OPERATING MANUAL

PQA 1101
Power Quality Analyzer

Power system monitoring
An instrument for the acquisition, analysis and monitoring of all key electrical data in low voltage 3-phase systems from 115 V to 690 V

FRAKO Kondensatoren- und Anlagenbau GmbH
www.frako.com

Contents

1 About this manual

Throughout this operating manual the Power Quality Analyzer PQA will be referred to simply as the PQA.

The most recent update of this manual can always be found on our website www.frako.com.

1.1 Objective

This operating manual has been prepared for persons who install, connect, commission and operate the PQA. The manual must be read through carefully and completely before any work on or with the instrument is carried out. All actions taken must be in accordance with this manual.

1.2 Safekeeping

This operating manual contains important instructions for operating the PQA safely, correctly and cost-effectively. It is to be considered part of the instrument itself and must be held in a secure place where it can be referred to at all times.

1.3 Symbols used in this manual

Special instructions in this operating manual are marked by symbols and separated from the other text by horizontal lines.

Warning signs

In order to avoid accidents, death or injury and damage to assets, these instructions must always be followed. The warning signs consist of the appropriate signal word – DANGER, WARNING, CAUTION or ATTENTION – plus a yellow symbol on the left-hand side, as shown below:

WARNING!

Type of danger!

Description of the danger and possible consequences

– Measures to avoid the danger

The symbols and signal words classify the severity of the danger:

Symbol	Signal word	Meaning
	DANGER	This signal word indicates a hazard with a high level of risk that if not avoided can result in death or serious injury.
	WARNING	This signal word indicates a hazard with an intermediate level of risk that if not avoided can result in death or serious injury.
	CAUTION	This signal word indicates a hazard with a low level of risk that if not avoided can result in slight or moderate injury.
	ATTENTION	Damage to equipment could occur if this sign is not heeded.

Notes

Notes supplement the general text with additional information on the correct functioning and fault-free operation of the PQA. They are marked with the white-on-blue symbol on the left-hand side, as shown below:

Note

Example of a note

1.4 Reference documents

For further information relevant to this manual please refer to the following documents:

– Modbus Specification
– REST Application Note

2 Safety

2.1 Intended use

Within the scope of the technical data (see Section 3, *Technical data*), the Power Quality Analyzer PQA is intended for the measurement and analysis of the secondary electrical distribution system supplying the user. Any use of the instrument that deviates from its intended use must be expressly approved by the manufacturer.

2.2 Instrument-specific dangers

The PQA has been manufactured using state-of-the-art technology. Nevertheless, not all potential dangers can be excluded.

Failure to observe the safety instructions can result in death, serious injury or severe damage to equipment and other assets.

Danger from electricity

The PQA operates at the supply voltage. Touching live components at the instrument terminals and connecting cables can cause serious injury or may even be life-threatening.

- Installation, commissioning and decommissioning of the PQA may only be carried out by appropriately qualified technicians who are also familiar with and understand the contents of this manual.
- When the PQA is being installed or serviced, the instrument and the electrical system must be isolated from the power supply.
- The isolated electrical system must be locked out and tagged out to prevent its being inadvertently switched on again.
- It must be verified that none of the terminals are live.
- All live components in the vicinity must be covered to prevent inadvertent contact.
- Current transformer circuits must be short-circuited before they are interrupted.
- Only approved installation cables must be used.
- The PQA must only be employed on duties up to the specified maximum power. Overloading the instrument can result in its destruction, create a fire hazard or cause an electrical accident. The load ratings for the various connections must not be exceeded.
- Do not open the PQA.
- When the PQA is in operation, the USB port must not be touched.

Danger from heat

The instrument terminals can become hot during operation.

– After the PQA has been operating, sufficient time must be allowed for the PQA and its terminals to cool down before work is carried out on the connections.

2.3 Management information

Personnel qualifications

The following qualifications are required for personnel working with the PQA:

– Installing, commissioning, troubleshooting (installation):
electricians
– Operation, troubleshooting (faulty configuration):
persons who have read and understood the operating manual.
– Troubleshooting (instrument faults):
FRAKO Service + Support

User responsibility

In commercial operations in Germany, it is essential to comply with the regulations of the Social Accident Insurance Institution covering electrical installations. In other countries, the equivalent local regulations must be followed.

The safety of the system in which the PQA is incorporated is the responsibility of the persons installing and operating the system.

For safety reasons and to retain conformity with product approval requirements (CE marking), the user is not permitted to convert or otherwise modify the PQA.

The user must ensure that all operators are familiarized with this operating manual and follow it at all times.

2.4 Disclaimer

No claims under guarantee shall be valid in the event of damages caused by failure to observe the instructions in this operating manual. We shall not be held liable for consequential damages!

Incorrect operation or failure to observe the safety instructions will invalidate all claims under the guarantee, and no liability is accepted for any injuries to persons or damages to assets arising therefrom or occasioned thereby!

2.5 Relevant standards

Installation and commissioning of the instrument in industrial plant must be carried out in strict compliance with the following standards:

– EN 61508-1:2011-02; VDE 0803-1:2011-02

For this product all other currently valid laws, standards, regulations and safety rules (IEC, EN, VDE, etc.) relating to the protection of persons and property must be strictly complied with. In Germany, it is essential to comply with the Equipment Safety Act (GSG) and the regulations of the German Social Accident Insurance Institutions. In other countries, the equivalent local regulations must be followed.

2.6 Repair

Should repair work be necessary, the customer or user must contact the manufacturer of the PQA: FRAKO Kondensatoren und Anlagenbau GmbH, Tscheulinstrasse 21A, D-79331 Teningen, Germany, www.frako.com.

3 Technical data

Power supply:

Supply voltage	85–267 V AC (absolute limits), frequency 45–65 Hz, or 100–377 V DC (absolute limits)
Power draw	maximum 5 VA
Overcurrent protection	External, maximum 2 A (time delay) specified

Inputs:

Voltage path measurement inputs	80 V AC – maximum 760 V AC (phase–phase, absolute limits), suitable for 115–690 V AC systems, electrically interconnected via high resistances, measurement of medium voltages possible using an x/100 V transformer; In areas where UL / CSA standards apply in systems with nominal voltages 115–600 V AC; power failure detection after duration of a half-wave
Current path measurement inputs	x/5 A AC or x/1 A AC (transformer secondary current ≥ 15 mA), electrically isolated, power draw maximum 1 VA per transformer connection, continuous overload rating up to 6 A AC, transient overload maximum 10 A AC for 10 seconds
Temperature inputs	Two PT100 RTDs, 4-wire or 2-wire configuration, measurement range
Tariff switching (T)	S0 pulse as per DIN 43864, common earth with FRAKO Starkstrombus (Frakobus)

Interfaces:

Type	-2x	-3x	-4x
Modbus RTU interface	120 Ω terminating resistor required at the end of the bus system		
Ethernet interface (Modbus TCP, web server)		100 Mbit/s Ethernet standard 100BASE-T	
FRAKO Starkstrombus (Frakobus)			RS-485, surge impedance 120 Ω, for connection to the FRAKO Energy Management System

Outputs:

Alarm contact[1]	Volt-free NO contact AC-14 250 V AC, maximum 3 A or DC-13 30 V DC, maximum 3 A, mechanical service life: 2 x 10^7 cycles, electrical service life AC-14 at 3 A: 1.5 x 10^5 cycles, AC-14 at 0.5 A: 2 x 10^6 cycles Note: utilization category AC-/DC- as per IEC 60947-5-1 In areas where UL / CSA standards apply: 3 A 250 V AC cos φ =1 at 85 °C, 3 A 30 V DC L/R = 0 ms at 85 °C
Output relays	NO contact with common pole P; AC-14 250 V AC, maximum 3 A or DC-13 30 V DC, maximum 3 A, mechanical service life 2 x 10^7 cycles, electrical service life AC-14 at 3 A: 1 x 10^5 cycles, AC-14 at 0.5 A: 2 x 10^6 cycles
	Common supply conductor P to the output relays maximum 10 A; Note: utilization category AC-14/DC-13 as per IEC 60947-5-1; for all PQA types in areas where UL / CSA standards apply: 3 A 250 V AC cos φ = 1 at 85 °C, 3 A 30 V DC L/R = 0 ms at 85 °C

Connections: Via pluggable screw terminals

Instrument power AUX, Insulation rating	Conductor cross section max. 2.5 mm², min. 0.2 mm²
	min. 250 V AC, 70 °C
Protective earth PE	Via 6.3 mm female slide connector; conductor cross section at least equal to the largest conductor cross section of the AUX phases, the voltage measurement connections, the output relays and the alarm connections; insulation colour yellow / green
Voltage measurement inputs L1, L2, L3, N	Conductor cross section max. 2.5 mm², min. 0.2 mm² Insulation rating: Example 1: for 230 V AC, select at least 250 V AC, 70 °C, Example 2: for 690 V AC, select at least 750 V AC, 70 °C
Current measurement inputs L1, L2, L3, terminals S1 and S2 in each case	Conductor cross section max. 2.5 mm², min. 0.2 mm² Insulation rating: min. 250 V AC, 70 °C

Output relays (control outputs)	Conductor cross section max. 2.5 mm², min. 0.2 mm²
	250 V relay, insulation rating: min. 250 V AC, 70 °C
Alarm contact	Conductor cross section max. 2.5 mm², min. 0.2 mm² Insulation rating: min. 250 V AC, 70 °C
USB for updates (service interface)	USB Micro A and Micro B ports

[1] The output relays of the PQA 1101 with firmware version 1.0 cannot be used.

