

CERTIFIED POWER SYSTEM ANALYSIS

MOBILE POWER QUALITY AND
ENERGY CONSUMPTION
MONITORING



LINAX PQ5000 MOBILE

IEC 61000-4-30 ED. 3.0 CLASS A  **METAS**



MOBILE POWER QUALITY AND ENERGY CONSUMPTION MONITORING



Power grids ensure that consumers can be supplied with electrical energy. The requirements for the quantity, availability and quality of the energy vary according to the consumer and are therefore contractually agreed between the consumer and the supplier. This way a trouble-free operation of customer installations should be ensured without unduly influencing other energy consumers on the same network.

By means of the mobile measurement solution **LINAX PQ5000-Mobile** the operational aspects of the energy supply can be verified.

LINAX PQ5000-MOBILE constitutes a metrologically independently certified Class A device according to IEC 61000-4-30 Ed. 3. It is based on standardised interfaces, generates conformity reports directly via the device website and excels with a comprehensive cyber security concept.



MONITORING OPTIONS AND BENEFITS

Statistical evaluation (Quality of supply)

PQ conformity assessment according to EN50160, IEC61000-2-2/2-4/2-12, GB/T, IEEE519, own limits

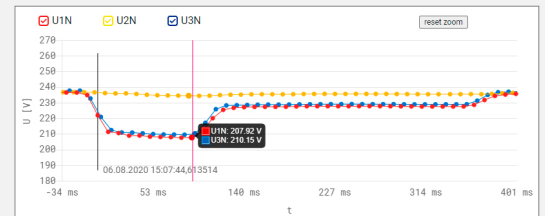
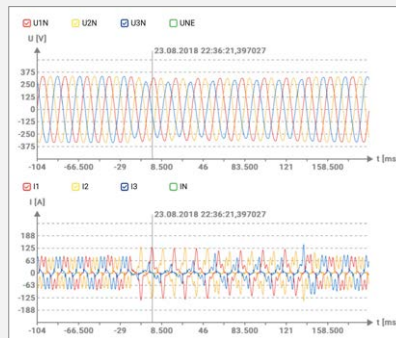
- Ensure trouble-free operations of the loads
- Delivery contract complied?



Recording of malfunctions (Availability of supply)

Detection of voltage events (dip, interruption, swell, rapid voltage changes, ripple control)

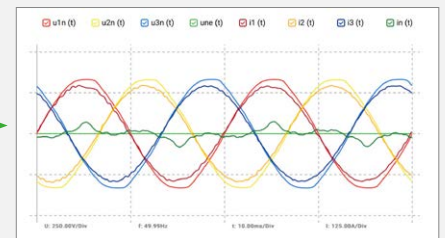
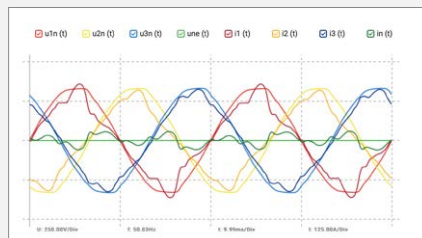
- Find the sources of disturbances and correct them
- Safe thanks to UPS



Evaluation of changes or improvement measures

Evaluate changes to the installation by comparing the results

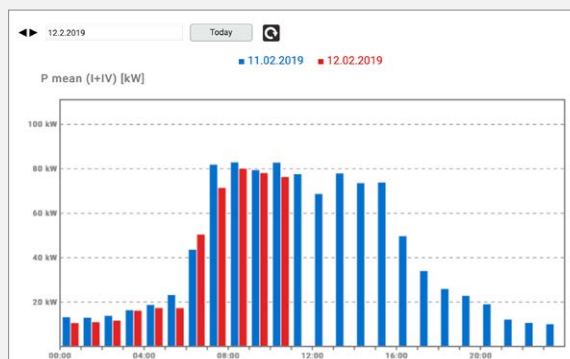
- Desired improvement?
- Side effects?



