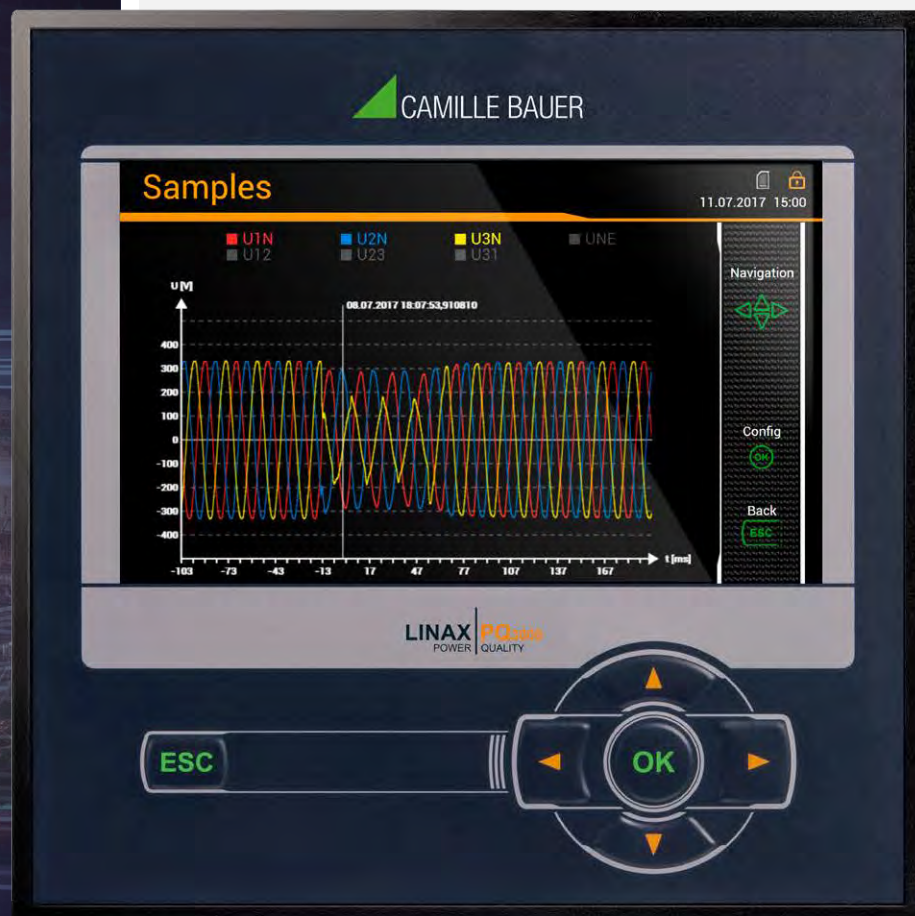


AVOIDING POWER QUALITY PROBLEMS

COMBINED POWER QUALITY
AND ENERGY CONSUMPTION
MONITORING



LINAX PQ-SERIES

LINAX PQ3000 • LINAX PQ5000



Comprehensive instrument for power quality monitoring in electric mains



Traditionally, power quality monitoring is only conducted as a reaction to trouble such as device failure, plant malfunctions, process interruptions or communication breakdowns. However, all these problems cost money and nobody wants to experience the same thing again just to be able to create a corresponding record for analysis.

Therefore, the biggest advantage of continuous power quality monitoring is that users put themselves in a position to proactively build up their knowledge thus increasing system availability.

LINAX PQ3000 / PQ5000 helps to detect trouble before it can do any damage and to provide data for the identification of the root cause in case an event actually occurs.

PQ3000 / PQ5000 is a Class A device according to the IEC 61000-4-30 Ed.3 power quality standard.

It can thus provide reliable and comparable information for regulatory agencies, negotiations with energy suppliers or internal quality control. It also supports a compliance report according to the EN 50160 voltage quality standard.

CLEAR

High resolution, colour TFT display for the pin-sharp indication of measured data

Consistently visible status information (alarms, password protection, data recording, time/date and much more)

Clear Design

INTUITIVE

Language-specific plain text menu navigation

Topical arrangement of measured value information for quick data access

Service area for maintenance and commissioning

MULTIFUNCTIONAL

Certified power quality monitoring according to IEC 61000-4-30 Ed. 3, class A

Acquisition of energy consumption: Meters and load profiles

Plant condition monitoring

FLEXIBLE

Applicable in all network configurations without hardware variance

Freely selectable measured variables for mean values and meters

Freely definable alarm conditions with summary alarm and recording

SCALABLE

Combinable device design (functionality, interfaces, I/Os, auxiliary energy)

May be integrated directly in the SMARTCOLLECT software



AVOIDING POWER QUALITY PROBLEMS - THROUGH CONTINUOUS MONITORING

Disruptions of the energy supply may result in production or equipment outages. Often people do not react until great financial damage has been caused. Yet, many of these incidents could be avoided if the signs were recognised in the continuous monitoring of the situation.

