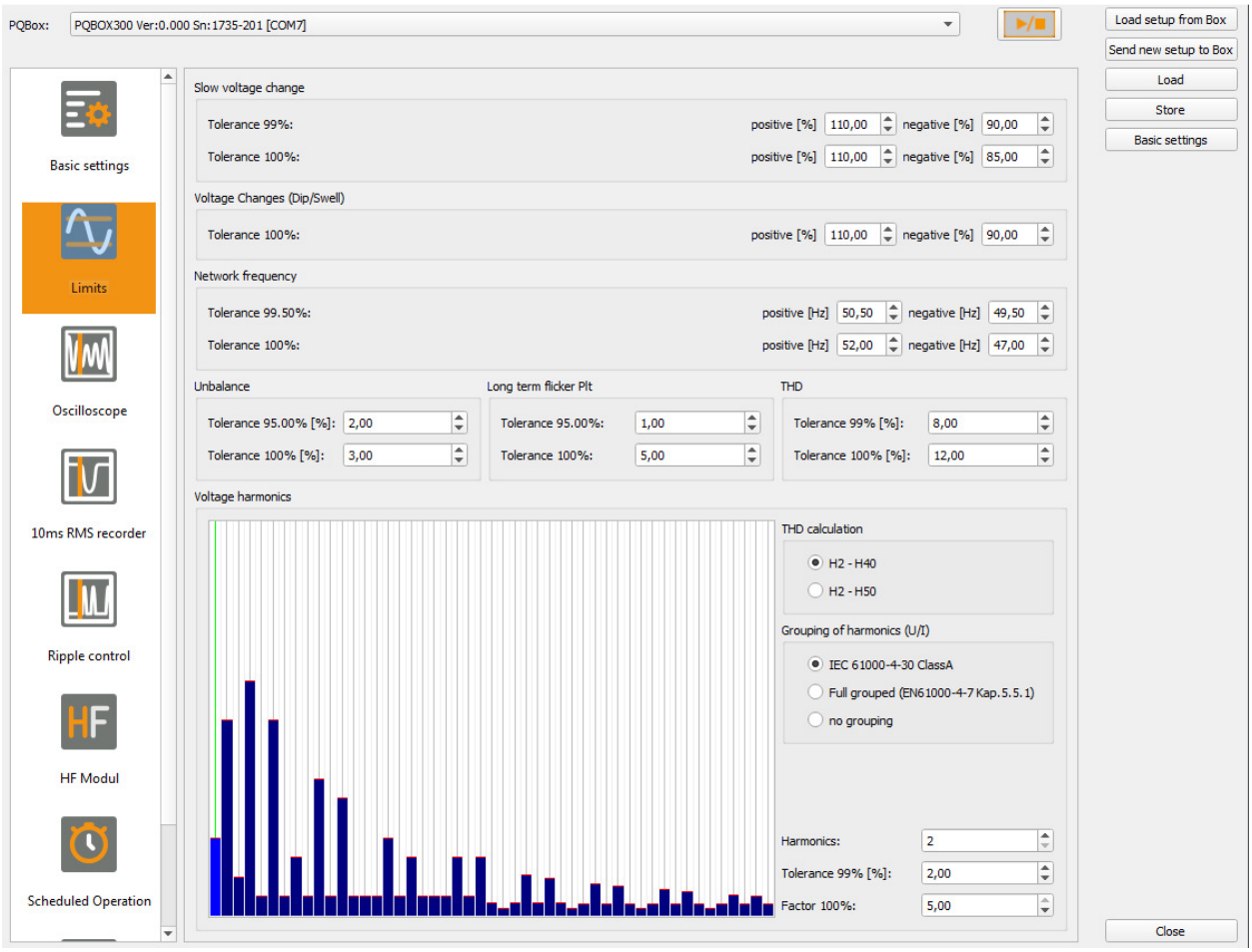
In the basic settings for the standard analysis, it is also possible to set a 100% limit. Should the 100% limit set be exceeded, the blue bar is cross-hatched red  .

Harmonic oscillations:

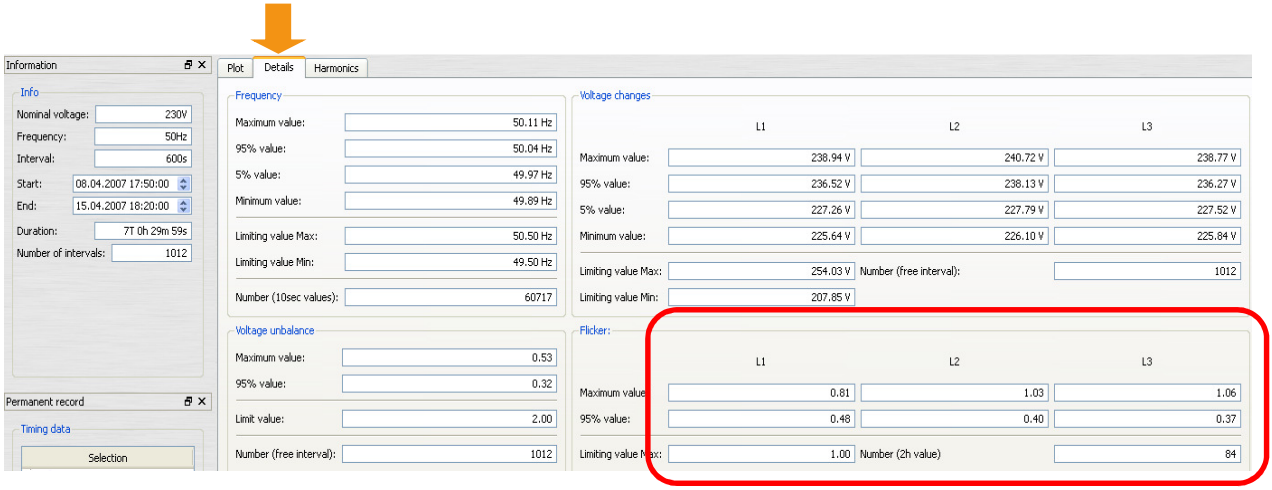
In the bars of the voltage harmonics all the measurements of the 2nd to 50th harmonic are compared with the respective performance level of standards EN50160 and IEC61000-2-2. The harmonic is displayed that is the next to the corresponding limit or exceeds it.

All standard limits can be changed by the user in the software "Configuration / Limits" menu.

List of the standard basic settings for the network analyzer:



In the "Details" panel of the standard report, detailed information is given on the respective maximum and minimum value, and the reference to the standard limit.



Example: Standard flicker evaluation

The maximum values for the phases are: L1 = 0.61; L2 = 1.02; L3 = 0.63. As the Plt limit is 1, the bars for the phases L2 exceed the limit line in the overview display. The 95% values (red bars) are all well below the limit.

The "Voltage Harmonics" page shows all the harmonics in a bar chart.

All harmonics are scaled to their limit from the specified standard.

The bars show in a clear format the 95% reading in red and the highest "100% value" measurement value occurring in blue.

In the "Harmonic" page the limits of the selected standard, and the 95% values and maximum values of the individual phases are shown in a table. If a harmonic exceeds the limits, the corresponding row is highlighted in red.

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

EN/IEC report | Details | Harmonics Plot | Harmonics

	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

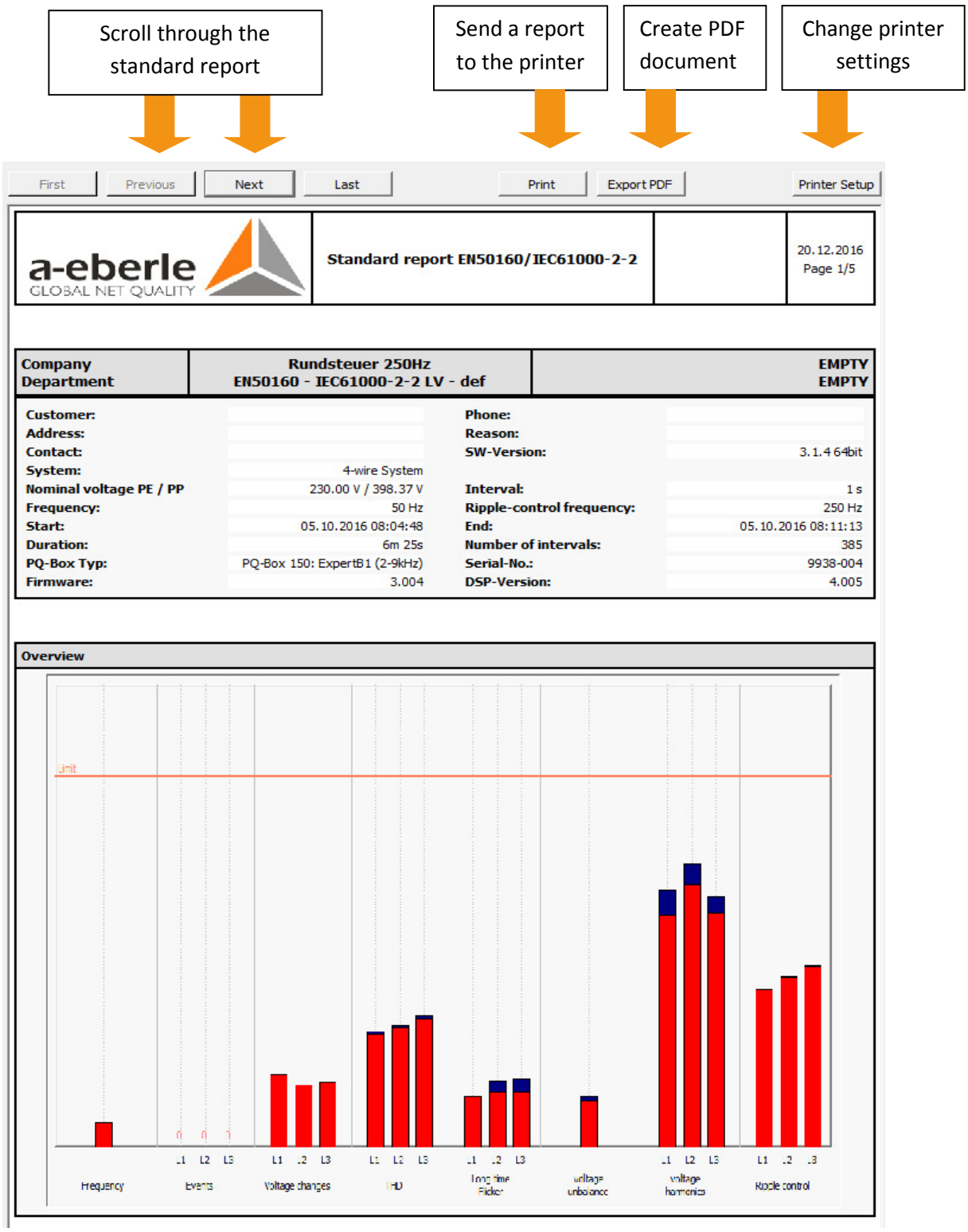
Highest value measured in the recording (L1)

95%-value of the measurement (L1)

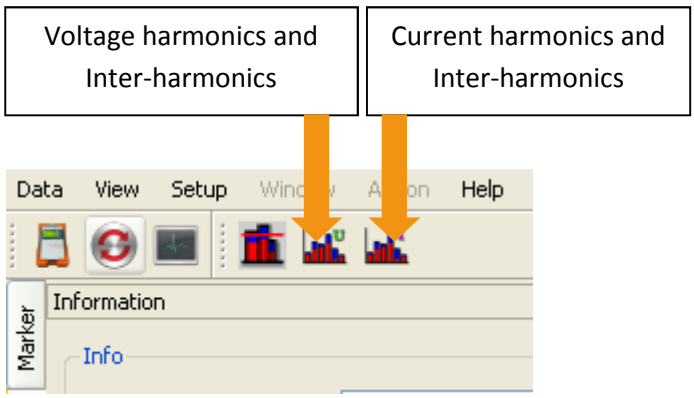
Limit from the standard

Create EN50160 / IEC61000-2-2 report:

With the Print function, a multi-page standard report opens.

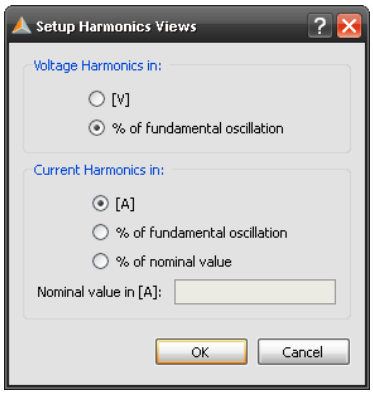


12.7.3 Bar chart of the Harmonics and Inter-harmonics



Using the two  icons, all voltage and current harmonics, as well as voltage and current inter-harmonics are displayed graphically or in a table form.

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.

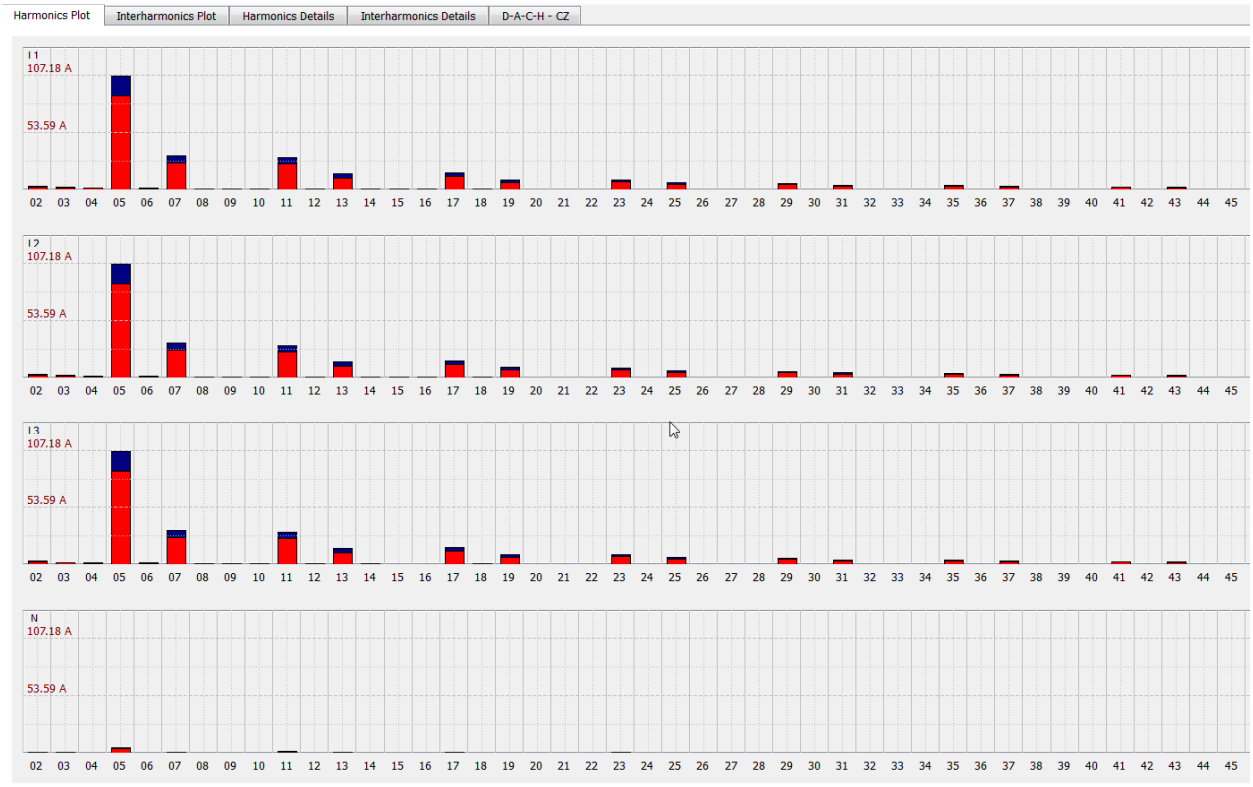


Table of harmonic values

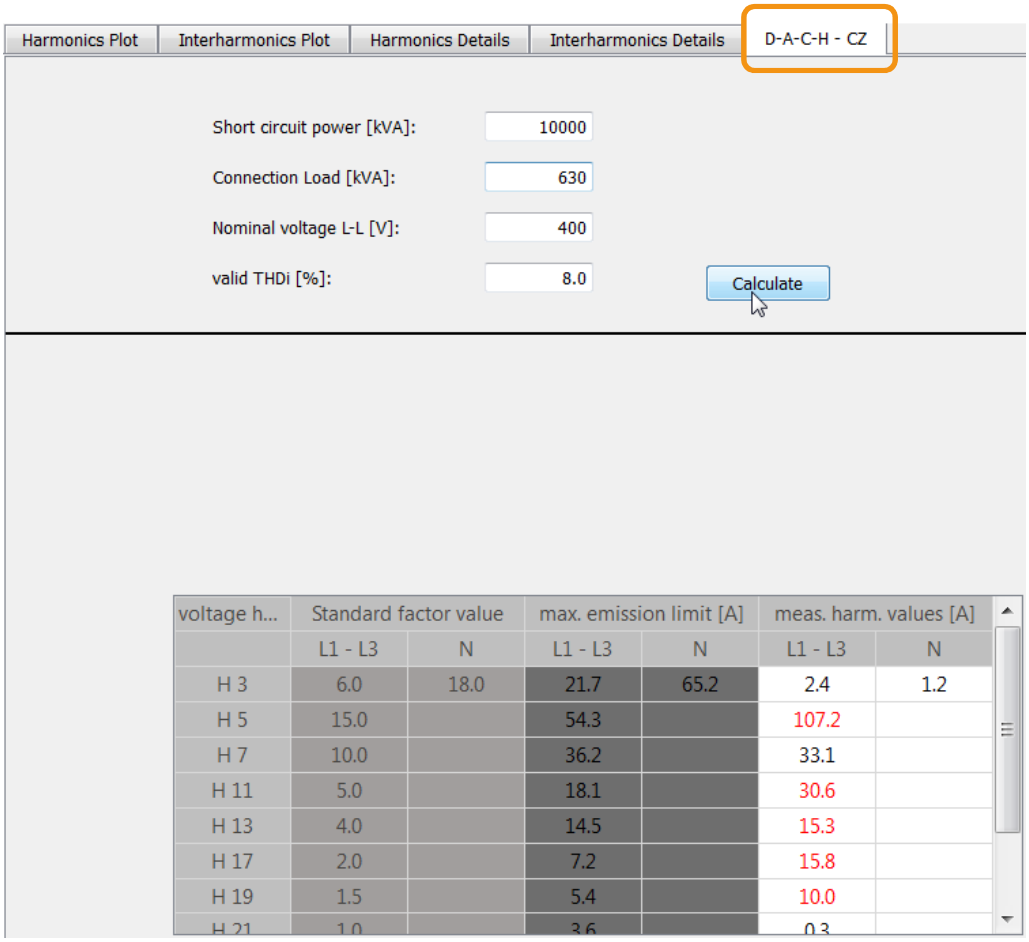
Harmonics Plot | Interharmonics Plot | Harmonics Details | Interharmonics Details | D-A-C-H - CZ

	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]

12.7.4 D-A-CH-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.

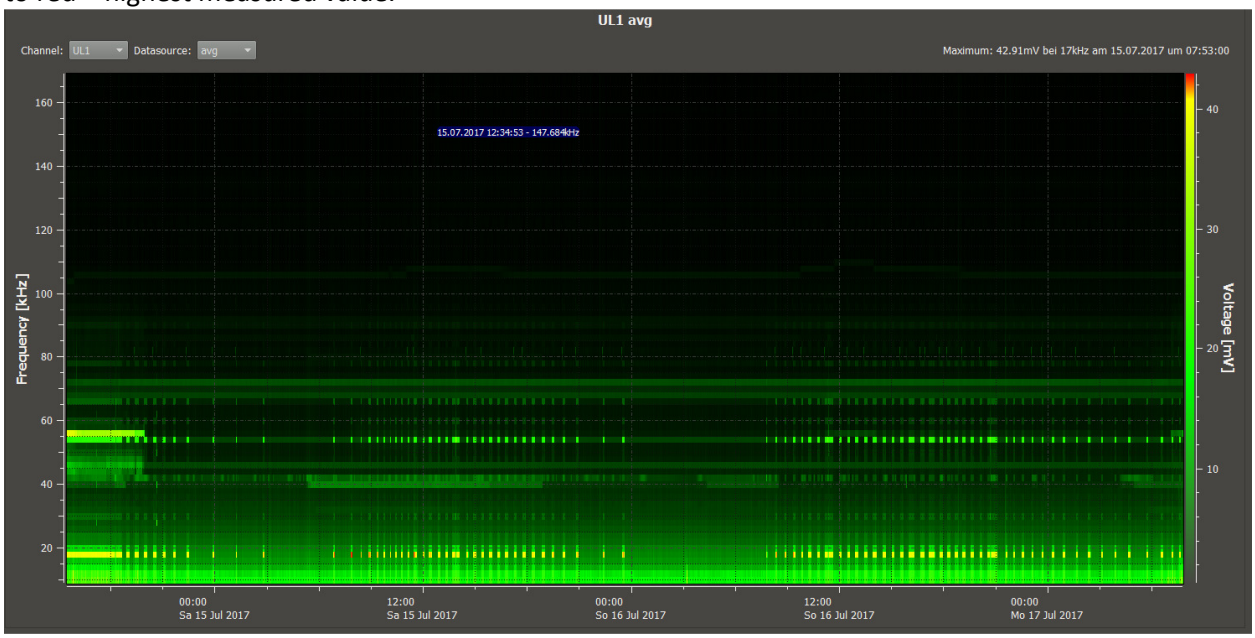
Details

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	

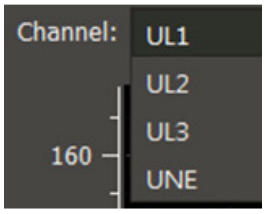
12.7.5 3D view for Supra-harmonics (only PQ-Box 300)


The icon "3D view" represents all Supra-harmonics ranges from 8 kHz to 170 kHz (or the parameterized range at 200 Hz frequency bands if the setting is different)
Supra-harmonics are scaled in a kind of 3D representation, on the left the frequency and below the time axis.
The right axis scales the measured value over the color. The color profile runs from 0 = black over green to red = highest measured value.

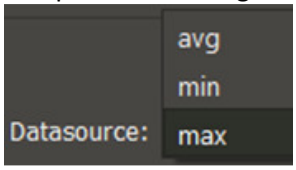


The largest measured value of the displayed values is given directly with the measured value and frequency in the upper right.

The channel selection can be switched between the voltage inputs L1, L2, L3 and NE.



Within the channel selection you can switch between the average values (free interval) and the recorded extreme values (200ms min, 200ms max). The display of the extreme values depends on the device setup. The recording of the extreme values must be activated in order to enable the display.



12.7.6 Level-time diagrams of the long-term data

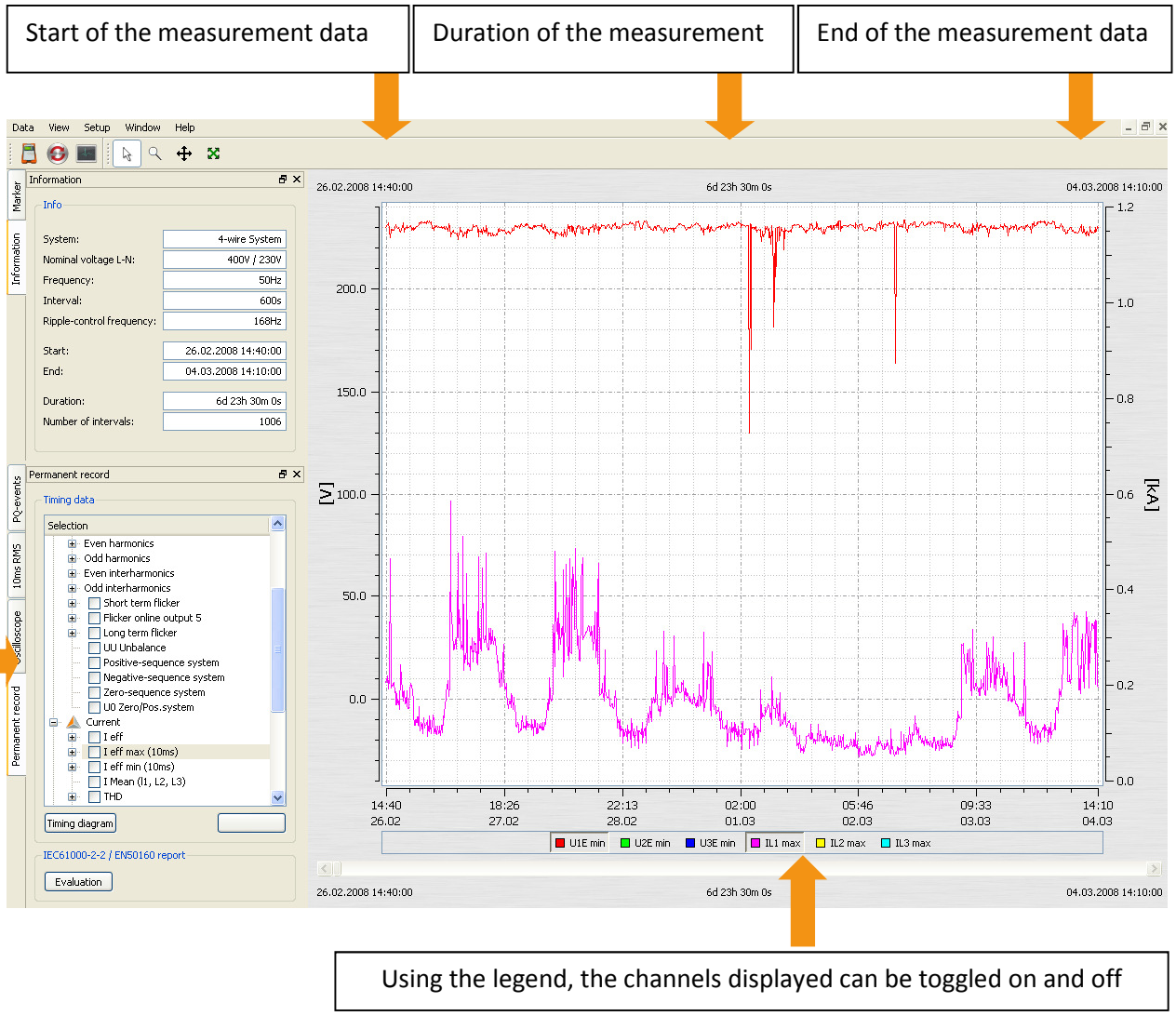
In the "Cyclic data" menu item all permanent recorded measurement data are listed. In each measurement more than 3800 different measurement values (voltage, harmonics, inter-harmonics, current, power and energy) are saved. Any measurement values can be displayed together in a level-time diagram. Thus, for example, a relationship between the voltage fluctuations, the resulting flicker level and the cause in the network can be shown by means of the associated current changes.

