KACO new energy.

KACO blueplanet 87.0 TL3
KACO blueplanet 92.0 TL3
KACO blueplanet 110 TL3
KACO blueplanet 125 TL3
KACO blueplanet 137 TL3
KACO blueplanet 150 TL3
S

Manual

■ English translation of German original

⚠ Authorised electrician

Important safety instructions

These instructions form part of the product and must be carefully read, observed and stored in a place which is freely accessible at all times.

Legal provisions

KACO warranty

The latest version of our warranty conditions is available for download at http://www.kaco-newenergy.com.

Definition of the product designation

In these operating instructions, the product "Photovoltaic feed-in inverter" is referred to as "device" for ease of reading.

Trademarks

Software

This device contains open source software that has been developed by third parties. The software is licensed, amongst others, under GPL and LGPL.

Other details regarding this topic and a list of the open source software used as well as the associated license texts can be found in the info display of the web interface under "license list".

KACO new energy.

Operating Instructions

Photovoltaik feed-in inverter

EN-US

Table of contents

1 General information

1.1 About this document

Other applicable documents

During installation, observe all assembly and installation instructions for components and other parts of the system. These instructions also apply to the equipment, related components and other parts of the system.

Some of the documents which are required for the registration and approval of your system are included with the operating instructions.

You can find links to further information at www.kaco-newenergy.com

Document title	Type of document
Technical data sheet	Product flyer
Remote access via web user interface	Instructions for use - operation
Grid protection and safety parameters Standard parameters	Instructions for use
Modbus© protocol RS485 protocol reactive power control	Instructions for use
SunSpec information model reference SunSpec information model reference KACO	Excel files regarding software version
Software package	ZIP/KUF files for current software
EU Declaration of Conformity Country-specific certificates Module-specific certification	Certification

Storing the documents

These instructions and other documents must be stored near the plant and be available at all times.

- You can download the current version of the operating instructions at www.kaco-newenergy.com.

English translation of German original

These operating instructions have been produced in several languages. The German-language version of the operating instructions is the original version. All other language versions are translations of the original operating instructions.

Scope of validity

This document is valid for the following types of device from firmware version V1.2x onwards

Type designation	KACO blueplanet 87.0 TL3 M1 WM OD IIF0
	KACO blueplanet 92.0 TL3 M1 WM OD IIG0
	KACO blueplanet 110 TL3 M1 WM OD IIK0
	KACO blueplanet 125 TL3 M1 WM OD IIP0
	KACO blueplanet 137 TL3 M1 WM OD IIP0
	KACO blueplanet 150 TL3 M1 WM OD IIQ0

1.2 Layout of Instructions

1.2.1 Symbols used

	General hazard		Fire and explosion hazard
	Electrical voltage		Risk of burns

	Earthing - ground conductor		
	The device conforms to the requirements of the FCC standard	Intertek	UL 1741 is the standard applied to the device by the underwriter laboratories as evidence that it conforms to the requirements of the National Electrical Code®, the Canadian Electrical Code® CSA C22.1 and IEEE1547

1.2.2 Guide to safety instructions

⚠ DANGER

Immediate danger

Failure to observe this warning will lead directly to serious bodily injury or death.

⚠ WARNING

Potential danger

Failure to observe this warning may lead to serious bodily injury or death.

⚠ CAUTION

Low-risk hazard

Failure to observe this warning will lead to minor or moderate bodily injury.

⚠ CAUTION

Risk of damage to property

Failure to observe this warning will lead to property damage.

1.2.3 Additional information symbols

NOTE

Useful information and notes

Information that is important in relation to a specific topic or objective but is not related to safety.

1.2.4 Layout of action steps

↻ Pre-requisite for the action

1 Carry out first action step

2 Next action step

⇨ Intermediate outcome of the action step

» Final outcome

1.3 Identification

You will find the name plate with the following data for service and other requirements specific to installation on the right side panel of the product:

- Product name
- Part no.
- Serial no.
- Date of manufacture
- Technical data
- Disposal information
- Certification marking, CE marking.

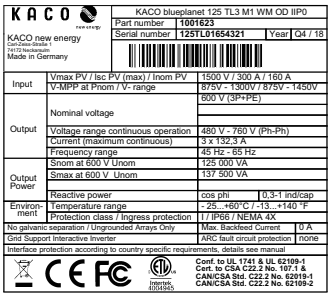


Fig. 1: Name plate

1.4 Warnings on the device

A warning sticker is affixed to the device. Read the warnings carefully.

Do not remove the sticker. If the sticker is missing or is illegible, please contact a KACO representative or distributor.

- Article number:

Fig. 2: Warning sticker

1.5 Target group

All activities described in the document may only be carried out by specially trained personnel with the following qualifications:

- Knowledge about how an inverter functions and operates.
- Training in the handling of hazards and risks during the installation and operation of electrical units and plants.
- Education concerning the installation and start-up of electrical units and plants.
- Knowledge of applicable standards and directives.
- Knowledge and adherence to this document with all safety notices.

2 Safety

Please read this safety information carefully before using the device for the first time.

⚠ DANGER

Lethal voltages are still present in the connections and cables of the device even after the device has been switched off and disconnected!

Severe injuries or death may occur if the cables and/or terminals/busbars in the device are touched.

- The device must be mounted in a fixed position before being connected electrically.
- Observe all safety regulations and current technical connection specifications of the responsible power supply company.
- The device may only be opened and serviced by an authorized electrician.
- Switch off the grid voltage by turning off the external circuit breakers.
- Do not touch the cables and/or terminals/busbars when switching the device on and off.
- Keep the device closed when it is in operation.

The electrician is responsible for observing all existing standards and regulations. This includes:

- Keeping unauthorized persons away from the device/system.
- In particular, making sure that the locally applicable version of the standard [1] "Requirements for special installations or locations – solar photovoltaic (PV) power supply systems" is observed.
- Ensuring operational safety by providing proper grounding, conductor dimensioning and appropriate protection against short circuiting.
- Observing all safety instructions on the device and in these operating instructions.
- Before performing visual inspections and maintenance, switching off all voltage sources and securing them against being inadvertently switched back on.
- When taking measurements while the device is live:
  - Not touching the electrical connections
  - Removing all jewelry from wrists and fingers
  - Ensuring that the testing equipment is in safe operating condition.
- Modifications to the surroundings of the device must comply with the applicable national standards.
- When working on the PV generator, it is also necessary to switch off the DC voltage with the external DC isolator switch (e.g. at the string combiner or the KACO DC switchbox) in addition to disconnecting the PV generator from the grid.

2.1 Intended use

The device is a transformerless PV inverter which converts the direct current of the PV generator into grid-compatible three-phase alternating current and then feeds the three-phase alternating current into the public power grid.

The device is built using state-of-the-art technology and in accordance with the recognized safety rules. Nevertheless, improper use may cause lethal hazards for the operator or third parties or may result in damage to the device and other property.

The device is intended for indoor and outdoor applications and may only be used in countries for which it has been approved or for which it has been released by KACO new energy and the grid operator.

[1]

Country	Standard
EU	Harmonized document - HD 60364-7-712 (European implementation of the IEC standard)
USA	PV section of NEC 690 and sections in article 100, 690.4, 690.6 and 705.10

Tab. 1: Examples of standards specific to business premises

Operate the device only with a permanent connection to the public power grid. The country and grid type selection must be commensurate with the respective location and grid type.

For grid connection, the requirements of the grid operator must be implemented. In addition, the authorisation to connect to the grid may be subject to approval by the responsible authorities.

The enclosed documentation is an integral part of the product. The documentation must be read, observed and stored in a place which is freely accessible at all times.

The name plate must be permanently attached to the product.

Any other use is regarded as unintended use.

This includes:

- Use of a distribution system that is not described (grid type)
- Use of sources other than PV-strings.
- Mobile use
- Use in rooms where there is a risk of explosion
- Use in direct sunlight, rain or a storm or in other tough environmental conditions
- Outdoor use in environmental conditions that exceed the limits stated in the technical specifications >Environmental data.
- Operation outside the specifications prescribed by the manufacturer
- Overvoltage of over 1500 V at the DC connection
- Modifying the device
- Stand-alone operation

2.2 Protection features

The following monitoring and protection functions are built-in:

- Overvoltage conductor/varistor to protect the power semiconductors from high-energy transients on the grid and generator side
- Device temperature monitoring system
- EMC filters to protect the product from high-frequency grid interference
- Grid-side grounded varistors to protect the product against burst and surge impulses
- Islanding detection (anti-islanding) according to the current standards
- IMI (Isolation Monitoring Interrupter) detection of a generator insulation fault.

3 Device description

3.1 Function

The device converts the DC voltage generated by the PV modules into AC voltage and feeds it into the grid. The starting procedure begins when there is sufficient sunlight and a specific minimum voltage is present in the device. The feed-in process begins once the PV generator has passed the insulation test and the grid parameters are within the requirements imposed by the grid operator for a specific monitoring time. If, as it gets dark, the voltage drops below the minimum voltage value, feed-in mode ends and the device switches off.

3.2 Structure of the device

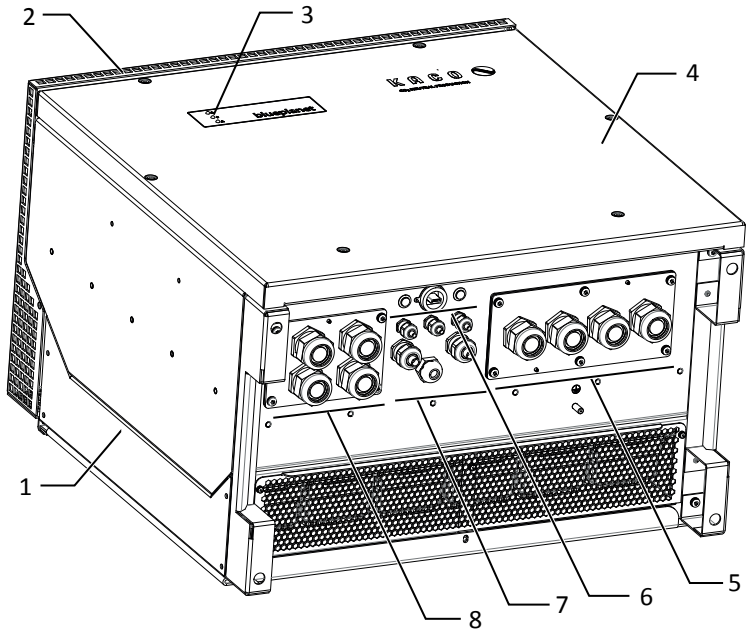


Fig. 3: Structure of the device

1	Housing	5	AC connection / gland
2	Cover	6	Communication / button / USB port
3	Status indicator	7	Interface / gland
4	Top panel	8	DC connection / gland

3.2.1 Electrical functions

A potential-free relay contact is integrated into the device. Use this contact for one of the following functions:

Fault signal relay

The potential-free relay contact closes as soon as there is a fault during operation. You use this function, for example, to signal a fault visually or acoustically.

3.2.2 Interfaces

You can configure the interfaces and the webserver in the Settings menu. The device has the following interfaces for communication and remote monitoring:

Ethernet interface

The device features two switched Ethernet ports to enable the user to, for example, connect several devices in series if the user prefers a linear topology.

RS485-Interface

The device features two RS485-Interfaces. One RS485-Interface is earmarked for communication with a string-combiner-box. This can be controlled using the Modbus RTU protocol. Data loggers that cannot be connected via Ethernet can be connected to the other RS485-Interface. The Sunspec and KACO protocol are supported in this case.