Energy flow - analysis

Acquisition of load profiles, short-term load peaks and metering values

- Save costs due to energy management



time	P (I+IV) [kW]	min P (I+IV) [kW]	max P (I+IV) [kW]
12.02.2019 00:00:00,000	9.01	5.34	16.64
12.02.2019 00:10:00,000	9.45	5.29	30.01
12.02.2019 00:20:00,000	12.39	5.96	30.73
12.02.2019 00:30:00,000	13.38	5.85	17.93
12.02.2019 00:40:00,000	9.99	5.81	32.74
12.02.2019 00:50:00,000	9.17	5.82	18.2
12.02.2019 01:00:00,000	10.28	5.78	31.24
12.02.2019 01:10:00,000	9.62	5.77	29.61
12.02.2019 01:20:00,000	6.74	5.65	15.95
12.02.2019 01:30:00,000	10.44	5.74	28.92
12.02.2019 01:40:00,000	14.05	5.8	32.1
12.02.2019 01:50:00,000	12.45	5.7	17.48
12.02.2019 02:00:00,000	16.94	12.18	37.18
12.02.2019 02:10:00,000	8.27	5.79	31.4
12.02.2019 02:20:00,000	11.24	7.16	17.69
12.02.2019 02:30:00,000	11.16	7.21	30.85
12.02.2019 02:40:00,000	10.71	7.4	32.33
12.02.2019 02:50:00,000	9.51	5.76	29.22



CONNECTION OPTIONS AND VARIANTS

SECURE COMMUNICATION

- Password
- https
- Client whitelist
- VPN upon request



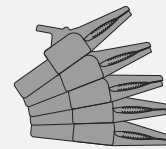
UPS
5x3min.



Lockable and waterproof



U_{1,2,3,N,PE}



Direct measurement via fused voltage taps

I_{1,2,3,N}

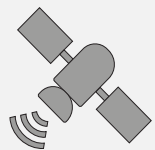
Rogowski coils or current clamps



WLAN

Commissioning, configuration, data analysis

GPS



Time synchronisation

LAN



ACCESSORIES



fused voltage taps (always included)



Current clamps



Rogowski coils



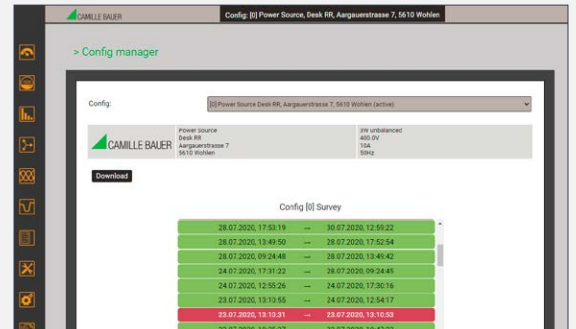
GPS receiver for time synchronisation



MEASURING CAMPAIGNS

The device supports measuring campaigns, i.e. measurements of a limited duration at the same locations, to observe changes in power quality at these points. Up to 20 configurations can be stored in the device for this purpose and are respectively activated prior to the implementation of a measurement.

- Configuration manager for up to 20 measuring points
- Any number of campaigns per measuring point
- Delimitation of individual campaigns by recording start / stop
- Data analysis with measured data of the active configuration



OPERATION AND EVALUATION

No software is required for the parameterization of the device or the evaluation of the measurement results. The **WEB interface** of the device provides all required functions. These can be used via mobile phone, tablet or laptop via the LAN or WLAN interface.



Status bar

- Complete device parameterization
- Measurement data visualization
- Bar with the current status of UPS, memory usage, recording, WLAN, LAN, alarm, RBAC
- Service functions
- PQ Easy-Report for compliance reports
- Complete device parameterization
- Data export in CSV format (load profiles, waveform, event lists)

COMMISSIONING AND SERVICE

The device provides versatile tools for safe and easy commissioning and maintenance. Some are listed below:

Vector diagram / phase sequence indicator

With these displays, you can easily verify whether the measuring inputs have been correctly connected. Non-conforming rotational directions of voltages and currents, reverse polarity current connections and interchanged current or voltage connections are immediately recognised.

Communication tests

These functions allow the network settings to be checked so that the communication structure functions reliably during operation.

Operating instructions

The operating instructions are stored in the device as a PDF file and can be opened in the browser or downloaded to a PC at any time. The instructions are respectively updated in any firmware update thus always documenting the implemented state.

Deletion of data

Recordings of measured data may be selectively deleted or reset. Every one of these activities can be protected via the Role Based Access Control system (RBAC) and is logged with the user identification upon execution.



Vector diagram to control connections

IPv4: Ping	192.168.56.5	Testen	
IPv6: Ping	fd2d:bb44:97f1:3976::5:1	Testen	
DNS	192.168.56.155	pool.ntp.org	Testen
NTP	pool.ntp.org	Testen	
SFTP Server	tenserv.camillebauer.intra	22	
	data		
	sftpuser	***	Testen

Communication tests: Control of network structure



DATA EXPORT

Automated

If the device is connected to the to the grid structure on site, measured value information cannot only be directly retrieved but also forwarded in files to an SFTP server using a data export scheduler. These files may be saved locally on the device. Supported are:

- CSV files: To make average progressions, load profiles or meter readings available
- PQDIF for event-controlled forwarding / saving of PQ event recordings
- PQDIF for periodic forwarding / saving of all PQ data (trends and events)

Tasks may be prepared for the generation of files which will then run automatically and are linked to the actions of save locally and / or send to SFTP server. Data locally saved in the device may be transferred to a computer via the device website or the REST interface.