Selecting the required parameter (or multiple parameters) 

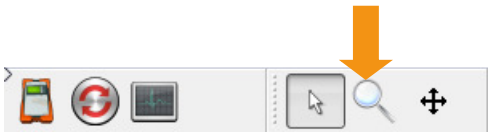
and pressing the 

button displays the level-time diagram of the required measurement value.

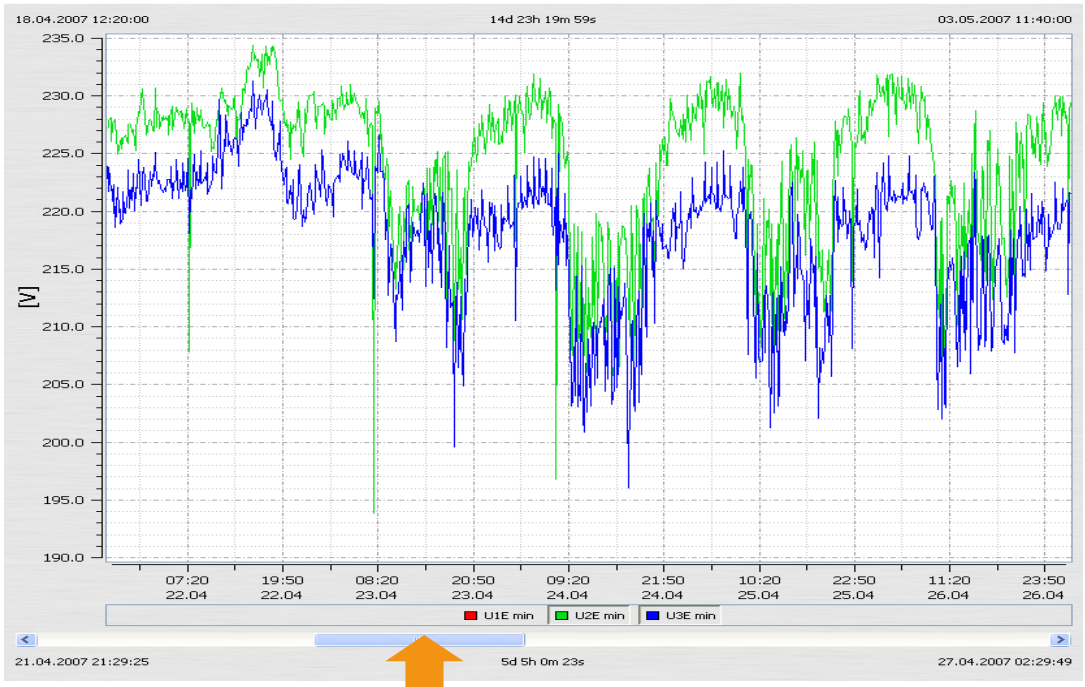
Figure: Level-time diagram of the 10 ms minimum value of the voltages L1, L2, L3



Zoom function in the graphic:



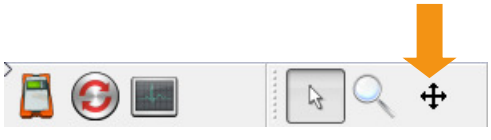
To magnify an area, activate the zoom function. Then pull with the left mouse button pressed, a window from the top left to bottom right. If the window is drawn in the opposite direction, the magnification is reset.



Bars represent the zoomed area.

The moving the bar you can scroll through the measurement

Move graphic:



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

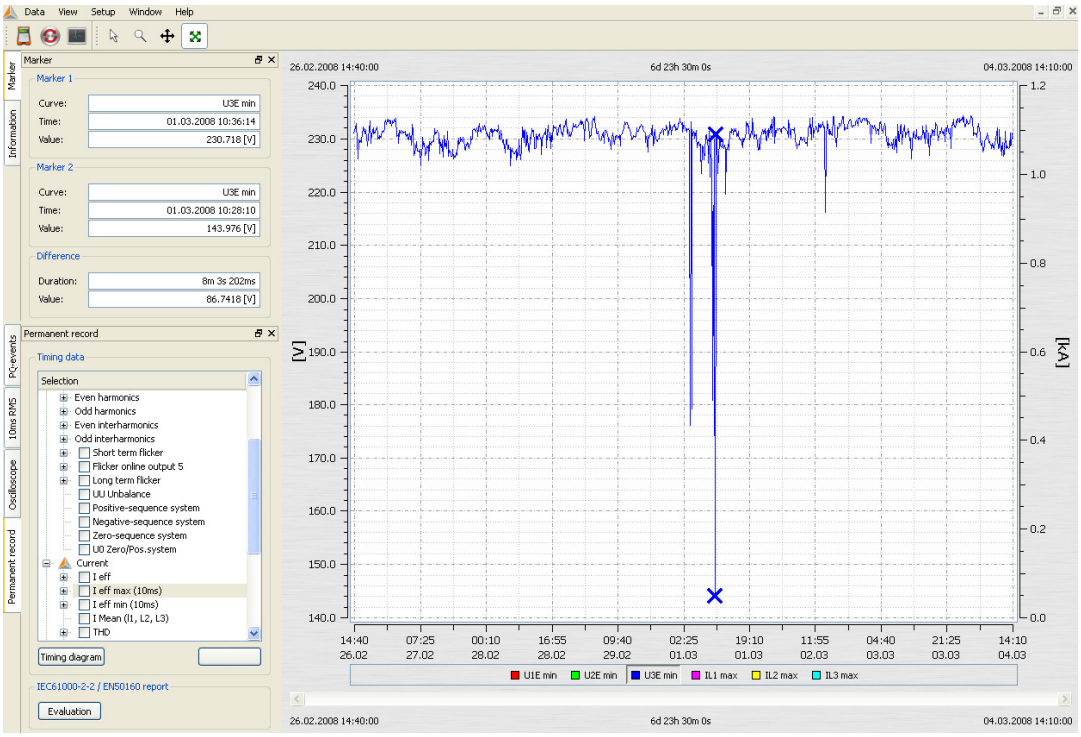
Place a marker:

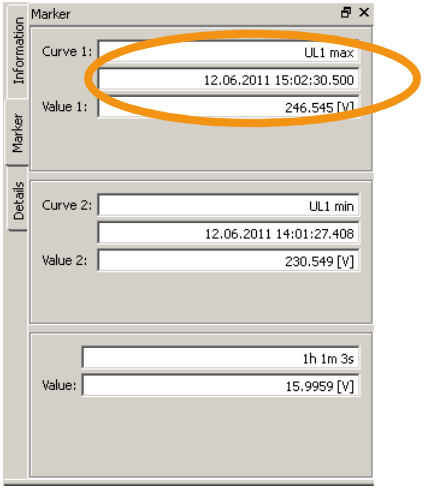
Using the "Marker“ button, two markers can be positioned in the graphic.

Two markers can be set in the plot using the left mouse button. This selects the closest curve and the marker acquires its color.

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

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.





With long measurement intervals set (e.g. 10 min) for the extreme values (10 ms), the exact times is shown in milliseconds in the marker.

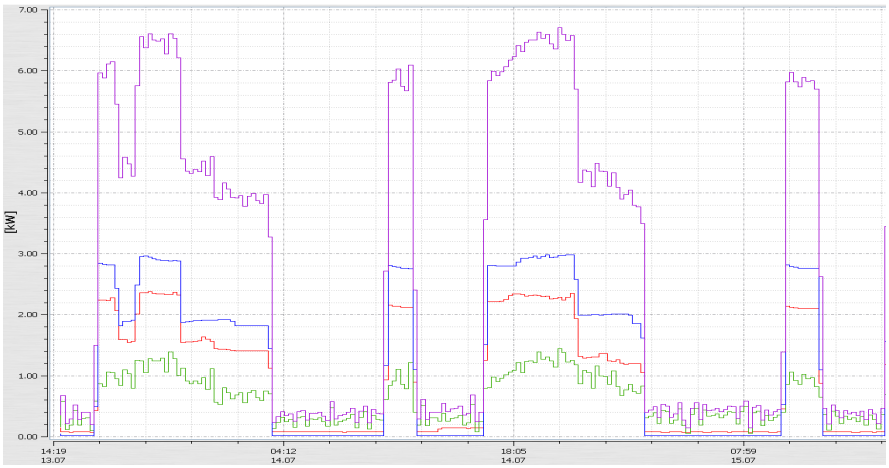
Representation of line styles

Four types of representation are offered for lines.

1st. Connects every measured point together (default for all graphs)

2nd. Represents only the measurement points, the points are not connected by lines

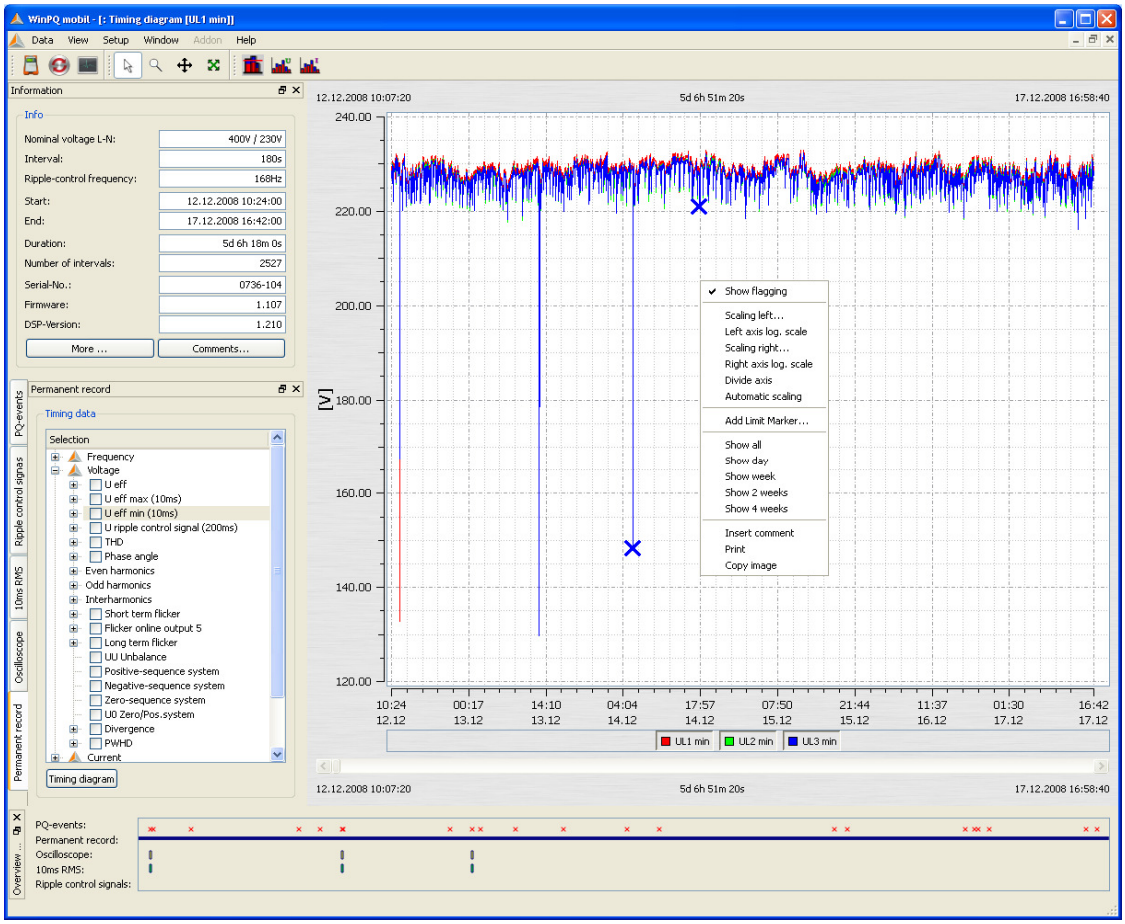
3rd. This level representation is particularly suitable for medium values, such as 15 minutes performance data. Here, the mean value over the measuring period is represented as a straight line.



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

Other functions in the right mouse menu:

- **Delete marker** – If one marker is set, it is possible to delete the marker
- **Flagging representation** = measurement data that were obtained during a network failure or interruption are marked (flagged). Here the marking can be toggled on and off.
- **Left axis scaling** = the left measurement axis can be scaled manually
- **Right axis scaling** = the right measurement axis can be scaled manually
- **Logarithmic axis scaling**
- **Share axes automatically** = SW automatically separates meaningful readings with their own scale so that no measurement values overlap .
- **Scale axes automatically** = SW automatically scales to the maximum and minimum values over the entire screen
- **Limit line setting** = the value and colour of a limit line can be set
- **Complete data** = the whole measurement period is shown
- **Data 1 day** = the time scale is set to one day
- **Data 7 days** = the time scale is set to exactly one week
- **Data 2 weeks** = the time scale is set to 14 days
- **Data 4 weeks** = the time scale is set to 1 month
- **Insert Comment** = This function enables a comment to be inserted into the graph. This will also appear in the printout.
- **Print** = the current graphic will be sent to the selected printer or saved as a PDF document
- **Clipboard** = The graphical display is copied to the clipboard. Then, for example, the graphic can be pasted into an ***MS-WORD***™ document

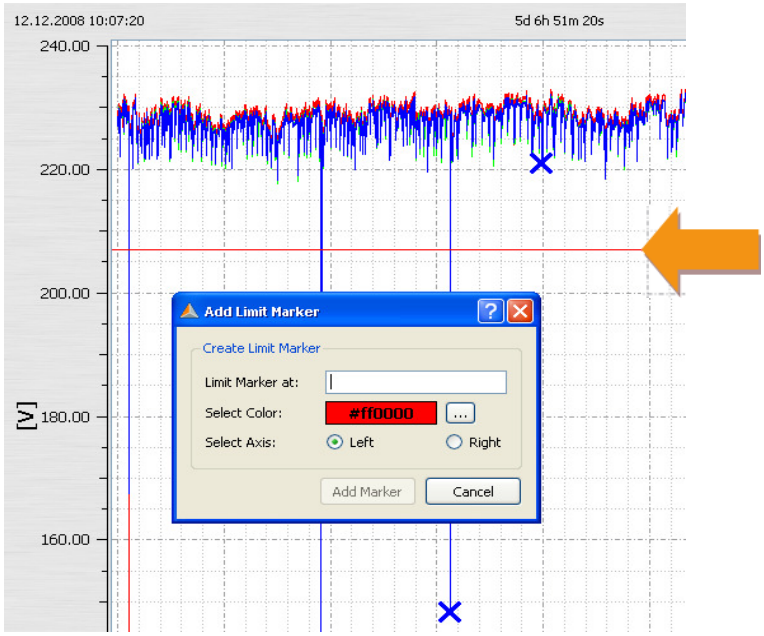


Limit Line Setting

In the "Limit line setting" menu option it is possible to define multiple limit lines.

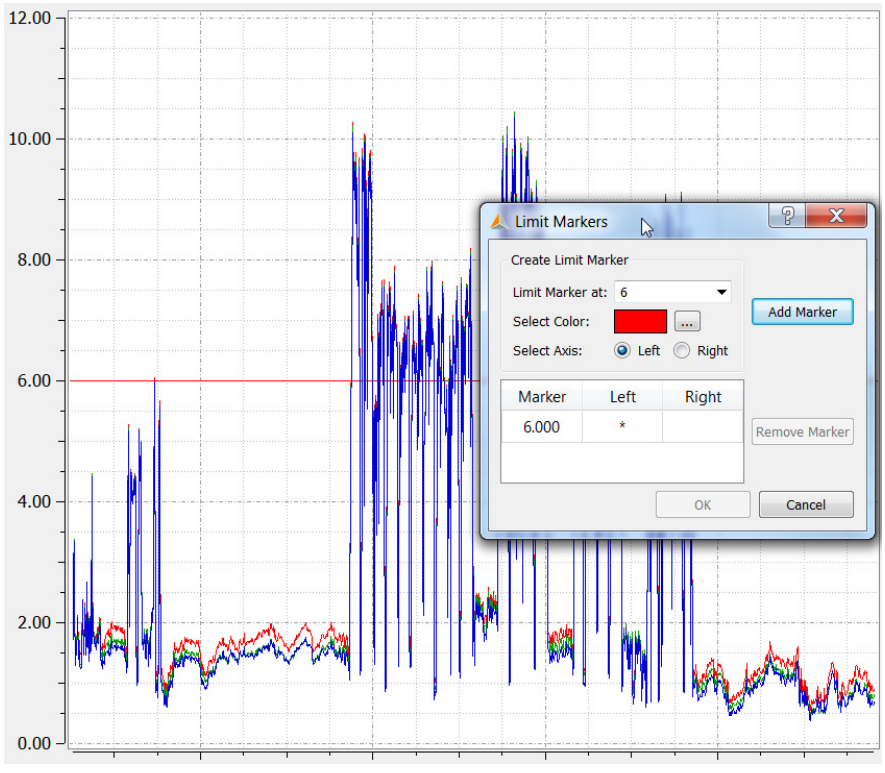
The colour, value, and the corresponding y-axis of the limit line can be set.

Example: Limit line for the voltage; 207 V (-10% Unom)



Show limit marker harmonics

The software automatically suggests the thresholds for harmonics, voltage, unbalance or flicker. The threshold can be a %-value or an absolute value, depending on the settings of the harmonics.



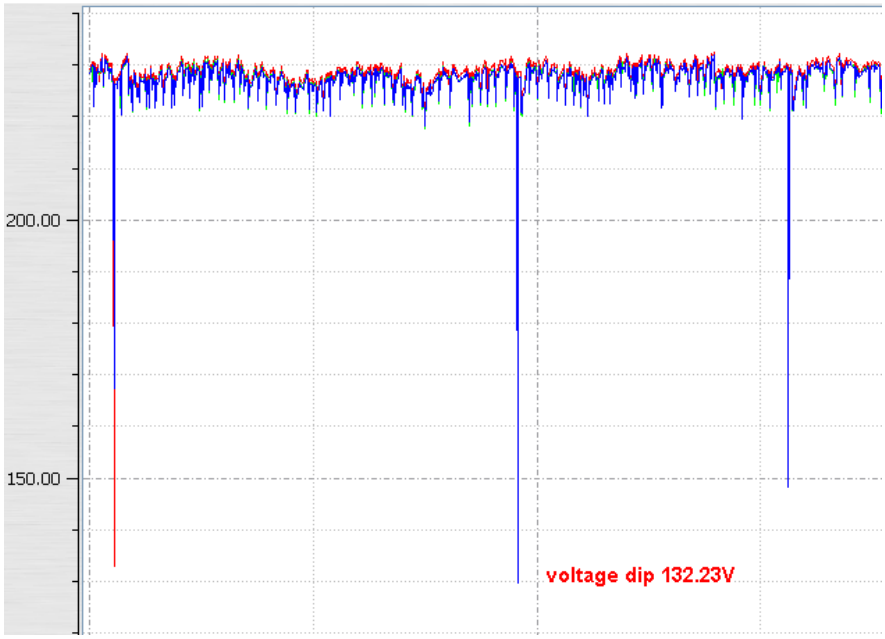
Insert and edit comment

With the "Insert comment" function, any number of text notes can be placed in the graphic.

To delete or move this term in the graph, click it with the mouse so that it turns red.

Now, using the MS Windows "remove" function the text can be deleted or moved using the mouse.

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

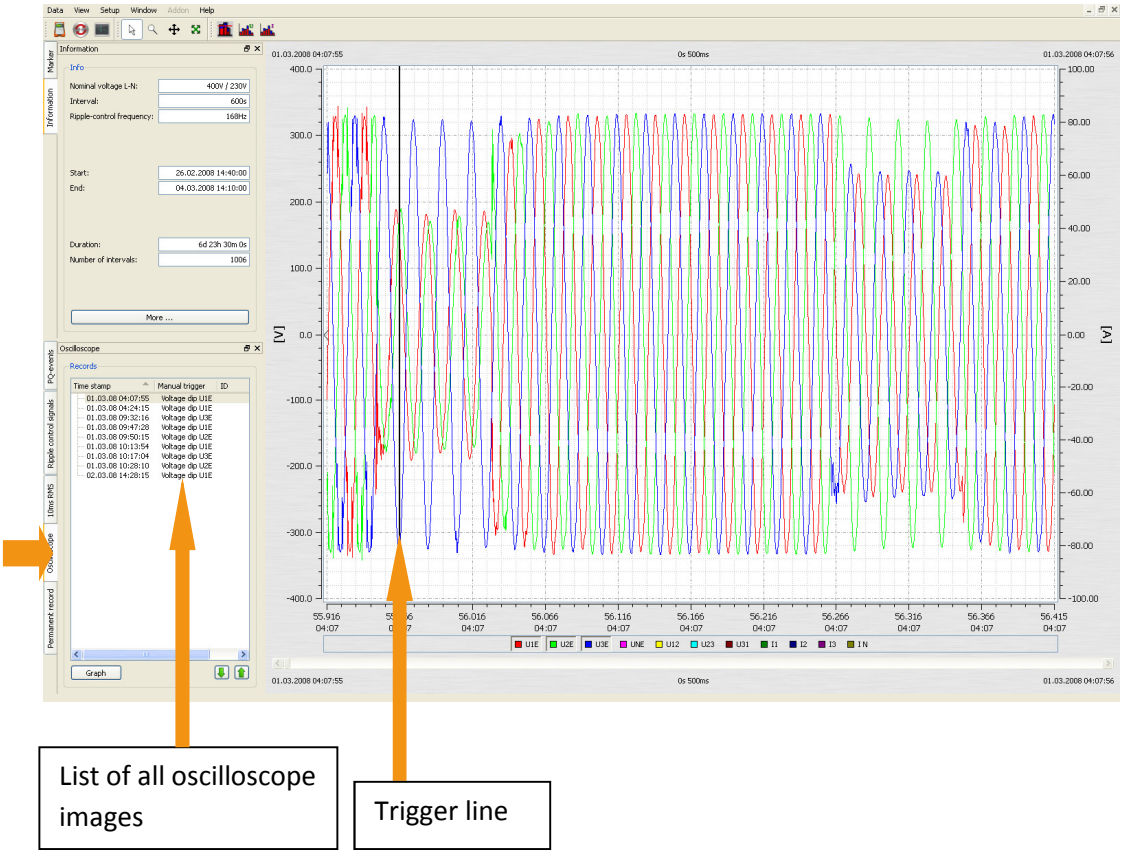


12.7.7 Oscilloscope recordings

With the "Oscilloscope" tab, all manually recorded and using oscilloscope trigger settings images are listed. These can be sorted by time, or trigger condition.

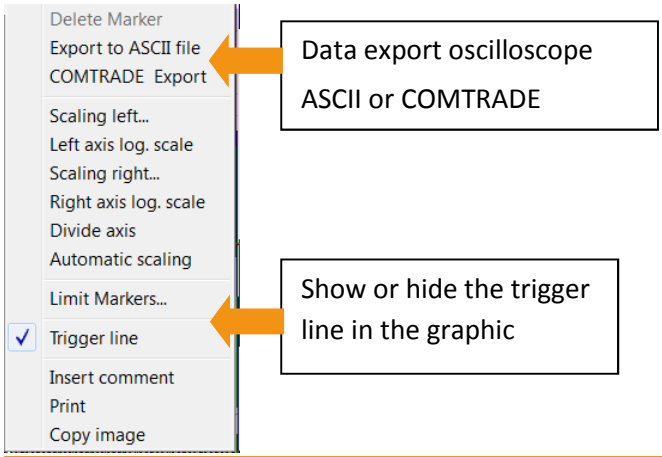
By double-clicking on the line, or by pressing the Graph button, you will get the relevant oscilloscope image.

For each fault record, all voltages "Conductor to Conductor" and "Conductors to Ground" are recorded.



