

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.

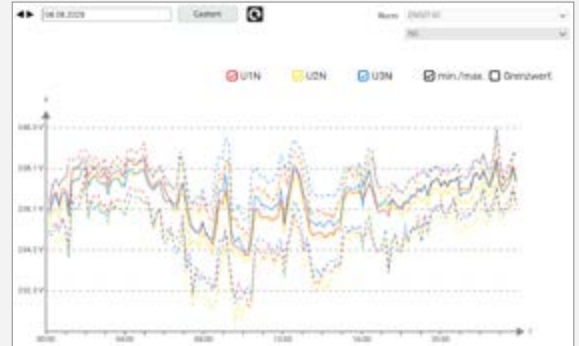
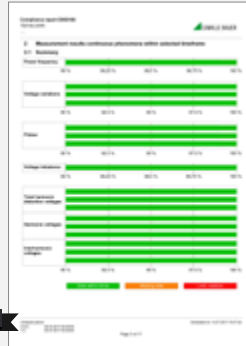


MONITORING OPTIONS AND BENEFITS

Statistical evaluation (Quality of supply)

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

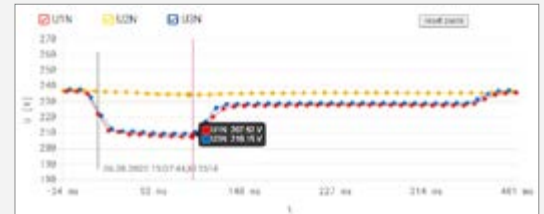
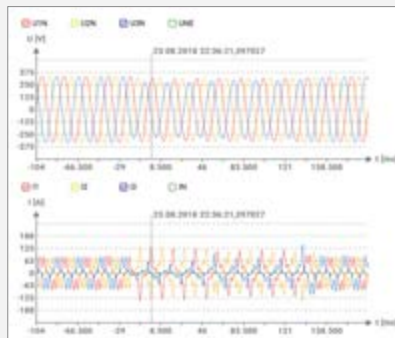
- Ensure trouble-free operations of the loads
- Delivery contract complied?



Recording of malfunctions (Availability of supply)

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

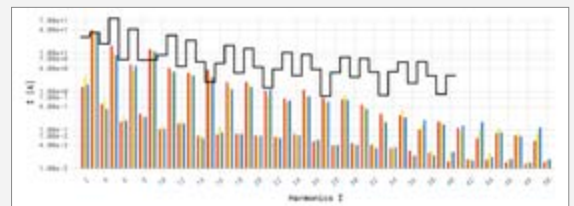
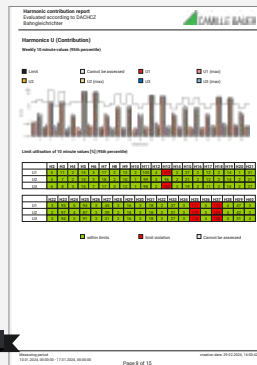
- Find the sources of disturbances and correct them
- Safe thanks to UPS



Assessment of harmonic contribution

e. g. according to DACHCZ Ed. 3, IEEE 519,
DTR, IEEE 1547, GB/T...

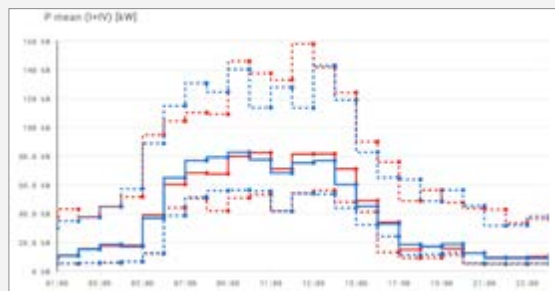
- Trouble-free due to optimum voltage quality



Energy flow - analysis

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

- Save costs due to energy management



Time	P (kW)	min P (kW)	max P (kW)
12.02.2019 00:00:00,000	9.01	5.34	16.64
12.02.2019 00:10:00,000	9.40	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



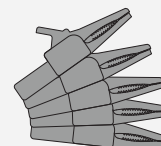
Lockable and waterproof



UPS

5x3min.