Any form of power quality monitoring provides both a statistical evaluation allowing the comparison with standards (e.g. EN 50160) or supply contracts as well as records of events in the grid (e.g. voltage dips). This facilitates the analysis of causes and effects.

POWER QUALITY EVALUATION	DESCRIPTION	BENEFIT
<p>Statistical evaluation</p> <p>The statistical evaluation section contains seven horizontal bar charts. Each chart has a scale from 90% to 100% with markers at 90%, 92.5%, 95%, 97.5%, and 100%. <ul style="list-style-type: none"> Power frequency: The bar is mostly green, reaching approximately 99.75%. Voltage variations: The bar is green, reaching 100%. Flicker: The bar is mostly red, reaching approximately 92.5%. Voltage imbalance: The bar is green, reaching 100%. Total harmonic distortion voltages: The bar is green, reaching 100%. Harmonic voltages: The bar is green, reaching 100%. Interharmonic voltages: The bar is green, reaching 100%. </p>	<p>All relevant parameters of the supply voltage are monitored, statistically averaged and compared to specified values. This way, one can either prove compliance or call attention to possible problems.</p> <p>Also currents are monitored for magnitude, harmonics content and unbalance. However, since there are no limit values, these results are not included in the statistical evaluation.</p>	<p>Verification of the compliance with standards (e.g. EN 50160) or contracts between energy suppliers and energy consumers.</p> <p>Users may adapt the specified values as they desire.</p> <p>By observing changes in the results, one can detect any deterioration of power quality early on and identify the causes. Introduced improvements can be verified immediately.</p>
<p>Recording of malfunctions</p> <p>The recording of malfunctions section shows a waveform graph. The vertical axis (y-axis) ranges from -350 to 350 with increments of 50. The horizontal axis (x-axis) ranges from -0.04 to 0.08 with increments of 0.02. The graph displays several overlapping waveforms in different colors (blue, red, green), showing significant fluctuations and a notable dip or interruption around the 0.02 mark.</p>	<p>All voltages are monitored for disturbances, such as dip, interruption or swell. These incidents are registered as event. A statistical evaluation is not required because there is no limitation for such events.</p> <p>An event recording comprises the waveshape of all voltages and currents upon occurrence of the event as well as the course of the corresponding RMS half cycle values for the entire duration of the event (max. 3 min.).</p>	<p>The evaluation of malfunction recording lets you identify the cause of the malfunction and - at best - establish a correlation with the events witnessed (such as outage of control systems or equipment). Suitable remedies may then be derived.</p>

POWER QUALITY DATA EXCHANGE


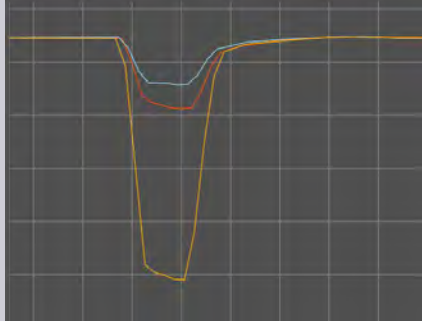
LINAX PQ3000 / PQ5000 stores the acquired power quality data in the standardized Power Quality Data Interchange Format (PQDIF) according to IEEE 1159.3.

Many evaluation programs for the analysis of power quality data support this data format, e.g. SMARTCOLLECT PM20 of Camille Bauer Metrawatt or PQView of Electrotek Concepts.

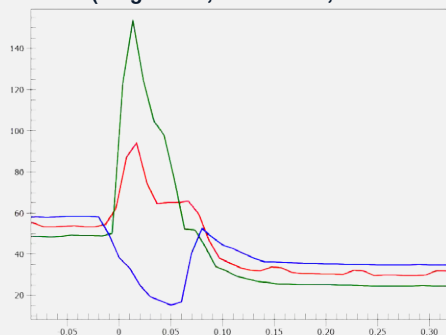
The storage principle provides daily PQDIF files containing either statistical data, histograms or event recordings. The creation is done shortly after midnight for the past day.

All these files may also be generated manually via the service menu of the device at any time for the ongoing day.



