

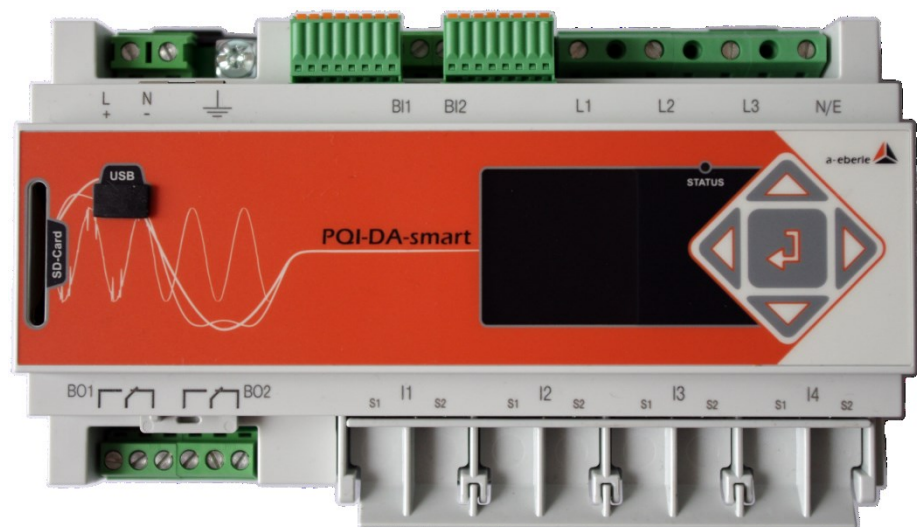


User Manual

Power Quality Network Analyser

Model PQI-DA *smart*

Power-Quality Evaluation Software WinPQ *smart*





Note:

Please note that these operating instructions may not always contain the latest information concerning the device. If, for example, you have changed the firmware of the device to a higher version via the Internet, this description will no longer be completely accurate.

In this case, contact us directly or use the latest version of the operating instructions available from our Internet site (www.a-eberle.de).

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We take care of it.

1. User prompt



1.1 Warnings

Types of warnings

Warnings are distinguished by the type of risk they represent by the following signal words:

- **Danger** warns of a risk of death
- **Warning** warns of physical injury
- **Caution** warns of damage to property

Structure of the warnings

 <p>SIGNAL WORD</p>	<p>Nature and source of the danger</p> <p> Actions to avoid the danger.</p>
---	---

1.2 Notes





Notes on appropriate use of the device

1.3 Other symbols

Instructions

Structure of the instructions:

-  Guidance for an action.
-  Indication of an outcome, if necessary.

Lists

Structure of unstructured lists:

- List level 1
- List level 2

Structure of numbered lists:

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

2. Scope of Delivery/Order Codes

2.1 Scope of Delivery

- PQI-DA *smart*
- User Manual
- TCP-IP Cable
- Calibration certificate
- CD WinPQ *smart* Software

2.2 Order Codes

PQI-DA *smart*

This version of the device is used as a power quality analyser, sequence of events recorder, data logger and power meter.

Option IEC61000-4-7 (sampling rate 40.96kHz) <ul style="list-style-type: none">● 10.24kHz sampling rate; without measuring 2kHz to 9kHz● Measuring the frequency of voltage and current from 2 kHz to 9 kHz Oscilloscope with 40.96kHz sampling rate	B0 B1
---	----------



The 2kHz to 9kHz option (41kHz sampling rate for oscilloscopic images) can be upgraded via a software license code.












Characteristic	Code
Power Quality Interface for Low and Medium Voltage Networks <ul style="list-style-type: none"> 4 voltage converters, 4 current transformers In accordance with DIN EN-50160 and IEC 61000-4-30 (Class A) 2 digital inputs 2 relay outputs WinPQ smart software for PQI-DA smart 	PQI-DA smart
Supply voltage <ul style="list-style-type: none"> AC 90 V...264 V oder DC 120 V...300 V DC 24 V - 60 V (+20%/-25%) 	H1 H2
Current inputs <ul style="list-style-type: none"> 4 current inputs for metering circuit 1A/5A (range 10A) 4 current inputs for protection circuit 1A/5A (range 100A) 	C30 C31
Option communication protocol <ul style="list-style-type: none"> Modbus RTU & TCP IEC 61870-5-104 (RJ45) IEC61850 (RJ45) 	P0 P1 P2
Option IEC61000-4-7 (40,96kHz sampling) <ul style="list-style-type: none"> 10.24kHz sampling; without 2kHz to 9kHz measurement Frequency measurement of voltage and current from 2 kHz to 9 kHz 40.96kHz sampling oscilloscope recorder 	B0 B1
Operating instructions <ul style="list-style-type: none"> German English French Spanish Italian Chinese Russian 	G1 G2 G3 G4 G5 G6 G7

Software WinPQ smart	Code
Software WinPQ smart For set-up PQI-DA smart, as well as reading PQI-DA smart measurement data (online / offline) – sold as a package	WinPQ smart
Expansion WinPQ smart for calibration of the PQI-DA smart and test report creation	900.9287

Additions to PQI-DA smart	Code
SD-memory card (external): 4 GByte industrial standard	900.9099.04
DIN-rail, wall mounted housing	564.0435
Frame for panel mounting	564.0433
Radio time clock interface DFC 77	111.9024.01
GPS-Clock – Navilog Set - RS485	111.7083
GPS receiver, GPS converter 5m connection cable, holder	
24V power supply for Navilog	111.7079
WinPQ database	Code
Software WinPQ For the set-up, archiving and analysis of PQI-D/DA measurement data having the following basic characteristics/functions: <ul style="list-style-type: none"> ● 32-bit/64-bit Windows program interface ● Database for storing measurement data for each measurement point Data access via TCP/IP network ● Possibility of visualization for all measurement variables accessible from a PQI-D/DA as a function of time and as a statistical magnitude plot ● A second seat license is included in the price 	WinPQ

Licenses <ul style="list-style-type: none"> ● Single-user license for 2 x PQI-D/DA/smart ● Single-user license for 2 - 10 x PQI-D/DA/smart ● Single-user license for > 10 x PQI-D/DA/smart 	L0 L1 L2
Operating instructions <ul style="list-style-type: none"> ● German ● English ● French 	A1 A2 A3

3. Safety instructions

-  Follow the operating instructions.
-  Keep the operating instructions with the device.
-  Ensure that the device is operated only in a perfect condition.
-  Never open the device.
-  Ensure that only qualified personnel operate the device.
-  Connect the device only as specified.
-  Ensure that the device is operated only in the original condition.
-  Connect the device only with recommended accessories.
-  Ensure that the device is not operated outside the design limits.
(Refer to the technical data)
-  Ensure that the original accessories are not operated outside the design limits.
-  Do not use the device in environments where explosive gases, dust or fumes occur.

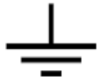


If the device is used in a way not specified by the equipment producer, the device protection will be impaired.

3.1 Meaning of the symbols used on the device



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



Functional earth



USB-interface



TCP-IP interface



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



AC alternating voltage



DC direct voltage

3.1.1 Site information and assembly instructions of PQI-DA smart

The PQI-DA smart is suitable for the following sites:

- Mounted in an cabinet
- Panel mounting

For panel mounting you have to use the frame for **panel mounting order code: 564.0435**.

4. Technical Data

4.1 PQI-DA *smart* Description

The new Power Quality Analyzer and sequence of events recorder PQI-DA *smart* for low, medium-voltage grids is the central component of a system that can solve all measurement tasks in such electrical grids. The PQI-DA *smart* can be used as either a Power Quality Interface in accordance with grid quality standards or as a measuring device for all physically defined variables in three-phase grids.

In addition to standard evaluations, the PQI-DA *smart* also features a high speed sequence of events recorder with a recording rate of 40.96kHz/10.24kHz as well as a 10ms RMS recorder. This enables a detailed evaluation of grid faults.

In particular, the device is suitable for monitoring, registering, evaluating and recording special reference quantities or quality agreements between the energy supplier and the customer

Modern Power Quality measuring devices operate in accordance with the IEC 61000-4-30 standard. This standard defines measurement methods helping to create a comparable basis for the user.

Devices from different manufacturers that operate according to this standard must give the same results. The standard distinguishes two classes of measuring devices:

- Class A devices are used mainly for measurements relating to contracts in customer-supplier relationships.
- Class S devices can be used to determine statistical quality values.

The PQI-DA *smart* meets all demands of the **IEC 61000-4-30 Ed.3 (2015) standard for an A-Class device:**

Parameter IEC61000-4-30	Class
Power frequency	A
Magnitude of the Supply Voltage	A
Flicker	A
Supply voltage dips and swells	A
Voltage interruptions	A
Supply voltage unbalance	A
Voltage harmonics	A
Voltage Interharmonic	A
Mains signaling voltage	A
Underdeviation and overdeviation	A
Measurement aggregation intervals	A
Time-clock uncertainty	A
Flagging	A
Transient influence quantities	A

The PQI-DA smart has been developed for measurements performed in public grids, as well as for recording PQ data in industrial environments, up to 690V (L-L) measurement voltage:

- No moving parts (fans, hard drives etc.)
- CAT IV
- Extensive storage capability (can be extended up to 32 GB by the user, permitting several years recording without connection to database)
- Optional “IEC61000-4-7 - 2kHz to 9kHz” (B1)
- Frequency measurement of voltage and current according IEC 61000-4-7 from 2 kHz to 9 kHz.
- Standard IEC61000-4-7 describes the measuring of harmonics and interharmonic in power supply grids and connected devices.

4.2 Technical Data

- 1.7-inch color display
- Keypad for basic/direct device configuration
- 1 GB internal memory
- Input channel bandwidth 20 kHz
- 4 voltage inputs Final value of measurement range: 57/ 230/ 480V L-N, accuracy < 0.1%
- 4 current inputs 1A/5A nominal, Final value of measurement range: 10A
- Simultaneous processing of sampled and calculated voltages and currents
- Oscilloscopic voltage and current recorder sampling rate : 40.96kHz / 10.24kHz
- Half cycle recorder:
 - power frequency, r.m.s. of voltages and currents, voltage and current phasors
 - power recording rate : ~10ms(50Hz) / ~8.33ms (60Hz)
- Powerful recorder triggering
- Online streaming of voltages and currents at 40.96 kHz sampling rate.
- IEC 61000-4-30 Class A Measurement data processing
- Recording of the voltage quality faults in accordance with DIN EN 50160; IEC61000-2-2; -2-12;-2-4.
- Spectral analysis 2 kHz...9 kHz,(35 frequency bands, BW = 200Hz) of voltages and currents according (IEC 61000-4-7)
- Phase of voltage and current harmonics n=2..50
- 2 general purpose digital inputs with 2 input level options
- 2 relay outputs for protection monitoring and alarm
- Complex analysis software WinPQ smart (sold as a package)

► Option WinPQ – Database Software

- Analysis of the data on an MYSQL-based database using the WinPQ software package.
- Permanent communication with many devices, in parallel.

4.2.1 Voltage inputs

Voltage inputs		Voltage inputs	
Channels	U1, U2, U3, UN/E/4	Dip duration	±20ms @ 10%..100%Un
Electrical safety IEC 61010-1:2010 + Cor.:2011, DIN EN 61010-1:2011	300V CAT IV 600V CAT III	Swell residual voltage	±0.2% Un @ 100%..150%Un
Input reference level	PE	Swell duration	±20ms @ 100%..150%Un
Impedance -> PE	10 MΩ 25pF	Interruption duration	±20ms @ 1%..100%Un
Nominal input voltage Un	100VAC /230VAC	Voltage unbalance	±0.15% @ 1%..5% reading
Full scale range (FSR)	0...480VAC L-E	Mains signaling voltage (< 3kHz)	±5% of reading @ Us = 3%..15% Un ±0.15% Un @ Us = 1%..3% Un
Waveform	Any		
Maximum crest factor @ Un	3		
Bandwidth	DC...20kHz		
Nominal power frequency fn	50Hz / 60Hz		
Frequency range of the fundamental	fn ± 15% 42.5..50..57.5Hz 51.0..60..69.0Hz		
Accuracy			
Fundamental, r.m.s	±0.1% Un (0°C...45°C) ±0.2% Un (- 25°C...55°C) @ 10%...150%Un Max. 50°C (H2) Max. 45°C (H1)		
Fundamental, Phase	±0.01° @ 10%...150%Un		
Harmonics n = 2..50, r.m.s.	±5% of reading @ Uh ≥ 1% Un ±0.05% Un @ Uh < 1% Un		
Harmonics n = 2..50, Phase	±n·0.01° @ Uh ≥ 1% Un		
Interharmonics n = 1..49, r.m.s.	±5% of reading @ Uih = ≥ 1% Un ±0.05% Un @ Uih < 1% Un		
Power frequency	±1mHz @ 10%...200%Un		
Flicker IEC61000-4-15:2011	Class F2		
Dip residual voltage	±0.2% Un @ 10%..100%Un		



Danger

Danger to life by electric shock!

Dangerous active voltage Voltage
Danger overload and high short
circuit current possible in CAT III
and CAT IV

Provide protection for CAT II, CAT III
or CAT IV

High-load safety fuses > 10 kA
resp. > 50 kA are to be used accord-
ing to the CAT

All voltage inputs are measured
against ground.

4.2.2 Current inputs

Current inputs		
Option	C30	C31
Channels	I1, I2, I3, IN/4	
Electrical safety IEC 61010-1:2010 + Cor.:2011, DIN EN 61010-1:2011	300V CAT III	
Input type	Differential, isolated	
Impedance	≤ 4mΩ	
Nominal input current In	1 A AC / 5 A AC	
Full scale range (FSR)	10A _{AC}	100A _{AC}
Overload capacity permanent ≤ 10s ≤ 1s	20 A 100 A 500 A	
Waveform	AC, any	
Maximum crest factor @ In	4	
Bandwidth	25Hz...20kHz	
Accuracy		
Fundamental, r.m.s	< 0.1% FSR 5%...100%	< 0.2% FSR 5% ... 10%
Fundamental, Phase	±0.1° 5%...100 %	±0.2° 5% ... 10%
Harmonics n = 2..50, r.m.s.	5% 5%...100 %	10% 5% ... 10%
Harmonics n = 2..50, Phase	±n·0.1° 5%...100 %	±n·0.2° 5% ... 10%
Interharmonics n = 1..49, r.m.s.	±5% 5%...100 %	±10% 5% ... 10%



Danger

Danger to life by electric shock!

Dangerous active voltage with direct connection to the low-voltage network without current transformer.

Protective cover of terminals must be fitted.

Danger overload and high short circuit current possible in CAT II and CAT III, provide safety fused for protection

Maximum 300V CAT III for direct connection. Current inputs are not allowed to connect to 300V CAT IV or 600V CAT III networks.

Not suitable for the use of DC currents.

Caution Do not interrupt the current transformer circuits.


Short-circuit the current transformer during assembly.

Current transformers must be grounded.

Only appropriately certified and suitable current transformers may be used which are designed for the overvoltage category and ensure safe separation.

4.2.3 Binary inputs – binary outputs

Binary inputs (BI)	
Range	48 - 250 V AC/DC
<ul style="list-style-type: none"> ● H – Level > 35 V ● L – Level < 20 V 	
Signal frequency	DC ... 70 Hz
Input resistance	> 100kΩ
Electrical isolation	Opto-coupler, electrically isolated
Electrical safety IEC 61010-1:2010 + Cor.:2011, DIN EN 61010-1:2011	300V CAT II



Danger to life by electric shock!
Dangerous active voltage Voltage

Danger

Binary outputs (BO)	
Contact specification (EN60947-4-1, -5-1) : Configuration Rated voltage Rated current Rated load AC1 Rated load AC15, 230VAC Breaking capacity DC1, 30/110/220 V	SPDT 250VAC 6A 1500VA 300VA 6/0.2/0.12A
No. of switching operations AC1	≥ 60·10 ³ electrical
Electrical isolation	Isolated from all internally potentials
Electrical safety IEC 61010-1:2010 + Cor.:2011, IEC 61010-1:2011	300V CAT II







Connection cable to be used

- Provide fuses for protection for CAT II
- No mix of touchable and dangerous active circuits
- Connecting cables must be designed for a temperature of at least 62 ° C

4.2.4 Power supply for PQI-DA smart

Power supply		
Feature	H1	H2
AC	100 - 240 V (+/-10%)	-
DC	120V-350V	24 - 60 V (+20%/-25%)
Power consumption.	< 20VA	≤ 10 Watt
Frequency	50 - 60Hz (-6%/+5%)	-
External fuse characteristics	6A B	6A B
Electrical safety IEC 61010-1:2010 + Cor.:2011, DIN EN 61010-1:2011	CAT II	CAT II

 CAUTION	Power supply for PQI-DA smart  Caution dangerous contact voltage  If a H2 device is connected to a 230V power supply , it is irreversibly damaged
---	--

 The device may only be operated within the permissible supply voltage range of the corresponding power supply unit.



Fusing of the auxiliary power supply

The PQI-DA-smart has to be fitted with a line circuit breaker in the building installation which meets the requirements of IEC 60947-1 and IEC 60947-3 and is suitable for use as a disconnecting device for the auxiliary power supply of the PQI-DA-smart.

Circuit breaker characteristic B is recommended. The rated current of the line circuit breaker depends on the number of connected devices but should not be less than 6A and not more than 10A. Three devices can be supplied via a B6 circuit breaker and a maximum of 5 PQI-DA-smarts can be supplied via B10. The circuit breaker must be arranged nearby the device, clearly marked as a separation switch for the device and for the users easily accessible.

H1: supplied by a CATII AC-voltage protected with an external circuit breaker not less than 6A and not more than 10A.

H2: supplied by a CATII DC-voltage protected by an external circuit breaker not less than 6A and not more than 10A.

We take care of it.

Functional ground



The function earth is the reference potential for the voltage inputs.



CAUTION

Power supply for PQI-DA smart

✋ The functional ground must always be connected to PE potential and must never be connected to a dangerous voltage.

4.2.5 Storage of measured values

Storage of measured values	
Internal memory	1024 MB
SD memory card	1 GByte to 32 GByte

4.2.6 Communication protocols

Communication Protocols

- MODBUS RTU
 - MODBUS TCP
-
- IEC60870-5-104 (Option P1)
 - IEC61850 (Option P2)

4.2.7 Time synchronization interface

Time synchronization protocols (Receive / Slave)

- IEEE1344 / IRIG-B000...007
-
- GPS (NMEA +PPS)
-
- DCF77
-
- NTP
-
- PTP (IEEE1588)

Interfaces

Ethernet	RJ45 (10/100 Mbit)
USB	mini USB connector
2 * RS232/RS485 on terminals	Switchable






LAN, COM interface



- All COM and LAN connection cables must not be below the insulation distance to dangerous parts, even when disconnected.
- The release of individual wires from the clamping must not be possible.
- Pull the plugs directly on the plug housing, never on the cable
- A fixation or strain relief for connection cable must be observed.

4.2.8 Electrical safety – environmental parameter

Environmental parameters	Storage and transport	Operation
Ambient temperature : Limit range of operation	IEC 60721-3-1 / 1K5 -40 ... +70°C IEC 60721-3-2 / 2K4 -40 ... +70°C	IEC 60721-3-3 / 3K6 -25 ... +55°C
Ambient temperature : Rated range of operation H1 Rated range of operation H2	---	IEC DIN EN 61010 -25 ... +45°C -25 ... +50°C
Relative humidity: 24h average No condensation or ice	5...95 %	5...95 %

 CAUTION	Overheating  Risk of overheating and fire  Observe the temperature resistance of the connection cables
---	---

Environmental parameters	Storage and transport	Operation
Solar radiations	---	700W/m2
Vibration, earth tremors	IEC 60721-3-1 / 1M1 IEC 60721-3-2 / 2M1	IEC 60721-3-3 / 3M1

 CAUTION	Mechanical damage  Protection against mechanical damage must be ensured
---	--

Electrical safety

- IEC 61010-1
- IEC 61010-2-030

Protection class	I
Pollution degree	II
Overvoltage category mains supply option : H1 H2	300V / CAT II 150V / CAT II
High voltage test	Pulse voltage 6 kV 5 sec 5.4kV RMS 1 min 3.6kV RMS
Measurement category	300V / CAT IV 600V / CAT III
Altitude	≤ 2000m
IP Code	IP 00



Danger

Danger to life by electric shock!

Care must be taken to secure and strain relief all the cables

All conductor requirements of the terminal blocks must be observed (for example, stripping length of the cables)

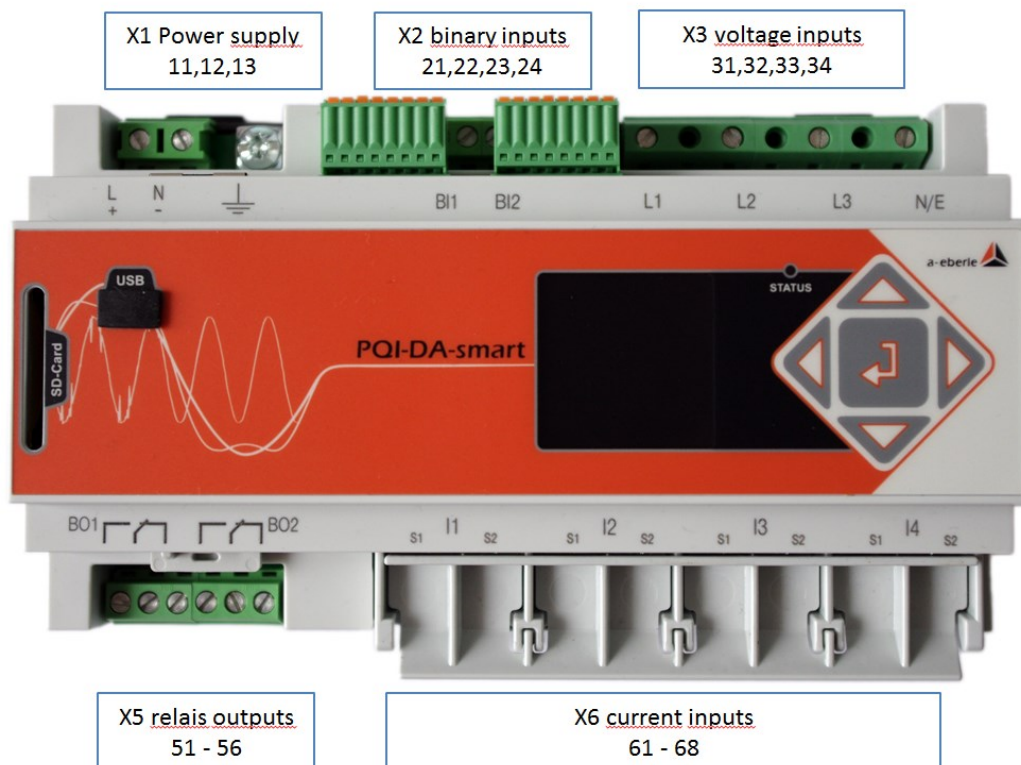
Dimensions / Weight

L x B x H	160 x 90 x 58 mm
Weight	500 g

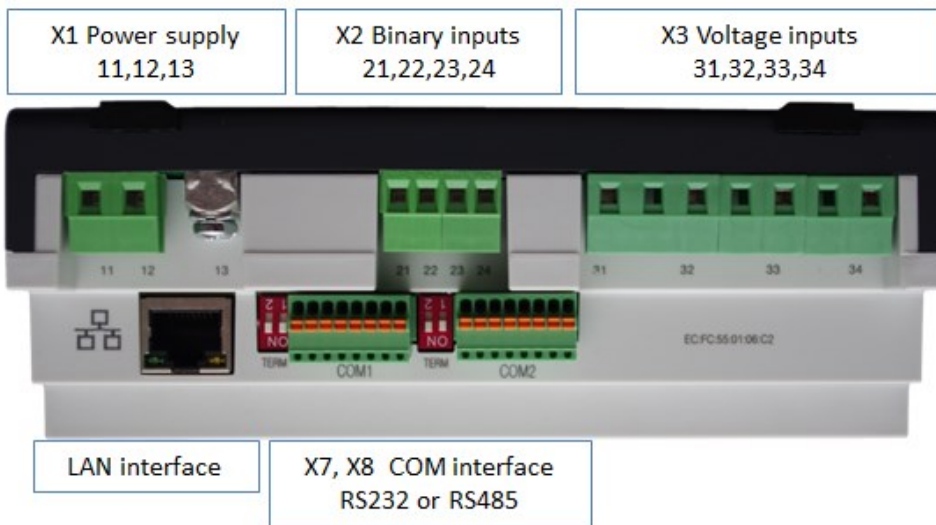
4.3 Mechanical design

The PQI-DA *smart* can be wall-mounted (optional DIN-rail), in-panel mounted (optional mounting frame) or used as a DIN-rail housing. On the front are one SD-Cord-Slot and one USB-connection available. The connection to the COM interfaces is via connectors with plug-in spring clamps. All other connections are screw terminals.

For the TCP/IP interface one RJ 45-connector is available.



Front view PQI-DA smart



Side view of PQI-DA smart

► Terminal strip number of COM interface

- X7 = COM1
- X8 = COM2

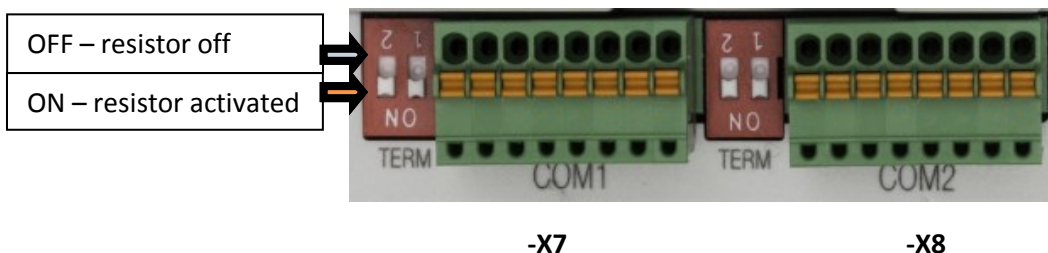


COM 1/2

1. TxD
2. RTS
3. GND
4. RxD
5. CTS
6. RS485 Neg/B
7. RS485 Neg/A
8. Shielding

► Termination resistor for COM-interface (COM1 / COM2)

- termination resistor "ON" activated
- termination resistor "OFF" turned off



Side view of PQI-DA smart

We take care of it.



Changing the battery:

The battery life time is > 5 years

A battery change does not affect the device operation when the power supply is connected and the device is internally supplied with power.

Pull the battery out of the housing and insert a new battery

Battery type:

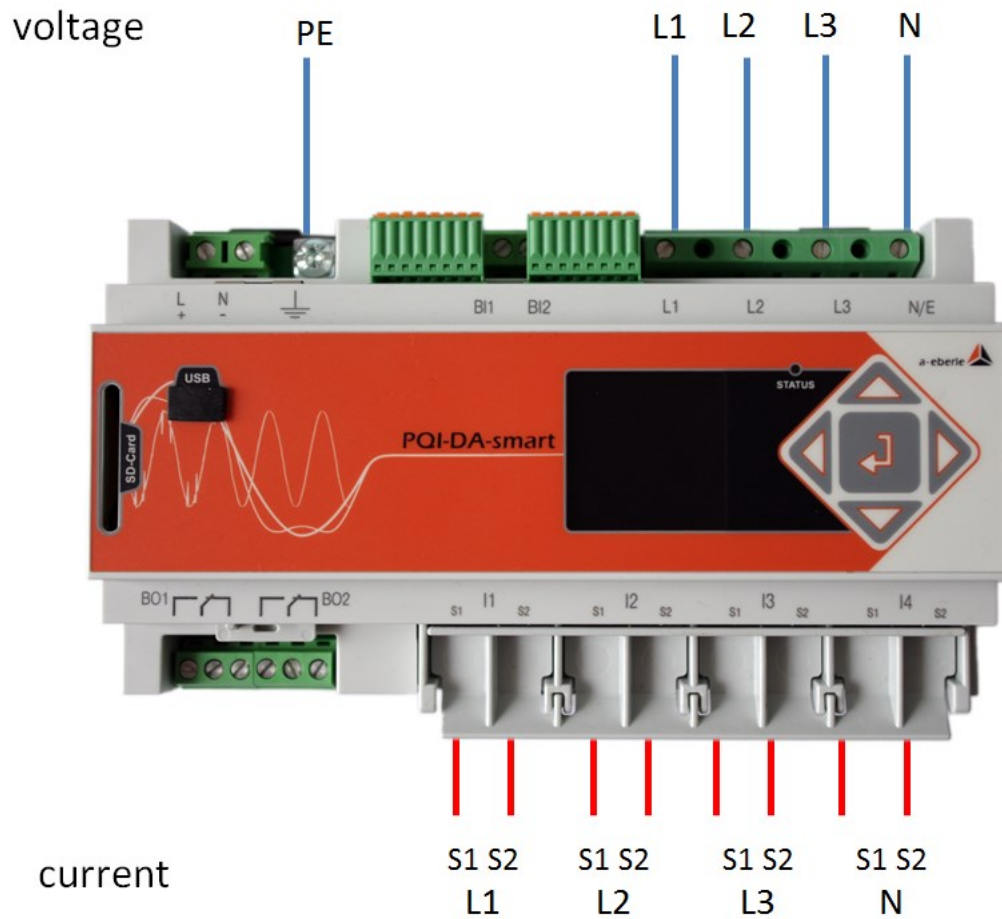
Li- button cell CR1632

4.4 Terminal strip number PQI-DA smart

Terminal strip no.	Designation		Function	Terminal no.	Cable cross section qmm	Stripped length in mm
X1	Auxiliary voltage	U _H	L (+)	11	0,75 – 1,5	6
			L (-)	12	0,75 – 1,5	6
X1	Ground	GND	E	13	1,5 – 2,5	8
X2	Binary input	BI1	+	21	0,75 – 1,5	6
			-	22	0,75 – 1,5	6
		BI2	+	23	0,75 – 1,5	6
			-	24	0,75 – 1,5	6
X3	Phase voltage	U ₁	L1	31	0,75 – 1,5	6
	Phase voltage	U ₂	L2	32	0,75 – 1,5	6
	Phase voltage	U ₃	L3	33	0,75 – 1,5	6
	Neutral point voltage	U ₄	N	34	0,75 – 1,5	6
X5	Binary output 1	R1	NC contact	51	0,75 – 1,5	6
			Pol	52	0,75 – 1,5	6
			NO contact	53	0,75 – 1,5	6
	Binary output 2	R2	NC contact	54	0,75 – 1,5	6
			Pol	55	0,75 – 1,5	6
			NO contact	56	0,75 – 1,5	6
X6	Phase current L1	I1	S1 S2	61 62	1,5 - 4	8
	Phase current L2	I2	S1 S2	63 64	1,5 - 4	8
	Phase current L3	I3	S1 S2	65 66	1,5 - 4	8
	Neutral conductor / sum current	I4	S1 S2	67 68	1,5 - 4	8

4.5 Mains connection for PQI-DA smart

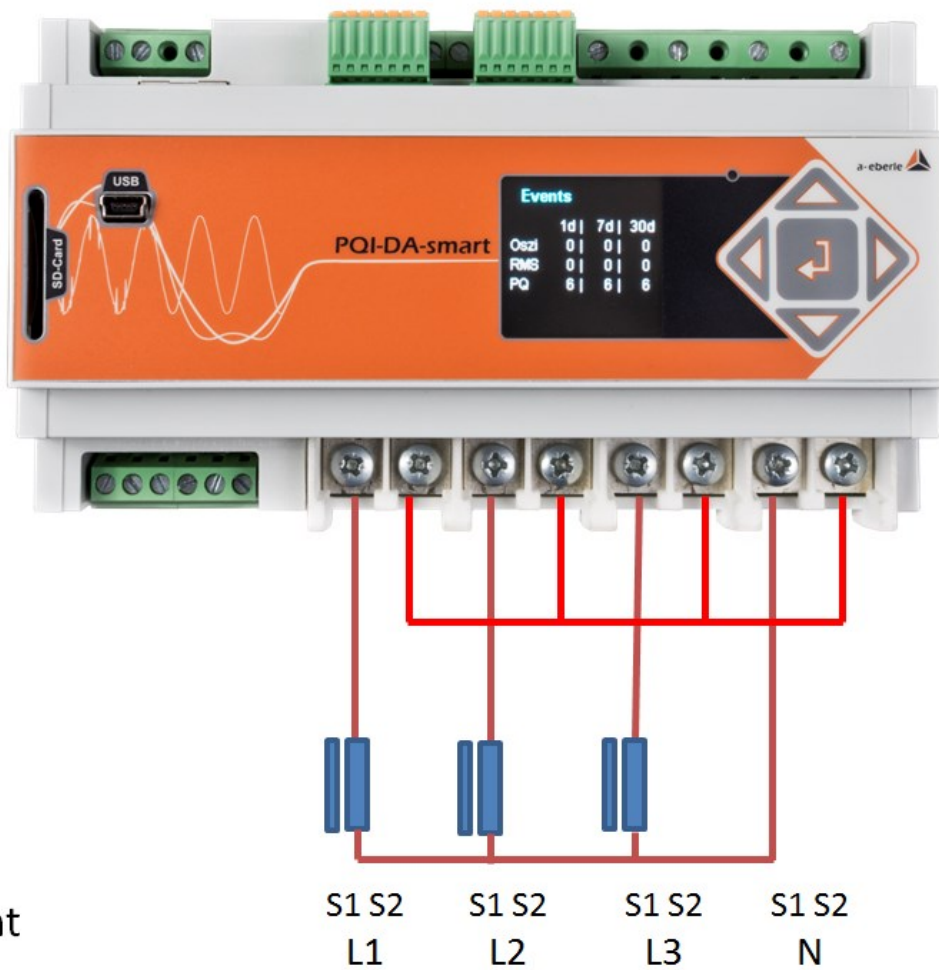
4.5.1 3-phase / 4-wire connection



Voltage connections

- ✎ Please ensure that the PE conductor (Earth) is connected to the PQI-DA smart.
- ✎ If no N conductor is available, connect E and N together.
- ✎ Ensure that switching (4-wire) is selected. (Setting via display or software)

4.5.2 4-wire connection without neutral current

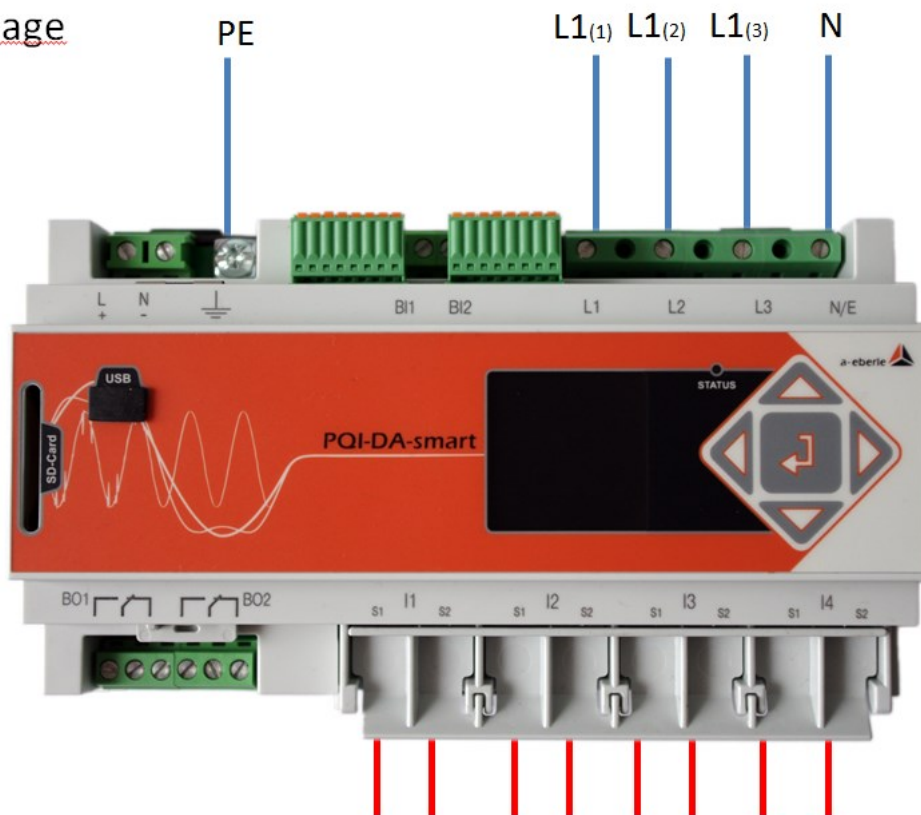


current

If no neutral current is available in the 3-phase, 4-wire grid, the power inputs of the PQI-DA *smart* are connected as shown in the illustration above.