USB interface

The device's USB connection is a type A socket. It is located on the connection board on the underside of the device under a cover. The USB connection is specified to draw 500 mA of power.

Use the USB interface to read out stored operating data, load software updates or device configurations using a FAT32-formatted USB stick.

It is possible to establish a connection to the webserver integrated into the device by connecting a USB-WiFi stick. In addition to starting up the device, the web interface can be used for service information purposes, software updates and for carrying out extensive configuration.

"Inverter Off" input

If Powador protect is installed as a central grid and system protection, the fail-safe disconnection of suitable KACO inverters from the public grid can be initiated by a digital signal instead of tie circuit-breakers. This requires the inverters in the photovoltaic system to be connected to the Powador protect.

If a Powador-protect is used for fast shutdown, it must be used as grid protection. The RS485 interface is not required for this.

Information on installation and use can be found in this manual, in the Powador protect manual and in the instructions for use of the Powador protect on the KACO web site.

Alternatively, it is also possible to connect an external device to the "Inverter Off" input in order to disconnect the device from the grid.

Digital inputs

It is possible to enhance the device with additional digital inputs by way of an expansion module (available from KACO Customer Service). This can be used to connect a ripple control receiver or a protective shutdown system.

3.3 Plant layout

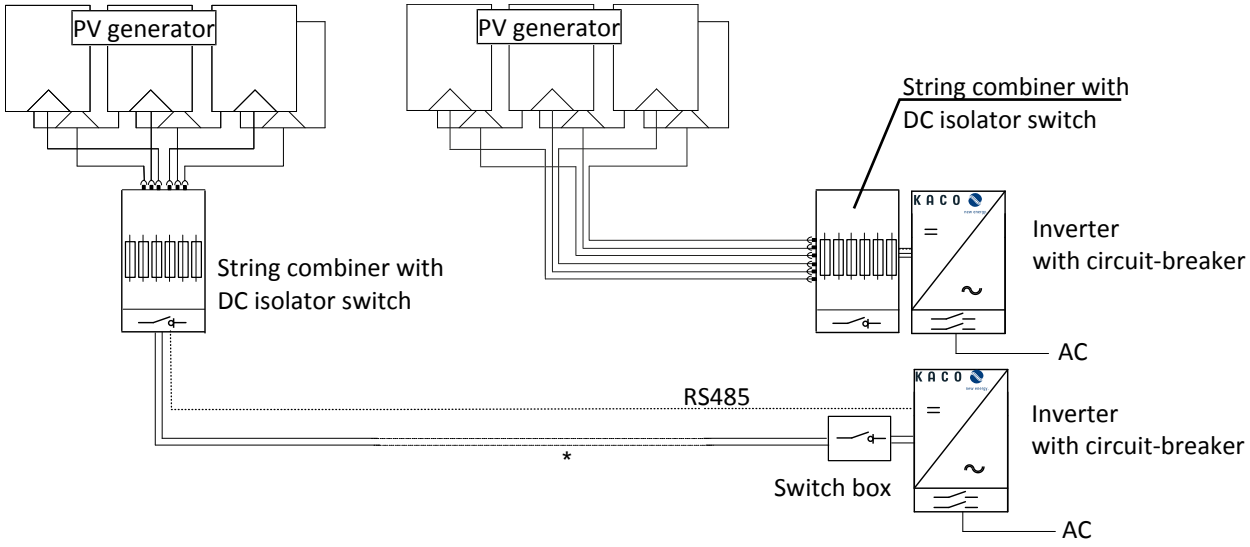


Fig. 4: Circuit diagram with a short or long supply cable to the inverter

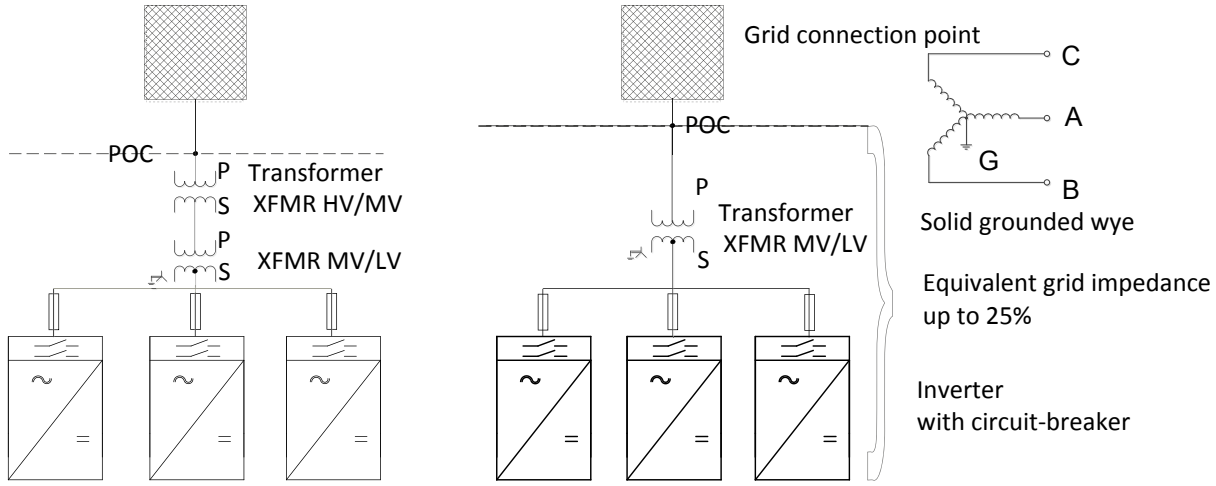


Fig. 5: Circuit diagram from the grid connection point to the inverter

Legend	Definition / Information about the connection
PV generator	The PV generator converts the radiant energy of sunlight into electrical energy.
String combiner	A string combiner can be coupled to the KACO device so that the DC lines can be combined. *) If the supply cable from the PV generator to the device is long, the string combiner can also be installed in the vicinity of the PV generator. An integrated DC isolator switch enables disconnection on the DC-side.
Switch box	A switch box with integrated DC isolator switch enables disconnection from the inverter on the DC-side.
Inverter with circuit-breaker	The PV generator is connected to the device's DC connection.
Transformer	All three phases need to be set up on the medium-voltage transformer or medium-voltage/high-voltage transformer. In this case, the total impedance of the transformer stations must be below 25%.
Grid connection point	The clean PV-current is made available at the grid connection point.

4 Technical data

4.1 Electrical data

	KACO blue-planet 87.0 TL3 M1 WM OD IIF0	KACO blue-planet 92.0 TL3 M1 WM OD IIG0	KACO blue-planet 110 TL3 M1 WM OD IIK0	KACO blue-planet 125 TL3 M1 WM OD IIP0	KACO blue-planet 137 TL3 M1 WM OD IIP0	KACO blue-planet 150 TL3 M1 WM OD IIQ0
Recommended generator power range	130.5 kW	138 kW	165 kW	187.5 kW	205.5 kW	225 kW
MPPrange@Pnom	563 V - 1300 V	591 V-1300 V	705 V-1300 V	875 V-1300 V	875 V -1300 V	960 V-1300 V
Working range	563 V - 1450 V	591 V-1450 V	705 V-1450 V	875 V-1450 V	875 V -1450 V	960 V-1450 V
Rated voltage	600 V	620 V	730 V	900 V		1000 V
Starting voltage	645 V	675 V	805 V	1000 V	1000 V	1100 V
Open circuit voltage	1500 V					
Max. input current	160 A					
Number of strings	1-2					
Number of MPP controls	1					
Max. short-circuit current (ISC max.) [A]	300 A					
Input source feedback current	0 A					
Polarity safeguard	no					
String fuse	no					
DC overvoltage protection	Yes					

	KACO blue-planet 87.0 TL3 M1 WM OD IIF0	KACO blue-planet 92.0 TL3 M1 WM OD IIG0	KACO blue-planet 110 TL3 M1 WM OD IIK0	KACO blue-planet 125 TL3 M1 WM OD IIP0	KACO blue-planet 137 TL3 M1 WM OD IIP0	KACO blue-planet 150 TL3 M1 WM OD IIQ0
AC Output levels	Output levels (AC)					
Nominal power	87 kVA	92 kVA	110 kVA	125 kVA	137 kVA	150 kVA
Rated voltage	380 V (3P+PE)	400 V (3P+PE)	480 V (3P+PE)	600 V [3P+PE]	600 V (3P+PE)	660 V (3P+PE)
Voltage range: continuous operation	300 V - 580 V			480 V - 760 V		
Rated current	3 x 132.3 A				3 x 120.3 A	3 x 132.3 A
Max. continuous current	3 x 132.3 A					
Contribution to peak short-circuit current ip	193 A					
Initial short-circuit alternating current (Ik" first single period effective value)	137 A					
Duration of short-circuit alternating current (max output fault current) [ms]	134 A					
inrush current	5 A [RMS (20ms)]					
Rated frequency	50/60 Hz					
Frequency range	45 - 65 Hz					
Reactive power	0-100 % Snom					
cos phi	1 - 0.3 ind/cap					
Number of feed-in phases	3					
Distortion factor (THD)	< 3 %				3 %	2.8 %

	KACO blue-planet 87.0 TL3 M1 WM OD IIF0	KACO blue-planet 92.0 TL3 M1 WM OD IIG0	KACO blue-planet 110 TL3 M1 WM OD IIK0	KACO blue-planet 125 TL3 M1 WM OD IIP0	KACO blue-planet 137 TL3 M1 WM OD IIP0	KACO blue-planet 150 TL3 M1 WM OD IIQ0
Max. voltage range (up to 100 s)	625 V			825 V		
AC overvoltage protection	Base					

4.2 General Data

	KACO blue-planet 87.0 TL3 M1 WM OD IIF0	KACO blue-planet 92.0 TL3 M1 WM OD IIG0	KACO blue-planet 110 TL3 M1 WM OD IIK0	KACO blue-planet 125 TL3 M1 WM OD IIP0	KACO blue-planet 137 TL3 M1 WM OD IIP0	KACO blue-planet 150 TL3 M1 WM OD IIQ0
General electrical data						
Max. efficiency	99.0 %	98.8 %	99.1 %	99.2 %		
European efficiency	98.6 %	98.5 %	98.8 %	99.0 %		
Self consumption: Standby	< 10 W					
Feed-in from	> 200 W					
Transformer unit	no					
Protection class / over voltage category	I / III					
Grid monitoring	Country-specific					
Distribution system	TN-C system, TT system, Solid grounded wye					

	KACO blue-planet 87.0 TL3 M1 WM OD IIF0	KACO blue-planet 92.0 TL3 M1 WM OD IIG0	KACO blue-planet 110 TL3 M1 WM OD IIK0	KACO blue-planet 125 TL3 M1 WM OD IIP0	KACO blue-planet 137 TL3 M1 WM OD IIP0	KACO blue-planet 150 TL3 M1 WM OD IIQ0
General Data						
Display	LEDs					
Controls	Button / web server					
Menu languages	EN; DE; FR; IT; ES; PL; NL; PT; CZ; HU; SL; TR; RO					
Interfaces	2 x Ethernet, USB, 2x RS485 (1x reserved for string combiner com.), optional: 4-DI	2 x Ethernet, USB, 2x RS485 (1x reserved for string combiner com.), optional: 4-DI				
Communication	0					
Potential-free relay	yes (integrated switch)					
DC isolator switch	no					
AC isolator switch	no					
Cooling	temp. regulated fan, max air throughput 364 m³/h					
Number of fans	3x outside, 1x inside					
Noise emission	<60 db(A)					
Housing material	AL					
HxWxD	719 mm x 699 mm x 460 mm					
Weight	78.2 kg					
Certifications	Overview: see homepage, download area					

4.3 Environmental data

	KACO blue-planet 87.0 TL3 M1 WM OD IIF0	KACO blue-planet 92.0 TL3 M1 WM OD IIG0	KACO blue-planet 110 TL3 M1 WM OD IIK0	KACO blue-planet 125 TL3 M1 WM OD IIP0	KACO blue-planet 137 TL3 M1 WM OD IIP0	KACO blue-planet 150 TL3 M1 WM OD IIQ0
Installation height	3000m (derating from 2000m)					
Installation distance from coast	>500 m					
Ambient temperature	-25 °C - 60 °C					
Power derating from	> 45 °C					
Protection rating (KACO installation location)	IP66 / NEMA 4X					IP66 /NEMA 4X
Humidity range (non-condensing) [%]	100 %					

4.4 Accessories

Accessory articles	KACO order no.
KACO blueplanet DC-Breaker	1001860

Accessory articles	KACO order no.
AC inverter overvoltage protection kit	1001884
DC inverter overvoltage protection kit	1001885
LAN inverter overvoltage protection kit	1001886
RS485 inverter overvoltage protection kit	1001887
PID connection set	1001888
WLAN adapter, Digitus 150N micro	3013222

5 Transportation and Delivery

Every device leaves our factory in perfect electrical and mechanical condition. Special packaging ensures that the units are transported safely. The shipping company is responsible for any transport damage that occurs.

