



**Operating Manual** 

# Network Analyzer / Transient Recorder PQ-Box 200

Power-Quality Evaluation Software









# 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 (<u>www.a-eberle.de</u>).

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# Table of Contents

1.	User Guidance
1.1	Warnings
1.2	Notes
1.3	Other Symbols6
2.	Scope of Delivery/Order Codes
2.1	Scope of Delivery
2.2	Order Codes
3.	Safety Instructions
4.	Technical Data11
4.1	PQ-Box 200
4.2	Environmentalconditions
4.3	Accessories for current measurement 15
4.3.1	Rogowski current clamps
4.3.2	Current clamps
4.3.3	Accessories for current measurement
5.	Intended use
6.	Description
7.	Operation19
7.1	PQ-Box Hardware
7.1.1	PQ-Box 200 Overview
7.1.2	Direct connection to a 3-phase low voltage network
7.1.3	Connection to a single-phase low voltage network
7.1.4	Connection to secondary transformer
7.1.5	Display
7.1.6	Starting a measurement 29
7.1.7	Manual Trigger
7.1.8	Time synchronisation using the RS232 interface
7.1.9	PQ-Box 200 Setup
7.1.10	Keypad Lock
7.1.11	Memory management
7.1.12	Continuous mode
7.1.13	TCP-IP settings
8.	Evaluation software WinPQ mobile35
8.1	SW – Installation / Removal / Update
8.2	WinPQ mobile start screen
8.2.1	General Software Settings

8.2.2	TCP-IP Settings in WinPQ mobil	42
8.3	Transferring measurement data from the PQ-Box 200 to the PC	43
8.3.1	Data folder in Windows Explorer	44
8.3.2	Transferring measurement data while a measurement is in progress	45
8.4	Evaluation of Measurement Data	46
8.4.1	Change the measurement data directory	47
8.4.2	Standard evaluation for EN50160 and IEC61000-2-2	50
8.4.3	Bar chart of the Harmonics and Interharmonics	55
8.4.4	DACH-CZ report	57
8.4.5	Level-time diagrams of the long-term data	58
8.4.6	Oscilloscope recordings	65
8.4.7	10 ms RMS Recorder	67
8.4.8	Transient recorder	68
8.4.9	Ripple Control Signal Recorder	69
8.4.10	PQ Events	70
8.4.11	Data export – Interval data	72
8.4.12	Additional functions	74
9.	PQ-Box 200 Limits and Settings	.77
9.1	Setup - Basic Settings	78
9.2	Setup – EN50160 / IEC61000-2-2 / IEC61000-2-4 Limits	85
9.3	Oscilloscope trigger settings	86
9.4	10 ms RMS Recorder	88
9.5	Trigger through Binary Input	89
9.6	Transient setup	89
9.7	PQ-Box 200 Firmware Update	90
9.8	PQ-Box 200 Licence Update	91
9.9	Data Converter	91
10.	Online Analysis: PQ-Box 200 & PC	.93
10.1	Online - Oscilloscope Image	93
10.2	Online – FFT – 20,000 Hz	94
10.3	Online - Harmonics	96
10.4	Online - Interharmonics	97
10.5	Online – Frequency Bands 2 kHz to 9 kHz	98
10.6	Online – Direction of the Harmonics	99
10.7	Online Level-Time Diagram	L00
10.8	Online - Measurement Value Details 1	L01
10.9	Online - Phasor Diagram 1	L02
10.10	Power Triangle 1	103



11.	Measurement Data – PQ-Box 200 Measurement Procedure	104
11.1	PQ-Box 200 Measurement Procedure / Formulas	
12.	Maintenance/Cleaning	117
13.	Calibration	117
14.	Disposal	117
15.	Product Warranty	

# 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



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:

- $^{\textcircled{b}}$  Guidance for an action.
- $\rightarrow$  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. Scope of Delivery/Order Codes

# 2.1 Scope of Delivery

- PQ-Box 200
- User Manual
- Case
- 3 red dolphin clips, 1 blue dolphin clip, 1 green dolphin clip
- 3 high-load fuses
- USB cable, Ethernet cable
- Adaptor cable for AUX input
- AC adapter with country-specific adapters

## 2.2 Order Codes

Two options are available for the PQ-Box 200:

#### - Transient measuring board (hardware circuit board)

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



The transient measuring board must be installed by the manufacturer.

#### - Ripple control signal analysis (Firmware update)

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



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

	CODE
Fault recorder and network analyzer according to DIN EN 50160 and IEC 61000-3-40 class A	A PQ-Box 200
networks according to DIN EN-50160/IEC 61000-4-30 class A	ge
4 GB micro SD card memory     Slot for SD memory card 1CB to 22CB	
<ul> <li>Slot for SD filemory card TGB to S2GB</li> <li>USB 2.0 and TCD/ID interface</li> </ul>	
PS222 interface to connect radio clock or GPS clock	
IP65 rated enclosure	
<ul> <li>Uninterruptible power supply</li> </ul>	
<ul> <li>USB- and TCP/IP cable set</li> </ul>	
• Connection cable with 4 mm banana plus for voltage (phase connections fused)	
• 5 pcs. Dolphin clips	
Hardcase for PQ-Box 200 and accessories	
Power supply 15V DC	
Evaluation software	
Option	
<ul> <li>Transient measuring circuit board</li> </ul>	T1
<ul> <li>Ripple control analysis</li> </ul>	R1
Operating manual and display language	
• German	G1
English	G2
French	G3
Spanish	G4
• Italian	G5
<ul> <li>Dutch</li> </ul>	G6
• Czech	G7
Russian	G8
Polish	G9

ACCESSOIRES	IDENT-NO.
Voltage tap on insulated cable; contact support 1 ~, connected for 35-240mm <sup>2</sup>	111.7037
<ul> <li>Cable set 4 phase, 1.5 mm<sup>2</sup>, 2m long, 4x 16A fuse, 4x 4mm safety plugs</li> </ul>	111.7038
<ul> <li>Network adapter connector socket for 1 ~; 4mm safety plugs</li> </ul>	582.0511
<ul> <li>Calibration set for PQ-Box 100/200; calibration software and adapter box</li> </ul>	111.7039
Kensington lock - Lock for PQ-Box 200, 1.8 m length	111.7032
<ul> <li>Temperature sensor, air temperature -2080°C</li> </ul>	111.7041
<ul> <li>Combination sensor for lighting 0-1400W/m2 and temperature -3070°C</li> </ul>	111.7040
Kit of magnetic voltage taps	111.7008
DCF 77 radio controlled clock	111.9024.01
<ul> <li>GPS radio clock (230 V – RS 232)</li> </ul>	111.9024.47
<ul> <li>CAT-Booster (600 V CAT IV) voltage adapter for PQ-Box 100 / 200</li> </ul>	111.7026
SD memory card, 4GByte industry-standard	900.9099
Replacement battery pack	570.0010



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 /	
Record free interval less to 20 min (>2 600 measurement parameter permanent parallel):	
Voltage: Average Min Max Value	
Power: P. O. S. PE. cos phi sin phi	
Distortion nower D: Fundamental oscillation nower	
Elickor (Det Dit Det)	
Linkalanced current and voltage: reactive system	
Voltage barmonies according to IEC61000.4.20 Class A	up to EQ
Voltage narmonics 200 Hz frequency bands	2 KHZ to 9 KHZ
	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	
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
Interharmonic 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

# 3. Safety Instructions

- <sup>™</sup> Follow the operating instructions.
- ${}^{\textcircled{W}}$  Keep the operating instructions with the device.
- $^{\textcircled{W}}$  Ensure that the device is operated only in a perfect condition.
- $^{\textcircled{b}}$  Never open the device.
- "When opening the battery compartment, disconnect the power supply.
- <sup>1</sup> Ensure that only qualified personnel operate the device.
- $^{\textcircled{b}}$  Connect the device only as specified.
- $^{\ensuremath{\mathfrak{V}}}$  Ensure that the device is operated only in the original condition.
- ${}^{\textcircled{W}}$  Connect the device only with recommended accessories.
- \* Ensure that the device is not operated outside the design limits. (See the technical data, Section 4)
- \* 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.



# 4. Technical Data

# 4.1 PQ-Box 200

Voltage range of the voltage measurement	0-400 V AC (565 V DC) Phase-Ground (L-E)
channel	0-690 V AC (975 V DC) Phase-Phase (L-L)
L1, L2, L3, N, E	
Voltage range AC adapter	100-240 V AC; 47Hz – 63Hz /
Power supply PQ-Box 200	15 V DC, 0,58A output
Voltage range of the current measurement channel	
- Mini current clamps / Adapter connection set	700 mV RMS; 1000 mV DC
- Rogowski coils	330 mV AC
- AUX input	1000 mV RMS; 1400 mV DC
micro SD card memory	4 GB standard / up to 32 GB optional
Interfaces	
- USB 2.0	Communication
- TCP/IP	Communication
- RS232	DCF77 connection or GPS synchronisation unit
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	1 ΜΩ
channel	
Accuracy	
Current measurement channel	
- 0.85 mV $\leq$ Ue < 5 mV	0.01 % of end value
$-5 \text{ mV} \le \text{Ue} < 50 \text{ mV}$	0,5 % of the measured value
$-50 \text{ mV} \le \text{Uc} \le 700 \text{ mV}$	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 <sub>din</sub>
	over 10% ~ 150% of $U_{din}$
Fundamental oscillation: Phase	± 0.15°
	over 50% ~ 150% of $U_{\rm din}$
	over f <sub>nom</sub> ±15%
2nd 50th harmonic	$\pm 5\%$ of display over U <sub>m</sub> = 1% ~ 16% of U <sub>din</sub>
	$\pm 0.05\%$ of U <sub>din</sub> over U <sub>m</sub> < 1% of U <sub>din</sub>
2nd 49th interharmonic	$\pm 5\%$ of display over U <sub>m</sub> = 1% ~ 16% of U <sub>din</sub>
	$\pm 0.05\%$ of U <sub>din</sub> over U <sub>m</sub> < 1% of U <sub>din</sub>
Frequency	$\pm$ 5mHz over f <sub>nom</sub> $\pm$ 15% (f <sub>nom</sub> = 50 Hz / 60 Hz)
Flicker, Pst, Plt	$\pm 5\%$ of display over 0.02% ~ 20% of $\Delta U$ / U
Dip residual voltage	$\pm 0.2\%$ of U_{din} over 10% ~ 100% of U_{din}
Dip duration	±20 ms over 10% ~ 100% of U <sub>din</sub>
Swell residual voltage	$\pm 0.2\%$ of U_{din} over 100% ~ 150% of U_{din}
Swell duration	±20 ms over 100% ~ 150% of U <sub>din</sub>
Interruption duration	±20 ms over 1% ~ 100% of U <sub>din</sub>
Voltage asymmetry	±0.15% over 1% ~ 5% of display
Ripple control voltage	$\pm 5\%$ of display over U <sub>m</sub> = 3% ~ 15% of U <sub>din</sub>
	$\pm 0.15\%$ of U <sub>din</sub> over U <sub>m</sub> = 1% ~ 3% of U <sub>din</sub>