4.5.3 4-wire 1-phase

voltage



current

S1 S2 S1 S2 S1 S2 S1 S2
L1(1) L1(2) L1(3) N

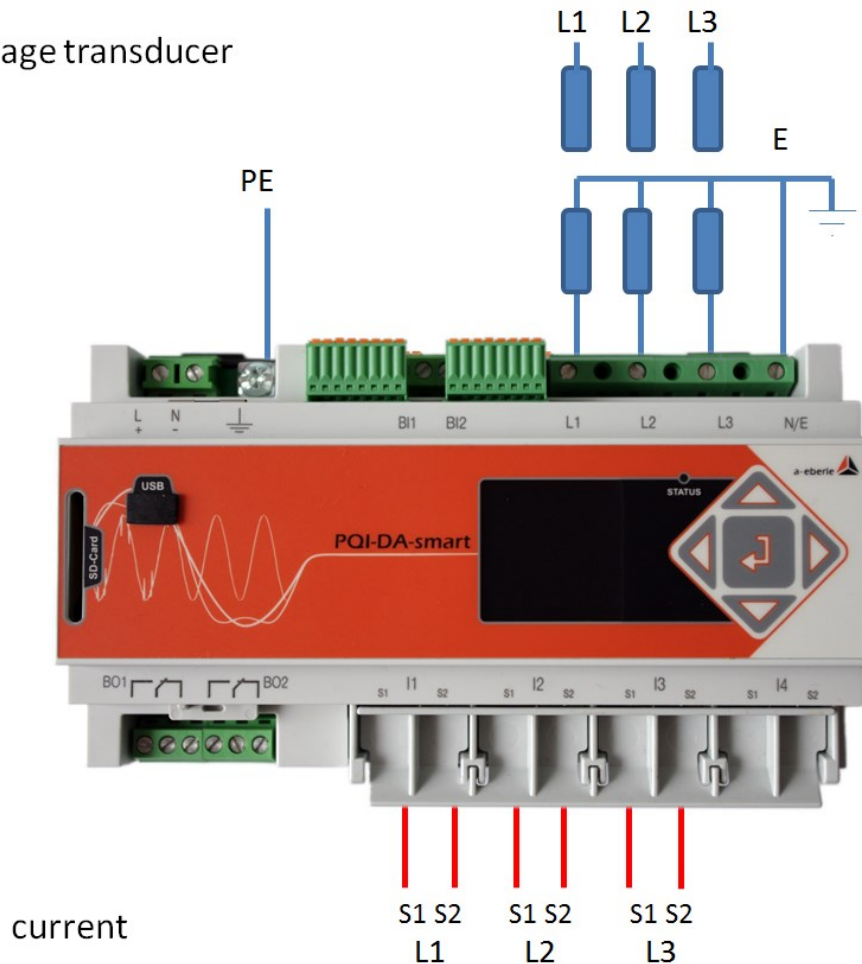
With the 4-wire grid, 1-phase set-up no conductor-conductor events and 3~grid events are evaluated.

Any voltage with the same earth potential can be connected (e.g. three grids with the L1 phase) and any current can be connected.

4.5.4 3-phase / 3-wire connection

► Connection to secondary transformer

Voltage transducer



current

Connections

- ✎ Please ensure that the PE conductor (earth) is connected to the PQI-DA smart.
- ✎ Ensure that measurement cable E is connected for each measurement. This is normally the earthing point of the voltage transformer.
- ✎ Ensure that switching (3-wire) is selected. (Setting via display or software)
- ✎ Set the voltage transformer ratio
- ✎ Enter the nominal conductor-conductor voltage
- ✎ Set the current transformer ratio

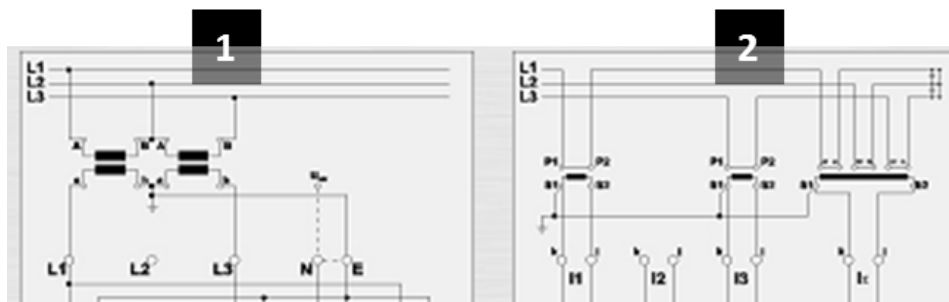


Connecting PQI-DA smart Power IN in a 3-wire grid

If a current is connected to the IN input in the 3-wire network, this is not recorded. The current IN is always calculated while in three-wire operation.

4.5.5 V connection; Aron connection

The V connection or Aron connection can be configured in the device set-up of the software. These connection types are only available in the 3-wire configuration.



- 1) V connection (set-up via the evaluation software)
- 2) Aron connection (set-up via the evaluation software)

Possible connection configurations in 3-wire grids:

- Voltage converter connections: 1, 2, 3, 4,
- Current transformer connections: 1, 2, 3, 4,

The voltage converter and current transformer selection fields can be set-up. The grounded voltage in each case or the current that has not been connected is calculated by the measurement device.

► 3-phase voltage converter connections:

Connection configuration	VT	Measuring channel				Reference potential
		1	2	3	4	
Voltage converter: L1, L2, L3, N/E	1	u_1	u_2	u_3	$u_{N/E}$	E
V connection, earth L1	2	u_1	u_2	u_3	u_4	
V connection, earth L2	3	u_1	u_2	u_3	u_4	
V connection, earth L3	4	u_1	u_2	u_3	u_4	

► 3-phase current transformer connections:

Connection configuration	CT	Measuring channel			
		5	6	7	8
Current transformer: L1, L2, L3, N	1	i_1	i_2	i_3	i_N
Current transformer: L2, L3	2	-	i_2	i_3	i_4
Current transformer: L1, L3	3	i_1	-	i_3	i_4
Current transformer: L1, L2	4	i_1	i_2	-	i_4

4.6 Measurement / Functions

PQI-DA smart complies with the automatic event detection and measurement standards, which are: EN50160 / IEC61000-2-2 / IEC61000-2-12 / IEC61000-2-4 (Class 1; 2; 3) / NRS048 / IEEE519 / IEC61000-4-30 class A ed. 3 / IEC61000-4-7 / IEC61000-4-15

4.6.1 Continuous Recording:

Five fixed and two variable measurement time intervals are available for continuous recording. All measured values can be freely activated or deactivated in the data classes.

- 10/12 periods (200ms)
- 1 sec
- n*sec (can be set from 2 seconds to 60 seconds)
- 150/180 periods (3sec)
- n*min (can be set from 2 seconds to 60 seconds)
- 10 min
- 2 hrs.

Time Interval Voltage	10/ 12T	150/ 180T	10 min	2 h	1 s	N* s	N* min
Power frequency	✓	✓	✓	✓	✓	✓	✓
Power frequency, 10s-Value (IEC61000-4-30)							
Extremes, standard deviation of power frequency (10s)			✓				
r.m.s. values (IEC61000-4-30)	✓	✓	✓	✓	✓	✓	✓
Extremes, standard deviation of T/2-values			✓				
Under deviation [%] , Over deviation [%] (IEC61000-4-30)	✓	✓	✓	✓			
Harmonic subgroups n= 0..50 (IEC61000-4-7)	✓	✓	✓	✓			
Maximum values of 10/12 T harmonic subgroups n = 2..50			✓				
Interharmonic subgroups n=0..49 (IEC61000-4-7)	✓	✓	✓	✓			
Total Harmonic Distortion (THDS) (IEC61000-4-7)	✓	✓	✓	✓	✓	✓	✓
Partial Weighted Harmonic Distortion (PWHD)	✓	✓	✓	✓	✓	✓	✓
Unbalance, negative-/positive- sequence , sequence sign	✓	✓	✓	✓	✓	✓	✓
Unbalance, zero-/positive- sequence	✓	✓	✓	✓	✓	✓	✓
Positive-, negative-, zero sequence phasors	✓	✓	✓	✓	✓	✓	✓
Phasors (fundamental)	✓	✓	✓	✓	✓	✓	✓
Flicker (IEC61000-4-15)			✓	✓			
Instant flicker (IEC61000-4-15)	✓		✓				
Mains signaling voltages [%] (IEC61000-4-30)	✓	✓					
Phase angle(zero crossings) of phase voltage harmonics n=2..50 to fundamental of reference voltage	✓	✓	✓	✓			
Frequency bands 1..35 , 2kHz..9kHz, r.m.s. (IEC61000-4-7)			✓	✓	✓	✓	✓

Time Interval Current	10/ 12T	150/ 180T	10 min	2 h	1 s	N* s	N* min
r.m.s. values	✓	✓	✓	✓	✓	✓	✓
Extremes of T/2-values			✓				
Harmonic subgroups n= 0..50 (IEC61000-4-7)	✓	✓	✓	✓			
Maximum values of 10/12 T harmonic subgroups n = 2..50			✓				
Interharmonic subgroups n=0..49 (IEC61000-4-7)	✓	✓	✓	✓			
Total Harmonic Distortion (THDS) (IEC61000-4-7)	✓	✓	✓	✓	✓	✓	✓
Total Harmonic Currents	✓	✓	✓	✓	✓	✓	✓
Partial Weighted Harmonic Distortion (PWHd)	✓	✓	✓	✓	✓	✓	✓
Partial Odd Harmonic Currents (PHC)	✓	✓	✓	✓	✓	✓	✓
K-Factors	✓	✓	✓	✓	✓	✓	✓
Unbalance, negative-/positive- sequence , sequence sign	✓	✓	✓	✓	✓	✓	✓
Unbalance, zero-/positive- sequence	✓	✓	✓	✓	✓	✓	✓
Positive-, negative-, zero sequence phasors	✓	✓	✓	✓	✓	✓	✓
Phasors (fundamental)	✓	✓	✓	✓	✓	✓	✓
Phase angle(zero crossings) of current harmonics n=2..50 to fundamental of reference voltage	✓	✓	✓	✓			
Frequency bands 1..35 , 2kHz..9kHz, r.m.s. (IEC61000-4-7)			✓	✓	✓	✓	✓

Time Interval Energy	10 min	2 h	1 s	N* s	N* min
Active energy, phase	✓	✓	✓	✓	✓
Active energy, total	✓	✓	✓	✓	✓
Exported active energy, phase	✓	✓	✓	✓	✓
Exported active energy, total	✓	✓	✓	✓	✓
Imported active energy, phase	✓	✓	✓	✓	✓
Imported active energy, total	✓	✓	✓	✓	✓
Reactive energy (inductive), phase	✓	✓	✓	✓	✓
Reactive energy (inductive), total	✓	✓	✓	✓	✓
Exported reactive energy (inductive), phase	✓	✓	✓	✓	✓
Exported reactive energy (inductive), total	✓	✓	✓	✓	✓
Imported reactive energy (inductive), phase	✓	✓	✓	✓	✓
Imported reactive energy (inductive), total	✓	✓	✓	✓	✓

Time Interval Power	10 min	2 h	1 s	N* s	N* min
Active power, phase	✓	✓	✓	✓	✓
Active power, total	✓	✓	✓	✓	✓
Active power extremes	✓				
Reactive power, phase	✓	✓	✓	✓	✓
Reactive power, total	✓	✓	✓	✓	✓
Reactive power extremes	✓				
Apparent power, phase	✓	✓	✓	✓	✓
Apparent power, total	✓	✓	✓	✓	✓
Fundamental active power, phase	✓	✓	✓	✓	✓
Fundamental active power, total	✓	✓	✓	✓	✓
Fundamental reactive power, phase	✓	✓	✓	✓	✓
Fundamental reactive power (displacement), total	✓	✓	✓	✓	✓
Fundamental apparent power, phase	✓	✓	✓	✓	✓
Phase angle of fundamental apparent power, phase	✓	✓	✓	✓	✓

Fundamental apparent power, total	✓	✓	✓	✓	✓
Phase angle of fundamental apparent power, total	✓	✓	✓	✓	✓
Reactive distortion power, phase	✓	✓	✓	✓	✓
Reactive distortion power, total	✓	✓	✓	✓	✓
Active power factors, phase, total	✓	✓	✓	✓	✓
Reactive power factors, phase, total	✓	✓	✓	✓	✓
COS ϕ + sign, phase, total	✓	✓	✓	✓	✓
SIN ϕ + sign, phase, total	✓	✓	✓	✓	✓
COS ϕ + sign of reactive distortion power, phase, total	✓	✓	✓	✓	✓
Capacitive-, inductive scaling factor of COS ϕ (-1..0..+1) :	✓	✓	✓	✓	✓
Triggered interval mean active power, phase					
Triggered interval mean active power, total					
Triggered interval mean reactive power, phase					
Triggered interval mean reactive power, total					

4.6.2 PQ Events

trigger quantity	lower	upper
voltage dip (T/2)	✓	
voltage swell (T/2)		✓
voltage interruption (T/2)	✓	
voltage rapid voltage change (T/2)	sliding average filter mean +/- threshold	
voltage change (10min)	✓	✓
voltage unbalance (10min)		✓
mains signaling voltage (150/180T)		✓
voltage harmonics (10min)		✓
voltage THD (10min)		✓
voltage short term flicker PST (10min)		✓
voltage long term flicker PLT (10min)		✓
power frequency (10s)	✓	✓

4.6.3 Recorder triggering

trigger quantity	lower	upper	step
r.m.s. phase voltages (T/2)	✓	✓	✓
r.m.s. phase-phase voltages (T/2)	✓	✓	✓
r.m.s. residual/neutral-ground voltage (T/2)		✓	✓
Positive sequence voltage (T/2)	✓	✓	
Negative sequence voltage (T/2)		✓	
Zero sequence voltage (T/2)		✓	
Phase voltage phase (T/2)			✓
phase voltages wave shapes (wave shape filter)	+/- threshold		
phase-phase voltages wave shapes (wave shape filter)			
residual/neutral-ground voltage wave shape (wave shape filter)			
r.m.s. phase currents (T/2)	✓	✓	✓
r.m.s. total / neutral current (T/2)		✓	✓
Power frequency (T/2)	✓	✓	✓
Binary inputs (debounced)	rising, falling slope		
Command	external		

4.6.4 Output relays



The functions of the output relays have been defined as follows:

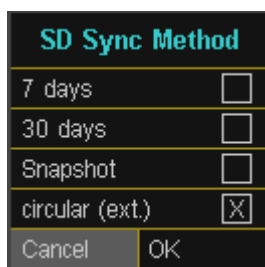
- Relay B01 – Watchdog relay
Self-monitoring of the measurement device
- Relay B02 – Reports new sequence of events recording
If a new event is captured relay B02 is operated for one second. Settings are described in Chapter 6.4.2.6

4.6.5 Memory management

The PQI-DA *smart* is equipped with an internal memory of one gigabyte.

If a SD-card is inserted in the device, you have to choose between different methods of using the SD-card.

- Copy all data of the last 7 days
- Copy all data of the last 30 days
- Copy all data a complete snapshot of the whole internal memory
- Circular (ext.) = the SD-card will stay in the device and will be filled in a circular memory.
If the SC-card is bigger than one gigabyte, the time period of the SD-card is much longer than into the PQI-DA smart. (extended Memory)

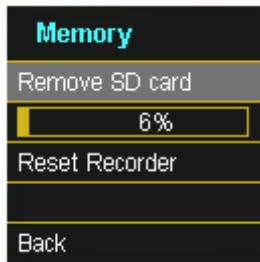


Confirm with “OK” and the PQI-DA *smart* will start automatically to copy the selected internal memory onto the SD card.



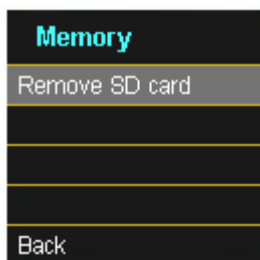
The minimum size of an external memory card is one gigabyte. The device can manage memory cards up to a max of 32GBytes.

In the display menu “memory” the progress of the copy process is shown.



 To remove the memory card, operate the "Remove SD card" function.

The "Remove SD card" function stops the copying function for the measuring data of the internal memory to the SD memory card and releases the card for removal.



▶ **Memory allocation**

The memory allocation of the PQI-DA *smart* uses the internal 1 gigabyte memory in a circular buffer for all measurement data.

The circular buffer is allocated as follows:

- 512 MB circular buffer for long-term measurement data
- 416 MB circular buffer for sequence of events recordings (oscilloscope images; ½ period RMS values)
- 16 MB circular buffer for log files and Power Quality events

5. Operation of the PQI-DA smart

5.1 Getting started - Wizard

When the PQI-DA smart power analyzer is put into operation for the first time, the device starts in a guided setup mode. The user is guided automatically through the first commissioning of the measuring instrument.

► Wizard page 1

The screenshot shows two panels of the 'PQ-Norm' screen. The left panel shows three options: EN50160-LV, EN50160-MV, and EN50160-HV, each with an unchecked checkbox. The right panel shows the same options, but EN50160-LV is checked with an 'X' in the box. A grey arrow points from the left panel to the right panel. At the bottom of each panel are 'Cancel' and 'Next' buttons.

Automatic basic settings and limit values for the following voltage level according to EN50160:

- Low-voltage grid => EN50160-LV
- Medium-voltage grid => EN50160-MV
- High-voltage grid => EN50160-HV

The selection of the Voltage Level has an influence on which measures should be recorded, on the thresholds and also at the IEC61850 Interface which data can be used at IEC61850 Interface.

► Wizard page 2

The screenshot shows the 'Setup-Wizard' screen. The 'Language' option is selected, and 'English' is displayed in a box. At the bottom are 'Cancel' and 'Next' buttons.

Selecting the Display Language PQI-DA smart

► Wizard page 3

Setup-Wizard	
Net type	
4-Cond,3-phase	
Net frequency	
[Hz]	50
Cancel	Next

Basic settings / network connection PQI-DA smart

For more information about the network connection, see Chapter 4.5 Hardware connection

● **Net Type:**

Entering the grid type "3-conductor grid", "4-conductor grid" and/or "4 x 1 conductor grid" will determine how the Power Quality events are recorded.

Switch between 3-conductor and 4-conductor grids.

- In a 3-conductor grid, all events are calculated from the line-line voltages.
- In a 4-conductor grid and/or a 4 x 1 conductor grid all Power Quality events are determined from the line-earth voltages.

● **Grid frequency**

Setting grid frequency to 50Hz or 60Hz

► Wizard page 4

Setup-Wizard	
Voltage Transd.	
1.00	
Current Transd.	
1.00	
Cancel	Next

Voltage Transducer: Corresponds to the ratio between the primary and secondary voltage.

Current Transducer: Corresponds to the ratio between the primary and secondary current.

Example:

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

Primary = 100A / secondary = 5A; Conversion factor = 20

► Wizard page 5

Setup-Wizard	
Reference Voltage	
[%]	100
[V] P-P	398.37
Cancel	Next

Setup of the **Reference voltage** in %.

The Setting has to be made in percent. The PQI-DA smart automatically calculates the Phase to Phase voltage [V] P-P.

The displayed value for the nominal voltage is:

- In a 4-conductor grid = 230V line-earth voltage
- In a 3-conductor grid = 100V line-line voltage, multiplied by the conversion factor

The % value is used to set the reference voltage at a different value to the nominal voltage.



Example 1: $20,000V * 105\% =$ Reference voltage of 21,000V. This is the reference value for all trigger thresholds as well as Power Quality events.

Example 2: 500V grid (conductor-conductor) $230V * 125\% = 287.5V$ (conductor-earth)

► Wizard page 6

Setup-Wizard	
Date	
	only in manual
Time	
	only in manual
Cancel	Next

Manual entry of date and time.

► Wizard page 7

Setup-Wizard	
DHCP	
	Deactivated
Cancel	Next

Activating or deactivating DHCP

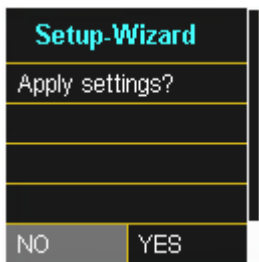
DHCP deactivated: The device is used with a fixed IP address which have to be parameterized in the next step

DHCP activated: The device gets its IP-Address direct from a DHCP Server, which has to be reachable!

Setup-Wizard	
IP-Address	
	192.168.1.1
Subnet mask	
	255.255.255.0
Cancel	Next

Entering a fix IP – Address and Subnetmask

▶ Wizard Page 8

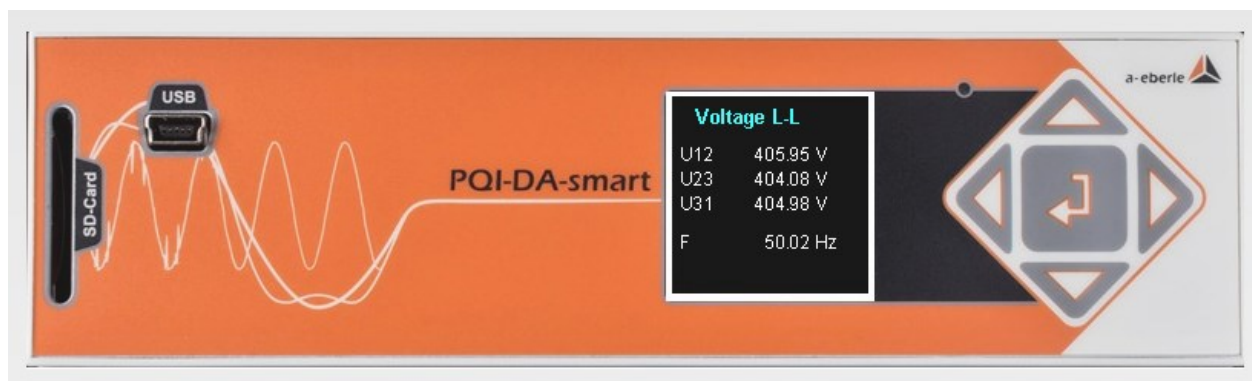



At this point, all the settings for the device can be transferred or canceled.

- With the confirmation of "Yes", the device restarts, change all settings and delete all old measurement files in the device memory.
- Nearly all settings (e.g. IEC61850 settings) are set to factory settings!
- The measurement campaign is now started.

5.2 Display

The color display of the device provides information about the correct connection of the measuring cables and transducers and shows online data for voltages, currents, total harmonic distortion (THD), power values and energy.



Pressing the "right" and "left"  keys on the keypad will change the side of the display. If no key is operated, the screen will switch to sleep mode after 5 minutes.

The following screens provide online information of the measured data:

Display page 1

Voltage L-N	
U1E	0.05 V
U2E	0.04 V
U3E	0.04 V
UNE	0.09 V

Line-Earth voltages

Display page 2

Voltage L-L	
U12	0.02 V
U23	0.01 V
U31	0.01 V
F	0.00 Hz

Line-to-line voltages & grid frequency

Display page 3

Current	
I1	0.74 mA
I2	0.04 mA
I3	0.72 mA
IN	0.97 mA

Currents L1, L2, L3, N conductor

Display page 4

Current-Maximum (1 Tag)	
I1	7.80 mA
I2	0.01 mA
I3	6.61 μ A
IN	0.00 μ A

10 minutes maximum current for the last day

Display page 5

Current-Maximum (7 Tage)	
I1	7.90 mA
I2	0.01 mA
I3	6.65 μ A
IN	0.00 μ A

10 minutes maximum current for the last 7 days

Display page 6

Current-Maximum (30 Tage)	
I1	7.95 mA
I2	0.01 mA
I3	7.21 μ A
IN	0.00 μ A

10 minutes maximum current for the last 30 days

Display page 7

Current-Maximum absolute [10Min]	
I1	0.86 A
I2	0.87 A
I3	0.02 A
IN	1.19 A

10 minutes maximum current since the last rest

Display page 8

Active Power	
P1	9.07 μ W
P2	-0.00 W
P3	-0.00 W
P	4.34 μW

Active power including sign

Display page 9

Apparent Power	
S1	0.04 mVA
S2	1.63 μ VA
S3	0.03 mVA
S	0.60 μVA

Apparent output

Display page 10

Reactive Power	
Q1	0.04 mVAr
Q2	1.57 μ VAr
Q3	0.03 mVAr
Q	0.07 mVAr

Reactive power

Display page 11

Power Factor	
PF1	1.000
PF2	1.000
PF3	1.000
PF	1.000

Power factor (active power / apparent output)

Display page 12

THD Voltage	
THD U1	0.00 %
THD U2	0.00 %
THD U3	0.00 %

Total harmonic distortion of voltages.

The THD calculation H2 to H40 and/or H2 to H50 is adjustable.

Display page 13

THD Current	
THD I1	0.00 %
THD I2	0.00 %
THD I3	0.00 %
THD IN	0.00 %

Total harmonic distortion of currents

The calculation H2 to H40 and/or H2 to H50 is adjustable

Display page 14

Active Energy	
Ep	0.00 kWh
Ep pos.	0.00 kWh
Ep neg.	0.00 kWh

Ep Total active energy

Ep pos. Active energy received (positive sign)

Ep neg. Active energy supplied (negative sign)

Display page 15

Reactive Energy	
Eq	0.00 kvarh
Eq pos.	0.00 kvarh
Eq neg.	0.00 kvarh

Eq Total reactive energy

Eq pos. Reactive energy received (positive sign)

Eq neg. Reactive energy supplied (negative sign)

Display page 16

PQ Smart	
Firmware	1856
Date	04.09.14
Time	09:53

Current firmware for PQI-DA smart / Device date and time

Display page 17

Lizenz state	
Sample rate	
■ 40 kHz	
SCADA	
■ IEC60870-5-104	
□ IEC61850	

Display information about the license of this device.

In this example the PQI-DA smart has no IEC61850 communication licensed.

Display page 18

Events			
	1d	7d	30d
Osci	18	21	21
RMS	16	17	17
PQ	86	92	92

The number of PQ events that occurred, Oscilloscopic and RMS value recordings for the last day, last week and last month appear on the device display.



The event counter changes over to the following day at 24:00 hours/ 12 am each day.

5.3 Setup display



Pressing the key on the keypad will change the display to the setup menu.

The following main menus are available in setup mode:

Setup	Setup
Parameter	Interface Config
Time Setup	SCADA
Basic Setup	
Memory Management	
	Back

5.3.1 Parameter

▶ Parameter page 1

Parameter	
Net type	
4-Cond,3-phase	
Net frequency	
[Hz]	50

Grid configuration

Entering the grid type "3-conductor grid", "4-conductor grid" and/or "4 x 1 conductor grid" will determine how the Power Quality events are recorded.

Switch between 3-conductor and 4-conductor grids.

- In a 3-conductor grid, all events are calculated from the line-line voltages.
- In a 4-conductor grid and/or a 4 x 1 conductor grid all Power Quality events are determined from the line-earth voltages.

Grid frequency

Setting grid frequency to 50Hz or 60Hz

▶ Parameter page 2

Parameter	
Voltage Transd.	
1.00	
Current Transd.	
1.00	

Voltage converter: Corresponds to the ratio between the primary and secondary voltage.

Current transformer: Corresponds to the ratio between the primary and secondary current.

Example:

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

Primary = 100A / secondary = 5A; Conversion factor = 20

► **Parameter page 3**

Parameter	
Nominal Voltage	
[V]	230
Reference Voltage	
[%]	100
[V] P-P	398.37

The displayed value for the nominal voltage is:

- In a 4-conductor grid = 230V line-earth voltage
- In a 3-conductor grid = 100V line-line voltage, multiplied by the conversion factor

The % value is used to set the reference voltage at a different value to the nominal voltage.



Example 1: $20,000\text{V} * 105\% = \text{Reference voltage of } 21,000\text{V}$. This is the reference value for all trigger thresholds as well as Power Quality events.