5.1 Scope of delivery

- Inverter
- Mount
- Installation kit
- Brief instructions [in several languages]

Checking the scope of supply

1. Inspect your device thoroughly.
2. Immediately notify the shipping company in case of the following:
   - Damage to the packaging that indicates that the device may have been damaged.
   - Obvious damage to the device.
3. Send a damage report to the shipping company immediately.
4. The damage report must be received by the shipping company in writing within 6 days following receipt of the device. We will be glad to help you if necessary.

5.2 Transporting the unit

⚠ CAUTION

Impact hazard, risk of breakage to the device!

› Pack the device securely for transport.

› Transport the device using the carrying handles provided on the packaging box.

› Do not subject the device to shocks.

For safe transportation of the device, use the holding openings in the cardboard box.

Packaging	Folding cardboard box
Height x width x depth	31,1x29,9x21,6 inch
Total weight	182 lb

5.3 Installation tools

The abbreviations listed in the following table are used when referring to the tools and tightening torques to be used in all assembly/installation/maintenance and disassembly instructions.

Abbreviations (en)	Contour of the connecting element
W	External hex
A	Internal hex
T	Torx
S	Slot

Tab. 2: Tool abbreviations legend

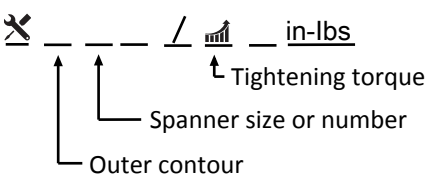


Fig. 6: Presentation format

6 Installation and preparation

6.1 Selecting an installation location

⚠ DANGER

Risk of fatal injury due to fire or explosions

Fire caused by flammable or explosive materials in the vicinity of the device can lead to serious injuries.

› Do not mount the device in an area at risk of explosion or in the vicinity of highly flammable materials.

⚠ CAUTION

Property damage due to gases that have an abrasive effect on surfaces when they come into contact with ambient humidity caused by weather conditions!

The housing of the device may be seriously damaged by gases (ammonia, sulfur, etc.) if it comes into contact with ambient humidity caused by weather conditions.

› If the device is exposed to gases, it must be installed in a location that is visible.

› Perform regular visual inspections.

› Immediately remove any moisture from the housing.

› Ensure that there is sufficient ventilation at the installation location.

› Immediately remove dirt, especially on vents.

› Failure to observe these instructions may result in damage to the device which is not covered by the warranty.

NOTE

Access by maintenance personnel for service

Any additional costs arising from unfavorable structural or mounting conditions shall be billed to the customer.

Installation space

- As dry as possible, climate-controlled, the waste heat must be dissipated away from the device.
- Unobstructed air circulation.
- Close to the ground, accessible from the front and sides without requiring additional resources.
- Protected on all sides against direct weather exposure and sunlight (thermal heating) in outdoor areas. Implementation where necessary via constructional measures, e.g. wind breaks.

Installation surface

- Must have adequate load-bearing capacity
- Must be accessible for installation and maintenance
- Must be made out of heat-resistant material (up to 194 °F)
- Flame-retardant
- Minimum clearances to be observed during installation: [See figure 14] [▶ Page 18]

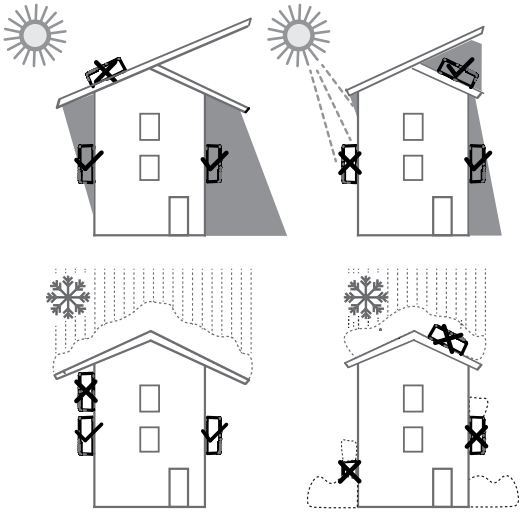


Fig. 7: Device for outdoor installation

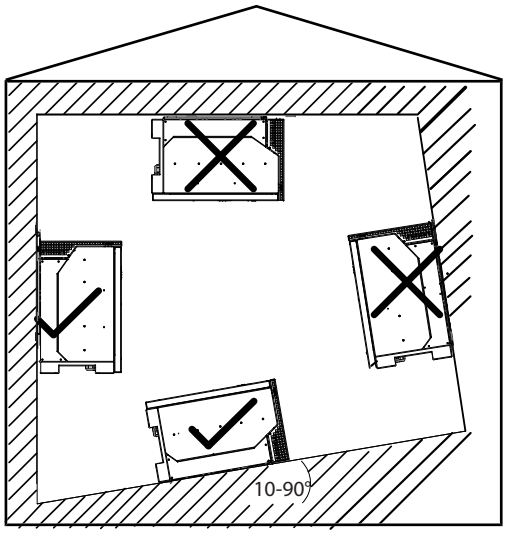


Fig. 8: Permissible installation location

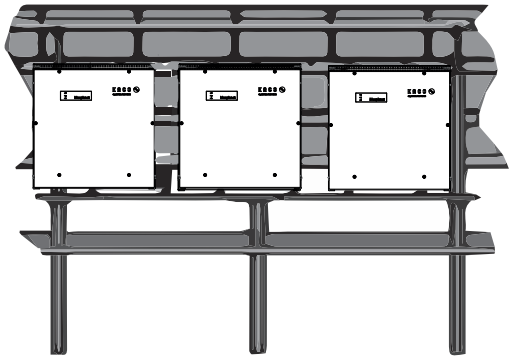


Fig. 9: Free-standing installation beneath PV system

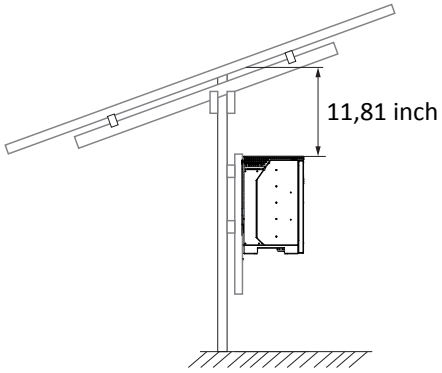


Fig. 10: Mounting advice for installation beneath PV system

6.2 Unpacking the unit

⚠ CAUTION

Risk of injury if the body is overloaded!

Lifting the device for transportation, to change location and during installation can lead to injuries (e.g. spinal injuries).

› Only lift the device using the openings provided.

› The device must be transported and installed by at least 2 persons.

↻ The device is transported to the installation location.

1 Remove the plastic strap from the pallet and packaging.

2 Pull the clip lock off the packaging.

3 Pull the hood upwards to remove it and place the cardboard packaging to one side together with the mount and accessories.

4 Set the device upright with the base section and side sections.

5 Remove the uppermost side section and base section from the device.

» If the device is in the correct installation position: Proceed with the installation of the mount.

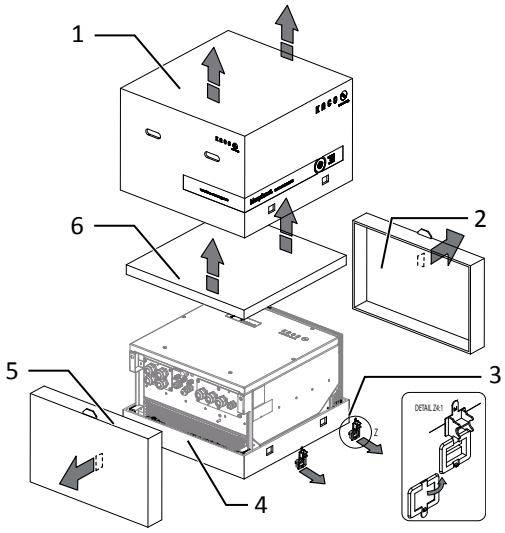


Fig. 11: Opening the cardboard packaging

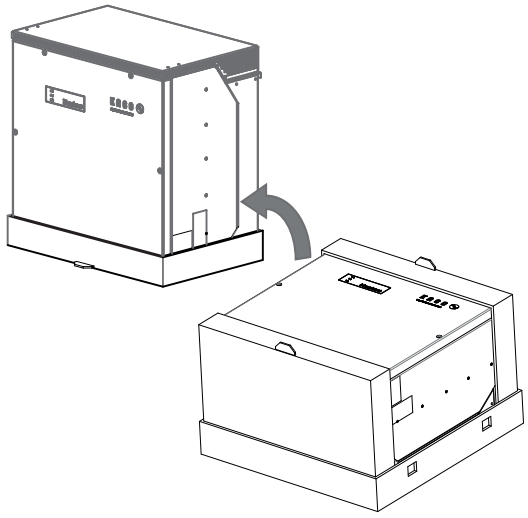


Fig. 12: Setting the device upright

Legend			
1	Hood	4	Base section
2	Upper side section	5	Lower side section
3	Clip lock (4x)	6	Cardboard packaging with mount and mounting kit

6.3 Fastening the mount

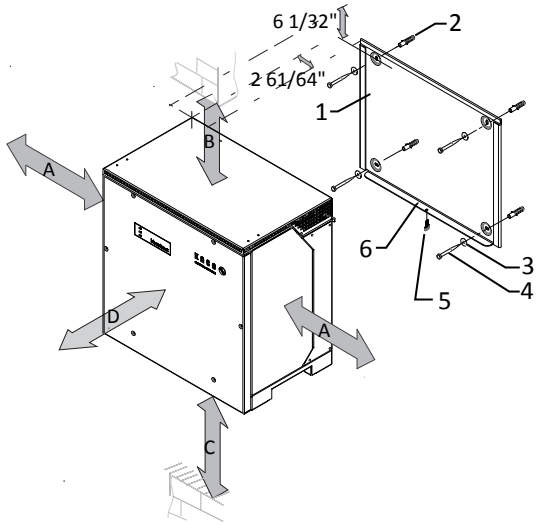


Fig. 13: Minimum clearances for wall mounting

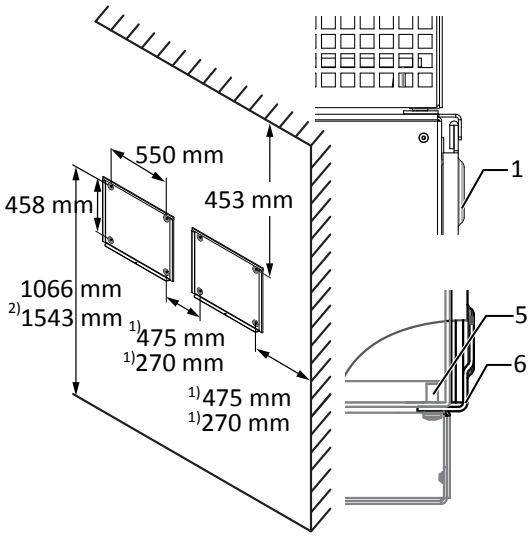


Fig. 14: Wall mounting

↻ Cardboard packaging with mount and mounting kit removed from the packaging and opened.