Type	-2x	-3x
Modbus RTU interface	Conductor cross section max. 1.5 mm², min. 0.14 mm² Insulation rating: 50 V DC, 70 °C	
Ethernet interface		Ethernet cable Cat 5 as per TIA-568A/B, S/FTP shielding S/FTP, RJ45 plug

Temperature inputs	Conductor cross section max. 1.5 mm², min. 0.14 mm² Insulation rating: min. 50 V DC, 70 °C
FRAKO Starkstrom-bus (Frakobus)	Conductor cross section max. 1.5 mm², min. 0.14 mm² Insulation rating: min. 50 V DC, 70 °C
Input for tariff switching	Conductor cross section max. 1.5 mm², min. 0.14 mm² Insulation rating: min. 50 V DC, 70 °C

Note

0.14 mm² = AWG 26; 0.2 mm² ≈ AWG 25;
1.4 mm² ≈ AWG 16; 2.5 mm² = AWG 14

Design data:

Dimensions (W x H x D)	144 mm × 144 mm × 70 mm casing 144 mm × 165 mm × 70 mm casing including connectors
Mounting	Front of panel in 138 mm x 138 mm cutout to IEC 61554, held by four retaining lugs at the corners of the casing Maximum screw tightening torque 0.4 Nm
Weight	approx. 770 g without packaging
Ingress protection	Front of instrument when mounted in cabinet IP40, when mounted in cabinet with upgrade kit (Article No. 20-50015) IP54; rear of instrument and terminals IP20; all as per EN 60529; Contamination level 2 as per EN 61010-1:2011-07
Electrical design	Casing protection class I as per EN 61140 Working voltage up to max. 760 V AC absolute value at voltage measurement inputs. TNV1 circuits, some of which interconnected: digital inputs and outputs, optional temperature inputs, optional Modbus interface.
Casing design	Flammability rating UL 94 V-0 according to casing manufacturer Impact resistance IK06 as per EN 61010-1:2011-07, 8.2.2
Service life	At +25 °C ambient temperature 15 years

EMC	EMC as per EN 61326-1 EN 61000-4-2, electrostatic discharge: air 8 kV and contact 6 kV with horizontal and vertical coupling plane EN 61000-4-3, radiated immunity (EMS) 80 MHz – 1 GHz, horizontal and vertical, level 10 V/m = industrial environment radiation, Class A EN 55022A EMI 30 MHz – 1 GHz = office and residential area, Class B EN 61000-4-6, immunity to conducted disturbances, level 10 V RMS, 150 kHz – 80 MHz[1] EN 61000-4-4, burst immunity, 1 kV capacitive coupling, 2 kV injection into power supply cable and voltage measurement inputs

Ambient conditions:

Temperature range	-25 °C to +65 °C, noncondensing
Installation altitude	Maximum height above sea level 2000 m

Measuring system:

Accuracy	Voltage and current measurement ±1% at 50/60 Hz and 25 °C ambient temperature
Averaging function	Over 1 second, updated every 100 ms
Harmonics	Measured via Lx–N All even and uneven harmonics up to the 19th

[1] The standard radio-frequency field test as per EN 61000-4-6 (EMC immunity) calls for amplitude modulation at a modulation frequency of 1 kHz. However, this frequency lies within the measurement range of the instrument in its intended use (20th harmonic of 50 Hz = 1 kHz). It is therefore to be expected that the measuring circuit clearly responds to the standard test. For this reason, the radio-frequency field test can only be carried out without amplitude modulation.

4 Instrument description

4.1 Function

The Power Quality Analyzer PQA is used to measure, analyse and monitor the relevant electrical variables in the power supply system. It stores these data temporarily before forwarding them for processing elsewhere. In addition, the PQA can be connected to two temperature probes and to a tariff switching system. Its contact can give an alarm signal when variables move outside set limits.

The PQA 1101 has been designed to integrate into the FRAKO Energy Management System, where it can exhibit its full potential. An integral bus interface enables connection to the FRAKO Starkstrombus or a Modbus RTU/TCP bus.

4.2 Operation

instrument is operated with the five keys located below the display:

Key					
Function	PQA Overview	Select	Select	Start submenu	Display information

Note

The keys are assigned different functions depending on the menu item. Each section describes these specific key functions.

Icon	Key	Function
	Escape	Go back one level in the system tree.
	Up	Increase a selected parameter by an increment. Move upwards to select the next item
	Down	Decrease a selected parameter by an increment. Move downwards to select the next item
	Return/ Enter	Go one level deeper in the system tree (e.g. Select a chosen parameter). Select and confirm a chosen parameter (e.g. Adopt a value).
	Info	Help text

The PQA offers the following languages, which can be selected at **Main menu > Configuration > Service > Commissioning** (see Section 5.3.2, *Initial start-up*):

– **German**
– **English**
– **French**

4.3 Password protection

The PQA is protected by a password to prevent unauthorized access to sensitive menu items.

Protected menu items:

– **Main menu > Configuration**
  Security level 1, Password: the last four numerals of the serial number. Refer to the label on the PQA or Section 6.4, *About PQA*.
– **Main menu > Configuration > Service > Service**
  Security level 2, Password: 3725

The password prompt is displayed immediately whenever a protected menu item is selected.

The ↑ and ↓ keys are used to change a numeral, which is then confirmed when the ⇄ key is pressed. Once the 4th numeral has been confirmed, the menus with the corresponding security level are enabled for one hour.

5 Installation

The PQA is installed in three steps:

– Mounting at the desired location (see Section 5.1.1, *Preparing for installation* and Section 5.1.4, *Mounting the instrument*)

– Electrical connections (see Section 5.2.1, *Electrical installation procedure* and Section 5.2.2, *Completing the electrical installation*)

– Commissioning (see Section 5.3.1, *Preparations for start-up*)

The steps must always be taken in this order.

5.1 Mounting at the desired location

5.1.1 Preparing for installation

1. Verify that the set is complete (see Section 5.1.2, *Scope of supply*).
2. Inspect the instrument for any external damage. If any damage is apparent, for safety reasons it must **not** be put into service. In case of doubt, please contact FRAKO Service.
3. Verify that the intended location of the PQA is suitable (see Section 5.1.3, *Suitable location*).

5.1.2 Scope of supply

The PQA and its accessories consist of:

– 1 PQA instrument

– 4 or more reverse-polarity-proof male connectors, supplied loose

– 1 operating manual

5.1.3 Suitable location

The location where the PQA is installed must comply with the following conditions (see also Section 2.1, Intended use and Section 3, *Technical data*):

– Only install the PQA in areas where there is no danger of gas or dust explosions.

– Do not expose the PQA to direct sunlight or high temperatures, and do not install the instrument near to devices that generate heat.

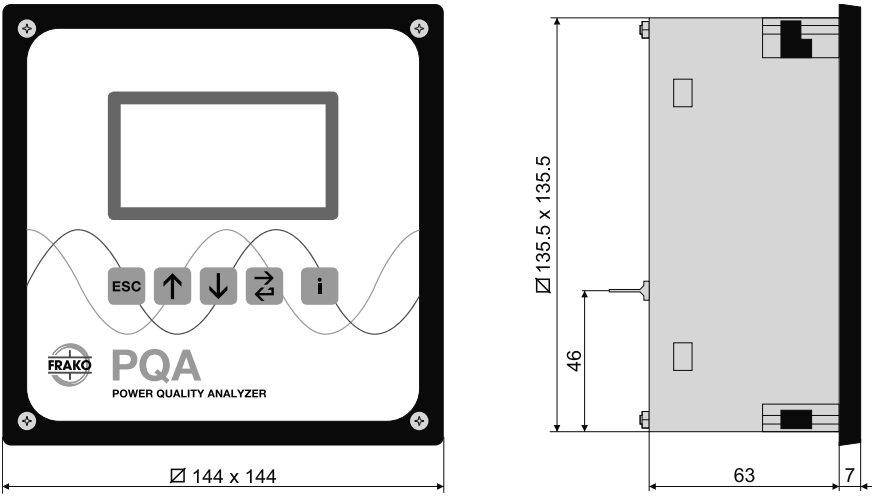
– The PQA must be mounted in an adequately ventilated area. Its rear and sidewalls must not be covered.

– Do not expose the instrument to rain, water, dampness or high levels of humidity. Avoid direct contact with water at all cost.
– Protect the PQA against jolting and physical blows.

The instrument is installed vertically on the outside of the control cabinet or enclosure so that the controls and display are accessible to the operator.

When considered from the rear, the PQA is a panel-mounted instrument with IP20 ingress protection. Adequate protection against inadvertently touching live components must be provided, and the ingress of dust and water must be prevented by ensuring that the instrument is installed in a suitable enclosure (e.g. control cabinet or distribution panel).

5.1.4 Mounting the instrument



The PQA is designed for mounting in a 138 mm x 138 mm cutout to IEC 61554 in the front of a control cabinet. It is held in place by four retaining lugs in the corners of the instrument.

Note

The option is given of mounting the PQA in control cabinets with IP54 ingress protection. For this an additional gasket (Article No. 20-50015) is available that seals the gap between the PQA front panel and the wall of the control cabinet.

WARNING!

Danger from electricity!

Touching live components at the instrument terminals and connecting cables can cause serious injury or may even be life-threatening.

- Installation, commissioning, decommissioning and removal of the PQA may only be carried out by appropriately qualified personnel who have read and understood the content of this manual.
- When the PQA is being fitted and connected, the instrument and the electrical system must be isolated from the power supply.
- The isolated electrical system must be locked out and tagged out to prevent its being inadvertently switched on again.
- It must be verified that none of the terminals are live.
- All live components in the vicinity must be covered to prevent inadvertent contact.