MONITORED VOLTAGE PHENOMENON	CAUSES	POSSIBLE CONSEQUENTIAL PROBLEMS
Mains frequency	<ul style="list-style-type: none"> • Loss of power generators • Large load changes 	<ul style="list-style-type: none"> • Instability of the mains power supply
Magnitude of supply voltage 	<ul style="list-style-type: none"> • Changes in grid load 	<ul style="list-style-type: none"> • Disruption of equipment • System shut-down • Loss of data
Flicker and rapid voltage changes (RVC)	<ul style="list-style-type: none"> • Frequent load changes • Start of engines 	<ul style="list-style-type: none"> • Flickering lighting • Impairment of the performance of exposed people
Supply voltage dips and swells 	<ul style="list-style-type: none"> • Large load changes • Short circuit, contact to earth • Thunderstorm • Power supply overload • Feed-in of renewable energies such as wind or photovoltaic energy 	<ul style="list-style-type: none"> • Disruption of equipment such as control or drive systems • Operational interruption • Data loss in control systems and computers
Voltage interruptions	<ul style="list-style-type: none"> • Short circuit • Blown fuses • Component failures • Planned supply interruption 	<ul style="list-style-type: none"> • Production stoppage • Process interruptions • Data loss in control systems and computers
Supply voltage unbalance	<ul style="list-style-type: none"> • Uneven load on phases due to one or two-phase consumers 	<ul style="list-style-type: none"> • Current in the neutral conductor • Overload / overheating of equipment • Increase of harmonics
Voltage harmonics 	<ul style="list-style-type: none"> • Non-linear loads such as frequency converters, rectifiers, switching power supplies, arc furnaces, computers, fluorescent tubes etc. 	<ul style="list-style-type: none"> • Reduction of machine efficiency • Increased energy losses • Overload / overheating of equipment • Current in the neutral conductor
Voltage interharmonics, mains signalling voltage on the supply voltage	<ul style="list-style-type: none"> • Frequency converters and similar control devices 	<ul style="list-style-type: none"> • Flicker • Malfunction of ripple control

Current (magnitude, harmonics, interharmonics, events)



In parallel with the voltages the corresponding current values are recorded in the same manner.

Current course during voltage dips in the mains



MEASURED VALUES

MEASURED VALUE GROUP	APPLICATION
<p>INSTANTANEOUS VALUES</p> <p>U, I, IMS, P, Q, S, PF, LF, QF ...</p> <p>Angle between voltage phasors</p> <p>Min/max of instantaneous values with time stamp</p>	<p>Transparent monitoring of present system state</p> <p>Fault detection, connection check, sense of rotation check</p> <p>Determination of grid variable variance with time reference</p>
<p>EXTENDED REACTIVE POWER ANALYSIS</p> <p>Total reactive power, fundamental frequency, harmonics</p> <p>cosφ, tanφ of fundamental frequency with min values in all quadrants</p>	<p>Reactive power compensation</p> <p>Verification of specified power factor</p>
<p>HARMONICS ANALYSIS (ACCORDING TO IEC 61000-4-7)</p> <p>Total harmonics content THD U/I and TDD I</p> <p>Individual harmonics U/I up to 50th</p>	<p>Evaluation of the thermic load of equipment</p> <p>Analysis of system perturbation and consumer structure</p>
<p>IMBALANCE ANALYSIS</p> <p>Symmetrical components (positive, negative, zero sequence system)</p> <p>Imbalance (derived from symmetrical components)</p> <p>Deviation from U/I mean value</p>	<p>Equipment overload protection</p> <p>Failure/earth fault detection</p>
<p>ENERGY BALANCE ANALYSIS</p> <p>Meters for the demand/supply of active/reactive power, high/low tariff, meters with selectable fundamental variable</p> <p>Power mean values active/reactive power, demand and supply, freely definable mean values (e.g. phase power, voltage, current and much more)</p> <p>Mean value trends</p>	<p>Preparation of (internal) energy billing</p> <p>Determination of energy consumption versus time (load profile) for energy management or energy efficiency verification</p> <p>Energy consumption trend analysis for load management</p>
<p>OPERATING HOURS</p> <p>3 operating hour counters with programmable running condition</p> <p>Operating hours of the device</p>	<p>Monitoring of service and maintenance intervals of equipments</p>
<p>POWER QUALITY</p> <p>Parameters according to IEC 61000-4-30, Class A</p> <p>Chap. 5.1 Power frequency</p> <p>Chap. 5.2 Magnitude of supply voltage</p> <p>Chap. 5.3 Flicker</p> <p>Chap. 5.4 Supply voltage dips / swells</p> <p>Chap. 5.5 Voltage interruptions</p> <p>Chap. 5.7 Supply voltage unbalance</p> <p>Chap. 5.8 Voltage harmonics</p> <p>Chap. 5.9 Voltage interharmonics</p> <p>Chap. 5.10 Mains signalling voltage on the supply voltage</p> <p>Chap. 5.11 Rapid voltage changes (RVC)</p> <p>Chap. 5.12 Underdeviation and overdeviation</p> <p>Chap. 5.13 Current (magnitude, harmonics, interharmonics)</p>	<ul style="list-style-type: none"> • Device type PQI-A F12 (IEC 62586-1) • Independent and accredited laboratory: Federal Institute of Metrology METAS. Tested at both 230V / 50Hz and 120V / 60Hz. • Thanks to the certification according to IEC 62586-2 (standard for verifying compliance with IEC 61000-4-30) the device can serve as a reliable and comparable source of information for regulatory agencies, for negotiations with energy suppliers or for internal quality control. • Generation of EN 50160 compliance reports by means of the SMARTCOLLECT PM20 Software. • Improving the quality and reliability of the mains supply • Identifying causes of disruptions