# 4.2 Environmentalconditions

#### **Temperature range**

	Function	-20 +60°C
	Transport and storage	-30 +80°C
Humidit	ÿ	
	No condensation	< 95 % rel.
Dry, col	d	
	IEC 60068-2-1	-15°C / 16 h
Dry, hot	:	
	IEC 60068-2-2	+55°C / 16 h
Constan	t 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%
Topplin	g	
	IEC 60068-2-31	100 mm drop, unwrapped
Vibratio	n	
	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	Current: 50Hz / 1,5μA/V; 1kHz / 50μA/V Voltage: 50Hz / 85dB; 1kHz / 60dB
input circuits	Isolated inputs

ENAC	
EIVIC	

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	30230 MHz, 40 dB 2301000 MHz, 47 dB
AC supply connection at a distance of 10 m	0,150,5 MHz, 79 dB 0,55 MHz, 73 dB 530 MHz, 73 dB



# 4.3 Accessories for current measurement

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

### 4.3.1 Rogowski current clamps

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



### Model 111.7006

6000 A measurement range

Adjustment of the power converter factor to x2

# Model 111.7001/6

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

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

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

### 4.3.2 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

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

#### Model 111.7015



#### 200 A Measurement range (111.7015)

\* Adjustment of the power converter factor to x10



Current range: 5mA to 5A AC RMS Frequency range: 40Hz to 20kHz Free current adapter set necessary



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

AC/DC hall sensor clamp. Set with power supply and 2 pcs. 4mm connectors Current range 60A/600A (two ranges)

### Model 111.7020

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



#### 600 A Measurement range (AC/DC)

 $^{\textcircled{b}}$  Adjustment of the power converter factor to x10

### 4.3.3 Accessories for current measurement

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

Adapter set for connecting 4 clamps or shunt with 4mm connectors. 2m length



#### Power conversion factor

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



#### Damage to the device from external current clamps

<sup>™</sup> Do not use clamps with A or mA output

 $^{igvee}$  Avoid input voltages at the current inputs greater than 30 V



Cable extension 5 m for current clamps or Rogowski coils.

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

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

# 5. Intended use

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

# 6. Description

The Network Analyzer PQ-Box 200 is suitable for analysis in low, medium and high-voltage networks. It meets all the requirements of the measurement equipment standard IEC61000-4-30 class A. Functions:

 $\rightarrow$  Voltage quality measurements according to EN50160, IEC61000-2-2 and IEC61000-2-4 for

low and medium voltage networks

- → Fault recorder functions
- → Load analyses; energy measurements
- → Ripple control signal analysis
- → Transient analysis



# 7. Operation

# 7.1 PQ-Box Hardware

### 7.1.1 PQ-Box 200 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



#### We take care of it

#### **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)



#### **Micro SD card**

To replace the microSD card, please note the following:

- The PQ-Box 200 supports 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.

#### Accumulator:

The PQ Box 200 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 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 barsstate of charge >= 75% -->three green barsstate of charge >= 40% -->two green barsstate of charge >= 20% -->one red barstate of charge < 20% -->empty

## 7.1.2 Direct connection to a 3-phase low voltage network

Connection in a 3-phase 4-wire AC network



#### Voltage connection

- <sup>♥</sup> Ensure that voltage measurement cable PE is connected for every measurement.
- <sup>♥</sup> If no PE connection is available, connect E and N together.
- <sup>1</sup> Ensure that switching (4-wire) is selected. (Setting via display or software)

#### PE conductor current measurement

The PQ Box 200 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.



## 7.1.3 Connection to a single-phase low voltage network



Connection for single-phase measurements

#### Voltage connection

- <sup>♥</sup> Ensure that voltage measurement cable E is connected for every measurement.
- <sup>♥</sup> If no PE connection is available, connect E and N together.
- \* Ensure that switching "1-wire system" is selected. (Setting via display or software)

1-wire System

<sup>♥</sup> Not necessary to connect phases L2 and L3 for voltage and currents in single phase measurement.

## 7.1.4 Connection to secondary transformer



#### Connections

- <sup>♥</sup> 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)
- <sup>™</sup> Set the voltage transformer ratio
- \* Enter the nominal conductor-conductor voltage
- <sup>™</sup> Set the current transformer ratio



#### Special circuit types

Configurations such as a V connection or aron connection can be parameterized.



- 1) V connection (parameterization through the evaluation software or device setup)
- 2) Aron connection (parameterization through the evaluation software or device setup)

#### **Isolated networks**

#### Connections

Connect voltage measurement conductors E and N to ground

<sup>1</sup>/<sub>2</sub> 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.

- <sup>®</sup> Ensure that switching (3-wire) is selected.
- <sup>™</sup> Set the voltage transformer ratio
- Enter the nominal conductor-conductor voltage
- <sup>™</sup> Set the current transformer ratio

#### Display 7.1.5

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

Display.

### Display page 1

	1	2			3				4	
	0	-		0d0	00:00	:00	9	44N	IB/95	6MB
			L1		L	.2		L3		Total
U	[kV]	1	.331		0.00	0	0.0	00		
I.	[A]	C	000.		0.00	0	0.0	00	0	.000
Ρ	[W]	+0	000.		+0.00	0	+0.0	00	+0	.000
Ph	ni [°]	+0	0.000		+0.00	0	+0.0	00		
F	[Hz]	C	0.000							

1) Recording "On" is indicated by a flashing red light

2)	Display state of charge b	atter	у
	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

•		0d00:00:00	) 701M	/IB/952MB
Recorder				Count
Oscillosco	ope Rec.			0
RMS Reco	order			0
Signal vol	tage			0
PQ events	S			0
Transient	Events			0

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





#### Display page 3

	•		0d00:00:00	) 944N	/IB/956MB
		L1	L2	L3	Total
s	[VA]	0.000	0.000	0.000	0.000
Q	[VAR]	+0.000	+0.000	+0.000	+0.000
Р	[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
со	s phi	+1.000	+1.000	+1.000	+1.000

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

#### **Display page 4**

•		••• 0d00:00:00		IB/956MB
	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

 $\rightarrow$  Display of the current and voltage THD (individual phases, neutral conductor)

 $\rightarrow$  Display of the conductor-conductor voltages

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

#### Display page 5

0	- 1	0d00:00:00 701M		MB/952MB
DCF		no	Serial number	9926-101
Battery		62%	BOOT-Version	0.173
Date		05.09.2012	MCU-Version	1.217
Time		11:25:19	DSP-Version	2.006

- $\rightarrow$  Date, time, version, current firmware version and time synchronization display.
- $\rightarrow$  After changing display pages once more, display page 1 appears again.

#### Graphic display PQ-Box 200

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



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



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



## 7.1.6 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.

### 7.1.7 Manual Trigger

🥗 Press the

key to set manual trigger.

 $\rightarrow$  Store the current voltages and currents with:

- Oscilloscope recorder
- 10ms RMS recorder
- Transient recorder

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

•		0d00:00:00	) 701N	1B/952MB	
Recorder				Count	_
Oscillosco	ope Rec.			0	
RMS Reco	order			0	
Signal vol	tage			0	
PQ events	5			0	
Transient	Events			0	

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

## 7.1.8 Time synchronisation using the RS232 interface

 $\rightarrow$  The RS232 interface is equipped as standard for a DCF77 or GPS receiver connection.

- Automatic synchronisation of the measurement equipment after connecting receivers. If synchronisation 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.



## 7.1.9 PQ-Box 200 Setup

Press the key to open Setup.

Press this key again to exit the Setup Menu.

 $\rightarrow$  Display page changes to the Main Menu.

Setup	_	1
Parametrisation		
Setup		
Ethernet Interface		

- 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

#### Parameterisation page 1

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

- 1) Freely adjustable measurement interval: 1 sec to 60 min (default interval setting = 600 sec) Settings < 1 min should only be used for short measurements.
- 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.
- 3) Voltage converter corresponds to the ratio between the primary and secondary voltage.
- 4) Current converter corresponds to the ratio between the primary and secondary current.

<sup>™</sup> scroll with the left/right control keys

#### Parameterisation page 2

Setup   Parametrisation		1 2
Net type	4 conductors	
Aron network	off	
V network	off	

5) 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 phasephase voltages.

In a 4-conductor system, all evaluations of the standard reports are calculated from the phaseground voltages.

- 6) Switch Aron connection for 2-current converter measurement on and off
- 7) Switch V connection for 2-voltage converter measurement on and off

#### **Changing parameters**

Setup   Parametrisation		12
Measurement Cycle	060 <u>0</u>	
Nominal Voltage	400	
Voltage Converter L	1	
Voltage Converter N	1	
Current Converter L	1	
Current Converter N	1	

💖 Press

- $\rightarrow$  the colour of the selected parameter changes to orange
- <sup>™</sup> Select position
- ightarrow the value can now be changed with the up and down arrows

Press to accept the changed value

ightarrow the new value appears in the Menu



#### Settings page 1

Setup   Setup		1
Language	English	
Date	18.01.2013	
Time	16:59	
Continuous mode	off	

- 1) Change the display language
- 2) Change the date
- 3) Change the time
- 4) Continuous mode (active = PQ-Box run permanent)

### 7.1.10 Keypad Lock



 $^{(!)}$  Press and hold the Setup key for > 5 sec while a measurement is in progress.

- $\rightarrow$  Keypad lock active.
- $^{(!)}$  Then press and hold > 5 sec.
- $\rightarrow$  Keypad lock inactive.

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

The Setup menu and screen pages are locked.

### 7.1.11 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 of 50% of the free space for 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.

The PQ-Box 200 memory size for one measurement file is limited to 690 MByte, to avoid problems with Windows 32bit systems. If the data size is reached then the PQ Box 200 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 data converter provides the opportunity to connect several measurements to one measurement file.

## 7.1.12 Continuous mode

If the function "continuous mode" is active, the PQ box 200 don't stop running if the power supply is pinched off. 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.

## 7.1.13 TCP-IP settings

In "Setup/ Ethernet Interface" you can change all parameters for IP interface.

Setup	1
Parametrisation	
Setup	
Ethernet Interface	

This example shows the basic settings for the PQ Box 200 interface. All parameters can be changed with the control keys on the box.

Setup   Ethernet Interface	
IP address	192.168.56.94
Subnet mask	255.255.0.0
Gateway	192.168.0.8
TCP port	5001



To accept the changed parameters, the device must be restarted



# 8. Evaluation software WinPQ mobile

The evaluation software WinPQ mobile supports the PQ-Box 100 and PQ Box 200 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

# 8.1 SW – Installation / Removal / Update

#### **System Requirements:**

Operating system: Microsoft Windows XP (Service Pack 2)

Microsoft Windows NT

Microsoft Windows 7 (32-bit & 64-bit)

Microsoft Windows 8

Memory, at least 1 GB (Windows 7 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 SETUP.EXE.