1. Turn the four retaining screws at the front of the PQA anticlockwise so that the four retaining lugs in the corners of the instrument are swivelled to lie flat behind its front panel.
2. Option: In the case of a cabinet with IP54 ingress protection, fit the gasket from the accessories set in the rear groove behind the PQA front panel.
3. Insert the sheet-metal rear of the PQA through the cutout provided in the control cabinet until fully home.
4. Press the PQA front panel gently against the control cabinet exterior and tighten the four retaining screws at the corners by turning them clockwise, applying a torque of ≤ 0.4 Nm. This causes the retaining lugs to swivel outwards and be drawn towards the inner side of the cabinet wall until they are held tightly up against it.

5.2 Electrical installation

5.2.1 Electrical installation procedure

WARNING!

Danger from electricity!

Touching live components at the instrument terminals and connecting cables can cause serious injury or may even be life-threatening.

- Installation, commissioning, decommissioning and removal of the PQA may only be carried out by appropriately qualified personnel who have read and understood the content of this manual.
- When the PQA is being fitted and connected, the instrument and the electrical system must be isolated from the power supply.

– The isolated electrical system must be locked out and tagged out to prevent its being inadvertently switched on again.
– It must be verified that none of the terminals are live.
– All live components in the vicinity must be covered to prevent inadvertent contact.

CAUTION!

Danger from heat

The instrument terminals can become hot during operation and could cause burns.

– After the PQA has been operating, sufficient time must be allowed for the instrument and its terminals to cool down before work is carried out on the connections.

The PQA is connected as shown in the diagrams in Section 5.2.9, *Connection diagrams* and as specified in Section 5.2.3, *Specifications for the electrical connections*:

1. Connect the earth (see Section 5.2.4, *Earth connection*).
2. An external disconnecting device with a fuse must be fitted in the power supply line to the PQA (see Section 5.2.5, *Power supply*).
3. Connect the voltage measurement cabling (see Section 5.2.6, *Voltage measurement*).
4. Connect the current measurement cabling (see Section 5.2.7, *Current measurement*).
5. If required, connect the alarm relay to transmit an alarm signal (see Section 5.2.8, *Alarm*).

5.2.2 Completing the electrical installation

WARNING!

Danger from electricity!

If there is a fault in the wiring adjacent to the PQA, there is a danger that its four retaining screws could become live and therefore a safety hazard. Touching live components at the instrument terminals and connecting cables can cause serious injury or may even be life-threatening.

– Securely fasten the cabling at the location where the PQA is mounted (e.g. control panel, cabinet).

At the location where the PQA is installed (e.g. control cabinet, enclosure), verify that all wires and cables are securely fastened or grouped in harnesses to ensure that any stray wire or strand cannot contact one or more of the instrument's retaining screws.

5.2.3 Specifications for the electrical connections

– Only approved solid core or stranded wire cables having an adequate cross section and sufficiently high voltage withstand ratings must be used for the connecting cabling.
– If flexible stranded cables are used for the PQA connections, short ferrules 6 mm in length must be crimped onto their ends.
– Suitable clips or other fasteners must be fitted to relieve any strain on the wires and cables connected to the PQA.
– No additional connectors must be fitted in the wires and cables connected to the PQA.
– All the connectors supplied with the PQA must be plugged in, even when it is not intended to use them, and be secured to the instrument with their retaining screws, if provided.

5.2.4 Earth connection

An earthing tab is provided for the PE connection in the rear wall of the casing. It is marked with the earthing symbol as per EN 60617-2 shown at left.

The earth connection must comply with the following stipulations:

– The PE conductor cross section must be at least equal to that of the largest conductor of the AUX phases, the voltage measurement connections, the relay outputs or the alarm connection,
– its insulation colour is yellow/green,
– earthing connections for system power circuits must have at least the same current-carrying capacity rating as the circuits themselves.

If the earthing tab has broken off, the PQA must not be started up. The instrument must either be repaired or replaced.

Note

The PQA may only be put into service if the earthing conductor is connected to it.

5.2.5 Power supply

External disconnector

An external disconnecting device, such as an isolator or circuit breaker, must be fitted in the power supply line to the PQA. This must be located in the vicinity of the instrument and must be able to isolate all cables connected to the AUX terminals of the PQA. This device must not disconnect the earthing conductor.

Fuses

The instrument power supply circuit AUX must be protected externally by one or two 2 A time delay 250 V AC fuses.

One such fuse is required in the phase line when the power is from a **phase–neutral** connection, but two fuses must be installed, one in each phase, if a **phase–phase** connection is used. Please refer to the diagrams in Section 5.2.9, *Connection diagrams*, for further information.

Note

If a phase–phase connection is used, the maximum permissible voltage must be taken into account. If the phase–phase voltage is too high, an appropriate instrument transformer must be installed.

5.2.6 Voltage measurement

Depending on the instrument type, the PQA can measure one, two or three AC voltages. The voltage measurement inputs are electrically interconnected via high resistances. See Section 3, *Technical data*, for the measurement ranges. DC voltages cannot be measured.

The PQA voltage measurement inputs are designed for 100–690 V AC systems.

It is possible to measure medium voltages using an x/100 V transformer.

It is not necessary to provide external overcurrent protection in the voltage measurement circuits since these are safety impedance-protected. In this case, a short-circuit-proof cable (double insulated stranded wire) must be used to connect the voltage measurement inputs.

For 3-phase measurement, the terminals **L1, L2, L3** and **N** are connected as shown in the connection diagrams in Section 5.2.9, *Connection diagrams*. Phases **L1, L2** and **L3** must be connected in correct phase sequence.

For 3-phase measurement, it is advisable to connect the **N** terminal as well. This enables the high measurement accuracy of the PQA to be achieved when measuring phase–neutral voltages and the variables derived from these. If no neutral conductor is present, the **N** terminal can be left unconnected. However, this is only advisable when the phases are symmetrically loaded.

Note

If an instrument type designed for 3-phase measuring is used to measure only one phase, the terminals **L1** and **N** must be used. The terminals **L2** und **L3** must then be commoned with the terminal **N** to prevent incorrect measurements being made.

5.2.7 Current measurement

The PQA is designed for connection to x/1 A and x/5 A external current transformers so as to be electrically isolated from the power supply. Depending on the instrument type, the PQA can measure one, two or three AC currents. Attention must be paid to the allowable measurement range. See Section 3, *Technical data*, for further information.

WARNING!

Danger from electricity!

If live current transformer circuits are interrupted, there is the danger that arcing may occur, which could cause electric shock, burns or eye injuries. In addition, red-hot metal particles could be spattered, which apart from the health hazard also constitute a fire risk.

– The retaining screws on the connectors must be tightened to prevent the connectors accidently working loose.

– The secondary-side connections of the current transformers must be short-circuited before the circuits to the PQA are interrupted or the connector removed!

Note

If an earth terminal is provided at the secondary side of the current transformer, this must be connected to an earthing conductor! We recommend in general that every current transformer circuit be earthed.

The current transformer circuits must be connected in correct phase sequence to the respective S1 and S2 terminals for each of the phases L1, L2 and L3, as shown in the diagram (see Section 5.2.9, *Connection diagrams*).

Unassigned current measurement inputs can be left unconnected.

Note

In systems with a nominal voltage of 1000 V and more, the regulations call for the current transformer circuits to be earthed.

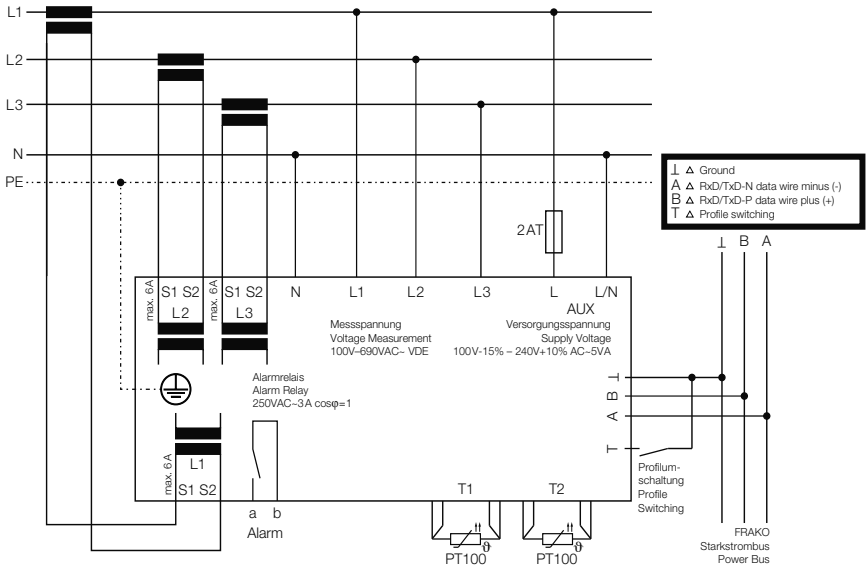
If systems with a nominal voltage of 1000 V or over are left unearthed, damage may occur to the instrument.