1 Mark the mounting position on the wall surface according to the position of the mount by drawing a line.

2 Mark the positions of the drill holes using the slot in the mount.

NOTE: The minimum clearances between two devices, or the device and the ceiling/floor have already been taken into account in the diagram.

3 Fix the mount to the wall using suitable mounting fixtures from the mounting kit.

NOTE: Make sure that the mount is oriented correctly.

» Proceed with the installation of the device.

6.4 Installing and securing the device

⚠ CAUTION

Risk of injury from improper lifting and transport.

Lifting the device improperly can cause the device to topple and fall over.

› Only ever raise the device vertically using the openings provided.

› Use a climbing aid for the chosen installation height.

› Wear safety gloves and safety shoes when lifting and lowering the device.

NOTE

Power reduction due to heat accumulation!

If the recommended minimum clearances are not observed, the device may go into power regulation mode due to insufficient ventilation and the resulting heat build-up.

› Observe the minimum clearances and provide for sufficient heat dissipation.

› Any objects on the housing of the device must be removed prior to operation.

› Make sure that foreign objects cannot hinder heat dissipation following installation of the device.

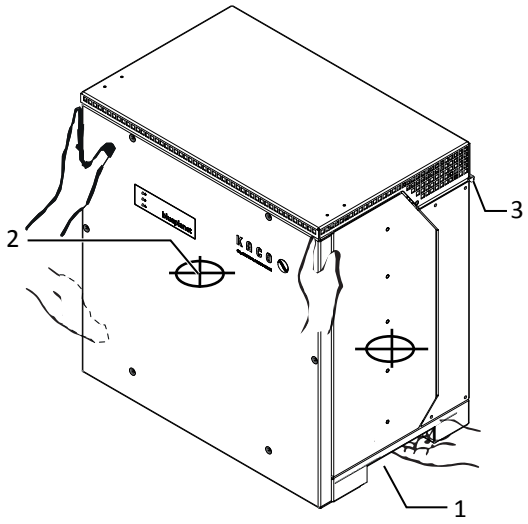


Fig. 15: Lifting the device by the opening

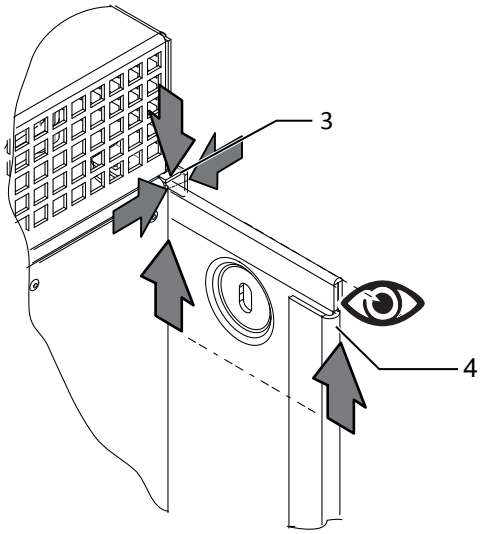


Fig. 16: Fitting the device onto the mount

Legend			
1	Opening	3	Mounting bracket
2	Center of gravity	4	Mount

Lifting and mounting the device

↻ The mount has been installed.

1 Lift the device using the lateral openings. Have regard to the position of the device's center of gravity!

NOTE: Do not lift the device by the lid or cover!

2 Fit the device onto the upper mount by means of the mounting bracket. Fit the device onto the lower mounting bracket in full so that the device sits flush with its rear side on the mount. ([See figure 14] [▶ Page 18]).

3 Insert the screw provided into the lug of the mount and secure the device to prevent it from being lifted off ([See figure 13] [▶ Page 18]).

NOTE: Alternatively: At this point, the screw mentioned above can be replaced with a special-purpose screw for protection against theft.

» The device is installed. Proceed with the electrical installation.

⚠ CAUTION

Damage to property due to condensation build-up

If the device is pre-assembled, moisture can get into the internal area via the dust-proof screw connections. The condensate that forms can cause damage to the device during installation and start-up.

- ✓ Keep the device sealed during pre-assembly and don't open the connection area until installation.
  - › Seal off any screw fittings using sealing covers.
  - › Check the interior space for any condensation water prior to electrical installation and, if necessary, allow it to dry out sufficiently.
  - › Immediately remove any moisture from the housing.

7 Installation

7.1 General

DANGER

Lethal voltages are still present in the connections and cables of the device even after the device has been switched off and disconnected!

Severe injuries or death may occur if the cables and/or terminals/busbars in the device are touched.

- The device must be mounted in a fixed position before being connected electrically.
- Observe all safety regulations and current technical connection specifications of the responsible power supply company.
- The device may only be opened and serviced by an authorized electrician.
- Switch off the grid voltage by turning off the external circuit breakers.
- Do not touch the cables and/or terminals/busbars when switching the device on and off.
- Keep the device closed when it is in operation.

7.2 Opening the device

↻ The device has been installed on the mount.

↻ Wipe any moisture off the frame of the housing cover using a cloth.

1 Undo the 6 screws and carefully remove the housing cover [T_25]

2 Be careful not to damage or soil the seals or optical fibers when setting the housing cover down.

» Proceed with the installation of the device.

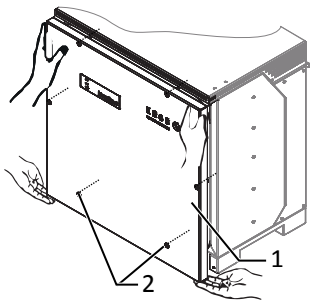


Fig. 17: Removing the housing cover

7.3 Surveying the connection area

The connection point for the AC supply is situated inside the housing. The DC input source is also connected inside the housing.

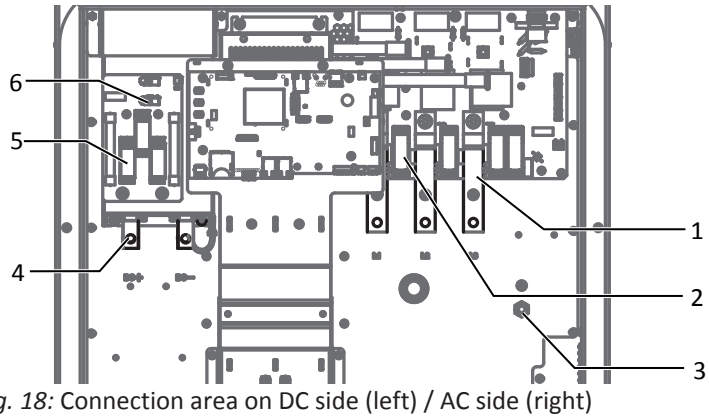


Fig. 18: Connection area on DC side (left) / AC side (right)

Legend			
1	AC connection point	4	DC connection point
2	AC overvoltage protection base	5	DC overvoltage protection
3	AC earthing bolt	6	PID connection point

7.4 Making the electrical connections

NOTE

Select the cable cross-section, fuse type and fuse value in accordance with the following master conditions:

Country-specific installation standards

Power class of the device

Line length

Type of line installation

Local temperatures

NOTE

All electrical installations must be carried out in accordance with local electrical standards and conform to the National Electrical Code® ANSI / NFPA 70 or the Canadian Electrical Code® CSA C22.1.

This document does not replace any local, federal or national laws, regulations or regulations that apply to the installation and use of the product, and is not intended to replace them, including the applicable electrical safety regulations.

All installations must conform to the laws, regulations and standards that are applicable in the country of installation. KACO new energy does not assume any responsibility for compliance or lack of compliance with such laws or codes in connection with the installation of the product.

7.4.1 Supply line and fuse requirements

AC-side	
Max. cable cross-section	450 kcmil
Min. cable cross-section	acc. to local installation standards
Diameter of cable for cable fitting	0,63 - 1,10 inch
Length of insulation to be stripped off	Depending on the ring cable lug
Cable lug Ø connection bolt	Bore for M10 screw
Tightening torque	265.50 In-lbs
Connection type	Cable lug
Cable lug dimension w - maximum width	1,65 inch
Ground conductor connection	M10
Ground conductor connection tightening torque	88.5 In-lbs
Electrical protection in installation (provided by the customer)	250A (preliminary)
Fitting for AC connection	M40
Torque for cable fitting	65 In-lbs
DC-side	
Max. cable cross-section	450 kcmil
Min. cable cross-section	acc. to local installation standards
Diameter of cable for cable fitting	0,63 - 1,10 inch
Cable lug dimension b width max.	1,65 inch
Length of insulation to be stripped off	Depending on the ring cable lug
Recommended cable type	Solar cable
Cable lug Ø connection bolt	Bore for M10 screw
Tightening torque	265.50 In-lbs
Fitting for DC connection	M40
Torque for cable fitting	65 In-lbs

Interfaces	
Diameter of cable for cable fitting	(2x) 0,31 - 0,67 inch
Torque for cable fitting	44.25 In-lbs
RS485 connection type	spring-type terminal
RS485 terminal cable cross-section	23 - 15 AWG
Diameter of cable for cable fitting	(3x) 0,19 - 0,39 inch
Torque for cable fitting	22 In-lbs
Ethernet connection type	RJ45

7.5 Connecting the device to the mains supply

7.5.1 Preparing the grid connection

↻ A connection cable with 4 cores (4 individual cores or multi-core up to max. cable cross-section 0,63 - 1,10 inch) is available on the device.

↻ The nominal grid voltage matches the "VAC nom" specification on the name plate.

1 For improved accessibility: Remove the AC attachment plate by undoing the 6 fastening screws [T_30]

2 Undo the cable fitting for AC connection and PE earthing (ground) [W_46].

3 Remove the sealing plugs.

4 Insert the AC cables into the cable fittings.

5 Strip the insulation from the AC cables.

6 Strip the insulation from the individual cores for L1 / L2 / L3 (ABC) and PE (ground) so that the stranded wire and insulation can be pushed into the shaft of the cable lug.

CAUTION! Risk of fire due to chemical corrosion. Cable lugs must be suitable for the conductor material and copper busbars used. [2]

7 Press the cable lug into place.

8 Slip a shrink-fit sheath (not part of the scope of supply) over the shaft of the ring cable lug of the AC cable.

9 For improved accessibility: Fasten the AC attachment plate by tightening the 6 fastening screws [T_30 / 53.10 In-lbs]

» Make the grid connection.

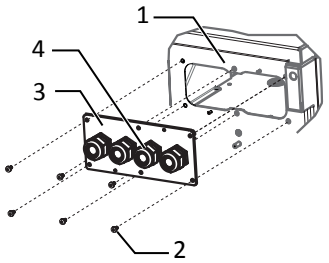


Fig. 19: Removing the AC attachment plate

1	Housing base - AC-side
2	Fastening screws
3	AC attachment plate
4	Cable fitting

7.5.2 Making the grid connection

NOTE

If a residual current circuit breaker is necessary due to the installation specification, a type A residual current circuit breaker must be used.