The Secure File Transfer Protocol (SFTP) facilitates the encoded transfer of files. It may also be used for the transmission of measured value information via secured network structures, e.g. via Smart Meter Gateways.

Manually

If a network structure is not available, it may make sense to prepare files manually via the device website and to save them on the PC:

- CSV files: For event lists, average progressions, curve shape representation, PQ event recordings
- PQDIF files of all PQ data of a selectable day or the current day

Task for daily saving / forwarding of average data

File formats

- **CSV:** Comma Separated Value
- **PQDIF:** Power Quality Data Interchange Format according to IEEE 1159.3

CERTIFIED POWER QUALITY MONITORING

- Independent certification by Federal Institute of Metrology METAS
- Device type PQI-A FI2 acc. IEC 62586-1
- Proven at 230V / 50 Hz and 120V / 60Hz
- Flicker meter class F1
- Flagging concept: Multiphase approach in accordance with IEC 61000-4-30
- Active energy class 0.2S

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.





CYBER SECURITY

Critical infrastructures - and this undoubtedly includes the supply of electrical energy - are increasingly the target of cyber attacks. There is not only the attempt of stealing data by unauthorised access or eavesdropping of communication but also the limitation or even interruption of energy supplies by manipulating data or data traffic.

A comprehensive safety concept on plant level comprising each grid component is required to repel such attacks. The safety mechanisms integrated into LINAX PQ5000-MOBILE support such concepts, thus contributing to safe energy supplies.

SAFETY MECHANISMS

- **Role-Based Access Control (RBAC)**
Only those access rights are granted to users which they need for their activities, no plain-text transmission of login information, increase of the latency period in case of repeated login attempts, software access only via access keys
- **Encoded data transmission via HTTPS**
using root certificates (CBM or client certificate)
- **Audit log**
Logging of all activities relevant to safety. Transfer option to central grid monitoring server by Syslog.
- **Client white list**
Limitation of computers authorised to access on basis of the IPv4/IPv6 address
- **Digitally signed firmware files for safe updates**
Safe updating due to the prevention of manipulated firmware

	admin	localgui	anonymous	Operator1	Operator2	Operator3	[AP]AccessKey
Local account (no weblogin)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Instantaneous values	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Energy	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Harmonics	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Phasor diagram	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Waveform	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Events	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
PQ statistic	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Service	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Reset values	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Reset/Update device	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Audit Log	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Use IO simulation	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Settings	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Basic device settings	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Measurement	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Communication	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Security system	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

RBAC access rights of different users

Time	PID	Priority	IP address	User name	Message
10.09.2020, 14:18:44	cb-gui	Notice	192.168.57.18:61983	admin	User logged in successfully
09.09.2020, 17:40:25	cb-gui	Info	192.168.57.50:62204	admin	User has been logged out due to inactivity
09.09.2020, 17:19:51	cb-pq5000mob	Notice	localhost	system	Logger started on configuration 16
09.09.2020, 17:19:45	cb-pq5000mob	Notice	localhost	system	Logger stopped on configuration 16
09.09.2020, 17:19:39	cb-gui	Notice	192.168.57.50:61450	admin	User logged in successfully
09.09.2020, 17:18:21	runsv	Critical	localhost	system	Process cb-gui[2072] has unexpectedly stopped running
09.09.2020, 08:46:26	cb-gui	Info	192.168.57.50:63721	admin	User has been logged out due to inactivity
09.09.2020, 08:26:27	cb-gui	Notice	192.168.57.50:63483	admin	User reviewed latest security event log (allow)
09.09.2020, 08:26:23	cb-gui	Notice	192.168.57.50:63457	admin	User logged in successfully
08.09.2020, 12:10:13	cb-gui	Info	system	admin	Login session timeout

Audit log with filter option



PQ DATA ANALYSIS

All of the PQ data acquired by the device can be directly visualised and analysed via the device website. Additional software is not required.