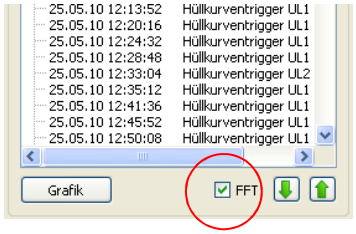
You can scroll through the triggered images using the two  keys. The software remembers the settings for the previous image and shows all other images with the same representation (e.g. in the example, only the voltage channels without the current)

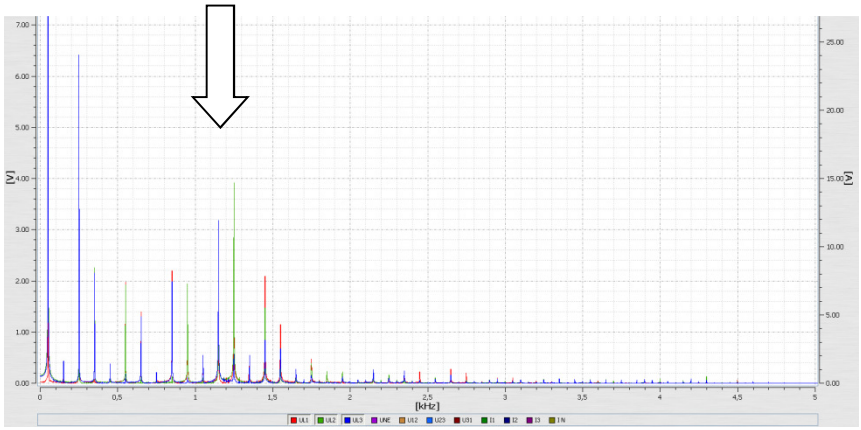
"Right mouse" menu:



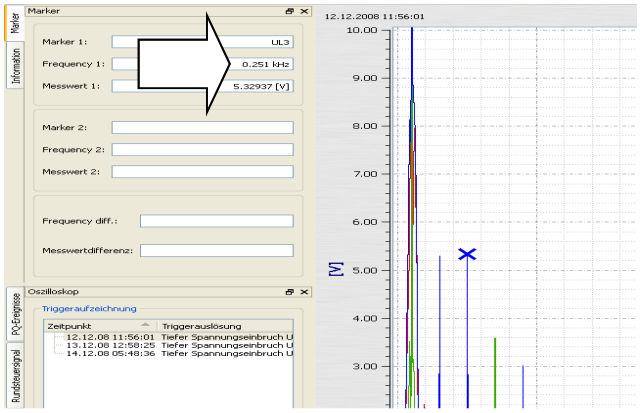
Calculation of the FFT spectrum is possible by activating the "FFT" field of each triggered oscilloscope image.

- PQ-Box 200/300 = DC to 20.000Hz



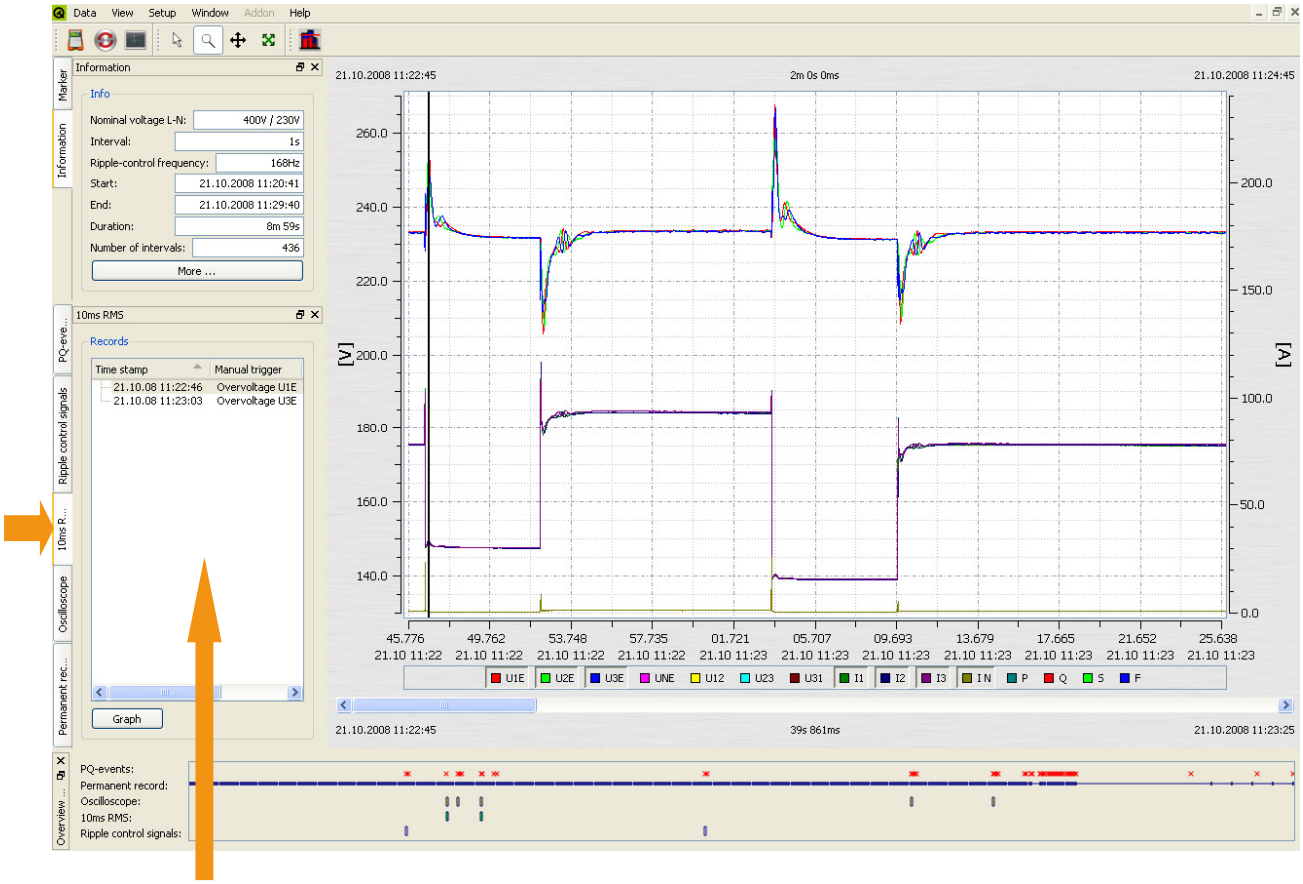


The markers fields in the FFT analysis show the selected frequency and amplitude in the spectrum.



12.7.8 10 ms RMS Recorder

With the "10 ms RMS" tab, all RMS recordings manually recorded and using trigger settings are listed. These can be sorted by time, or trigger condition. Double-clicking the line or pressing the Graph button retrieves the corresponding 10 ms RMS recorder value.



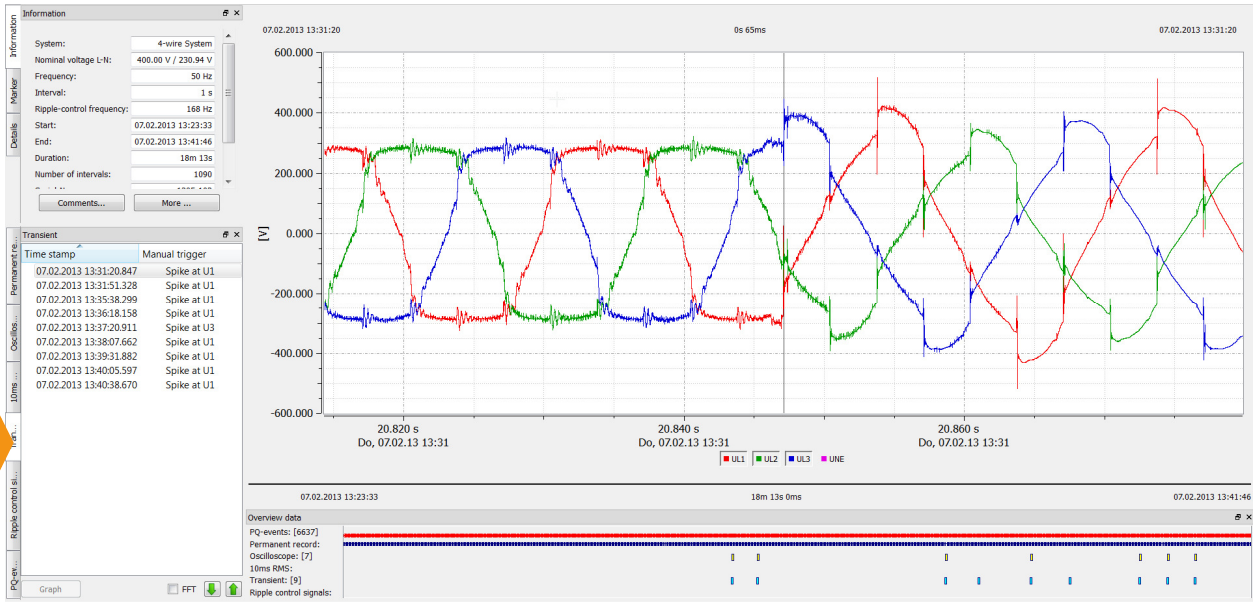
Listing all 10 ms RMS recorder recordings

You can scroll through the triggered images using the two keys. The software remembers the settings for the previous image and shows all other images with the same representation (e.g. in the example, only the voltage channels without the current)

12.7.9 Transient recorder (Option for PQ-Box 200)

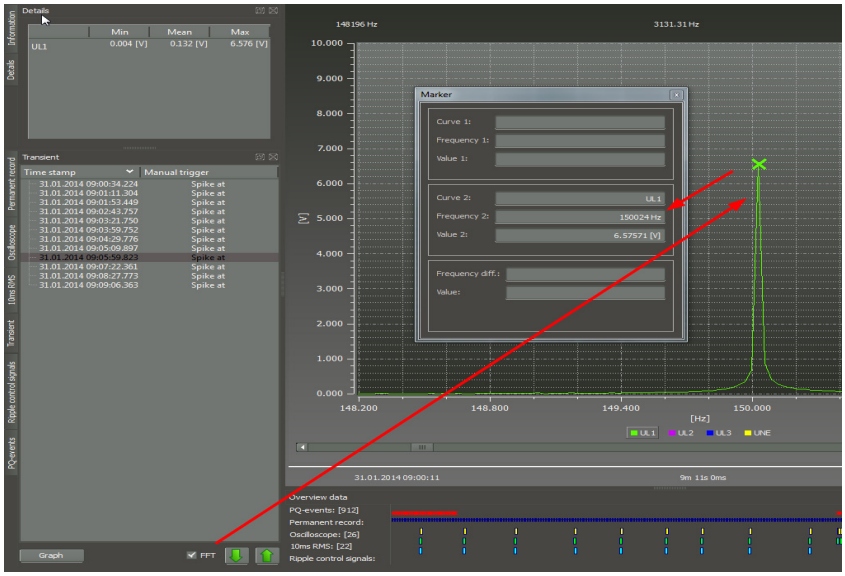
With the "Transient" tab, all manually recorded and transients triggered with thresholds are listed. These can be sorted by time, or trigger condition.

By double-clicking on the line, or by pressing the Graph button, you will get the relevant transient recorder image.



FFT function of the Transient Recorder

Using the FFT of the transient recorder, it is possible to conduct reviews of the amplitudes in a frequency range up to a maximum of 2 MHz. The frequency range in the spectrum is limited to 50% of the sampling frequency of the transient measurement. For example: sampling frequency setting is 1MHz = FFT spectrum is limited to 500kHz.



12.7.10 Ripple Control Signal Recorder

With the option “R1-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.

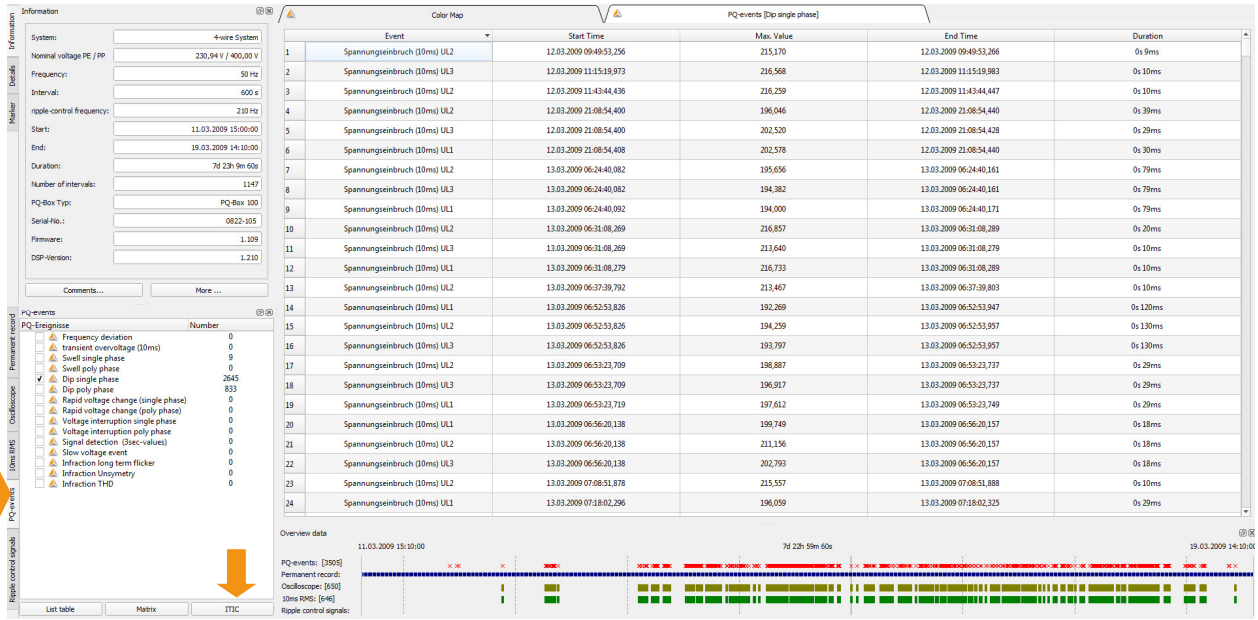
All ripple control records are shown in the recorder list and in the overview picture

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

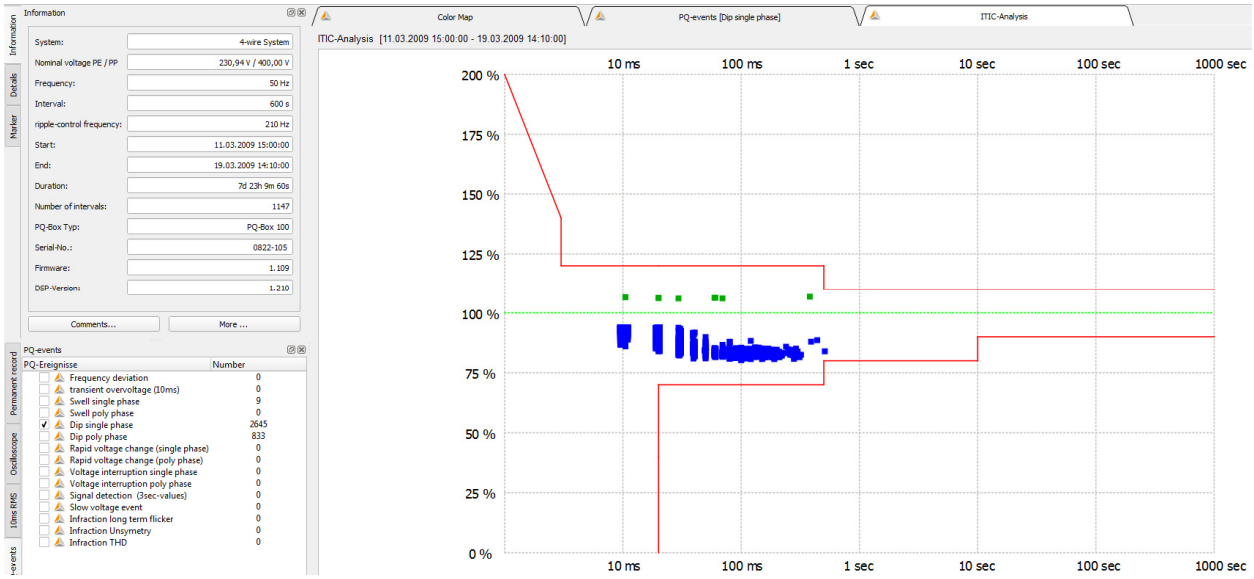
12.7.11 PQ Events

With the "PQ Events" tab, all violations of the specified limits are displayed.

With the List table button, the detailed list of the PQ events with time point and extreme values is displayed.

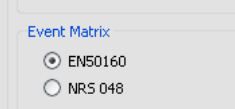


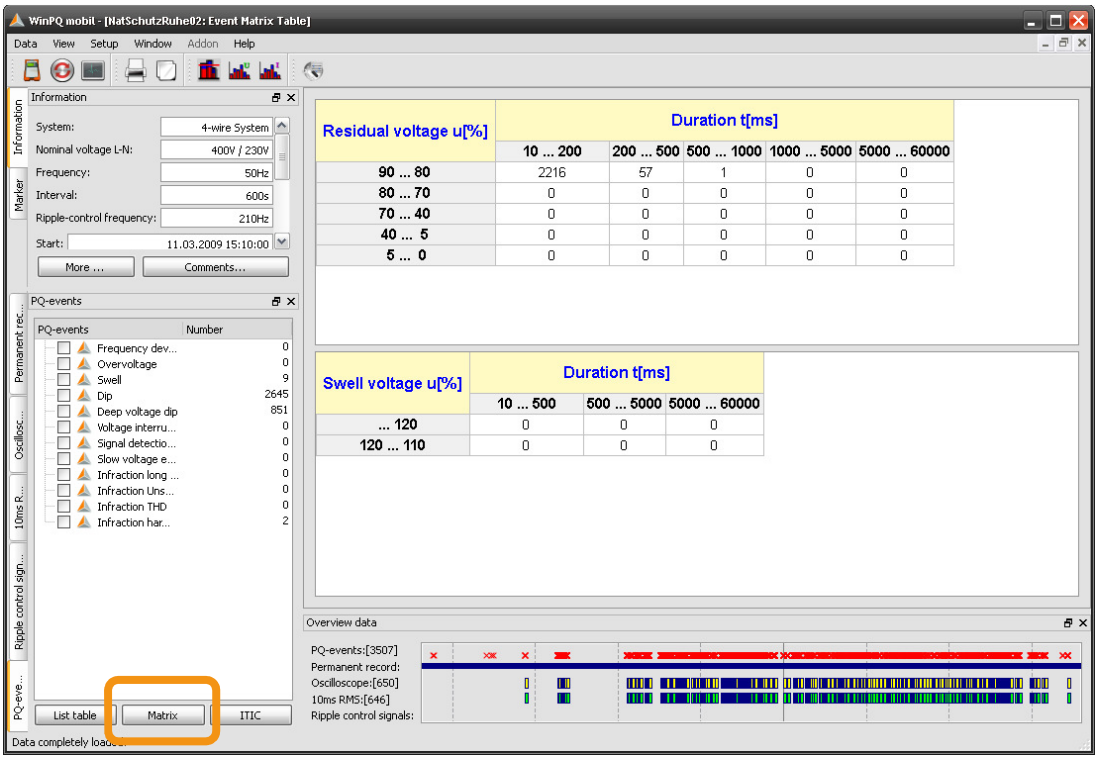
With the ITIC button it is possible to display all the voltage events as an ITIC representation. All deviations from the nominal voltage in duration and amplitude are displayed graphically.



On the "PQ Events" page in addition to the ITIC graphic is a UNIPEDE statistics event table for all voltage dips and over voltages.

Using WinPQ mobil / Settings / General, these statistics from Evaluation to NRS 048 (South Africa PQ standard).

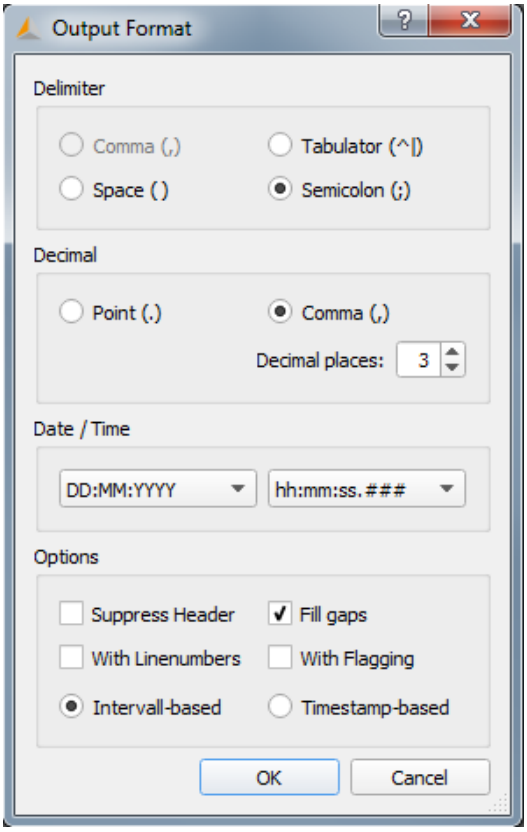




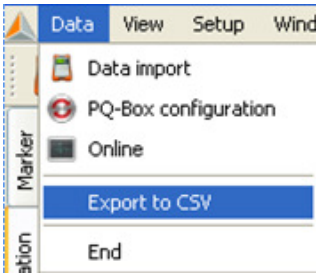
12.7.12 Data export – Interval data

Using "Settings / Export“, it is possible to set basic parameters for the measurement data export.

The decimal point separator in a German Windows is a comma; in the English-language Windows it is a full stop (dot).

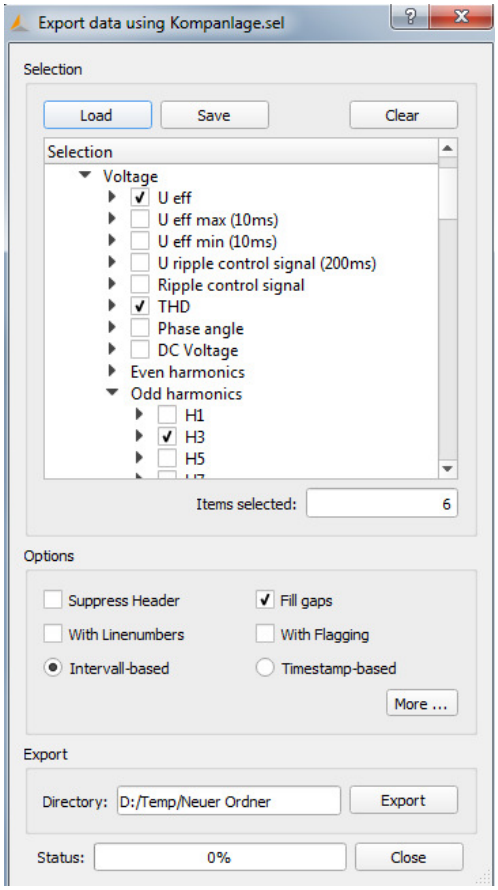


Using "Data / CSV Export", all measurement interval data can now be exported for open, for example, in MS Excel.

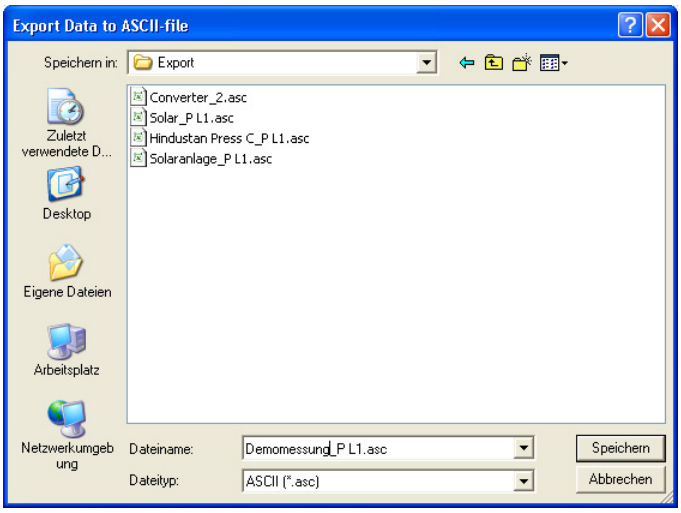


In the following menu, all measured values can be selected and exported with the "Export" button to a file.

Using "Save Selection", various selection data can be saved (e.g. file export of all harmonics)



Any name can be specified for the export file. The file is saved in the PQ-Box / Export directory.

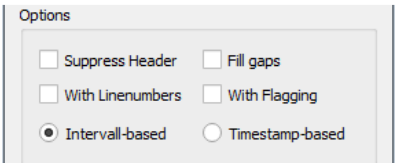


Example of an export file in MS Excel:

	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.

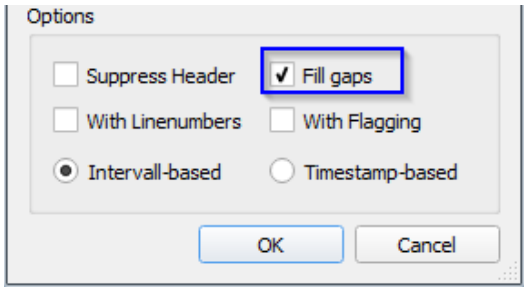


The time format for CSV Export can be changed in general settings for export data

Also, the Short Time Flicker (PST) and the Long time Flicker (PLT) have its 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.

