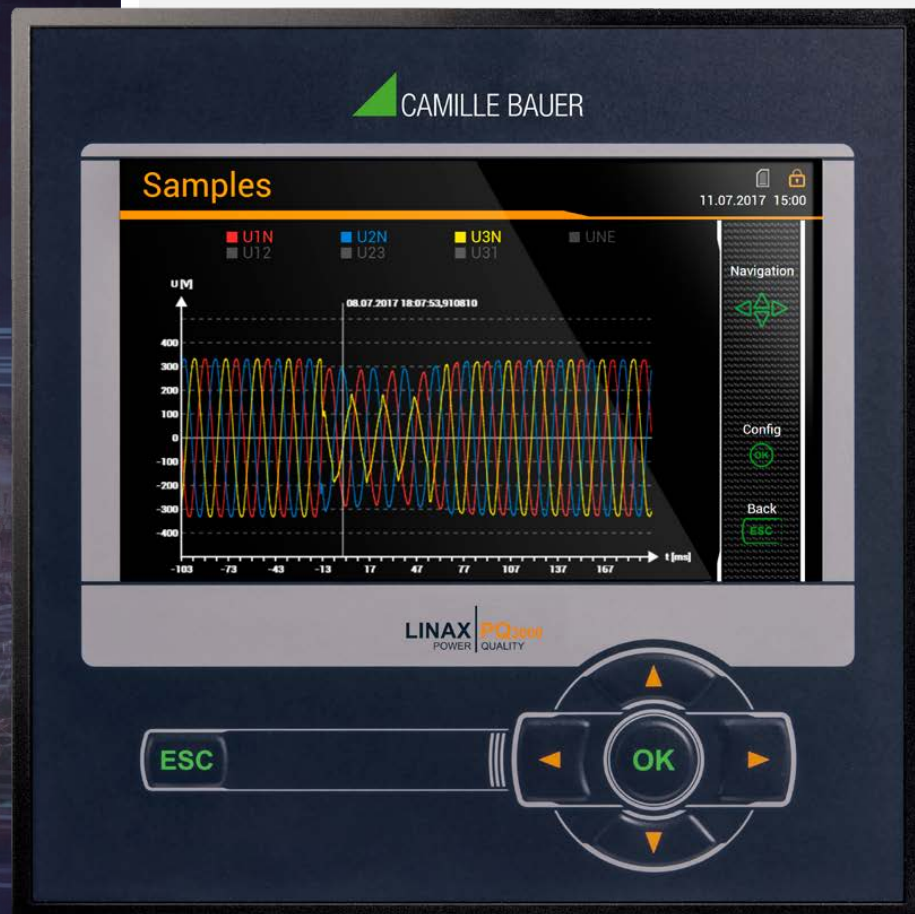# AVOIDING POWER QUALITY PROBLEMS

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

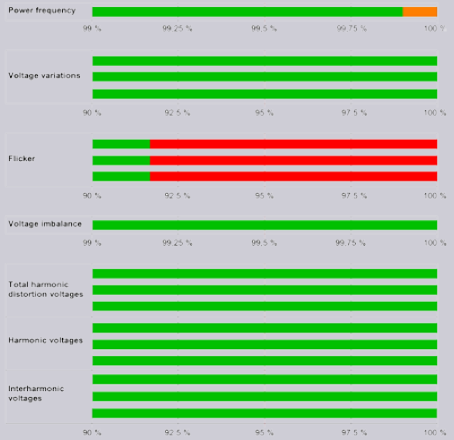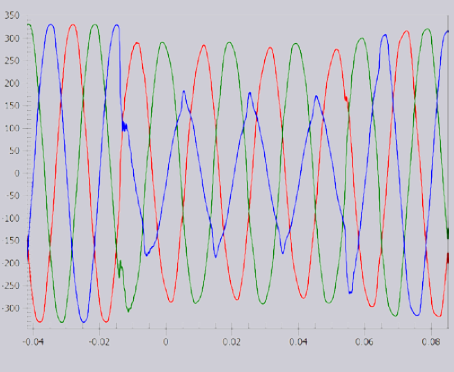Combinable device design (functionality, interfaces, I/Os, auxiliary energy)

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
Statistical evaluation	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. 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.	Verification of the compliance with standards (e.g. EN 50160) or contracts between energy suppliers and energy consumers. Users may adapt the specified values as they desire. 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.
Recording of malfunctions	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. 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.).	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.