5.2.8 Alarm

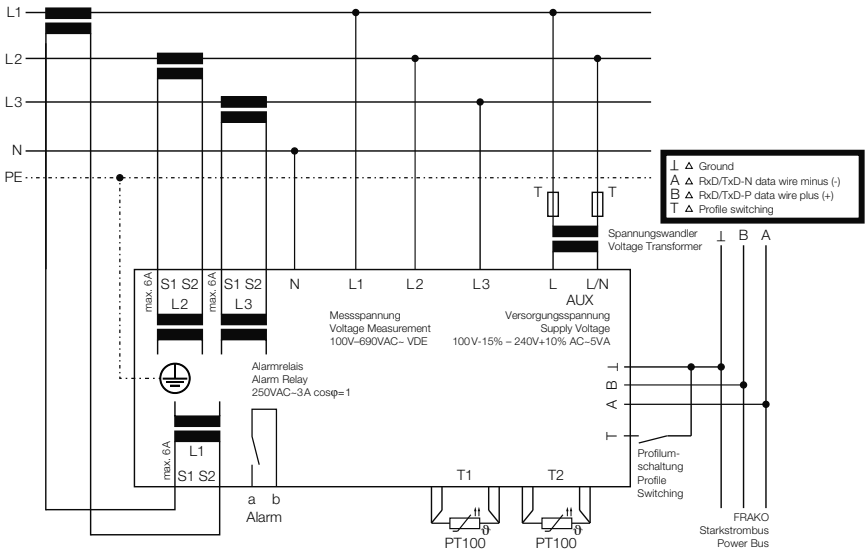
The PQA has a volt-free contact to transmit alarms externally, alarm terminals **a** and **b** being provided for this external connection as shown in the diagrams in Section 5.2.9, *Connection diagrams*. Attention must be paid to the load rating of the contact (see Section 3, *Technical data*).

5.2.9 Connection diagrams

5.2.9.1 Connection diagram 1



5.2.9.2 Connection diagram 2



5.3 Commissioning

5.3.1 Preparations for start-up

WARNING!

Danger from electricity!

Touching live components at the instrument terminals and connecting cables can cause serious injury or may even be life-threatening.

– It must be verified that the PQA is installed and connected in accordance with its intended use before power is switched on.

– Cover the instrument terminals.

ATTENTION!

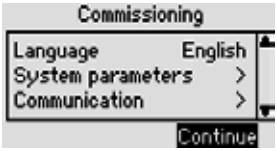
Risk to equipment!

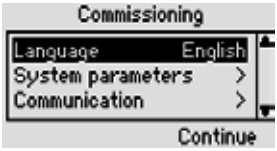
If the PQA terminals are wrongly connected, or if the wrong voltages or signals are applied to them, this can damage the instrument itself and the installation.

– Verify that all the connections are correct before switching on the power.

1. Verify that the PQA has been correctly installed and connected as described in Section 5.1, *Mounting at the desired location*, and Section 5.2, *Electrical installation*, and that all the connectors supplied with the instrument have been plugged in.
2. Verify that the earth connection has been made.
3. Ensure, for example by means of a closed door or a suitable cover, that the instrument terminals can no longer be touched.
4. Switch on the instrument power.
5. Carry out the initial start-up (see Section 5.3.2, *Initial start-up*).

5.3.2 Initial start-up





Key	ESC	↑	↓	⇄	i
Function	Main menu	Select language dt – en – fr	Select language dt – en – fr	Confirm language and return to parameter selection	–

When the power is switched on, the Start screen is displayed, showing information about the installed firmware. The initial start-up dialogue then starts automatically, in which the essential parameters for operation can then be set and the start-up mode selected.

Note

If the PQA does not start, switch off the power and check the cabling.

The following parameters must be selected or confirmed:

Language	German, English (factory default), French
System parameters	**Voltage transformer ratio** Range 1 to 300, PT ratio : $\frac{V_{primary}}{V_{secondary}}$ **Current transformer ratio** Range 1 to 7000, CT ratio : $\frac{I_{primary}}{I_{secondary}}$ Example: current transformer for 500 $\frac{500A}{5A}$ CT ratio: $k = \frac{I_{primary}}{I_{secondary}} = \frac{500A}{5A} = 100$
Communication	Where relevant: settings for communication interface (Modbus RTU / Modbus TCP / Frakobus). See Section 6.3.3, *Communication*, for further information.

Note

For the voltage and current readings (and the values of power derived from them) to be displayed correctly, it is essential that the voltage and current transformer ratios be entered.

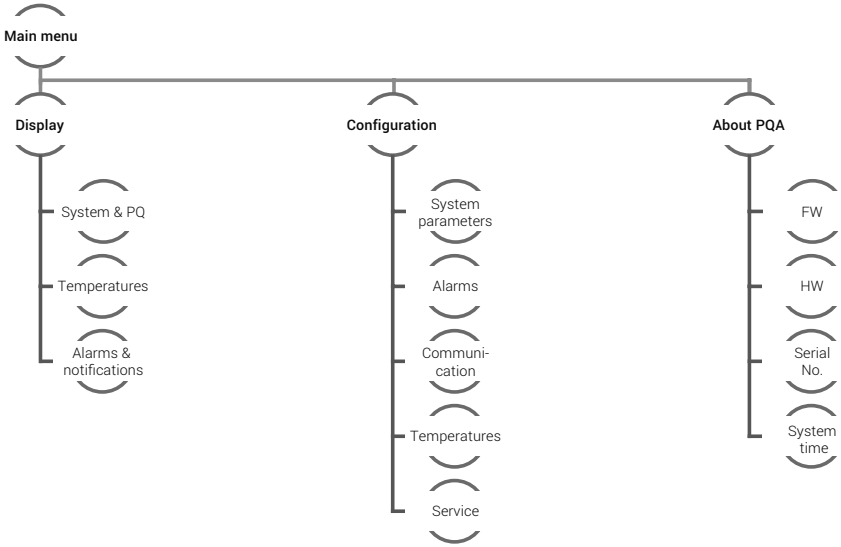
Regardless of the initial start-up mode, all the configuration data are saved in a non-volatile memory. In the event of power loss (intended or not) these data are not lost. When the power supply returns, the PQA starts up automatically and begins the data acquisition process after booting up.

6 Description of the menu

6.1 Main menu

From the main menu, all the measurement readings and settings that the PQA makes available can be displayed and, where appropriate, changed.

The main menu is divided into three main groups: **Display, Configuration** and **About PQA**.

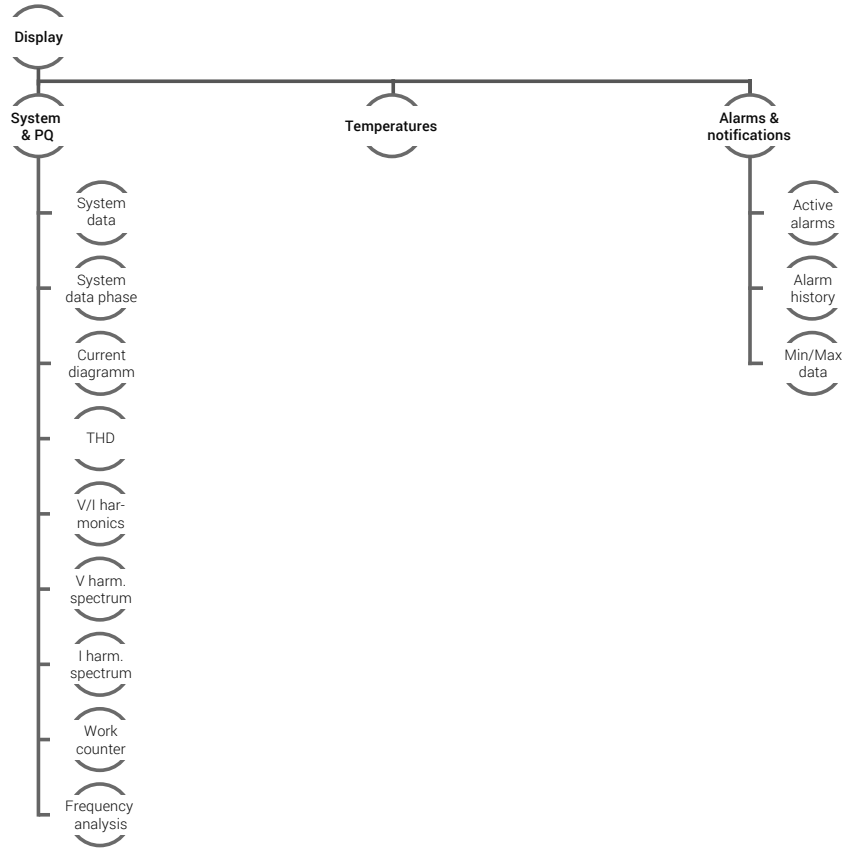


6.2 Display

Main menu > Display

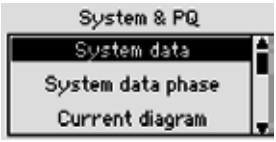
In the Display menu, all measurement readings are shown, the main menu items being:

System & PQ	System and power quality variables
Temperatures	Display of temperature readings from the connected temperature probes
Alarms & Notifications	Display of momentary alarms and the alarm history



6.2.1 System & PQ

Main menu > Display > System & PQ

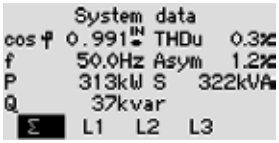


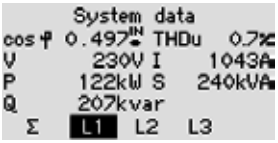
All relevant system variables and power quality data are displayed.

System data	For each phase L1/L2/L3 plus aggregate values
System data phase	V & I for phases L1/L2/L3
	P & Q for phases L1/L2/L3
	S & PF for phases L1/L2/L3
	P & cos φ for phases L1/L2/L3
Current diagram	Bar chart for currents and maximum current alarm limit
THD	Total harmonic distortion (EN 50160), THDv [%], THDi [%] and THDi [A]
V/I harmonics	Harmonics in tabular form
V harm. spectrum	Voltage harmonics shown on spectrum chart
I harm. spectrum	Current harmonics shown on spectrum chart
Work counter	Energy metering for each tariff
Frequency analysis	Analysis of manually selected frequency. Identification of the harmonic currents and voltages up to the 50th harmonic.