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 will 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 200, to avoid problems.


# 8.2 WinPQ mobile start screen

Start screen of the evaluation software WinPQ mobile



## 8.2.1 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.

Data View	Setup Window I	Help
AG	Languages	▶ 英语
	Default Colors	<ul> <li>Czech</li> </ul>
Information		Deutsch
Info	English	
	Español	
System:	Italiano	
Nominal volt	Polski	
Frequency:		Английский

#### Changing the colours of lines

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



#### **Export Preferences:**



Here the basic settings for data export are set.

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



#### General

#### Change the logo in printouts and headers

Setup Common 2 2 2 Basics	Set the header for automatic standard
Titel of IEC report Auswertung nach EN50160/IEC61000-2-2 Fix Comment 1: Firma Fix Comment 2: Abteilung Logo (360x115, 300dpl) Public/Documents/WinPQ mobil/logos/logo32_Eberle.png	Two predefined comment fields can be set. These will be shown in any printout, as well as in the standard report.
a-eberle GLOBAL NET QUALITY	Insert your own logo for printouts and PDF
EN Statistics         Upper Limit           Frequency:         99,50%         100,00%         0 EN50160	
Voltage 4-wire-systems:       95,00%       100,00%         Voltage 3-wire-systems:       99,00%       100,00%         Harmonics / THD:       95,00%       100,00%         Voltage unbalance / Flicker:       95,00%       100,00%         Header Labels       Co2       Factor:       550 g/kWh         Header Label 1:       Kunde:       Options       Options         Header Label 3:       Kontakt:       Include harmonics in Report         Header Label 3:       Grund:       ØK Cancel	<ul> <li>1) Extended standard report: This feature extends the standard report for all PQ event information and the ITIC graphic</li> <li>2) Standard report including tan phi The inclusion of the tan phi in the stand- ard report can be switched on or off here</li> </ul>
5 text boxes for the standard report and all printouts can be specified here	

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.

#### We take care of it

	WinPQ mobil	áddan Haln	-	_		
	🚦 🞯 🔳 🛛 🏛 🖬					
5	Information	₽×				
matic	System:	4-wire System				
Infor	Nominal voltage L-N:	230V / 132V				
_	Frequency:	60Hz				
arker	Interval:	15				
Ŵ	Ripple-control frequency:	168Hz				
-Viet	Start:	29.08.2012 09:01:35		Manage Measuren	nent Comments	<u>? ×</u>
Det	End:	29.08.2012 09:28:19		Comment 1	Langanikishan	_
				Commeric 1.		_
	Duration:	26m 44s		Comment 2:	- -	_
	Number of intervals:	1562		Comment 3:		
				Comment 4:		
	Serial-No :	9930-101		Kupde:		_
	Firmware:	1.217			1	_
	DSP-Version:	2.6		Adresse:	-	- 1
	, , , , , , , , , , , , , , , , , , , ,			Kontakt:	1	_
	Comments			Telefonnummer:		
pug	Permanent record	5×		Grund:		
reco	Selection					
nent	Frequency					
erma	E 🔬 Current					
ā	🗄 🕀 📥 AUX					

#### 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: Display as "Ampere", "% of the fundamental oscillation" or "% of the nominal current"

A Setup Harmonics Views	×
Voltage Harmonics in:	
C % of fundamental oscillation	
Current Harmonics in:	
C [A]	
% of fundamental oscillation	
C % of nominal value	
Nominal value in [A]: 1.000	
OK Cancel	



#### 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".

## 8.2.2 TCP-IP Settings in WinPQ mobil



In the analysis software in "Settings / Network Connections", multiple network connections from PQ-Box 200 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.



# 8.3 Transferring measurement data from the PQ-Box 200 to the PC

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

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

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

🛦 File Load Dialog				? ×	Loads meas. data from PQ-Box 100
Hard disk Import Meas	surement device				to the PC
PQBox: PQBOX200 Ver:1.321 S	5n:1305-103 [CC	DM11]	- Load c	lata from Bo	
Date	Version	Size		Delete	
12.08.2013 07:51:14	V1.321		3785 KB		Deletes highlighted meas, data from
▲ 08.08.2013 13:37:01	V1.321		2981 KB		DO Dev 100
▲ 08.08.2013 11:16:14	V1.321		13274 KB		PQ-BOX 100
▲ 08.08.2013 11:10:48	V1.321		3586 KB		
A 06.08.2013 08:46:14	V1.321		34656 KB		
A 01.08.2013 15:48:22	V1.321		441480 KB		
10:26:14 🔬 🔬 🔬	V1.321		31233 KB		
🛦 03.07.2013 12:11:36	V1.316		3067 KB		
L				.44	

After reading the data from the device to the PC hard drive , the message "Should the measurement data in the PQ-Box 200 now be deleted?" is displayed.

🔼 PQB	ox100
⚠	Do you want to delete the file from the PQ-Box?
	Yes <u>N</u> o

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.

#### We take care of it

🗶 File Load Dialog						? 🛛
Hard disk Import PQ Box	< 100					
Directory: C:/Programme/	Eberle/PQBox100/Dat	i (				 Load
Date	Version Size	Comment 1	Comment 2	Comment 3	Comment 4	Delete
29.04.2008 16:13:28         31.03.2008 09:50:13         31.03.2008 09:50:13         31.03.2008 09:50:14         26.02.2008 11:29:47         26.02.2008 14:32:31         18.02.2008 14:32:31         18.02.2008 14:32:31         18.02.2008 14:32:31         18.02.2008 14:32:31         18.02.2008 14:32:31         18.02.2008 11:21:54         11.02.2008 15:36:05         01.02.2008 15:36:05         18.01.2008 15:36:05         18.01.2008 15:36:05         11.12.2007 08:54:25         06.12.2007 12:23:46         04.12.2007 13:18:53         03.12.2007 14:50:33         26.11.2007 14:50:33         26.11.2007 14:40:42         26.11.2007 14:40:42         26.11.2007 09:18:52	V01.006         10400 ł           V01.006         12135 k           V01.006         4915 k           V01.006         4915 k           V01.005         6059 k           V01.002         20473 k           V01.006         1007 k           V01.006         1007 k           V01.006         1007 k           V01.001         4733 k           V01.001         1007 k           V01.001         1038 k           V01.001         705 k           V01.001         1038 k           V01.001         1038 k           V01.001         1038 k           V01.001         1077 k           V01.001         1079 k           V01.001         1079 k           V01.001         2714 k           V01.001         39712 k	B Irland B Kommentar 1 B Kommentar 1 B Kroatien B Solaranlage B OHplus B Birro B Salvo B NS B MS B Kommentar 1 B AHA Deponie Lahe B ter B Kommentar 1 B Robert Bosch-Kra B Robert Bosch Ku B Robert Bosch Stu B Robert Bosch Stu B Kat.300 UW Mai B Kommentar 1 B Kommentar 1	Comment 2 Kommentar 2 Kommentar 2 EMPTY Demomessung Stassfurt Verteilung 32 Tallin Messe Papierfabrik Kommentar 2 Station Deponieg ter Kommentar 2 Messung DC 2 Messung DC 1 Gerät 3 Niederspannungs Messung 1 Kommentar 2 Kommentar 2	Comment 3 Kommentar 3 Kommentar 3 Kommentar 1 Kommentar 1 Kommentar 1 Kommentar 3 Test Kommentar 1 Kommentar 1	Comment 4 Kommentar 4 Kommentar 4 EMPTY Kommentar 1 Kommentar 4 Kommentar 4 Kommentar 4 Kommentar 1 Kommentar 1	Abort

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.

## 8.3.1 Data folder in Windows Explorer

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





## 8.3.2 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.

🛃 File Load Dialog	? 🛛
Hard disk         Import         PQ Box 100           PQBox:         PQBOX100 Ver:01.105 Sn:0736-003 [COM8]           Date         Version         Size           09.09.2008 13:39:19         V01.105	Delete Load data from Box Continue

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.

ard disk Import PQ Box 100	
QBox: PQBOX100 Ver:01.105 Sn:0736-003 [COM8]	✓
Pate Version Size	Delete
09.09.2008 13:39:19 V01.105	409 KB Load data from Box Continue

# 8.4 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.



Sort the data in ascending or des (by Date or Commen	Change th data direc	e measurement tory		
File Load Ding Hard disk In rt PQ Box 100				?
Directory: /Programme/Eberle/PQBox100/Data				Load
Date 🛛 🝸 Version Size Commen	Comment 2	Comm C 3	Comment 4	Delete
🛁 🙏 09.09.2008 13:39:19 V01.105 409 KB Comment 1	Comment 2	Comment 3	Comment 4	
— A 05.09.2008 09:43:57 V01.104 779 KB frequency convert	.er 690V	Danfos	Kommentar 4	
— 🔔 04.09.2008 17:11:37 V01.104 9306 KB ripple signal	neue FW1.207	Kommentar 3	Kommentar 4	
— 🔔 02.09.2008 14:04:40 V01.104 1967 KB Trafo 4	ET304	Kommentar 3	Kommentar 4	
— 🔔 02.09.2008 14:00:16 V01.100 1605 KB Trafo 6	ET306	Kommentar 3	Kommentar 4	
— 🔔 02.09.2008 13:54:42 V01.104 1992 KB Trafo 5	ET305	Kommentar 3	Kommentar 4	
— 🔔 02.09.2008 12:16:12 V01.104 900 KB Trafo 3	ET303	Bau 142	Station 3	
🛛 🖳 🔔 02.09.2008 12:16:12 V01.104 🛛 2037 KB Trafo 1	ET301	BAu 142	Station 3	Abort

## 8.4.1 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".



1

#### We take care of it

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.