Example 2: $500\text{V grid (line-line)} \quad 230\text{V} * 125\% = 287.5\text{V (line-earth)}$

► **Parameter page 4**

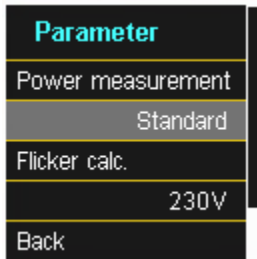
Parameter	
Nominal Current	
[A]	5
Reference channel	
	U1E

Rated current

All trigger thresholds for the current refer to the set nominal current. The nominal current for the system should be entered here.

Reference channel defines the measuring channel for frequency measurements and grid synchronization.

▶ **Parameter page 5**



Power measurement: The power calculation in the device firmware can be selected from two measuring functions:

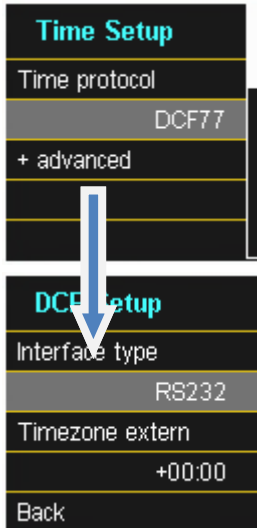
- Power calculation in accordance with DIN 40110, part 2 – including the calculation of the imbalance reactive power (factory setting for the device)
- Simplified power calculation without considering the imbalance reactive power in the 3~ phase power



This setting has an impact on the measured power values on the device display, the online measured values and the recorded measured values.

5.3.2 Time settings

5.3.2.1 DCF77 time setting



Time synchronization to an external DCF77 radio-controlled clock

DCF77 settings on the RS232/RS485 interface and the time zone of the DCF signal.

5.3.2.2 Connection DCF77 GPS Clock

To connect the DCF77 time clock art no. 111.9024.01 to PQI-DA smart please use this wiring.

Connection DCF77 time clock:



1: TxD → black wire time clock = -6V

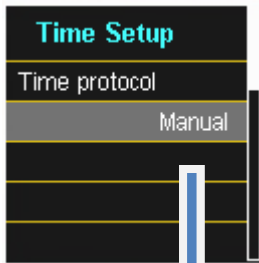
2: RTS → red wire time clock = +6V

3: GND → white wire time clock = GND

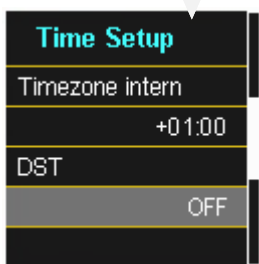
4: RxD → green wire time clock = clock signal

- In extended mode, parameterize interface type RS232
- Time zone external: + x hours for time zone (time of data shown in the software)
- Time zone internally: + x hours for time zone (time of the PQI-smart display)

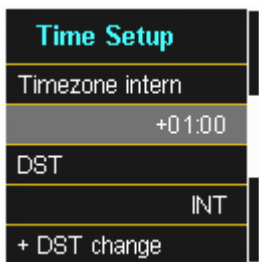
5.3.2.3 Manual time setting



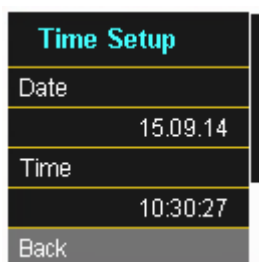
The time is set manually on the device



Summer / winter time setting is switched off (DST = OFF)



Setting the time zone in which the device is located



Manual time and date setting for PQI-DA smart

5.3.2.1 Summer- Wintertime change (DST – Daylight Saving Time)

If the DST operating mode is set to **internal**, the summer/winter time changeover inside the PQI-DA smart takes place automatically each year. The PQI-DA smart use an internal algorithm with the following three parameters:

- **Day and month:** This is not specifically the date/month of the next change, but rather a method to specify **the week** in the month that the change is to occur on. Refer to the following examples.
- **Weekday:** The day of the week that the changeover always takes place on.
- **Time:** Time that the changeover will occur (the start of the changeover).

DST change	DST change
Summer > winter	Winter > summer
25.10.	25.03.
Sunday	Sunday
03:00	02:00
	Back

Menu for setting the parameters for daylight savings changes.

► Example 1: Europe – Germany

The changeover from **summer to wintertime** always takes place on the last Sunday in the month of October at 03:00 with the time changing back to 02:00 hrs.

The changeover from winter to summertime always takes place on the last Sunday in March at 02:00 with the time changing forward to 03:00 hrs.

	Summer to wintertime	Winter to summertime
Date and Month :	25.10	25.3
Day ::	Sunday	Sunday
Time :	03:00	02:00

These parameters cause the PQI-DA smart to:

- change from daylight savings at 3 am on the Sunday that occurs **on or after** the 25.10, i.e The first Sunday that occurs **on or following** the 25th of the month. As there are 31 days in October, the Sunday occurring **on or after** the 25th will always be the last Sunday of the month of October.
- change to daylight savings at 2 am on the Sunday that occurs **on or after** the 25.3, i.e the last Sunday of the month of March.

► Example 2: Australia – New South Wales

The changeover from **summer to wintertime** takes place on the first Sunday in the month of April at 03:00 with the time changing back to 02:00 hrs

The changeover from **winter to summertime** always takes place on the first Sunday in the month of October at 2:00 with the time changing forward to 03:00 hrs.

	Summer to wintertime	Winter to summertime
Date and Month :	1.4	1.10
Day :	Sunday	Sunday
Time :	03:00	02:00

These parameters ensure for all future years that the changeover from summer to wintertime is always performed automatically by the PQI-DA smart on the first Sunday **on or after** 01.4 and the change from winter to summertime is always performed on the first Sunday **on or after** 01.10.

5.3.2.2 NTP time setting

Time synchronization to a NTP time server



Time Setup

Time protocol

NTP

+ advanced

NTP Setup

Time server 1 IP

172.16.0.10

Time server 1 port

123

NTP Setup

Time server 2 IP

0.0.0.0

Time server 2 port

123

NTP Setup

Time server 3 IP

0.0.0.0

Time server 3 port

123

NTP Setup

Time server 4 IP

0.0.0.0

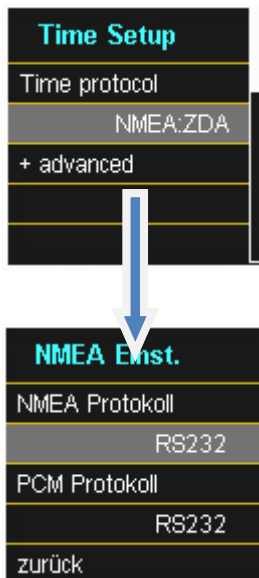
Time server 4 port

123

Back

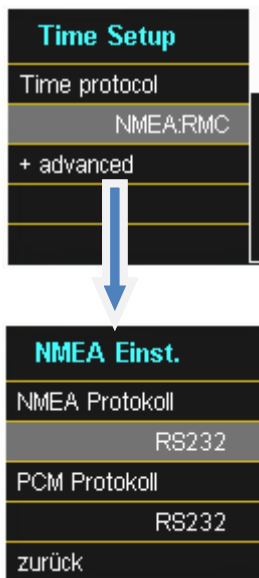
The PQI-DA smart supports up to four time servers in the network. The device automatically uses the strongest signal that is available in the network.

5.3.2.3 NMEA-ZDA time setting



Setting up the RS232/RS485 interface for the NMEA protocol

5.3.2.4 NMEA-RMC time setting



Setting up the RS232/RS485 interface for the NMEA-RMC protocol

5.3.2.5 IRIG-B time setting

IRIG-B formats 0 to 3

Time Setup	
Time protocol	
	IRIG-Bxx0..3
+ advanced	



IRIG-B Setup	
Interface type	
	RS232
Timezone extern	
	+00:00
Back	

IRIG-B formats 4 to 7

Time Setup	
Time protocol	
	IRIG-Bxx4..7
+ advanced	



IRIG-B Setup	
Interface type	
	RS232
Timezone extern	
	+00:00
Back	

Selecting the IRIG-B format

Setting up the interface and the time zone

5.3.2.6 IEEE 1344 time setting

Time Setup	
Time protocol	
	IEEE1344
+ advanced	



IRIG-B Setup	
Interface type	
	RS232
Timezone extern	
	+00:00
Back	

Time synchronization to an IRIG-B time protocol (in accordance with IEEE1344)

Setting up the interface and the time zone

5.3.3 Basic setting

▶ Basic setting page 1



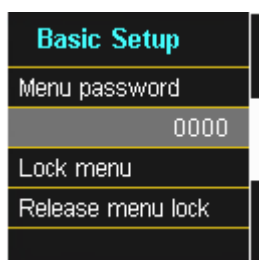
Language: Select the display language

Automatic setup: This function takes you through an automatic device setup. This function is started automatically when the device is put into operation for the first time and does then not appear again. You can go to the guided setup at any time via "Auto Setup".



When automatic setup is performed, all the data saved on the meter is deleted. In addition, the complete set-up is reset to the factory state, except for the changes made in the wizard itself.

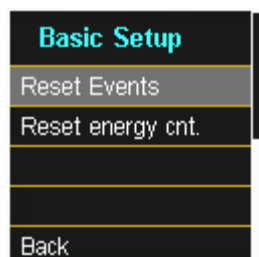
▶ Basic setting page 2



Access to the device setup can be disabled via a 4-digit password.

- Enter a four digit passkey
- Activate with "Lock menu"

▶ Basic setting page 3

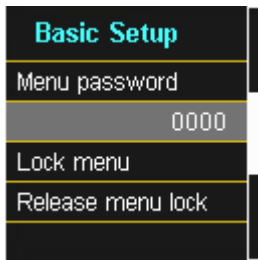


Reset events: The event counter for sequence of events recordings and PQ events on the device display is reset to 0. All measurement data and PQ events are retained in the device memory.

Reset energy counter: The energy counters in the device display and in the device memory are set to 0.

5.3.4 Password lock device display

Access to the device setup can be disabled via a 4-digit password.



If a password is assigned, no access to the device set-up via the display is possible.

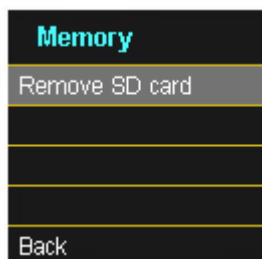


- Enter your correct password
- Confirm with unlock

Now the device setup over the keys and the display can be achieved. The password has no restriction for the software.

5.3.5 Memory management

The "Remove SD card" function stops the copying function for the measuring data of the internal memory to the SD memory card and releases the card for removal.



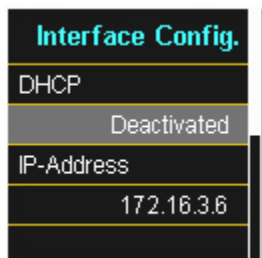
5.3.6 Setting up the device interfaces



PQI-DA smart is supplied with the following default IP address:

192.168.56.95 / 255.255.0.0

► Interfaces page 1

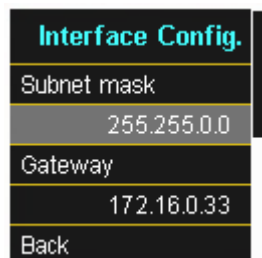


Activating or deactivating DHCP

DHCP deactivated: The device is used with a fixed IP address which have to be parameterized in the next step

DHCP activated: The device gets its IP-Address direct from a DHCP Server, which has to be reachable!

► Interfaces page 2



Entering a fix IP – Address and Subnet mask

6. WinPQ smart Software


The free WinPQ smart evaluation software has been created exclusively for the Network Analyzer PQI-DA smart and includes the following functions:

- Set-up of the Network Analyzer PQI-DA *smart*
- Online analysis of the measurement data
- Reading the measurement data from the measuring device
- Evaluating measurement data
- Firmware update for PQI-DA *smart*



The powerful database and evaluation software WinPQ which is available at an extra charge supports all mobile and permanently installed Network Analyzers supplied by A. Eberle in one system. Measuring data from different devices can be compared to each other. There is a fully automated and permanent connection to all permanently installed devices. Detailed Power-Quality reports and sequence of events recording are automatically created by the system and can be sent via e-mail. There are separate operating and commissioning instructions for the WinPQ software.

6.1 Installing 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 system via the "Software" option on the Control Panel. The installation location of the program (target directory) can be freely selected during installation.



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



The start icon  is created automatically on your PC's Desktop.

We take care of it.

► Uninstalling the software via the control panel

The components are removed from the PC using Windows "Control panel".

Under "Software", "WinPQ smart" entry, use the "Remove" button to delete the evaluation software.

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

You find the evaluation software and all updates and the current device firmware, free of charge, on our website under the product group "Power Quality / Software WinPQ smart":

www.a-eberle.de

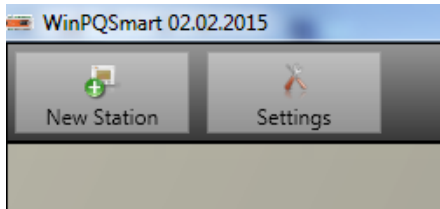


Please also install the current device firmware on your measuring device to ensure that you can use any new functions.

Start screen for WinPQ smart, example with 6 PQI-DA smart devices

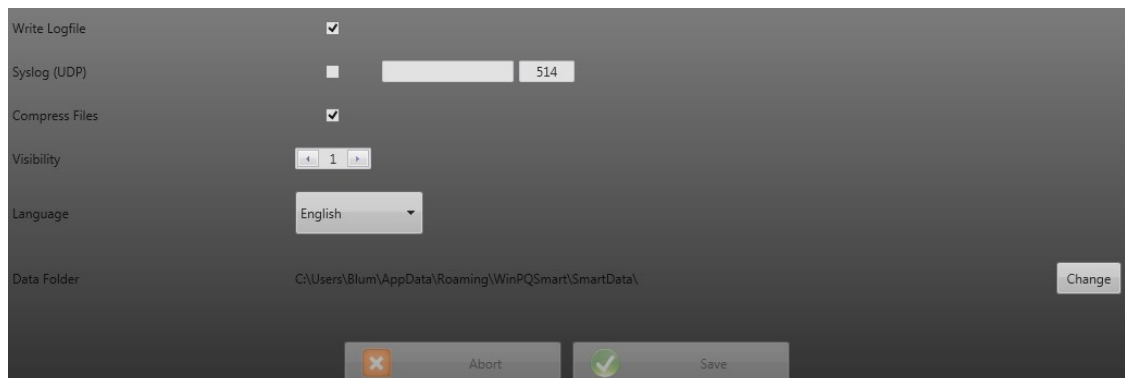


6.2 Basic setting for Software



Under the "Settings" menu point, the following changes can be made:

- Language setting for the software (the software must be restarted after any change)
- Visibility of the setup parameters
 - 0 = Basic Desktop = Basic user with restricted selection of main parameters
 - 1 = Expert Desktop = Expert mode with all setting options displayed
 - 2 = only for support and development (password protected)
- Write log files for error messages (can be activated or deactivated here)
- Data folder = the standard folder for archiving the measurement data can be changed here



6.3 Setting up a new PQI-DA smart

A device is set up as a tile on the screen via the "New device" function.



The TCP-IP address of the PQI-DA smart is stored in the "IP" field.

The port number of the device can be allocated any number. The device is delivered with the value "5040" set as the port number.

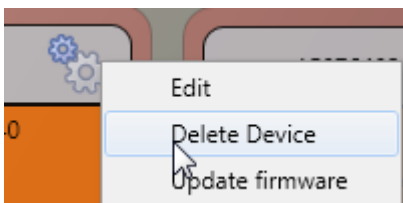
With USB communication only the port of the USB interface has to be selected.



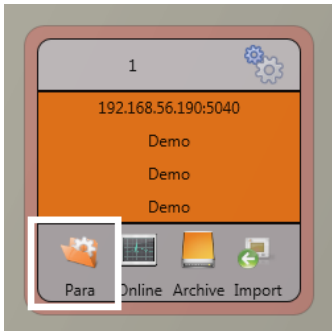
The values will be adopted by pressing OK, and a device tile for this device is then stored on the software interface. An unlimited number of devices can be set up.

▶ Deleting a device tile

Device tiles can be deleted via the "Setup general" device menu.



6.4 Device setup



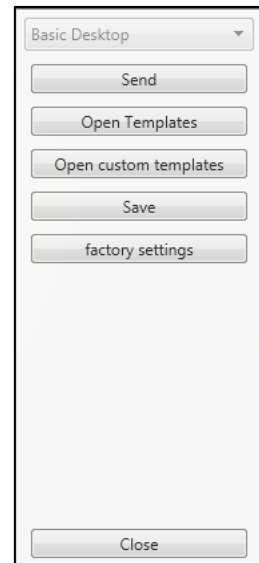
The PQIDA smart's parameter setup can be accessed via **para** button on the device panel. Parameters can be set in basic or expert view, which is also referred to as the classic view in the following sections. These views can be switched by choosing the corresponding selection field in the right main menu of the parameterization window.

The **main menu** (fig. right) is displayed in the right area of the parameterization window. The **parameters menu** with selectable parameter groups is shown in the left window area (fig. bottom right).

► Main Menu: Views and functions

The **basic view** allows application-driven parameterization of the device, the **classic expert view** shows the parameter structure of the device in list form and is described in Section 6.5. The service view should only be used for parameterizations in cooperation with the A-Eberle service team. Incorrect parameterizations can lead to malfunctions!

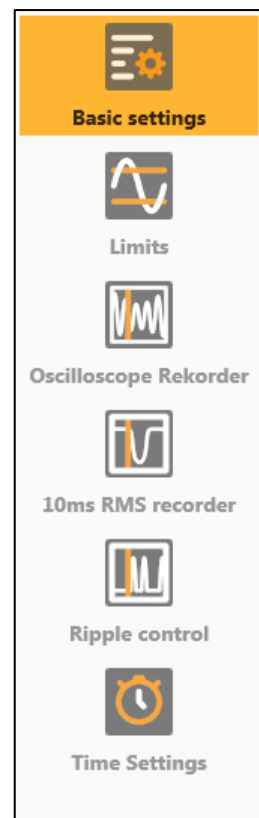
Via **Send** button, the previously defined parameters are sent to the device. The buttons **open templates** or **open custom templates** can be used to load different standard templates or custom parameter sets. Via **save** button, settings are saved to an XML file. For setting back all settings on the device (except network, connection and license settings), the option **factory settings** is used. After resetting the PQI-DA smart to factory settings, the setup wizard must be executed again! All measurement data are deleted from the device after the wizard has been executed! The close button is used to close the parameterization window, unsaved changes will be lost!



► Parameter Menu: Device parameters and settings

The device parameters and settings are divided into functional groups and can be selected in the left window area (see fig. right). These are explained in more detail in the following sections. The different parameters are partly dependent on each other as well as on the loaded or selected template when the device has been commissioned.

Further explanations of the various setting values can be found in Chapter 6.5.

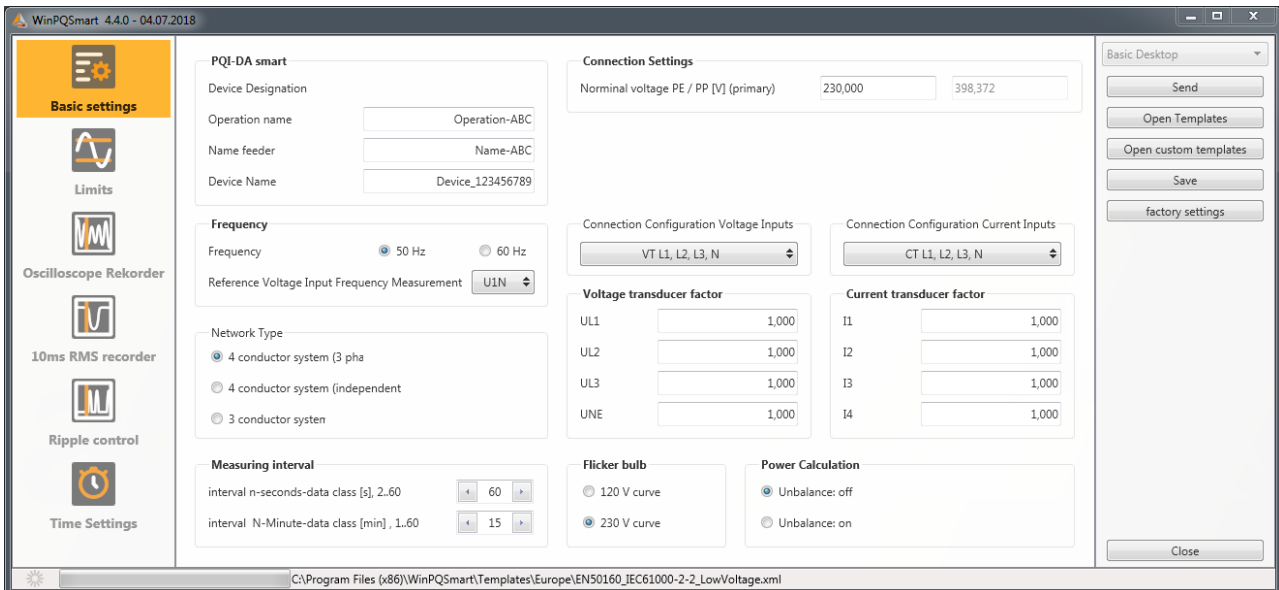




The basic parameters can also be created as so-called **offline parameterization**. This means, that parameter settings can be edited without a device being connected. Simply create a new device on the WinPQ Smart Desktop and do not assign a network address to it. The parameter interface is loaded after selecting a parameter template or a self-created parameterization file and displays the previously set values and settings.

6.4.1 Basic Settings

All main settings can be found into the basic settings window.



WinPQSmart 4.4.0 - 04.07.2018

PQI-DA smart

Device Designation:

Operation name:

Name feeder:

Device Name:

Frequency

Frequency: ☒ 50 Hz ☐ 60 Hz

Reference Voltage Input Frequency Measurement:

Network Type

☒ 4 conductor system (3 pha)

☐ 4 conductor system (independent)

☐ 3 conductor system

Measuring interval

interval n-seconds-data class [s], 2..60:

interval N-Minute-data class [min], 1..60:

Connection Settings

Normal voltage PE / PP [V] (primary):

Connection Configuration Voltage Inputs

Connection Configuration Current Inputs

Voltage transducer factor

UL1	<input type="text" value="1,000"/>
UL2	<input type="text" value="1,000"/>
UL3	<input type="text" value="1,000"/>
UNE	<input type="text" value="1,000"/>

Current transducer factor

I1	<input type="text" value="1,000"/>
I2	<input type="text" value="1,000"/>
I3	<input type="text" value="1,000"/>
I4	<input type="text" value="1,000"/>

Flicker bulb

☐ 120 V curve

☒ 230 V curve

Power Calculation

☒ Unbalance: off

☐ Unbalance: on

Basic Desktop

Send

Open Templates

Open custom templates

Save

factory settings

Close

C:\Program Files (x86)\WinPQSmart\Templates\Europe\EN50160_1EC61000-2-2_LowVoltage.xml

To provide a clear overview, all parameters are bundled into functional groups.

▶ PQI-DA smart

verwendetAll device identifiers can be entered here for a clear assignment of the PQI-DA smart. These identifiers are used for presentation in the WinPQ Smart interface, when copying data to an SD card (folder name) and also for unique assignment into the WinPQ database.

▶ Connection Settings

Nominal voltage (conductor-earth) in volts is defined here (primary). The PQI-DA smart refers all trigger thresholds or PQ events to the set nominal voltage. The nominal voltage in the 3-wire network is the agreed conductor-conductor voltage, e.g. 20400V. In 4-wire network, the conductor-ground voltage is specified, e.g. 230V.

▶ Frequency

Selection of the grid frequency and selection of the reference voltage input for frequency measurement

▶ Network Type

Selection of the network type:

If a 3 conductor system has been selected, all evaluations of standard EN50160 are calculated based on the conductor-conductor voltages. In 4 conductor system, all power quality parameters are determined from the conductor-ground voltages. Choosing 4 conductor system with independent phases, the power values of the individual phases are calculated separately.

▶ **Connection configuration of voltage and current inputs**

Selection of the connection configuration and the voltage transformer factors.

Enter the ratio of the current and voltage transformers to which the power analyser is connected in the transformer settings.

Example:

- Voltage: primary = 20.000V; secondary = 100V; conversion factor UL1 = 200
Current: 100A / 5A = conversion factor = 20

▶ **Measuring interval**

Configuration of the two adjustable recording intervals N-seconds and N-minutes.

In addition to the class A measurement intervals, numerous values can be recorded by the PQI-DA smart at freely adjustable intervals. For example, this can be used for the measurement of maximum power in the 15 min interval. The intervals are always synchronic to full hours.

▶ **Flicker-Curve-Lamp model**

Select the lamp model for a 120V or 230V flicker curve. In 120 V systems (e.g. America), a different flicker curve is specified than in a 230 V system (e.g. Europe).

▶ **Power calculation**

Selection of the power calculation with or without unbalance.

The various types of reactive power can be switched on or off as required. This has an influence on the calculation of the collective reactive power as well as the apparent power.

- **Unbalance: On**

Power calculation according to DIN40110 Part 2 - with calculation of the unbalance reactive power and the modulation reactive power is the default setting of the device. This Adjustment is strongly recommended for measurements on the transformer stations.

- **Unbalance: Off**

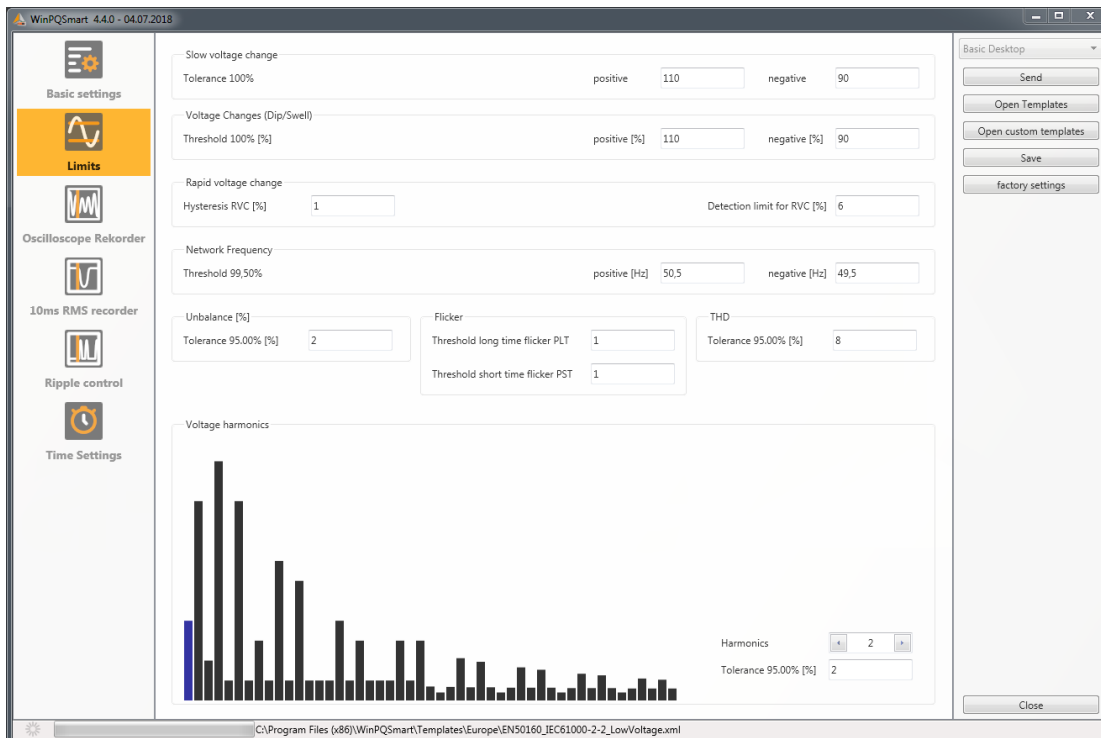
Power unbalance is not considered in the calculation of reactive power.

This setting influences the measured power values of reactive and apparent power in the display, the online measured data and the recorded measured data as well as in process controlling.

6.4.2 Limits

In this menu all limit values of the currently set standard or loaded standard template are preselect-ed. The compatibility levels can be changed by the user. This setting has a direct influence on the standard reports!

6.4.3 It is recommended to work with standard templates!



For a clearer overview, all parameters are organized in functional groups. The various (physical) quantities and their calculation methods are defined and described in *chapter 11*.

► Voltage changes

Limits for slow voltage changes and fast voltage changes (for details see the respective standard).

► Frequency

Upper and lower limit value of the permitted frequency deviation in relation to the set grid frequency.

► Unbalance

Limit value for unbalance.

► Flicker

Limits of long and short-term flicker.

► THD

Limits of the Total Harmonic Distorsion.

► Voltage harmonics

Limits of voltage harmonics with direct selection.

6.4.3 Oscilloscope Recorder

The trigger conditions and thresholds, i.e. trigger criteria for oscilloscope recorder, as well as other settings of the oscilloscope recorder can be set in this menu. In default configuration, an effective value threshold of +10% and -10% of the nominal voltage is defined.

WinPQSmart 4.4.0 - 04.07.2018

Basic settings
Limits
Oscilloscope Rekorder
10ms RMS recorder
Ripple control
Time Settings

Basic Desktop

Send
Open Templates
Open custom templates
Save
factory settings

Close

C:\Program Files (x86)\WinPQSmart\Templates\Europe\EN50160_2-2_LowVoltage.xml

Voltage- / current trigger

	active	passive	Lower threshold [V]	active	passive	Upper threshold [V]	Step [V]	Phase Step [°]	Envelope Trigger[%]
UL1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	90	<input checked="" type="checkbox"/>	<input type="checkbox"/>	110	10	6	20
UL2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	90	<input checked="" type="checkbox"/>	<input type="checkbox"/>	110	10	6	20
UL3	<input checked="" type="checkbox"/>	<input type="checkbox"/>	90	<input checked="" type="checkbox"/>	<input type="checkbox"/>	110	10	6	20
UNE	<input type="checkbox"/>	<input type="checkbox"/>		<input checked="" type="checkbox"/>	<input type="checkbox"/>	30	10		20
U12	<input checked="" type="checkbox"/>	<input type="checkbox"/>	90	<input checked="" type="checkbox"/>	<input type="checkbox"/>	110	10		20
U23	<input checked="" type="checkbox"/>	<input type="checkbox"/>	90	<input checked="" type="checkbox"/>	<input type="checkbox"/>	110	10		20
U31	<input checked="" type="checkbox"/>	<input type="checkbox"/>	90	<input checked="" type="checkbox"/>	<input type="checkbox"/>	110	10		20
I1	<input type="checkbox"/>	<input type="checkbox"/>	0,05	<input type="checkbox"/>	<input type="checkbox"/>	10	1		
I2	<input type="checkbox"/>	<input type="checkbox"/>	0,05	<input type="checkbox"/>	<input type="checkbox"/>	10	1		
I3	<input type="checkbox"/>	<input type="checkbox"/>	0,05	<input type="checkbox"/>	<input type="checkbox"/>	10	1		
I4	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	2,5	1		

Display current values in
☐ %
☒ A
of nominal current 5 A

Symmetrical Components Trigger

	Undervoltage positive sequence component	Overvoltage positive sequence component	Overvoltage negative sequence component	Zero sequence system
active	<input type="checkbox"/> 90	<input type="checkbox"/> 110	<input type="checkbox"/> 10	<input type="checkbox"/> 30
passive	<input type="checkbox"/> 90	<input type="checkbox"/> 110	<input type="checkbox"/> 10	<input type="checkbox"/> 30

Frequency Trigger

	active	passive
Frequency: Lower Limit [Hz]	<input checked="" type="checkbox"/> 49,5	<input type="checkbox"/> 49,5
Frequency: Upper limit [Hz]	<input checked="" type="checkbox"/> 50,5	<input type="checkbox"/> 50,5
Frequency Step	<input type="checkbox"/> 0,5	

Binary Trigger

Binary input falling edge 1	<input type="checkbox"/>	Binary input falling edge 2	<input type="checkbox"/>
Binary Input Rising Edge 1	<input type="checkbox"/>	Binary Input Rising Edge 2	<input type="checkbox"/>
Trigger Command			<input checked="" type="checkbox"/>

Recorder length / Pre-event time

Sampling Frequency: 40960Hz / 10240Hz	10240	Minimum Recorder Time [ms]	400
Pre-Event Time [ms]	100	Maximum Recorder Time [ms]	1000

For a clearer overview, all parameters are organized in functional groups. If a field is grayed out and/or not selected, this trigger criterion is not active or cannot be activated. The parameters of the current trigger can be displayed either absolute or as percentage value of the nominal current (setting in the basic configuration).