6.2.1.1 System data

Main menu > Display > System & PQ > System data





The PQA default screen for this menu item has the ∑ symbol highlighted and shows the aggregate system data. Each individual phase can then be selected at the lower edge of the screen.

Key	ESC	↑	↓	⇄	i
Function	Back to **System & PQ**	–	–	Navigate between ∑/L1/L2/L3	–

cos φ Display of momentary cos φ (power factor)

V Phase-to-neutral voltage

P Display of momentary active power (negative active power = generator mode)

Q Display of momentary reactive power (+ = inductive reactive power, - = capacitive reactive power)

I Display of momentary current

S Display of momentary apparent power

THDv Display of momentary THDv

Asy Display of momentary asymmetry

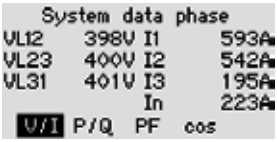
Σ Sum of all phases (L1, L2, L3)

6.2.1.2 System data phase

Main menu > Display > System & PQ > System data phase

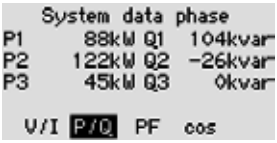
Vxy Phase-to-phase RMS voltage

Ix Display of momentary RMS current



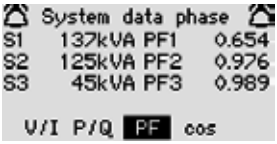
Px Momentary measured phase active power (fundamental frequency)

Qx Momentary measured phase reactive power (fundamental frequency)



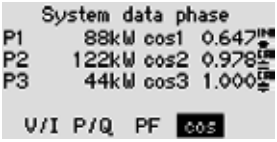
Sx Momentary measured phase apparent power

PFx Momentary measured phase power factor



P Momentary measured phase active power (fundamental frequency)

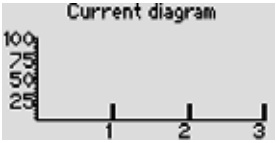
PF Momentary measured power factor (cos φ) of fundamental frequency



6.2.1.3 Current chart

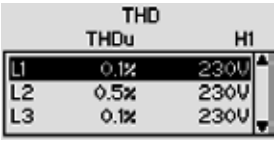
Main menu > Display > System & PQ > Current chart

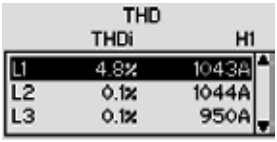
This menu item shows the currents in the individual phases as percentages of the maximum alarm limit. See Section 6.3.2.6, *Current min*, and Section 6.2.3.7, *Current max*, for the current alarm settings.

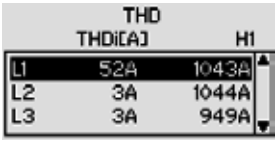


6.2.1.4 THD

Main menu > Display > System & PQ > THD





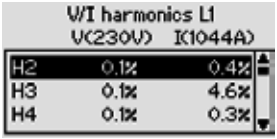


Display of THDv [%], THDi [%] and THDi [A] for each phase in relation to the voltages and currents at the fundamental frequency H1.

6.2.1.5 V/I harmonics

Main menu > Display > System & PQ >V/I harmonics

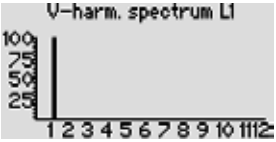
Display of the voltage and current harmonics as percentages together with the fundamental voltage and current.

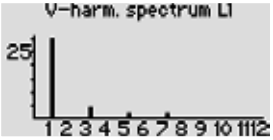


Key	ESC	↑	↓	⇄	i
Function	Back to **System & PQ**	Navigate upwards	Navigate downwards	Change the phase	–

6.2.1.6 V harmonics spectrum

Main menu > Display > System & PQ > V harm. spectrum



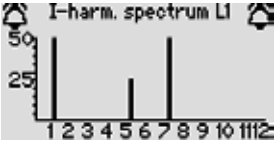


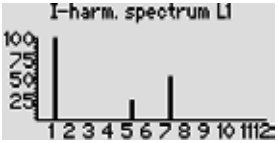
Display of the spectrum up to the 19th harmonic as graphic. The fundamental voltage at 50/60 Hz is defined as 100%. One graduation on the y-axis represents 5%.

Key	ESC	↑	↓	⇄	i
Function	Back to **System & PQ**	Zoom +	Zoom -	Change the phase	Change harmonics 1 – 12/ 8 – 19

6.2.1.7 I harmonics spectrum

Main menu > Display > System & PQ > I harm. spectrum



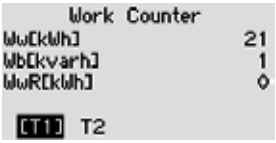


Display of the spectrum up to the 19th harmonic as graphic. The fundamental current at 50/60 Hz is defined as 100%. One graduation on the y-axis represents 5%.

Key	ESC	↑	↓	⇄	i
Function	Back to **System & PQ**	Zoom +	Zoom -	Change the phase	Change harmonics 1 – 12/ 8 – 19

6.2.1.8 Work counter

Main menu > Display > System & PQ > Work counter



Ww Active energy in kWh

Wb Reactive energy (inductive) in kVArh

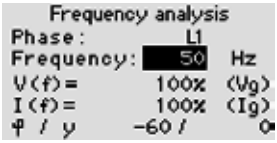
WwR Regenerated active energy in kWh

A volt-free contact for tariff switching can be connected (Tariff 1, HT / Tariff 2, NT), enabling the metering of active and reactive energy to be diverted to a second counter T2.

Key	ESC	↑	↓	⇄	i
Function	Back to **System & PQ**	Change counter	Change counter	Change tariff T1/T2	–

6.2.1.9 Frequency analysis

Main menu > Display > System & PQ > Frequency analysis



Phase Measurement at Lx [1 ≤ X ≤ 3]

Frequency 10–2500 Hz in increments of 10 Hz

V(f) Magnitude of the voltage at the selected frequency as percentage of the fundamental voltage V_G (f = 50/60 Hz)

I(f) Magnitude of the current at the selected frequency as percentage of the fundamental current I_G (f = 50/60 Hz)

Angle φ Angle between $V_{(f)}$ and $I_{(f)}$ in degrees (angle of lag/lead)

Angle γ Angle between $V_{(fundamental)}$ and $I_{(f)}$ in degrees (EN 61000-3-12, EN 50160:2008)

Key	ESC	↑	↓	⇄	i
Function	Info Status	Frequency +10Hz	Frequency -10Hz	Select phase	–

6.2.2 Alarms & Notifications

Main menu > Display > Alarms & Notifications

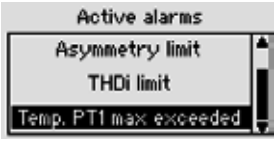
Status of active alarms, alarm history and Min/Max data memory.

6.2.2.1 Active alarms

Main menu > Display > Alarms & Notifications > Active alarms

All currently active alarms are shown in a list. If one of these is selected and the ⇄ key is pressed, details such as the momentary reading are displayed.

The limits for several alarms can be set in the Configuration menu (see Section 6.3.2, *Alarms*). All alarms are listed in Section 9, *Troubleshooting*.



Note

Pressing the i key in any submenu under **Display > System & PQ** displays the **Active alarms** menu.

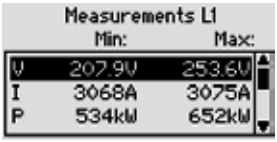
6.2.2.2 Alarm history

Main menu > Display > Alarms & Notifications > Alarm history

The alarm storage function displays the 10 most recently occurring alarms, with the latest alarm at the top and the oldest one at the bottom of the list (sorted by time). Selecting one of the lines shown and pressing the i key causes the alarm condition to be displayed in plain language.

6.2.2.3 Min/Max data

Main menu > Display > Alarms & Notifications > Min/Max data



The Min/Max data memory holds the minimum and maximum values of the following measurement readings:

– Measurement data per phase
  - Voltage
  - Current
  - Power (active, reactive and apparent)
  - System frequency
  - Overcurrent
– Voltage harmonics
– Current harmonics
– Temperatures
  - PT1
  - PT2

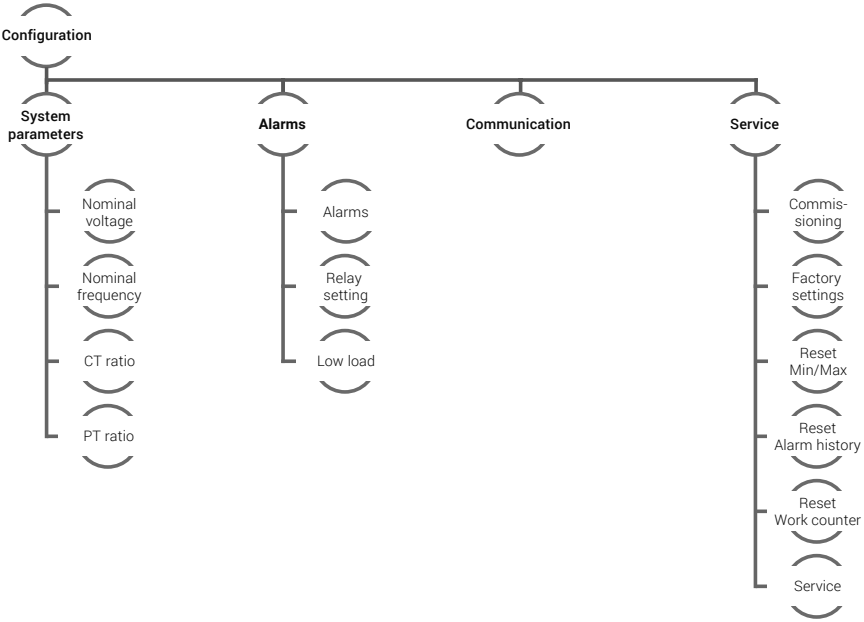
Note

Pressing the [i] key shows the times elapsed since the minimum and maximum values displayed on the screen occurred.