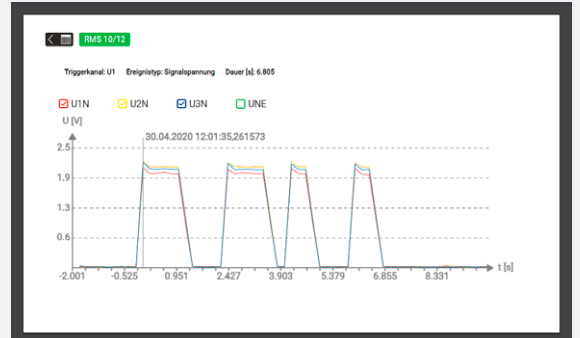
PQ events

- PQ event list with trigger source, event type, event duration and characteristic event values
- Direct display of event details by selecting an entry in the event list: Measured value progressions of RMS 1/2 values and curve shapes for all currents and voltages with time zoom and value display
- Recording of ripple control sequences to verify the ripple control level and pulse sequences at the receiver

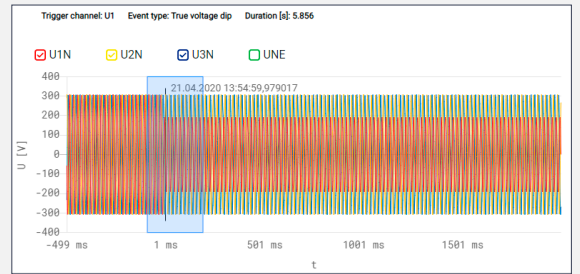
PQ statistics

- Overview of conformity with a selectable standard. Depending on the standard selected, more or less criteria are taken into consideration.
- Daily progressions of all acquired PQ trend values, display with/without limit values and fluctuation range
- PQ easy report: Preparation of a conformity report (pdf format) of a selectable extent

Using the data export options and due to standardised formats like PQDIF and COMTRADE, the analysis of PQ data can also be delegated to software solutions like SMARTCOLLECT PM20 or PQView4. Freely available viewers, e.g. PQDiffactor of Electrotek Concepts, may be used for analysis purposes.



Ripple control sequence acquired as an event



Curve shape recording of an event with zoom option

PQ EASY-REPORT

- Preparation of reports via the device web interface
- Tamper-resistant PDF format
- Selectable report duration (multiples of 10 minutes - recommended for minimum 7 days)
- Selectable report scope (overview, statistic details, event overview)
- Direct compliance assessment of standards EN 50160, IEC 61000-2-2 / 2-4 / 2-12, GB/T, IEEE 519 or customer specific limits
- Customer specific logo in the report





ALTERNATIVE DESIGNS

LINAX PQ3000 / PQ5000

The devices are designed for permanent hat rail mounting or panel assembly. They provide a wide functionality which may be extended by optional components. The process environment can be connected via digital I/Os, analog outputs or relays using communication interfaces.

Design

- All basic functions of LINAX PQ5000-MOBILE
- Modular function extensions by digital inputs, analog outputs, relay outputs, GPS time synchronisation, fault current or temperature monitoring, communication via Profinet or IEC 61850
- Current measurement directly or via current transformer
- Different power supply variants
- Optional uninterruptible power supply (UPS): bridging 5 times for 3 minutes in case of supply interruption
- High-resolution TFT display (option in PQ5000)

Communication

- Commissioning, configuration, monitoring and data analysis via web interface
- Extensive cyber security protection



PQ5000 for hat-rail mounting



PQ3000 for panel mounting

LINAX PQ5000 RACK

The device in 19" rack design according to EN 60297 is based on LINAX PQ5000 and can also monitor several measuring points.

Design

- All functions of LINAX PQ5000-MOBILE
- Current inputs for 5A or 3V
- 12 digital inputs to acquire grid states or trigger event recording and 1 digital output to issue different system conditions (option)
- 4 analog outputs or Modbus/RTU interface (option)
- Design for one or two measuring points (double bus bar, transformer)
- Power supply 100 to 230 VAC/DC
- Integrated Uninterrupted Power Supply (UPS): Bridging 5 times for 3 minutes in case of an interruption of supply
- Input for GPS time synchronisation

Communication

- Commissioning, configuration, monitoring and data analysis via LAN (front and rear): Modbus/TCP, NTP, http, https, IPv4, IPv6
- 3G/4G router (option)
- IEC 61850 (option)
- Extensive cyber security protection