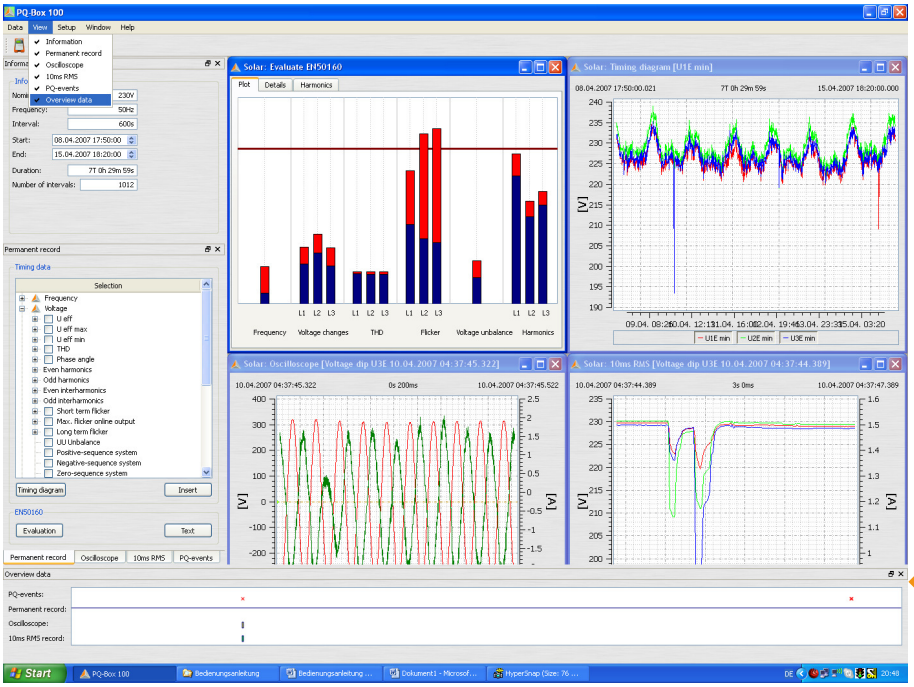


Datum	Zeit	'UL1 [V]'	'UL2 [V]'	'UL3 [V]'	'UL1 max [V]	'UL2 max [V]	'UL3 max [V]	'UL1 min [V]'	'UL2 min [V]'	'UL3 min [V]'	'IL1 [A]'	'IL2 [A]'	'IL3 [A]'	'I Neutral [A	'IL1 Max [A]'	'IL2 Max [A]'	'IL3 M
01.04.2016	05:10:00.000	271.283	275.863	270.185	271.919	276.491	270.827	269.174	274.863	268.923	483.327	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	279.241	273.271	271.648	275.464	269.379	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	369.983	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
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
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	2.576	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	268.000	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

12.7.13 Additional functions

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

The "information" and "Measurement data overview" fields can be closed to give more space for the evaluation graphics. These can be re-displayed with the "View" field.

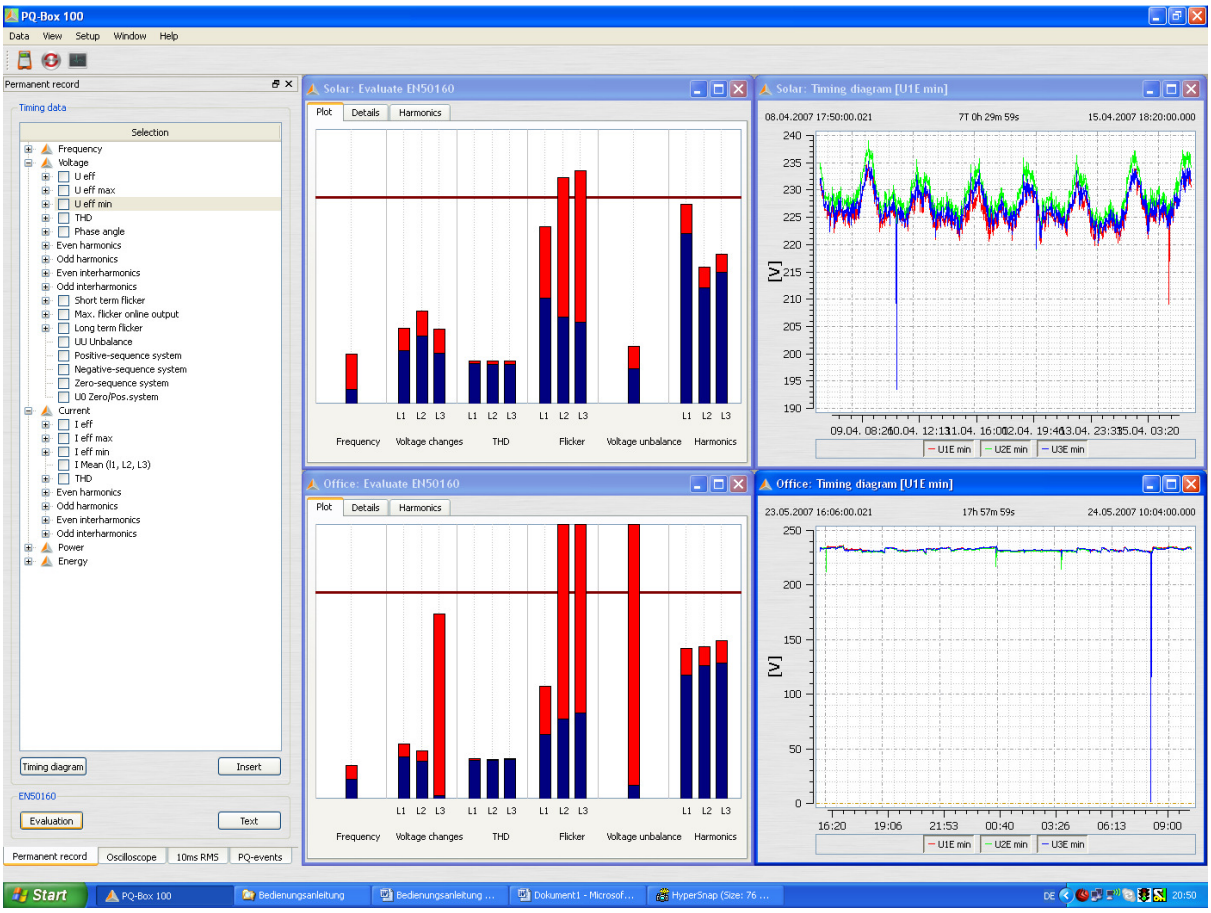


Comparing two separate measurement files.

During an evaluation, it is possible to open another measurement, start level-time charts and standard evaluations, display them next to one another in an image and compare them.

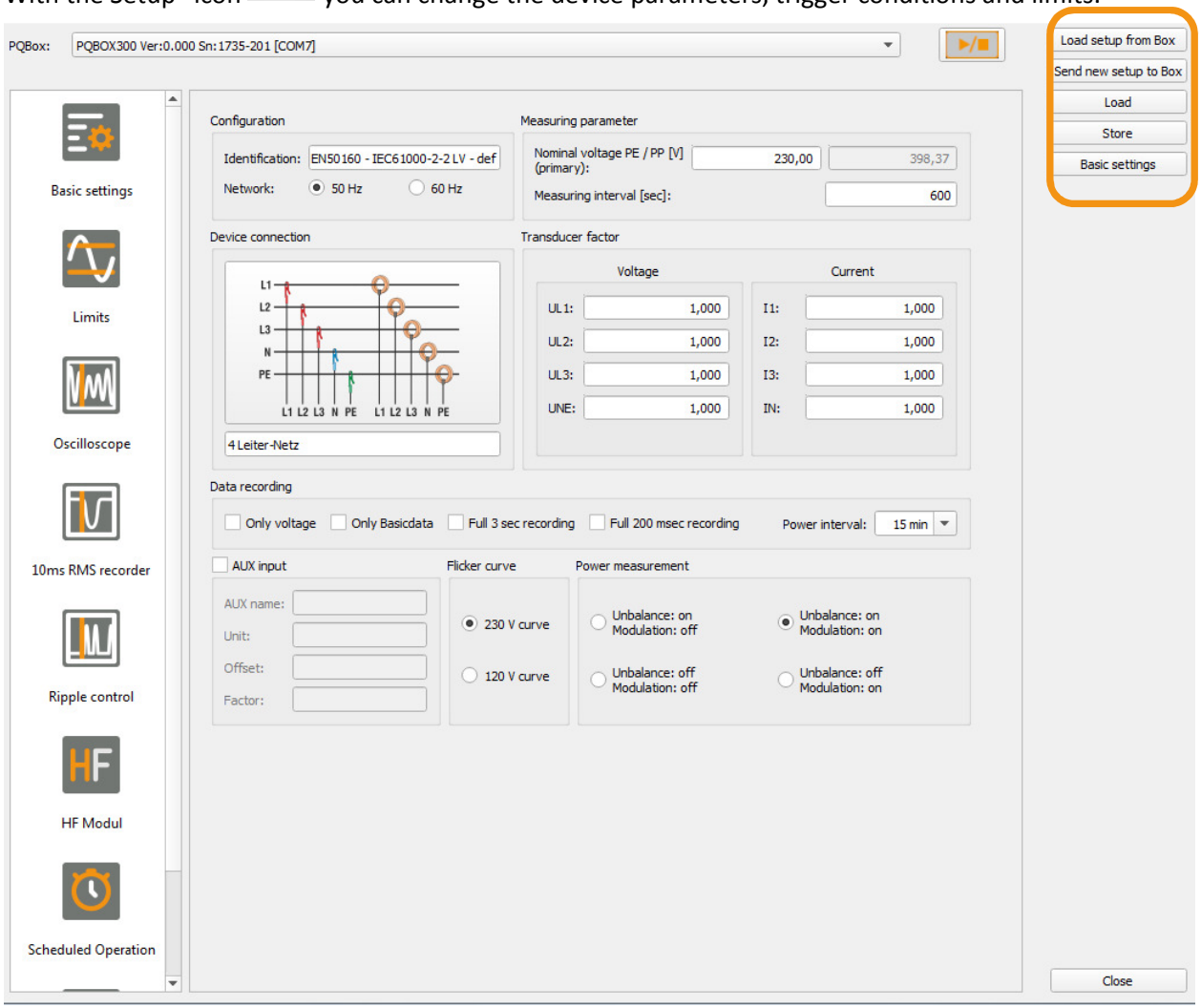
Figure: Two separate measurements displayed next to one another

(2 x EN50160 report; 2 x level-time diagrams)

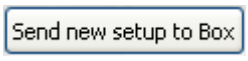


13. PQ-Box Limits and Settings

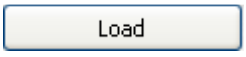
With the Setup“ ïcon  you can change the device parameters, trigger conditions and limits.



Loads the current settings from the network analyzer to PC screen



Sends currently displayed settings to the PQ-Box



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

Saves a setup file to the PC

Resets displayed settings to default values. (Please note these still need to be “sent” to the PQ-Box 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 re-corder” setting values. These are not stored individually.

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

13.1 Setup - Basic Settings

Basic settings

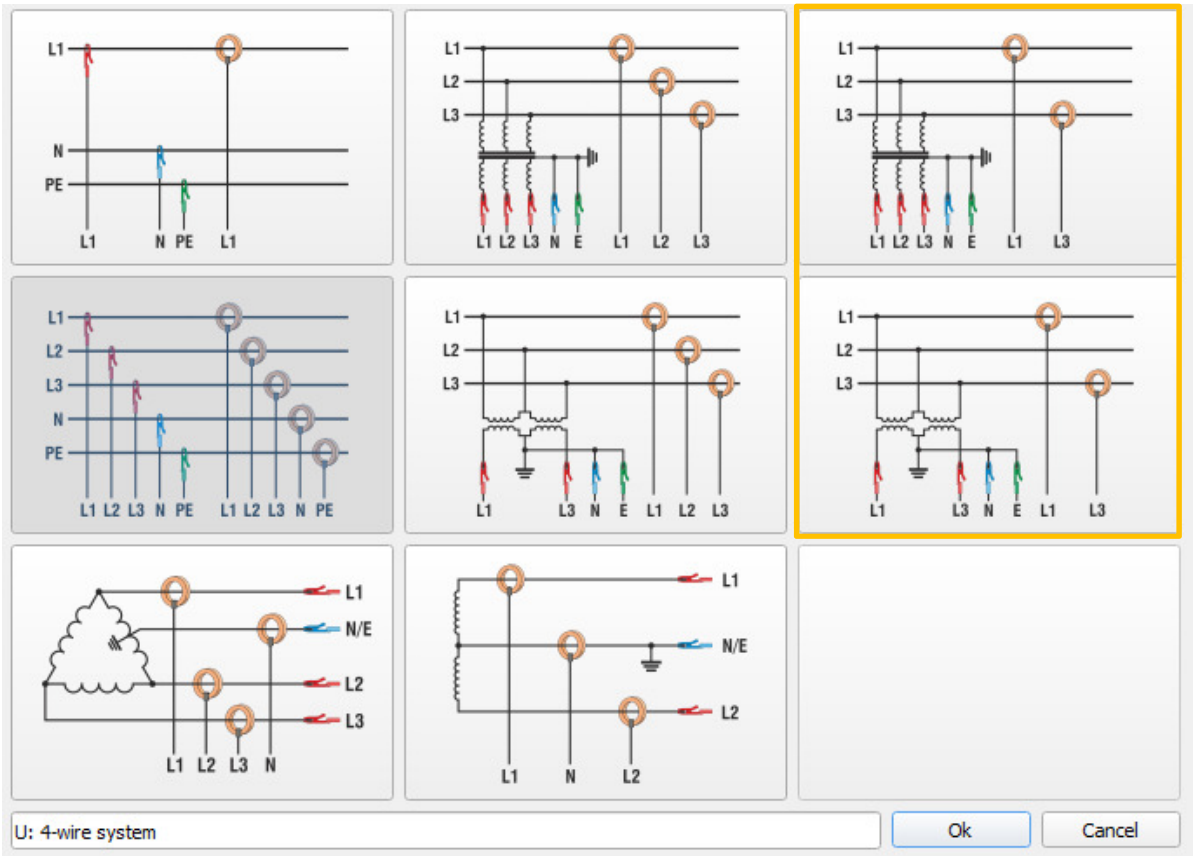
In the Basic Settings menu, settings such as the network configuration, nominal voltage and transmission ratio of current and voltage transformers are set.

Voltage configuration:

- 1 wire system (single phase L1)
- 3 wire system (insolated network)
- 4 wire system (L1, L2, L3, N, earth)
- V-circuit (This function is activated if the secondary voltage transformer in the medium or high-voltage network is connected in a V-connection. The power connection U2 is at ground.
- Delta high leg network
- Split phase network

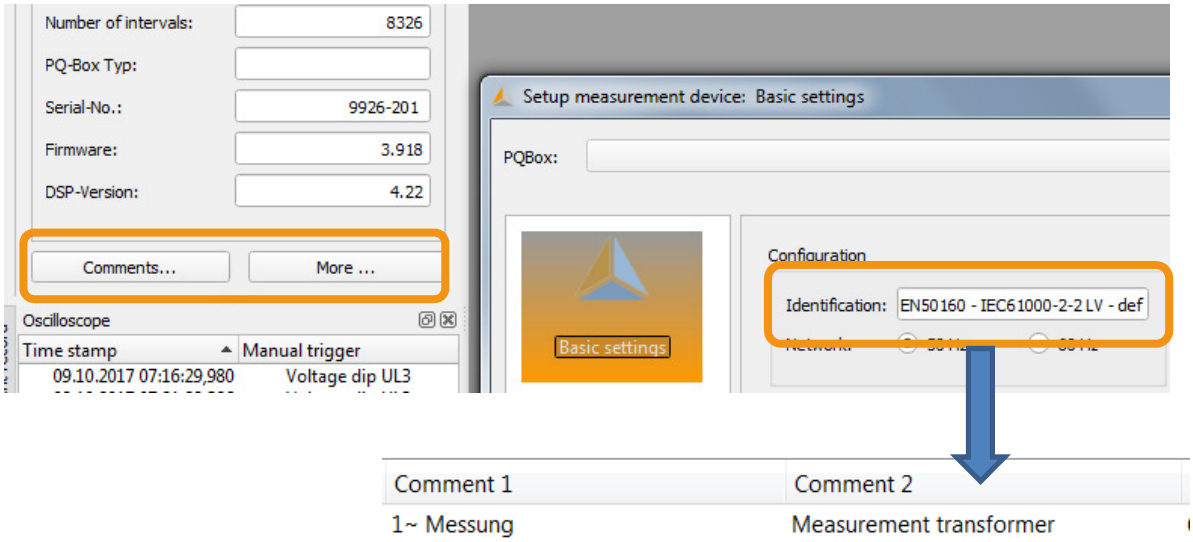
With the 3-wire or 4-wire the device distinguishes the configuration of the network to be measured. In an isolated 3-wire network, all ratings from the EN50160 standard are calculated from the wire voltages. In a 4-wire network (grounded network) all Power-Quality parameters are derived from the phase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

8 configurations are available for PQ-Box connection.



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”.



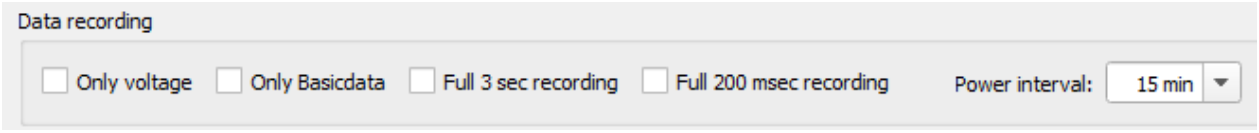
The PQ-Box bases all trigger thresholds and PQ events on the set “Nominal voltage”.

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

The measuring interval of the PQ-Box can be set to any value within the range of one second to 1800 seconds. The default setting is 10 minutes as this is the interval specified in the EN50160 and IEC61000-2-2 standards.

Data recording of PQ-Box

The resulting data size can be strongly influenced at this point.



- **Only voltage**

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

Only Basic data

In “Basic data” no harmonics, inter-harmonics or phase angle of harmonics will be recorded. All recorders are still active.

- **Measuring interval 200ms / 3 sec**

Parallel to the freely selectable data class (1Sec to 30Min), the two data classes can be activated for 3 seconds and / or 200ms

Note - data quantity

These two data classes are only suitable for short measuring periods and produce a very large amount of data. The same applies to the setting of the free measuring interval less than 60 seconds. The fault records additional increase the memory.

Examples of the data size:

- The measurement interval of **10 minutes (600 seconds)** produces a data size of about **15 MB in a week**
- The measurement interval of **1 second** produces a data size of about **15 MB in 30 minutes**
- The 200 ms interval produce a data size of about **80MB per one hour**
- The 3 sec interval produce a data size of about **5MB per one hour**

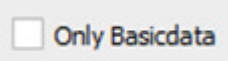
- **Power interval**

All power values are also recorded at the freely adjustable interval of 10, 15 or 30 minute intervals.

These intervals always start 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.

Measurement values in basic data:

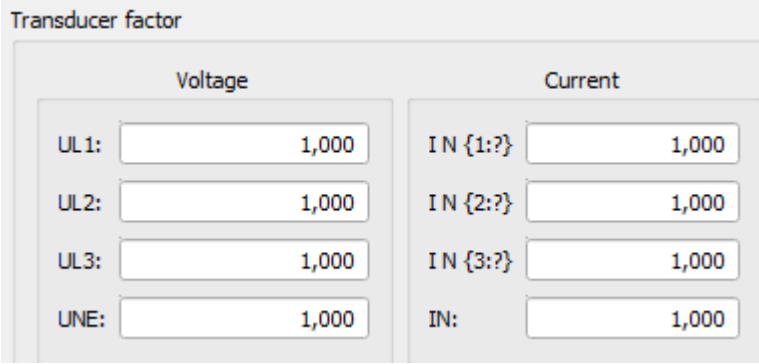


Status, Events, Flagging
Frequency values (mean, extreme)
Voltage values (mean, extreme)
Flicker
Current values (mean, extreme)
Power values (mean, extreme)
Ripple signal voltage
THC, K-Factor, Phase angle, symmetrical components
Distortion power, Power factor
Voltage deviation, Symmetry, PWHD
PWHD, PHC current
cos Phi, sin Phi, tan Phi, power values fundamental
Reactive power fundamental
10/15/30-minutes interval
Power values (mean, extreme)
Distortion power, Power factor
cos Phi, sin Phi, tan Phi, power values fundamental
Reactive power fundamental

Example for basic data:

- One measurement file with 1 sec interval produces about 6.6 MB data per hour.
- 1 GB memory will be filled in 6.6 days.

Transducer factor voltage and current



In the converter settings the transmission ratio of current and voltage transformers to which the network analyzer is connected is entered.

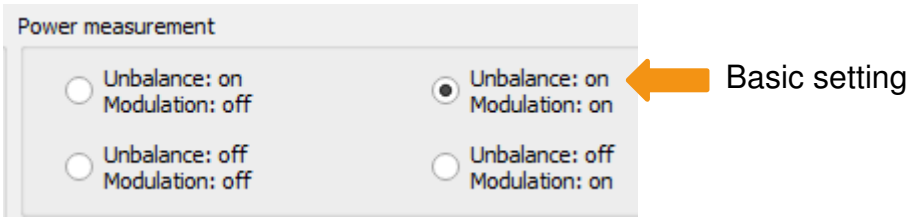
Example:

Voltage: primary = 20,000 V; secondary = 100 V; Conversion factor UL1 = 200

Current: 100 A / 5 A = Conversion factor 20

Setting of Power measurement

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



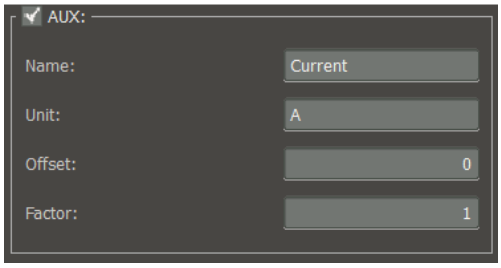
This setting on power calculation has also an effect on the power values in the display of the PQ-Box and the online values.

- Power measurement with calculation of the unbalance reactive power and modulation reactive power is the basic setting of the PQ-Box.

AUX Input (Only PQ-Box 200)

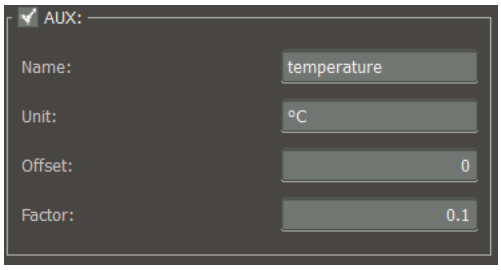
The AUX input can be activated or deactivated.

Basic settings of PQ Box are: 1 A / 1 mV.



Example 1: current clamp 20A/200mV – Factor = 0.1

Example2: connection of temperature sensor with 0-1V output at 0°C to 100°C.

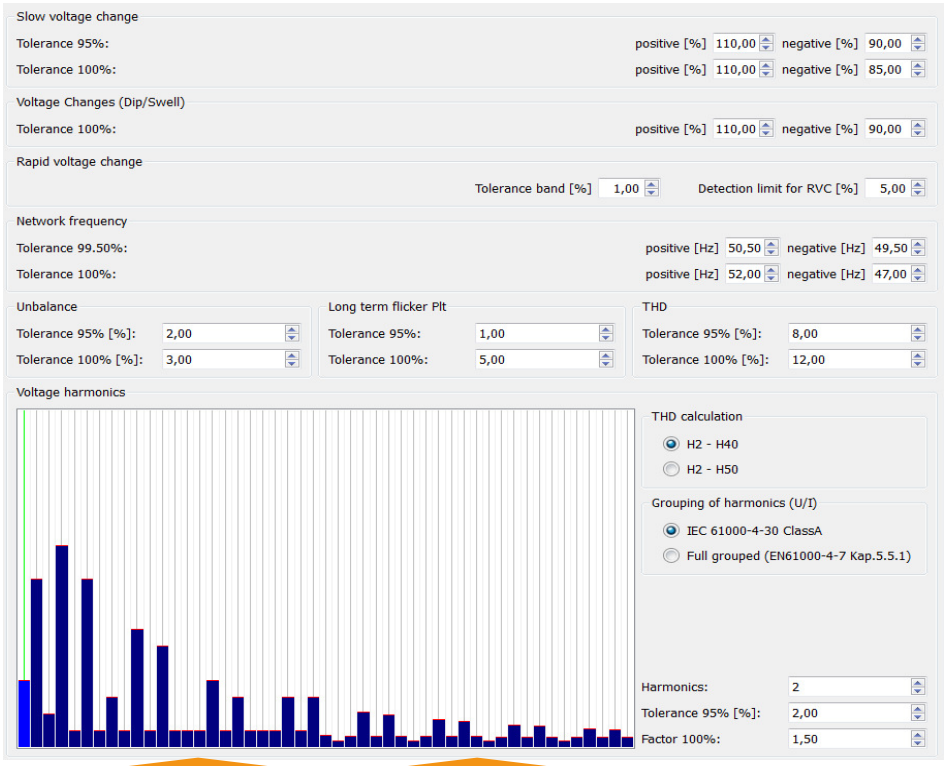


13.2 Setup – EN50160 / IEC61000-2-2 / IEC61000-2-4 Limits

Limits

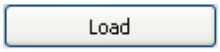
In this menu item, all the limits from the EN50160 and IEC61000-2-2 standard are present. The compatibility levels can be changed by the user.

Using the Basic settings button, all the limits are reset to the standard values.