The trigger thresholds of the oscilloscope and RMS recorder are not completely independent. All common parameters are automatically adjusted in both recorders.

▶ **Voltage and current trigger**

In general, the trigger thresholds refer to the nominal voltage, e.g. 230 V or 20400 V, which has been set in the basic settings.

If the voltage/current value (10ms RMS value) falls below the lower trigger threshold or exceeds the upper trigger threshold, a recording is started as well as in case of RMS value jump or phase jump.

The envelope trigger starts a recording in case of a so-called sinus violation. Thereby the device detects a violation of sampling points with respect to the configured envelopes of the sinusoidal curve (e.g. commutation dips). In practice, a setting in the range of 10 to 25% (of the nominal voltage) is usually recommended.

▶ **Symmetrical Components Trigger**

A record is started in case of the specified symmetrical component thresholds are violated.

▶ **Frequency Trigger**

The frequency trigger starts a recording in case of shortfall or overrun of the set frequency limits as well as in case of a frequency jump within a second.

▶ **Binary Trigger**

A record is started in case of an external trigger via software or a falling or rising edge at binary input 1 or 2.

▶ **Recorder length and Pre-event time**

The recorder length specifies the total time frame of the oscilloscope recorder in milliseconds. Pre-event time is defined as the time that passed before a (trigger) event occurred and is also recorded.

The PQI-DA smart's fault recorders provide a minimum recording length and a maximum recording length. Thereby, the minimum recording length is extended up to the maximum recording length, depending on the trigger condition. This function offers the possibility to reduce data due to short events as well as to record very long events ensuring an effective use of data storage!

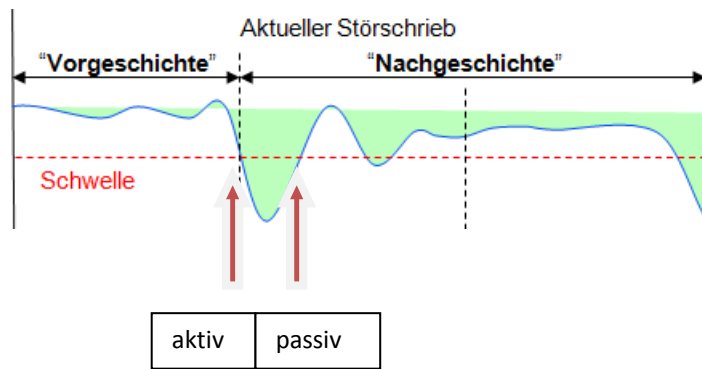
▶ **Active / passive trigger:**

Active triggering occurs, if e.g. the voltage drops from desired to undesired state.

Passive triggering allows triggering the transition from undesired to desired state e.g. after voltage interruptions.

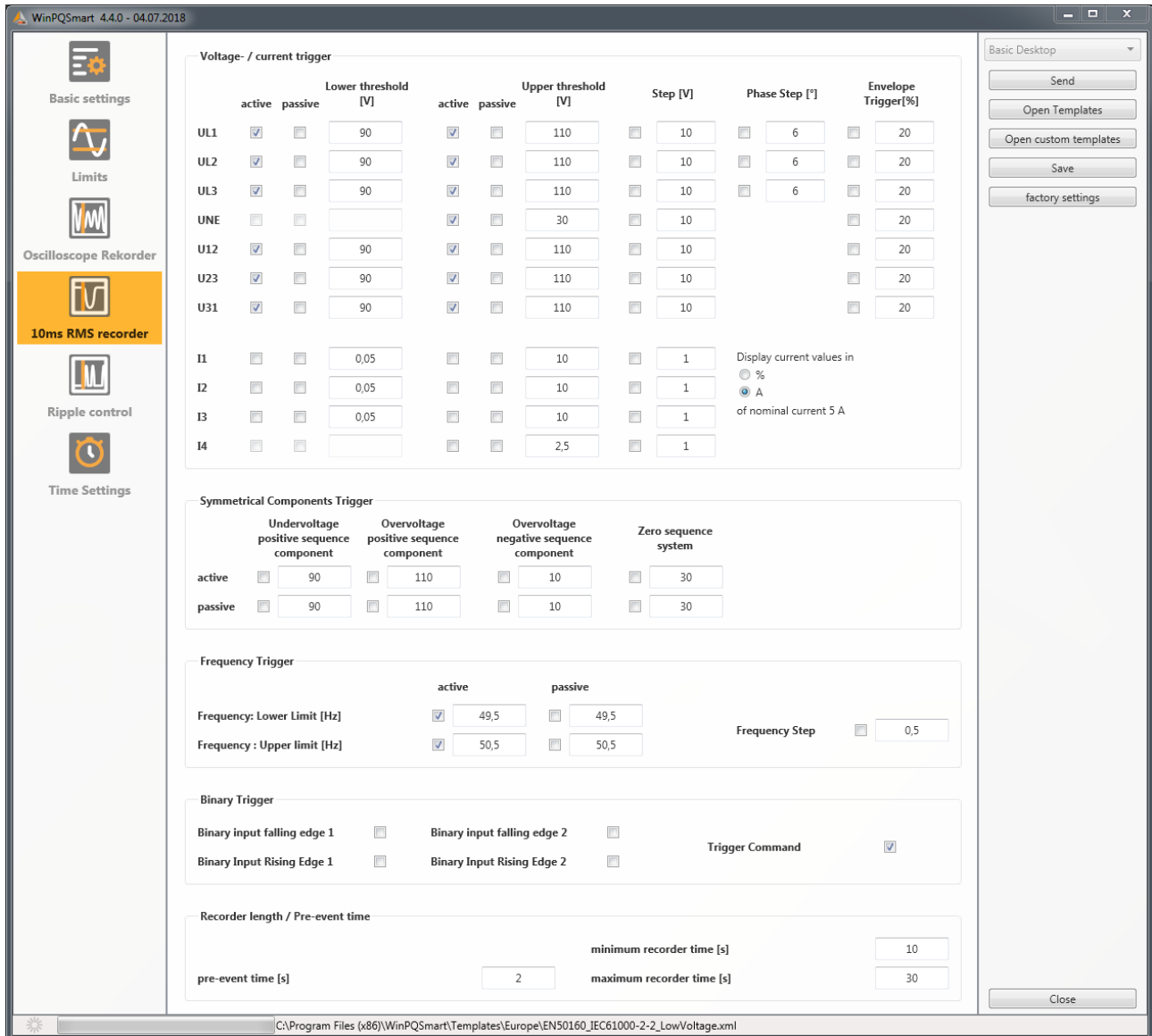
This feature offers the possibility to record very long earth faults with an enormous data reduction, since both the beginning and the end of the event can be recorded entirely, without the obligation to record the whole event!

We take care of it.



6.4.4 RMS Recorder

In this menu, the trigger conditions of the RMS recorder can be set. In the default settings, an effective value threshold of +10% and -10% of the nominal voltage is set.



WinPQSmart 4.4.0 - 04.07.2018

Basic settings

Limits

Oscilloscope Rekorder

10ms RMS recorder

Ripple control

Time Settings

Voltage- / current trigger

	active	passive	Lower threshold [V]	active	passive	Upper threshold [V]	Step [V]	Phase Step [°]	Envelope Trigger[%]
UL1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	90	<input checked="" type="checkbox"/>	<input type="checkbox"/>	110	10	6	20
UL2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	90	<input checked="" type="checkbox"/>	<input type="checkbox"/>	110	10	6	20
UL3	<input checked="" type="checkbox"/>	<input type="checkbox"/>	90	<input checked="" type="checkbox"/>	<input type="checkbox"/>	110	10	6	20
UNE	<input type="checkbox"/>	<input type="checkbox"/>		<input checked="" type="checkbox"/>	<input type="checkbox"/>	30	10		20
U12	<input checked="" type="checkbox"/>	<input type="checkbox"/>	90	<input checked="" type="checkbox"/>	<input type="checkbox"/>	110	10		20
U23	<input checked="" type="checkbox"/>	<input type="checkbox"/>	90	<input checked="" type="checkbox"/>	<input type="checkbox"/>	110	10		20
U31	<input checked="" type="checkbox"/>	<input type="checkbox"/>	90	<input checked="" type="checkbox"/>	<input type="checkbox"/>	110	10		20
I1	<input type="checkbox"/>	<input type="checkbox"/>	0,05	<input type="checkbox"/>	<input type="checkbox"/>	10	1		
I2	<input type="checkbox"/>	<input type="checkbox"/>	0,05	<input type="checkbox"/>	<input type="checkbox"/>	10	1		
I3	<input type="checkbox"/>	<input type="checkbox"/>	0,05	<input type="checkbox"/>	<input type="checkbox"/>	10	1		
I4	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	2,5	1		

Display current values in
☐ %
☒ A
 of nominal current 5 A

Symmetrical Components Trigger

	Undervoltage positive sequence component	Overvoltage positive sequence component	Overvoltage negative sequence component	Zero sequence system
active	<input type="checkbox"/> 90	<input type="checkbox"/> 110	<input type="checkbox"/> 10	<input type="checkbox"/> 30
passive	<input type="checkbox"/> 90	<input type="checkbox"/> 110	<input type="checkbox"/> 10	<input type="checkbox"/> 30

Frequency Trigger

	active	passive
Frequency: Lower Limit [Hz]	<input checked="" type="checkbox"/> 49,5	<input type="checkbox"/> 49,5
Frequency: Upper limit [Hz]	<input checked="" type="checkbox"/> 50,5	<input type="checkbox"/> 50,5
Frequency Step	<input type="checkbox"/> 0,5	

Binary Trigger

Binary input falling edge 1	<input type="checkbox"/>	Binary input falling edge 2	<input type="checkbox"/>	Trigger Command	<input checked="" type="checkbox"/>
Binary Input Rising Edge 1	<input type="checkbox"/>	Binary Input Rising Edge 2	<input type="checkbox"/>		

Recorder length / Pre-event time

pre-event time [s]	2	minimum recorder time [s]	10
		maximum recorder time [s]	30

Close

The settings in this menu are similar to the settings of oscilloscope recorder (see previous section) and are therefore not explained here again. If a field is grayed out and/or not selected, this trigger criterion is not active or cannot be activated.

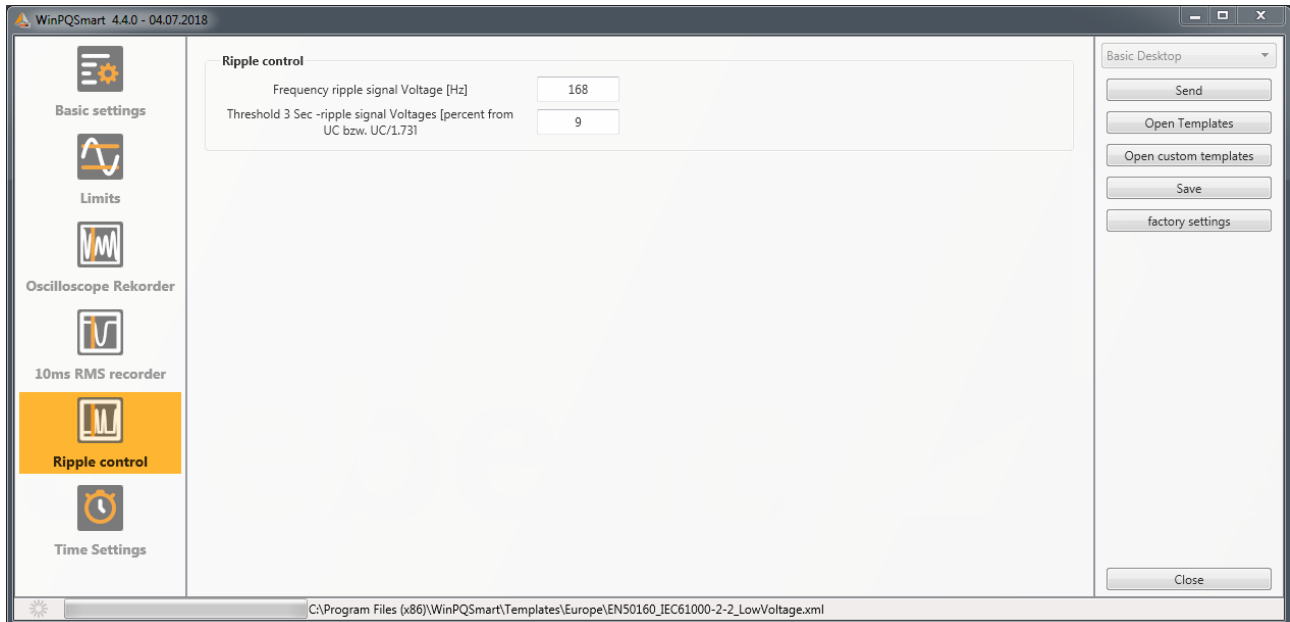


The trigger thresholds of the oscilloscope and RMS recorder are not completely independent. All common parameters are automatically adjusted in both recorders.

We take care of it.

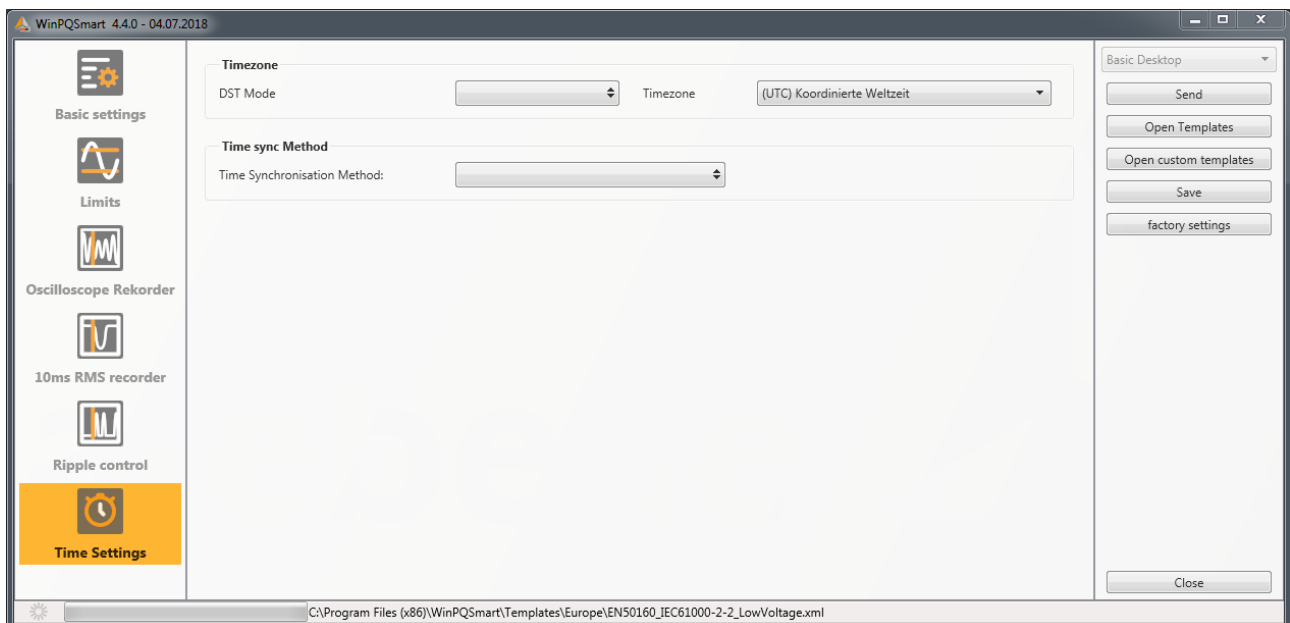
6.4.5 Ripple Control

In this menu, the parameters frequency ripple signal voltage [Hz] and threshold 3 sec ripple signal voltage [% of UC] can be set.



6.4.6 Time settings

In this window, the time settings of the device are parameterized. In the upper area, the time zone and the daylight saving time (DST) can be set.



Below, the method of time synchronization can be selected.

For high-precision measurements, an independent clock such as GPS/DCF or NTP is recommended. (IEC61000-4-30: Class A - Measuring method!)

Depending on the selection, the corresponding settings are displayed. The necessary setup steps, e.g. connection of a GPS clock etc. are described in detail in chapter 5.3.2.

The following time sync methods can be selected:

► Manual Clock Setting

Manual synchronization of time and date with the local time of the computer. After synchronization, the function is locked for the current session. The parameterization interface must be restarted for a new execution.

The screenshot shows the 'Time sync Method' section with 'Manual Clock setting' selected. Below, the 'Time Settings by Hand' section contains input fields for 'Date PC' (11.07.2018), 'Date Device' (01.04.2018), 'Local Time PC' (08:53:25), and 'Local Time Device' (01:42:20). A 'Time Synchronisation' button is at the bottom.

► DCF77

Settings for synchronization with DCF 77 radio clock Art. No. 111.9024.01.

The screenshot shows the 'Time sync Method' section with 'DCF77' selected. The 'Time settings DCF 77 with article 111.9024.01' section includes settings for 'Pulse-code Interface (COM2)' (COM2), 'Protocol' (RS232), 'Timezone of time source: sign' (plus), 'Timezone of time source: hour' (0), and 'Timezone of time source: minute' (0). A wiring diagram on the right shows connections for TxID, RTS, GND, RxID, CTS, RS485 Neg/B, RS485 Pos/A, and Shield to COM 1 and COM 2.

► IEEE1344

Settings for synchronization according to IEEE1344.

The screenshot shows the 'Time Settings IEEE 1344' section with settings for 'Pulse-code Interface (COM2)' (COM2), 'Protocol' (RS232), 'Timezone of time source: sign' (plus), 'Timezone of time source: hour' (0), and 'Timezone of time source: minute' (0). A wiring diagram on the right is identical to the DCF77 section, showing connections for TxID, RTS, GND, RxID, CTS, RS485 Neg/B, RS485 Pos/A, and Shield to COM 1 and COM 2.

► **IRIGB0..3**

Settings for synchronization according to IRIGB formats 0 to 3.

The screenshot shows a configuration window for the IRIGB0..3 time synchronization method. At the top, the 'Time sync Method' is set to 'IRIGB0..3'. Below this, the 'Time Synchronisation Method' dropdown is also set to 'IRIGB0..3'. The 'Time settings IRIG-B Formats 0 to 3' section contains several settings: 'Pulse-code Interface (COM2)' is set to 'COM2', 'Protocol' is set to 'RS232', 'Timezone of time source: sign' is set to 'plus', 'Timezone of time source: hour' is set to '0', and 'Timezone of time source: minute' is set to '0'. To the right of these settings is a diagram of a two-pin connector with pins labeled 1 through 8. The labels are: Tx/D, RTS, GND, Rx/D, CTS, RS485 Neg/B, RS485 Pos/A, and Shield. The pins are connected to COM 1 and COM 2.

► **IRIGB4..7**

Settings for synchronization according to IRIGB formats 4 to 7, see IRIGB formats 0 to 3.

► **NMEA:RMC (GPS-Clock 111.7083)**

Settings for synchronization according to GPS-Clock 111.7083 with NMEA protocol an message format RMC.

The screenshot shows a configuration window for the NMEA:RMC (GPS-Clock 111.7083) time synchronization method. At the top, the 'Time sync Method' is set to 'NMEA:RMC (GPS-clock 111.7083)'. Below this, the 'Time Synchronisation Method' dropdown is also set to 'NMEA:RMC (GPS-clock 111.7083)'. The 'Time Settings NMEA RMC with GPS Clock 111.7083' section contains a message: 'Connection via COM1 and COM2 via RS485, Modbus RTU is not available in this mode.' Below this message, there are two settings: 'NMEA Interface (COM1)' is set to 'RS232' and 'Pulse-code Interface (COM2)' is set to 'RS232'.

► **NMEA:ZDA**

Settings for synchronization with NMEA protocol and message format ZDA.

► **NTP**

The PQI-DA smart supports up to four time servers in one network. It automatically uses the best signal available.

Time Settings NTP

NTP Sever 1: IP address	<input type="text" value="0.0.0.0"/>	Port:	<input type="text" value="123"/>
NTP Sever 2: IP address	<input type="text" value="0.0.0.0"/>	Port:	<input type="text" value="123"/>
NTP Sever 3: IP address	<input type="text" value="0.0.0.0"/>	Port:	<input type="text" value="123"/>
NTP Sever 4: IP address	<input type="text" value="0.0.0.0"/>	Port:	<input type="text" value="123"/>
NTP Pollycycle [s]	<input type="text" value="60"/>		



Incorrect time settings can lead to errors or problems during measurement data recording! Using NTP, a good signal quality should be assured (at least Stratum 7)!

The availability of the NTP server, the stratum and the quality of both NTP and the other time synchronization methods can be checked with the help of online diagnostics!

6.5 Device setup classical view

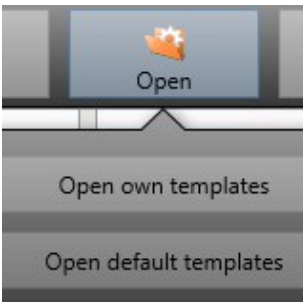
The following basic functions are available:



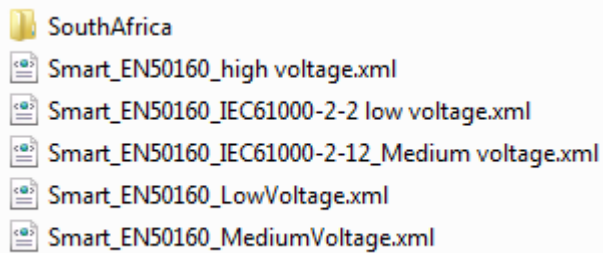
Send device settings (measurement values, limit values, trigger thresholds) to the device

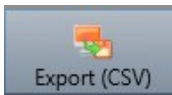


Save all device settings as a template on the PC.

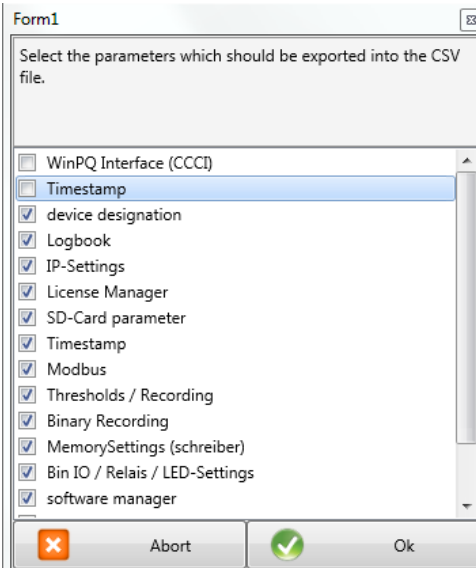


- Open own settings that have already been saved on the PC (for instance, to send these to another device)
- “Open default” provide standard settings, for a low voltage network, medium voltage network and high voltage network.





With “Export (CSV)” it is possible to export all device parameter or selected settings in one CSV file.



Select the parameters which should be exported into the CSV file.

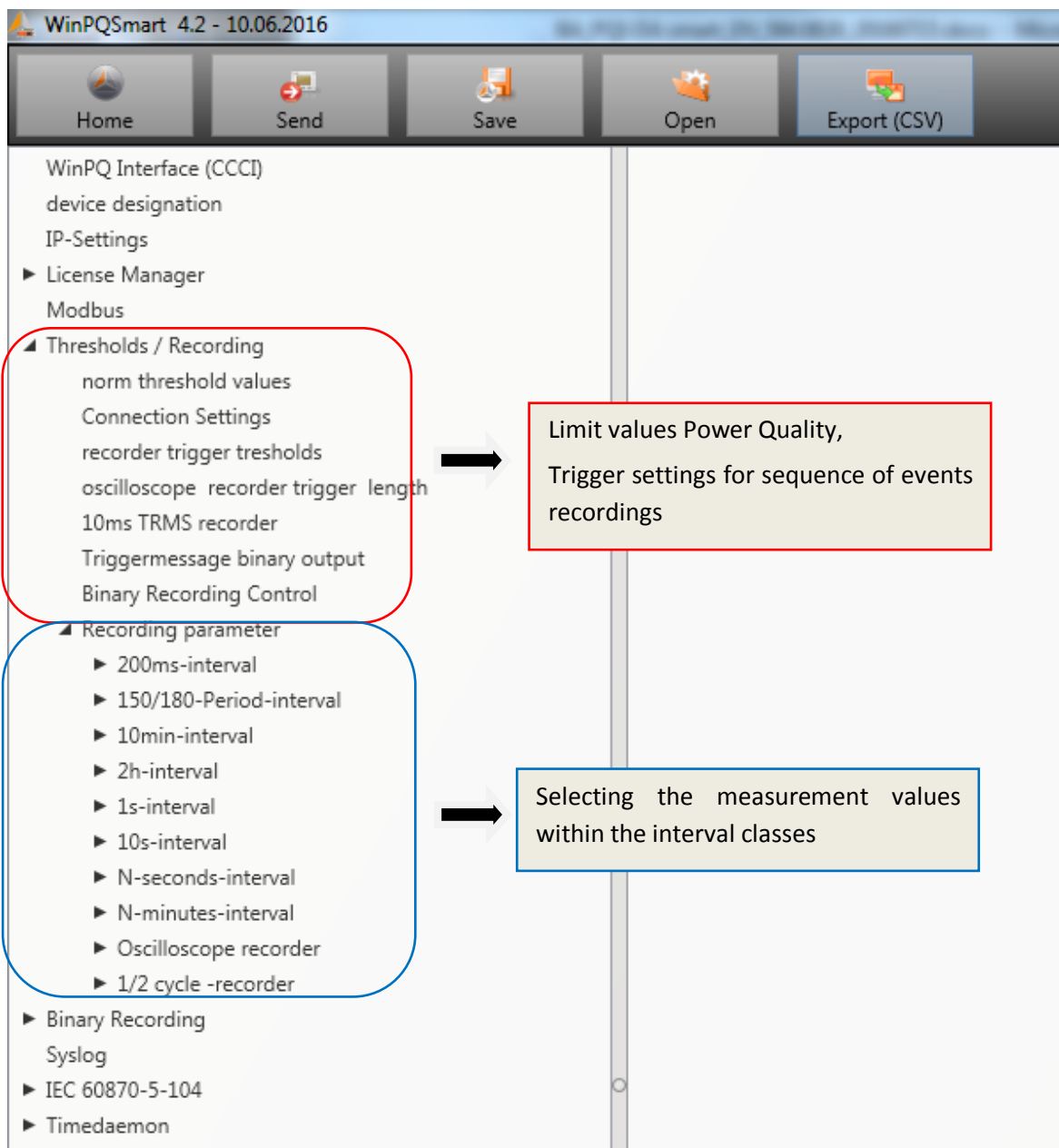
- ☐ WinPQ Interface (CCCI)
- ☒ Timestamp
- ☒ device designation
- ☒ Logbook
- ☒ IP-Settings
- ☒ License Manager
- ☒ SD-Card parameter
- ☒ Timestamp
- ☒ Modbus
- ☒ Thresholds / Recording
- ☒ Binary Recording
- ☒ MemorySettings (schreiber)
- ☒ Bin IO / Relais / LED-Settings
- ☒ software manager

Abort Ok

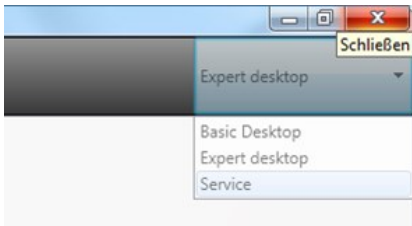
Example CSV file with settings:

36		
37	Frequency	50
38	Frequency ripple signal voltage [Hz]	168
39	Flicker bulb	1
40	Normalized voltage L-L-Sp. [percent from UNOM]	100
41	hysteresis 1/2-Perioden-voltage [percent from UC bzw. UC/1.73]	1
42	tolerance band fast voltage change RVC, dd [percent from UC bzw. UC/1.73]	1
43	dmax -threshold fast voltage change RVC [% from UC bzw. UC/1.73]	6
44	threshold voltage dip (Dip) [percent from UC bzw. UC/1.73]	90
45	threshold voltage swell (threshold) [percent from UC bzw. UC/1.73]	110
46	threshold voltages interruption [percent from UC bzw. UC/1.73]	5
47	lower threshold 10s- network frequency /Hz	49,5
48	higher threshold 10s-Total network frequency /Hz	50,5
49	lower threshold 10min-voltage [percent from UC bzw. UC/1.73]	90
50	higher threshold 10min- voltage [percent from UC bzw. UC/1.73]	110
51	threshold 10min-THD [percent]	8
52	threshold 10min-voltages unbalance [percent]	2
53	threshold short time flicker PST	1
54	threshold long time flicker PLT	1
55	threshold 3 Sec-ripple signal voltages [percent from UC bzw. UC/1.73]	9
56	Trigger-threshold 200ms-ripple signal voltage recorder [percent]	1
57	limit table 10min-voltages harmonic (H2) [percent]	2
58	threshold 10min-voltages harmonic (H3) [percent]	5
59	threshold 10min-voltages harmonic (H4) [percent]	1
60	threshold 10min-voltages harmonic (H5) [percent]	6
61	threshold 10min-voltages harmonic (H6) [percent]	0,5
62	threshold 10min-voltages harmonic (H7) [percent]	5
63	threshold 10min-voltages harmonic (H8) [percent]	0,5
64	threshold 10min-voltages harmonic (H9) [percent]	1,5
65	threshold 10min-voltages harmonic (H10) [percent]	0,5
66	threshold 10min-voltages harmonic (H11) [percent]	3,5

► **Device set-up**



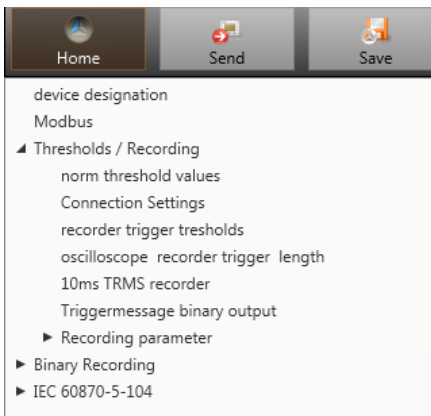
► Visibility of the setup parameters



The Software has three types of visibilities of Parameters:

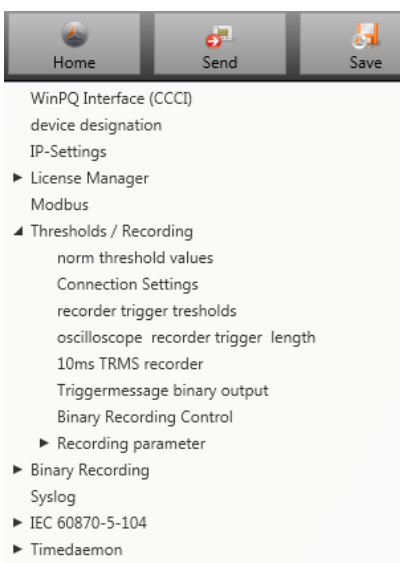
- Basic Desktop = Basic user with restricted selection of main parameters
- Expert Desktop = Expert mode with all setting options displayed
- Service = Password protected for service only

► Basic Desktop



Also in the submenu the number of parameters is reduced to basic settings

► Expert Desktop



A lot of more Parameters are visible and also settable

We take care of it.

6.5.1 Device designation

In the menu "Device designation", the description of the device is determined.

WinPQSmart 02.02.2015

Home Send Save Open own... Open default...

device designation

- IP-Settings
- Modbus
- ▲ PQ application
 - PQ-parameter
 - General user-settings
 - Trigger-parameter
 - Oszilloskope recorder (User!)
 - 1/2 cycle -recorder (User!)
- ▲ Recording parameter
 - ▶ 200ms-interval
 - ▶ 150/180-Perioden-interval
 - ▶ 10min-interval
 - ▶ 2h-interval
 - ▶ 1s-interval
 - ▶ 10s-interval
 - ▶ N-seconds-interval
 - ▶ M-seconds-interval
 - ▶ Oscilloscope recorder
 - ▶ 1/2 cycle -recorder
- ▶ Timedaemon

Info	Value
Werks Identifikator	Werksidentifikator
Werks Bezeichner	test
Betriebsname	UW Nord
Station name	Station
street	Strasse
number	Nr
zip code	Plz
city	Ort
GPS coordinates	GPS
Name feeder	Trafo 102
Groupe feeder	Messfeld-Gruppe
nominal voltage measurement point	Messfeld-Unenn
nominal power measurement point	Messfeld-Inenn
nominal frequency measurement point	Messfeld-f
Typ des Verkabelungssystems	Messfeld-Leitersys
device name	Schweighof
device typ	PQI-DA smart
Betriebsressourcen	Betriebsmittelkennzeichen

The fields marked in red describe the device icon as well as all the fault records and data in the archive.