6.3 Configuration

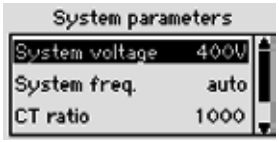
From the Configuration menu, all the parameters relevant to the operation of the PQA can be changed and configured to give user-specific characteristics.

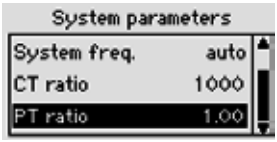
Main menu > Configuration



6.3.1 System parameters

Main menu > Configuration > System parameters





Setting the specific parameters to be monitored for the system:

System nominal voltage Setting range: 60 V–60 kV

System nominal frequency 50 Hz, 60Hz, auto
Automatic mode: The PQA determines the system frequency automatically. In the case of systems with heavy voltage harmonics or commutation notches, it can be necessary to set the system nominal frequency manually to the appropriate value.

Voltage transformer Range 1 to 300 (in increments of 0.01),

PT ratio: $\frac{V_{primary}}{V_{secondary}}$

Current transformer Range 1 to 7000, CT ratio: $\frac{I_{primary}}{I_{secondary}}$

Example: current transformer for 500 A

CT ratio $K = \frac{I_{primary}}{I_{secondary}} = \frac{500A}{5A} = 100$

6.3.2 Alarms

Main menu > Configuration > Alarms

Alarms See Section 6.3.2.1, *Alarms*

Relay setting With this option the action of the alarm relay can be inverted:

- **NO mode** contact closes when an active alarm occurs.
- **NC mode** contact opens when an active alarm occurs.

Low load Sets the user-specific definition of low load operation in W. This parameter serves to inhibit the cos φ and asymmetry alarms when the active power falls below the low load setting.

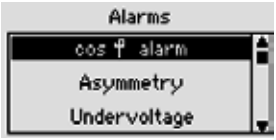
Setting parameter	Setting range	Default
Low load limit P_{min}	0 - 10 MW	2 W

Note

A list of the active and historical alarms is displayed at **Main menu > Display > Alarms & Notifications**. See Section 6.2.2, *Alarms & Notifications*, for further information.

6.3.2.1 Alarms

Main menu > Configuration > Alarms > Alarms



Key	ESC	↑	↓	⇄	i
Function	Back to Alarms	Select limit	Select limit	Select limit to edit	–

Alarm management

When an alarm condition occurs, the PQA offers various actions for signalling or processing the alarm. These can be configured individually for each alarm type.

– Transmission via **alarm relay**
  If the alarm relay function is assigned to an alarm, the alarm relay incorporated in the PQA switches when the alarm occurs (connections: Alarm a, b) and remains in that state as long as the alarm is active.
– **Alarm warning** in the display
  If the alarm display function is assigned to an alarm, an information window pops up in the PQA display. This notification can be acknowledged by pressing the ⇄ key, regardless of whether the alarm condition is still present or not.
– Transmission via **communication channel**
  The PQA has the communication options FRAKO Starkstrombus, Modbus RTU and Modbus TCP, enabling the alarm register to be read remotely for all existing alarms.

Note

The setting possibilities for the alarms are described in the following sections. All alarm notifications are listed in Section 9, *Troubleshooting*.

6.3.2.2 cos φ alarm

Main menu > Configuration > Alarms > Alarms > cos φ alarm

$$\cos \varphi = \frac{P_{total,fundamental}}{S_{total,fundamental}}$$

If the inductive power factor cos φ falls below the set alarm limit when the active power is greater than P_{min}, an alarm is given after a delay of about one minute.

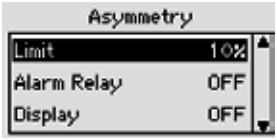
The set limit P_{min} for active power is intended to inhibit a cos φ alarm during periods of low load. See also Section 6.3.2, *Alarms*.

Setting parameter	Setting range	Default	Alarm relay	Display
Cos φ	0.5 cap -0.5 ind	0.92 ind	ON/**OFF**	ON/**OFF**

6.3.2.3 Asymmetry

Main menu > Configuration > Alarms > Alarms > Asymmetry

The maximum permissible percentage differential between the lowest and highest apparent RMS currents in the phases.



$$\text{Asymmetry [\%]} = \left(1 - \frac{I_{min(L1,L2,L3)}}{I_{max(L1,L2,L3)}}\right) \cdot 100\%$$

where I_{min} is the apparent RMS current in the phase with the lowest current and I_{max} is the apparent RMS current in the phase with the highest current.

Note

An asymmetry alarm is only initiated under the following conditions:

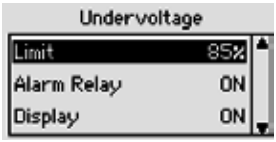
- Asymmetry increases above the set alarm limit.
- The momentary active power is greater than its set low load limit P_{min}, i.e. it is not within the low load zone (see also Section 6.3.2, *Alarms*).

Setting parameter	Setting range	Default value	Alarm relay	Display
Asymmetry [Asym]	0 – 100%	10%	ON/**OFF**	ON/**OFF**

6.3.2.4 Undervoltage

Main menu > Configuration > Alarms > Alarms > Undervoltage

As soon as a voltage reading falls below the set limit, an alarm is initiated. This alarm limit is set as a percentage of the configured system nominal voltage (see Section 6.3.1, *System parameters*).

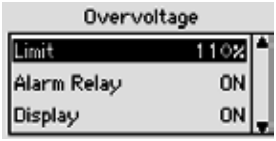


Setting parameter	Setting range	Default value	Alarm relay	Display
Undervoltage	0 – 100%	85%	**ON**/OFF	**ON**/OFF

6.3.2.5 Overvoltage

Main menu > Configuration > Alarms > Alarms > Overvoltage

As soon as a voltage reading rises above the set limit, an alarm is initiated. This alarm limit is set as a percentage of the configured system nominal voltage (see Section 6.3.1, *System parameters*).

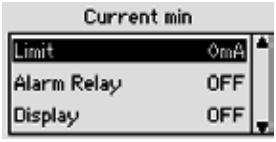


Setting parameter	Setting range	Default value	Alarm relay	Display
Overvoltage	100 – 200%	110%	**ON**/OFF	**ON**/OFF

6.3.2.6 Current min

Main menu > Configuration > Alarms > Alarms > Current min

As soon as a current reading falls below the set limit, an alarm is initiated. This alarm limit is set in A. All currents are monitored continuously in all three phases.



Setting parameter	Setting range	Default value	Alarm relay	Display
Current min [A]	0 – 30 kA	0 A	ON/**OFF**	ON/**OFF**

6.3.2.7 Current max

Main menu > Configuration > Alarms > Alarms > Current max

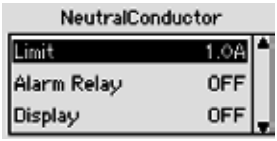
As soon as a current reading rises above the set limit, an alarm is initiated. This alarm limit is set in A. All currents are monitored continuously in all three phases.

Setting parameter	Setting range	Default value	Alarm relay	Display
Current max [A]	0 – 30 kA	5 A	ON/**OFF**	ON/**OFF**

6.3.2.8 Neutral conductor current

Main menu > Configuration > Alarms > Alarms > Neutral current

The upper limit for the RMS current in the neutral conductor.



Setting parameter	Setting range	Default value	Alarm relay	Display
$I_{N\,max}$ [A]	0 – 30 kA	1 A	ON/**OFF**	ON/**OFF**

6.3.2.9 THDi

Main menu > Configuration > Alarms > Alarms > THDi

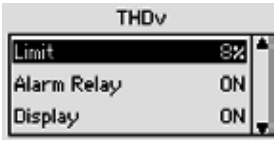
As soon as a THDi reading rises above the set limit, an alarm is initiated.

Setting parameter	Setting range	Default value	Alarm relay	Display
$THD_{\,I\,max\,L1=L2=L3}$	5 – 500 [%]	100%	ON/**OFF**	ON/**OFF**

6.3.2.10 THDv

Main menu > Configuration > Alarms > Alarms > THDv

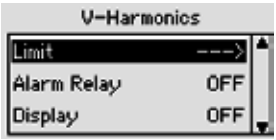
As soon as a THDv reading rises above the set limit, an alarm is initiated.