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



Direct measurement via fused voltage taps

$I_{1,2,3,N}$

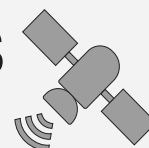
Rogowski coils or current clamps



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 192.168.36.5 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



ASSESSMENT OF HARMONIC CONTRIBUTION (OPTION)

In order for the DSO to keep the power quality at the point of coupling to customer installations within the agreed limits, none of these installations is allowed to emit more interference into the grid than it is entitled to, based on the connection power. Only this way it can be ensured that the provided quality of the supply voltage enables a trouble-free operation of all connected loads.

Before new customer installations are connected to the distribution network, relevant guidelines (e. g. DACHCZ Ed. 3) are used to check whether

this installation can be connected to the grid without any restrictions or whether measures, such as the installation of a filter system, are required.

The option for the **assessment of harmonic contribution** allows to provide the metrological proof of compliance with the limits for harmonic emissions after an installation has been connected. Of course, any existing customer installation can also be checked for impermissible emission values.

Procedure of the campaign

1. Input

Plant-specific parameters

Impedance information:

Reference impedance (e. g. DACHCZ, etc.)

or

Real measured
grid impedance parameters (fNI)

Network and connection point

S_K Short circuit power

S_A Connected load

U_{LL} Rated voltage

Z_K Short circuit impedance
(magnitude and phase)

Z_N Neutral impedance

2. Measurement on the system

LINAX® PQ5000-Mobile, Class A



Systems such as districts, large photovoltaic parks, large individual consumers, charging parks, large battery storage systems, Combined heat and power unit, etc.

3. Output

Reports



Compliance report (e. g. EN50160)



Report about the emission of harmonics
e. g. DACHCZ Ed. 3

Benefits and findings of the harmonic contribution assessment

- Metrological proof of compliance with the harmonic limit values in report form
- Identification of customer installations with impermissible high system perturbation
- Detecting existing interactions between grid and customer installation (e. g. compensation effects)
- Avoiding investments in unnecessary mitigation measures
- Consideration of disturbances in the neutral conductor for customer installations far away from the transformer
- More reliable operation of existing and future networks with more efficient use of the grid infrastructure
- Increased security of supply
- No in-depth knowledge about the assessment of harmonic contribution required
- Unknown system parameters can be replaced with standard values
- Various standards are taken into account (e.g. according to DACHCZ Ed. 3, IEEE 519, DTR, IEEE 1547, GB/T...)



DATA EXPORT OPTIONS

Using the data export scheduler, measured value information can be saved as CSV or PQDIF files in the device or forwarded to an SFTP server if required. This type of communication can also be used to transmit measured value information via secure network structures, for example via smart meter gateways.

CSV data pool

The following load flow and PQ information is stored in the internal data storage in the form of CSV daily files:

- Mean values for power quality assessment
- Mean values for quality of currents
- Mean values (configurable interval) of the power quantities for load profile analysis
- PQ event list
- Measured voltages during PQ events
- Measured currents during PQ events
- List of mains signalling events
- Measured values for mains signalling events

This data pool can be downloaded at any time for a selectable time range, even during an ongoing measurement campaign. This allows PQ data assessment to be delegated to software solutions like PQIS®.

PQDIF files

The same measurement data can also be saved and transferred in the standardized PQDIF format.

- Periodic PQDIF files include trends and event data for a day or a week
- PQDIF files with event data can be generated after a PQ event and used for immediate alarming

Selection of CSV data to download

active	Name	Creation	File format	Action
☒	Periodic PQDIF	daily (with 24 hours)	[PQDIF] All values in three files	+ store on local Storage
☒	PQ Events	immediately	[PQDIF] events	+ push to SFTP server
☒	Periodic PQIS	daily (with 24 hours)	[PQIS] All values in separate files	+ store on local Storage