▲       19.11.2008 00:18:53       V01.106       4017 KB Warwick       EMPTY       EMPTY       EMPTY       EMPTY         ▲       28.10.2008 17:34:06       V01.106       V01.106       Image: Constraint of the second se		EMPTY	EMDTY E						
▲       28.10.2008 17:34:06       V01.106       Iter 4         ▲       28.10.2008 17:38:03       V01.106       Iter 4         ▲       28.10.2008 17:08:46       V01.106       Iter 4         ▲       28.10.2008 17:08:45       V01.106       Iter 4         ▲       28.10.2008 17:08:45       V01.106       Iter 4         ▲       28.10.2008 17:08:45       V01.106       Iter 4         ▲       28.10.2008 16:53:31       V01.106       Iter 4         ▲       28.10.2008 16:52:20       V01.106       Iter 4         ▲       28.10.2008 16:20:10       V01.106       Iter 4         ▲       28.10.2008 16:05:30			LIMP IT L	EMPTY	KB Warwick	4017 K	V01.106	.11.2008 00:18:53	📐
▲ 28.10.2008 17:34:03       V01.106       ▲ Valuation period       ✓ ▲ ntar 4         ▲ 28.10.2008 17:08:46       V01.106       ▲ valuation period       ✓ ▲ ntar 4         ▲ 28.10.2008 17:08:45       V01.106       ■ mtar 4       ntar 4         ▲ 28.10.2008 17:08:45       V01.106       ■ mtar 4         ▲ 28.10.2008 16:53:31       V01.106       ■ mtar 4         ▲ 28.10.2008 16:52:20       V01.106       ■ mtar 4         ▲ 28.10.2008 16:52:10       V01.106       ■ mtar 4         ▲ 28.10.2008 16:20:10       V01.106       ■ mtar 4         ▲ 28.10.2008 16:05:30       V01.106       ■ mtar 4         ▲ 28.10.2008 06:05:30       ■ mtar 4         ▲ 28.10.2008 06:05:30       ■ mtar 4         ■ 21.10.2		ntar 4					V01.106	.10.2008 17:34:06	📥
▲ 28.10.2008 17:08:46       V01.106       ntar 4         ▲ 28.10.2008 17:08:45       V01.106       ntar 4         ▲ 28.10.2008 16:53:31       V01.106       ntar 4         ▲ 28.10.2008 16:52:20       V01.106       ntar 4         ▲ 28.10.2008 16:20:10       V01.106       duration:       6d 23h 30m 0s         ▲ 28.10.2008 16:20:10       V01.106       ntar 4         ▲ 28.10.2008 16:50:30       V01.106       ntar 4         ▲ 28.10.2008 16:05:30       V01.106       ntar 4         ▲ 28.10.2008 16:05:30       V01.106       from:       26.02.2008 ♥ 14:0:00 ♥         ▲ 28.10.2008 16:05:30       V01.106       from:       26.02.2008 ♥ 14:0:00 ♥       ntar 4         ▲ 28.10.2008 16:05:30       V01.106       from:       26.02.2008 ♥ 14:0:00 ♥       ntar 4         ▲ 27.10.208 08:07:314       V10.02       vtar 4       ntar 4       ntar 4<		🗾 🔼 ntar 4	<u>_</u>		valuation period	<u>23</u>	V01.106	.10.2008 17:34:03	- 🔺
▲ 28.10.2008 17:08:46       V01.106       ntar 4         ▲ 28.10.2008 17:08:45       V01.106       ntar 4         ▲ 28.10.2008 17:08:45       V01.106       ntar 4         ▲ 28.10.2008 16:53:31       V01.106       to:       04.03.2008       14:10:00         ▲ 28.10.2008 16:52:20       V01.106       to:       04.03.2008       14:10:00       ntar 4         ▲ 28.10.2008 16:52:10       V01.106       duration:       6d 23h 30m 0s       ntar 4         ▲ 28.10.2008 16:20:10       V01.106       to:       04.03.2008       ntar 4         ▲ 28.10.2008 16:20:10       V01.106       trar 4       ntar 4         ▲ 28.10.2008 16:05:30       V01.106       to:       04.03.2008       tar 4         ▲ 28.10.2008 16:05:30       V01.106       to:       04.03.2008       tar 4         ▲ 27.10.2008 04:25:56       V01.106       to:       04.03.2008       14:10:00       thar 4		ntar 4			Appaurement period	0.0	V01.106	.10.2008 17:08:46	📥
▲ 28.10.2008 17:08:45       V01.106       1         ▲ 28.10.2008 17:08:45       V01.106       1         ▲ 28.10.2008 16:53:31       V01.106       1         ▲ 28.10.2008 16:52:20       V01.106       1         ▲ 28.10.2008 16:52:20       V01.106       1         ▲ 28.10.2008 16:52:20       V01.106       1         ▲ 28.10.2008 16:52:10       V01.106       1         ▲ 28.10.2008 16:20:10       V01.106       1         ▲ 28.10.2008 16:20:10       V01.106       1         ▲ 28.10.2008 16:05:30       V01.106       1         ▲ 28.10.2008 06:05:30       V01.106       1         ← 27.10.2008 04:25:56       V01.106       1         to:       04.03.2008       14:10:00         ↓ 21.10.2008 04:25:56       101.06       1         to:       04.03.2008       14:10:00		ntar 4			leasurement period		V01.106	.10.2008 17:08:46	- 🙏
▲ 28.10.2008 1/:08:45 V01.106       1         ▲ 28.10.2008 16:53:31 V01.106       to:       04.03.2008       14:10:00       ntar 4         ▲ 28.10.2008 16:52:20 V01.106       duration:       6d 23h 30m 0s       ntar 4         ▲ 28.10.2008 16:20:10 V01.106       duration:       6d 23h 30m 0s       ntar 4         ▲ 28.10.2008 16:20:10 V01.106       Evaluation period       ntar 4         ▲ 28.10.2008 16:05:30 V01.106       From:       26.02.2008 ♥       14:40:00 ♥         ▲ 28.10.2008 16:05:30 V01.106       from:       26.02.2008 ♥       14:10:00 ♥         ▲ 27.10.2008 04:25:56 V01.106       to:       04.03.2008 ♥       14:10:00 ♥		ntar 4	14:40:00	26.02.2008	rom:	, fr	V01.106	.10.2008 17:08:45	··· 🐥
28.10.2008 16:53:31 V01.106       to:       04.03.2008       14:10:00       ntar 4         28.10.2008 16:52:20 V01.106       duration:       6d 23h 30m 0s       ntar 4         28.10.2008 16:20:10 V01.106       duration:       6d 23h 30m 0s       ntar 4         28.10.2008 16:20:10 V01.106       to:       04.03.2008 ¥       ntar 4         28.10.2008 16:05:30 V01.106       Evaluation period       ntar 4         28.10.2008 16:05:30 V01.106       from:       26.02.2008 ¥       14:10:00 \$         28.10.2008 04:25:56 V01.106       to:       04.03.2008 ¥       14:10:00 \$		ntar 4				1	VU1.106	.10.2008 17:08:45	- 🐥
▲ 28.10.2008 16:52:20       V01.106       duration:       6d 23h 30m 0s       ntar 4         ▲ 28.10.2008 16:20:10       V01.106       tar 4       ntar 4         ▲ 28.10.2008 16:20:10       V01.106       tar 4         ▲ 28.10.2008 16:20:10       V01.106       ntar 4         ▲ 28.10.2008 16:05:30       V01.106       tran 4         ▲ 28.10.2008 16:05:30       V01.106       from:       26.02.2008 ♥       14:40:00 ♥         ▲ 27.10.2008 04:25:56       V01.106       to:       04.03.2008 ♥       14:10:00 ♥		ntar 4	14:10:00	04.03.2008	:0:	ta	VUI.106	10.2008 16:53:31	-
▲ 28.10.2008 16:20:10       V01.106       ■ <td< td=""><td></td><td>ntar 4</td><td>23h 30m 0s</td><td>6d</td><td>duration:</td><td>d</td><td>V01.106</td><td>10.2008 16:52:20</td><td>4</td></td<>		ntar 4	23h 30m 0s	6d	duration:	d	V01.106	10.2008 16:52:20	4
▲ 28.10.2008 16:05:30       V01.106       Evaluation period       ntar 4         ▲ 28.10.2008 16:05:30       V01.106       from:       26.02.2008 ♥       14:0:00 ♥         ▲ 27.10.2008 04:25:56       V01.106       to:       04.03.2008 ♥       14:10:00 ♥       ntar 4		otar 4					V01.100	10.2008 16:20:10	1
▲       28.10.2008 16:05:30       V01.106       from:       26.02.2008 ♥       [4]:40:00 ♥       ntar 4         ▲       27.10.2008 04:25:56       V01.106       to:       04.03.2008 ♥       14:10:00 ♥       ntar 4		ntar 4			valuation period	-EV	V01.100	10.2008 16:20:10	1
-▲     28.10.2008 16:05:30     V01.106     from:     26.02.2008 ♥     14:40:00 ♥     ntar 4       -▲     27.10.2008 04:25:56     V01.106     to:     04.03.2008 ♥     14:10:00 ♥     ntar 4		ntar 4					V01.106	.10.2008 16:05:30	1
- 27.10.2008 04:25:56 V01.106 to: 04.03.2008 ♥ 14:10:00 ♥ ptar 4		ntar 4	🗙 [4:40:00 😂	26.02.2008	rom:	fr	V01.106	.10.2008 16:05:30	
▲ 21 10 2008 09:07:14 V01 002			14,10,00	04.02.2009			V01.106	.10.2008 04:25:56	👗
		ntar 4	14:10:00	04.03.2000	.0:	u	V01.002	.10.2008 09:07:14	- 👗
- 👗 13.10.2008 09:58:24 V01.107 1 duration: 6d 23h 30m 0s ntar 4		ntar 4	23h 30m 0s	6d	duration:	1 d	V01.107	.10.2008 09:58:24	👗
- 🔬 07.10.2008 15:37:39   V01.106							V01.106	.10.2008 15:37:39	- 🔺
A 26.02.2008 14:32:31 V01.001 Presets raße		raße			resets	Pr	V01.001	.02.2008 14:32:31	-
		_							
all 1 day 1 week 4 weeks			week 4 weeks	1 day 1	all				

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 the demo measurement:



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

Overview data					
PQ-events:[19]	×		×	×	
Permanent record: Oscilloscope:[3] 10ms RMS:[3] Ripple control sign	Display of the daily changes	or weekly	Discilloscope Time stamp: 13.12.08 Trigger: Voltage dip l	0 1 / 12:58:25 ULI [ID=1]	
_			-		

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

## 8.4.2 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 **1**. In the example shown, the flicker in phase L1 exceeded this 100% limit.



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 PQ-box 200:

Setup PQ-Box 100		?
QBox:	0%	Load setup from Box
	Limits Standard Limits: Narrow Limit [%]: 95,00 🗘 Wide Limit [%]: 100,00 🗘	Send new setup to Box Synchronize Time Load
Basic settings	Slow voltage change           Tolerance 95.00%:         positive [%] 110,00 \$ negative [%] 90,00 \$           Tolerance 100.00%:         positive [%] 110,00 \$ negative [%] 85.00 \$	Store Basic settings
	Fast voltage change     Tolerance 100%     positive [%] 106,00 \$ negative [%] 94,00 \$	
Limits	Network frequency Tolerance 95.00%: positive [Hz] 50,50 🗘 negative [Hz] 49,50 📚	
	Tolerance 100.00%:     positive [Hz]     52,00 Image interve [Hz]     47,00 Image interve	
	Tolerance         95.00% [%]:         2,00          Tolerance         95.00%:         1,00          Tolerance         95.00% [%]:         8,00          Image: Comparison of the state of t	
10ms RMS recorder	Voltage harmonics	
	Harmonics: 2 C	
Retresh	Factor 100.00%: 1,50 📚	Close

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.