If the type A is used, the insulation threshold must be set to greater than/equal to (≥) 200kOhm in the “DC parameters” menu Configuration via web user interface [See section 9.4.2 Page 45].

For questions regarding the appropriate type, please contact the installer or our KACO new energy customer service.

[2] When using aluminum cable lugs we recommend using cable lugs with galvanic tin plating or, alternatively, AL/CU cable lugs with suitable AL/CU washers.

Otherwise, with the electrolytes present (e.g. Condensation water), the aluminum could be destroyed by the copper bus bars.

4-pole connection, TN, TT system

↻ The grid connection has been prepared.

↻ AC cables equipped with an M10 ring cable lug [max. width b 1,65 inch]

1 Slacken the nut and lock washer at the marked earthing point.

2 Place the earth cable at the earthing point. Secure it with the nut and lock washer provided [W_17 / 88.5 In-lbs].

3 Place the cable lug of cores L1 / L2 / L3 on the busbar in accordance with the labeling and secure it with a nut, screw and lock washer (fastening elements in scope of supply) [W_17 / 265.50 In-lbs].

4 Check that all connected cables are fitted securely.

5 Tighten the AC cable fittings [W_46 / 65 In-lbs].

» The device is now connected to the power grid.

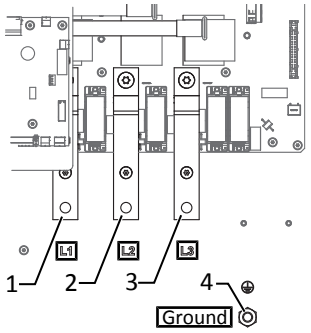


Fig. 20: 4-Pole AC grid connection

1	L1 busbar
2	L2 busbar
3	L3 busbar
4	Ground - earthing point

7.6 Connecting the PV generator to the device

7.6.1 Checking the PV generator for a ground fault

⚠ DANGER

Risk of fatal injury due to electric shock!

Severe injuries or death will result if the live connections are touched. When there is solar radiation on the PV generator, DC voltage will be present at the open ends of the DC cables.

› Activate the connection power at the switchbox or string combiner with the DC isolator switch.

› The DC connection is intended exclusively for PV generators. Other sources fall within the scope of improper operation (e.g. batteries).

› Only touch the PV generator cables on the insulation. Do not touch the exposed ends of the cables.

› Avoid short circuits.

› Do not connect any strings with a ground fault to the device.

Ensuring that there is no ground fault

1 Measure the DC voltage between the protective earth (PE) and the positive cable of the PV generator.

2 Measure the DC voltage between the protective earth (PE) and the negative cable of the PV generator.

⇨ If stable voltages can be measured, there is a ground fault in the DC generator or its wiring. The ratio between the measured voltages gives an indication as to the location of this fault.

3 Rectify any faults before taking further measurements.

4 Measure the electrical resistance between the protective earth (PE) and the positive cable of the PV generator.

5 Measure the electrical resistance between the protective earth (PE) and the negative cable of the PV generator.

⇨ In addition, ensure that the PV generator has a total insulation resistance of more than 2.0 MOhm, since the device will not feed in if the insulation resistance is too low.

6 Rectify any faults before connecting the DC generator.

7.6.2 Configuring the PV generator

⚠ CAUTION

Damage to components due to faulty configuration

In the expected temperature range of the PV generator the values for the no-load-voltage and the short circuit current must never exceed the values for U_{DCMAX} and I_{SCMAX} in accordance with the technical data.

› Observe limit values in accordance with the technical data.

EN-US

NOTE

Type and configuration of the PV modules.

Connected PV modules must be dimensioned for the DC system voltage in accordance with IEC 61730 Class A, but at least for the value of the AC grid voltage

7.6.3 Connecting the PV generator

⚠ DANGER

Risk of fatal injury due to electric shock!

Severe injuries or death will result if the live connections are touched. When there is solar radiation on the PV generator, DC voltage will be present at the open ends of the DC cables.

- Activate the connection power at the switchbox or string combiner with the DC isolator switch.
- The DC connection is intended exclusively for PV generators. Other sources fall within the scope of improper operation (e.g. batteries).
- Only touch the PV generator cables on the insulation. Do not touch the exposed ends of the cables.
- Avoid short circuits.
- Do not connect any strings with a ground fault to the device.

Preparing to connect the PV generator

↻ PV generator checked to ensure there is no ground fault.

↻ A connection cable with 2 x 1 or 2 x 2 cores is available on the device.

1 For improved accessibility: Remove the DC attachment plate by undoing the 4 fastening screws [🔧T_30].

2 Undo the cable fitting for DC connection [🔧W_46]

3 Remove the sealing plug in the cable fitting used.

4 Remove the outer cladding of the DC cables.

5 Insert the DC cables into the cable fittings.

6 Strip the insulation from the DC cables pursuant to the M10 ring cable lug so that the stranded wire and insulation can be pushed into the shaft of the cable lug.

CAUTION! Risk of fire due to chemical corrosion. Cable lugs must be suitable for the conductor material and copper busbars used. [2].

7 Push the ring cable lug onto DC cores.

8 Slip a shrink-fit sheath (not part of the scope of supply) over the shaft of the ring cable lug of the DC cable.

9 For improved accessibility: Fasten the DC attachment plate by tightening the 4 fastening screws [🔧T_30 / 53.10 In-lbs]

10 Connect the PV generator.

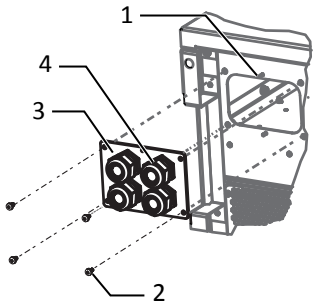


Fig. 21: Removing the DC attachment plate

1	Housing base - DC-side
2	Fastening screws
3	Attachment plate
4	Cable fitting

Connecting the PV generator

↻ PV generator connection prepared.

↻ DC cables equipped with a ring cable lug [max width 1,65 inch].

1 Place the cable lug of cores DC- and DC+ on the busbar in accordance with the labeling and secure it with a nut, screw and lock washer (fastening elements in scope of supply) [W_17 / 265.50 In-Ibs].

2 Check that the connected cables are fitted securely.

3 Tighten cable fittings [W_46 / 65 In-Ibs].

» The device is connected to the PV generator.

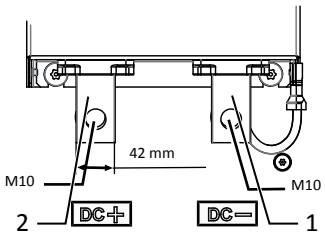


Fig. 22: DC connection

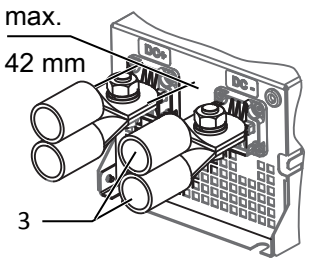


Fig. 23: DC connection with 2 DC+/- inputs

1	DC- busbar
2	DC+ busbar
3	Cable lug (optional with 2 DC +/- inputs)

7.7 Inserting the overvoltage protection

Installing the AC overvoltage protection

↻ A check has been performed to ensure there is no AC/DC voltage present.

↻ The device has been opened [Opening the device [See section 7.2 Page 21]].

↻ Following initial delivery, remove the intermediate mounting frame on the AC overvoltage protection module.

1 Place the intermediate mounting frame on the AC overvoltage base and click it into place.

2 Insert the AC overvoltage protection modules into the AC overvoltage base one after another.

3 Ensure that all protective elements are properly secured.

4 Remove the short-circuit bridge for automatic monitoring.

» Proceed with the installation of the device.

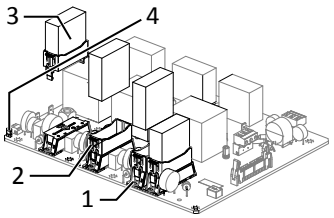


Fig. 24: Retrofitting the AC overvoltage protection

1	AC overvoltage base
2	AC intermediate mounting frame
3	AC overvoltage protection module (4 slots)
4	Short-circuit bridge

Installing the RS485 overvoltage protection

↻ A check has been performed to ensure there is no AC/DC voltage present.

↻ The device has been opened [Opening the device [See section 7.2 Page 21]].

NOTE: Clip the RS485 base element for overvoltage protection bottom end first into the top-hat rail as shown in the drawing.

1 The following color coding scheme must be adhered to for the internal/external RS485 cable:
Data A => white (WH); Data B => blue (BU); GND => violet (VT)

2 The internal RS485 cable must be connected to the overvoltage base as shown on the instruction leaflet for the base.

NOTE: At input/output on the RS485 external, the output of the overvoltage base is to be assigned twice.

3 Insert the RS485 through the interface cable fitting into the connection area.

4 Remove the insulation from the RS485 cable [approx. 20 mm] and isolate the individual wires [8 mm].

5 Fit wire end sleeves onto the wires and connect them to the RS485 base element in accordance with the wiring diagram [S_M3 / 4.42 In-lbs].

6 Connect the output cable with RS485 connector (included in the scope of supply of the overvoltage kit) to the RS485 base element and insert the RS485 connector into the RS485 socket on the communication circuit board.

7 Affix the output cable to the cable guide.

8 Insert the RS485 overvoltage protection module into the base.

9 Ensure that the protective elements are properly secured.

» Proceed with the installation of the protective elements.

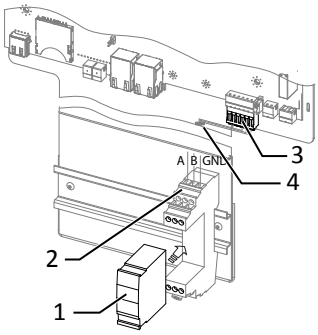


Fig. 25: Inserting the RS485 overvoltage protection

1	RS485 overvoltage protection module (optional)
2	RS485 overvoltage protection base assembly on top-hat rail
3	RS485 communication connector
4	Cable guide

Installing Ethernet overvoltage protection

↻ A check has been performed to ensure there is no AC/DC voltage present.

1 Clip the Ethernet overvoltage protection module into the top-hat rail top end first.

2 Connect the short Ethernet cable (included in the scope of supply of the Ethernet overvoltage protection module) to an Ethernet port on the communication circuit board.

3 Route the Ethernet cable through the cable fitting provided and insert it into the overvoltage protection module.

4 Attach the Ethernet cable to the cable guide and tighten the cable fitting [W_30/ 22 In-lbs].

» Proceed with the installation of the device.

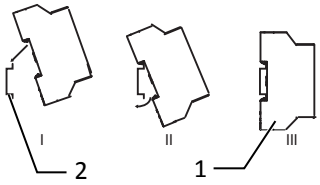


Fig. 26: Inserting the Ethernet overvoltage protection

1	Ethernet overvoltage protection module (optional)
2	Top-hat rail

7.8 Establishing additional equipotential bonding

NOTE

Depending on the local installation specifications, it may be necessary to earth the device with a second ground connection. To this end, the threaded bolt on the underside of the device can be used.

↻ The device has been installed on the mount.

1 Remove the insulation from the equipotential bonding line.

2 Furnish the stripped cable with an M8 ring cable lug.

3 Place the earth cable at the earthing point and secure it with an additional M8 nut and lock washer [W_17/ 88.5 In-lbs].