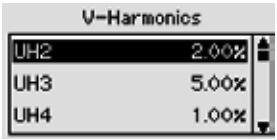


Setting parameter	Setting range	Default value	Alarm relay	Display
THD $_{V\ max\ L1=L2=L3}$	0 – 100%	8% (EN 61000-2-4)	ON/**OFF**	ON/**OFF**

6.3.2.11 V harmonics

Main menu > Configuration > Alarms > Alarms > V harmonics



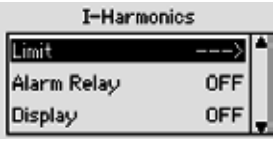


Alarm limit 0% to 100% (in increments of 0.01%)

Setting parameter	Setting range	Default value[1]	Alarm relay	Display
$V_{h02\ max}$	0 – 100 [%]	2	ON/**OFF**	ON/**OFF**
$V_{h03\ max}$	0 – 100 [%]	5		
$V_{h04\ max}$	0 – 100 [%]	1		
$V_{h05\ max}$	0 – 100 [%]	6		
$V_{h06\ max}$	0 – 100 [%]	0.5		
$V_{h07\ max}$	0 – 100 [%]	5		
$V_{h08\ max}$	0 – 100 [%]	0.5		
$V_{h09\ max}$	0 – 100 [%]	1.5		
$V_{h10\ max}$	0 – 100 [%]	0.5		
$V_{h11\ max}$	0 – 100 [%]	3.5		
$V_{h12\ max}$	0 – 100 [%]	0.47		
$V_{h13\ max}$	0 – 100 [%]	3		
$V_{h14\ max}$	0 – 100 [%]	0.43		
$V_{h15\ max}$	0 – 100 [%]	0.4		
$V_{h16\ max}$	0 – 100 [%]	0.41		
$V_{h17\ max}$	0 – 100 [%]	2		
$V_{h18\ max}$	0 – 100 [%]	0.39		
$V_{h19\ max}$	0 – 100 [%]	1.76		

6.3.2.12 I harmonics

Main menu > Configuration > Alarms > Alarms > I harmonics



Alarm limit 0% to 100% (in increments of 0.01%)

Setting parameter	Setting range	Default value	Alarm relay	Display
$I_{h2\ max}$	0 – 100 [%]	100%	ON/**OFF**	ON/**OFF**
– .	–			
$I_{h19\ max}$	0 – 100 [%]	100%		

[1] Default according to EN 61000-2-4

6.3.2.13 Voltage sag

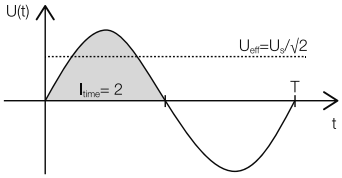
Main menu > Configuration > Alarms > Alarms > Voltage sag

The voltage sag alarm function serves to detect **short-term** voltage sags in all three phases L1/L2/L3 (minimum 10 ms, I_{time} = 2, 50 Hz).

Alarm limit	50% to 93% (in increments of 1%)
Voltage Sag	as percentage (100% = V_{nom}) 50% (insensitive) to 93% (highly sensitive)

The instrument has a default alarm limit setting of 85%, corresponding to 85% of the nominal voltage, following the process described in EN 61000-4-30 (2009) (Class A, V_{RMS} (1/2),V_{rest}).

Setting parameter	Setting range	Default value	Alarm relay	Display
Voltage sag (sag Value) $_{L1/L2/L3}$	50 – 93 [%]	85%	ON/**OFF**	ON/**OFF**

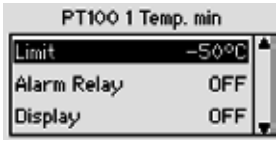


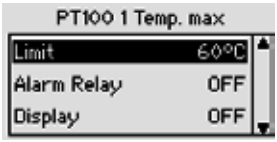
$$SagValue = \sqrt{\frac{1}{T\left(\frac{I_{Time}}{4}\right)}\int_{t_0}^{t_0+T\left(\frac{I_{Time}}{4}\right)} u(t)^2\,dt}$$

6.3.2.14 PT-100-1/2

Main menu > Configuration > Alarms > Alarms > PT-100-1

Main menu > Configuration > Alarms > Alarms > PT-100-2





Setting parameter	Setting range	Default value	Alarm relay	Display
PT100-1 alarm min.	-50 – +200 °C	-50 °C	ON/**OFF**	ON/**OFF**
PT100-1 alarm max.	-50 – +200 °C	60 °C	ON/**OFF**	ON/**OFF**
PT100-2 alarm min.	-50 – +200 °C	-50 °C	ON/**OFF**	ON/**OFF**
PT100-2 alarm max.	-50 – +200 °C	60 °C	ON/**OFF**	ON/**OFF**

6.3.3 Communication

Main menu > Configuration > Communication

As the PQA offers several communication options, the presence of this menu item depends on the type of communication incorporated in the instrument.

6.3.3.1 Modbus TCP (IoT)

DHCP ON

To operate the PQA in DHCP mode, DHCP ON must be selected. The data displayed in this menu (IP, Mask, Gateway) indicate the network settings assigned by the server, meaning that the available services (Modbus TCP, web server) are accessible in the network.

DHCP OFF

To use the Ethernet interface with manual network configuration, the following settings must be made in the PQA:

– IP adress
– Subnet mask
– Gateway (optional)

When these settings have been made, the available services (Modbus TCP, web server) can be accessed in the system.

The PQA is accessible via the Modbus TCP/IP protocol and port 502 at the set IP address. The data that can be retrieved are listed in the FRAKO Modbus Specification.

Note

The web server is only fully functional with the following browsers:

– Mozilla Firefox version 60.0.1 or later

– Google Chrome version 66.0.3359.181 or later.

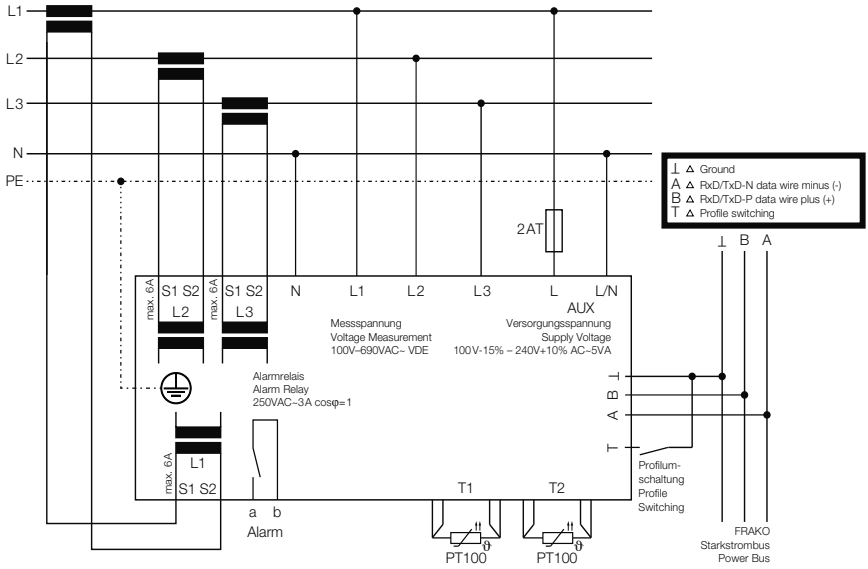
The PQA allows a maximum of 2 simultaneous connections.

Note

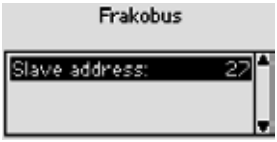
For additional information on the optional Ethernet interface please refer to the PQA Application Note.

6.3.3.2 FRAKO Starkstrombus (Frakobus)

Frakobus connections

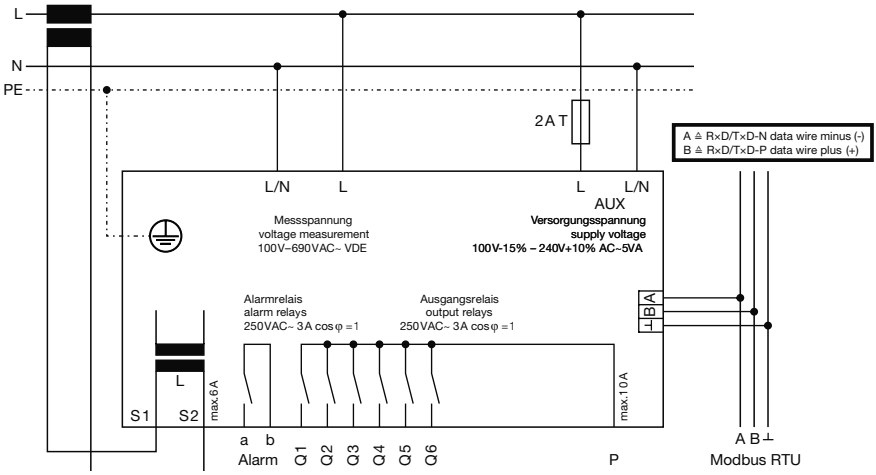


The PQA bus address can be set either at the instrument itself or via the FRAKO Energy Management System.

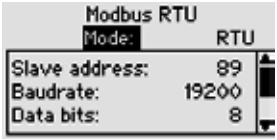


6.3.3.3 Modbus RTU

Modbus RTU connection



The following parameters can be set in the Modbus configuration menu:



Bus adress	The PQA is accessed at the set bus address
Baud rate	1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200
Data bits	5 to 8
Stop bits	1 or 2
Parity	even, odd or none

Note

Further details are described in the Modbus Specification.

6.3.4 Service

Main menu > Configuration > Service (password protected)

6.3.4.1 Commissioning

Main menu > Configuration > Service > Commissioning

See Section 5.3.2, *Initial start-up.*

6.3.4.2 Factory default settings

Main menu > Configuration > Service > Factory default settings

Reset PQA to the factory default settings.

6.3.4.3 Reset Min/Max

Main menu > Configuration > Service > Reset Min/Max

Reset all Min/Max values.

6.3.4.4 Reset Alarm history

Main menu > Configuration > Service > Reset Alarm history

Reset the alarms recorded up until the present.

6.3.4.5 Reset Work counter

Main menu > Configuration > Service > Reset Work counter

Reset the work counter readings for Tariffs T1 and T2 totalized up until the present time.

6.3.4.6 Service

Main menu > Configuration > Service > Service

Optional service functions.