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

As the EN50160 only specifies limits for harmonics up to the 25th ordinal, in the PQ-Box 200 basic settings the compatibility level from IEC61000-2-2 for the 26th to 50th harmonics are stored.

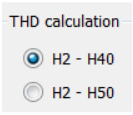
The 

button enables different configurations stored on the PC to be opened. The IEC61000-2-4 limit files for industrial networks are also stored in the templates.

With the 

icon any number of settings templates can be stored for the PQ-Box 200.

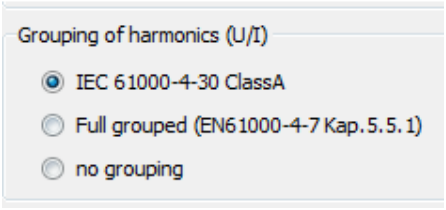
THD calculation



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

- 2 – 40th
- 2 – 50th

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 calculation (i.e. 2. Harm. = 75Hz to 125Hz).

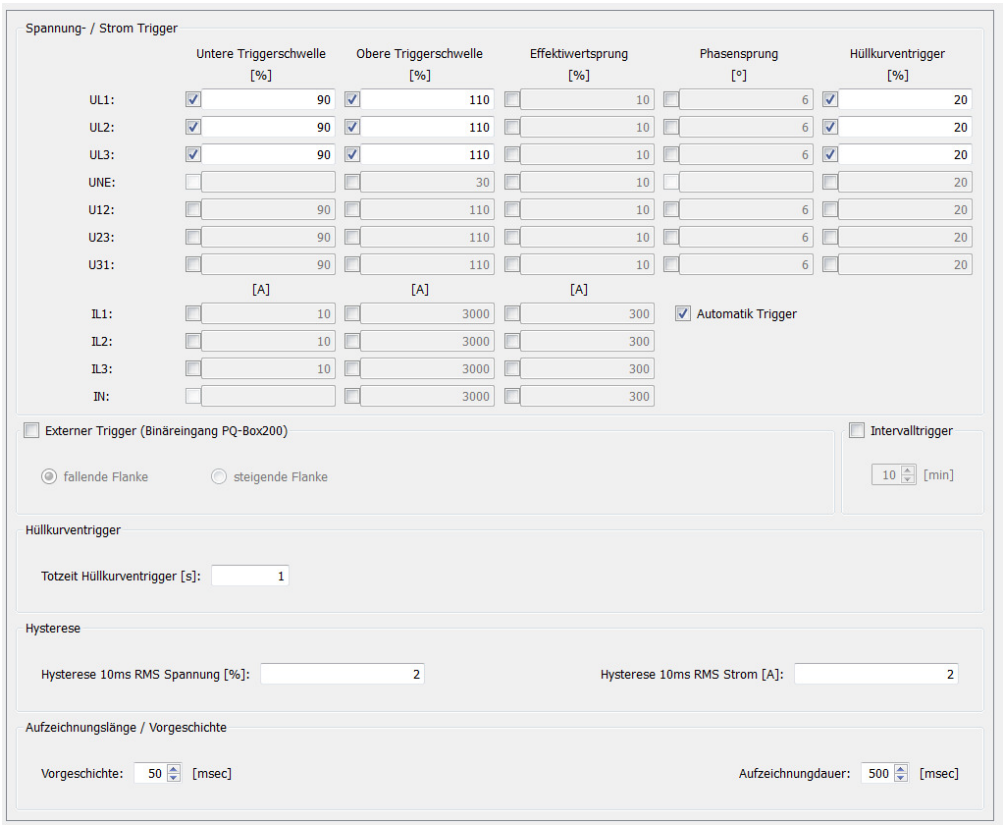
  Inter-harmonics. (i.e. IH1 55Hz to 95Hz)
- No grouping – single frequency

13.3 Oscilloscope trigger settings

Oscilloscope

In the "Oscilloscope" menu item, trigger criteria can be set for the oscilloscope. In the default setting an RMS value threshold of +10% and -10% of the nominal voltage is set.

If a field is greyed out  and not checked, this trigger criterion is not active.
All trigger conditions can be operated in parallel and work in “or operation”.

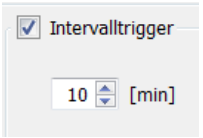


The "Recording Time" is the total recording time for the oscilloscope in milliseconds.

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

The length of the oscilloscope image and the history can be set to any value between 20 ms and 4,000 ms.

Automatic trigger for oscilloscope recorder: If enabled, then the PQ-Box 200 changes all activated trigger thresholds on this page automatically in a limit setting is too sensitive. This prevents unnecessarily large amounts of data being recorded. The "Automatic Trigger" acts selectively on each threshold and increases it. If the network is without any problems, the limits automatically go back to the threshold in the setup.



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.

Explanation of the trigger conditions:

If the trigger thresholds are indicated in "%", this value refers to the nominal voltage set in the setup, e.g. 20,300 V or 400 V.

lower threshold [%]

Starts a trigger recording on exceeding the set trigger threshold.
Trigger bases are the 10 ms RMS value.

upper threshold [%]

Starts a trigger recording on exceeding the set trigger threshold.
Trigger bases are the 10 ms RMS value.

step [%]

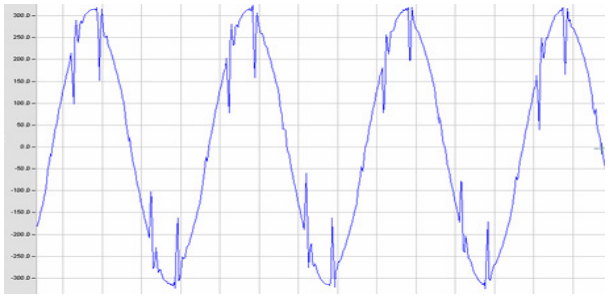
Starts a trigger recording on an RMS value jump of the specified amount.
Trigger bases are the 10 ms RMS value.

phase step [°]

Starts a trigger recording on a phase jump.
The trigger base is a displacement of the sine wave zero crossings in “ ° “.

envelope [%]

Starts a trigger recording on a sine wave violation. The measurement device identifies a violation of the sine curve on scanning. (e.g. switching notch)
A reasonable setting of the threshold value is between 10% and 25% of the nominal voltage.
Example of a switching notch:



Deadtime envelope trigger:

The dead time envelope trigger can very quickly produce a very large number of oscilloscope images. To reduce the amount of data you can set a fixed time interval between the individual recordings.

Example: Deadtime = 5 seconds

At the end of an oscilloscope recording the trigger condition "envelope trigger" is deactivated for 5 seconds. All other trigger settings continue to work without a deadtime.

Hysteresis: In the IEC61000-4-30 standard a hysteresis is provided for events.

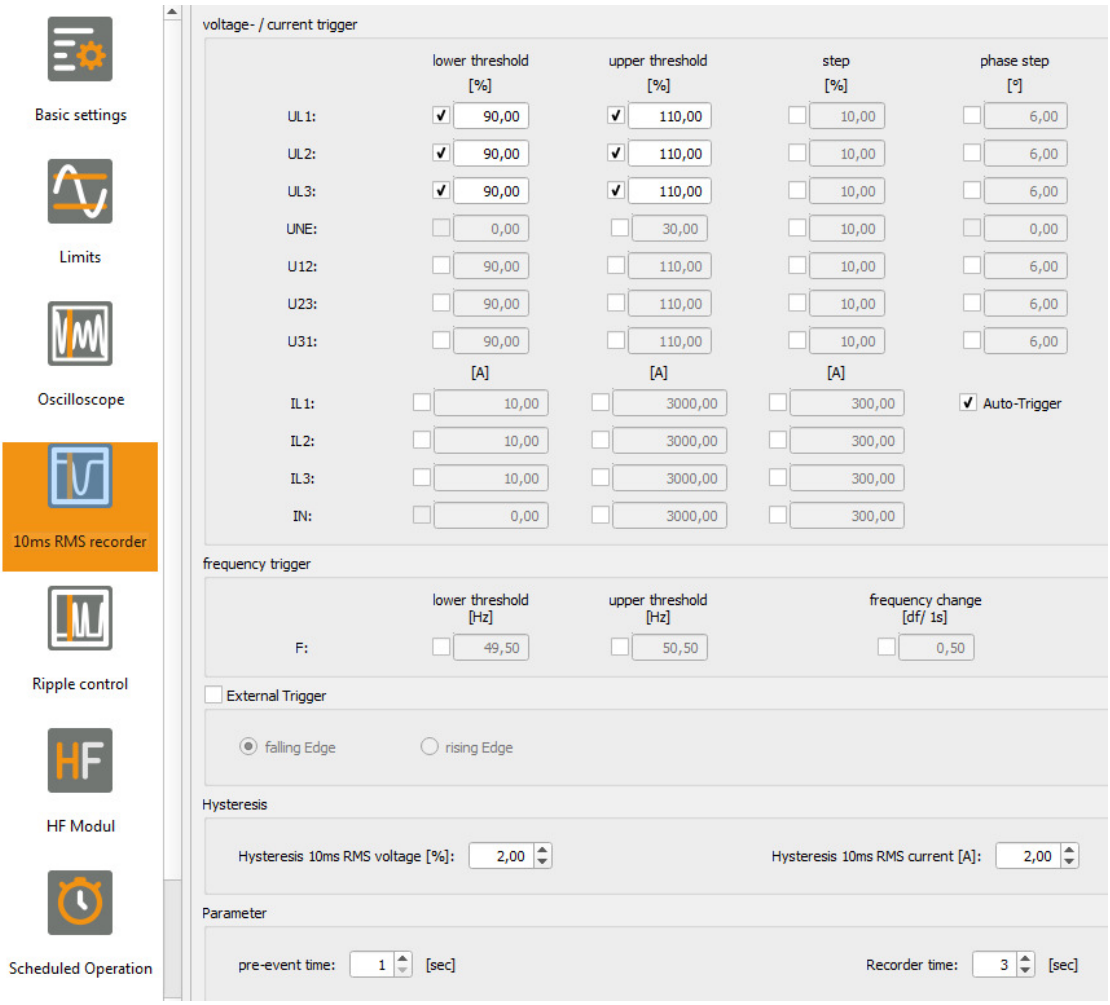
Example: Limit for a voltage dip = 90% - Hysteresis = 2%

A network breakdown begins with the 90% limit line being exceeded and is ended when the network voltage reaches 92% (+2%) again.

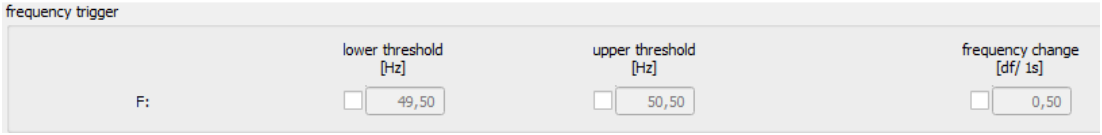
13.4 ½ period RMS Recorder

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 13.3:



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.**

13.5 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 larger decrease in 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**

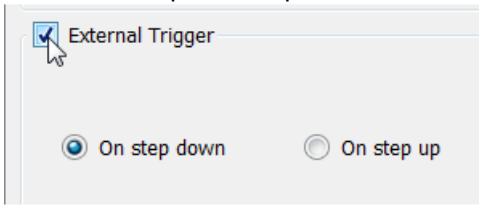
At the end of the ‘hold threshold’, the 'approximation threshold' timer adjusts exponentially the threshold back to the setting value.

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.

13.6 Trigger through Binary Input

The oscilloscope and ½ period RMS recorder can be triggered via a binary input.

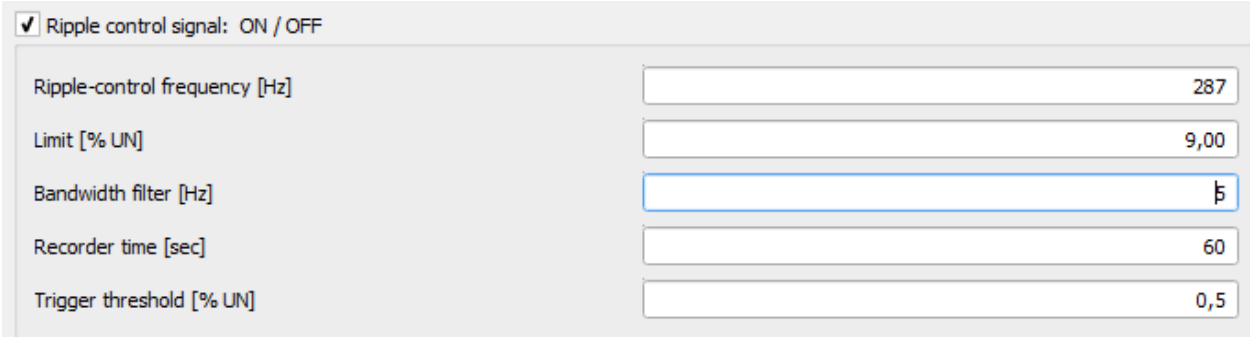


A digital input for an external trigger signal is available via two 4 mm sockets. This input starts the oscilloscope and/or ½ period RMS recorder.

AC and DC signals up to 250 V can be used. A trigger can be activated by a rising or falling edge. The threshold value is 10 V.

13.7 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.

13.8 Transient setup (Option T1 for PQ-Box 200)

Transient

In the "Transient" menu item, trigger criteria can be set for the recording transients.

- Trigger threshold for transient signal

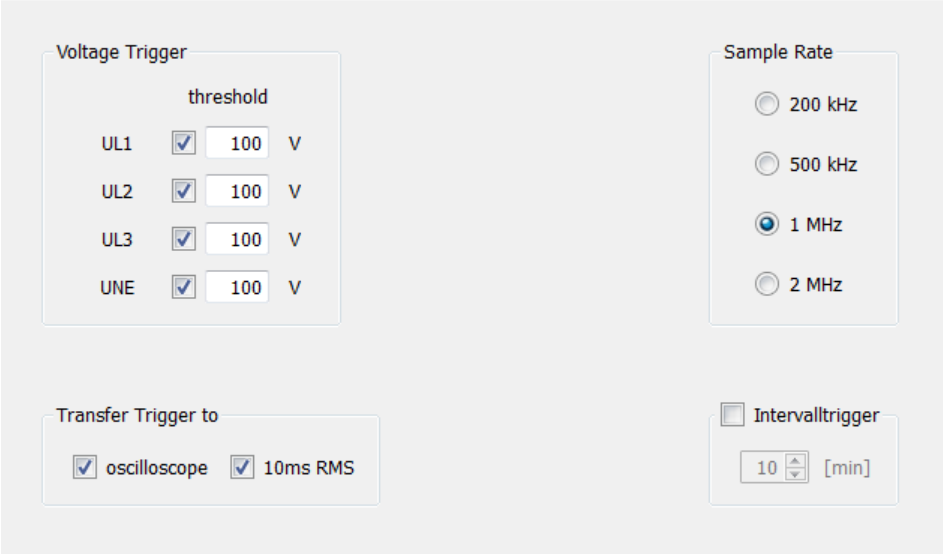
  It is not necessary to care the fundamental voltage level. The threshold level is only for the transient. The threshold is always a secondary value without included VT factor.

- The sampling frequency can be select between 200kHz and 2MHz.

The length of the record depends on the sampling frequency.

- **2MHz sampling = 32ms**
- **200kHz sampling = 320ms.**

The pre trigger time is 50% of the recorder length.

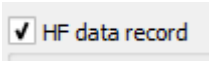


- The function „transfer trigger“, starting the oscilloscope recorder and / or the RMS recorder with each transient signal.
- Interval trigger, starting the transient recorder according to the interval of time. The interval trigger does not start the transfer trigger function.

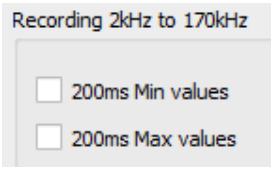
13.9 High frequency measurement (only PQ-Box 300)

HF Modul

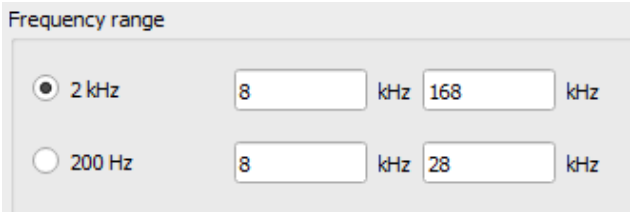
The PQ-Box 300 can be set-up for the detection of supra-harmonics.
The following settings are possible:



This setting can be used to switch the detection of frequencies 8kHz to 170kHz on and off. The frequency range 2kHz to 9kHz is always recorded as a 200Hz frequency band and is independent of this setting.



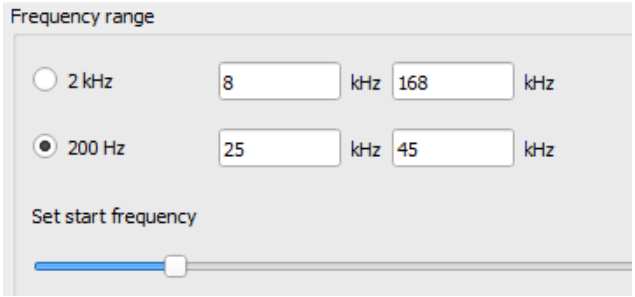
The supra-harmonics are recorded for all measured values, with the freely adjustable mean interval in the setup. In addition, the 200ms extreme values for the recording can be switched on and off.



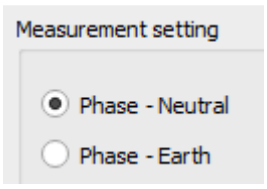
The following settings can be made in the available frequency range.

a) 2kHz frequency band
- Start 2kHz frequency band at 8kHz
  8kHz to 10kHz = 1st. Frequency band / 168kHz to 170kHz last frequency band
- Start 2kHz frequency band at 9kHz
  9kHz to 11kHz = 1st. Frequency band / 169kHz to 171kHz last frequency band

b) 200Hz frequency band
100 frequency bands can be selected.
The following example records all 200Hz frequency bands from 70kHz to 90kHz.



The start frequency of the 2 kHz or 200 Hz frequency bands can be changed with the slider "Set start value".



The calculation method of the supra-harmonics can be selected between conductors to earth or conductors to neutral detection.

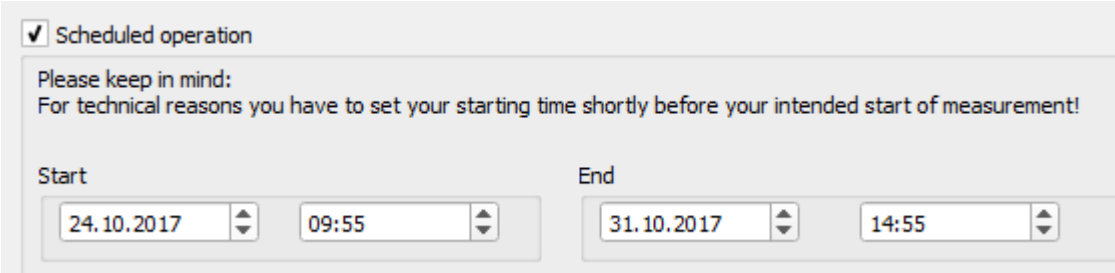
13.10 Scheduled Operation

Scheduled Operation

Programming the PQ-Box with a time job

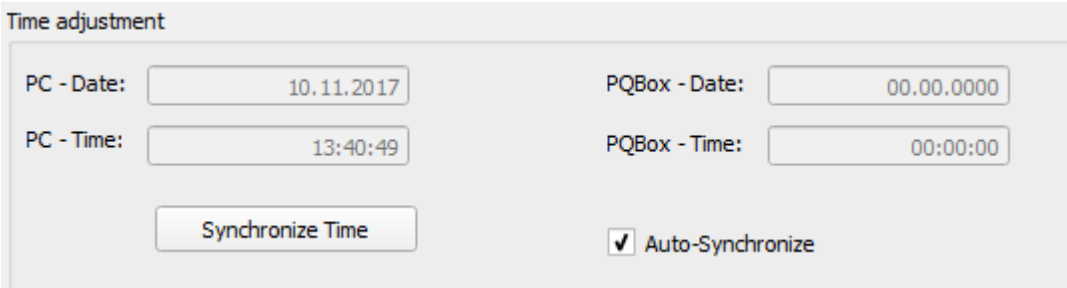
It is possible to start and stop a measurement of a PQ-Box with a preset time job.

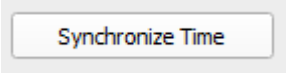
Example: The PQ-Box should start a measurement independently on October 24th at 10 o'clock and stop on 31th.



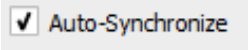
- By pressing the start button on the PQ-Box, the device starts the measurement at once.
- By pressing the stop button on the PQ-Box, The device immediately stops the measurement if the stop button on the

Clock time adjustment:





The PQ-Box time is synchronized at the moment of the button press. The current time of the PQ-Box is not refreshed in the software window.



The PQ-Box time is synchronized automatically every time the setup is send to the device.

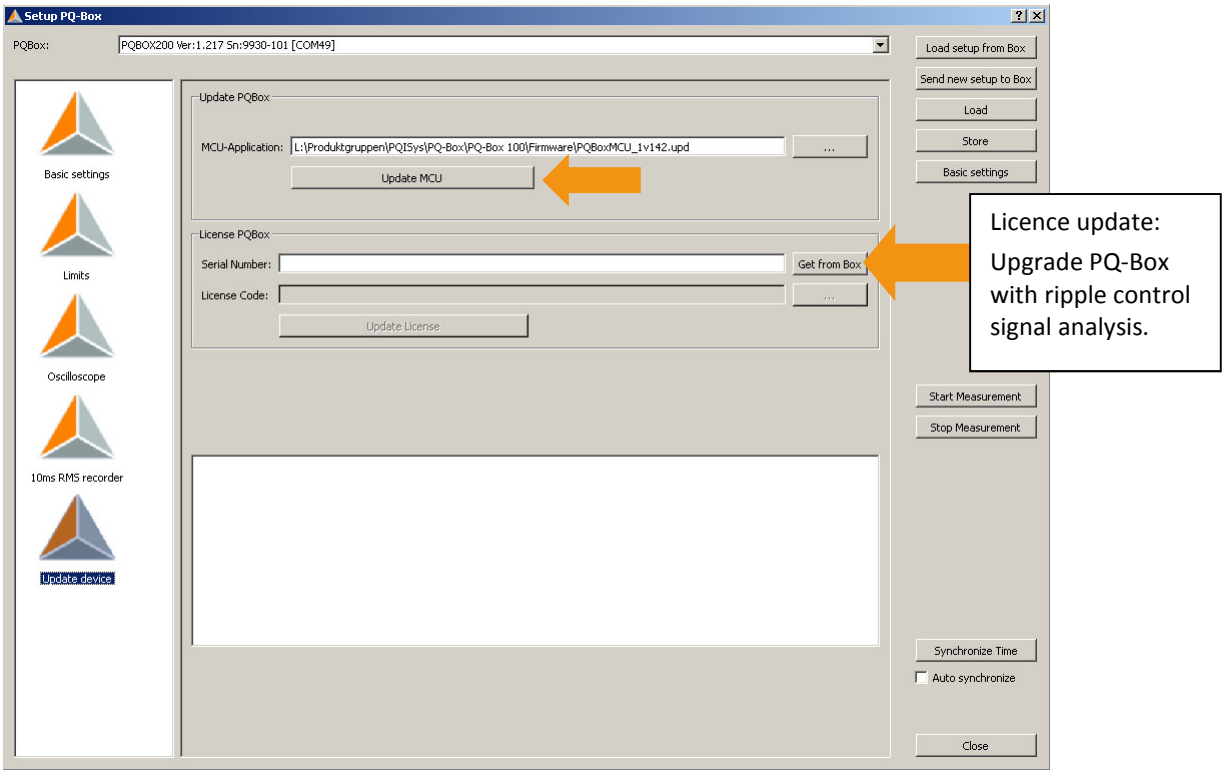
13.11 Firmware Update PQ-Box 200 & 300

Update device

In the "Update" menu the firmware of the network analyzer can be updated or the PQ-Box can be assigned with a license code with more functions.

Sequence for a PQ-Box firmware update:

1) Connect the power to the PQ-Box (power supply).
2) Connect PQ Box with USB or TCP interface to PC.
3) Open the Settings / Update menu in the software.
4) Load the update file "MCU-Application" onto the device.
5) The PQ-Box restarting automatically.



13.12 License Update PQ-Box

Using the Get from Box button, with the measurement device connected, the serial number of the PQ-Box is displayed. Enter the license code in the "License Code" field by specifying the directory or using the keyboard. If the license code matches the serial number of the device, the field "Update License" is activated.