DATA RECORDING

Apart from the automatic recording of power quality statistics, the high-performance data logger provides the following recording options:

• PERIODIC DATA

This feature allows to record the time course of measured variables. Averaged measurements or meter contents serve as base and are saved in regular intervals. Typical applications are the acquisition of load profiles (intervals of 10s to 1h) or the determination of the energy consumption from the difference of meter readings. For both categories pre-defined courses are available, based on the system power values, and as well courses for freely selectable basic quantities.

For further processing periodic data can be exported in Excel format for a definable time range.

• EVENTS

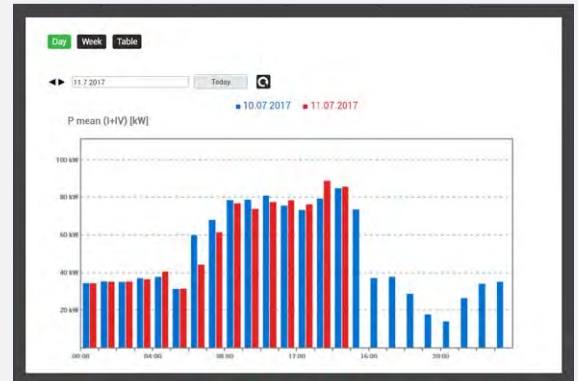
Here the occurrence of events or alarms is recorded in form of a list with time information. A distinction is made between self-defined events (such as ON/OFF of limit states or monitoring functions) which the user can classify as alarm change or event and the so-called operator list in which system events such as changes of the device configuration, reset operations, powering the device and many more are held.

• PQ EVENTS

The occurrence of monitored PQ events is available in list form with the most important information about the events. Each entry can be directly selected to switch to the graphical event presentation. There the courses of the RMS half-cycle values and the waveshape during the disturbance are available, divided into presentations of all voltages, all currents and mixed displays.

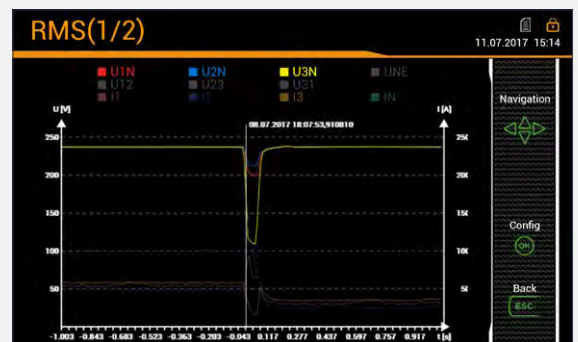
Event lists, PQ event recordings, mean value courses (load profiles) and meter readings may be displayed directly at the device or via the device webpage.

Further analysis of the PQ events is possible by means of the SMARTCOLLECT PM20 software.