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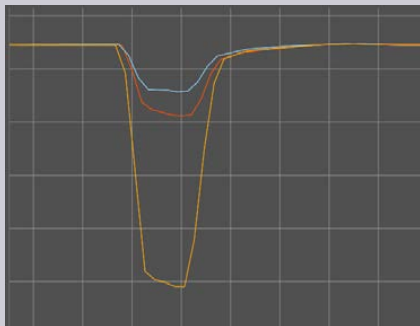
LINAX PQ3000 / PQ5000 stores the acquired power quality data in the standardized Power Quality Data Interchange Format (PQDIF) according to IEEE 1159.3.

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	• Loss of power generators • Large load changes	• Instability of the mains power supply
Magnitude of supply voltage 	• Changes in grid load	• Disruption of equipment • System shut-down • Loss of data
Flicker and rapid voltage changes (RVC)	• Frequent load changes • Start of engines	• Flickering lighting • Impairment of the performance of exposed people
Supply voltage dips and swells 	• Large load changes • Short circuit, contact to earth • Thunderstorm • Power supply overload • Feed-in of renewable energies such as wind or photovoltaic energy	• Disruption of equipment such as control or drive systems • Operational interruption • Data loss in control systems and computers
Voltage interruptions	• Short circuit • Blown fuses • Component failures • Planned supply interruption	• Production stoppage • Process interruptions • Data loss in control systems and computers
Supply voltage unbalance	• Uneven load on phases due to one or two-phase consumers	• Current in the neutral conductor • Overload / overheating of equipment • Increase of harmonics
Voltage harmonics 	• Non-linear loads such as frequency converters, rectifiers, switching power supplies, arc furnaces, computers, fluorescent tubes etc.	• 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	• Frequency converters and similar control devices	• Flicker • Malfunction of ripple control

Current (magnitude, harmonics, interharmonics, events)
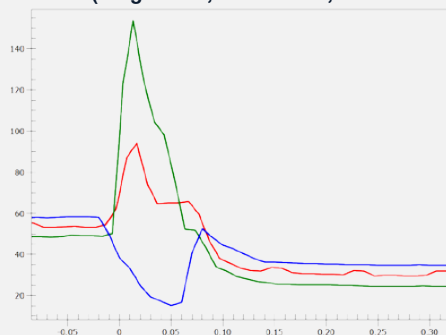
In parallel with the voltages the corresponding current values are recorded in the same manner.