14. Data Converter

14.1 Change VT and CT ratio

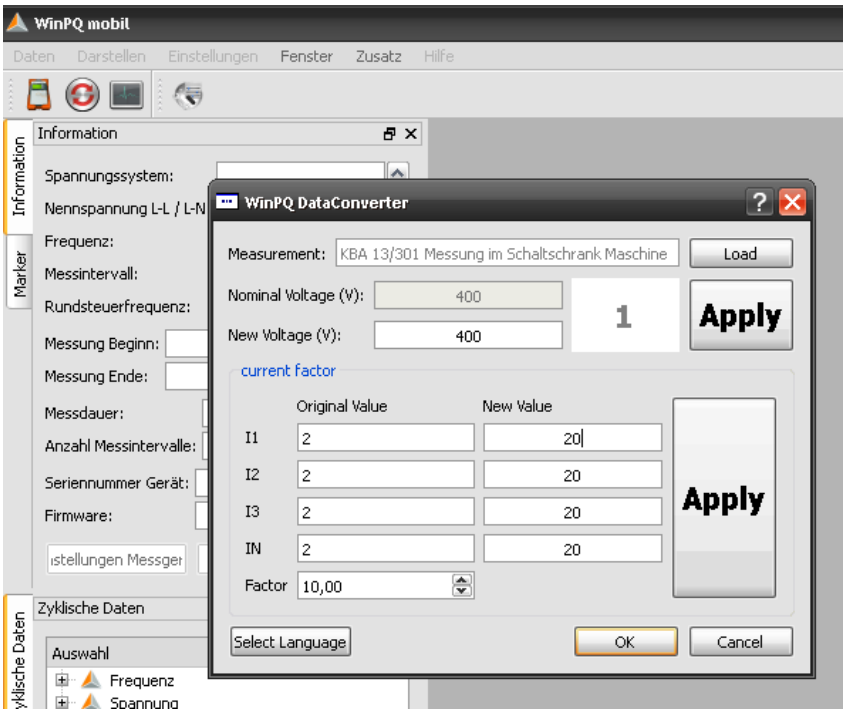
With the "Data Converter" program it is possible to make corrections to an existing measurement file. If a PQ-Box is parameterized with the wrong nominal voltage or the wrong current conversion factor, this can be changed afterwards.

- **Changing the nominal voltage, e.g. from 400 V to 20,000 V**
- **Changing the current conversion factor, e.g. from 1:1 to 1:10**

1) Open the measurement file to be changed with "Load“

2) Enter the correct voltage or current conversion factor

3) With "Execute", the measured data are now converted and saved to a copy of the original file. This can be identified by the label "New" in comment field 4.



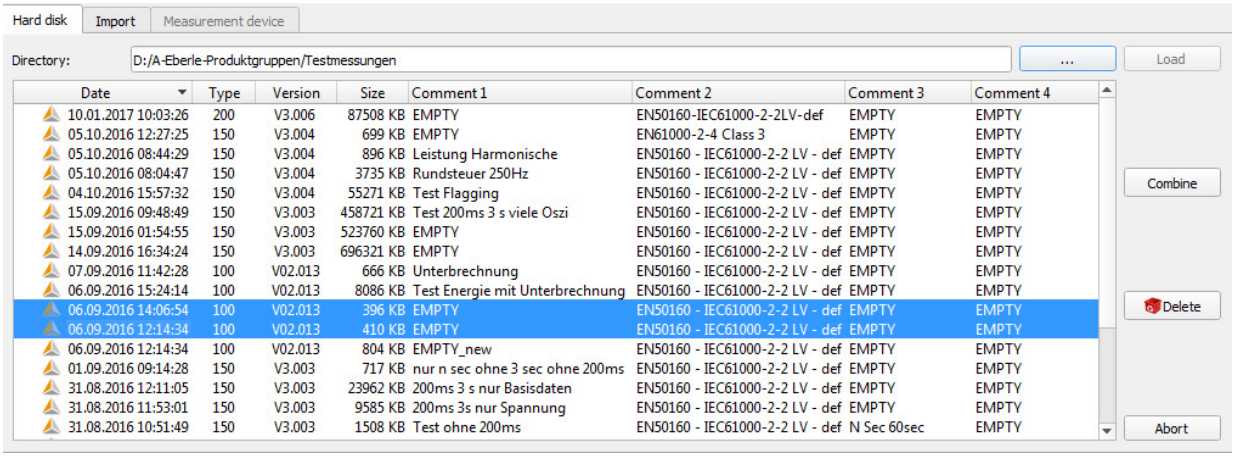
14.2 Merging partial measurements into a combined measurement

Using the Data Converter-program, individual partial measurements can be merged into one combined measurement.

1) Open the measurement file to be changed with "Load“

2) Mark two or more data files

3) With "Combine" these measurement files will be merged and saved in a new measurement file.



Date	Type	Version	Size	Comment 1	Comment 2	Comment 3	Comment 4
10.01.2017 10:03:26	200	V3.006	87508 KB	EMPTY	EN50160-IEC61000-2-2LV-def	EMPTY	EMPTY
05.10.2016 12:27:25	150	V3.004	699 KB	EMPTY	EN61000-2-4 Class 3	EMPTY	EMPTY
05.10.2016 08:44:29	150	V3.004	896 KB	Leistung Harmonische	EN50160 - IEC61000-2-2 LV - def	EMPTY	EMPTY
05.10.2016 08:04:47	150	V3.004	3735 KB	Rundsteuer 250Hz	EN50160 - IEC61000-2-2 LV - def	EMPTY	EMPTY
04.10.2016 15:57:32	150	V3.004	55271 KB	Test Flagging	EN50160 - IEC61000-2-2 LV - def	EMPTY	EMPTY
15.09.2016 09:48:49	150	V3.003	458721 KB	Test 200ms 3 s viele Oszi	EN50160 - IEC61000-2-2 LV - def	EMPTY	EMPTY
15.09.2016 01:54:55	150	V3.003	523760 KB	EMPTY	EN50160 - IEC61000-2-2 LV - def	EMPTY	EMPTY
14.09.2016 16:34:24	150	V3.003	696321 KB	EMPTY	EN50160 - IEC61000-2-2 LV - def	EMPTY	EMPTY
07.09.2016 11:42:28	100	V02.013	666 KB	Unterbrechnung	EN50160 - IEC61000-2-2 LV - def	EMPTY	EMPTY
06.09.2016 15:24:14	100	V02.013	8086 KB	Test Energie mit Unterbrechnung	EN50160 - IEC61000-2-2 LV - def	EMPTY	EMPTY
06.09.2016 14:06:54	100	V02.013	396 KB	EMPTY	EN50160 - IEC61000-2-2 LV - def	EMPTY	EMPTY
06.09.2016 12:14:34	100	V02.013	410 KB	EMPTY	EN50160 - IEC61000-2-2 LV - def	EMPTY	EMPTY
06.09.2016 12:14:34	100	V02.013	804 KB	EMPTY_new	EN50160 - IEC61000-2-2 LV - def	EMPTY	EMPTY
01.09.2016 09:14:28	150	V3.003	717 KB	nur n sec ohne 3 sec ohne 200ms	EN50160 - IEC61000-2-2 LV - def	EMPTY	EMPTY
31.08.2016 12:11:05	150	V3.003	23962 KB	200ms 3 s nur Basisdaten	EN50160 - IEC61000-2-2 LV - def	EMPTY	EMPTY
31.08.2016 11:53:01	150	V3.003	9585 KB	200ms 3s nur Spannung	EN50160 - IEC61000-2-2 LV - def	EMPTY	EMPTY
31.08.2016 10:51:49	150	V3.003	1508 KB	Test ohne 200ms	EN50160 - IEC61000-2-2 LV - def	N Sec 60sec	EMPTY

15. Online Analysis: PQ-Box & PC

Using the "Online analysis" function, RMS values, oscilloscope images, harmonics, inter-harmonics, and current flow direction of the harmonics can be displayed online on the screen of a PC or laptop. The data displayed will be refreshed in the second intervals.

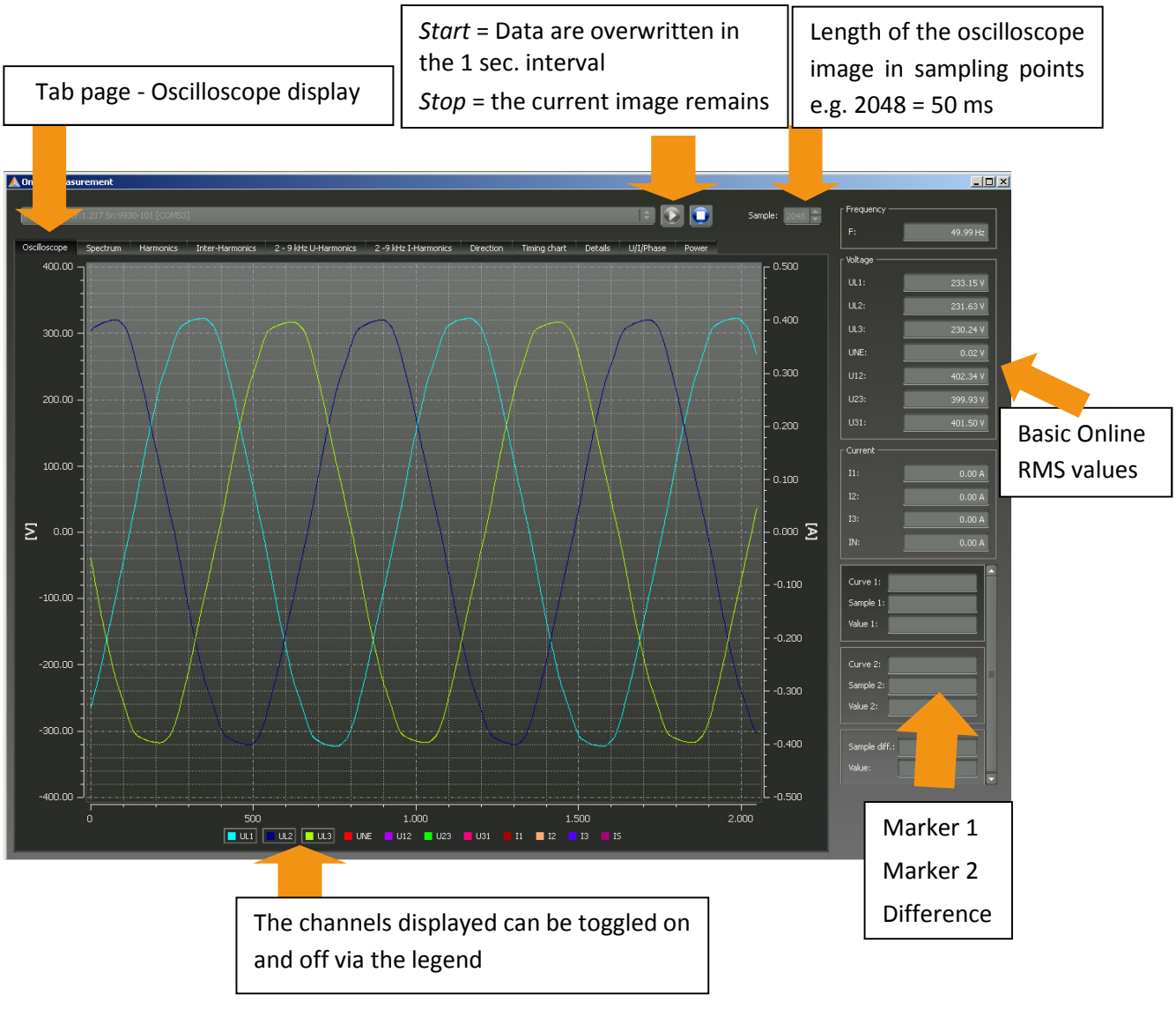
The online measurement is possible during a current measurement, before a started measurement and after a completed measurement,

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

15.1 Online - Oscilloscope Image

All of the following images of the online measurement are shown in the "Black Magic" design.

From the "Oscilloscope" page, the online oscilloscope, with 40.96 kHz sampling of all voltage and current channels are displayed on the screen.

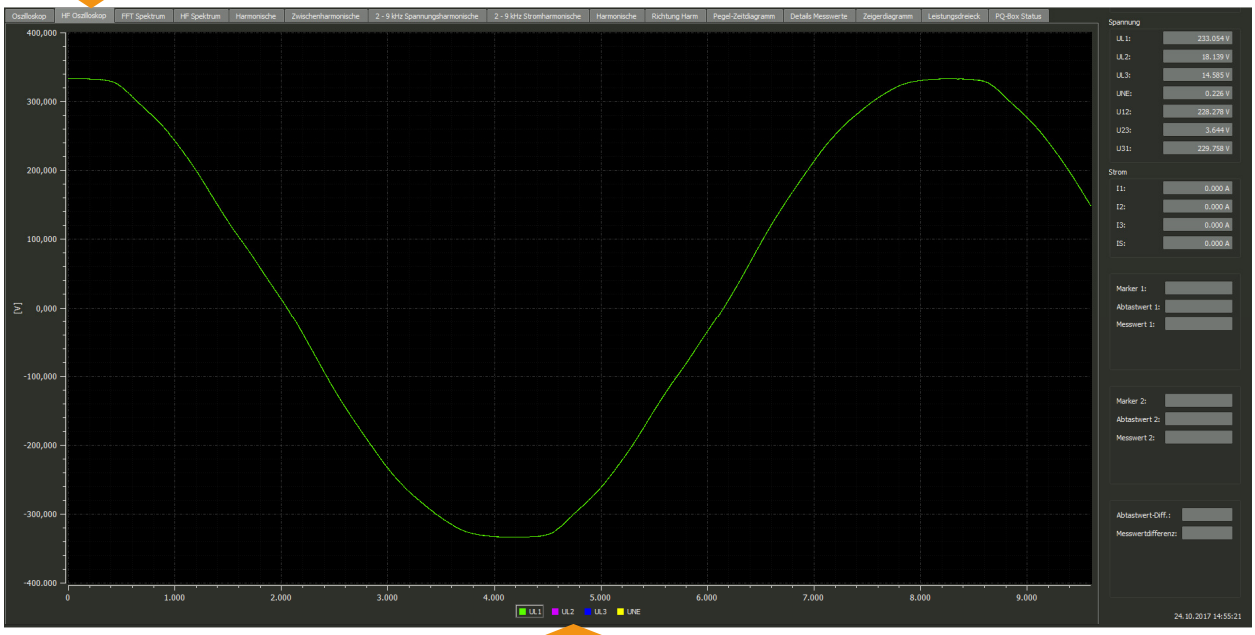


15.2 HF-Oscilloscope (only PQ-Box 300)

With the tab “HF-Oscilloscope” all sampled values of voltage channels will be displayed with 409.6kHz sampling frequency.

Tab – HF-Oscilloscope

Display with 409.6 kHz sampling rate



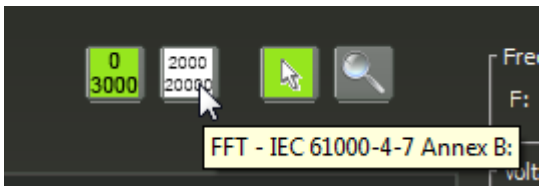
The channels displayed can be toggled on and off via the legend

15.3 Online – FFT – 20,000 Hz

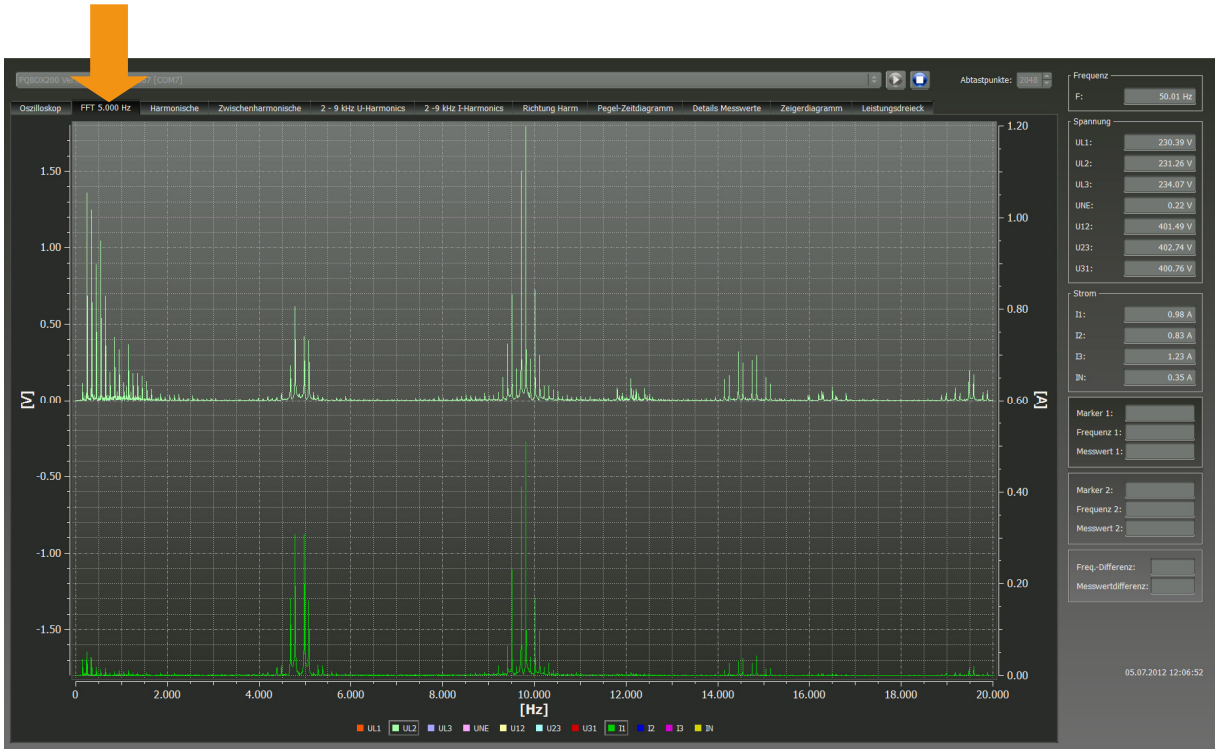
With the "Spectrum" measurement function, all of the harmonics and inter-harmonics for voltages and currents are displayed online.

- PQ-Box 200/300 - DC to 20,000 Hz

There is the possibility to choose between two FFT calculation methods in the online software:



- 0 – 3,000 Hz: calculation procedure according to IEC 61000-4-30 class A (Grid synchronous FFT)
- 2,000 Hz – 10kHz/ 20kHz: calculation procedure according to IEC 61000-4 -7 Appendix B



The following functions are available in the "right mouse" menu:

Print: The current image is sent to the printer

Clipboard: The spectrum is coped to the Windows clipboard

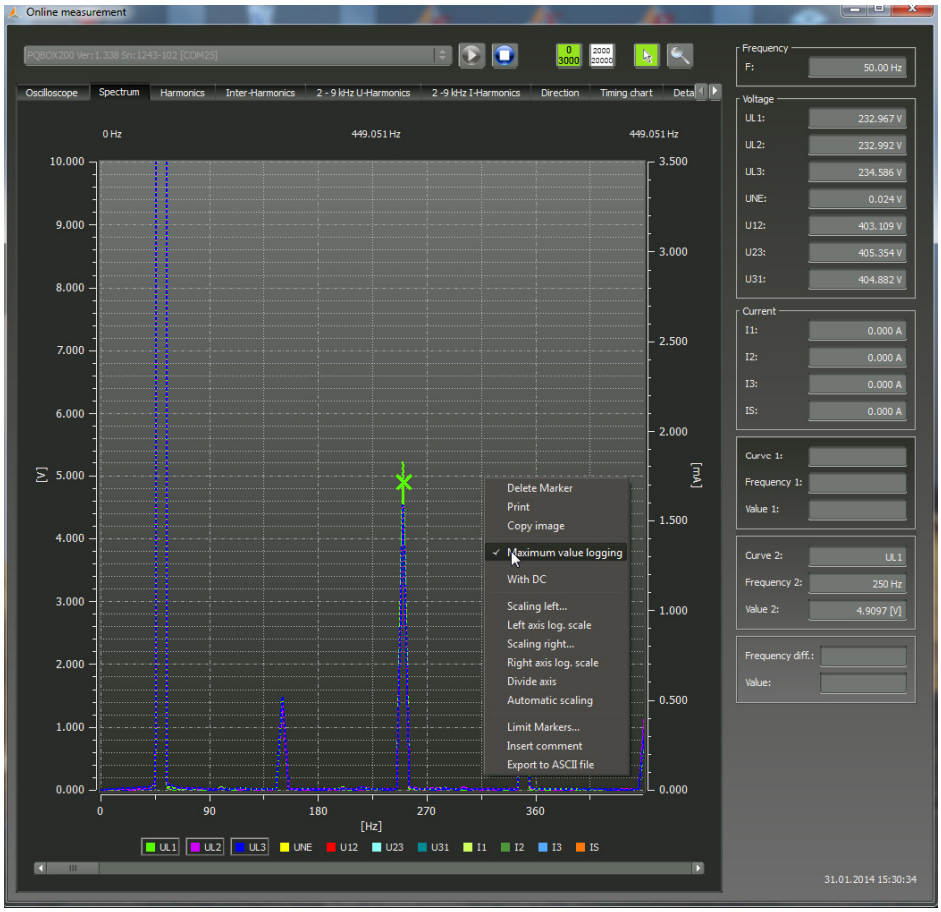
Incl. DC: The DC components can be toggled on and off in the graphic

Incl. Fundamental oscillation: The fundamental oscillations can be toggled on and off in the graphic

Maximum values logging FFT

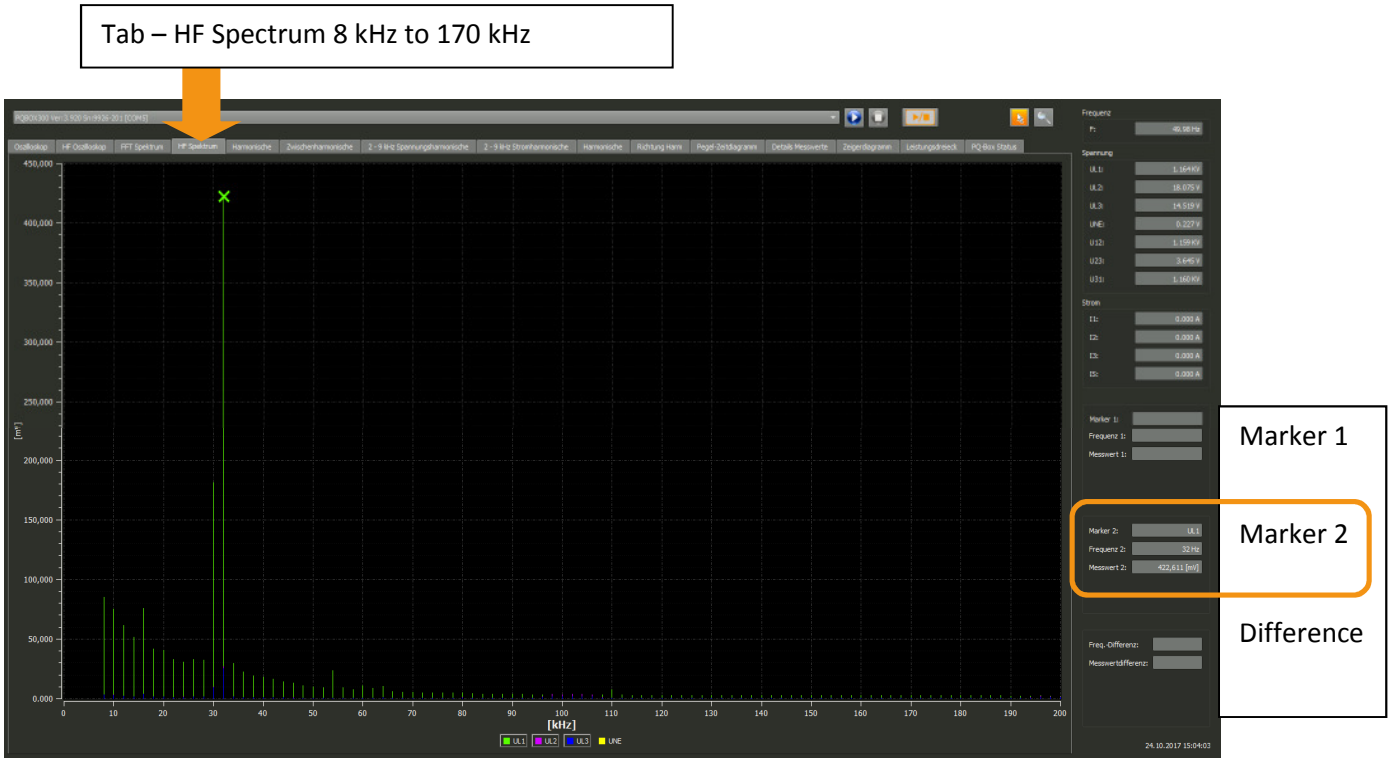
Using this function it is possible to hold the maximum value of the spectral lines of online FFT. (Dashed line).

With this function it is possible to determine direct in online view which maximum values of harmonics or inter-harmonics exists direct during one measurement period.



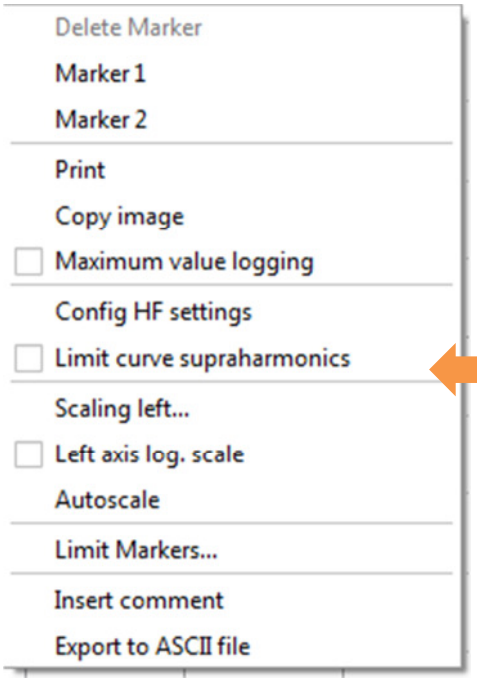
15.4 Online – HF Spectrum (only PQ-Box 300)

The Tab “HF Spectrum” shows all Supra-harmonics up to a maximum frequency of 170 kHz as online values.