» The housing is included in the equipotential bonding.

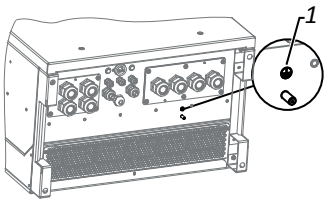


Fig. 27: Additional earthing point

1 Earthing bolt

7.9 Connecting the interfaces

7.9.1 Overview

⚠ DANGER

Risk of fatal injury due to electric shock!

Severe injuries or death may result from improper use of the interface connections and failure to observe protection class III.

› The SELV circuits (SELV: safety extra low voltage) can only be connected to other SELV circuits with protection class III.

⚠ CAUTION

Damage to the unit from electrostatic discharge

Components inside the unit can be damaged beyond repair by static discharge.

› Note the ESD protective measures.

› Earth yourself before touching a component by touching a grounded object.

All interfaces are located on the communication circuit board (HMI board) inside the housing.

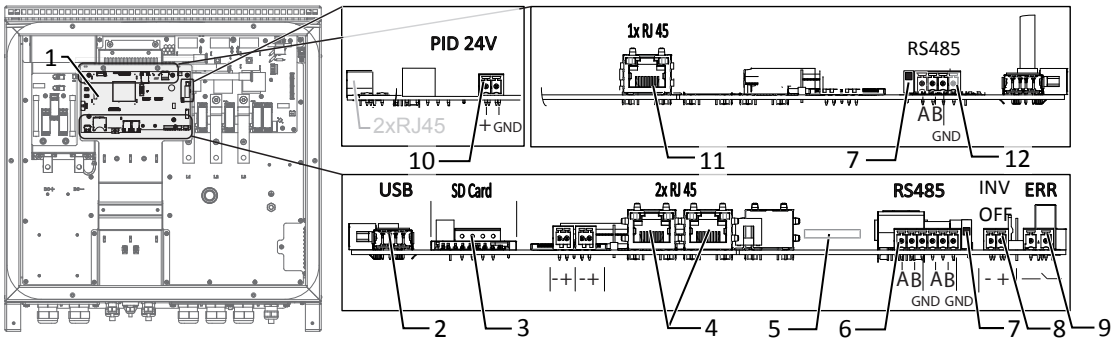


Fig. 28: Communication circuit board (HMI board)

1	Communication circuit board	7	DIP switch - activate terminator (2x)
2	USB socket	8	INV OFF - connection for remote controls - 24V(+/-20%) / 1A (at least 15mA)
3	SD slot	9	ERR connection for external grid protection components (fault signal relay)
4	Ethernet for network connection DHCP	10	24V 0.5A PID supply (optional)
5	Digital input (optional)	11	Ethernet – only for starting up by means of static IP (Start-up via cable connection [See section 8.4.2▸ Page 37])
6	RS485 - default	12	RS485 - connection for string combiner

7.9.2 Connecting via Ethernet

NOTE

The connection plug of an RJ45 cable is larger than the opening of an M25 cable fitting when it is installed. For this reason, remove the sealing insert before installation and thread the Ethernet cable outside of the cable fitting through the sealing insert.

NOTE

Use a suitable category 7 network cable. The maximum distance between two devices is 100 m (328 ft). The Ethernet switch allows for the repeater function and supports auto-sensing. Ensure that the cable is correctly assigned. You can use both crossed and 1:1 protectively-wired Ethernet connection cables.

Connecting the device to the network

↻ The Ethernet cable has been connected to the device.

1 Connect the Ethernet cable to the network or a computer.

2 Configure the Ethernet settings and the webserver in the Settings menu.

Connecting the Ethernet cable

1 Loosen and remove the cover of the cable fitting [W_29].

2 Remove the sealing insert.

3 Thread the connection cable through the cover of the cable fitting and the sealing insert.

4 Insert the sealing insert into the cable fitting.

5 Connect the connection cable to Ethernet interface.

6 Attach and tighten the cover of the cable fitting [W_29 / 5 Nm]

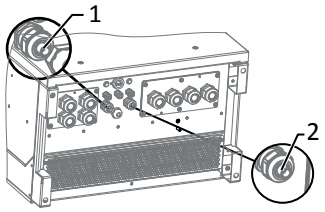


Fig. 29: Inserting signal cables

1 Cable fitting for routing the Ethernet cable

2 Cable fitting for routing the signal cable

7.9.3 Connecting the RS485 bus

NOTE

Ensure that the DATA+ and DATA- wires are properly connected. Communication is not possible if the wires are reversed. Different manufacturers do not always interpret the standard on which the RS485 protocol is based in the same way. Note that the wire designations (DATA+ and DATA-) for wires A and B may vary from one manufacturer to another.

Properties of the RS485 data line	
Maximum length of the RS485 bus line	Max. 3940 ft This length can be reached only under optimum conditions. Cable lengths exceeding 1640 ft generally require a repeater or a hub.
Maximum number of connected bus devices	99 devices + 1 data monitor device or max. 49 devices and 49 string combiners + 1 data monitor device
Data cable	Twisted, shielded.
Recommendation	Black twisted pair for laying cable outside and in the ground, 14 x 14 x 20 AWG Gray twisted pair for dry and damp indoor spaces, 14 x 14 x 20 AWG

↻ To prevent interference during data transmission:
- Observe the wire pairing when connecting DATA+ and DATA-.
- Do not lay the RS485 bus line in the vicinity of live DC/AC cables.

1 Unscrew the cable fitting.

2 Thread the connection cables through the cable fitting.

3 Connect the connection cable to the corresponding connection terminals.

4 The following must be connected to all inverters and to the data monitor unit in the same way:
- Wire A (-) to wire A (-) and wire B (+) to wire B (+)
- GND to GND

5 Tighten the cable fittings.

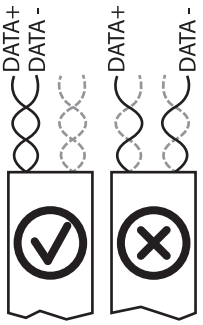


Fig. 30: Assignment of twisted-pair wires

NOTE

When using the RS485 bus system, assign a unique address to every bus device (inverter, sensor) and terminate the terminal units (see the “Settings” menu) .

↻ Check whether one of the devices represents the terminal unit.

☞ Only activate the terminating resistor on the communication circuit board of the terminal unit using the DIP switch Connecting the interfaces [See section 7.9 Page 28].

» Close the connection area or connect “inverter off”.

7.9.4 Connecting external grid protection components

The contact is designed as an N/O contact and is labeled "ERR" or "Relay" on the circuit board.

Maximum contact load	
DC	30 V/1A

↻ Connection area cover open.

1 Loosen the cable fitting to pass the signal cable through [W_19]

2 Thread the connection cables through the cable fitting.

3 Attach the connection cables to the terminals.Overview [See section 7.9.1 Page 28]

4 Tighten the cable fitting [W_19 / 2.5 Nm].

7.9.5 Connecting "Inverter Off"

Connect Powador-protect

↻ The cable to the external grid protection device is available on the device.

↻ Cover of the device has been opened.

1 Loosen the cable fittings [W_19]

2 Thread the connection cables through the cable fittings.

3 Connect wire A (+) to the terminal marked "INV OFF+" on the first device via the "DO1" terminal of the protective device.

4 Connect wire B (-) to the terminal marked "INV OFF-" on the first device via the "GND" terminal of the protective device.

5 Connect the other devices to one another as follows:
- Wire A (+) to wire A (+) and wire B (-) to wire B (-).

6 Tighten cable fitting [W_19 / 22 In-lbs]

7 After commissioning: Configure the `external` Overvoltage protection Powador-protect in the menu entry `Properties / Functions` Features / Functions.

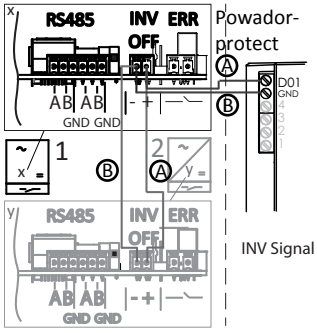


Fig. 31: Connect the device to Powador-protect

Connect the external device

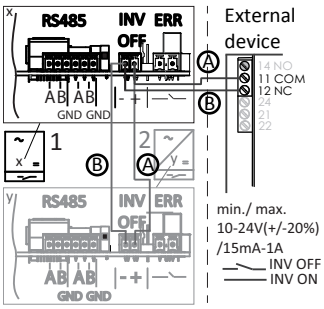


Fig. 32: Connecting the device to the external grid protection device

↻ The cable to the external grid protection device is available on the device.

↻ Cover of the device has been opened.

1 Loosen the cable fittings [W_19]

2 Thread the connection cables through the cable fittings.

3 Connect wire A (+) from "COM" (11) on the terminal of the protective device to the terminal marked "INV OFF+" on the first device.

4 Connect wire B (+) from "NC" (12) on the terminal of the protective device to the terminal marked "INV OFF-" on the first device.

5 Connect the other devices to one another as follows:
- Wire A (+) to wire A (+) and wire B (-) to wire B (-).

6 Tighten cable fitting [W_19 / 22 In-lbs]

7 After commissioning: Configure the `external` Overvoltage protection external device in the menu entry Properties / Functions Features / Functions.

7.10 Sealing the connection area

↻ The grid connection has been prepared.

1 Lift the housing cover onto the housing and loosely tighten the fastening screws.

2 Secure the housing cover by tightening all 6 screws in a diagonally opposite sequence [T_25 / 42.48 In-lbs].

» The device has been mounted and installed.

» Put the device into operation.

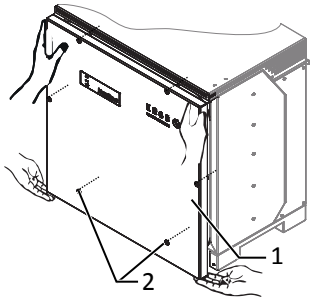


Fig. 33: Closing the housing cover

1	Housing cover
3	Screws

8 Start-up

8.1 Conditions

⚠ DANGER

Lethal voltages are still present in the connections and cables of the device even after the device has been switched off and disconnected!

Severe injuries or death may occur if the cables and/or terminals/busbars in the device are touched.

› The device is only permitted to be put into operation by a specialist.

› Unauthorized persons must not be able to access the device.

↻ The device has been mounted and electrically installed.

↻ The PV generator supplies a voltage above the configured start voltage.

1 Connect the grid voltage using the external circuit breakers.

2 Connect the PV generator using the DC isolator switch (0 > 1)

» The device begins to operate.

» During initial start-up: Follow the instructions of the New Connection Wizard.

NOTE

A mobile terminal device with WIFI interface is required in order to put the device into operation.

The following functions are only available via the WEB interface:

› Initial start-up

› Parameterization

› Resetting the device to its factory defaults

NOTE

We recommend using an up-to-date Firefox or Chrome browser or the default browser that is available on the mobile terminal devices to configure the device via the web interface.

8.2 Preconditions relating to standards

Attachment of safety label in accordance with UTE C15-712-1

The code of practice UTE C15-712-1 requires that, upon connection to the French low-voltage distribution network, a safety sticker showing a warning to isolate both power sources when working on the device must be attached to each device.

☞ Attach the provided safety sticker to the outside of the device housing where it is clearly visible.

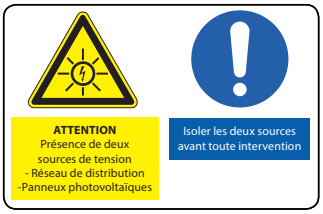


Fig. 34: Adhesive label UTE_C15-712-1

Attach the DRM 0 safety sticker

According to AS/NZS 4777.2:2015, in Australia PV devices are marked that support the "Mode 0" remote control command.