Current course during voltage dips in the mains

MEASURED VALUES

MEASURED VALUE GROUP	APPLICATION
INSTANTANEOUS VALUES U, I, IMS, P, Q, S, PF, LF, QF … Angle between voltage phasors Min/max of instantaneous values with time stamp	 Transparent monitoring of present system state Fault detection, connection check, sense of rotation check Determination of grid variable variance with time reference
EXTENDED REACTIVE POWER ANALYSIS Total reactive power, fundamental frequency, harmonics $\cos\phi$, $\tan\phi$ of fundamental frequency with min values in all quadrants	 Reactive power compensation Verification of specified power factor
HARMONICS ANALYSIS (ACCORDING TO IEC 61000-4-7) Total harmonics content THD U/I and TDD I Individual harmonics U/I up to 50th	 Evaluation of the thermic load of equipment Analysis of system perturbation and consumer structure
IMBALANCE ANALYSIS Symmetrical components (positive, negative, zero sequence system) Imbalance (derived from symmetrical components) Deviation from U/I mean value	 Equipment overload protection Failure/earth fault detection
ENERGY BALANCE ANALYSIS Meters for the demand/supply of active/reactive power, high/low tariff, meters with selectable fundamental variable Power mean values active/reactive power, demand and supply, freely definable mean values (e.g. phase power, voltage, current and much more) Mean value trends	 Preparation of (internal) energy billing Determination of energy consumption versus time (load profile) for energy management or energy efficiency verification Energy consumption trend analysis for load management
OPERATING HOURS 3 operating hour counters with programmable running condition Operating hours of the device	 Monitoring of service and maintenance intervals of equipments
POWER QUALITY Parameters according to IEC 61000-4-30, Class A Chap. 5.1 Power frequency Chap. 5.2 Magnitude of supply voltage Chap. 5.3 Flicker Chap. 5.4 Supply voltage dips / swells Chap. 5.5 Voltage interruptions Chap. 5.7 Supply voltage unbalance Chap. 5.8 Voltage harmonics Chap. 5.9 Voltage interharmonics Chap. 5.10 Mains signalling voltage on the supply voltage Chap. 5.11 Rapid voltage changes (RVC) Chap. 5.12 Underdeviation and overdeviation Chap. 5.13 Current (magnitude, harmonics, interharmonics)	 • Device type PQI-A FI2 (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.
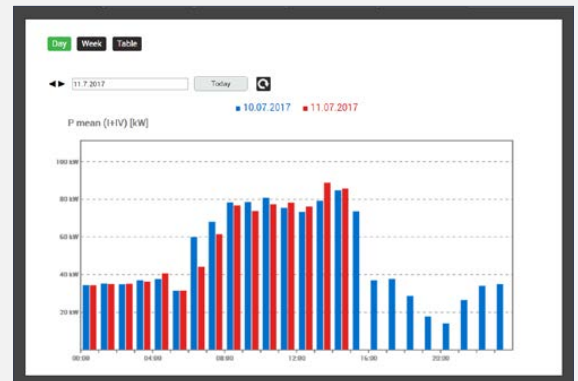
• EVENTS

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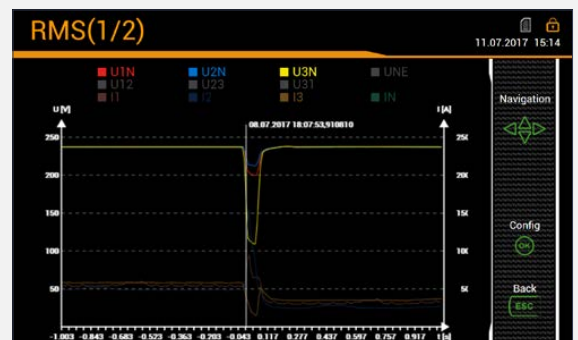
Event lists, PQ event recordings, mean value courses (load profiles) and meter readings may be displayed directly at the device or via the device webpage.

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

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.
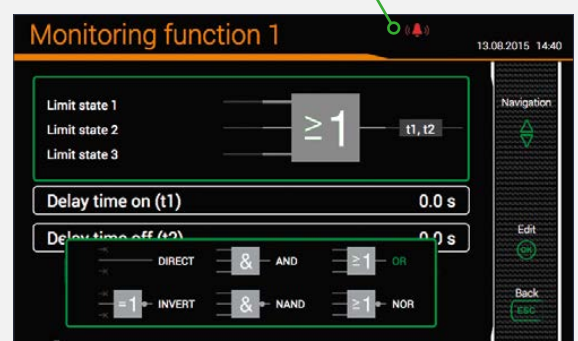
OPERATION AND ANALYSIS