Information	₽×	Plot Details	Harmonics					
Info		Frequency			Voltage changes			
Nominal voltage: 2	:30V	Maximum value:		50.11 Hz		L1	L2	L3
Frequency: 5	OHz	95% value:		50.04 Hz	Maximum value:	238.94 V	240.72 ¥	238 77 V
Start: 08.04.2007 17:50:00	<u> </u>	5% value:		49.97 Hz	95% value:	236.52 V	238.13 V	236.27 V
End: 15.04.2007 18:20:00	\$	Minimum value:		49.89 Hz	5% value:	227.26 V	227.79 ¥	227.52 V
Duration: 7T 0h 29m	59s	Limiting value Ma	ax:	50.50 Hz	Minimum value:	225.64 V	226.10 V	225.84 V
Number of intervals:	012	Limiting value Min:		49.50 Hz	Limiting value Max:	254.03 V	Number (free interval):	1012
		Number (10sec v	values):	60717	Limiting value Min:	207.85 V		
		-Voltage unbaland	се		Flicker:			
		Maximum value:		0.53		L1	L2	L3
		95% value:		0.32	Maximum value	0.81	1.03	1.06
Timing data	6' X	Limit value:		2.00	95% value:	0.48	0.40	0.37
	_	Number (free int	toruañ	1012	Limiting value Navy	1.00	Number (2h value)	

#### 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.





# i

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.

EN/IEC	report Details	Harmoni	ics 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)									
	Limit f	rom the s	tandard	7						
		ion the s	lanudiu							

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

#### Create EN50160 / IEC61000-2-2 report:

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





## 8.4.3 Bar chart of the Harmonics and Interharmonics



Using the two icons, all voltage and current harmonics, as well as voltage and current interharmonics 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]



## 8.4.4 DACH-CZ report

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

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

					f			
Harmonics Plot	Interharmonics	s Plot Harr	monics Details	Interharmo	nics Details	D-A-C-H - CZ		
					C C			
	Chart sine		1.	10000				
	Short circi	uit power [kvA	J:	10000				
	Connection	n Load [kVA]:		630				
	Nominal v	oltage I-L [V]:		400				
	normal v	ondge z z [v].						
	valid THDi	[%]:		8.0	Caj	culate		
						v		
	voltage h	Standard 1	factor value	max. emissi	on limit [A]	manage barma		
		L1 - L3	N	11 10		meas. nam	. values [A]	ſ
	H 3	6.0	18.0	LI - L3	N	L1 - L3	. values [A] N	
				21.7	N 65.2	L1 - L3 2.4	. values [A] N 1.2	
	H 5	15.0		21.7 54.3	N 65.2	L1 - L3 2.4 107.2	. values [A] N 1.2	
	H 5 H 7	15.0 10.0		21.7 54.3 36.2	N 65.2	L1 - L3 2.4 107.2 33.1	. values [A] N 1.2	
	H 5 H 7 H 11	15.0 10.0 5.0		21.7 54.3 36.2 18.1	N 65.2	L1 - L3 2.4 107.2 33.1 30.6	. values [A] N 1.2	
	H 5 H 7 H 11 H 13	15.0 10.0 5.0 4.0		21.7 54.3 36.2 18.1 14.5	N 65.2	L1 - L3 2.4 107.2 33.1 30.6 15.3	. values [A] N 1.2	
	H 5 H 7 H 11 H 13 H 17	15.0 10.0 5.0 4.0 2.0		21.7 54.3 36.2 18.1 14.5 7.2	N 65.2	L1 - L3 2.4 107.2 33.1 30.6 15.3 15.8	. values [A] N 1.2	
	H 5 H 7 H 11 H 13 H 17 H 19	15.0 10.0 5.0 4.0 2.0 1.5		21.7 54.3 36.2 18.1 14.5 7.2 5.4	N 65.2	L1 - L3 2.4 107.2 33.1 30.6 15.3 15.8 10.0	. values [A] N 1.2	

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

Details										
	DACH-CZ: NOT COMPLIED									
voltage harmonics	Standard fa	actor value	max. emissi	on limit [A]	meas. harm. values [A]					
	L1 - L3	N	L1 - L3	N	L1 - L3	N				
Н 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					

## 8.4.5 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 1850 different measurement values (voltage, harmonics, interharmonics, 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) **U** off min and pressing the **Timing diagram** 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

Using the legend, the channels displayed can be toggled on and off



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.



Move graphic:



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

#### We take care of it

#### 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 colour.

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**

M 🕅 M

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**<sup>™</sup> 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% Unenn)



#### Show limit marker harmonics

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



#### Insert and edit comment

With the "Insert comment" function, any number of texts 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 Windows "remove" function the text can be deleted or moved using the mouse.

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

	***		hhit
- 200.00 —			
-			
- 150.00 –			
-		voltage dip 132.23V	



## 8.4.6 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 (DC - 20,000 Hz) is possible by activating the "FFT" field of each triggered oscilloscope image.



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





Graph

## 8.4.7 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 button retrieves the corresponding 10 ms RMS recorder value.



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)

## 8.4.8 Transient recorder

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 1 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.





# 8.4.9 Ripple Control Signal Recorder

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



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

## 8.4.10 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.

and the second se									
rmation			Event	Start Time	Max. Value	Harmonic	End Time	Duration	
nto		1	Dip U3E	21.10.2008 11:22:27	216.486		21.10.2008 11:22:27	Os 80ms	
iominal voltage L-N:	4007 / 2307	2	Infraction harmonic U2E	21.10.2008 11:22:28		6	21.10.2008 11:22:28		
Ripple-control frequency:	168Hz	3	Swell U2E	21.10.2008 11:22:46	252.48		21.10.2008 11:22:46	0s 187ms	
itart: 2	1.10.2008 11:20:41	4	Swell U1E	21.10.2008 11:22:46	254.575		21.10.2008 11:22:46	0s 196ms	
ind: 2	1.10.2008 11:29:40 8m 59c	5	Swell U3E	21.10.2008 11:22:46	248.196		21.10.2008 11:22:46	0s 196ms	
Jumber of intervals:	436	6	Dip U3E	21.10.2008 11:22:52	214.975		21.10.2008 11:22:52	Os 10ms	
More		7	Dip U3E	21.10.2008 11:22:52	211.719		21.10.2008 11:22:52	0s 308ms	
events	ē x	8	Dip U1E	21.10.2008 11:22:52	205.539		21.10.2008 11:22:52	Os 194ms	
PO-events		9	Dip U2E	21.10.2008 11:22:52	207.659		21.10.2008 11:22:52	Os 215ms	
PQ-events	Number	10	Infraction harmonic U1E	21.10.2008 11:22:53		2	21.10.2008 11:22:53		
Frequency deviation	2	11	Infraction harmonic U2E	21.10.2008 11:22:53		2	21.10.2008 11:22:53		
- Vervorage	14	12	Infraction harmonic UDE	21.10.2000 11:22:50		2	21.10.2000 11:22:50		
🗸 Deep voltage dip	4	13	Infraction harmonic U1E	21.10.2008 11:22:54		2	21.10.2008 11:22:54	·	
<ul> <li>Voltage interruption</li> <li>Voltage interruption</li> <li>Voltage interruption</li> <li>Signal detection (3sec</li> </ul>	-va 0	14	Infraction harmonic U2E	21.10.2008 11:22:54		2	21.10.2008 11:22:54		
<ul> <li>Image event</li> <li>Image event</li> <li>Infraction long term fli</li> </ul>	cker 0	15	Infraction harmonic U3E	21.10.2008 11:22:54		2	21.10.2008 11:22:54		
A Infraction Unsymetry     A Infraction THD	3	16	Swell U2E	21.10.2008 11:23:03	245.665		21.10.2008 11:23:03	Os 9ms	
🖂 🖌 Infraction harmonic	33	17	Swell U2E	21.10.2008 11:23:03	258.604		21.10.2008 11:23:03	Os 281ms	
		18	Swell U1E	21.10.2008 11:23:03	267.542		21.10.2008 11:23:03	0s 262ms	
		19	Swell U3E	21.10.2008 11:23:03	266.804		21.10.2008 11:23:03	0s 234ms	
		20	Infraction harmonic U1E	21.10.2008 11:23:04		2	21.10.2008 11:23:04		
		21	Infraction harmonic U2E	21.10.2008 11:23:04		2	21.10.2008 11:23:04		
List table	піс	22	Infraction harmonic U3E	21.10.2008 11:23:04		2	21.10.2008 11:23:04		
events:		*	× * * *		*		*	*	*** **********************************

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 overvoltages.



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

Event Matrix	
EN50160	
NRS 048	



## 8.4.11 Data export – Interval data

Using "Settings / Export" you can 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.

<b>@</b>	Data	View Setup Window Addon Help
	30	📠 😣 ک 🕹 📠
à	Inform	ation 🕹 🕹 🕹
Mark	Info	
-	Non	📕 Output Format 🛛 💽 🔀
atio	Inte	Delimitter
Inform	Ripp	O Comma
	Star End	Tabulator (^ )     Space ( )     Semicolon (;)
	Dur	Decimalplace
	Nun	Point (.)
		O Comma (,)
events	Permar	Suppress header (for correct CSV-Format) With linenumbers
s PQ	Sel	Cancel OK

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



In the following menu, all the desired 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:

	А	В	С	D	E	F	G	Н	- I	J	К
1	PQ Box 100	Q Box 100 Serial-No.: 0804-0		804-004							
2											
3	Measuremer	nt: Solar plant, H	lofweg 28,								
4											
5	Interval: 600	sec									
6	Voltage: 230	V									
7											
8											
9	9 Date/Time: 18.11.2008 12:40:00 - 26.11.2008 09			08 09:50:00							
10											
11	Date	Time	P L1	P L2	P L3	P total	S L1	S L2	S L3	S total	QL1
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.

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

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

### 8.4.12 Additional functions

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





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.



### We take care of it

### 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)





# 9. PQ-Box 200 Limits and Settings

With the Setup" ïcon you can change the PQ-Box 200 device parameters, trigger conditions and limits.