In the example shown, a frequency of 32 kHz with an amplitude of 422 mV is present. (Marker No. 2)

The menu "right mouse button" provides additional settings.



Showing the limit line from 8kHz to 150kHz. These limits can be changed in the main menu "Settings".

The function HF Setup offers the possibility to change the calculation methods for the online measurement of the supra-harmonics during a measurement. For example, the PQ-Box 300 can record all supra-harmonics from 8 kHz to 170 kHz with 2 kHz frequency bands. The online values show the 200 Hz frequency bands of 70 kHz to 90 kHz.

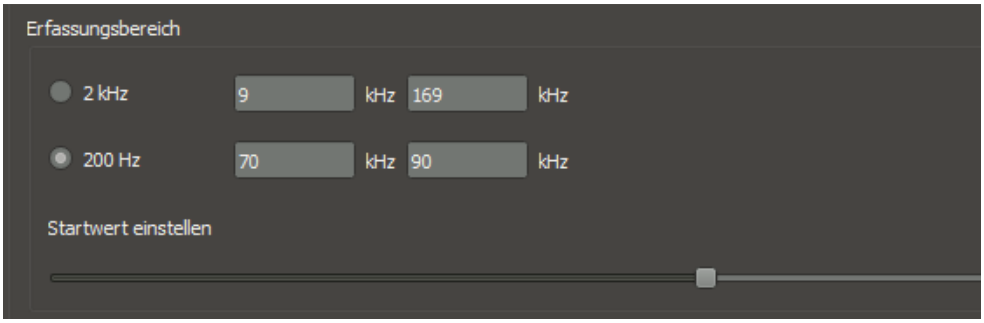
▶ **The following settings can be made for the online display.**

a) 2 kHz frequency band

- Start 2 kHz frequency band at 8 kHz
  8 kHz to 10 kHz = 1st. Frequency band / 168 kHz to 170 kHz last frequency band
- Start 2kHz frequency band at 9kHz
  9 kHz to 11 kHz = 1st. Frequency band / 169 kHz to 171 kHz last frequency band

b) 200 Hz frequency band

100 frequency bands can be selected.
The following example records all 200 Hz frequency bands from 70 kHz to 90 kHz.



The start frequency of the 2 kHz or 200 Hz frequency bands can be changed with the slider "Set start value".

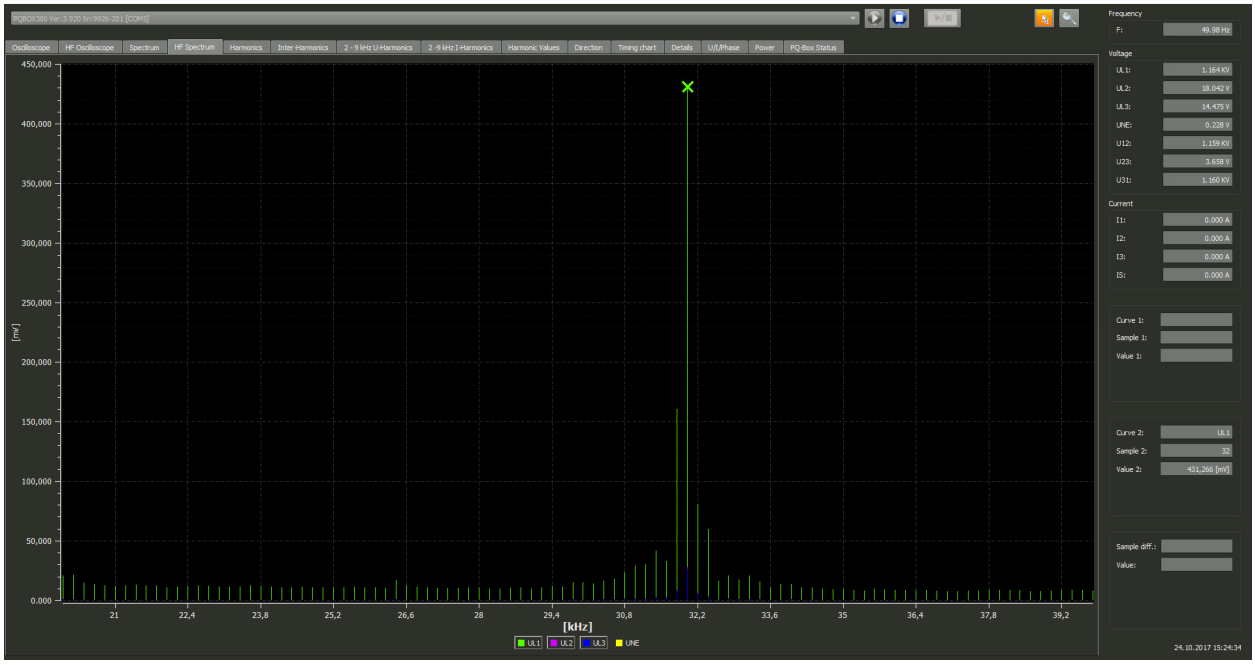
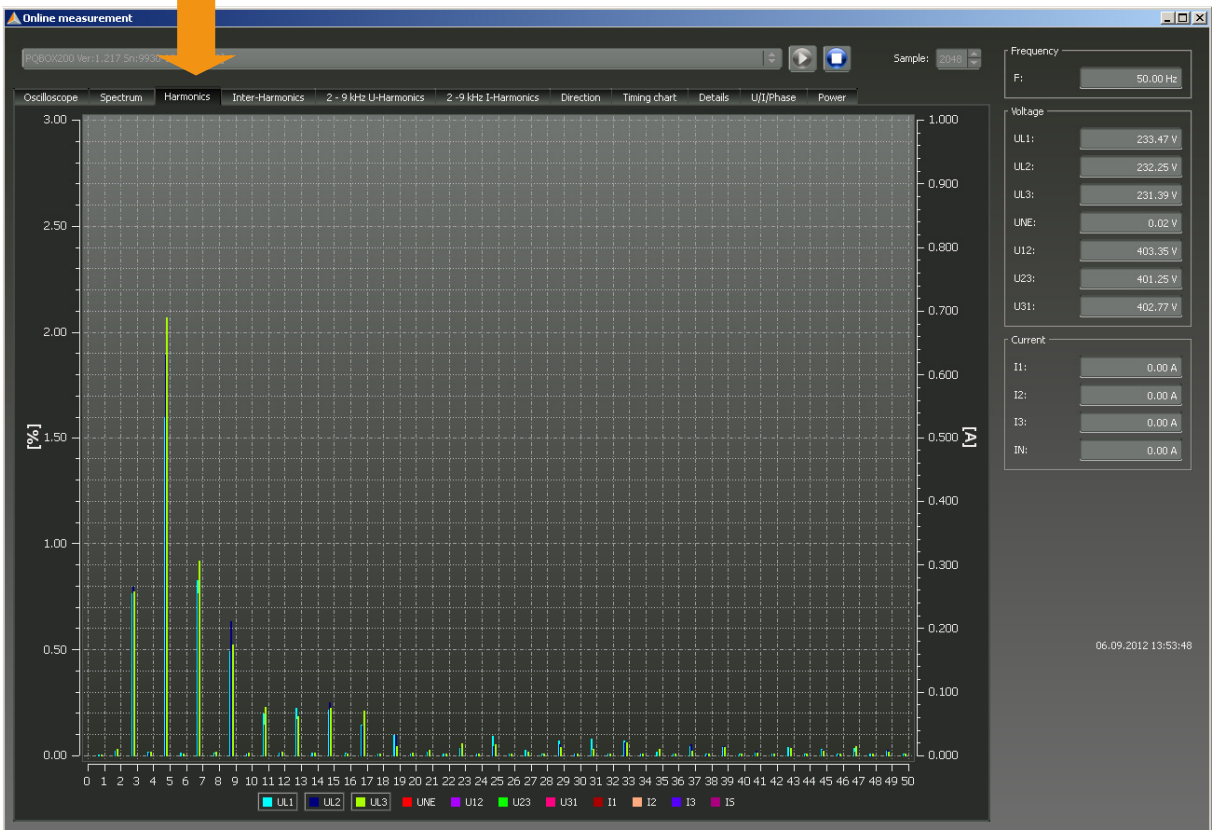


Image shows 200 Hz resolution in the frequency range 20 kHz to 40 kHz. Noise level 32 kHz - 418mV

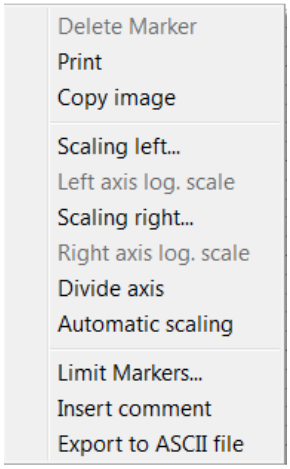
15.5 Online - Harmonics

From the "Harmonics" tab page, all of the current and voltage harmonics (2nd to 50th) can be displayed online. The measurement data is calculated by the measuring device in accordance with IEC61000-4-30 Class A and transferred to the PC.

Tab page – Voltage and current harmonics

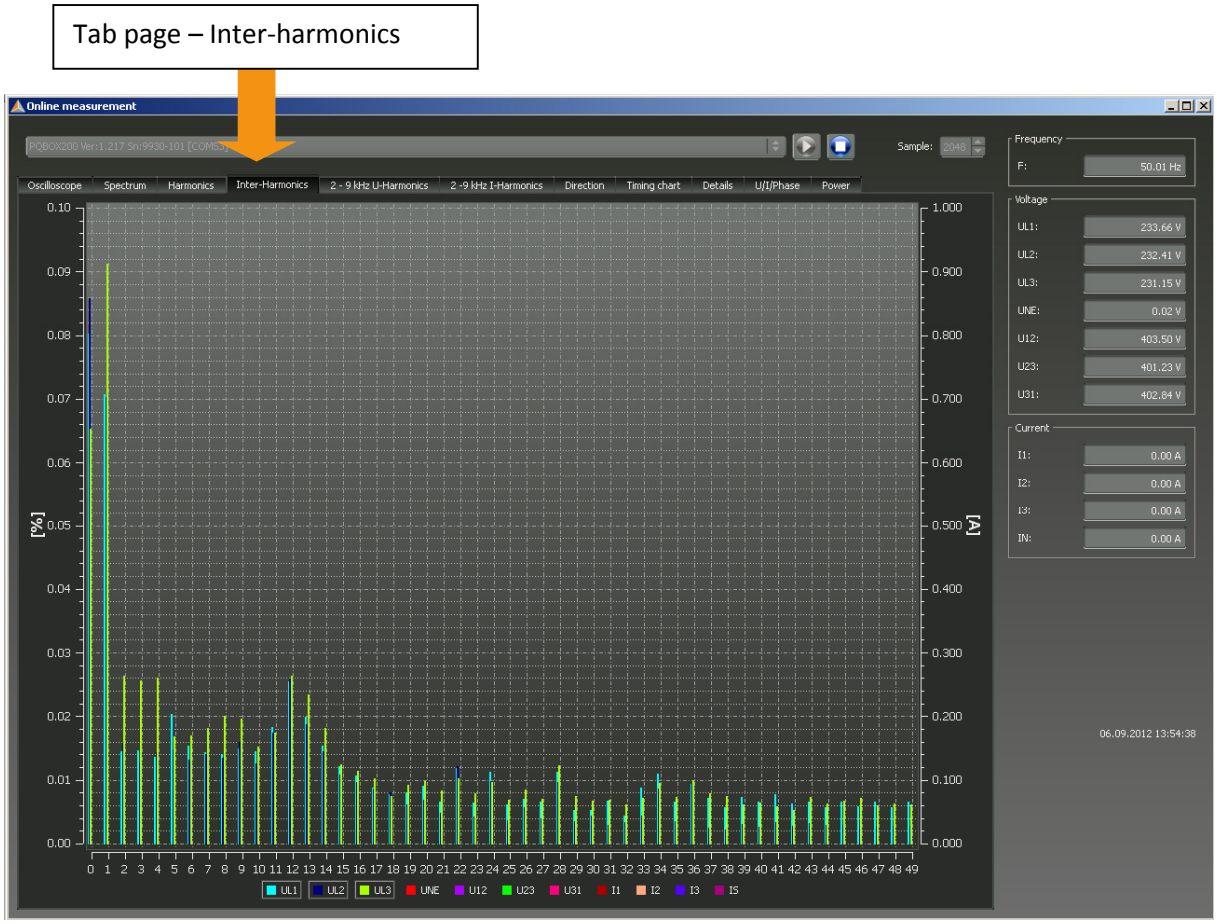


Different functions are possible via the “right mouse menu” (Data export, manual scaling, split axis)



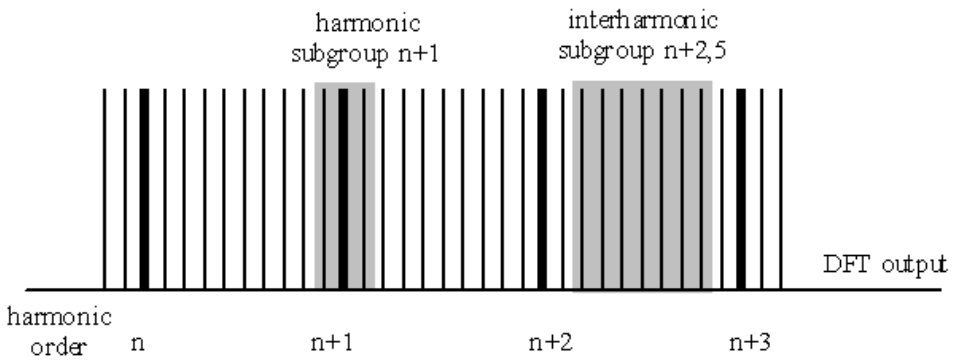
15.6 Online – Inter-harmonics

From the "Inter-harmonics" tab page, all of the current and voltage inter-harmonics up to 2,500 Hz can be displayed online. The measurement data is calculated by the measuring device in accordance with IEC61000-4-30 Class A following the grouping process and transferred to the PC.



Explanation of the grouping process in accordance with the IEC:

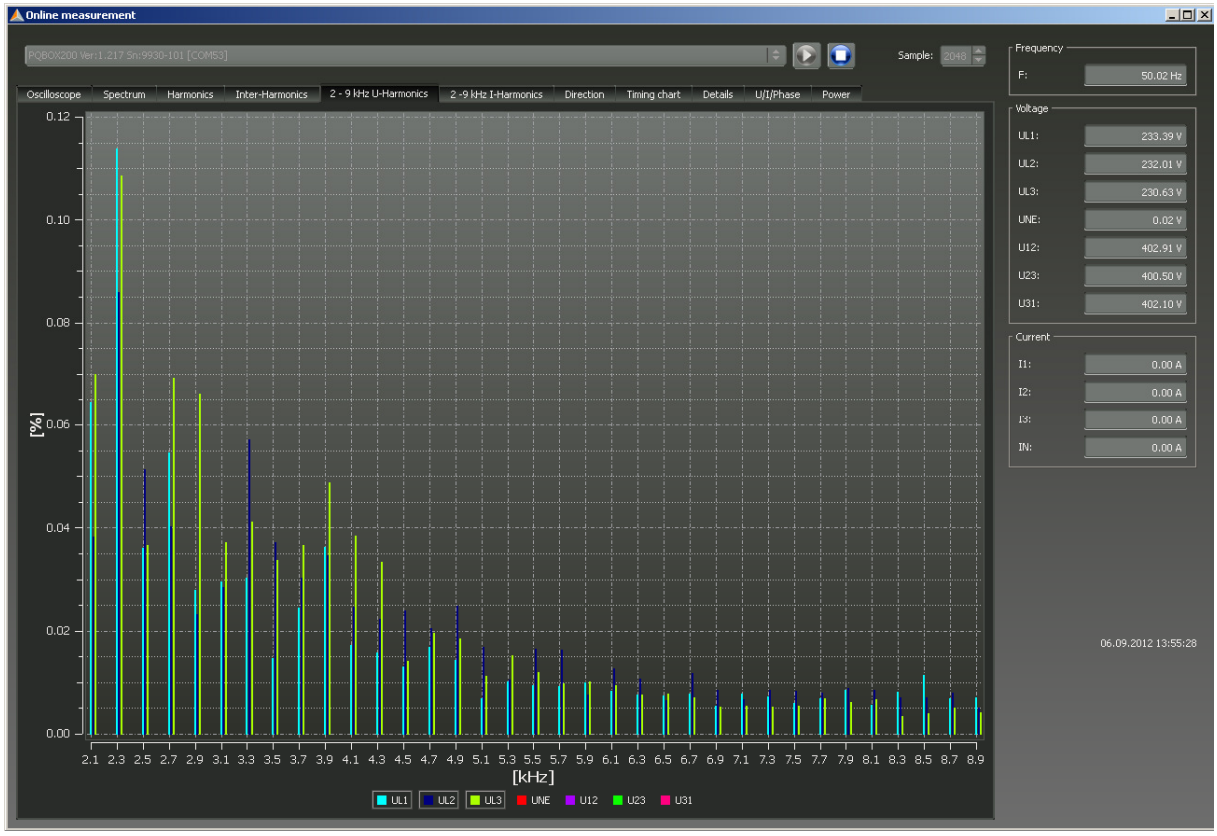
To evaluate the inter-harmonics in the network, subgroups are created. In each case, all of the inter-harmonics between two harmonics are combined into one harmonics subgroup.



15.7 Online – Frequency Bands 2 kHz to 9 kHz

From the "2 to 9 kHz" tab page, all of the current and voltage harmonics shown in 200 Hz-groups. The centre frequency is always indicated.

- Example: All frequencies from 8.805 Hz to 9.000 Hz are located in the 8.9 kHz band.



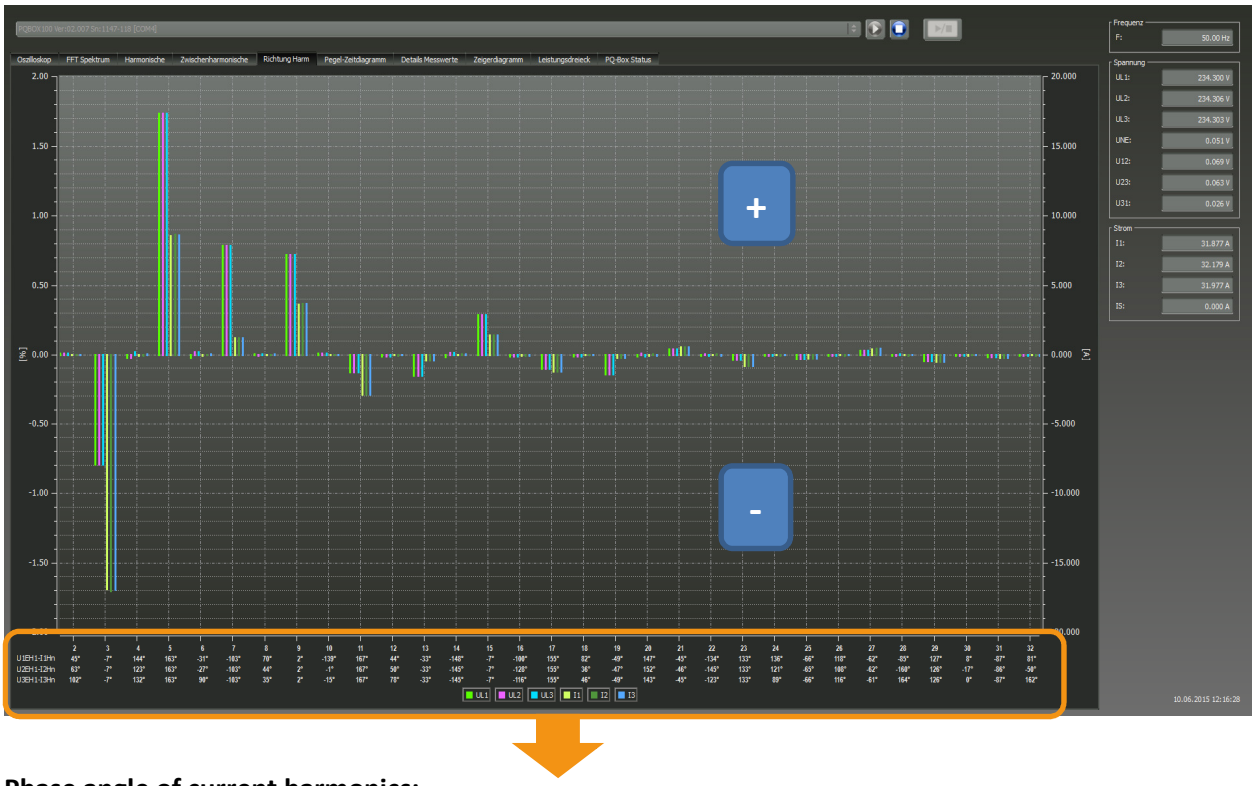
15.8 Online – Direction of the Harmonics

From the "Harmonics Direction" tape page, the current flow direction of the harmonics at the measuring point is displayed. A positive value (+) represents a direction of current flow from the network to the consumer (in this example, the 5th harmonic).

If the measurement value is negative (-), a current flow from the consumer to the network is present.

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

Note: In a network preloaded with voltage harmonics, the statement about the direction of the harmonics is not always certain. The greater the load on the network with a current harmonic from the consumer is and the less the network is preloaded with voltage harmonics, the greater the significance of this sign on the source of harmonics in the network.

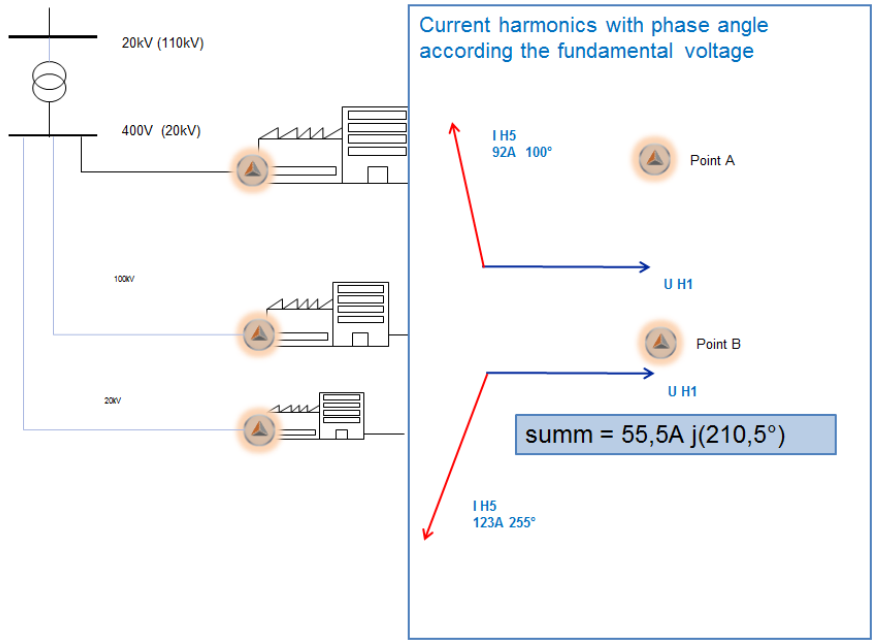


Phase angle of current harmonics:

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:

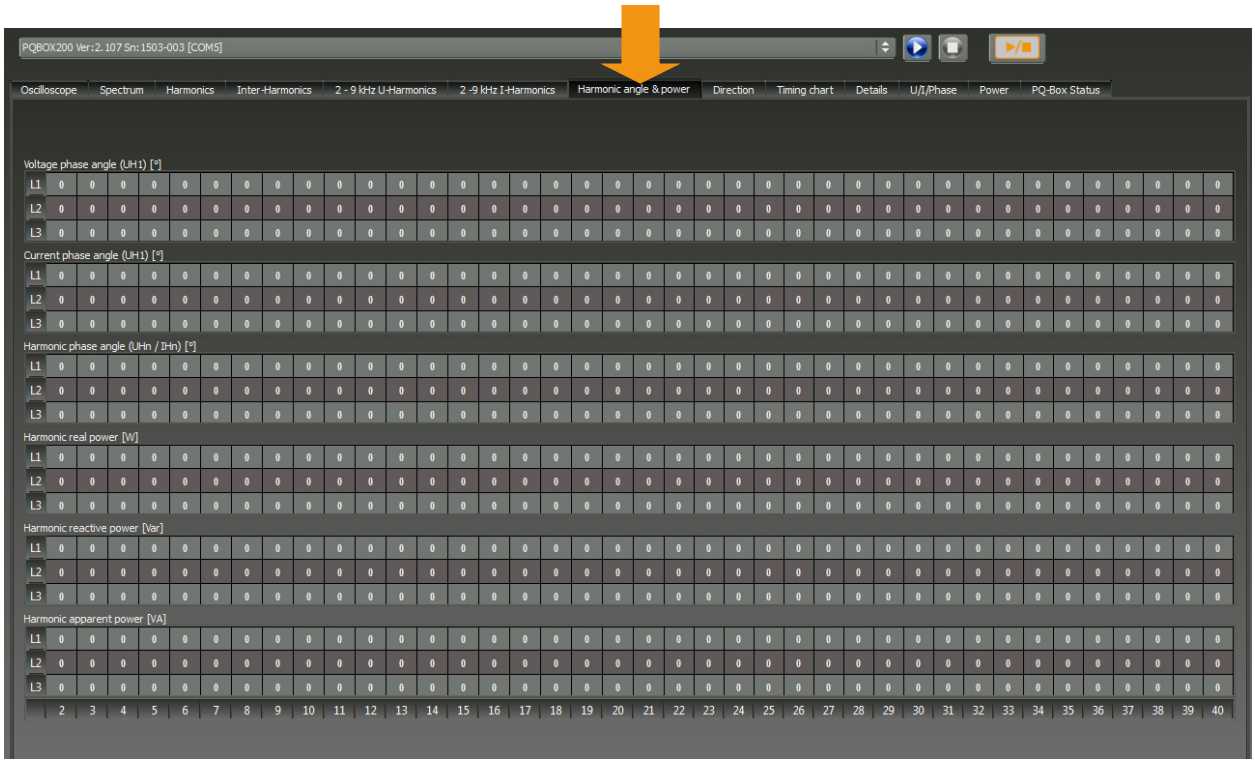
At one connections point with several consumers should be analyzed, whether the 5th harmonic will be added or subtracted. In our example customer A has 92A and customer B has 123A 5th harmonic current. Together with the phase angle of the current harmonic, it is possible to calculate complex the result with 55.5A.