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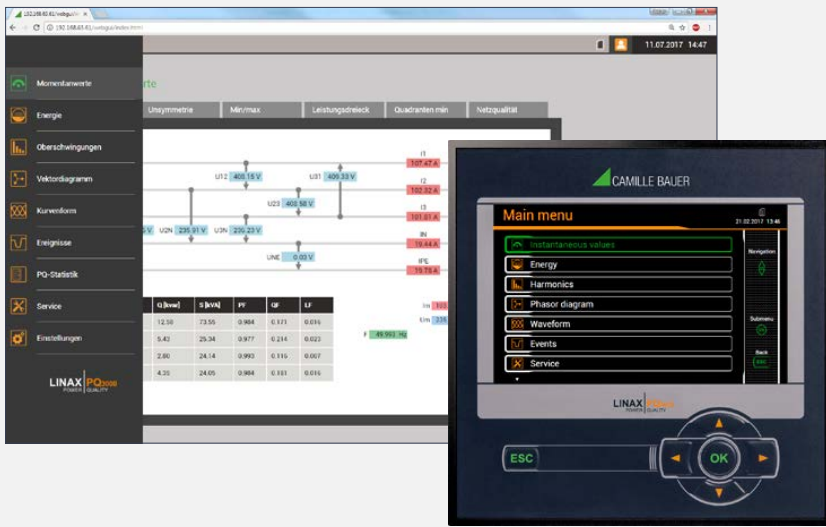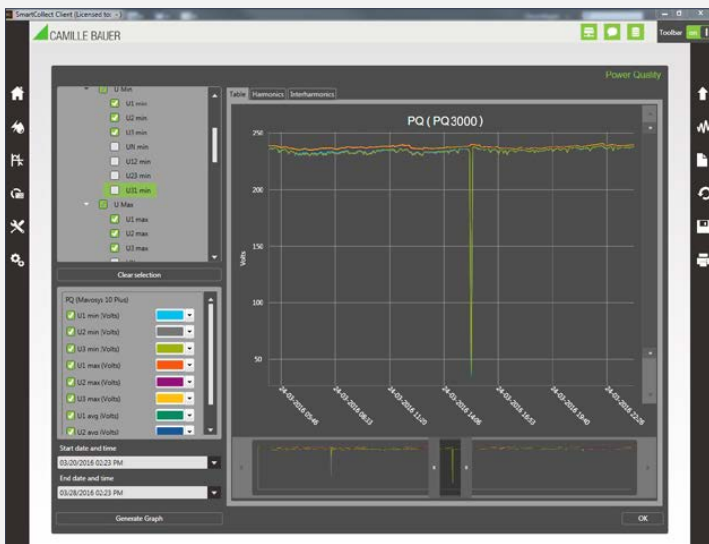
Apart from the details of the PQ statistics, all data are available via both the local GUI and the WEB interface of the device.

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

NOMINAL CURRENT   1 … 5 A (max. 7.5 A)
Maximum   7.5 A
Overload capacity   10 A permanent
100 A, 5x1 s, interval 300 s

NOMINAL VOLTAGE   57.7 … 400 V_{LN}, 100 … 693 V_{LL}
Maximum   PQ3000: 480 V_{LN}, 832 V_{LL} (sinusoidal)
PQ5000: 520 V_{LN}, 900 V_{LL} (sinusoidal)
Overload capacity   PQ3000: 480 V_{LN}, 832 V_{LL} permanent
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

Sampling rate   18 kHz

POWER SUPPLY VARIANTS

Nominal voltage   100...230 V AC/DC (PQ5000)
110…230 V AC, 130…230 V DC (PQ3000)
110…200 V AC, 110…200 V DC (PQ3000)
24…48 V DC (PQ3000 / PQ5000)
Consumption   ≤ 20 VA

UNINTERRUPTIBLE POWER SUPPLY (UPS)