6.5.2 Thresholds / Recording

- ▲ Thresholds / Recording
 - norm threshold values
 - Connection Settings
 - recorder trigger tresholds
 - oscilloscope recorder trigger length
 - 10ms TRMS recorder
 - Triggermessage binary output
 - Binary Recording Control
- ▲ Recording parameter
 - ▶ 200ms-interval
 - ▶ 150/180-Period-interval
 - ▶ 10min-interval
 - ▶ 2h-interval
 - ▶ 1s-interval
 - ▶ 10s-interval
 - ▶ N-seconds-interval
 - ▶ N-minutes-interval
 - ▶ Oscilloscope recorder
 - ▶ 1/2 cycle -recorder

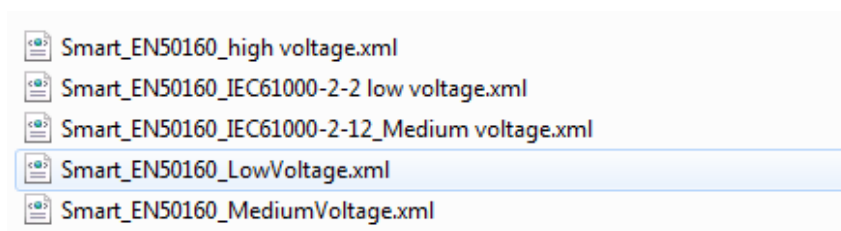
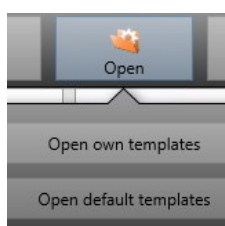
6.5.2.1 Norm threshold values

In “threshold values” the limits for standard evaluations and for power quality events are set. The limits of EN 50160 for a low voltage system are stored in the default setting of delivery.

- Value: Value of PQI-DA smart – this value can be changed
- Default: Default setting

device designation	Frequency	50Hz	▼ 50Hz
IP-Settings	Frequency ripple signal voltage [Hz]	168	168
► License Manager	Flicker bulb	230V	▼ 230V
Modbus	Normalized voltage L-L-Sp. [percent from UNOM]	100	100
▲ Thresholds / Recording	hysteresis 1/2-Perioden-voltage [percent from UC bzw. UC/1....	1	1
norm threshold values	tolerance band fast voltage change RVC, dd [percent from U...	1	1
Connection Settings	threshold voltage dip (Dip) [percent from UC bzw. UC/1.73]	90	90
recorder trigger thresholds	threshold voltage swell (threshold) [percent from UC bzw. UC...	110	110
oscilloscope recorder trigger length	threshold voltages interruption [percent from UC bzw. UC/1.7...	5	5
10ms TRMS recorder	lower threshold 10s- network frequency /Hz	49,5	49,5
Triggermessage binary output	higher threshold 10s-Total network frequency /Hz	50,5	50,5
Binary Recording Control	lower threshold 10min-voltage [percent from UC bzw. UC/1.73]	90	90
▲ Recording parameter	higher threshold 10min- voltage [percent from UC bzw. UC/1...	110	110
► 200ms-interval	threshold 10min-THD [percent]	8	8
► 150/180-Period-interval	threshold 10min-voltages unbalance [percent]	2	2
► 10min-interval	threshold short time flicker PST	1	1
► 2h-interval	threshold long time flicker PLT	1	1
► 1s-interval	threshold 3 Sec -ripple signal voltages [percent from UC bzw....	9	9
► 10s-interval	Trigger-threshold 200ms-ripple signal voltage recorder [perc...	1	1
► N-seconds-interval	limit table 10min-voltages harmonic (H2) [percent]	2	2
► N-minutes-interval	threshold 10min-voltages harmonic (H3) [percent]	5	5
► Oscilloscope recorder	threshold 10min-voltages harmonic (H4) [percent]	1	1
► 1/2 cycle -recorder	threshold 10min-voltages harmonic (H5) [percent]	6	6
► Binary Recording	threshold 10min-voltages harmonic (H6) [percent]	0,5	0,5
Syslog			
► IEC 60870-5-104			
► Timedaemon			

Under "Open default setting" templates are located for a low, medium and high-voltage network.



6.5.2.2 Connection settings

device designation	connection configuration voltage inputs	VT L1, L2, L3, N	▼ VT L1, L2, L3, N
IP-Settings	reference voltage input Frequency measurement	U1N	▼ U1N
▶ License Manager	Power calculation	without Unbalance Reactive Power	▼ without Unbalance Reactive Power
Modbus	connection configuration current inputs	CT L1, L2, L3, N	▼ CT L1, L2, L3, N
▲ Thresholds / Recording	Network type	4 - wire system (three phase grid)	▼ 4 - wire system (three phase grid)
norm threshold values	interval n-seconds-data class [s], 2..60	60	60
Connection Settings	binary input for trigger interval-Power	internal interval	▼ internal interval
recorder trigger thresholds	interval N-Minute-data class [min] , 1..60	15	15
oscilloscope recorder trigger length	THD and THC calculation	H40	▼ H40
10ms TRMS recorder	voltage transducer factor (VT)	1	1
Triggermessage binary output	current transducer factor (CT)	1	1
Binary Recording Control	Transducer correction factor U1	1	1
▲ Recording parameter	Transducer correction factor U2	1	1
▶ 200ms-interval	Transducer correction factor U3	1	1
▶ 150/180-Period-interval	Transducer correction factor U4	1	1
▶ 10min-interval	CT correction factor I1	1	1
▶ 2h-interval	CT correction factor I2	1	1
▶ 1s-interval	CT correction factor I3	1	1
▶ 10s-interval	CT correction factor I4	1	1
▶ N-seconds-interval			
▶ N-minutes-interval			
▶ Oscilloscope recorder			

The following basic instrument settings can be made in this menu item:

▶ Connection voltage inputs: 1, 2, 3, 4

VT L1, L2, L3, N
V-circuit, grounding L1
V-circuit, grounding L2
V-circuit, grounding L3

V-connection (two voltage transformers)
Grounding L2 = connect VT L1 and VT L3
L2 will be calculated from the device

▶ Reference voltage:

Determining the frequency measurement input channel: U1, U2, U3, U4, U12, U23, U31

▶ Power calculation:

- Simplified power calculation - without calculation of unbalance power
- According DIN40110-2; with calculation of the unbalance reactive power

This setting has also an effect on the power values in the display of the PQI-smart

▶ Connection current inputs:

CT L1, L2, L3, N
CT L2,L3
ct's L1, L3
ct's L1, L2

Aron connection of current (two CT's)
CT L1, L3 = connect L1 and L3, current L2 will be calculated from the device

We take care of it.

▶ **Network connection:**

4 - wire system (three phase grid)
4 - wire system (unique independent phases)
3 - wire system

▶ **Interval “n”-seconds data class:**

Free interval - 2 seconds to 60 seconds

▶ **Binary input for power intervals:**

internal interval
synchronised Power values at Binary Input 1
synchronised Power values at Binary Input 2

All power and energy intervals are synchronized to this impulse

▶ **Interval “n”-minutes data class:**

Free interval - 1 minute to 60 minutes (basic setting 15 minutes)

▶ **Calculation THD / THC:**

Calculation 2nd to 40th harmonic or 2nd to 50th harmonic

▶ **Voltage transducer factor (basic setting = 1)**

Example: VT 20.000V / 100V = factor 200

▶ **Current transducer factor (basic setting = 1)**

Example: CT 600V / 5A = factor 120

▶ **CT correction factor**

Additional to the current transducer factor it is possible to have a second CT correction factor. This factor will be multiplied with the current transducer factor. Possible values are from -2 to 2.



Using a current transformer correction factor of "-1", it is possible to change the power flow direction by software.

6.5.2.3 Trigger parameter for disturbance recorder

In this menu all limits for triggering of fault records can be changed. These thresholds are independently to the Power Quality thresholds.

Upper and lower trigger thresholds for frequency, voltage, current or unbalance can be set.

device designation	trigger signal-hold time [s]	1	1
IP-Settings	Frequency-hysteresis [Hz]	0,05	0,05
► License Manager	Frequency : upper limit [Hz]	50,5	50,5
Modbus	Frequency : lower limit [Hz]	49,5	49,5
▲ Thresholds / Recording	Frequency : threshold df 1/2 [Hz/s]	0,5	0,5
norm threshold values	voltages-hysteresis [percent from UC bzw. UC/1.73]	2	2
Connection Settings	Star voltage: upper limit [percent from UC/1.73]	110	110
recorder trigger thresholds	Star voltage: lower limit [percent from UC/1.73]	90	90
oscilloscope recorder trigger length	Star voltage: threshold dU 1/2 [percent from UC/1.73]	10	10
10ms TRMS recorder	Star voltage: threshold dphi 1/2 /Grad	6	6
Triggermessage binary output	Displacement voltage: upper limit [percent from UC/1.73]	30	30
Binary Recording Control	Displacement voltage: threshold dU 1/2 [percent from UC/1.73]	10	10
▲ Recording parameter	line-to-line voltage: upper limit [percent from UC]	110	110
► 200ms-interval	line-to-line voltage: lower limit [percent from UC]	90	90
► 150/180-Period-interval	line-to-line voltage: threshold dU 1/2 [percent from UC]	10	10
► 10min-interval	Star voltage: threshold envelopentrigger [percent from UC/1....]	20	20
► 2h-interval	line-to-line voltage: threshold envelopentrigger [percent fro...]	20	20
► 1s-interval	Displacement voltage: threshold envelopentrigger [percent fr...]	20	20
► 10s-interval	positive sequence voltage: upper limit [percent from UC/1.73]	110	110
► N-seconds-interval	positive sequence voltage: lower limit [percent from UC/1.73]	90	90
► N-minutes-interval			
► Oscilloscope recorder			
► 1/2 cycle -recorder			

Example:

line-to-line voltage: lower limit [percent from UC]	90
line-to-line voltage: threshold dU 1/2 [percent from UC]	10

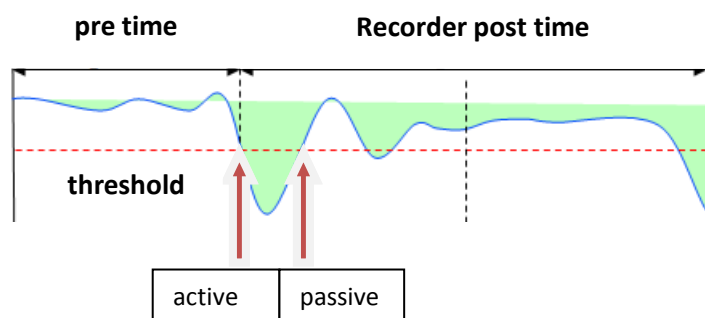
If one phase to phase voltage exceeds 110% or 90% of the nominal voltage, the oscilloscope and the ½ period RMS recorder will start recording.

6.5.2.4 Oscilloscope recorder

Settings for Oscilloscope recorder can be changed here.

device designation	minimum recorder length (Nr. of items)	4096	4096
IP-Settings	maximum recorder length (Nr. of items)	10240	10240
▶ License Manager	Recorder pretime (Nr. of items)	1024	1024
Modbus	lower voltage U1E -> aktive	1	1
▲ Thresholds / Recording	lower voltage U2E -> aktive	1	1
norm threshold values	lower voltage U3E -> aktive	1	1
Connection Settings	lower voltage U12 -> aktive	1	1
recorder trigger thresholds	lower voltage U23 -> aktive	1	1
oscilloscope recorder trigger length	lower voltage U31 -> aktive	1	1
10ms TRMS recorder	lower voltage U1E -> passive	0	0
Triggermessage binary output	lower voltage U2E -> passive	0	0
Binary Recording Control	lower voltage U3E -> passive	0	0
▲ Recording parameter	lower voltage U12 -> passive	0	0
▶ 200ms-interval	lower voltage U23 -> passive	0	0
▶ 150/180-Period-interval	lower voltage U31 -> passive	0	0
▶ 10min-interval	over voltage U1E -> aktive	1	1
▶ 2h-interval	over voltage U2E -> aktive	1	1
▶ 1s-interval	over voltage U3E -> aktive	1	1
▶ 10s-interval	over voltage U12 -> aktive	1	1
▶ N-seconds-interval	over voltage U23 -> aktive	1	1
▶ N-minutes-interval	over voltage U31 -> aktive	1	1
▶ Oscilloscope recorder			
▶ 1/2 cycle -recorder			

- Minimum recorder length: Setting of the standard fault recorder length
- Maximum recorder length: If one fault last longer than the minimum recorder length, the PQI-DA smart will enlarge the recorder length up to a maximum recorder length. The maximum recorder length of one recorder file can be set here.
- Recorder pre time is the time of the recorder file before the trigger threshold occurred.



- Active trigger = value exceeds or falls below threshold (start of the event)
- Passive trigger = value comes back to normal (end of the event)

Sampling frequency : 40960Hz / 10240Hz 10240 40960 10240 40960

- Sampling frequency of oscilloscope recorder can be changed from 10240 Hz to 40960 Hz

The maximum recorder length with 10,24kHz is 16 seconds

The maximum recorder length with 40,96kHz is 4 seconds

(40960Hz is only available with option B1)

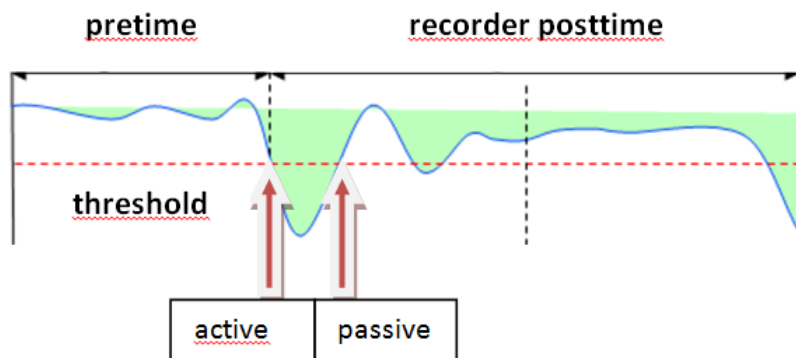
Example recorder length: 20480 = 2 seconds recorder length with a sampling frequency of 10240Hz and 500ms length with a sampling frequency of 40960Hz.

6.5.2.5 ½ cycle recorder

The trigger settings of ½ cycle recorder (10ms at 50Hz) are independent to oscilloscope recorder.

device designation	minimum recorder length (valuee)	1000	1000
IP-Settings	maximum recorder length (valuee)	30000	3000
▶ License Manager	Rekorder pretime (valuee)	250	250
Modbus	lower voltage U1E -> aktive	1	1
▲ Thresholds / Recording	lower voltage U2E -> aktive	1	1
norm threshold values	lower voltage U3E -> aktive	1	1
Connection Settings	lower voltage U12 -> aktive	1	1
recorder trigger thresholds	lower voltage U23 -> aktive	1	1
oscilloscope recorder trigger length	lower voltage U31 -> aktive	1	1
10ms TRMS recorder	lower voltage U1E -> passive	0	0
Triggermessage binary output	lower voltage U2E -> passive	0	0
Binary Recording Control	lower voltage U3E -> passive	0	0
▶ Recording parameter	lower voltage U12 -> passive	0	0
▶ Binary Recording	lower voltage U23 -> passive	0	0
Syslog	lower voltage U31 -> passive	0	0
▶ IEC 60870-5-104	over voltage U1E -> aktive	1	1
▶ Timedaemon	over voltage U2E -> aktive	1	1
	over voltage U3E -> aktive	1	1
	over voltage U12 -> aktive	1	1

Please see Chapter 6.5.2.3 explanation trigger thresholds



Example recorder length:

3000 x 10ms (at 50Hz) r.m.s values results in a length of 30 seconds for this recorder.

6.5.2.6 Trigger of binary output 2

It is possible to set all trigger events of the fault recorder on the relay no. 2.

If one threshold is reached e.g. "frequency", the relays output will be switched very fast.

The reaction time from the detection of the event to trigger the relay output is <5ms.

▲ Thresholds / Recording	lower voltage U12 -> aktive	1
norm threshold values	lower voltage U23 -> aktive	1
Connection Settings	lower voltage U31 -> aktive	1
recorder trigger thresholds	lower voltage U1E -> passive	0
oscilloscope recorder trigger length	lower voltage U2E -> passive	0
10ms TRMS recorder	lower voltage U3E -> passive	0
Triggermessage binary output	lower voltage U12 -> passive	0
Binary Recording Control	lower voltage U23 -> passive	0
▲ Recording parameter	lower voltage U31 -> passive	0
▶ 200ms-interval	over voltage U1E -> aktive	1
▶ 150/180-Period-interval	over voltage U2E -> aktive	1
▶ 10min-interval	over voltage U3E -> aktive	1
▶ 2h-interval	over voltage U12 -> aktive	1
▶ 1s-interval	over voltage U23 -> aktive	1
▶ 10s-interval	over voltage U31 -> aktive	1
▶ N-seconds-interval	over voltage UNE -> aktive	1
▶ N-minutes-interval	over voltage U1E -> passive	0
▲ Oscilloscope recorder	over voltage U2E -> passive	0
Parameter oscilloscope recorder	over voltage U3E -> passive	0
▶ 1/2 cycle -recorder	over voltage U12 -> passive	0
▶ Binary Recording	over voltage U23 -> passive	0
Syslog	over voltage U31 -> passive	0
▶ IEC 60870-5-104	over voltage UNE -> passive	0
▶ Timedaemon	Trigger-command	1
	lower voltage positive-sequence system -> aktive	0
	over voltage positive-sequence system -> aktive	0

Possible triggering criteria:

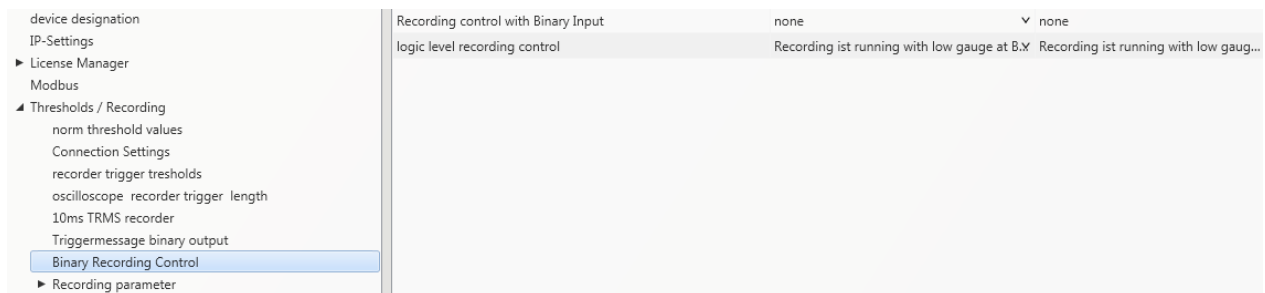
- Lower / upper voltage
- Positive sequence / negative sequence
- Envelop voltage trigger
- Voltage step / current step
- Phase change
- Lower frequency / upper frequency
- Frequency change
- Lower current / upper current
- Binary input

All trigger events can be set to the start of the event or to the end of the event (active / passive trigger)

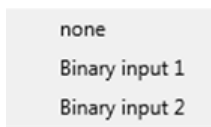
6.5.2.7 Control of recording via binary inputs

With the input signal of the two digital inputs, it is possible to start and stop the PQI-DA smart recorders. The following functions can be started or stopped via the digital input:

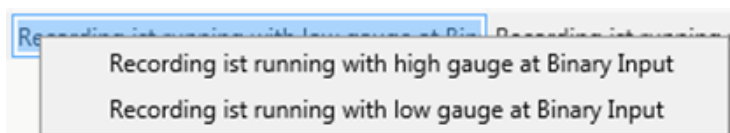
- All permanent recorder
- Oscilloscope recorder
- ½-cycle r.m.s recorder



To control the recording of PQI-DA smart with the two binary inputs, two settings are available:



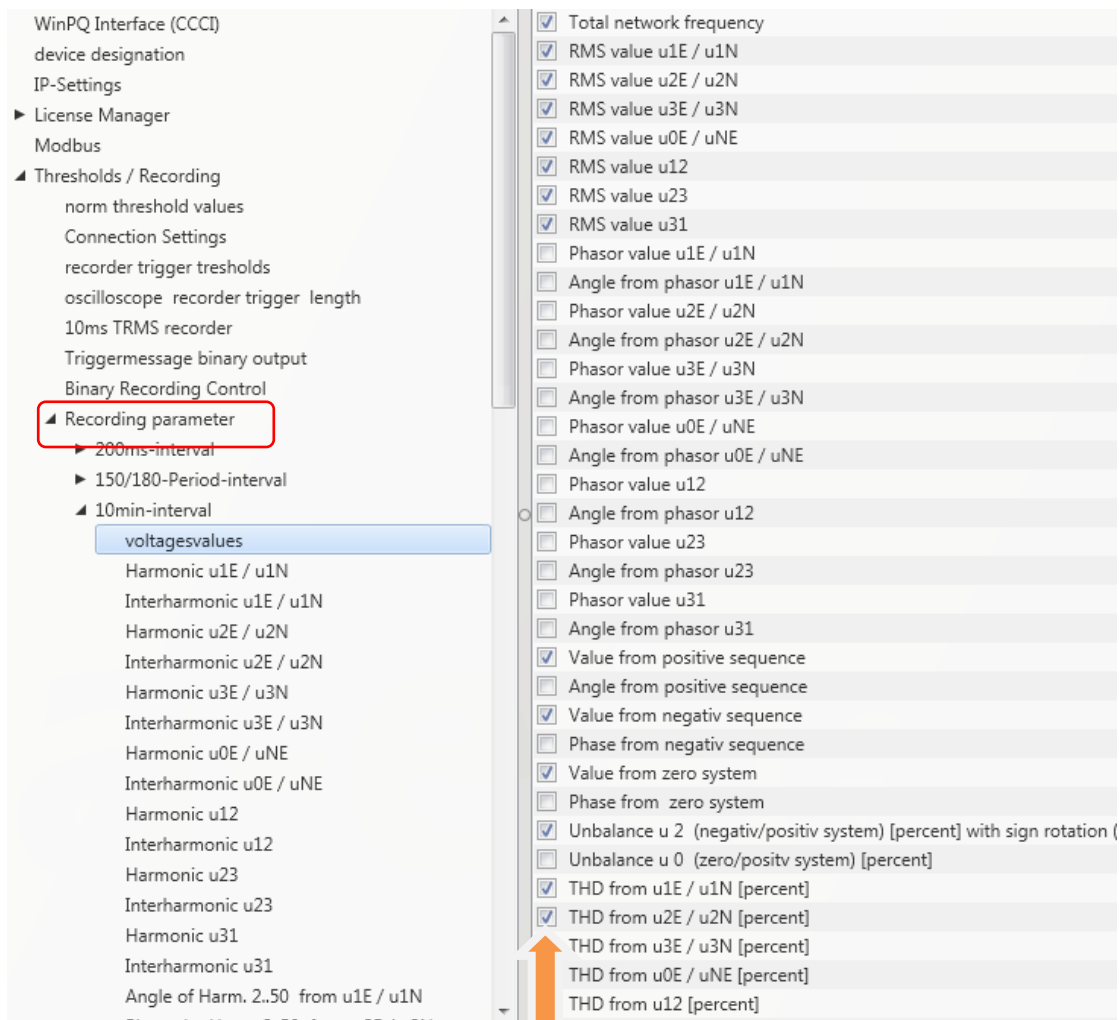
With the function "logic level recording control" the signal may be negated.



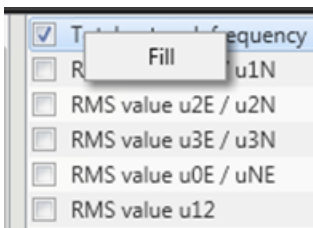
6.5.3 Recordings parameter

At this point, the selection of all permanent measured values within the interval data class is set.
The following interval data classes available

- 10/12 cycle (200ms interval)
- 150/180 cycle (3 seconds interval)
- 10 minutes interval
- 2 h interval
- 1 seconds interval
- 10 seconds interval
- N x seconds interval (range 2 to 60)
- N x minutes interval (range 1 to 60 – basic setting 15 min.)



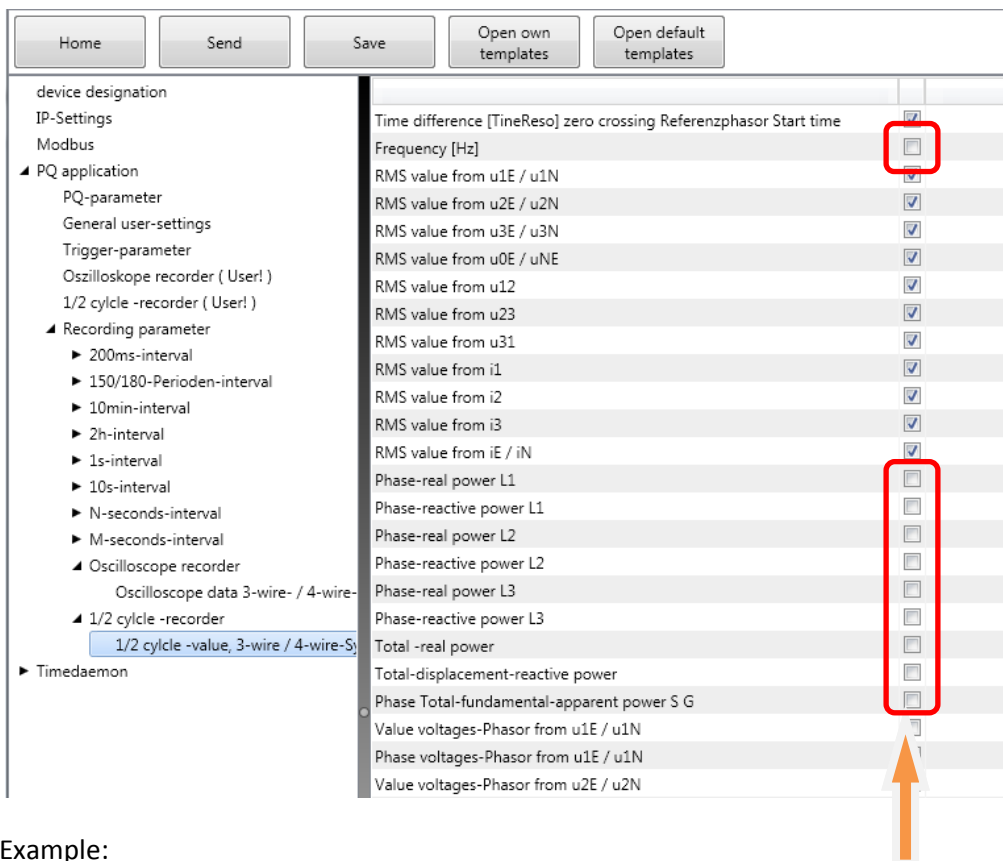
All activated measuring values are permanently recorded in this data class.



With right mouse click you can activate or deactivate all parameters in this list with the function "fill".

6.5.3.1 Disturbance recorder parameter

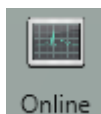
For oscilloscope recorder and ½ cycle recorder it is possible to activate and deactivate measurement values.



Example:

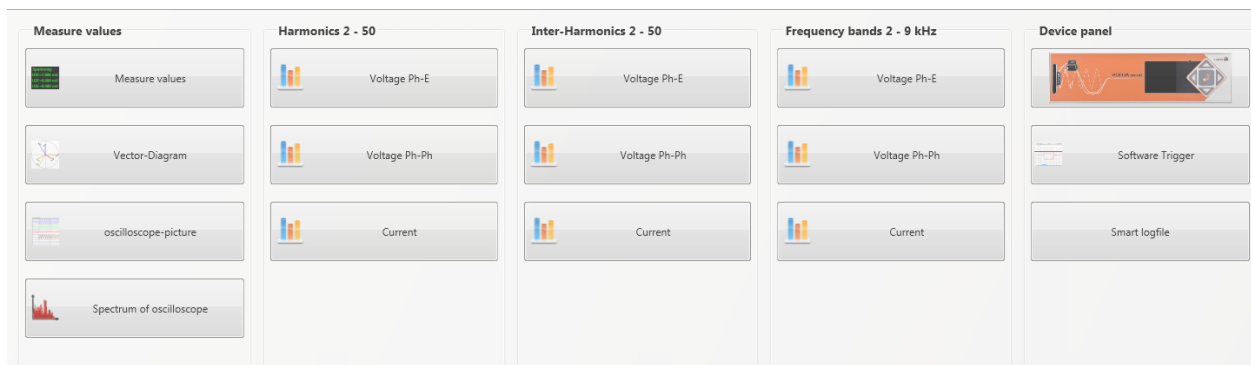
The ½ cycle recorder should also record the power and the frequency during a disturbance record.

6.6 Online measurement values



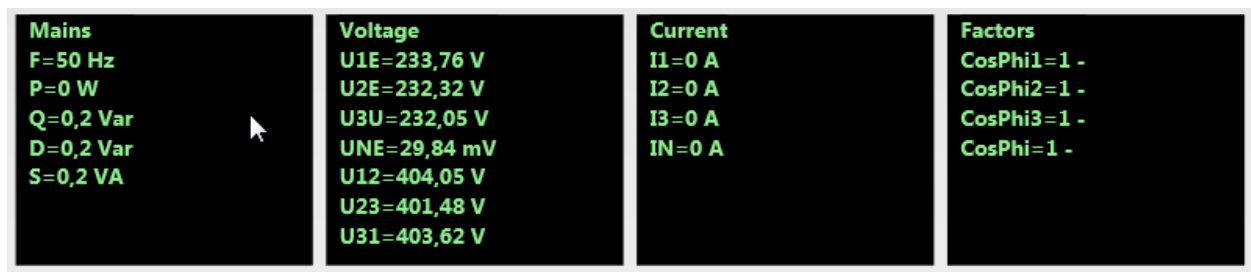
The "Online" function offers extensive analysis functions for online measurement values.

Start screen of the online measurement values:

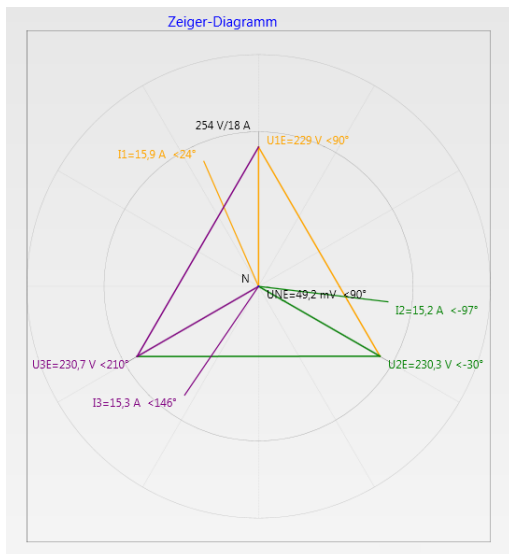


6.6.1 Measurement values

Display of online measurement values for voltages, currents, power and grid frequency.