Overview of data export settings

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

Filter: Emergency Alert Critical Error Warning Notice Info Debug					
Time	PID	Priority	IP address	User name	Message
10.04.2020, 14:18:44	cb-gui	Notice	192.168.57.18.61983	admin	User logged in successfully
09.09.2020, 17:40:23	cb-gui	Info	192.168.57.50.62304	admin	User has been logged out due to inactivity
09.09.2020, 17:19:51	cb-pq5000mod	Notice	localhost	system	Logger started on configuration 16
09.09.2020, 17:19:45	cb-pq5000mod	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	runex	Critical	localhost	system	Process cb-gui(2072) has unexpectedly stopped running
09.09.2020, 08:46:25	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 (active)
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

	admin	localgui	anonymous	Operator1	Operator2	Operator3	JWP/AccessKey
Local account (no weblogin)	☐	☒	☐	☐	☐	☐	☐
Instantaneous values	☒	☒	☒	☒	☒	☒	☒
Energy	☒	☒	☒	☒	☒	☒	☒
Harmonics	☒	☒	☒	☒	☒	☒	☒
Phasor diagram	☒	☒	☒	☒	☒	☒	☒
Waveform	☒	☒	☒	☒	☒	☒	☒
Events	☒	☒	☒	☒	☒	☒	☒
PQ statistic	☒	☒	☒	☒	☒	☒	☒
Service	☒	☒	☒	☒	☒	☒	☒
Reset values	☒	☒	☒	☒	☒	☒	☒
Reset/Update device	☒	☒	☒	☒	☒	☒	☒
Audit Log	☒	☒	☒	☒	☒	☒	☒
Use IO simulation	☒	☒	☒	☒	☒	☒	☒
Settings	☒	☒	☒	☒	☒	☒	☒
Basic device settings	☒	☒	☒	☒	☒	☒	☒
Measurement	☒	☒	☒	☒	☒	☒	☒
Communication	☒	☒	☒	☒	☒	☒	☒
Security system	☒	☒	☒	☒	☒	☒	☒

RBAC access rights of different users



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

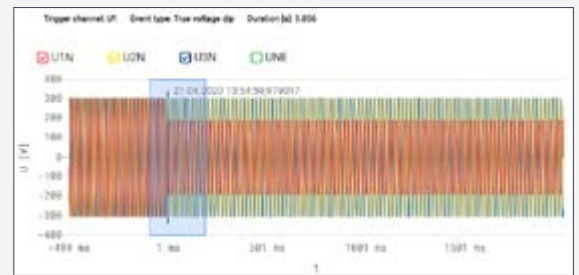
PQ statistics

- 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 a software solution like 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
- Report on compliance with harmonic emission limits, e. g. in accordance with DACHCZ Ed. 3
- Customer specific logo in the report





TECHNICAL DATA

INPUTS			
NOMINAL VOLTAGE	57.7 ... 400 V _{LN} , 100 ... 693 V _{LL}	Power	±0.2 %
Maximum	520 V _{LN} , 900 V _{LL} (sinusoidal)	Power factor	±0.1°
Overload capacity	520 V _{LN} , 900 V _{LL} permanent	Frequency	±0.01 Hz
	800 V _{LN} , 1386 V _{LL} , 10x1 s, interval 10 s	Imbalance U, I	±0.5 %
Nominal frequency	42 ... 50 ... 58 Hz, 50.5 ... 60 ... 69.5 Hz	Harmonic	±0.5 %
		THD U, I	±0.5 %
CURRENT SENSORS	depends on the device variant	Active energy	Class 0.2S (IEC/EN 62 053-22)
Rogowski coils	Measurement up to 3800 A	Reactive energy	Class 0.5S (IEC/EN 62 053-24)
Current clamps	10 A, 100 A or 1000 A		
Sampling rate	18 kHz	INTERFACES	
Data memory internal	16 GB	ETHERNET	Standard
POWER SUPPLY	Standard	Physics	Ethernet 100 Base TX; RJ45 socket
Power adapter	100 ... 230 V AC 50/60Hz ±15%	Mode	10/100 MBit/s, full/half duplex, autonegotiation
Consumption	≤ 20 VA	Protocols	Modbus/TCP, http, https, IPv4, IPv6, NTP
POWER SUPPLY	Accessory	WLAN ACCESS POINT	Standard
Rated voltage	100 ... 230 V AC 50/60Hz ±15%	Connection	via USB socket
Overvoltage category	OVC IV 300 V		
Consumption	≤ 20 VA	TIME REFERENCE	Internal clock
		Clock accuracy	± 2 minutes/month (15 to 30 °C)
		Synchronisation	via NTP server or GPS
UNINTERRUPTIBLE POWER SUPPLY		ENVIRONMENTAL CONDITIONS, GENERAL INFORMATION	
Capacity	1150 mAh, 4.5 Wh	Operating temperature	-10 up to 15 up to 30 up to + 55 °C
Operating duration	5 times 3 minutes	Storage temperature	-25 to +70 °C
Life time	3 up to 5 Years	Temperature influence	0.5 x basic uncertainty per 10 K
		Long-term drift	0.5 x basic uncertainty per year
TYPES OF CONNECTION		Others	Application group II (IEC/EN 60 688)
• Single phase		Relative air humidity	<95 % without condensation
• Split phase (2-phase system)		Operating altitude	≤2000 m above NN
• 3 or 4-wire balanced load			
• 3-wire unbalanced load, Aron connection		SAFETY	
• 3 or 4-wire unbalanced load		Protection class	II (protective insulation, voltage inputs via protective impedance)
BASIC UNCERTAINTY		Pollution degree	2
(additional uncertainty due to current sensors not considered)		Protection	IP65 (closed housing)
Voltage, current	±0.1 %	Measurement category	600 V CAT III / 300 V CAT IV