Type (3.7 V)   VARTA Easy Pack EZPAckL, UL listed MH16707

TYPES OF CONNECTION

- Single phase or split phase (2-phase system)
- 3 or 4-wire balanced load
- 3-wire balanced load [2U, 1I]
- 3-wire unbalanced load, Aron connection
- 3 or 4-wire unbalanced load
- 4-wire unbalanced load, Open-Y

I/O-INTERFACE

ANALOG OUTPUTS   (optional)
Linearisation   Linear, kinked
Range   ± 20 mA (24 mA max.), bipolar
Accuracy   ± 0.2 % von 20 mA
Burden   ≤ 500 Ω (max. 10 V/20 mA)
Burden influence   ≤ 0.2 %
Residual ripple   ≤ 0.4 %

RELAYS   (optional)
Contacts   Changeover contact
Load capacity   250 V AC, 2 A, 500 VA; 30 V DC, 2 A, 60 W

DIGITAL INPUTS PASSIVE
Nominal voltage   12/24 V DC (30 V max.)

DIGITAL INPUTS ACTIVE (optional)
Open circuit voltage   ≤ 15 V

DIGITAL OUTPUTS   2, Standard
Nominal voltage   12/24 V DC (30 V max.)

BASIC UNCERTAINTY ACCORDING IEC/EN 60688

Voltage, current   ±0.1°
Power   ±0.2 %
Power factor   ±0.1°
Frequency   ±0.01 Hz
Imbalance U, I   ±0.5 %
Harmonic   ±0.5 %
THD U, I   ±0.5 %
Active energy   Class 0.5S   (IEC/EN 62 053-22)
Reactive energy   Class 0.5S   (IEC/EN 62 053-24)

INTERFACES

ETHERNET   Standard
Connection   RJ45 socket
Physics   Ethernet 100Base TX
Mode   10/100 MBit/s, full/half duplex, autonegotiation
Protocols   Modbus/TCP, http, NTP (time synchronisation)

MODBUS/RTU   Standard (PQ5000), optional (PQ3000)
Physics   RS-485, max. 1200 m (4000 ft)
Baud rate   9.6 to 115.2 kBaud
Number of participants   ≤ 32

TIME REFERENCE   Internal clock
Clock accuracy   ± 2 minutes/month (15 to 30°C)
Synchronisation   via NTP server
Power reserve   > 10 years

ENVIRONMENTAL CONDITIONS, GENERAL INFORMATION

Operating temperature   without UPS: −10 up to <u>15 up to 30</u> up to + 55 °C
with UPS: 0 up to <u>15 up to 30</u> up to + 35 °C
Storage temperature   −25 to +70 °C
Temperature influence   0.5 x basic uncertainty per 10 K
Long-term drift   0.5 x basic uncertainty per year
Others   Aplication group II (IEC/EN 60 688)
Relative air humidity   <95 % without condensation
Operating altitude   ≤2000 m above NN
Only to be used in buildings!

MECHANICAL PROPERTIES

Housing material   Polycarbonate (Makrolon)
Flammability class   V-0 according UL94, self-extinguishing,
not dripping, free of halogen
Weight   800 g (PQ3000), 600g (PQ5000)

SAFETY

Current inputs are galvanically isolated from each other.
Protection class   II (protective insulation, voltage inputs via
protective impedance)
Pollution degree   2
Protection   IP54 (front), IP30 (housing), IP20 (terminals)
Measurement category   CAT III