PQ events

#	time	Trigger channel	Event type	Event value	Event value	Duration[s]
1	08.07.2017, 18:12:00.728	U2, U3	Rapid voltage change	ΔU_{max} : 17.15 V	ΔU_{osc} : 0.68 V	0.323
2	08.07.2017, 18:31:35.519	U2	Rapid voltage change	ΔU_{max} : 7.18 V	ΔU_{osc} : 1.07 V	0.010
3	08.07.2017, 18:07:55.915	U2	Voltage dip	Residual voltage: 174.25 V	Depth: 55.71 V	0.070
4	08.07.2017, 18:07:53.910	U1, U3	Voltage dip	Residual voltage: 109.29 V	Depth: 720.61 V	0.090
5	30.06.2017, 04:29:31.512	U1	Rapid voltage change	ΔU_{max} : 17.17 V	ΔU_{osc} : 0.88 V	0.060
6	28.06.2017, 09:09:25.776	U1	Rapid voltage change	ΔU_{max} : 18.56 V	ΔU_{osc} : 0.24 V	0.090
7	27.06.2017, 14:30:05.106	U1	Surge/shot			0.020
8	25.06.2017, 06:31:55.826	U1	Rapid voltage change	ΔU_{max} : 16.46 V	ΔU_{osc} : 0.12 V	0.050
9	23.06.2017, 07:50:15.169	U1	Surge/shot			0.020
10	21.06.2017, 14:34:08.515	U2, U3	Rapid voltage change	ΔU_{max} : 13.07 V	ΔU_{osc} : 0.28 V	0.090
11	19.06.2017, 02:14:27.478	U1, U2	Rapid voltage change	ΔU_{max} : 24.53 V	ΔU_{osc} : 0.27 V	0.110



MONITORING AND ALARMING

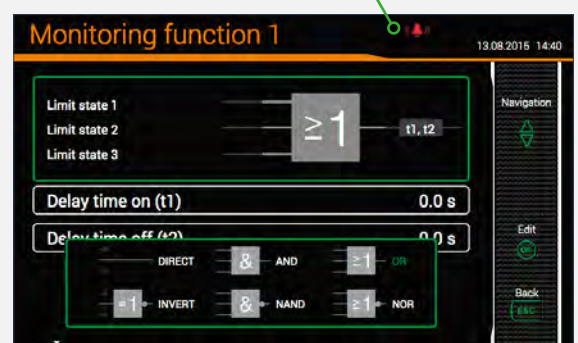
The instrument supports the on-site analysis of acquired measured data in order to initiate directly immediate or delayed actions. This facilitates the protection of equipment and also monitoring of service intervals.

The following items are available:

- 12 limit values
- 8 monitoring functions with 3 inputs each
- 1 collective alarm as a combination of all monitoring functions
- 3 operating hourcounters with definable running conditions

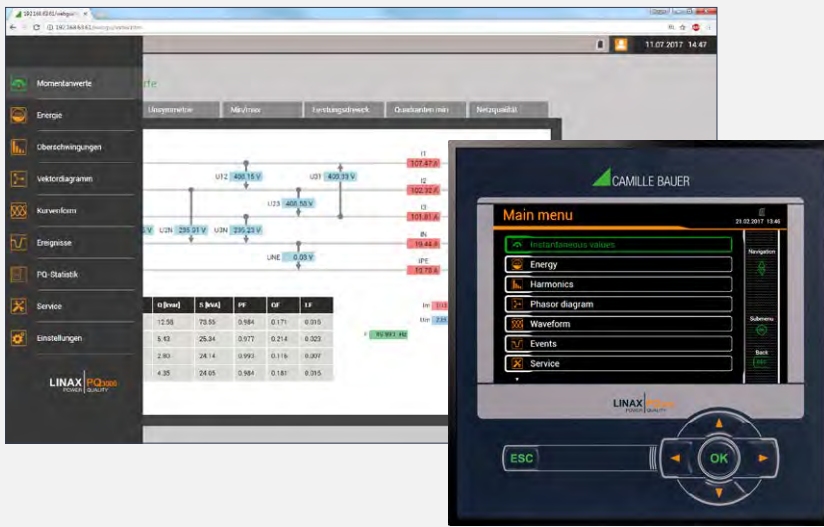
The available digital outputs may be used directly for the transmission of limit values and monitoring functions as well as the resettable summary alarm.

A text may be allocated to each monitoring function and can be used for both the alarm and event list in the data logger.