☞ Attach the supplied sticker next to the name plate on the device housing where it is clearly visible.

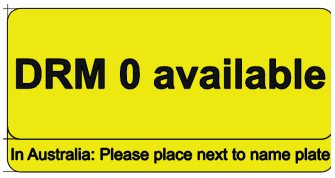


Fig. 35: Sticker DRM 0 for Australia

8.3 Network topologies

Plant segmentation

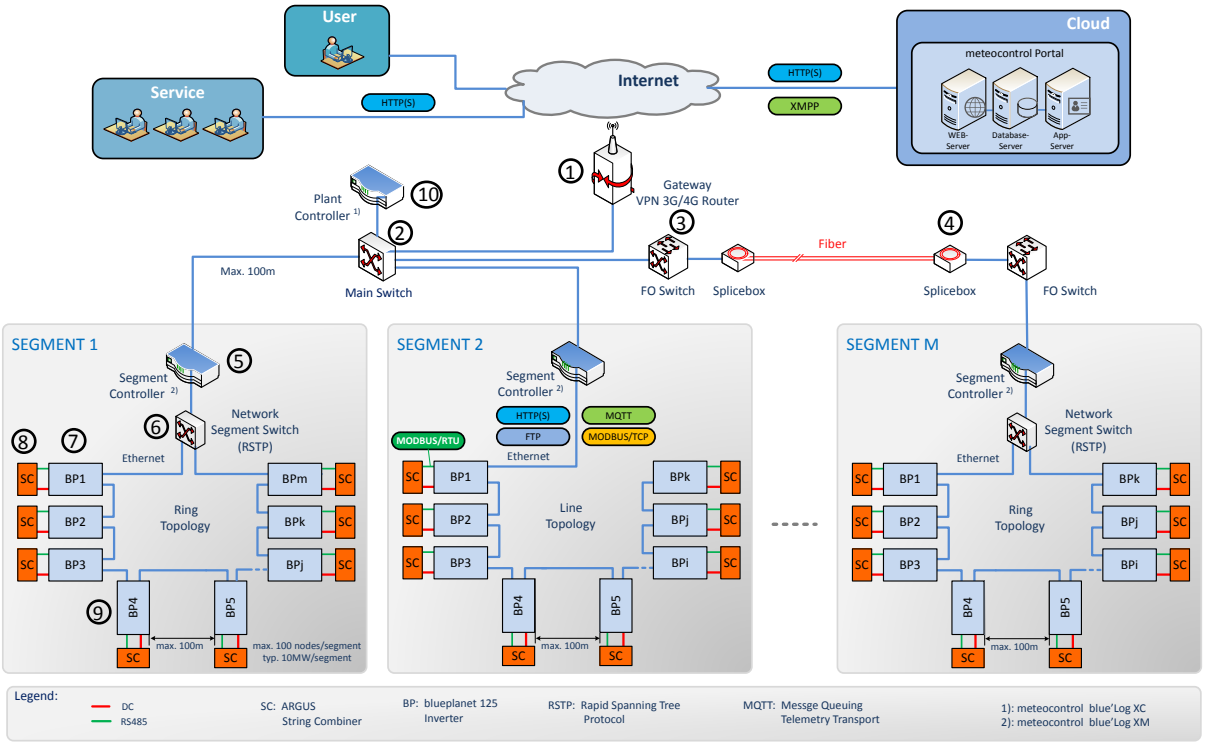


Fig. 36: Segmentation of a plant

1	Gateway VPN 3G/4G router	6	Network segment switch
2	Main switch	7	Inverter device
3	FO - switch (fiber optic)	8	String combiner
4	Slicebox (for fiber optic data transfer)	9	Connection cable and protocol - DC / Modbus RTU / RS485
5	Segment Controller		

This figure shows a potential alternative for multiple segments. Depending on the local circumstances, it may be more favorable to position the components differently (e.g. positioning the segment controller centrally and connecting the segment switch via glass fiber cable).

The `main switch` is located immediately downstream of the `Gateway VPN-Router` and is used to connect up the `Segment Controller`. If the plant is of a certain size (distance from `main switch` to `Segment Controller` >100m), it may also be necessary to couple segments that are located further away via a glass fiber connection.

Within a segment, it is possible to link KACO devices to one another as part of an Ethernet daisy-chain by way of an integrated switch, whereby the Segment Controller is connected at the first element in the chain. For this purposes of an example, this topology is shown in segment 2. A Segment Controller can manage up to 100 nodes (45 inverter-SC-pairs (90 inverters) + 10 reserve nodes for other substation/segment data sources).

If an enhanced degree of fail-safety is required, then the KACO devices can also be arranged in a ring by means of a suitably configured `network segment switch` (which knows the Rapid Spanning Tree protocol "RSTP"). In this case, the Segment Controller would also be linked to this switch. For this purposes of an example, this configuration is shown in segments 1 and M.

As you can see in the figure, a string combiner is assigned to every KACO device. In terms of communication, these are connected to the device directly via an RS485 cable (green cable). To this end, MODBUS RTU is used as a communication protocol. Monitoring of the SC is also carried out using the Segment Controller. The KACO device takes on the role of a MODBUS gateway during this process.

8.4 Start-up options

Option 1: Local, guided start-up by means of WIFI or LAN connection	· Installation technician connects to a KACO device via WIFI · Installation wizard carries out start-up steps interactively.
Option 2: Local start-up with pre-arranged configuration	· Installation technician uses a USB memory stick that contains a pre-prepared device configuration. · The device imports these settings and is then ready for operation.
Option 3: Start-up in a network without Segment Controller	· Start-up in an existing network · The installation technician can start up the device with the aid of the installation wizard as described at option 1. The device can be addressed using its host name.
Option 4: Centralized start-up via Segment Controller	· A device configuration that is available on the Segment Controller can be uploaded to several KACO devices. · The devices are ready for operation once the configuration is activated.
Option 5: Centralized start-up via Plant Controller	· Available in future development levels. · A device configuration that is available on the Plant Controller can be uploaded to the relevant devices via the subordinate Segment Controllers.

Tab. 3: Start-up variants for individual devices/plant segments/overall plant

Once authorization is successfully completed and the configuration button is pressed, the installation wizard opens immediately (provided the device is still in its default state and start-up has not been carried out yet).

However, the installation wizard can also be re-opened at a later date to carry out changes to the original configuration.

There are currently 9 steps in the installation process and these are detailed below.

Step 1: Language selection

↻ The installation wizard has been started or re-started.

1 Select `Menu language` via the dropdown menu.

2 Confirm the action field.

» Pressing the `Next` button will take you to the next installation step.

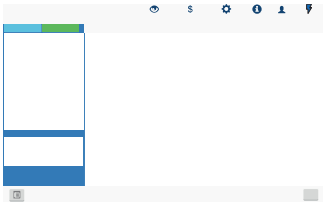


Fig. 37: Menu item: Configuration via web user interface [See section 9.4.2 Page 45]

Step 2: Country configuration

↻ A language has been selected.

1 Select `Country` and `Grid type` from the dropdown menu.

2 Confirm the action field.

» Pressing the `Next` button will take you to the next installation step.

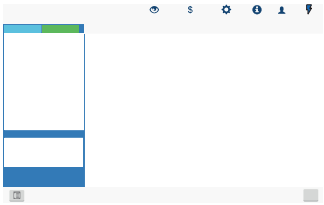


Fig. 38: Menu item:Configuration via web user interface [See section 9.4.2 Page 45]

Step 3: Network parameters

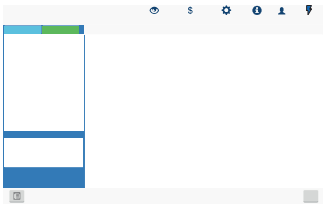


Fig. 39: Menu item: Configuration via web user interface [See section 9.4.2 Page 45]

↻ The country and grid type have been selected.

NOTE: By default, IP addresses are assigned via the plant DHCP server.

NOTE: If static IP addresses are required, you will have to assign these. CAUTION! In this case, it is no longer possible to distribute the configuration via the Segment Controller!

1 Activate `DHCP` or enter the `IP address` at the deactivated DHCP.

2 Confirm the action field.

» Pressing the `Next` button will take you to the next installation step.

Step 4: Localization

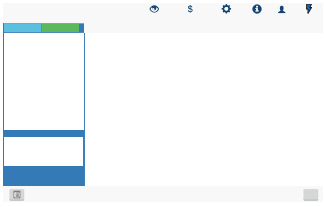


Fig. 40: Menu item: Configuration via web user interface [See section 9.4.2 Page 45]

↻ The network parameters have been set up.

1 Set the `date`, `time and time zone` or arrange for synchronization with the client.

2 PLEASE NOTE: An NTP server needs to be activated for synchronization purposes [3]

3 Select temperature unit from the dropdown menu.

4 Confirm the action field.

» Pressing the `Next` button will take you to the next installation step.

Step 5: Cloud & portal configuration [4]

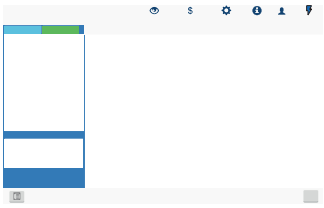


Fig. 41: Menu item: Configuration via web user interface [See section 9.4.2 Page 45]

↻ Localization has been carried out.

1 If available, activate `Web portal` and select `Portal` from the dropdown menu.

2 Configure the portal.

3 Confirm the action field.

» Pressing the `Next` button will take you to the next installation step.

Step 6: ModBus

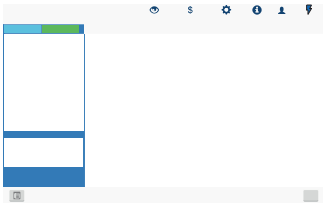


Fig. 42: Menu item:

↻ Portal configuration completed.

NOTE: The device supports MODBUS/TCP and conventional SUNSPEC models. If there are concerns over security, write access can be deactivated.

1 Specify the `Modbus port` and determine `Read/write access`.

2 Confirm the action field.

» Pressing the `Next` button will take you to the next installation step.

[3] It is preferable to install this on a plant component. It is also possible to select an NTP server localized on the internet provided the device has direct access to the internet.

[4] The Cloud and portal configuration page is not currently supported. This will be enabled in a subsequent version of the firmware.

Step 7: String collector

↻ Modbus has been specified.

1 If available, activate `string collector monitoring`.

2 Set other parameters.

3 Confirm the action field.

» Pressing the `Next` button will take you to the next installation step.

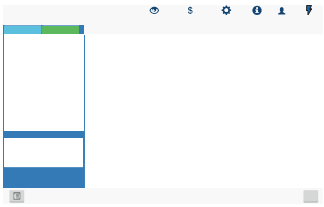


Fig. 43: Menu item: Configuration via web user interface [See section 9.4.2 Page 45]

Step 8: Optional parameters

↻ String collector monitoring has been set up.

NOTE: Using the plant ID, the device followed by its firmware version can be detected automatically in the Cloud/portal and assigned to the relevant plant.

1 Enter the device name used to reach the device in the network.

NOTE: The coordinates identify the device installation location.

2 Confirm the action field.

» Pressing the `Next` button will take you to the next installation step.

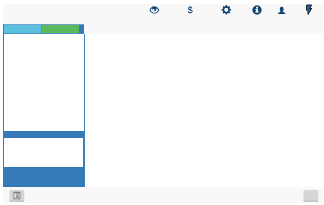


Fig. 44: Menu item: Only on the installation wizard!