ORDER CODE

ORDER CODE PQ3000-	
1. BASIC DEVICE FOR PANEL-MOUNTING	
With TFT display	1
2. INPUT | FREQUENCY RANGE	
Current transformer inputs, 42 … <u>50/60</u> … 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 … <u>50/60</u> … 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
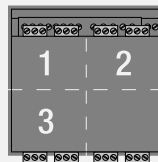
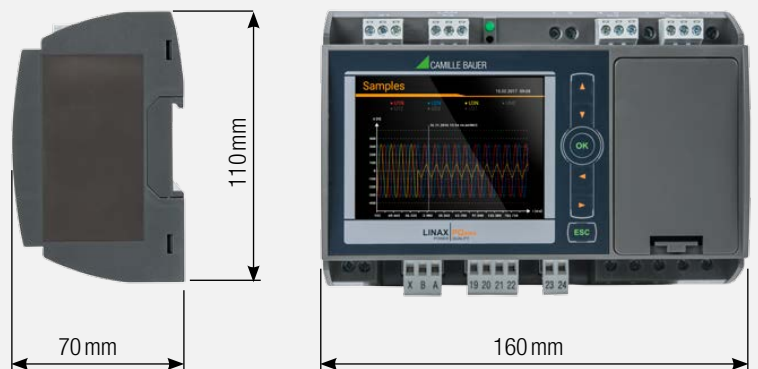**EXTENSIONS PQ3000**

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

DIMENSIONAL DRAWING PQ3000

Panel cut-out
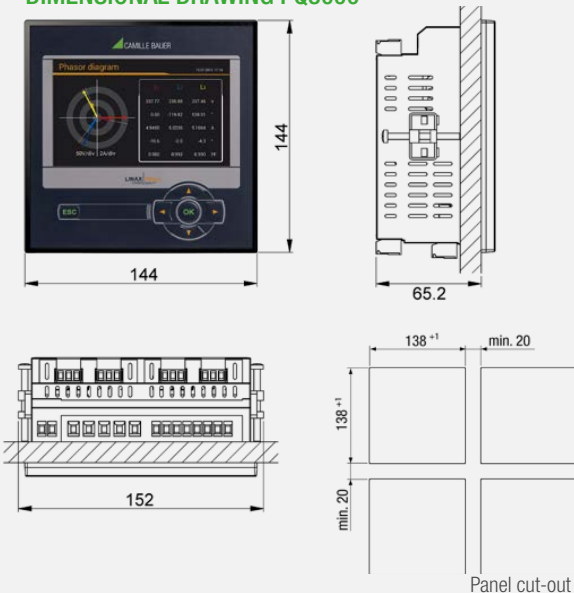
DIMENSIONAL DRAWING PQ5000

SMARTCOLLECT

SMARTCOLLECT is a data management software which can acquire measured data in an easy manner and store the same in an open 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 SQL database
- 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
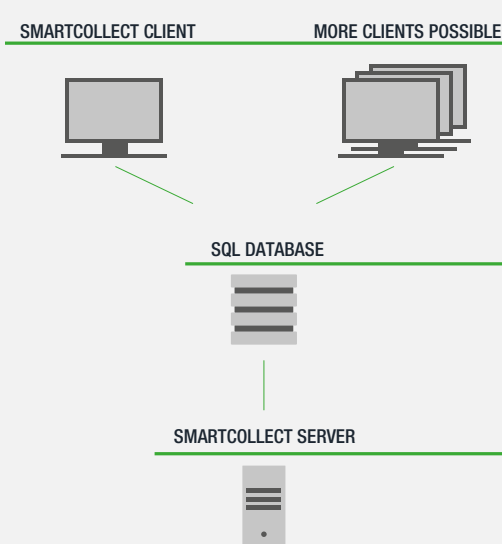
SMARTCOLLECT CLIENT

- 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.

SQL DATABASE

SMARTCOLLECT DATABASE

- SQL database
- Contains the collected data
- Open and unencrypted

SMARTCOLLECT SERVER

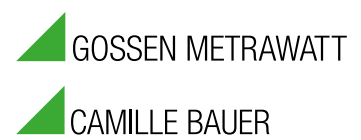### SMARTCOLLECT SERVER

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

| MM1400 | CAM | AM1000 | AM3000 | PQ3000 | V604s |

| BM1200 | Energy meter | DM5S | APLUS | HW730 |

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

GMC INSTRUMENTS

GOSSEN METRAWATT

CAMILLE BAUER