PQBox:									
	PQBOX100 Ver:02.004 Sn:0	0950-113 [COM7]			▼	Load setup from Box			
						Send new setup to Box			
		Configuration				Load			
		Network:	<ul> <li>50 Hz</li> <li>Record</li> </ul>	0 60 Hz		Store			
Basic	settings	"only" voltages	only" Basicdata	Identification: EN	50160 - IEC61000-2-2 LV - der	Basic settings			
		Converter configuration							
		N PE	L1	L1 L2 L3 N PE	11				
	imite	<u></u>	L3 A 0 B C 0						
					S1 52 S1 52 S1				
			99 9 9 9		1    2    3    b				
Osci	lloscope	: 1-wire system U: 3-wire system U: 4-wire system 1: Aron-circuit							
10ms F	RMS reco	← Ⅲ →							
		Measuring parameter		Power measurement	Iransducer factor				
				acc. DIN40110-2	111 1				
Upda	te device	Nominal voltage PE / PP [V] (primary): 23	398,37	Powercalculation					
				Unbalance-	UL2 1				
		Measuring interval [sec]:	600	Elicker cupie	UL3: 1				
		Power interval:	15 min 🔻	<ul> <li>230 V curve</li> </ul>	UNE 1				
				120 V curve	II. 1				
		Ripple control signal recorder C	N / OFF						
		Ripple-control frequency [Hz]	168		1				
		Bandwidth [Hz]	5		I3: 1				
		Recorder time [sec]	60		IN: 1				
		Trigger threshold [% UN]	0.5						
		Please keep in mind: For technical	reasons you have to set your starting time sl	hortly before your intended start of n	neasurement!				
		Start	00.00.00	End	00-00-00				
		00.00.0000	00.00.00	00.0000	00.00.00	Synchronize Time			
		Time adjustment	05.08.2014	PORox - Date:	00.00.00	Auto synchronize			
		PC - Time:	14:27:20	POBox - Date:	00:00:00				
			11127120	r quox mine.	00.00.00	Close			

Load setup from Box

Loads the current settings from the network analyser to PC screen

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

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

Load Store

Saves a setup file to the PC

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

Synchronize Time

Synchronize time of PQ-Box 100 to the PC time at this moment.

### We take care of it

🗹 Auto-Synchronize

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

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

### 9.1 Setup - Basic Settings

<sup>Grundeinstellungen</sup> 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.





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".

Ripple-control frequency:	PQ-Box 100	? 🔀
Start:	Configuration Network: System: Only volkages Converter configuration Ut v-circuit	Load setup from Box Send new setup to Box Synchronize Time     Synchronize Time     Auto-Synchronize     Load     Synchronize Time     Auto-Synchronize     Load     Synchronize     Synchronize     Synchronize     Load     Synchronize     Synchroniz
	Comment 1	Comment 2

### Special switching modes for secondary current transformer:



This function is activated if the secondary current transformer in the medium or high-voltage network is connected in an Aron-connection. The current I L2 is not connected and calculated by the PQ-Box 200.



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

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

Measuring interval [sec]:	600

The measuring interval of the PQ-Box 200 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.



### Note - Data Quantity

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

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

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

The resulting data size can be limited in two ways.



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



b)

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

All recorder are still active.

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

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

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



### Transducer factor voltage and current

Transducer factor						
UL1	1					
UL2	1					
UL3:	1					
UNE	1					
11:	1					
12:	1					
13:	1					
IN:	1					

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 = 200Current:100 A / 5 A = Conversion factor 20

### **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.

Power interval:	15 min 💌
	15 min
Ripple control signal	30 min

#### **Power measurement**

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

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



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

### **AUX Input**

The AUX input can be activated or deactivated.

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

AUX:	
Name:	Current
Unit:	A
Offset:	0
Factor:	1

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

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

AUX:	
Name:	temperature
Unit:	°C
Offset:	
Factor:	0.1



### Ripple control signal analysis:

Ripple control signal recorder ON / OFF						
Ripple-control frequency [Hz]	168					
Bandwidth [Hz]	5					
Recorder time [sec]	60					
Trigger threshold [% UN]	0.5					

Rundsteuerfreq.:

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.

### **Option ripple signal recorder**

If the option "ripple signal recorder" activated in the PQ-Box 100, 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.

Ripple control signal recorder ON / OFF It is possible to enable or disable this recorder

286

PQ-Box 100's with licensed/active optional "Ripple Signal Recorder" can be identified by the LCD display (6<sup>th</sup> Screen) showing "+S" after the PQ-Box 100 type.

### Programming the PQ-Box through a time command

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

Example: The PQ-Box should be controlled by time to switch on and off from 0:00 to 3:00 hours with an interval of 1 second.

Scheduled operation									
Start			End						
07.09.2012	10:00:00	<b></b>	14.09.2012	•	10:00:00				

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

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

### Setting the PQ-Box 200 time:

Time adjustment			
PC - Date:	09.09.2008	PQBox 100 - Date:	09.09.2008
PC - Time:	17:57:50	PQBox 100 - Time:	17:57:44

#### Synchronize Time

ton is pressed. The PQ-Box 200 time will not hereafter be permanently shown in the display.



# 9.2 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.

ing the Basic settings	button, al	l the lim	its are	reset to the	standaı	rd valu
low voltage change						
plerance 95%:				positive [%] 110,00 🚔	negative [%]	90,00 🚖
plerance 100%:				positive [%] 110,00 🖨	negative [%]	85,00 🚔
oltage Changes (Dip/Swell)						
plerance 100%:				positive [%] 110,00 🖨	negative [%]	90,00 🚖
apid voltage change		Toloranco ha	od [96] 1.	Detection limit	for PVC [%]	5 00 🛋
etwork frequency		Toler ance bai	IG [ 70] 1,			5,00 💌
plerance 99.50%:				positive [Hz] 50,50 🖨	negative [Hz]	49,50 🜲
lerance 100%:				positive [Hz] 52,00 🖨	negative [Hz]	47,00 🌲
balance	Long term flicker Plt			THD		
lerance 95% [%]: 2,00	Tolerance 95%:	1,00		Tolerance 95% [%]:	8,00	
lerance 100% [%]: 3,00	Tolerance 100%:	5,00		Tolerance 100% [%]:	12,00	
Itage harmonics						
				THD calculation		
				H2 - H50		
				Grouping of harmonic	s (U/I)	
				IEC 61000-4-30	ClassA	
				Full grouped (El	N61000-4-7 Ka	p.5.5.1)
U.n				Harmonics: Tolerance 95% [%]:	2 2,00	
				Factor 100%:	1,50	-
2nd to 25th Harmoni	ic 26th to	50th H	armon	ic		
EN50160	IE	C61000-	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 Load 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

H2 - H40

 $\bigcirc$  H2 - H50 The THD calculation of voltage and current can be changed in the settings: 2 – 40<sup>th</sup> or 2 – 50<sup>th</sup>

Grouping of harmonics (U/I)

IEC 61000-4-30 ClassA

© Full grouped (EN61000-4-7) The calculation method for the harmonic groupings can be adjusted depending on the application (PowerQuality measurement or equipment testing).

## 9.3 Oscilloscope trigger settings



<sup>Oscilloscope</sup> 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".

Spannung- / Strom Tri	gger									
	Untere Tri	ggerschwelle [%]	Obere Tr	riggerschwelle [%]	Effektiv	wertsprung [%]		Phasensprung [°]		Hüllkurventrigger [%]
UL1:		90		110		10		6		20
UL2:		90	<b>v</b>	110		10		6	-	20
UL3:		90		110		10		6		20
UNE:				30		10				20
U12:		90		110		10		6		20
U23:		90		110		10		6		20
U31:		90		110		10		6		20
		[A]		[A]		[A]				
IL1:		10		3000		300	<b>v</b>	Automatik Trigger		
IL2:		10		3000		300				
IL3:		10		3000		300				
IN:				3000		300				
<ul> <li>fallende Flanke</li> <li>Hüllkurventrigger</li> </ul>	⊚ ste	gende Flanke								10 🔔 [min]
Totzeit Hüllkurventri	gger [s]:	1								
Hysterese										
Hysterese 10ms RM	S Spannung [%]:			2		Hysterese	10ms	RMS Strom [A]:		2
Aufzeichnungslänge / \	Vorgeschichte									

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.



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
sten	
год Год 1	
[ /0]	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. commutation notch)
	A recorrection of the threshold value is between 10% and 25% of the nervicel
	voltage
	Example of a commutation notch:
	- 180

### **Deadtime envelope trigger:**

The deadtime 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.

## 9.4 10 ms RMS Recorder



<sup>10ms RM5 recoder</sup> In the "RMS (10 ms)" 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.

PQBox:	PQBOX20	00 Ve	r:1.321 S	n:1305	i-103 [COM11]						•	Load setup from Box
		V	oltage- /	curren	trigger							Send new setup to Box
			, under		lower threshold		upper threshold		step		phase step	Load
					[%]		[%]		[%]		[°]	Store
Basic settings			UL1:		90	V	110		10		6	Pasic cottings
			UL2:		90	V	110		10		6	basic settings
			UL3:	-	90	V	110		10		6	
			UNE:				30		10	]		
Limits			U12:		90		110		10		6	
			U23:		90	]	110		10		6	
			U31:		90		110		10		6	
Oscilloscope					[A]		[A]		[A]			
		2	IL1:		10		3000		300			
			IL2:		10		3000		300		Auto-Trigger	Start Measurement
			IL3:		10		3000		300		2	Stop Measurement
10ms RMS reco	.		IN:				3000		300			
			Externa	al Trigg	er							
			falli	ng Edg	e 💿 rising	Edg	le					
Transient												
		н	ysteresis									
Undate device			Hystere	sis 10r	ns RMS voltage [%]:		2	Hys	teresis 10ms RMS curre	ent [	A]: 2	
opute device												Synchronize Time
			arameter									Auto synchronize
			pre-eve	nt time	. 1	1000	[msec]	F	Recorder time:		3000 [msec]	
												Close

The "Recorder 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 recording, and the history can be set to any value between **20 ms and 2 minutes** (120,000 milliseconds).

### Automatic trigger for the 10 ms recorder

If enabled, then if a limit is set that is too sensitive, the PQ-Box 200 automatically changes all the trigger thresholds activated on this page. This prevents unnecessarily large amounts of data being recorded and the device permanently holding the same images. 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.



## 9.5 Trigger through Binary Input

The oscilloscope and 10ms RMS recorder can be triggered via a binary input.

External Trigger	
On step down	🔘 On step up

A digital input for an external trigger signal is available via two 4 mm sockets. This input starts the oscilloscope, 10ms RMS recorder or transient 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.

### 9.6 Transient setup

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

The length of the record depends on the sampling frequency.

2MHz sampling = 32ms und 200kHz sampling = 320ms. The pre trigger time is 50% of the recorder length.

Voltage Trigger	Sample Rate
threshold	200 kHz
UL1 🔽 100 V	🔘 500 kHz
UL2 📝 100 V	1 MHz
UL3 🔽 100 V	
UNE 🔽 100 V	© 2 MHz
Transfer Trigger to	Intervalltrigger
✓ oscilloscope ✓ 10ms RM	S 10 (min)

- The function "transfer trigger", starting the oszilloskop recorder and / or the RMS recorder with each transient signal.
- Interval trigger, starting the transient recorder according to the interval of time.

## 9.7 PQ-Box 200 Firmware Update



In the "Update" menu the firmware of the network analyzer can be updated or the PQ-Box 200 can be assigned with a license code with more functions.