6.6.2 Vector diagram

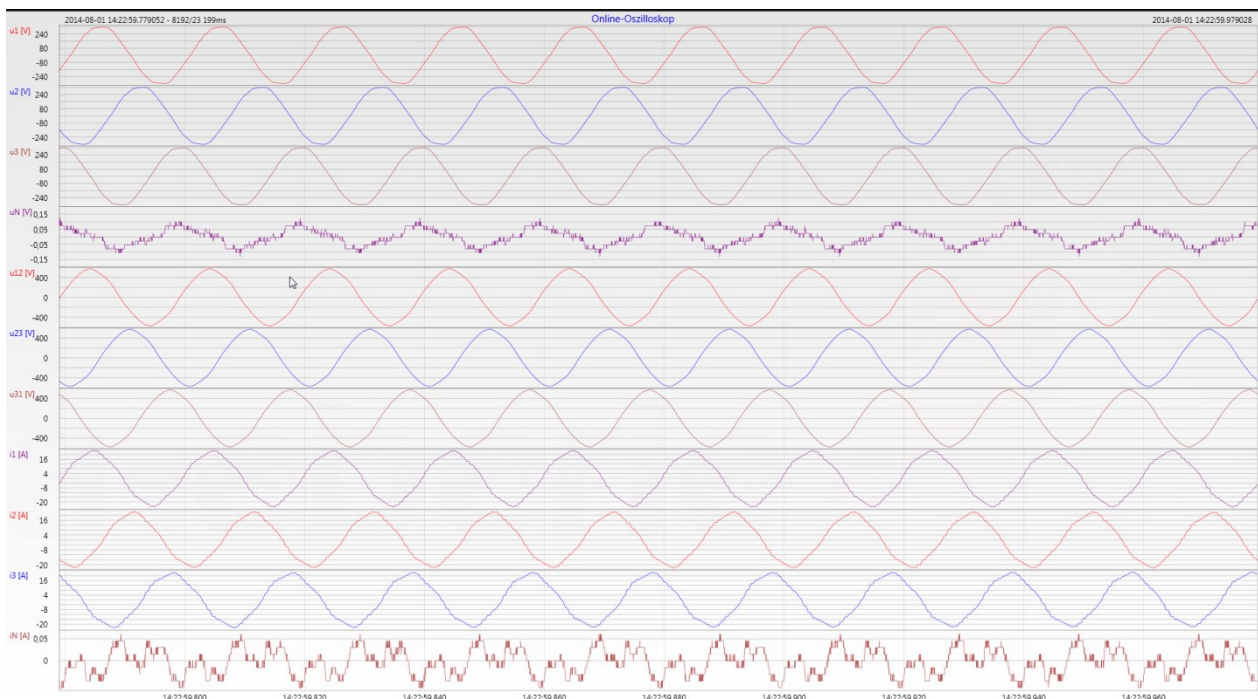


In the vector diagram, connection faults are easy to detect. All phase voltages and currents are displayed with phase angles.

6.6.3 Oscilloscope image

Online oscilloscope (40.96 kHz/ 10.24kHz) for the following channels:

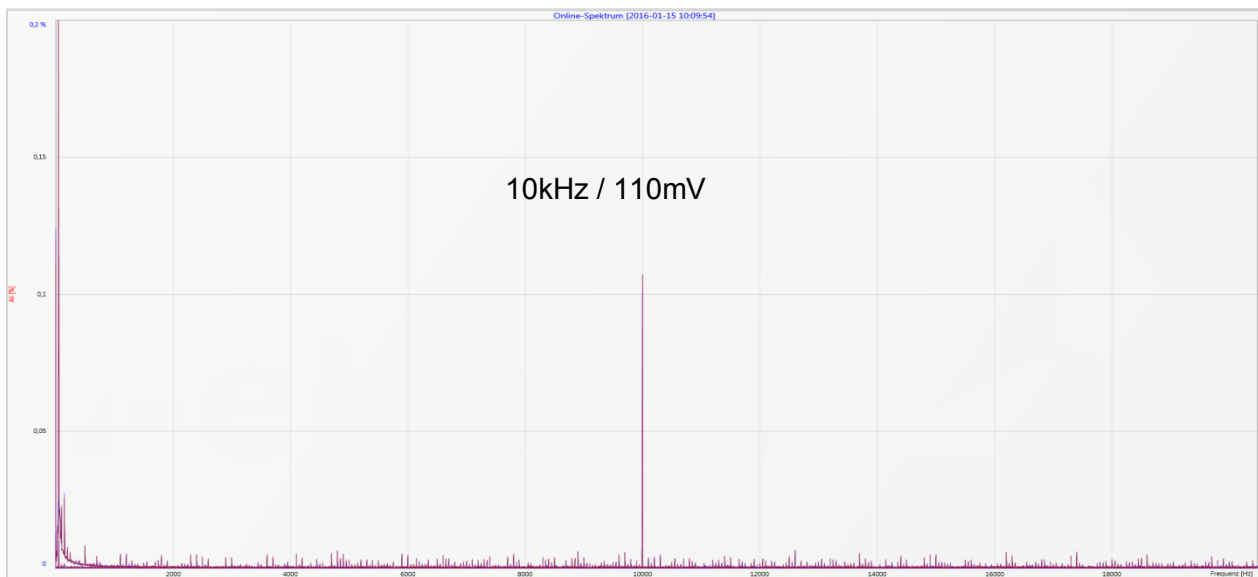
- Conductor-earth voltages L1, L2, L3, NE
- Conductor-conductor voltages L12, L23, L31
- Currents L1, L2, L3, N



6.6.4 Online spectrum FFT-Analyse

Online-FFT analysis depending on the license of the device

- Sampling frequency 41,96kHz = FFT analysis up to 20kHz
- Sampling frequency 10,24kHz = FFT analysis up to 5kHz



Example: charging device for electrical cars / 10 kHz sampling frequency visible in the FFT analysis.

6.6.5 Harmonic

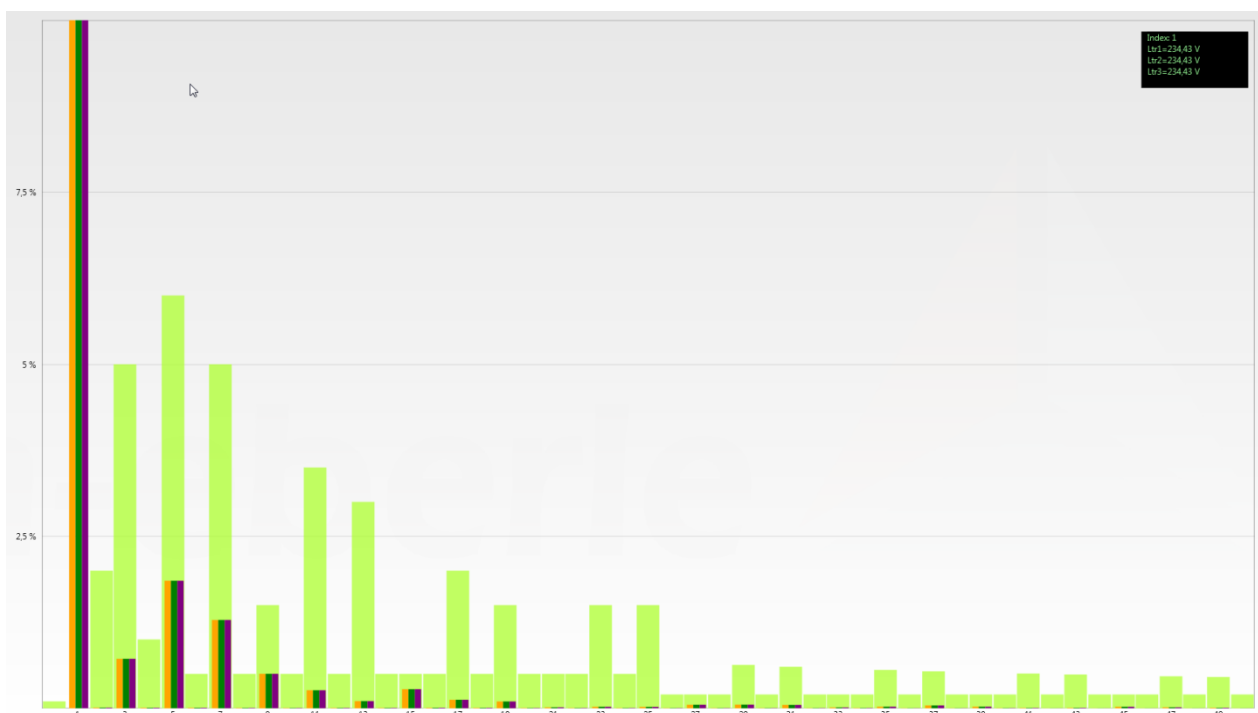
From the "Harmonics" tab page, all of the current and voltage harmonics (2nd to 50th) can be displayed online. The measurement data is calculated by the measuring device in accordance with IEC61000-4-30 Class A Ed. 3 and transferred to the PC.

There are three bar charts available:

- Voltage harmonics conductor-earth
- Voltage harmonics conductor-conductor
- Current harmonics

As the EN50160 only specifies limits for harmonics up to the 25th ordinal, the compatibility level of IEC61000-2-2 has been stored for the 26th to the 50th harmonics in the basic settings.

Compatibility levels in accordance with EN50160 & IEC61000-2-2 are shown as green limit value bars.



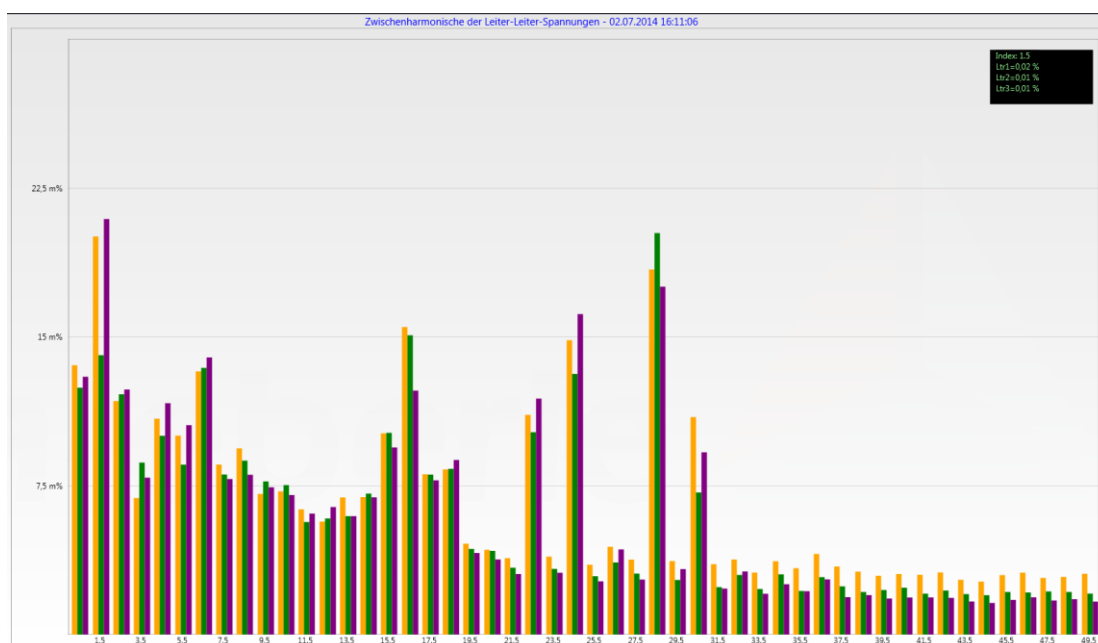
If a harmonic is selected with the mouse pointer, this measurement value is displayed in the field on the top right.

6.6.6 Interharmonic

The "Interharmonic" card is used to display all current and voltage Interharmonic up to 2,500 Hz 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.

There are three bar charts available:

- Interharmonic voltages line-earth
- Interharmonic voltages line-earth
- Interharmonic currents

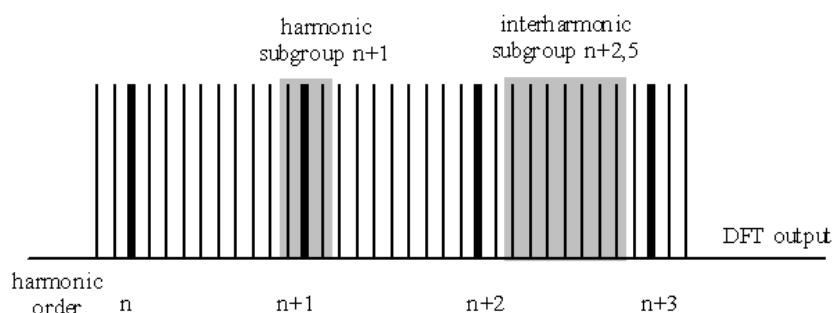


If an Interharmonic is selected with the mouse pointer, this measurement value is displayed in the field on the top right.

► Explanation of the grouping process in accordance with the IEC:

To evaluate the Interharmonic in the grid, subgroups are created. In each case, all of the Interharmonics between two harmonics are combined into one harmonics subgroup.

Example for 50Hz: Interharmonic H2 includes all frequencies from 110Hz to 140Hz.



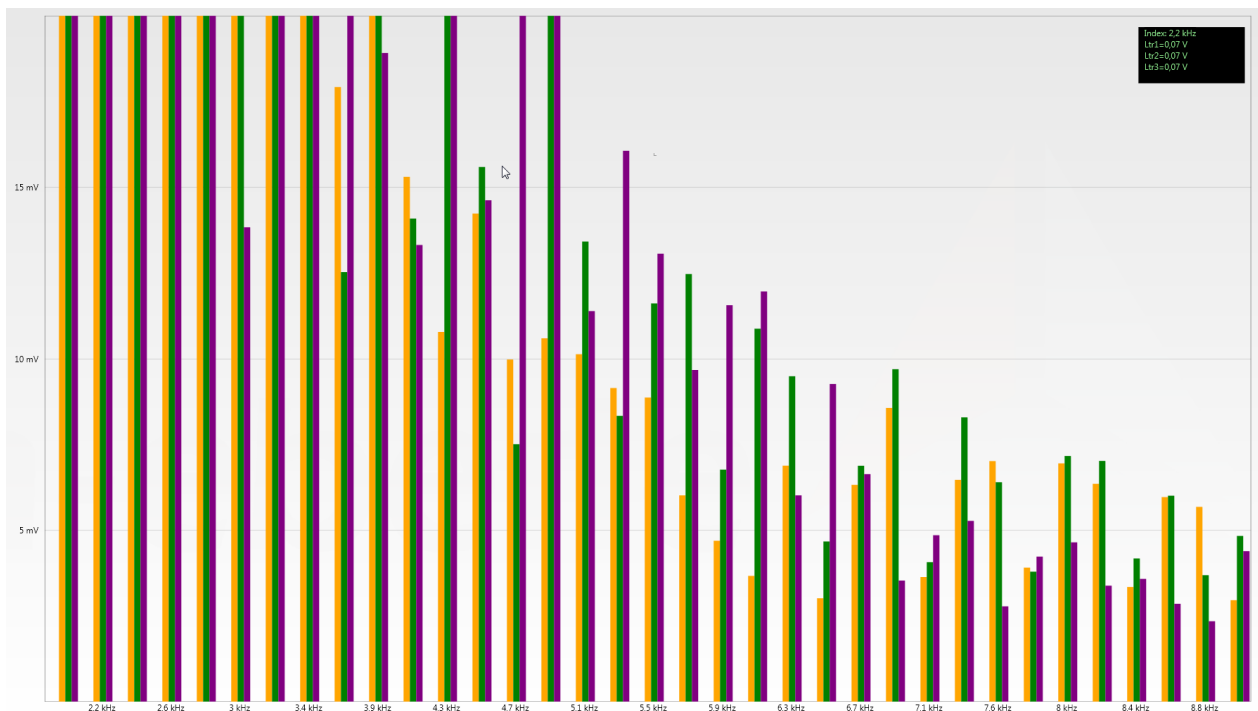
6.6.7 Frequency bands from 2kHz to 9kHz

▶ The device characteristic "Frequency bands from 2kHz to 9kHz" is a device option

The card "2 to 9kHz" is used to display all current and voltage harmonics in 200Hz groups. Evaluation is in accordance with the IEC61000-4-7 standard.

The center frequency of the corresponding frequency band is stated.

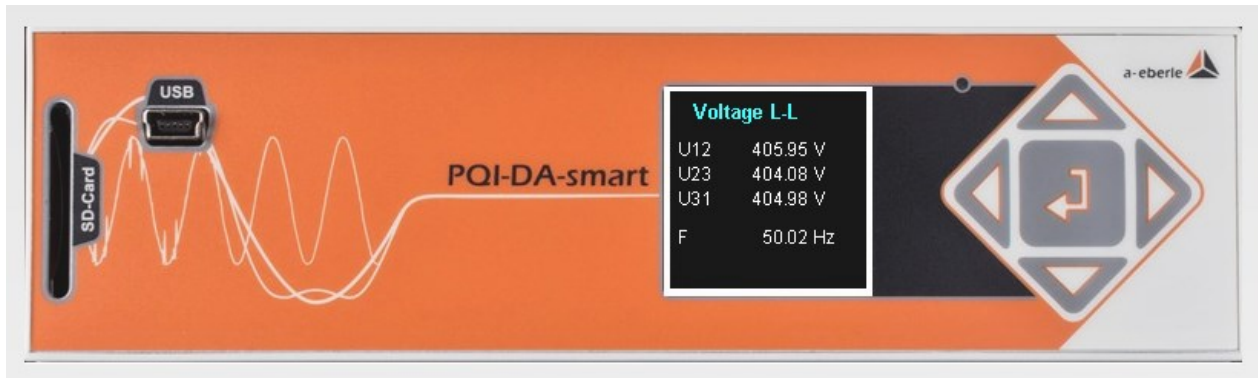
Example: All frequencies from 8,805Hz to 9,000 Hz are located in the 8.9 kHz band.



If a frequency band is selected with the mouse pointer, this measurement value is displayed in the field on the top right.

6.6.8 Device panel


The device panel can be used for the remote control of the device via the 5-key keypad.

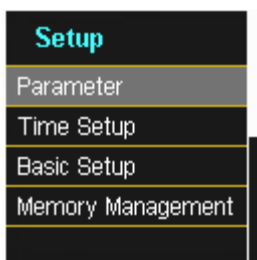


- Scrolling the measurement value displays (right – left keys)

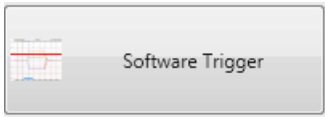
The left and right keys can be used to scroll the measurement value screens.

- Setup settings

The Enter key  is used to open the setup menu of the device.



6.6.9 Software trigger

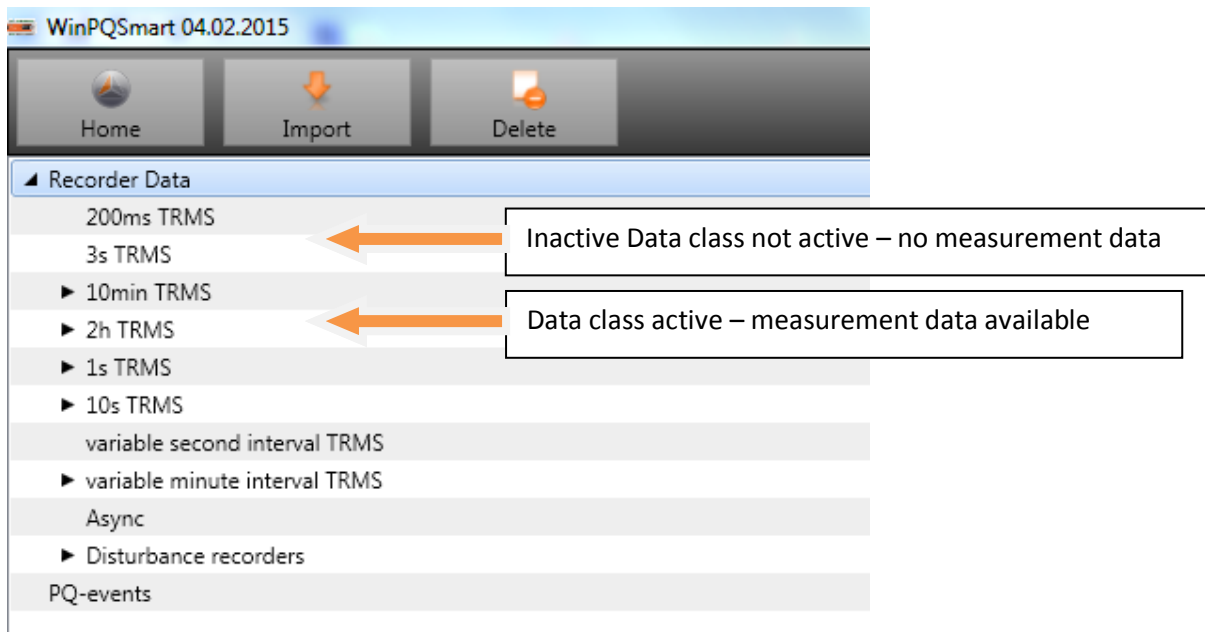


The "Software Trigger" key can be used to trigger the oscilloscope recorder and $\frac{1}{2}$ -period RMS recorder manually. The recorder length corresponds with the settings in the setup menu of the device.

6.7 Measurement data import

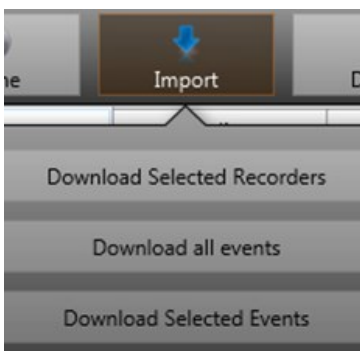


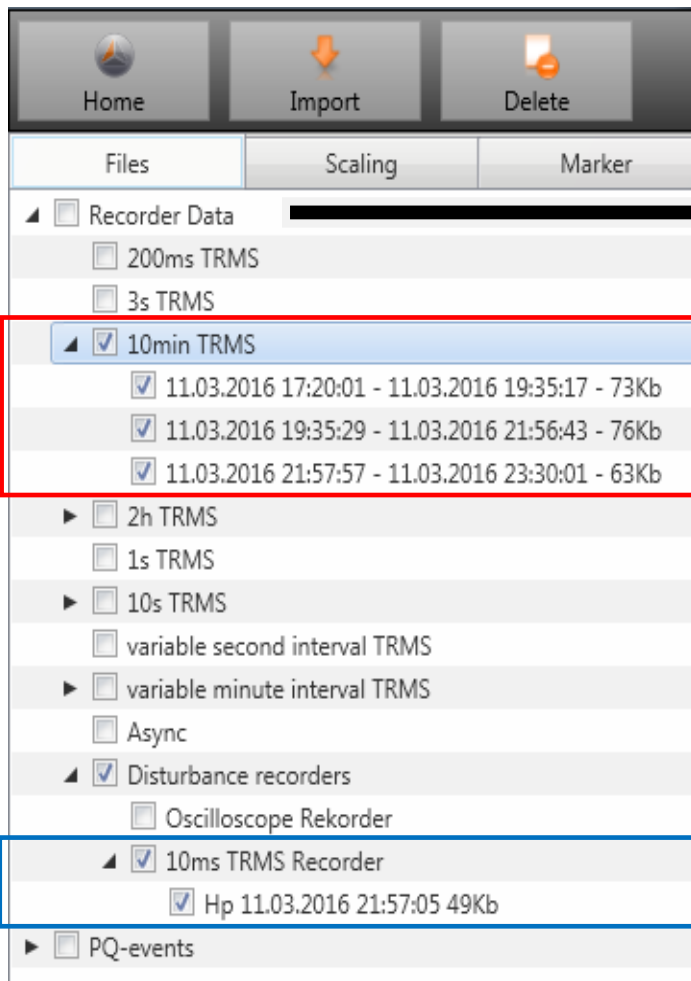
The "Import" function can be used to load all measurement data from the PQI-DA smart to the PC and to evaluate it there.



Import of data can be selected to:

- Only selected data files from the device
- All events
- Selected events





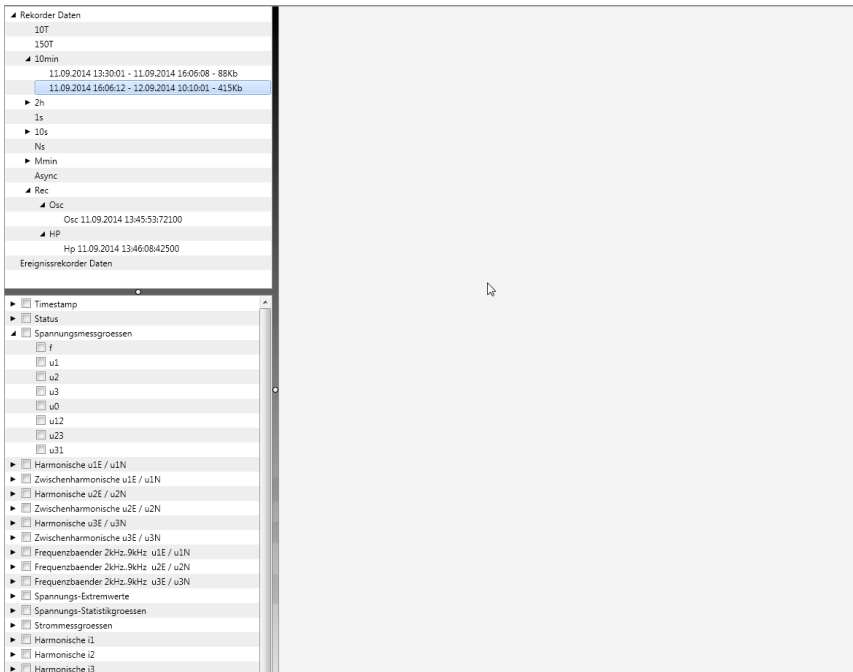
Selecting the main folder "recorder date" will activate all available data for download

Select the interval data classes
3 permanent recorder files available

Select the number of the triggered sequence of events recordings (oscilloscope and ½ cycle RMS recorder)

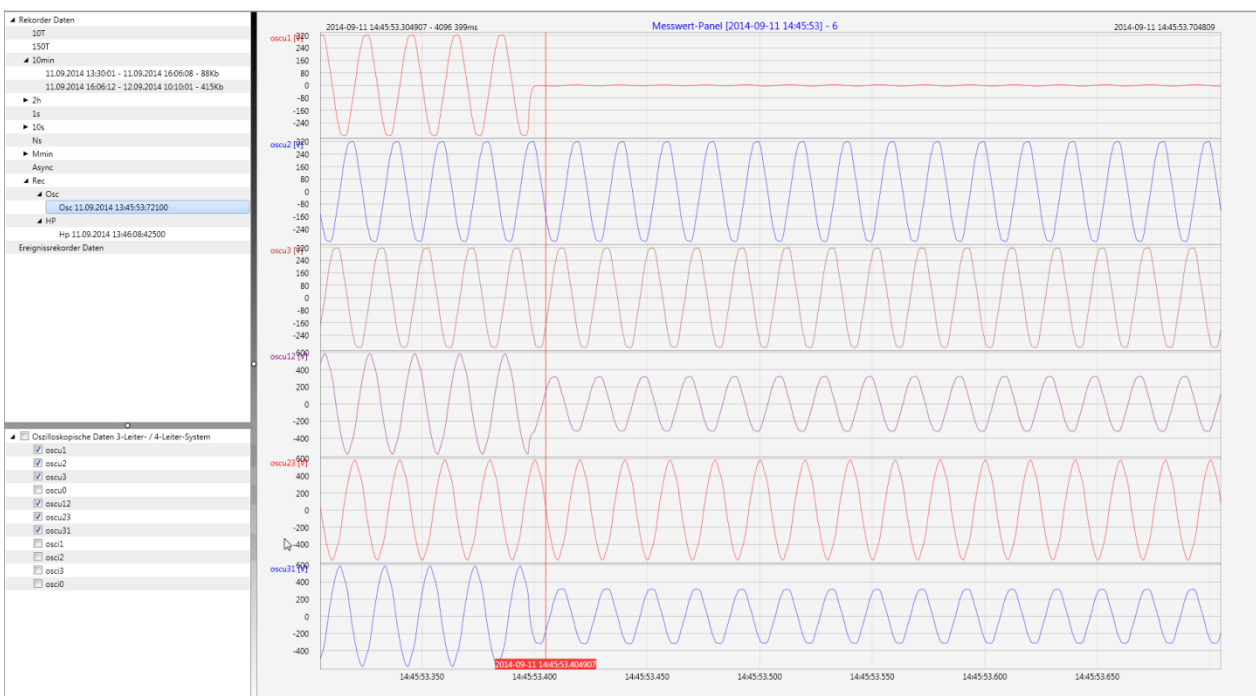
► **Level-time diagram of permanent measuring data**

When a file is selected this measurement data is saved on the PC immediately and a selection field with all available measurement data appears in the window.

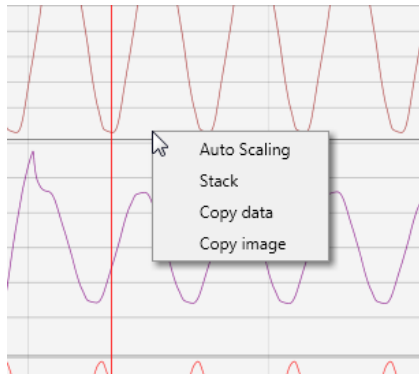


If measurement values are selected, they appear as a level-time diagram on the screen.

Example: Oscilloscope recorder – selecting voltage L1, L2, L3, L12, L23, L31



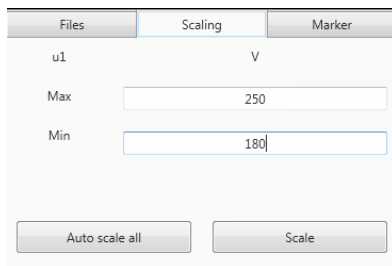
Right-clicking the graphics with the mouse will open the following menu:



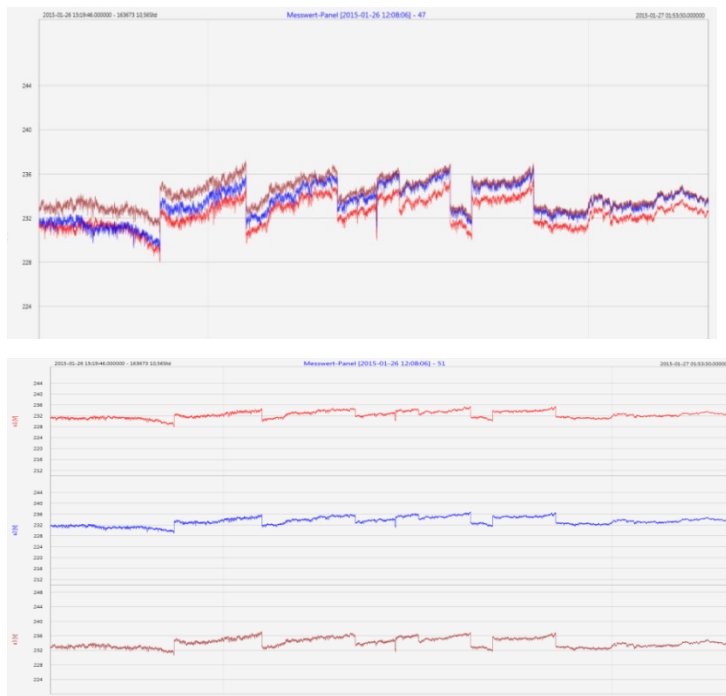
► **Functions:**

- **Auto scaling:** The Y-axis of the measurement values is scaled automatically or can be scaled manually.

A Menu appears where the last measurement can be scaled free or automatic



- **Stack** – associated measurement data can be represented with a common scale or separated

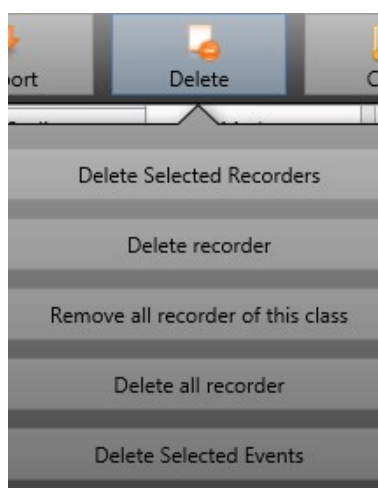


Example: presentation of voltage L1, L2, L3 in two variants

- **Copy data:** Measurement data is copied to the clipboard and can be processed further, e.g. in MS Excel.
- **Copy Image:** Copies the level-time diagram to the Windows clipboard and can then be inserted, e.g. in MS Word.

6.8 Deleting measurement data in the device memory

With the "Delete" function, measurement data can be deleted in the PQI-DA *smart* device memory.