Device design for one measuring point



Device design for two measuring points



TECHNICAL DATA

INPUTS		INTERFACES	
NOMINAL VOLTAGE	57.7 ... 400 V _{LN} , 100 ... 693 V _{LL}	ETHERNET	Standard
Maximum	520 V _{LN} , 900 V _{LL} (sinusoidal)	Physics	Ethernet 100 Base TX; RJ45 socket
Overload capacity	520 V _{LN} , 900 V _{LL} permanent	Mode	10/100 MBit/s, full/half duplex, autonegotiation
	800 V _{LN} , 1386 V _{LL} , 10x1 s, interval 10 s	Protocols	Modbus/TCP, http, https, IPv4, IPv6, NTP
Nominal frequency	42 ... <u>50</u> ... 58 Hz, 50.5 ... <u>60</u> ... 69.5 Hz	WLAN ACCESS POINT	Standard
CURRENT SENSORS	depends on the device variant	Connection	via USB socket
Rogowski coils	Measurement up to 3800 A	TIME REFERENCE	Internal clock
Current clamps	10 A, 100 A or 1000 A	Clock accuracy	± 2 minutes/month (15 to 30 °C)
Sampling rate	18 kHz	Synchronisation	via NTP server or GPS
Data memory internal	16 GB	ENVIRONMENTAL CONDITIONS, GENERAL INFORMATION	
POWER SUPPLY		Operating temperature	-10 up to <u>15 up to 30</u> up to + 55 °C
Power adapter	100 ... 230 V AC/DC	Storage temperature	-25 to +70 °C
Consumption	≤ 20 VA	Temperature influence	0.5 x basic uncertainty per 10 K
UNINTERRUPTIBLE POWER SUPPLY		Long-term drift	0.5 x basic uncertainty per year
Capacity	1150 mAh, 4.5 Wh	Others	Application group II (IEC/EN 60 688)
Operating duration	5 times 3 minutes	Relative air humidity	<95 % without condensation
Life time	3 up to 5 Years	Operating altitude	≤2000 m above NN
TYPES OF CONNECTION		SAFETY	
• Single phase		Protection class	II (protective insulation, voltage inputs via protective impedance)
• Split phase (2-phase system)		Pollution degree	2
• 3 or 4-wire balanced load		Protection	IP65 (closed housing)
• 3-wire unbalanced load, Aron connection		Measurement category	600 V CAT III / 300 V CAT IV
• 3 or 4-wire unbalanced load		REMOTE ACCESS	
BASIC UNCERTAINTY		Remote access and remote maintenance using a secure channel via cellular network or internet on request.	
(additional uncertainty due to current sensors not considered)			
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 0.2S (IEC/EN 62 053-22)		
Reactive energy	Class 0.5S (IEC/EN 62 053-24)		



ORDER CODE

Mobile power quality analyzer according to IEC 61000-4-30 class A, with 5 measuring cables including dolphin clamps, standard power adapter, carrying case and device manual.

ORDER CODE PQ5000MOB-		ACCESSORIES	ARTICLE NO
1. CURRENT MEASUREMENT		Current clamp 10 A / 1 V for PQ5000MOB-2	182 775
Connectors for 4 current clamps (/1V)	2	Current clamp 100 A / 1 V for PQ5000MOB-2	182 808
Connector for 4 phase Rogowski probe	3	Current clamp 1000 A / 1 V for PQ5000MOB-2	182 783
2. CURRENT SENSORS		4 phase Rogowski current probe 2000 A for PQ5000MOB-3	181 727
None	0	Standard power adapter 100 ... 230 V AC/DC, with world plug set (included)	183 038 182 965
4 current clamps 10 A / 1 V	1	Dolphin clamp red (included)	182 709
4 current clamps 100 A / 1 V	2	Dolphin clamp blue (included)	182 717
4 current clamps 1000 A / 1 V	3	Dolphin clamp yellow/green (included)	182 725
4 phase Rogowski current probe 2000 A	A	GPS receiver 16x-LVS for PQ5000MOB, configured	181 131
3. GPS TIME SYNCHRONIZATION		RJ45 cable, IP protected, length 5m	183 004
Without	0	WLAN access point dongle (included)	181 701
With GPS time synchronization, with GPS receiver	7	Carrying case (included)	182 634
With GPS time synchronization, without GPS receiver	9		
4. DEVICE HANDBOOK			
German	D		
English	E		
5. UNINTERRUPTIBLE POWER SUPPLY ¹⁾			
With uninterruptible power supply	1		

¹⁾ Standard from date of manufacture 20/15

DIMENSIONS AND CONNECTIONS



Dimensions W x H x D: 25 cm x 12 cm x 23 cm *



Device variant with current measurement via 4-phase Rogowski probe

Device variant with current measurement via current clamps xA/1V

* The external dimensions are changing at the version with gateway (secure channel).



GMC INSTRUMENTS

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 CAMILLE BAUER

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