Sequence for a PQ-Box 200 update:

- 1) Disconnect the PQ-Box 200 from the power supply
- 2) Press and hold the "Manual Trigger" and "Up arrow" keys together



- 3) Connect the power to the PQ-Box 200 (power supply) the device now show the message "waiting for download"
- 4) Open the Settings / Update menu in the software
- 5) Load the update file "MCU-Application" onto the device
- 6) Disconnect the PQ-Box 200 from the power supply
- 7) Next time the PQ-Box starting, the new firmware will be installed

🙏 Setup PQ-Box		<u>? ×</u>	
PQBox:	PQB0X200 Ver:1.217 Sn:9930-101 [COM49]	Load setup from Box	
Basic settings	Update PQBox  MCU-Application: L:\Produktgruppen\PQI5ys\PQ-Box\PQ-Box100\Firmware\PQBoxMCU_1v142.upd  Update MCU	Send new setup to Box Load Store Basic settings	
Linits	License PQBox Serial Number:	Licence update: Upgrade PQ-Box 200 with ripple control signal analysis.	)
Osciloscope		Start Measurement Stop Measurement Synchronize Time Auto synchronize	
		Close	



## 9.8 PQ-Box 200 Licence Update

Using the Get from Box button, with the measurement device connected, the serial number of the PQ-Box 200 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.

### 9.9 Data Converter

With the "Data Converter" program it is possible to make corrections to an existing measurement file. If a PQ-Box 200 is parameterized with the wrong nominal voltage or the wrong current conversion factor, this can be changed here 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

🙏 Data View Setu	up Window	Addon H	Help		
			at at	۲	

- 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.

٨	WinPQ mobil		
Da	ten Darstellen Einste	llungen <b>Fenster Zusatz</b> Hilfe	
	📑 🙆 🔳 🤄		
E	Information	₽×	
ormatic	Spannungssystem:		
Ē	Nennspannung L-L / L-N	WinPQ DataConverter	? 🔀
*	Frequenz:	Measurement: KBA 13/301 Messung im Schaltschrank Maschine	oad
Jarke	Messintervall:		
£	Rundsteuerfrequenz:	Nominal Voltage (V): 400	ply
	Messung Beginn:	New Voltage (V): 400	
	Messung Ende:	current factor	
	Messdauer:	Original Value New Value	
	Anzahl Messintervalle:	I1 2 20	
	Seriennummer Gerät:	I2 2 20	
	Firmware:	I3 2 20 App	ny
	stellungen Messger	IN 2 20	_
	iscollanger Hossger	Factor 10,00	
G	Zyklische Daten		
e Dat	Auswahl	Select Language OK Ca	incel
lische	🗈 🔺 Frequenz		
¥	🗏 🗄 🙏 Spannung		

### 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 "Connect" these measurement files are now merged and saved in a new measurement file.

estplatte Import PQ Box 100							
rzeichnis: C:/A-Eberle-Produktg	uppen/PQ-Box100/S	eminardaten					Laden
atum 👻 Version	Größe	Kommentar 1	Kommentar 2	Kommentar 3	Kommentar 4	^	
📕 🙏 11.10.2011 06:16:13 V01.119	) 3256 KB	Frequenzumricht	3kHz	1 Teilmessung	getrenne Messung		
🙏 06.10.2011 16:16:00 V01.119	27327 KB	Frequenzumricht	3kHz	2 Teilmessung	getrennte Messung		Verbinde
- 📥 06.10.2011 16:16:00 V01.11	) 30582 KB	Frequenzumricht	3kHz	2 Teilmessung	getrennte Messung		
- 📥 23.09.2011 14:28:30 V01.13	) 2634 KB	Sitzanlage Nr.361	Automobilwerk 5	Überlast von Asy	Seminar		
🗕 📥 08.06.2011 11:36:50 V01.13	) 13029 KB	Probleme Solaran	2 x 3~ Wechselri	10 ms Rekorder	Schwingen Netz	1	🗢 i Sacha
🗕 📥 16.05.2011 08:29:12 V01.13	) 9367 KB	Fuhrländer	In Anlage FL 625	Ab 18.05, 21:31	Rückwirkung Haramonische		o Losche
🗕 📥 16.05.2011 08:29:12 V01.13	) 9367 KB	Fuhrländer	In Anlage FL 625	Ab 18.05. 21:31	Rückwirkung Haramonische(new)		
- 📥 02.05.2011 13:13:00 V01.11	182817 KB	Solaranlagen	1~ Wechselrichter	Netzunsymmetrie	Überspannung		
- 🙏 19.04.2011 07:14:34 V01.120	816546 KB	HA Pflegeheim Vi	Juri-Gagarin-Straße	07743 Jena	große Messdatei		Abbruch



# 10. Online Analysis: PQ-Box 200 & PC

Using the "Online analysis" function, RMS values, oscilloscope images, harmonics, interharmonics, 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 seconds intervals.

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

## 10.1 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 40,96kHz sampling of all measurement channels are displayed on the screen.



## 10.2 Online – FFT – 20,000 Hz

With the "Spectrum" measurement function, all of the harmonics and interharmonics for voltages and currents from DC to 20,000 Hz are displayed online.

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 20.000 Hz: 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 printerClipboard:The spectrum is coped to the Windows clipboardIncl. DC:The DC components can be toggled on and off in the graphicincl. 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 exists direct at the measurement point.



## 10.3 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.



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

Delete Marker
Print
Copy image
Scaling left
Left axis log. scale
Scaling right
Right axis log. scale
Divide axis
Automatic scaling
Limit Markers
Insert comment
Export to ASCII file



## 10.4 Online - Interharmonics

From the "Interharmonics" tab page, all of the current and voltage interharmonics 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 interharmonics in the network, subgroups are created. In each case, all of the interharmonics between two harmonics are combined into one harmonics subgroup.



# 10.5 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 8,800 Hz to 9,000 Hz are located in the 8.9 kHz band.





## 10.6 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.



### Note:

In a network preloaded with voltage harmonics, the statement of 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 causer of harmonics in the network.

# 10.7 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 copied to the clipboard.

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





## 10.8 Online - Measurement Value Details

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

	Tab page - Measurement Details	
PQBOX100 Ver:01.151 Sn:0746-106 [COM7] Oscilloscope Spectrum Harmonics Inter-Harmonics	Direction Timing chart Details U/I/Phase Power	Frequency           F:         50.01 Hz           Voltage           UL1:         539.832 V           UL2:         536.217 V
	Power factor   THD	UL3: 534.554 V
P1: 197.867 W	PF1: 0.838 THD UL1: 2.11 %	U12: 931.613 V
P2: -85.759 W	PF3: -0.488	U23: 927.035 V
P total: 15.888 W	PF total: 0.021	U31: 930.870 V
S1:       236.246 VA       D1:       126.788 V         S2:       212.189 VA       D2:       91.434 V         S3:       197.064 VA       D3:       95.840 V         S total:       758.857 VA       D total:       314.062 V         Q1:       129.078 Var       QV1:       -24.208 V         Q2:       194.086 Var       QV2:       171.199 V         Q3:       171.976 Var       QV3:       -142.795 V         Q total:       758.690 Var       QV total:       4.197 V	ar       PHL1:       -6.98 °         ar       PHL2:       116.47 °         PHL3:       -124.26 °       THD U31:       2.18 %         ar       cos PHL1:       0.99       THD I1:       12.39 %         ar       cos PHL2:       -0.45       THD I1:       12.39 %         ar       cos PHL2:       -0.45       THD I1:       12.39 %         ar       Short time flicker       THD I3:       13.73 %         THD IN:       11.08 %       THD IN:       11.08 %	Current 11: 0.000 A 12: 0.000 A 13: 0.000 A 15: 0.000 A
AUX	Pst2:         0.142         Symmetry           Pst3:         0.165         UU:         0.31 %	

Description of power values in online "Details"

- P = real power values
- S = apparent power values
- D = distortion power

 $Q = \sqrt{Q_{\nu}^{2} + D^{2}}$ Q = reactive power

QV = reactive power of fundamental frequency

# 10.9 Online - Phasor Diagram

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





## 10.10 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.



# 11. Measurement Data – PQ-Box 200 Measurement Procedure

### PQ-Box 200 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 half the memory space is reserved for cyclic data (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.

Explanation of symbols:  $\checkmark$  = calculated and saved

 $\checkmark$  \* = calculated and online data

Cycle time	10 ms	0.2 s	1 s	Interval
Measurement values				
RMS value from $u_{1E/N}$ , $u_{2E/N}$ , $u_{3E/N}$ , $u_{NE}$ , $u_{12}$ , $u_{23}$ , $u_{31}$ :	√*	√*	✓	~
$U_{1E/N}, U_{2E/N}, U_{3E/N}, U_{NE}, U_{12}, U_{23}, U_{31}$				
RMS value from $i_1$ , $i_2$ , $i_3$ , $i_{\Sigma/N}$ :	√*	√*	~	~
$I_1, I_2, I_3, I_{\Sigma/N}$				
Wire-Active powers:		√*	~	~
P <sub>1</sub> , P <sub>2</sub> , P <sub>3</sub>				
Frequency (fundamental oscillation):	√*	√*	✓	~
f			10 s	
RMS values of the DC components and fundamental oscilla-			✓	
tions for each measurement channel 18				

#### **Primary measurement values**



### **Derived Measurement Values:**

Cycle time	10 ms	0.2 s	1 s	Interval
Measurement values				
Standardized Voltage Harmonics (n=150)		√*	$\checkmark$	~
from $u_{1E/N}$ , $u_{2E/N}$ , $u_{3E/N}$ , $u_{NE}$ , $u_{12}$ , $u_{23}$ , $u_{31}$ :				
$U_{1E/N-n}, U_{2E/N-n}, U_{3E/N-n}, U_{NE-n}, U_{12-n}, U_{23-n}, U_{31-n}$				
Current Harmonics (n=150)		√*	$\checkmark$	~
from $i_1, i_2, i_3, i_{\Sigma/N}$ :				
<sub>1-n</sub> ,   <sub>2-n</sub> ,   <sub>3-n</sub> ,   <sub>Σ-n</sub>				
Standardized Voltage Interharmonics (n=049)		√*	✓	✓
from u <sub>1E/N</sub> , u <sub>2E/N</sub> , u <sub>3E/N</sub> , u <sub>NE</sub> , u <sub>12</sub> , u <sub>23</sub> , u <sub>31</sub> :				
$U_{1E/N-n+0.5}, U_{2E/N-n+0.5}, U_{3E/N-n+0.5}, U_{NE-n+0.5}, U_{12-n+0.5}, U_{23-n+0.5},$				
U <sub>31-n+0.5</sub>				
Cycle time	10 ms	0.2 s	1 s	Interval
Measurement values				
Current Interharmonics (n=049)		√*	$\checkmark$	✓
from i <sub>1</sub> , i <sub>2</sub> , i <sub>3</sub> , i <sub>Σ/N</sub> :				
<sub>1-n+0.5</sub> ,   <sub>2-n+0.5</sub> ,   <sub>3-n+0.5</sub> ,   <sub>Σ-n+0.5</sub>				
RMS ripple control signal at $u_{1E/N}$ , $u_{2E/N}$ , $u_{3E/N}$ , $u_{NE}$ , $u_{12}$ , $u_{23}$ , $u_{31}$ :		√*	$\checkmark$	
U Ripple Control (200 ms)				
$U_{s1}, U_{s2}, U_{s3}, U_{sN}, U_{s12}, U_{s23}, U_{s31}$				
Harmonic energy flow direction (n=132)		√*	$\checkmark$	~
at L <sub>1</sub> , L <sub>2</sub> , L <sub>3</sub> :				
FD <sub>1-n</sub> , FD <sub>2-n</sub> , FD <sub>3-n</sub>				
Total Voltage Harmonic Distortion (240. harmonic)		√*	$\checkmark$	~
from u <sub>1E/N</sub> , u <sub>2E/N</sub> , u <sub>3E/N</sub> , u <sub>NE</sub> , u <sub>12</sub> , u <sub>23</sub> , u <sub>31</sub> :				
$THD_{1E/N}$ , $THD_{2E/N}$ , $THD_{3E/N}$ , $THD_{NE}$ , $THD_{12}$ , $THD_{23}$ , $THD_{31}$				
Total Current Harmonic Distortion in %		√*	$\checkmark$	✓
(240. harmonic)				
from $i_1$ , $i_2$ , $i_3$ , $i_N$ : THD <sub>1</sub> , THD <sub>2</sub> , THD <sub>3</sub> , THD <sub><math>\Sigma/N</math></sub>				
Total Harmonic Currents in Ampere (240. harmonic)		√*	✓	✓
from i <sub>1</sub> , i <sub>2</sub> , i <sub>3</sub> , i <sub>N</sub> :				
$THD(A)_1$ , $THD(A)_2$ , $THD(A)_3$ , $THD(A)_N$				
K Factors (Transformer Reduction factor) from $i_1$ , $i_2$ , $i_3$ , $i_{\Sigma/N}$		√*	✓	✓
$k_1, k_2, k_3, k_{\Sigma/N}$				
Centre value of $I_1$ , $I_2$ , $I_3$ , $I_N$		<b>√</b> *	$\checkmark$	✓