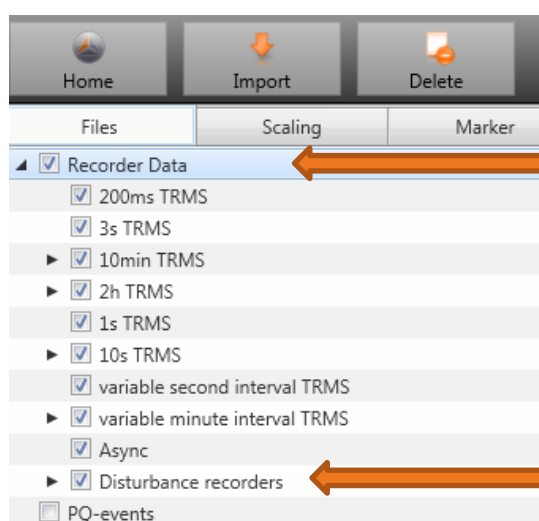


Delete selected recorders – deletes only selected files.

Delete recorder - deletes all recorder file.

Remove all recorders of this class - deletes e.g.. all 10-minute data files.

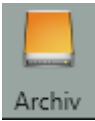
Delete all records – All disturbance recordings and long-term measurement data on the device memory are deleted.



Main folder mark all data files

Mark only selected files to delete only these records.
i.e. the disturbance records which were recorded during installation

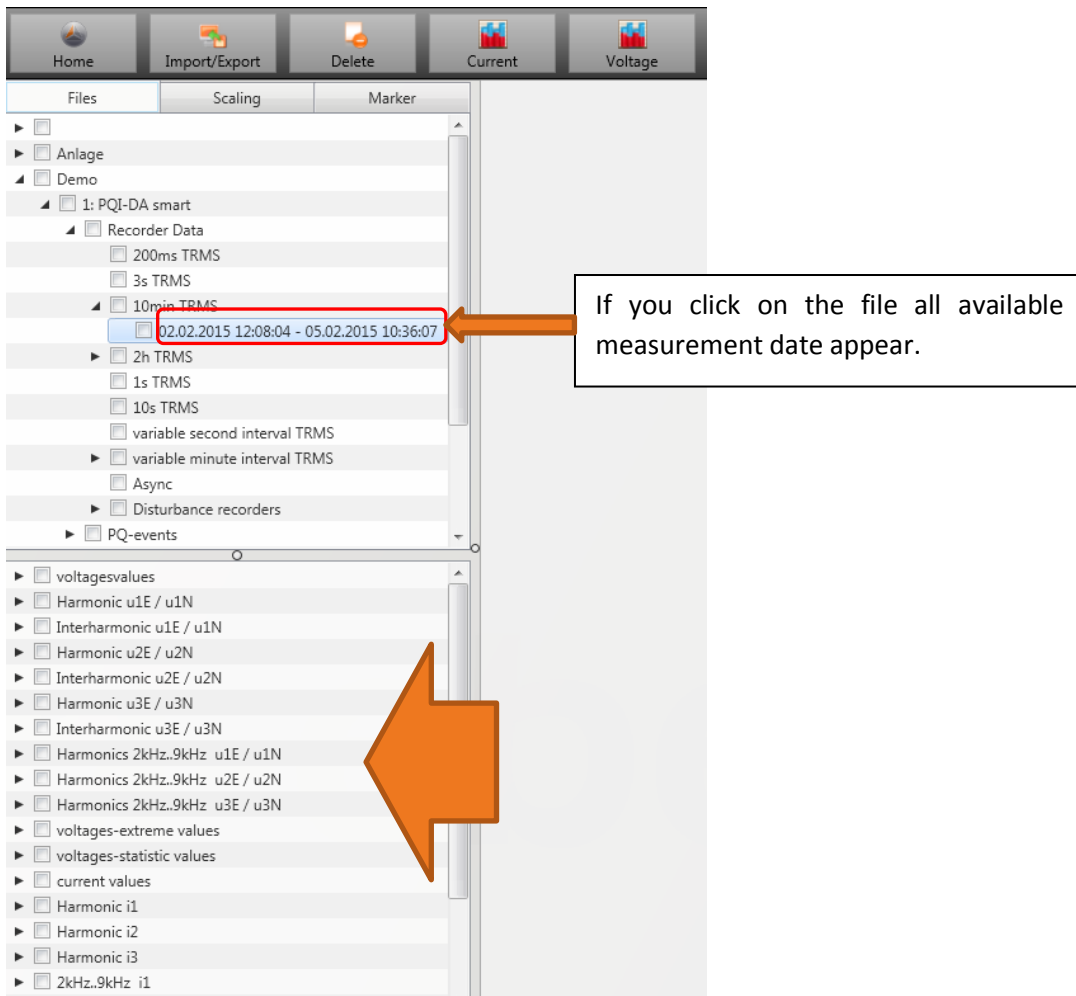
6.9 Evaluating measurement data offline



The "Archive" function can be used to evaluate all measurement data offline.

All measurement data which has been selected in the "Import" function is saved automatically on the PC. These can be evaluated offline without being connected to the measuring device.

Screen: Data folder



We take care of it.

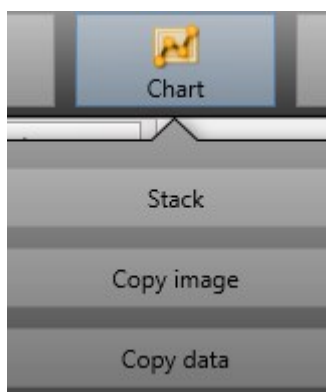
When measurement values or measuring channels have been selected, the associated level-time diagram appears.

Example: selection voltage extreme value and 5th harmonic L1



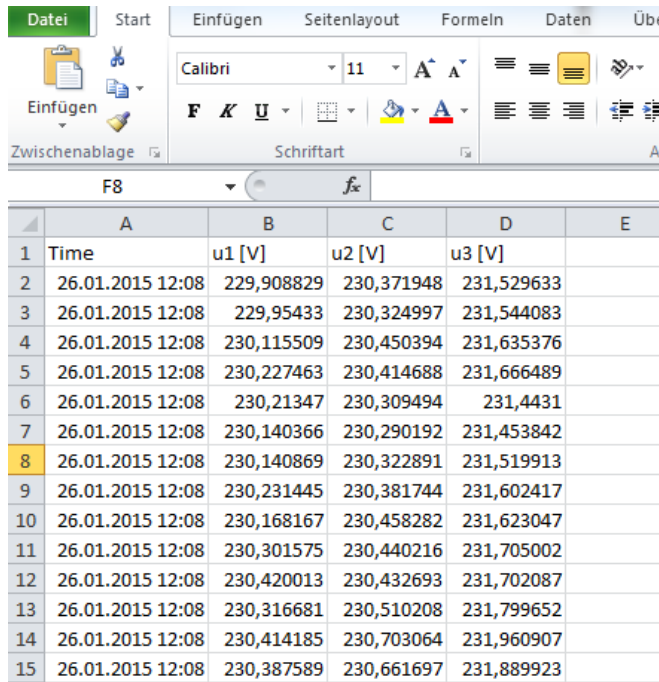
6.9.1 Edit measurement data

With the icon "Chart", the following functions are available:



► **Copy data – copies all the data displayed in the Windows clipboard**

Example – measurement values in MS Excel

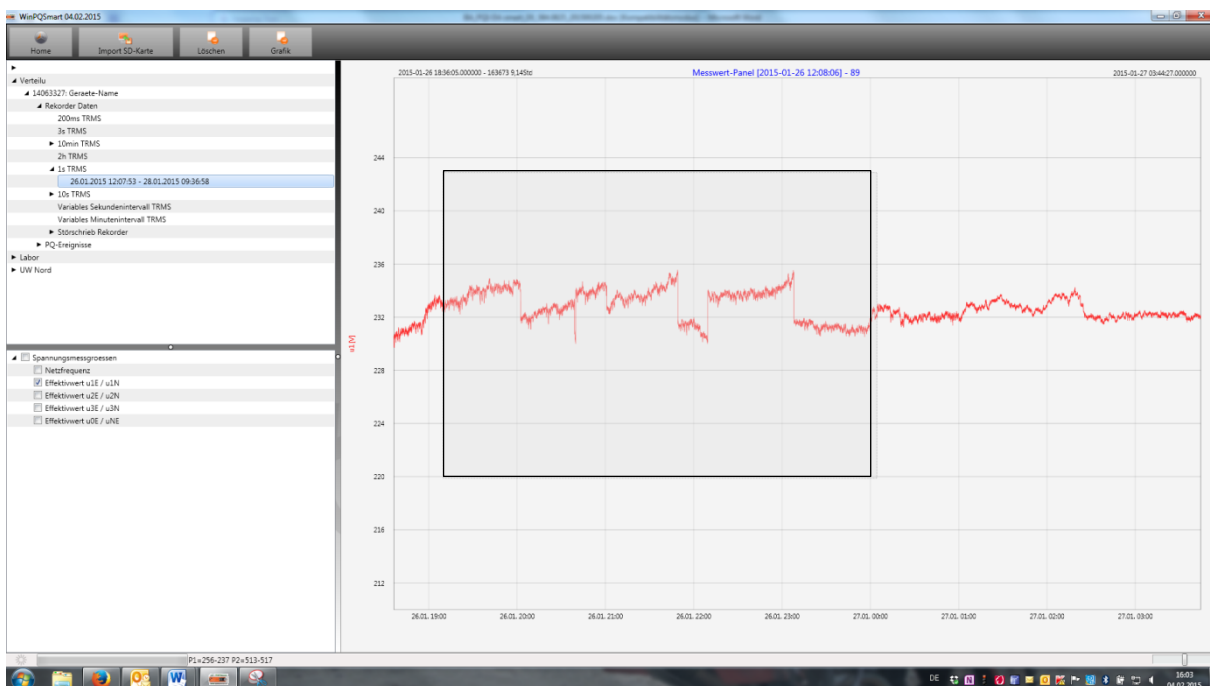


	A	B	C	D	E
1	Time	u1 [V]	u2 [V]	u3 [V]	
2	26.01.2015 12:08	229,908829	230,371948	231,529633	
3	26.01.2015 12:08	229,95433	230,324997	231,544083	
4	26.01.2015 12:08	230,115509	230,450394	231,635376	
5	26.01.2015 12:08	230,227463	230,414688	231,666489	
6	26.01.2015 12:08	230,21347	230,309494	231,4431	
7	26.01.2015 12:08	230,140366	230,290192	231,453842	
8	26.01.2015 12:08	230,140869	230,322891	231,519913	
9	26.01.2015 12:08	230,231445	230,381744	231,602417	
10	26.01.2015 12:08	230,168167	230,458282	231,623047	
11	26.01.2015 12:08	230,301575	230,440216	231,705002	
12	26.01.2015 12:08	230,420013	230,432693	231,702087	
13	26.01.2015 12:08	230,316681	230,510208	231,799652	
14	26.01.2015 12:08	230,414185	230,703064	231,960907	
15	26.01.2015 12:08	230,387589	230,661697	231,889923	

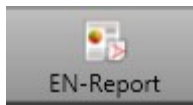
► **Copy image – photo is copied to the Windows clipboard**

► **Zoom function**

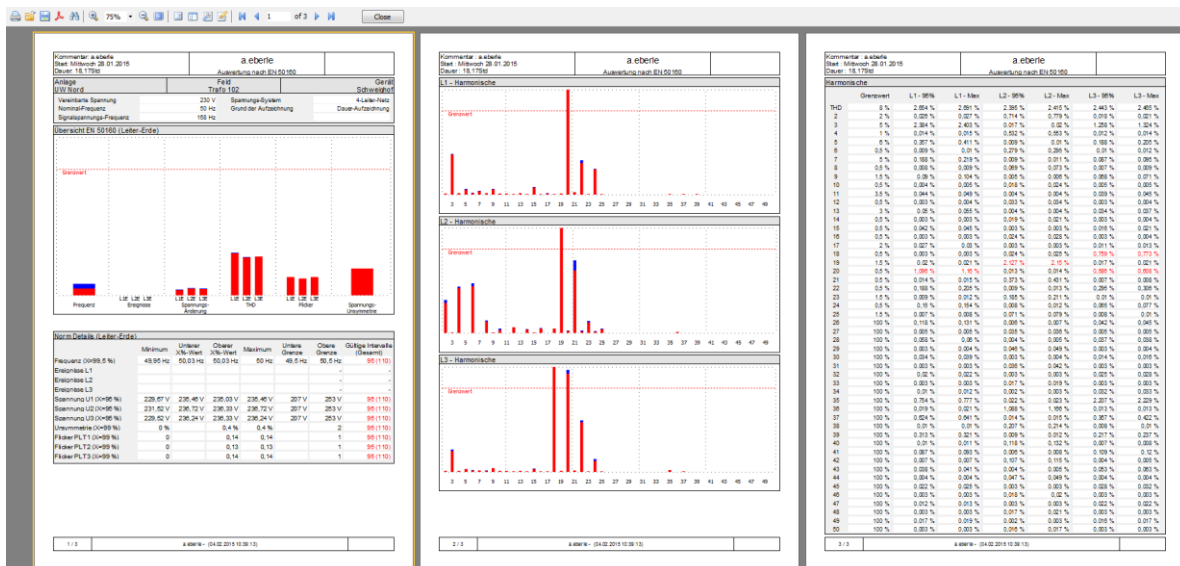
To zoom in an area you draw with the left mouse button a window from top left to bottom right. To zoom out is the opposite direction. You can zoom in multiple stages or zoom out an image.



6.9.2 EN50160 report



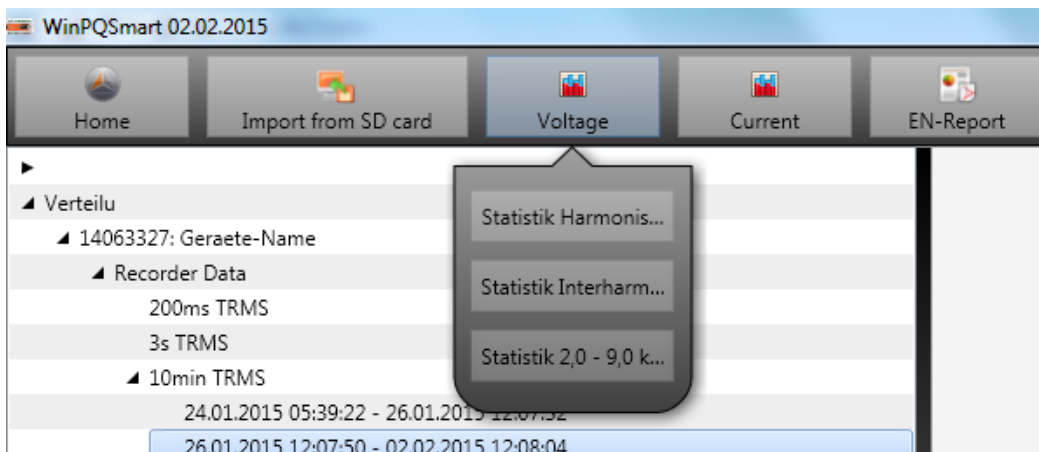
In the 10 minute data class, the EN50160 report is readily available. If you select one measurement file a multipage report is created.

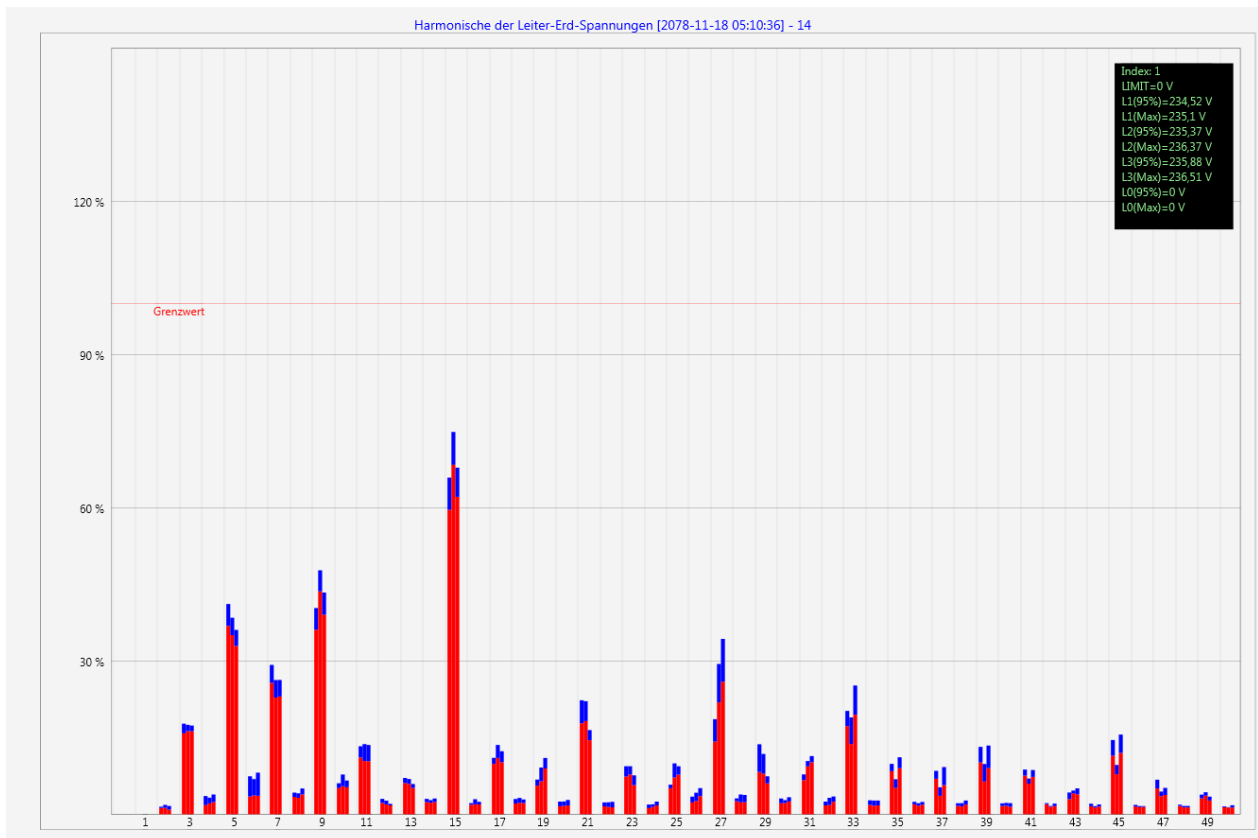


6.9.3 Voltage harmonics and interharmonics



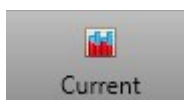
With the Icon "Voltage" you can reach the statistics of the voltage harmonics, voltage interharmonics and frequency bands 2 kHz to 9 kHz.



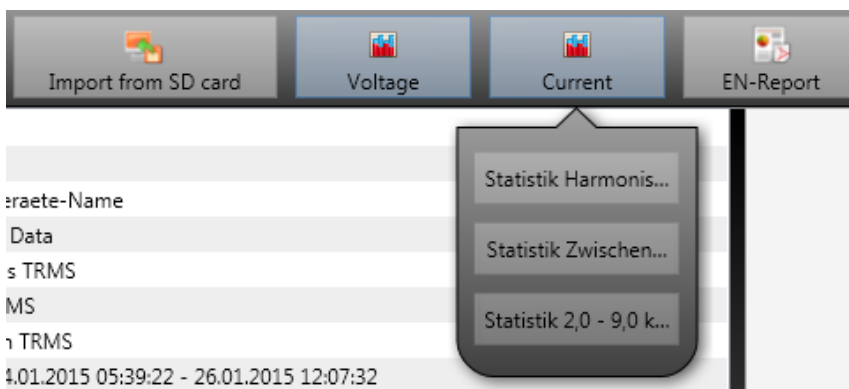


Statistic voltage harmonic - scaled to the corresponding compatibility level of the power quality standard.

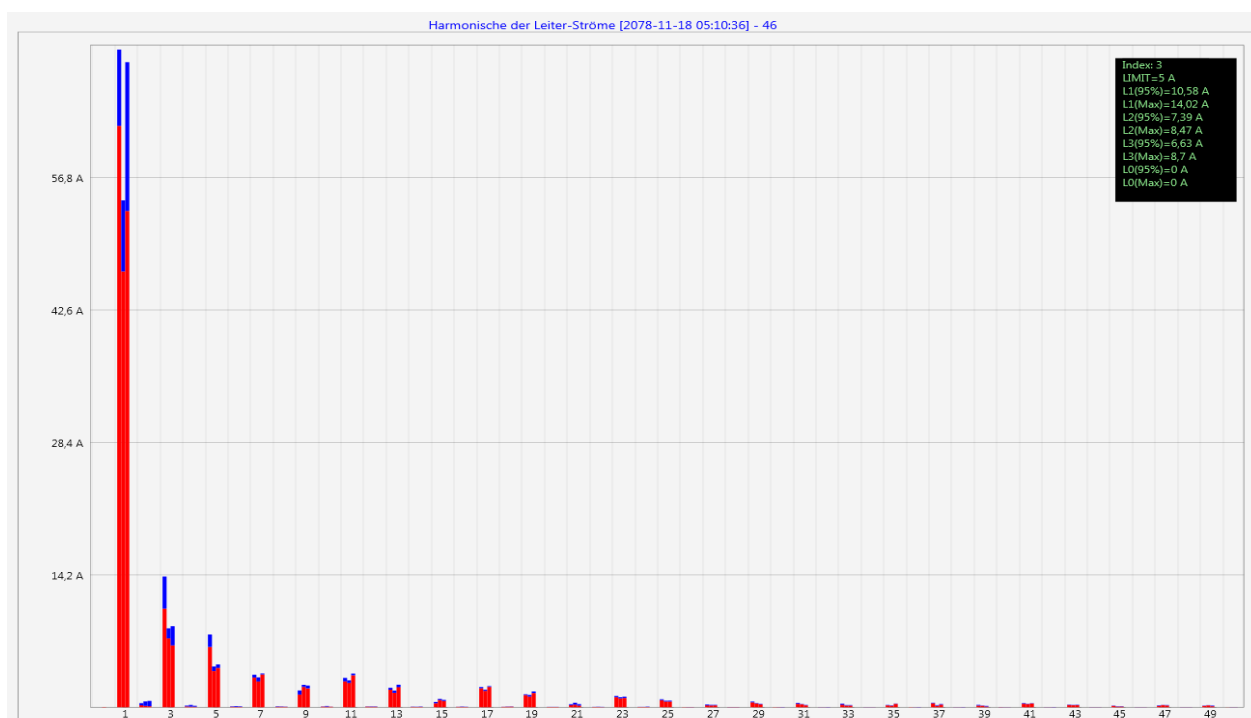
6.9.4 Current harmonics and interharmonics



With the Icon "Voltage" you can reach the statistics of the voltage harmonics, voltage interharmonics and frequency bands 2 kHz to 9 kHz.

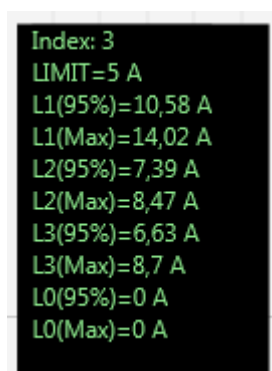


We take care of it.

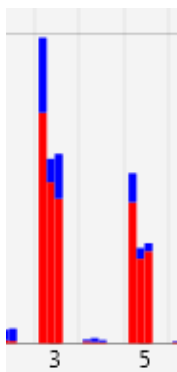


Example: Statistic current harmonics 2nd to 50th - scaling in ampere

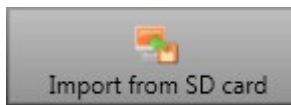
If you select with the cursor a particular harmonic, the corresponding measured values are displayed for these harmonics in the display window.



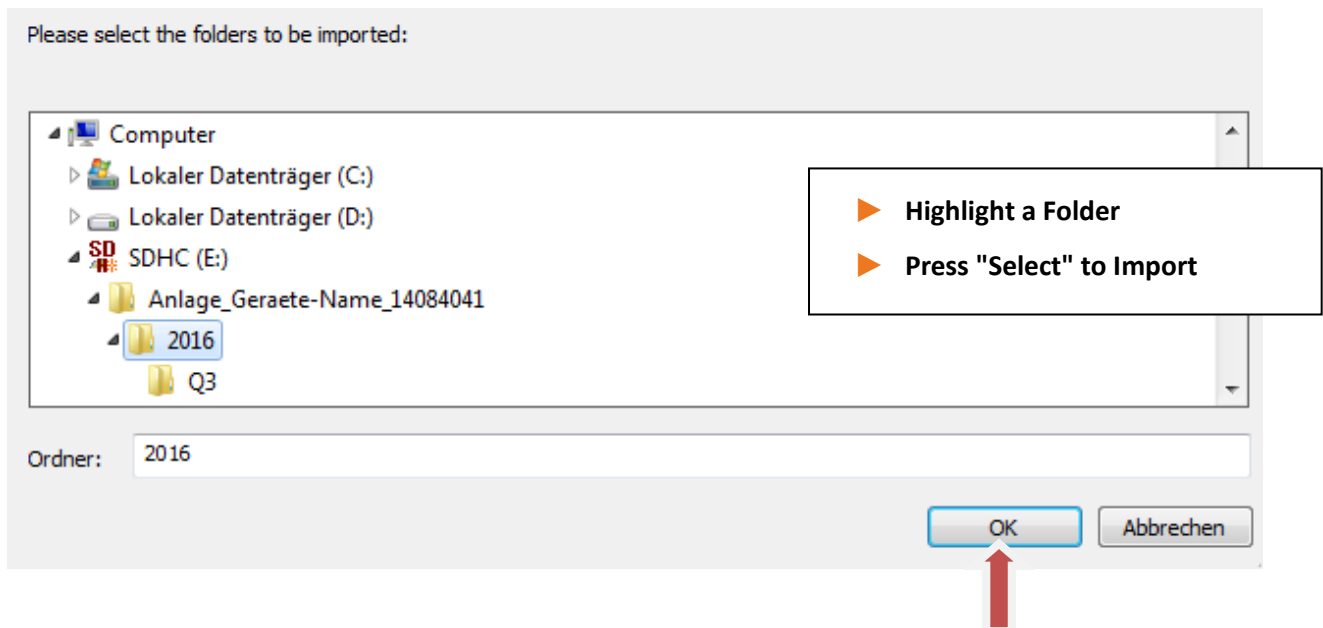
The **red bar** always shows the 95% values and the **blue bar** shows the maximum measured value.



6.10 Importing measurement data from an SD card



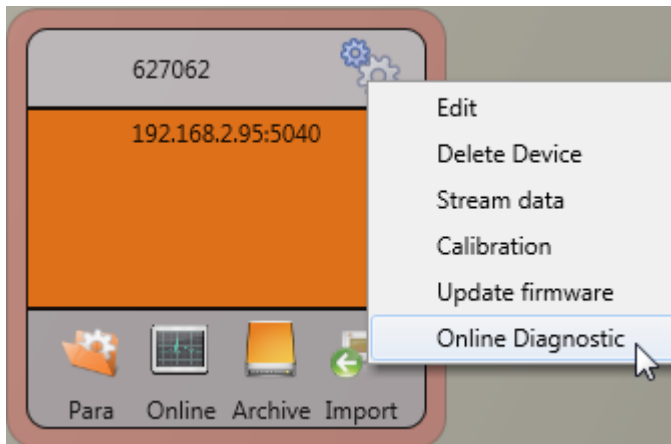
The function "Import from SD" function is used to transfer selected measurement data from the SD memory card to the PC.



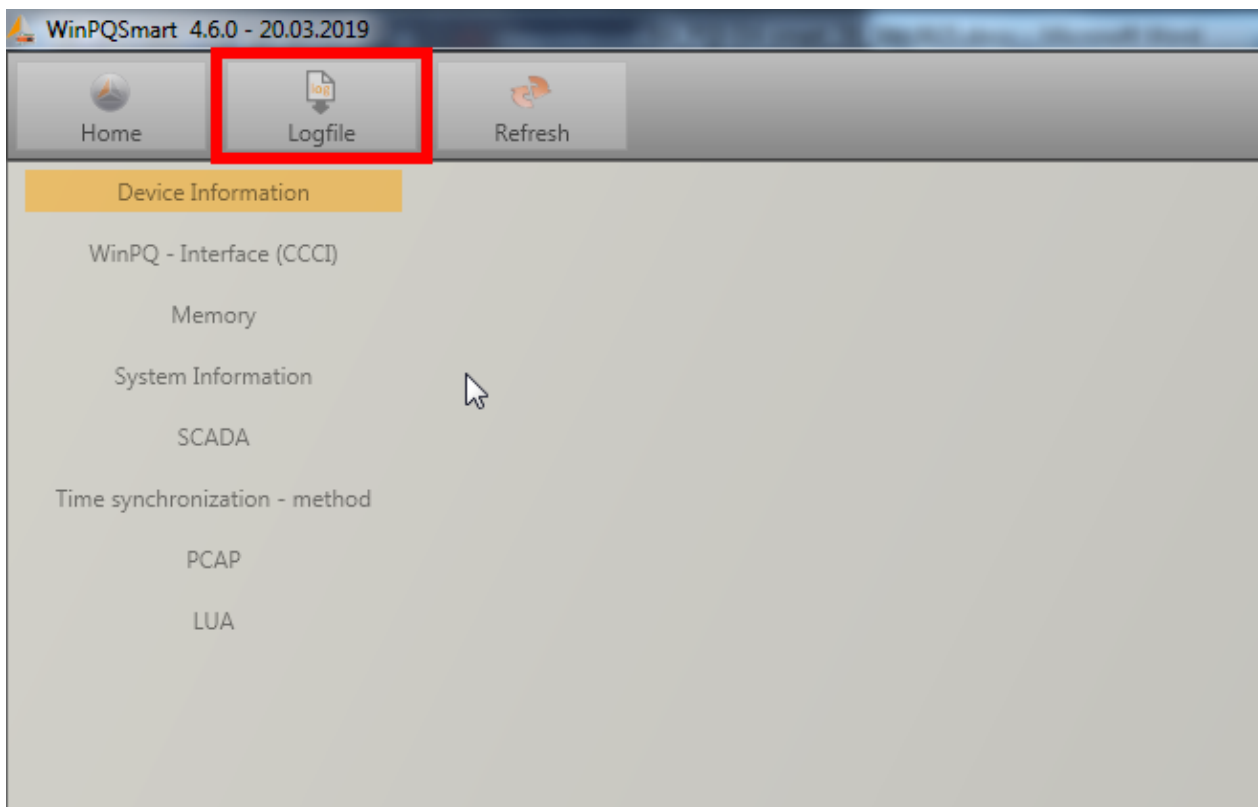
We take care of it.

7. Online Diagnostic

With the help of online diagnostics, the most important information of the PQI-DA smarts can be read out via Streaming . The device status can be seen as well as the complete device properties v



In the "Device information" part, the device log file can be loaded from the device using the **Logfile** button.



8. Firmware update for PQI-DA smart

Power Quality devices are constantly evolving in terms of functions and standards. It may therefore become necessary to update a device, e.g. due to changes in standards, new functions or necessary (security) patches. You will find the latest firmware version with a transparent changelog to check whether an update is necessary using the following link:

<https://www.a-eberle.de/en/download-center-categories/f%C3%BCr-festinstallierte-ger%C3%A4te-0>

A.Eberle generally provides two firmware packages which differ in their function:

► Incremental update (patch) - available on the homepage

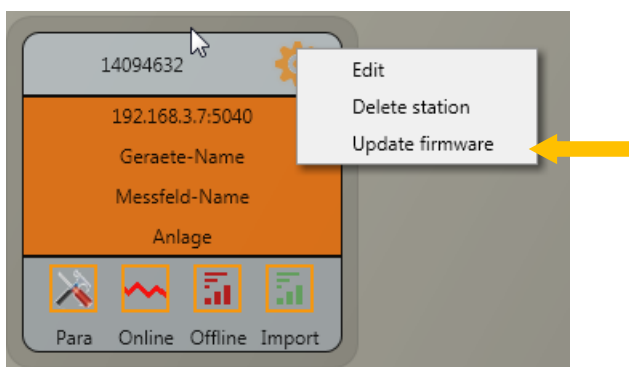
The incremental update does not change any parameters or settings. It also does not delete any measurement data, but only updates the changes to the last version.