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



ORDER CODE

LINAX® PQ5000-MOBILE, Mobile power quality monitor acc. IEC 61000-4-30 Class A

Mechanical design	Measuring channels & probes						GPS time synchronization	Device handbook	Uninterruptible power supply	Evaluation of the harmonic emission		Communi-cation	Article Number
In hard case, operation via terminal device	4 current clamps 10 A / 1 V	4 current clamps 100 A / 1 V	4 current clamps 1000 A / 1 V	4 current clamps 1 A / 1 V	4 current clamps 5 A / 1 V	4-fold Rogowski probe 2000 A	With GPS time synchronization without GPS receiver	Device handbook German and English	With UPS	Without	With	Ethernet (LAN & WLAN)	
•	-	-	-	-	-	•	•	•	•	•	-	•	
•	-	-	-	-	-	•	•	•	•	-	•	•	
•	•	-	-	-	-	-	•	•	•	•	-	•	
•	-	•	-	-	-	-	•	•	•	•	-	•	
•	-	-	•	-	-	-	•	•	•	•	-	•	
•	-	-	-	•	-	-	•	•	•	•	-	•	
•	-	-	-	-	•	-	•	•	•	•	-	•	
•	•	-	-	-	-	-	•	•	•	-	•	•	
•	-	•	-	-	-	-	•	•	•	-	•	•	
•	-	-	•	-	-	-	•	•	•	-	•	•	
•	-	-	-	•	-	-	•	•	•	-	•	•	
•	-	-	-	-	•	-	•	•	•	-	•	•	

• Variant active / - variant inactive

ACCESSORIES	ART. NO	ACCESSORIES	ART. NO
Current clamp 1 A / 1 V (only for PQ5000MOB-2)	191 169	Power adapter OVC IV, 100-230 VAC-12 VDC, CEE7/7 plug	191 513
Current clamp 5 A / 1 V (only for PQ5000MOB-2)	191 177	Power adapter OVC IV, 100-230 VAC-12 VDC, T12 plug	191 521
Current clamp 10 A / 1 V (only for PQ5000MOB-2)	182 775	Dolphin clamp red (included)	182 709
Current clamp 100 A / 1 V (only for PQ5000MOB-2)	182 808	Dolphin clamp blue (included)	182 717
Current clamp 1000 A / 1 V (only for PQ5000MOB-2)	182 783	Dolphin clamp yellow/green (included)	182 725
4-fold Rogowski current probe 2000 A (only for PQ5000MOB-3)	181 727	GPS receiver 16x-LVS for PQ5000MOB, configured	181 131
Standard power adapter 100-230 V AC (included)	183 038	RJ45 cable, IP protected, length 5m	183 004
World plug set	191 873	WLAN access point dongle (included)	181 701
		Carrying case (included)	182 634



 **CAMILLE BAUER**
GMC-INSTRUMENTS GROUP

Camille Bauer Metrawatt AG
Aargauerstrasse 7 ■ 5610 Wohlen ■ Switzerland
TEL +41 56 618 21 11

www.camillebauer.com ■ sales@camillebauer.com