15.9 Harmonic power and phase angle

Phase angle and power values of harmonics 2nd to 40th order number listed on the screen below.

- **Phase angle of the voltage harmonic relative to fundamental of the voltage**
- **Phase angle of the current harmonic relative to fundamental of the voltage**
- **Real power harmonics (W)**
- **Reactive power harmonics (Var)**
- **Apparent power harmonics (VA)**



15.10 Online Level-Time Diagram

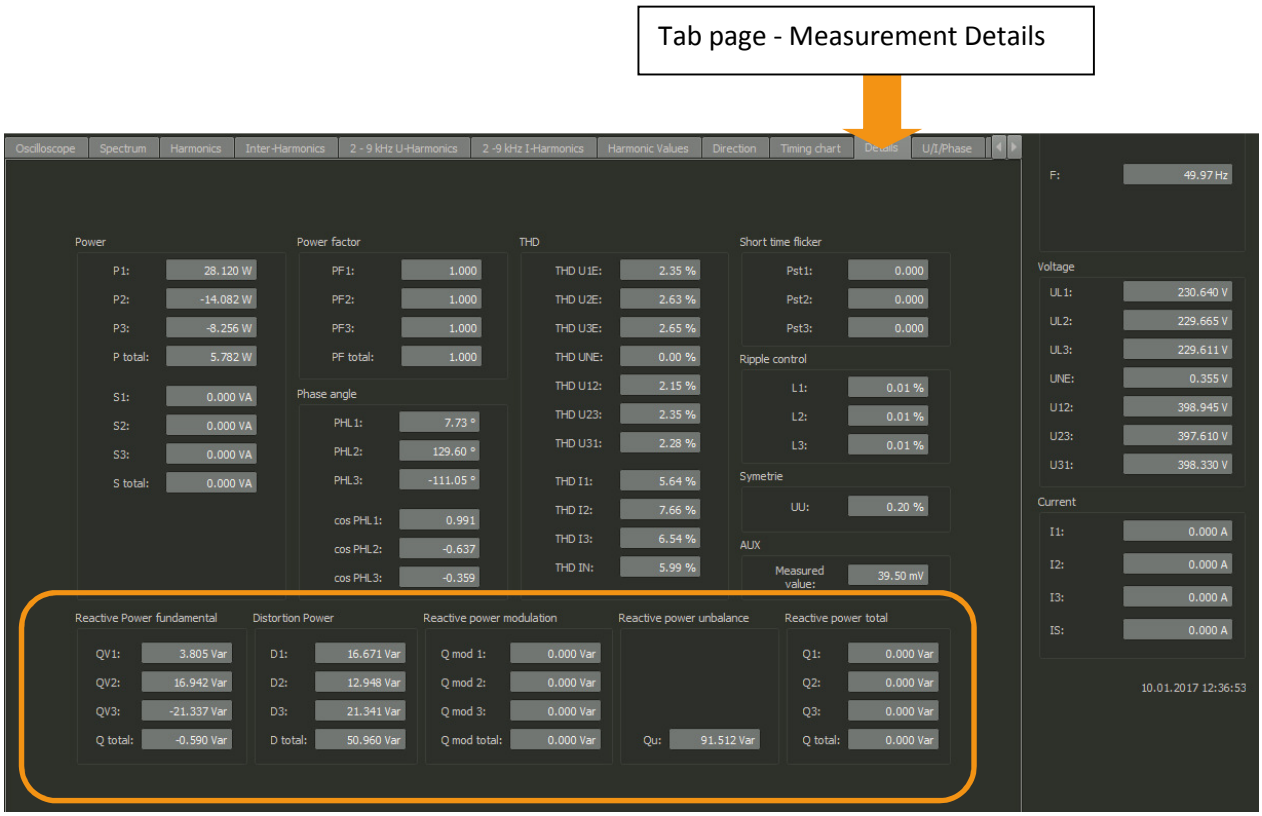
In the "Online level-time diagram", the voltages, currents and performance can be monitored over an adjustable period (1, 3, 5 or 10 minutes).

Using the right mouse menu, the scales can be adjusted or the image can be copied to the clipboard.

With the "Clear Display" function, the measurement data are removed from this image.

15.11 Online - Measurement Value Details

From the "Details" tab page, the active, reactive and apparent power of the single-phase and three-phase values are also displayed online, as well as the power factor and phase angle of the fundamental oscillation of the network.



Description of power values in online “Details”

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

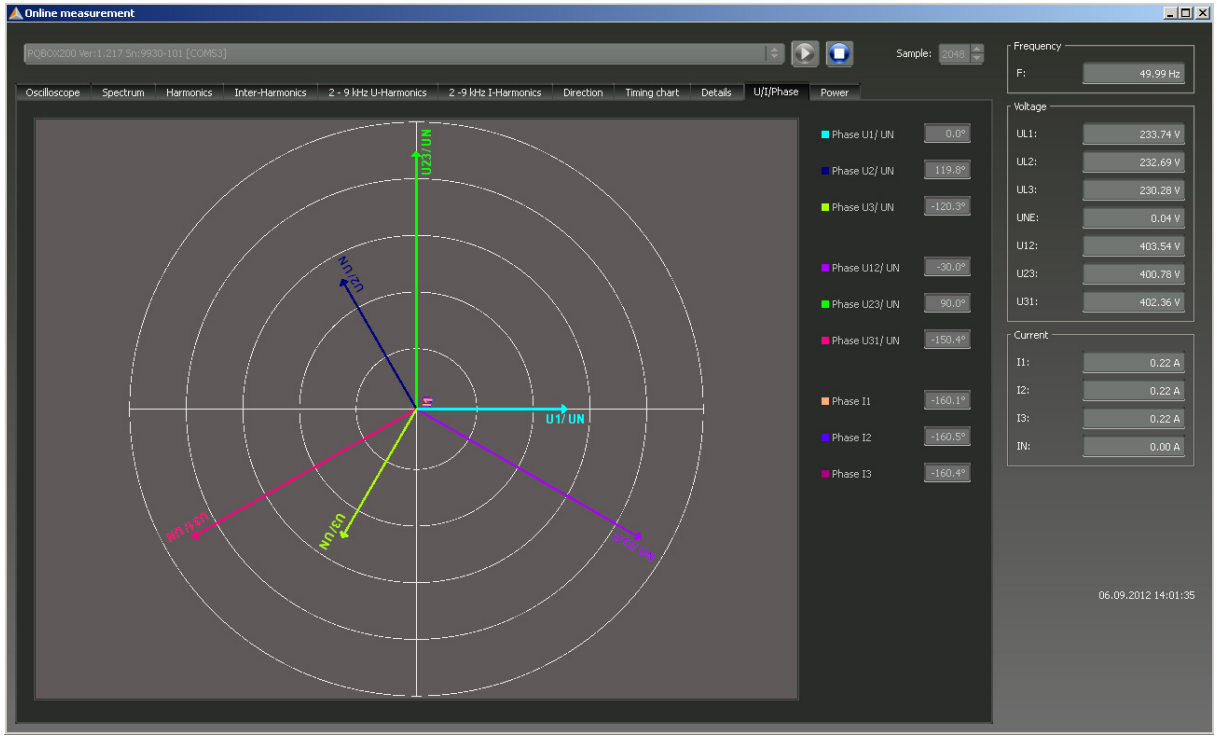
The total reactive power will be calculated from:

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

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

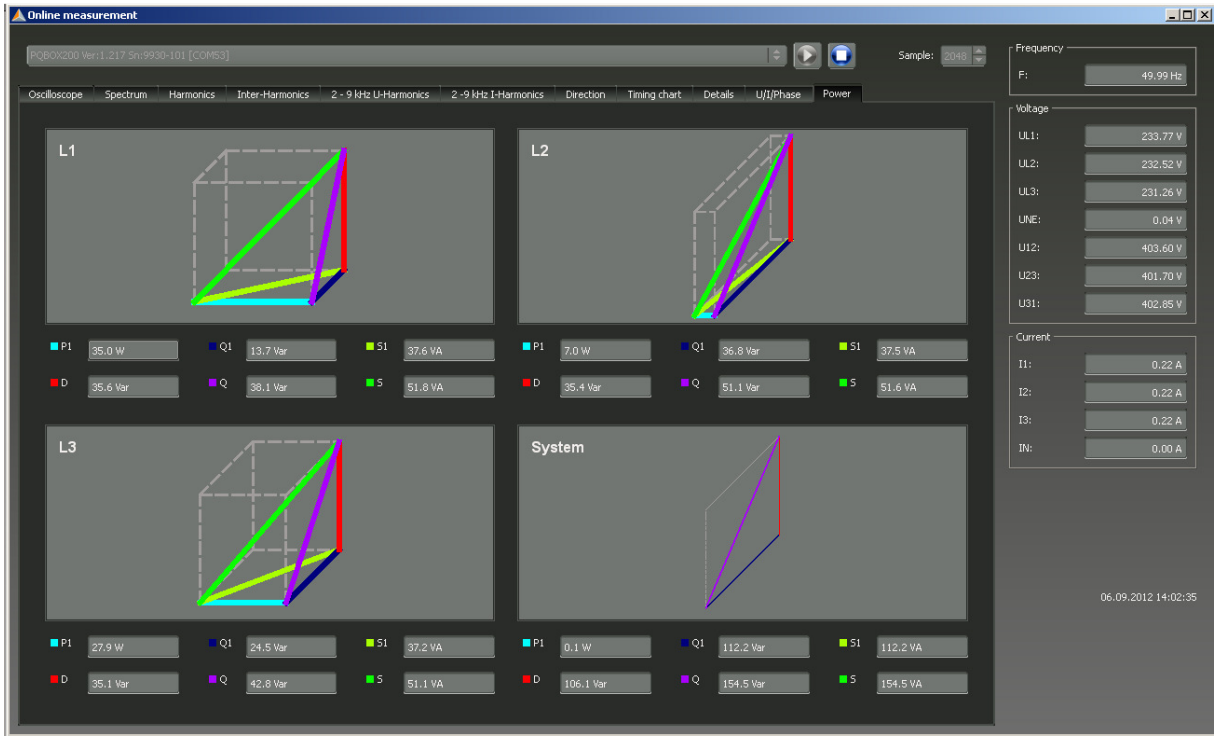
15.12 Online - Phasor Diagram

Using the Phasor Diagram function, the voltages and currents are plotted graphically with their magnitude and phase angle.

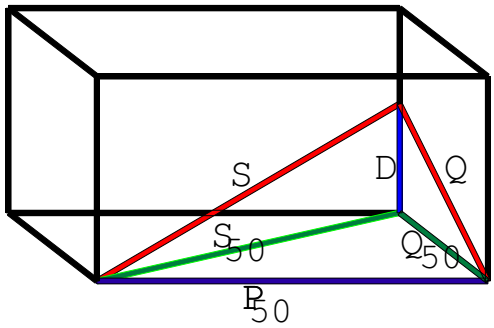


15.13 Power Triangle

On the "Power Triangle" tab page, all performance values are shown in a three-dimensional graphic. It in each case a power triangle is displayed for each phase and for the overall network performance.



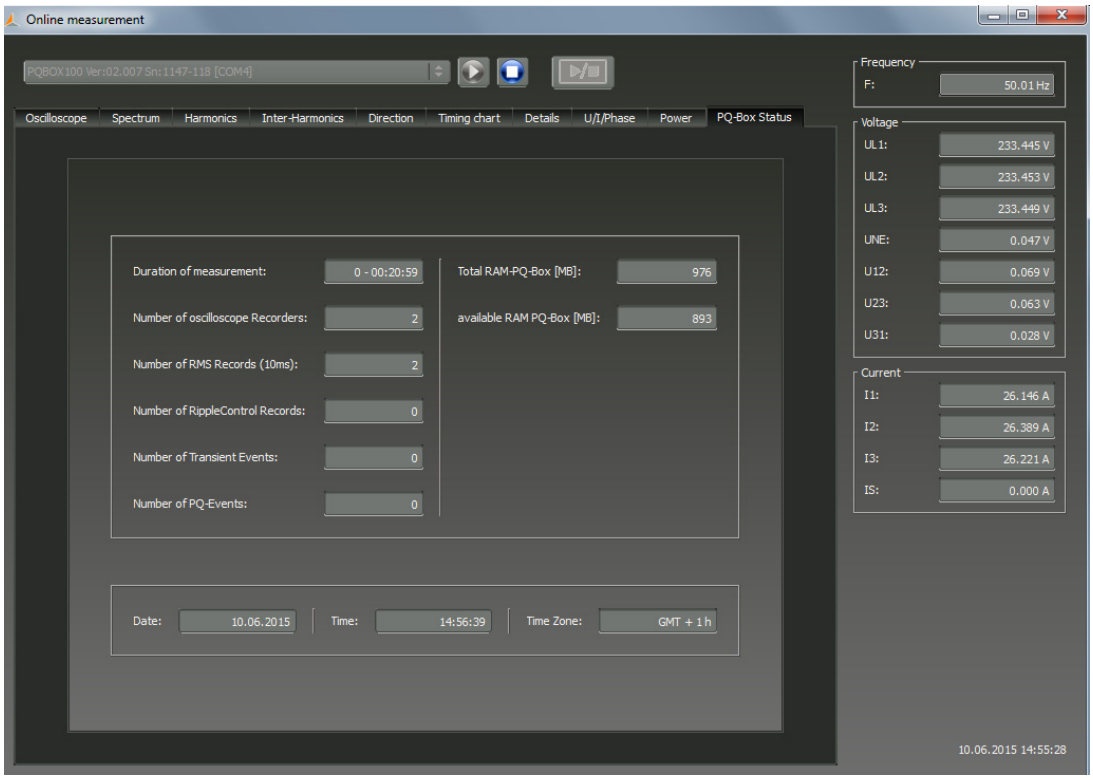
The graphic displays the individual power values once for the total RMS value as well as for the fundamental oscillation values.



15.14 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



16. Measurement Data – PQ-Box 200 / 300

16.1 Measured quantities

PQ-Box Cyclic Measurement Values

Note: The interval corresponds to the freely selectable measurement interval (1 sec up to 30 min)

For each cyclic measurement interval there are 5604 bytes of recording data. If the memory space is reserved for cyclic data f. e. to 500 MB, 91360 measuring intervals can be written until the reserved disk space is full.
If the recording interval is set to 10 minutes, this corresponds to a recording duration of 632 days.

16.2 PQ-Box Measurement Procedure / Formulas

Signal sampling:

The voltage and current inputs are filtered with an anti-aliasing filter and digitized with a 24-bit converter.

The sampling rate is at the nominal frequency

- PQ-Box 200 40.96 k samples/s for voltage and current per channel
- PQ-Box 300 409.6 k samples/s for voltage and 40.96 k samples/s for current per channel

The aggregation of the measurements is based on IEC61000-4-30 for Class A devices.

RMS values of the voltages and currents, min. / max. values

U eff / I eff

The interval value of the voltage or current is the mean of the RMS values of the length of the selected interval.

U min / max; I min / max
Per measurement period, the highest and lowest 10 ms voltage or current RMS value is saved in addition to the average.

Ripple control signal

U Ripple Control (200 ms)

Any inter-harmonics can be set In the PQ-Box 200 setup. This is displayed as the 200 ms maximum value within a measurement interval.

Flicker levels 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.

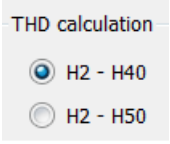
- **The measuring interval of the Pst is set to 10 minutes fix and is independently from the free intervall.**

Formula for Plt calculation:

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

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 voltage:

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

THD 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

The partial weighted THD calculates the 14th to 40th harmonics.

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

PHC - Partial Odd Harmonic Current

The PHC is calculated from the odd current harmonics n = 21..39.

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

K Factor

The values of the K-factors for phase currents are calculated from the corresponding RMS values C_n of the harmonics n = 1..40.

The K factor is a measure that indicates the ability of a transformer to withstand the current harmonics of a system.

Various transformer suppliers offer transformers with, for example, K factors K=4, K=13, K=20 and K=30.

Transformers are heated more by harmonic currents than 50 Hz currents.

A transformer with a higher K-factor withstands this better and is not heated as much as a transformer with a lower K factor.

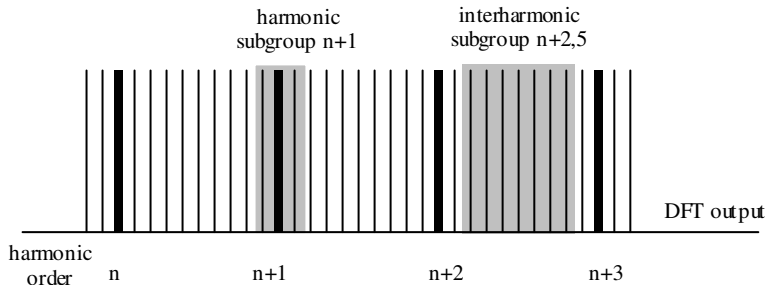
The PQ-Box 200 shows the K factor for the current. Only the K values that appear at maximum power are of interest. Just as with the THD of the currents in %, the value is not relevant at very low currents.

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

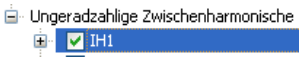
Harmonics / Inter-harmonics

The determination of the harmonics and inter-harmonics interval values displayed using the methods of the IEC61000-4-30 Class A standard based on 10/12 period values.

The PQ-Box 200 recognizes for all voltage and current channels, respectively, the harmonics up to the 50th ordinal. To evaluate the inter-harmonics, harmonic subgroups are created. 50 subgroups are recorded for all current and voltage channels.



Example:



"IH1“ is the first inter-harmonics group and evaluated the frequency range from 5 Hz to

45 Hz.

The harmonics for n=0...50 are calculated

Voltage harmonics (standardized, 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:

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

Frequency analysis 2 kHz to 9 kHz

In the frequency analysis 2 kHz to 9 kHz respectively 200 Hz frequency bands are summarized.

The specification of each frequency is the center frequency in this 200 Hz band.

$$Y_b = \sqrt{\sum_{f=b-95\,\mathrm{Hz}}^{b+100\,\mathrm{Hz}} Y_{C,f}^2}$$

Example: Frequency band 8.9 kHz corresponds to all 5 Hz spectral lines from 8.805Hz to 9.000Hz

Reactive power / Reactive energy

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:

$$Q = \sqrt{Q_V{}^2 + D^2}$$ Q ∑ = Q L1+ Q L2 + Q L3

b) Reactive power calculation according DIN40110 part 2

Reactive power calculation with unbalanced power:

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

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

Reactive energy:

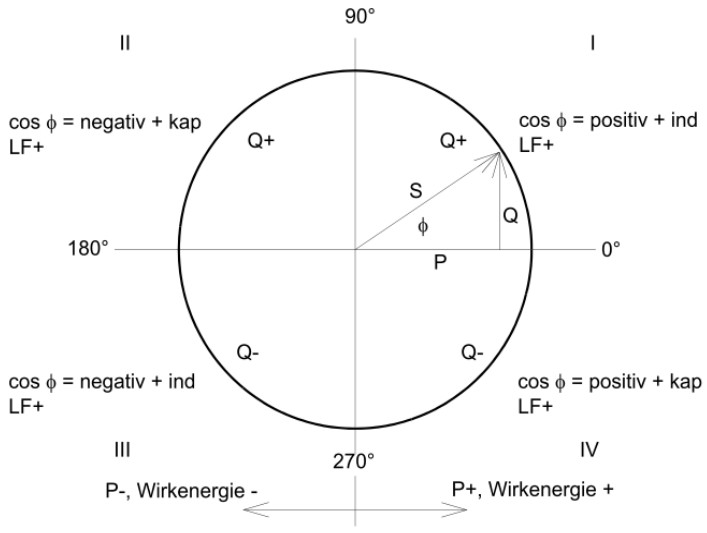
"Supply reactive energy" inductive reactive energies +EQ.

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

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

"Consumer reactive energy" capacitative reactive energies -EQ.

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

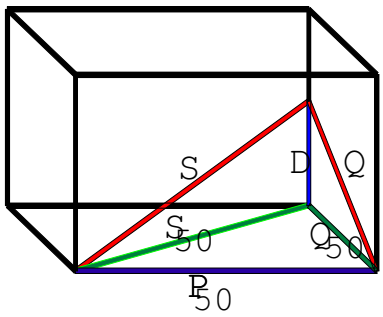


Distortion reactive power - D

The distortion reactive power - also called the harmonic reactive power - describes a specific form of reactive power that is caused in single phase and three-phase systems with non-linear loads such as rectifiers in power supplies. The current harmonics in combination with the line voltage result in reactive power components, which are called the distortion reactive power.

The distortion reactive powers are calculated from the voltage and the associated distortion currents:

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



Power Factor PF

In electrical engineering the power factor or active power factor is calculated as the ratio of real power P to the apparent power S. The power factor can be between 0 and 1.

The ration is expressed in the following equation:

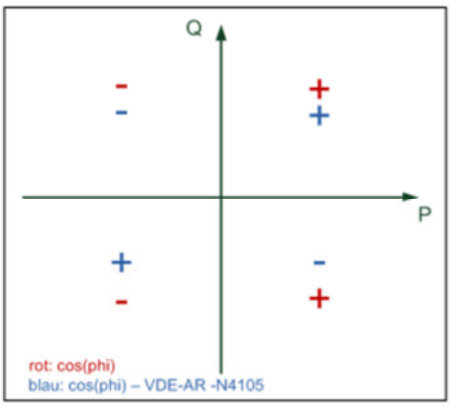
Power Factor PF: $\lambda = |P| / S$

The power factor contains the sign of the real power.

Cos phi

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

a) Cos phi – standard (red)
b) Cos phi – calculated in the direction of the real power (blue)



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.

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

Conductor apparent power 4-wire system:

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

Conductor apparent power 3-wire system:

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

Collective apparent power in accordance with DIN40110:

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

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 :

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

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

Geometric Fundamental Oscillations - Apparent Power:

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

Active Power - P

The sign of the active power corresponds with the flow direction of the fundamental oscillation active energy (+: supply, - : consumer).

The values of the conductor - active power are calculated from the samples of a synchronization cycle.

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

(200 ms values) with conductor index L = {1, 2, 3, E}

The 10 min values are calculated as linear averages.

The collective effective power is defined for 4-wire systems as

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

The collective effective power is defined for 3-wire systems as

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

Fundamental oscillation - active power (line):

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

$\underline{S}_G$ = Geometric fundamental oscillation apparent power

Symmetric Components

The complex symmetrical components are calculated from the corresponding complex spectral components of the fundamental oscillations of the phase voltages and phase currents.

Phase voltage in a 4-wire system = Phase-to-Neutral voltage

Phase voltage in a 3-wire system = Phase-to-Ground voltage

Positive sequence:

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

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

Negative sequence:

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

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

Zero sequence:

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

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

UU Unbalance

The unbalanced voltages are calculated from the corresponding values of the modal positive sequence, negative sequence and zero sequence components.
For the EN50160 (events) only the voltage unbalance u_u is relevant since it corresponds to the ratio of the negative sequence to the positive sequence. The value is expressed in [%].

17. Maintenance/Cleaning

17.1 Maintenance

This unit is maintenance-free for customers.

Exceptions are the battery pack and micro-SD card, which can be accessed via a maintenance cover on the rear panel. The fuse in the voltage leads.

- PQ-Box 200/300 Open the battery compartment on the rear panel

Spare parts no.

SD memory card, 8GByte industry-standard	900.9099-8
Replacement battery pack	570.0010
Fuse for voltage leads; 500mA (FF) 30kA AC/DC; 1000V 6,3mmx32mm	582.1058

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

17.2 Cleaning

Cleaning of labeling fields

Use a soft, light moistened and lint-free cloth for cleaning the surface of the device. Do not use any kind of window or household cleaner, spray, solvents, spirit cleaners, ammonia solution or scouring agents for cleaning.

18. Calibration

We recommend a calibration interval of three years for the network analyzer PQ-Box 150 & 200 to maintain the accuracy of GEFOR-made-IEC61000-4-30 Class A instruments.

19. Disposal

To dispose of the device and its accessories, send all components to A-Eberle.

20. 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

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No. 584.0851

Vers. PQ Box 300 – 21/03/2018