The file name is e.g. "PQI-DA_Smart_v1.8.10_11544.zip". The incremental update is the common way to bring the measuring instruments up to date.

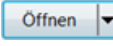
► Factory Update - only available on request

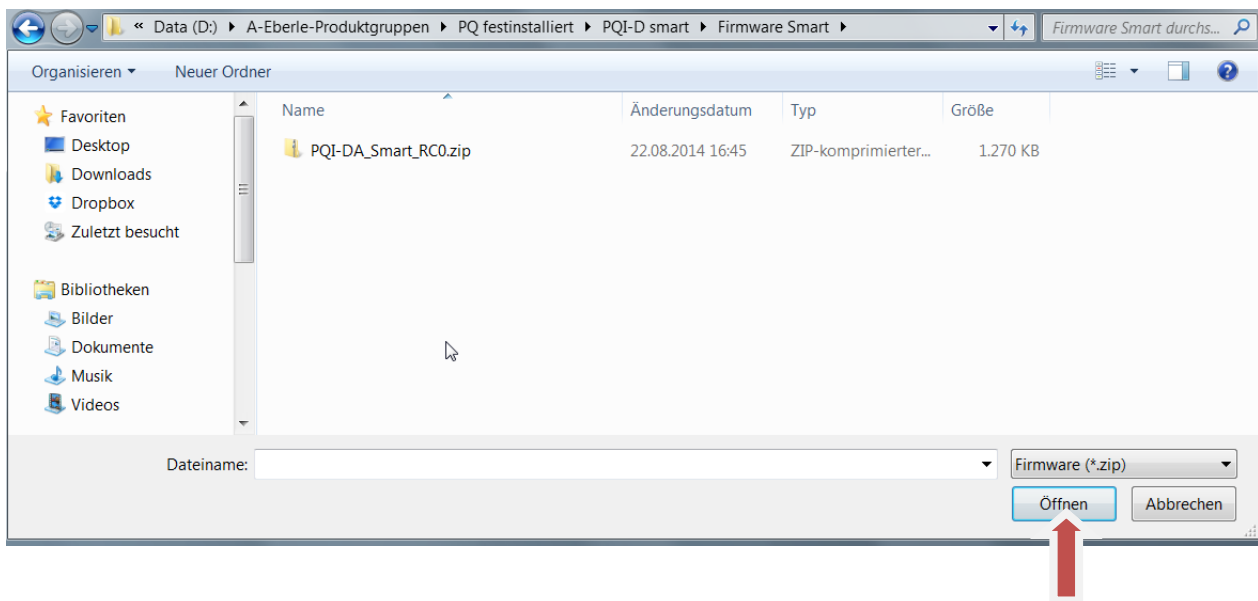
This update deletes all settings including all recorded data and resets the device to factory settings. The file name of the update has the extension "factory" Example: "PQI-DA_Smart_factory_v1.8.10_11544.zip". The factory update should only be used in consultation with product support.

8.1 Firmware update with software WinPQ smart



The "General setup" device function tile can be used to carry out a firmware update for the PQI-DA *smart* measuring device.

- Select the folder where the file for the firmware update is located.
- The  function is used to transfer the firmware to the network analyzer.



When the transfer of the firmware to the measuring device has been completed, it will automatically re-start and install the new version.

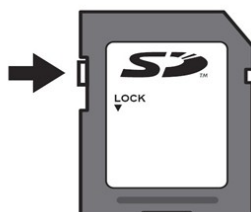
8.2 Firmware update with SD - card

Additional to the WinPQ Smart software update, it is also possible to update the firmware of the PQI-DA smart measuring device using an SD memory card. To do this, please proceed as follows:

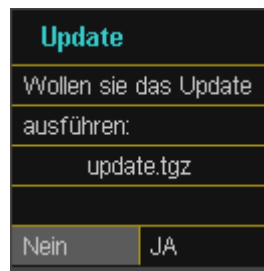
- Unpack the firmware file (zip file e.g. PQI-DA_Smart_v1.8.10_11544.zip) directly into the root directory of the SD card used. Accordingly, the following files can be found on the SD card in the top directory:

Name	Typ	Komprimierte Größe
readme.txt	Textdokument	2 KB
update.md5	MD5-Datei	1 KB
update.tgz	TGZ-Datei	3.463 KB

- Before inserting the SD card into the slot of the PQI-DA smarts, please check that the write protection switch of the SD card is set to "unlocked". (This is mostly "above", see picture)



- Insert the SD card into the SD card slot on the PQI-DA smart. If there is a suitable firmware on an SD card, the measuring instrument automatically recognizes this file after insertion and the following message appears on the instrument display.



- The firmware update is carried out automatically by pressing the "YES" button. The process can take up to 5 minutes.
- The device restarts after successful installation.

8.3 Automatic Firmware Update of Many Devices

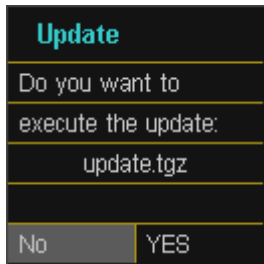
Using the WinPQ system software, many PQI-DA smarts can be updated with just a few clicks, with full clarity and control. Further information can be found in the documentation "[WinPQ Commissioning Instructions](#)" of the WinPQ system software.

(https://www.a-eberle.de/sites/default/files/media/ba_WinPQ_Commissioning_en.pdf)

8.4 Firmware update with SD-memory card

It is possible to make a firmware update on the PQI-DA smart using an SD memory card. If an appropriate firmware is stored on the SD card, the instrument automatically detects this file after plugging.

- The following message appear automatically



- Press YES to install the firmware update on this device
- The PQI-DA smart does a reboot, after a successful installation.

9. Calibration PQI-DA smart (license required)

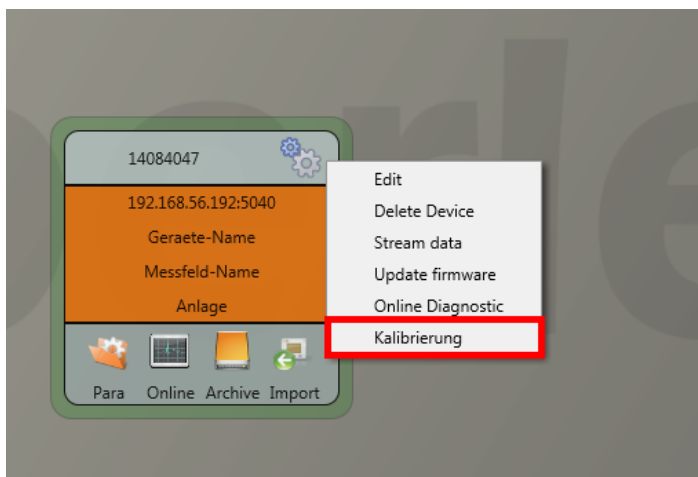
The power quality network analyzer PQI-DA smart is ex work calibrated and delivered with a corresponding test report certificate. We recommend a calibration cycle of 4-5 years for the PQI-DA smart. The device can either sent to A. Eberle for calibration or calibrated with the WinPQ smart software. This functionality of the software requires a fee-based license key.

► Requirements for calibration equipment

According IEC61000-4-30 class A the PQI-DA smart has an accuracy of < 0.1% for voltage measurement. The reference measurement device must meet a minimum accuracy of 0.02% (e.g. Fluke 8508A or Agilent multimeter 34410 A). The voltage source has to deliver a sinus signal with 100 V (50 or 60 Hz) with a THD > 0.1%. In addition a current source with a sinus-shaped signal of 5 A (50 or 60 Hz) is required.

► Calibration process with the WinPQ smart software

The calibration process with the WinPQ smart is completely guided by an assistant. The complete process with the corresponding instructions is described by the software wizard. The calibration wizard is started by the settings menu of a PQI-DA smart, see next figure.



Starting the calibration requires a valid license key. Please enter the key in the corresponding input field on the start screen page.

The wizard guides the user through the complete calibration process. Please follow the instructions of the assistant.

► Creation of the calibration test report certificate

After successful completion of the calibration process the PQI-DA smart performs an automatic restart and is then again ready for operation. At the end of the calibration process the software automatically generates and displays the corresponding test report certificate with the specified calibration parameters and results in PDF format.

10. License Update PQI-DA smart

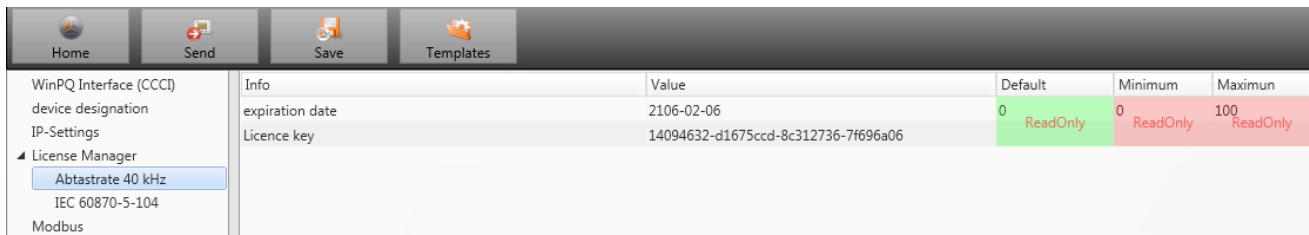
The network analyzer PQI-DA Smart can be equipped with various options. These options can be activated via a license code, even after the purchase, at any time.

To order an option the following information to create a license codes are required:

- Serial number of the instrument
- Article number of the instrument
- Option to install

If you received a valid license for the connected device please paste it to the device setting.

Example: Upgrading Option 40.96kHz for PQI-DA smart



Info	Value	Default	Minimum	Maximum
expiration date	2106-02-06	0	0	100
Licence key	14094632-d1675ccd-8c312736-7f696a06	ReadOnly	ReadOnly	ReadOnly

► The following options are available:

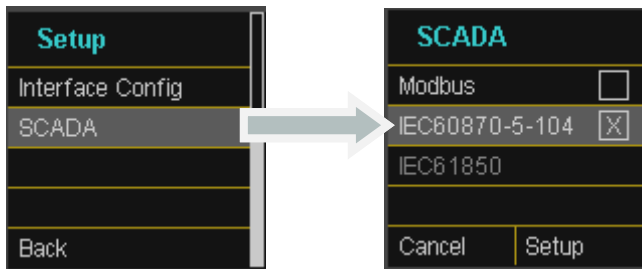
- 40.96kHz sampling (2kHz to 9kHz harmonic measurement)
- IEC 60870-5-104
- IEC 61850

11. SCADA

SCADA settings

In the device settings "SCADA" the following protocols can be selected:

- Modbus – supplied as standard
- IEC60870-104 – chargeable device option
- IEC61850 – chargeable device option



11.1 Modbus

The following data classes and events are available in the PQI-DA smart via Modbus TCP or Modbus RTU:

- 200ms data class (frequency, voltage L1, L2, L3)
- 1 sec data class (all measurement values)
- 10 min data class (all measurement values)
- N x min data class (power measurement values)
- 2h data class Plt long term flicker value
- Status of two binary inputs
- Power Quality and disturbance event counter (display PQI-DA smart)
- Endless counter for disturbance recorder
- Power Quality settings – write Modbus

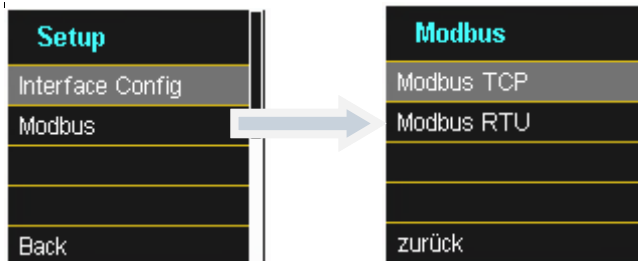
11.1.1 Modbus data list

Please download the extensive Modbus data point list from our website www.a-eberle.de
For Modbus there are over 5000 measurement values available.

We take care of it.

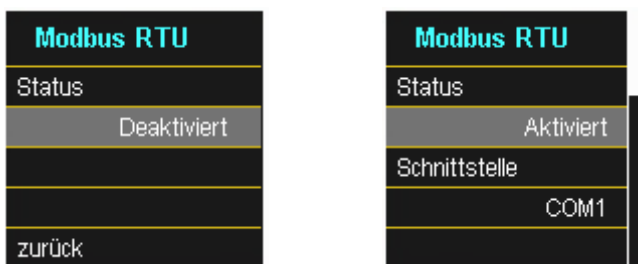
11.1.2 Modbus settings

Settings of the Modbus TCP and Modbus RTU interface can be changed via the device setup.



11.1.3 Modbus RTU

You can enable Modbus RTU. Modbus interface is fixed assigned to COM1



The interface can be changed to Modbus RTU RS232 or RS485.



11.1.4 Modbus TCP

Modbus TCP is deactivated by default and can be enabled at this point. The port number can be set-up.

Modbus TCP	
Status	Aktiviert
Port	502
zurück	

11.1.5 Set-up parameter Modbus with WinPQ

WinPQ Interface (CCCI)	Parametername:	Wert:	Werkseinstellung:
device designation	TCP Server activated	1	1
IP-Settings	RTU Server activated	0	0
► License Manager	TCP Port	502	502
Modbus	TCP endianness	Little-Endian	▼ Little-Endian
NTP	Serial Interface	COM 1	▼ COM 1
► Thresholds / Recording	RTU Slave ID	17	17
► Binary Recording	RTU endianness	Little-Endian	▼ Little-Endian
SCADA-Manager	Baud rate	115200	▼ 115200
Syslog	Parity	None	▼ None
► Timedaemon	Interface mode	RS232	▼ RS232

The Modbus TCP and Modbus RTU interfaces can be modified via the WinPQ smart software. Modbus could be activated via the parameters TCP or RTU Server (0 = OFF / 1 = ON)

► Parameter serial:

Serial Interface	Selection of the COM interface used (COM1 / COM2)
Baud rate	Baud rate of the serial interface for Modbus RTU
Parity	Serial port parity for Modbus RTU
interface mode	Switching between RS232 and RS 485
RTU - byte order	See 11.1.5.1

► Parameter TCP/IP

TCP - Port	Änderung des TCP / IP Ports für Modbus TCP / IP
RTU - byte order	See 11.1.5.1

11.1.5.1 Byte Order

According to the Modbus specification, data are transmitted in the byte order Big-Endian. Regarding a 16-bit Modbus register, the data on the client side is interpreted without conversion. The following example illustrates this with the example value 0x1A2B:

Address	Communication (Big-Endian)	Client-Side (Big-Endian)
High Byte	0x1A	0x1A
Low Byte	0x2B	0x2B

11.1.5.1 Modbus-Register-Order

Interpreting the data transferred via multiple Modbus registers (e.g., 32 bits Unsigned Integer => 2 x 16 Bit Modbus registers), a distinction must be made between the Little-Endian and Big-Endian sequences. In this case, the entire register contents and not the bytes are exchanged. In the default configuration, the software is operated in Little-Endian mode. The following examples illustrate the variants:

▶ **32 Bit-value 0x1A2B3C4D - Modus Little-Endian:**

Address	Example (Big-Endian)	Communication (Little-Endian)	Client-Side (Big-Endian)
Register 0 High Byte	0x1A	0x3C	0x1A
Register 0 Low Byte	0x2B	0x4D	0x2B
Register 1 High Byte	0x3C	0x1A	0x3C
Register 1 Low Byte	0x4D	0x2B	0x4D

▶ **32 Bit-Wert 0x1A2B3C4D - Mode Big-Endian:**

Address	Example (Big-Endian)	Communication (Little-Endian)	Client-Side (Big-Endian)
Register 0 High Byte	0x1A	0x1A	0x1A
Register 0 Low Byte	0x2B	0x2B	0x2B
Register 1 High Byte	0x3C	0x3C	0x3C
Register 1 Low Byte	0x4D	0x4D	0x4D

11.1.5.2 Data Types

The Modbus implementation in the PQI-DA smart currently works with the following data types.

▶ **Unsigned Integer 32 Bit (uint32_t)**

This data type stores unsigned integer values. According to the width of 32 bits, they are stored in two registers.

▶ **Float 32 Bit (float32)**

Float 32 bit floating point numbers are transmitted according to the IEEE 754 standard. These are stored in two registers. The interpretation of the values is described in detail at https://de.wikipedia.org/wiki/IEEE_754

▶ **Float 64 Bit (double)**

Float 64 bit floating-point numbers are also transmitted according to the IEEE 754 standard. The width of 64 bits requires storage in four registers. The interpretation of these values is also described at https://de.wikipedia.org/wiki/IEEE_754.

► **Status (status_t)**

The status value has a width of 32 bits. It is stored accordingly in two registers. The meaning of the individual bits is listed in the following table:

Bit-Number	Meaning
0	RVC, Voltage U1E
1	Dip, Voltage U1E
2	Swell, Voltage U1E
3	Interruption, Voltage U1E
4	Overload, Voltage U1E
5	RVC, Voltage U2E
6	Dip, Voltage U2E
7	Swell, Voltage U2E
8	Interruption, Voltage U2E
9	Overload, Voltage U2E
10	RVC, Voltage U3E
11	Dip, Voltage U3E
12	Swell, Voltage U3E
13	Interruption, Voltage U3E
14	Overload, Voltage U3E
15	RVC, Voltage U12
16	Dip, Voltage U12
17	Swell, Voltage U12
18	Interruption, Voltage U12
19	Overload, Voltage U12
20	RVC, Voltage U23
21	Dip, Voltage U23
22	Swell, Voltage U23
23	Interruption, Voltage U23
24	Overload, Voltage U23
25	RVC, Voltage U31
26	Dip, Voltage U31

27	Swell, Voltage U31
28	Interruption, Voltage U31
29	Overload, Voltage U31
30	State Frequency Synchronization
31	free

► Timestamp (uint32_t)

The 32-bit-wide time stamp is stored in two registers and must be interpreted as an integer value without sign. This is a UNIX time stamp, that is, the number of seconds since 1 January 1970, 00:00 hours (coordinated world time UTC), with no switching counts being counted.

Example: 1478787619 (0x58248223)

Value of time: 11. October 2016 14:20:19 (UTC)

Further information and an implementation example can be found at <https://de.wikipedia.org/wiki/Unixzeit>.

► **Sub seconds (tmFracSec_t)**

The sub second value has a width of 32 bits and is accordingly stored in two registers. The data type is based on the time format, which is defined in IEEE C37.118. The meaning of the individual bits is listed in the following table:

Bit-Number	Meaning
0..23	Sub seconds in 100 ns increments
24..27	time quality indicator
28	Set as the announcement of a switch (1 min before)
29	Set, 24 hours after a switch
30	Add Leap Second (0) or remove (1)
31	Indicator winter time (0) or summer time (1)

11.2 IEC60870-104

Under Device Settings / SCADA protocol can be selected and activated IEC60870-104.

SCADA

Modbus ☐

IEC60870-5-104 ☒

IEC61850

Cancel Setup

IEC60870-5-104

Status

Activated

Client 1 IP address

192.168.1.68

You can setup the device address and client address directly in the display menu.

IEC60870-5-104

Station address

13104

high 51

low 48

Back

11.2.1 IEC60870-104 Data point

Please download the extensive IEC60870-104 data point list from our website www.a-eberle.de

BA-SCADA PQI-DA smart

11.2.2 IEC60870-104 Settings in WinPQ smart

WinPQ Interface (CCCI)	Parametername:	Wert:	Werkseinstellung:
device designation	ASDU-Adress (Decimal):	104	104
IP-Settings	Client IP address 1	192.120.50.10	0
▶ License Manager	Client IP address 2	0.0.0.0	0
Modbus	Client IP address 3	0.0.0.0	0
NTP	Client IP address 4	0.0.0.0	0
▶ Thresholds / Recording	Timeout connection establishment [s]	30	30
▶ Binary Recording	Timeout wait of ACK [s]	15	15
▲ SCADA-Manager	Send acknowledges after [s]	10	10
▲ IEC 60870-5-104	Idle Time-out for test frames [s]	20	20
Protocol Settings	K: Max. APDU without ACK [s]	12	12
▶ Datapoints IEC 104	W: latest ACK after receiving w APDU [s]	8	8
▶ PQ-Event counter			
▶ Binary Inputs			

IEC60870-104 settings can be modified via the WinPQ smart software.

We take care of it.

▶ **ASDU Address:**

The ASDU address must be entered unstructured as a decimal number and has a value range of 0 - 256

Example: Address of the PQI-DA smart is "104" - which would correspond to "0" (high byte) - "104" (low byte) in a structured display.

▶ **Client IP – Addresses:**

It is possible to enter several client IP addresses (up to a maximum of 4) into the set-up of the interface, whereby only one client can actively access the PQI-DA smart. If the setting for all four client IP addresses is set to "0.0.0.0", any IEC60870-5-104 server could theoretically connect to the PQI-DA smart. **However, this is not recommended for safety reasons!**

11.2.2.1 Settings of the data points for IEC60870-5-104

The IEC 60870-5-104 interface has the following data types with the corresponding settings for each individual data point:

- TK 30: Single message with time stamp (UTC)(e.g. Binary inputs of the PQI-DA smart).
- TK 36: Measured value floating point with time stamp (UTC), e.g. Voltage current

Each data point can be activated or deactivated individually to reduce the amount of data. A special feature is that all TK 36 measurement values can be scaled via the scale Factor parameter



Since the set-up of the individual modules is can be individually transferred to the PQI-DA smart, for example, "Limit values / recording" or "IEC60870-5-104", it is recommended to save a template which can be used for all devices in your Grid!

Parametername:	Wert:	Werkseinstellung:
Datapoint active (0:Deactivated / 1: Active)	1	0
IEC Object Type	TK 30: single-point infor..	TK 30: single-point information with..
Information Object Address:	1376513	0

11.3 IEC61850

The IEC61850 interface offers the possibility to connect 6 clients directly to the IEC61850 server (PQI-DA smart). The implementation of the IEC 61850 has been implemented on the basis of edition 2.1 of IEC 61850. The interface has the most important Power Quality parameters according to EN50160.

11.3.1 Display settings IEC61850

Under Device Settings / SCADA protocol IEC61850 can be selected and activated.



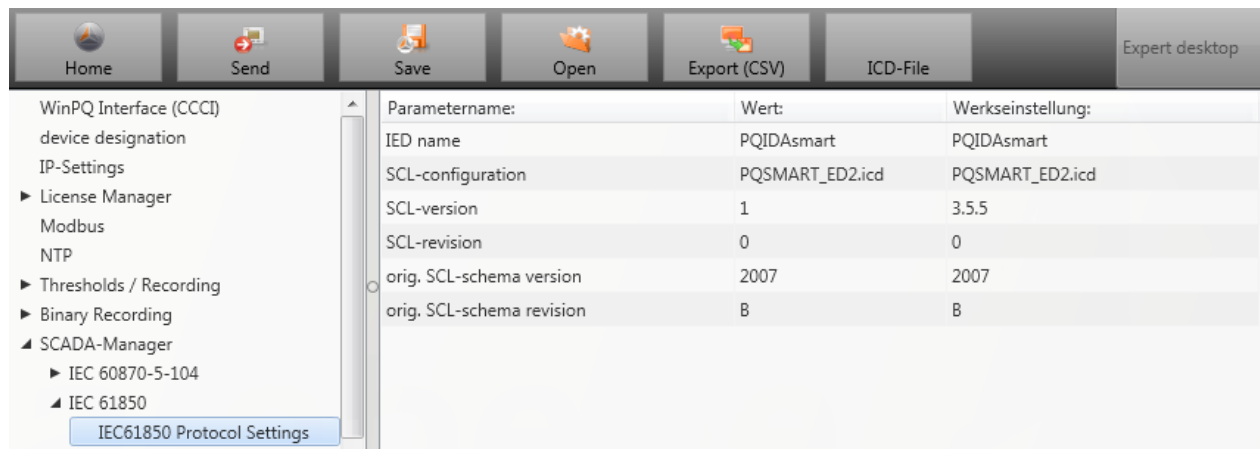
11.3.2 IEC61850 Data Points

Please download the comprehensive description and data point list from our website www.a-eberle.de. The PQI-DA smart is supplied with two standard ICD files in the basic delivery with activated IEC61850 license. The profile (ICD file) matching the voltage level is selected automatically depending on the basic setting used (commissioning assistant).

- Low Voltage
- Medium Voltage / High Voltage

In the low voltage (EN50160 LV - Low Voltage), the harmonics and events conductor / earth are evaluated and correspondingly also made available in the IEC61850 interface. On the other hand, when selecting the EN50160 MV (medium voltage medium voltage) or HV (high voltage), the harmonics are provided as conductor / conductor sizes. The basic settings of the measuring instrument are described in detail in Chapter 5.1 and must be performed once.

11.3.3 IEC61850 settings in WinPQ smart

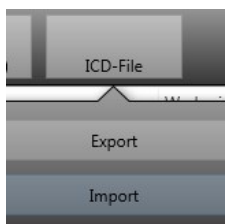


► IED – name:

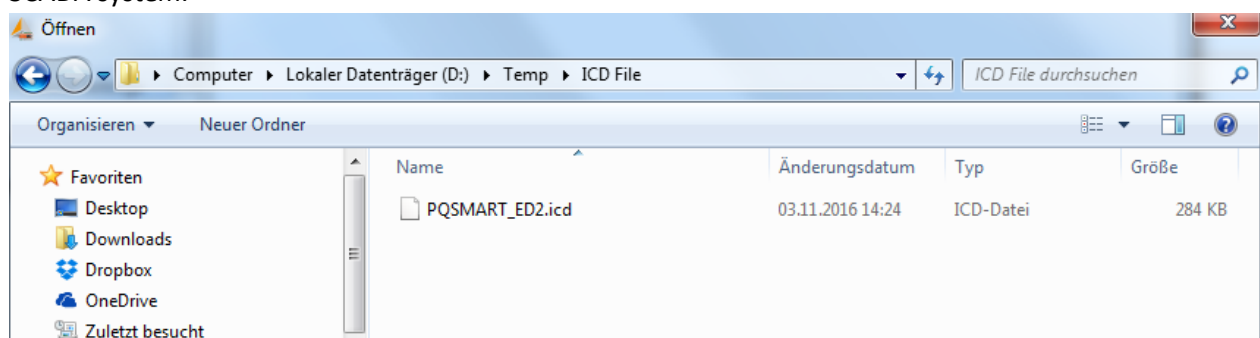
Each participant in an IEC61850 subnet requires a unique identifier. This can be adjusted using the "IED name" parameter. The IED name must meet the following standards (according to IEC61850):

- The IED name can consist of a maximum of eight letters or numbers
- Letter "Umlauts" or blanks are not allowed
- The first character must be a letter

If the IED name has been changed in the interface and sent with "Send" to the PQI-DA smart, the IED name is automatically accepted in the ICD file. The next readout of the set-up also takes the IED name into the ICD file and displays it.



The icon "ICD File" can be used to download the ICD file in the device to be able to import it back into the SCADA system.



12. Intended use

The product is used exclusively for the measurement and evaluation of voltage and current signals in the energy network. If the instrument is used in a manner which is not specified by the manufacturer, the protection supported by the device may be severely impaired.

13. Measurement methods PQI-DA smart

The aggregation of the measurement values is carried out in accordance with the IEC61000-4-30 (2008) standard 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)

In the PQI-DA *smart* setup any interharmonic can be set. This is displayed as the 200 ms maximum value within a measurement interval.

▶ **Flicker levels P_{st} / P_{lt}**

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

The source for implementation recommendations is "EMV Messung von Spannungsschwankungen und Flickern mit dem IEC-Flickermeter" by W.Mombauer, VDE-Verlag, VDE-Schriftenreihe „Normen verständlich“, ISBN 3-8007-2525-8.

Formula for P_{lt} calculation:

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

The flicker meter can be parameterized in the device setup for the following grid configurations:

230V/50Hz; 230V/60Hz and 120V/50Hz; 120V/60Hz

► **THD – PWHD – K factor**

Total harmonic content, calculated using the following formulae in accordance with IEC61000-4-7.

Calculating the THD values of the voltages and signal sampling:

- H2 up to H40 (based on EN50160)
- H2 up to H50 (based on IEC61000-x-x)

● THD voltage:

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

● THD current in %:

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

● THD(A) current in Ampere:

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

● PWHD - Partial Weighted Harmonic Distortion

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

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

● PHC - Partial Odd Harmonic Current

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

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

● K Factor

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

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

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

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

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

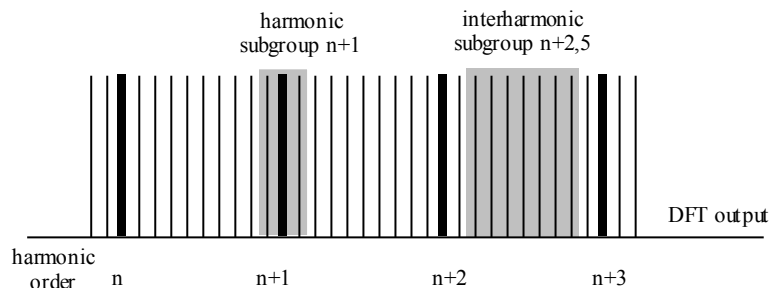
The device shows the K factor for the current. Only the K values that appear at maximum power are of interest. Just as with the THD of the currents in %, the value is not relevant at very low currents.

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

► 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 PQI-DA smart 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:

"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):

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

Current harmonics:

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

► **Reactive power / Reactive energy**

In the setup of the device two variants of the power calculation are adjustable

- Simplified power calculation

Reactive power without unbalanced reactive power calculation:

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

- Reactive power calculation according DIN40110 part 2

Reactive power calculation with unbalanced power:

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

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

- Reactive energy:

"Supply reactive energy" inductive reactive energies +EQ.

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

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

"Consumer reactive energy" capacitive reactive energies -EQ.

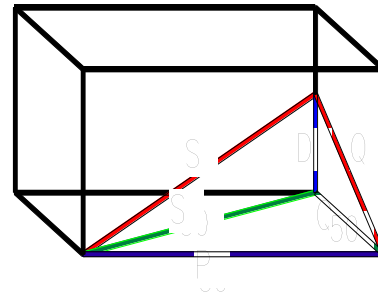
$$Q_S(n) = |Q_{L-10/12}(n)| \quad \text{für : } Q_{L-10/12}(n) < 0$$

► Distortion reactive power - D

The distortion-reactive power - also called harmonic oscillation power - describes a special form of reactive power caused by alternating and three-phase current through nonlinear loads such as rectifiers in power supplies. The harmonics of the current in combination with the mains voltage give reactive power components, which are referred to as distortion-blocking powers.

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

$$D = U \cdot \sqrt{\sum_{v=2}^{\infty} I_v^2}$$



► Power Factor PF

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

The ration is expressed in the following equation:

$$\text{Power Factor PF: } \lambda = P / S$$

► Apparent Power - S

In the setup of the device two variants of the power calculation are adjustable

- Simplified power calculation

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

- 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:

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

4-wire network:

We take care of it.

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

3-wire network, $I_1 + I_2 + I_3 \neq 0$:

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

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

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 synchronization cycle.

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

(200 rms 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):

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

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

● Symmetric Components

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

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

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

We take care of it.

Positive sequence:

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

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

Negative sequence:

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

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

Zero sequence:

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

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

► **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 [%].

► **Frequency analysis 2 kHz to 9 kHz**

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




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

$$Y_b = \sqrt{\sum_{f=b-95 \text{ Hz}}^{b+100 \text{ Hz}} Y_{C_f}^2}$$

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

14. Service

This unit is maintenance-free for customers.

 DANGER	<p>Danger of electric shock!</p> <ul style="list-style-type: none">  Do not open the unit.  Maintenance of the device must only be carried out by A. Eberle.
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For service, contact A-Eberle.

Service address:

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

Use a short, slightly damp, lint-free cloth. Make sure no liquid gets in the housing. Do not use window cleaner, household cleaners, sprays, solvent, cleaners that contain alcohol, ammonia solutions or abrasive cleaning agents. Please use only water for cleaning.

15. Disposal

To dispose of the device and its accessories, please return all components to A. Eberle.

16. Product Warranty

A. Eberle warrants that this product and its accessories shall be free from defects in materials 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 make a claim under this warranty, please contact A.Eberle GmbH & Co KG in Nurnberg, Germany.

We take care of it.

A. Eberle GmbH & Co. KG

Frankenstraße 160
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