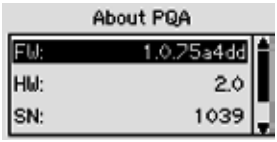
Temp-I/O Update Software update mode for Temp I/O

Temp I/O CLI	for FRAKO service
IoT Update	Software update mode for IoT
IoT CLI	for FRAKO-Service
Frakobus update	Software update mode for Frakobus

6.4 About PQA

Main menu > About PQA

This menu item gives information about the instrument:



FW	Firmware version number
HW	Hardware version number
SN	Serial number
Sys Time	Operating hours

6.5 Factory default settings

Main menu > Configuration

Menu	Parameter	Hysteresis [%] / T_{on} [s] / T_{off} [s]	Alarm route/Value
System parameters (Section 6.3.1, *System parameters)*			
System parameters	Nominal voltage	–	400 V AC
	Nominal frequency	–	Auto
	Current transformer ratio	–	1
	Voltage transformer ratio	–	1
Alarms (Section 6.3.2, *Alarms*)			
Relay	Relay setting	–	NO (Normally Open)
cos φ alarm	Alarm limit	–	0,95
	Alarm relay	1.5% / 60 / 5	OFF
	Display	5 / 60 / 5	OFF
Asymmetry	Asymmetry	–	10%
	Alarm relay	1.5% / 5 / 5	OFF
	Display	1.5% / 5 / 5	OFF
Voltage	V_{min}	–	85%
	V_{max}	–	110%
	Alarm relay	1.5 / 30 / 5	ON
	Display	1.5 / 30 / 5	ON

Menu	Parameter	Hysteresis [%] / T_{on} [s] / T_{off} [s]	Alarm route/Value	
Current	I min	–	10 mA x CT ratio	
	I max	–	5 A x CT ratio	
	Alarm relay	1.5 / 60 / 60	OFF	
	Display	1.5 / 60 / 60	OFF	
THDi	Alarm limit	2.0 / 60 / 60	100%	
	Alarm relay	2.0 / 60 / 60	OFF	
	Display	2.0 / 60 / 60	OFF	
THDv	Alarm limit	1.5 / 60 / 60	8%	
	Alarm relay	1.5 / 60 / 60	OFF	
	Display	1.5 / 60 / 60	OFF	
V harmonics	Alarm limit	1.5 / 60 / 60	Harmonic 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19	% 2 5 1 6 0.5 5 0.5 1.5 0.5 3.5 0.47 3 0.43 0.4 0.41 2 0.39 1.76
	Alarm relay	1.5 / 60 / 60	OFF	
	Display	1.5 / 60 / 60	OFF	
I harmonics	Alarm limit	1.5 / 60 / 60	100% for all (IH2 to IH19)	
	Alarm relay	1.5 / 60 / 60	OFF	
	Display	1.5 / 60 / 60	OFF	
Voltage sag	*Sensitivity*	– / – / –	85%	
	Alarm relay	– / – / –	OFF	
	Display	– / – / –	OFF	

Menu	Parameter	Hysteresis [%] / T_{on} [s] / T_{off} [s]	Alarm route/Value
Communication (Section 6.3.3, *Communication*)			
Modbus RTU	Slave address	0	
	Baud rate	19200	
	Data bits	8	
	Parity	None	
	Stop bits	1	
Modbus TCP	DHCP	ON	
	IP	192.168.0.61	
	Subnet	255.255.255.0	
	Gateway	192.168.0.1	
Starkstrombus	Device address	– / – / –	0
Temperatures (Section 6.3.2.14, *PT-100-1/2*)			
Temperatures	Temperature units	– / – / –	°C
	Alarm limit PT100-1	1.5K / 5 / 5	50 °C
	Display PT100-1	1.5K / 5 / 5	ON
	Alarm relay PT100-1	1.5K / 5 / 5	ON
	Alarm limit PT100-2	1.5K / 5 / 5	50 °C
	Display PT100-2	1.5K / 5 / 5	ON
	Alarm relay PT100-2	1.5K / 5 / 5	ON

6.6 Service interface

The PQA has a service interface in the form of a Micro USB port. This is used for servicing tasks such as firmware updates.

Note

This interface is solely for the use of trained FRAKO Service personnel.

For further information concerning firmware updates please contact FRAKO Service by telephone at +49 7641 453 544 or by e-mail at service@frako.de.

7 General operation

The following points must be observed when the PQA is operated:

– The instrument must always be operated in a closed control cabinet.

– All voltages applied to the instrument must never exceed the limits specified in the technical data.

– The ambient temperatures must always be within the range specified in the technical data.

8 Cleaning and maintenance

8.1 Safety during cleaning and maintenance

WARNING!

Danger from electricity!

There are dangerous voltages inside the PQA. Touching live components in the PQA or at the instrument terminals and connecting cables can cause serious injury or may even be life-threatening.

- Do not open the PQA casing.
- During cleaning and maintenance, the PQA and the connecting cables must be isolated from the power supply.
- The isolated electrical system must be locked out and tagged out to prevent its being inadvertently switched on again.
- All connections must be checked to verify that they are no longer live.
- All live components in the immediate vicinity must be covered.

8.2 Cleaning

The PQA may only be cleaned with a dry cloth. Do not use aggressive or abrasive cleaning agents or solvents.

8.3 Maintenance

The PQA does not contain any components that need maintenance.

9 Troubleshooting

If alarms occur during operation of the PQA, the following table provides assistance in identifying and remedying the faults.

Alarm notification	Fault	Possible cause	Remedial action
	PQA does not function, no display on the screen.	No power—or the wrong voltage—connected.	Check that the correct instrument power supply is connected and that the fuse in the circuit has not blown.
Under-voltage	PQA indicates or states that voltage is less than set alarm limit, although a voltage is shown on the screen.	The alarm limit has not been adjusted for the system nominal voltage.	Set the correct alarm limit for the system nominal voltage (see Section 6.3.1, *System parameters*).
Undercurrent	No value for current shown in the display (0 A)	Break or short circuit in the current transformer cable.	Use an ammeter to check current in current path ($I_{min} \geq 0.015$ A). Danger: see Section 5.2.7, *Current measurement*.
		The current in the current path is too low.	($I_{min} \geq 0.015$ A) Install a smaller current transformer.
		Defective current transformer	Check the current transformer.
Undervoltage + Undercurrent	PQA shows no measured voltage and no current, although it has been verified that power is connected and a current is flowing.	Multiple zero-voltage crossings in measured voltage.	Settings for the system nominal parameters → Change setting from Auto to the appropriate system frequency (50 Hz or 60 Hz).
V harm. > set limit	Voltage harmonics in system too high		

Alarm notification	Fault	Possible cause	Remedial action
Voltage sag		Short-time voltage sag Triggered if a voltage sag causes the RMS voltage to fall below the set limit within the duration of a half-wave.	
	The LCD backlighting comes on briefly then goes off again, while the LCDs display nothing or only the starting logo – the instrument restarts repeatedly.	Instrument power supply voltage is too low.	Check whether the correct voltage is reaching the PQA. Is there a high contact resistance in the power supply circuit?

Note

Additional error notifications are described in the *PQA Application Note*.

10 Decommissioning and removal, storage and disposal

10.1 Decommissioning the PQA

WARNING!

Danger from electricity!

Touching live components at the instrument terminals and connecting cables can cause serious injury or may even be life-threatening.

- Installation, commissioning and decommissioning of the PQA may only be carried out by appropriately qualified personnel who have read and understood the content of this manual.
- To decommission the PQA, switch off the power and isolate the instrument and its system.
- The isolated electrical system must be locked out and tagged out to prevent its being inadvertently switched on again.
- It must be verified that none of the terminals are live.
- All live components in the vicinity must be covered to prevent inadvertent contact.

CAUTION!

Danger from heat!

The instrument terminals can become hot during operation and could cause burns.

- After the PQA has been operating, sufficient time must be allowed for the instrument and its terminals to cool down before work is carried out on the connections.

ATTENTION!

Risk to equipment!

If the exposed ends of disconnected cables come into contact with each other, this can result in short-circuits and overloading of the installation conductors, resulting in damage to equipment.

- All disconnected cables must be individually isolated and insulated, and measures must be taken to prevent their inadvertent contact with live components or electrically conducting parts.

1. Current transformers must be short-circuited.
2. Remove all cables from the PQA.
3. Individually isolate and insulate all disconnected cables and take measures to prevent their inadvertent contact with live components or electrically conducting parts.

10.2 PQA removal

The PQA is held in place against the rear of the cabinet front wall by four retaining lugs in the corners of the instrument. These can be released by undoing the retaining screws.

1. Turn all four screws anticlockwise with a screwdriver. This slackens the four retaining lugs and swivels them to lie flush behind the PQA front panel.
2. Withdraw the PQA from the front of the cabinet.

10.3 Storage

– The PQA must be stored in a clean, dry and dust-free location.
– The storage temperature must be within the range -20 °C to +80 °C.

10.4 Disposal

Any electronic instrument that is no longer required must be disposed of in an environmentally sound manner.

ATTENTION!

Risk to the environment from equipment!

Incorrect disposal can cause environmental pollution.

– Dispose of the instrument in compliance with the regulations of the country concerned.

In the European Union, electrical scrap and electronic components are subject to the WEEE (Waste Electrical and Electronic Equipment) Directive. These components must not be disposed of as normal domestic or commercial waste. In other countries, the equivalent local regulations must be followed when electronic instruments are disposed of. They must be handed in at special recycling centres.

One way of ensuring environmentally sound disposal is to return the instruments to FRAKO Kondensatoren- und Anlagenbau GmbH in Teningen, Germany, or the company's local representatives. Alternatively, the instruments can be given to a firm specializing in the recycling of electronic equipment.

11 Notes

Power capacitors
Reactive power control relays
Power factor correction systems
Modules
EMS components
Measuring instruments and network analyzers
Power quality
EMS ISO 50001

FRAKO Kondensatoren- und Anlagenbau GmbH
Tscheulinstraße 21a
D-79331 Teningen
Tel: +49 7641 453-0
Fax: +49 7641 453-535
sales@frako.de
www.frako.com

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