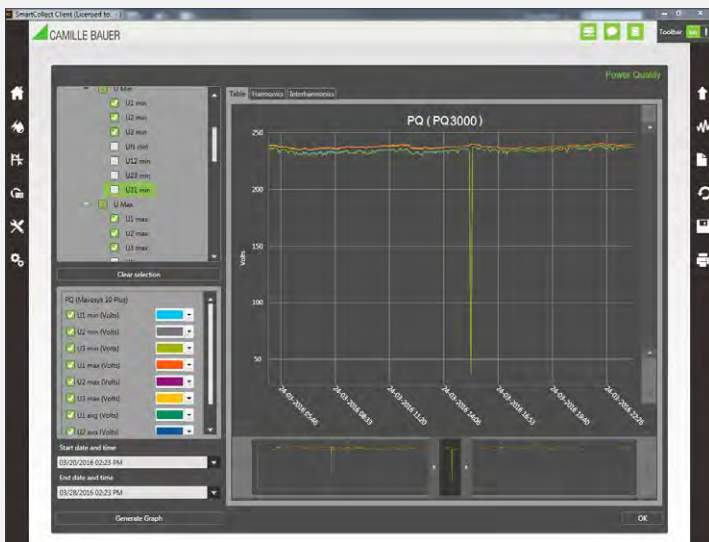
OPERATION AND ANALYSIS



OPERATION

The local operation at the device itself and the access via web interface are structured identically. One can access the available measured data, parametrise the instrument or use the service functions via the language-specific, topically structured menu navigation. The status bar at the top right, uniformly shows the statuses of alarm monitoring, the password protection system, the data recording and the UPS as well as time and date.

Apart from the details of the PQ statistics, all data are available via both the local GUI and the WEB interface of the device.



ANALYSIS

Using the SMARTCOLLECT PM20 software, PQDIF files generated in the device can be imported, either automated or manually, stored in the data base and analyzed.

With this software all statistical power quality data can be evaluated and a detailed analysis of the PQ events can be made.

The PM20 also provides the possibility to periodically retrieve state or energy consumption data from the device and store them in the data base.

COMPLIANCE REPORT

The SMARTCOLLECT PM20 software can be used to create a user-definable compliance report including all criteria of the EN 50160.

ITIC CURVE

This graphic shows all voltage events detected by the device with magnitude and duration of the event. All events outside of the range between the upper and lower curve may disrupt or damage connected equipment.



TECHNICAL DATA

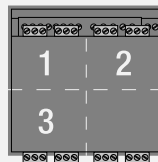
INPUTS		BASIC UNCERTAINTY ACCORDING IEC/EN 60688	
NOMINAL CURRENT	1 ... 5 A (max. 7.5 A)	Voltage, current	±0.1 %
Maximum	7.5 A	Power	±0.2 %
Overload capacity	10 A permanent 100 A, 5x1 s, interval 300 s	Power factor	±0.1°
		Frequency	±0.01 Hz
		Imbalance U, I	±0.5 %
NOMINAL VOLTAGE	57.7 ... 400 V _{LN} , 100 ... 693 V _{LL}	Harmonic	±0.5 %
Maximum	PQ3000: 480 V _{LN} , 832 V _{LL} (sinusoidal)	THD U, I	±0.5 %
	PQ5000: 520 V _{LN} , 900 V _{LL} (sinusoidal)	Active energy	Class 0.5S (IEC/EN 62 053-22)
Overload capacity	PQ3000: 480 V _{LN} , 832 V _{LL} permanent	Reactive energy	Class 0.5S (IEC/EN 62 053-24)
	PQ5000: 520 V _{LN} , 900 V _{LL} permanent		
	800 V _{LN} , 1386 V _{LL} , 10x1 s, interval 10 s		
Nominal frequency	42 ... <u>50</u> ... 58 Hz, 50.5 ... <u>60</u> ... 69.5 Hz	INTERFACES	
		ETHERNET	Standard
Sampling rate	18 kHz	Connection	RJ45 socket
		Physics	Ethernet 100Base TX
POWER SUPPLY VARIANTS		Mode	10/100 MBit/s, full/half duplex, autonegotiation
Nominal voltage	100...230 V AC/DC (PQ5000)	Protocols	Modbus/TCP, http, NTP (time synchronisation)
	110...230 V AC, 130...230 V DC (PQ3000)		
	110...200 V AC, 110...200 V DC (PQ3000)	MODBUS/RTU	Standard (PQ5000), optional (PQ3000)
	24...48 V DC (PQ3000 / PQ5000)	Physics	RS-485, max. 1200 m (4000 ft)
Consumption	≤ 20 VA	Baud rate	9.6 to 115.2 kBaud
		Number of participants	≤ 32
UNINTERRUPTIBLE POWER SUPPLY (UPS)		TIME REFERENCE	Internal clock
Type (3.7 V)	VARTA Easy Pack EZPackL, UL listed MH16707	Clock accuracy	± 2 minutes/month (15 to 30°C)
		Synchronisation	via NTP server
TYPES OF CONNECTION		Power reserve	> 10 years
• Single phase or split phase (2-phase system)			
• 3 or 4-wire balanced load		ENVIRONMENTAL CONDITIONS, GENERAL INFORMATION	
• 3-wire balanced load [2U, 1]		Operating temperature	without UPS: -10 up to <u>15 up to 30</u> up to + 55 °C
• 3-wire unbalanced load, Aron connection			with UPS: 0 up to <u>15 up to 30</u> up to + 35 °C
• 3 or 4-wire unbalanced load		Storage temperature	-25 to +70 °C
• 4-wire unbalanced load, Open-Y		Temperature influence	0.5 x basic uncertainty per 10 K
		Long-term drift	0.5 x basic uncertainty per year
		Others	Application group II (IEC/EN 60 688)
I/O-INTERFACE		Relative air humidity	<95 % without condensation
ANALOG OUTPUTS	(optional)	Operating altitude	≤2000 m above NN
Linearisation	Linear, kinked	Only to be used in buildings!	
Range	± 20 mA (24 mA max.), bipolar		
Accuracy	± 0.2 % von 20 mA	MECHANICAL PROPERTIES	
Burden	≤ 500 Ω (max. 10 V/20 mA)	Housing material	Polycarbonate (Makrolon)
Burden influence	≤ 0.2 %	Flammability class	V-0 according UL94, self-extinguishing, not dripping, free of halogen
Residual ripple	≤ 0.4 %	Weight	800 g (PQ3000), 600g (PQ5000)
RELAYS	(optional)		
Contacts	Changeover contact	SAFETY	
Load capacity	250 V AC, 2 A, 500 VA; 30 V DC, 2 A, 60 W	Current inputs are galvanically isolated from each other.	
DIGITAL INPUTS PASSIVE		Protection class	II (protective insulation, voltage inputs via protective impedance)
Nominal voltage	12/24 V DC (30 V max.)	Pollution degree	2
DIGITAL INPUTS ACTIVE (optional)		Protection	IP54 (front), IP30 (housing), IP20 (terminals)
Open circuit voltage	≤ 15 V	Measurement category	CATIII
DIGITAL OUTPUTS	2, Standard		
Nominal voltage	12/24 V DC (30 V max.)		