### We take care of it

Cycle time	10 ms	0.2 s	1 s	Interval
Measurement values				
Total active power:	√*	√*	√	✓
Ρ				
Wire-Apparent Power		√*	$\checkmark$	<ul> <li>✓</li> </ul>
S <sub>1</sub> , S <sub>2</sub> , S <sub>3</sub>				
Wire-Reactive Power (m.Sgn.) :	√*	√*	√	✓
Q <sub>1</sub> , Q <sub>2</sub> , Q <sub>3</sub>				
Wire-Distortion Apparent Power:		√*	√	✓
D <sub>1</sub> , D <sub>2</sub> , D <sub>3</sub>				
Total Apparent Power, 3-/4-Wire Network	√*	√*	√	✓
n. DIN 40110 : S				
Total Reactive Power:	√*	√*	√	✓
Q				
Total Distortion Reactive Power		√*	√	✓
D				
Wire-Total Active Energy		√*	√	✓
E <sub>1</sub> , E <sub>2</sub> , E <sub>3</sub>				
Collective Overall Active Energy:		√*	√	✓
E				
Wire-Charge Active Energy:		√*	$\checkmark$	✓
-E <sub>1</sub> , -E <sub>2</sub> , -E <sub>3</sub>				
Collective Charge-Active Energy:		√*	$\checkmark$	✓
-Е				
Wire-Purchase-Active Energy:		√*	√	✓
E <sub>1</sub> , E <sub>2</sub> , E <sub>3</sub>				
Collective Purchase-Active Energy:		√*	√	✓
+E				
Wire-Total-Reactive Energy:		√*	√	✓
EQ <sub>1</sub> , EQ <sub>2</sub> , EQ <sub>3</sub>				
Collective Overall Reactive Energy:		√*	√	✓
EQ				
Wire-Reactive Energy (inductive) supplied:		√*	$\checkmark$	✓
-EQ <sub>1</sub> , -EQ <sub>2</sub> , -EQ <sub>3</sub>				
Collective Reactive Energy (inductive) supplied:		√*	✓	<ul> <li>✓</li> </ul>
-EQ Netz				



Cycle time	10 ms	0.2 s	1 s	Interval
Measurement values				
Related Wire-Reactive Energy (inductive):		√*	$\checkmark$	✓
+EQ <sub>1</sub> , +EQ <sub>2</sub> , +EQ <sub>3</sub>				
Related Collective Reactive Energy (inductive):		√*	$\checkmark$	✓
+ EQ Netz				
Active factors:			$\checkmark$	✓
PF <sub>1</sub> , PF <sub>2</sub> , PF <sub>3</sub> , PF				
Reactive factors:			✓	✓
QF <sub>1</sub> , QF <sub>2</sub> , QF <sub>3</sub> , QF				
Active factor display function:			$\checkmark$	✓
Y <sub>1</sub> , Y <sub>2</sub> , Y <sub>3</sub> , Y				
Voltage-Current Phase Difference (fundamental oscillation) :		√*	✓	✓
φ1, φ2, φ3				
Voltage-Reference Voltage Phase Difference (fundamental	√*	√*	✓	✓
oscillations) from $u_{1E/N}$ , $u_{2E/N}$ , $u_{3E/N}$ , $u_{NE}$ , $u_{12}$ , $u_{23}$ , $u_{31}$ :				
φ <sub>1E/N</sub> , φ <sub>2E/N</sub> , φ <sub>3E/N</sub> , φ <sub>NE</sub> , φ <sub>12</sub> , φ <sub>23</sub> , φ <sub>31</sub>				
Direction (fundamental oscillations)		√*		
Flicker levels at $u_{1E/N}$ , $u_{2E/N}$ , $u_{3E/N}$ :				✓
Pst <sub>1E/N</sub> , Pst <sub>2E/N</sub> , Pst <sub>3E/N</sub>				
Flicker levels at $u_{12}$ , $u_{23}$ , $u_{31}$ :				✓
Pst <sub>12</sub> , Pst <sub>23</sub> , Pst <sub>31</sub>				
Voltage, positive sequence, negative sequence, zero	√*	<b>√</b> *	~	✓
sequence				
Voltage unbalance u <sub>u</sub>		√*	$\checkmark$	~
Voltage unbalance $u_0$		√*	$\checkmark$	~
10 ms voltage extreme value per measurement interval				~
$U_{1E/N-1/2}, U_{2E/N-1/2}, U_{3E/N-1/2}, U_{NE-1/2}, U_{12-1/2}, U_{23-1/2}, U_{31-1/2}$				
Current, positive sequence, negative sequence, zero se-				
quence				,
Current unbalance u <sub>u</sub>		√*	~	~
Current unbalance u <sub>0</sub>		√*	~	~
10 ms current extreme value per interval		√*	$\checkmark$	✓
$ _{1-1/2},  _{2-1/2},  _{3-1/2},  _{\Sigma/N-1/2}$				
200 ms power extreme value				✓
P <sub>1-10/12</sub> , P <sub>2-10/12</sub> , P <sub>3-10/12</sub> , P <sub>10/12</sub>				

We take care of it

Cycle time	10 ms	0.2 s	1 s	Interval
Measurement values				
Frequency extreme value at				✓
f (10 s) and f (200 ms)				
Maximum of $U_{S1-10/12}$ , $U_{S2-10/12}$ , $U_{S3-10/12}$ , $U_{SN-10/12}$ , $U_{S12-10/12}$ , $U_{S23-10/12}$ , $U_{S12-10/12}$ , $U_{S23-10/12}$ , $U_{S12-10/12}$ , $U_{S12-10/12}$ , $U_{S23-10/12}$ , $U_{S12-10/12}$				✓
10/12, U <sub>S31-10/12</sub>				

## 11.1 PQ-Box 200 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 40.96 kSamples/s.

### 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 interharmonics 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**<sub>st</sub> (10 min) and **Long tern flicker levels P**<sub>lt</sub> (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:

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

## <u>THD – PWHD – K factor</u>

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)

THD calculation H2 - H40
H2 - H50

The THD calculation of voltage and current can be changed in the settings:  $2 - 40^{\text{th}}$  or  $2 - 50^{\text{th}}$ 

THD voltage:

$$THD_{u} = \frac{\sqrt{\sum_{\nu=2}^{40} U_{\nu}^{2}}}{U_{1}}$$

THD current in %:

$$THD_i = \frac{\sqrt{\sum_{\nu=2}^{40} I_{\nu}^2}}{I_1}$$

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 / Interharmonics

The determination of the harmonics and interharmonics 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 interharmonics, harmonic subgroups are created. 50 subgroups are recorded for all current and voltage channels.



Example:

🖃 Ungeradzahlige Zwischenharmonische

"IH1" is the first interharmonics 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):

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

Current harmonics:

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

## 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.

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

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  $\Sigma = Q L1 + Q L2 + Q L3$ 

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

Reactive power calculation with unbalanced power:

$$Q_{L-10/12} = Sgn(\varphi_{L-10/12}) \cdot \sqrt{S_{L-10/12}^2 - P_{L-10/12}^2}$$
$$Q_{10/12} = Sgn(\varphi_{1-10/12}) \cdot \sqrt{S_{10/12}^2 - P_{10/12}^2}$$

Reactive energy:

"Supply reactive energy" inductive reactive energies +EQ.

$$Q_{s}(n) = |Q_{L-10/12}(n)| \qquad \qquad f \ddot{u}r : Q_{L-10/12}(n) \ge 0$$
$$Q_{s}(n) = 0 \qquad \qquad f \ddot{u}r : Q_{L-10/12}(n) < 0$$

"Consumer reactive energy" capacitative reactive energies -EQ.

$$Q_{s}(n) = |Q_{L-10/12}(n)|$$
 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:





## **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:  $\lambda$  = IPI / S The power factor contains the sign of the real power.

## <u>Cos phi</u>

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

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



On device display and in online measurement data, the standard cos phi (version a) is shown. In the long-term measurement data both versions are available.

#### **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,  $I1 + I2 + I3 \neq 0$ :

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

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 synchronisation 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):

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

 $\underline{S}_{G}$  = 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 <u>4-wire system</u> = <u>Phase-to-Neutral voltage</u>

Phase voltage in a <u>3-wire system</u> = <u>Phase-to-Ground voltage</u>

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 and corresponds to the ratio of the negative sequence to the positive sequence. The value is expressed in [%].



# 12. Maintenance/Cleaning

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.

Spare parts no.

•	SD memory card, 4GByte industry-standard	900.9099
•	Replacement battery pack	570.0010
•	Fuse for voltage leads; 500mA (FF) 30kA AC/DC; 1000V 6,3mmx32mm	582.1058



Danger of electric shock!

 $^{(!)}$  Do not open the unit.

<sup>(\*)</sup> 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

## 13. Calibration

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

## 14. Disposal

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

## 15. Product Warranty

A-Eberle guarantees that this product and accessories will remain free of defects in material and workmanship for a period of three years from the date of purchase. 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.



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http://www.a-eberle.de

Software Version:

Vers. PQ Box 200 – 04.02.2015