ORDER CODE

ORDER CODE PQ3000-	
1. BASIC DEVICE FOR PANEL-MOUNTING	
With TFT display	1
2. INPUT FREQUENCY RANGE	
Current transformer inputs, 42 ... 50/60 ... 69,5 Hz	1
3. POWER SUPPLY	
Nominal voltage 110 ... 230 V AC, 130 ... 230 V DC	1
Nominal voltage 24 ... 48 V DC	2
Nominal voltage 110 ... 200 V AC, 110 ... 200 V DC	3
4. BUS CONNECTION	
Ethernet (Modbus/TCP protocol+web server)	1
Ethernet (Modbus/TCP+web server)+RS485 (Modbus/RTU)	2
5. EXTENSION 1	
Without	0
2 relays	1
2 analog outputs, bipolar (± 20 mA)	2
4 analog outputs, bipolar (± 20 mA)	3
4 digital inputs passive	4
4 digital inputs active	5
6. EXTENSION 2	
Without	0
2 relays	1
2 analog outputs, bipolar (± 20 mA)	2
4 analog outputs, bipolar (± 20 mA)	3
4 digital inputs passive	4
4 digital inputs active	5
7. EXTENSION 3	
Without	0
2 relays	1
2 analog outputs bipolar (± 20 mA)	2
4 analog outputs bipolar (± 20 mA)	3
4 digital inputs passive	4
4 digital inputs active	5
Uninterruptible power supply	8
8. TEST CERTIFICATE	
Without	0
Test certificate in German	D
Test certificate in English	E

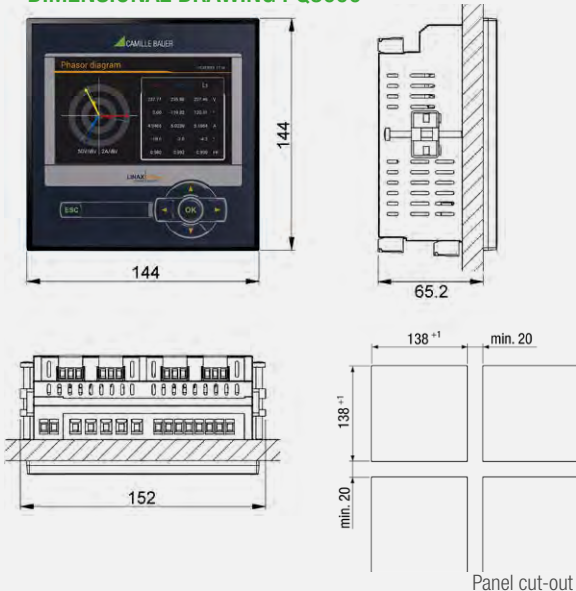
ORDER CODE PQ5000-	
1. BASIC DEVICE FOR TOP-HAT RAIL MOUNTING	
Without display	0
With TFT display	1
2. INPUT FREQUENCY RANGE	
Current transformer inputs, 42 ... 50/60 ... 69,5 Hz	1
3. POWER SUPPLY	
Nominal voltage 100 ... 230 V AC/DC	1
Nominal voltage 24 ... 48 V DC	2
4. BUS CONNECTION	
Ethernet (Modbus/TCP+web server) + RS485 (Modbus/RTU)	1
5. UNINTERRUPTIBLE POWER SUPPLY	
Without	0
With uninterruptible power supply	1
6. EXTENSION 1	
Without	0
2 relays	1
2 analog outputs, bipolar (± 20 mA)	2
4 analog outputs, bipolar (± 20 mA)	3
4 digital inputs passive	4
4 digital inputs active	5
7. EXTENSION 2	
Without	0
2 relays	1
2 analog outputs, bipolar (± 20 mA)	2
4 analog outputs, bipolar (± 20 mA)	3
4 digital inputs passive	4
4 digital inputs active	5
8. TEST CERTIFICATE	
Without	0
Test certificate in German	D
Test certificate in English	E



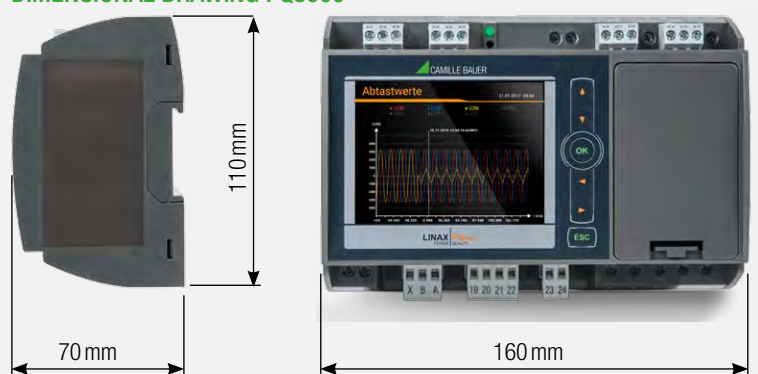
EXTENSIONS PQ3000

Maximum one I/O extension with analog outputs may be provided per device.

DIMENSIONAL DRAWING PQ3000



DIMENSIONAL DRAWING PQ5000





SMARTCOLLECT



SMARTCOLLECT is a data management software which can acquire measured data in an easy manner and store the same in an open MS SQL database. This software offers basic functionalities for data analysis and for easy energy monitoring as well as the easy preparation and disposal of reports.

Providing a mature graphic user interface, the SMARTCOLLECT software is clearly structured and easily operated.

SMARTCOLLECT is modularly designed and permits supplementing modules or functions at any time.

CUSTOMER BENEFITS

- Easy data communication via Modbus RTU / TCP, ECL and SmartControl-Direct
- Connection also via OPC
- Devices of Camille Bauer and Gossen Metrawatt are already predefined and selectable in the software
- Open for the devices of all manufacturers
- Data is stored in an open MS SQL database (depending on the scope Express or Server)
- Modular cost / performance model – basic version may be extended at any time

MODULAR DESIGN

COMPONENTS

The SMARTCOLLECT data management software consists of the following components:

SMARTCOLLECT CLIENT

MORE CLIENTS POSSIBLE



SQL DATABASE



SMARTCOLLECT SERVER



SMARTCOLLECT CLIENT

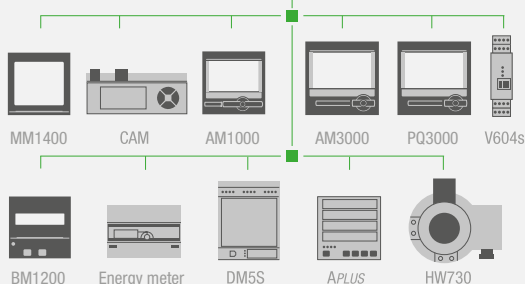
- Graphic visualisation of queried data
- Export via Excel file
- User interface to define the data sources to be read out as well as error and warning messages via email.

SMARTCOLLECT DATABASE

- MS SQL database (depending on the scope Express or Server)
- Contains the collected data
- Open and unencrypted

SMARTCOLLECT SERVER



- Collects and configures data from active sources and channels and writes the same directly into the central database.



SMARTCOLLECT software components may be installed on an individual system or on several servers or computers.



GMC INSTRUMENTS

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 **CAMILLE BAUER**

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