Step 9: Finalizing the installation

↻ Optional parameters have been set.

1 Device configuration completed successfully. Please click "Finalize" to put the device into operation.

2 Specify a name for logging the setup result.

3 Confirm the action field.

» Pressing the `Next` button will take you to the next installation step.

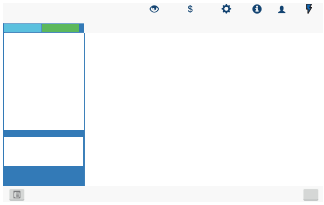


Fig. 45: Menu item: Only on the installation wizard!

8.4.1 Start-up via WIFI

To start up the device directly, the first option is to carry out the installation interactively with a WIFI-compatible adapter. If such an adapter is not available, the other option is to perform an automatic configuration using a USB memory stick.

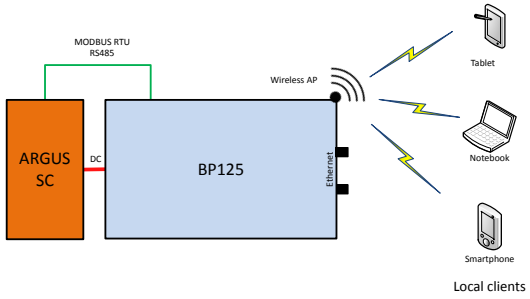


Fig. 46: Start-up via a direct WiFi connection

Application

The planned network infrastructure or AC-coupling is not yet in place or has not been completed.

A DC supply to the KACO device is sufficient for start-up.

Required components

- WiFi-compatible notebook, tablet or smartphone (Android or iOS devices can be used).
- USB WiFi stick (KACO accessory, type: WLAN adapter Digitus 150N micro article no.: 3013222)

Establishing a connection to the KACO device via WiFi

1 Connect the USB WiFi stick to the device and connect to the access point generated by the device using a notebook or mobile device. Every device generates a unique AP-name so that it is possible to install several devices at the same time if multiple WiFi sticks happen to be available.

2 Name of the access point: bp125-<inverter serial number>

3 Password: kacowifi

4 Launch the browser on the terminal device and enter server name a) or server address b):

5 http:// 192.168.1.1

» The device configuration page is displayed.

1 At the Login/register icon, log in as:

2 User name: user

3 Password: kaco-user.

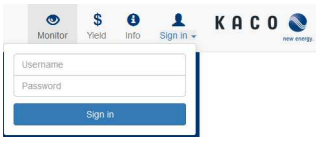


Fig. 47: Login screen

8.4.2 Start-up via cable connection

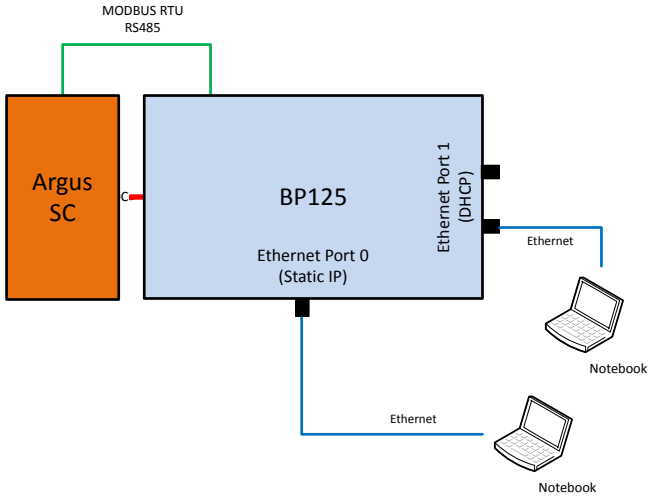


Fig. 48: Start-up via Ethernet

Application

The planned network infrastructure or AC-coupling is not yet in place or has not been completed.

A DC supply to the KACO device is sufficient for start-up.

Required components

- Notebook with Ethernet interface
- Ethernet cable (uncrossed patch cable)

Establishing a connection to the KACO device

1 The device must be opened in order to connect the Ethernet cable! For safety reasons, KACO therefore recommends establishing a connection via WiFi.

2 The device's communication circuit board has 3 Ethernet ports that can be used:

1. The 2 neighboring shielded Ethernet ports are marked LAN1 and LAN2. These ports have an internal switch and, in their factory default state, they expect to receive an IP address from a DHCP server. As such, these can only be used if the connected PC makes a DHCP service available.
2. The port marked CON700 that can be used to speak to the device using the static IP address 169.254.1.1. This option is preferable if you have decided to go with a wired solution.

☞ **NOTE: Please do not under any circumstances connect the Ethernet cable to the unshielded RJ45 slot marked J200 as this typically causes damage to the printed circuit board!**

1. Launch the browser on the terminal device and enter the IP address of the device:

1 http://<IP address of device> (if ports LAN1 or LAN2 have been used)

2 http://169.254.1.1 (if the port marked CON700 has been used)

» The device configuration page is displayed.

8.4.3 Start-up via a USB memory stick

Application

The installation technician has saved a pre-prepared device configuration on a USB memory stick (e.g. a configuration that he has uploaded during the guided installation of a device or one that has been given to him by a third party).

Required components

- USB memory stick with pre-prepared start-up configuration file.

Procedure

1 Connect the USB memory stick to the USB slot on the underside of the device.

⇨ The device checks the saved configuration and emits a flash code via the LEDs on the front of the device which allows conclusions to be drawn about the validity of the configuration ().

2 If the configuration is valid, the parameters should be adopted by pressing the right-hand multi-function button on the underside of the device.

» Once the parameters have been adopted and the device has been restarted, the device is put into operation.

8.4.4 Starting up a network without Segment Controller

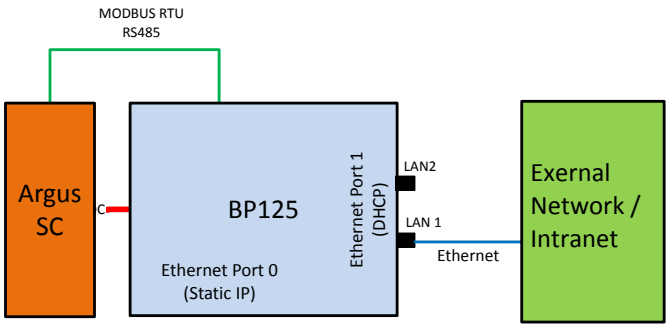


Fig. 49: Start-up via an external network

Application

The device can also be operated without an external Segment Controller or data logger. In this case however, the internal logging options are limited and log data are only available for a certain period of time.

If the device is to be integrated into an existing network, then the configuration shown in the following figure should be used. It is immaterial whether port LAN1 or LAN2 is used.

Required components

- A notebook that is logged into the external network.
- Ethernet cable (uncrossed patch cable)

Establishing a connection to the KACO device

☞ The device must be opened in order to connect the Ethernet cable! The device has 3 Ethernet ports that can be used. These are located on the printed-circuit board marked LP400. In this application only one of the 2 neighboring shielded Ethernet ports (marked LAN1 and LAN2) should be used. These ports have an internal switch and, in their factory default state, they expect to receive an IP address from a DHCP server.

» **CAUTION! Please do not under any circumstances connect the Ethernet cable to the unshielded RJ45 slot marked J200 as this typically causes damage to the printed circuit board!**

1 Use a functioning Ethernet slot on the external network end.

2 It may be necessary to take additional IT configuration measures in the external network so that the device is assigned an IP address.

3 Next, launch the browser on the terminal device and enter the IP address of the device:

⇨ http://<IP address of the device>

⇨ The IP address can either be requested from the network administrator or determined using an IP scanner tool.

4 There is also the option of addressing the device using its host name. In its factory default state, the host name consists of a combination of the device derivative designation and the serial number, as shown below:
<Device designation serial number>, for example bp125-125TL01234567

⇨ http://bp125-125TL01234567

5 If this is unsuccessful, please use the full domain name:
http://bp125-125TL01234567<ExternalNetworkDomainName>

8.4.5 Starting up a plant segment

The following figure provides an example of the structure of a plant segment consisting of a Segment Controller and a certain number of KACO devices with string combiner (SC) combinations.

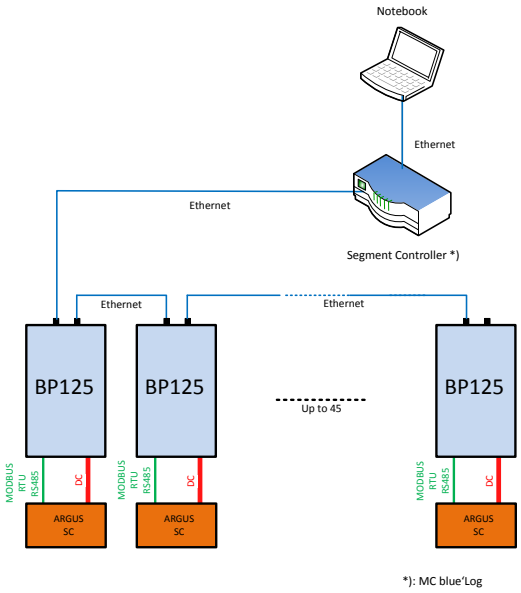


Fig. 50: Start-up via Segment Controller

Scope of application

The network infrastructure already exists. All of the KACO devices in the segment can be reached via Ethernet using a Segment Controller.

NOTE: When multiple Segment Controllers are present, keep in mind that the Segment Controllers are not connected to one another via the network during start-up. Once start-up is complete (assignment of devices to the individual Segment Controllers), these can be connected to the network by pressing a main switch.

Required components

- Notebook with Ethernet interface and pre-prepared start-up configuration file
- Segment Controller

Procedure

1 Connect the notebook to the Segment Controller via Ethernet (or to a switch that provides access to the Segment Controller).

2 Upload a pre-prepared device configuration (e.g. a device configuration that has been set up successfully on a single device).

3 Using the Segment Controller's WEB server, it is then possible to display and select all of the connected devices on the Segment Controller that should have this configuration.

4 Once the configuration has been uploaded to the respective devices, they will go into operation automatically following a restart.

8.4.6 Starting up an entire plant

Scope of application [5]

The network infrastructure is available in full. All of the KACO devices in the segments can be reached via Ethernet using the Segment Controller assigned to them. All Segment Controllers are monitored by a central Plant Controller.

Required components

- Notebook with Ethernet interface or WiFi and pre-prepared start-up configuration file.
- Plant Controller.

Procedure

1 Connect the notebook to the Plant Controller via Ethernet or a WiFi-compatible Client.

2 Upload a pre-prepared device configuration (e.g. a device configuration that has been set up successfully on a single device).

3 All of the connected devices are displayed on the webserver of the Plant Controller and are selected from a list.

⇨ The device checks the saved configuration and emits a flash code via the LEDs on the front of the device which allows conclusions to be drawn about the validity of the configuration ().

4 If the configuration is valid, the parameters can be adopted by pressing the right-hand multi-function button on the underside of the device.

» Once the parameters have been adopted and the device has been restarted, the device is put into operation.

[5] Group configuration is not currently supported. This will be enabled in a subsequent version of the firmware.

9 Configuration and operation

9.1 Initial start-up

NOTE

The DC power supply must be guaranteed during initial start-up.

The sequence of the settings required for initial start-up is preset in the configuration assistant.

9.2 Control elements

9.3 User interface

NOTE

Depending on the tolerances of the measuring elements, the measured and displayed values are not always the actual values. However, the measuring elements ensure maximum solar yield. Due to these tolerances, the daily yields shown on the display/screen may deviate from the values on the grid operator's feed-in meter by up to 15%.

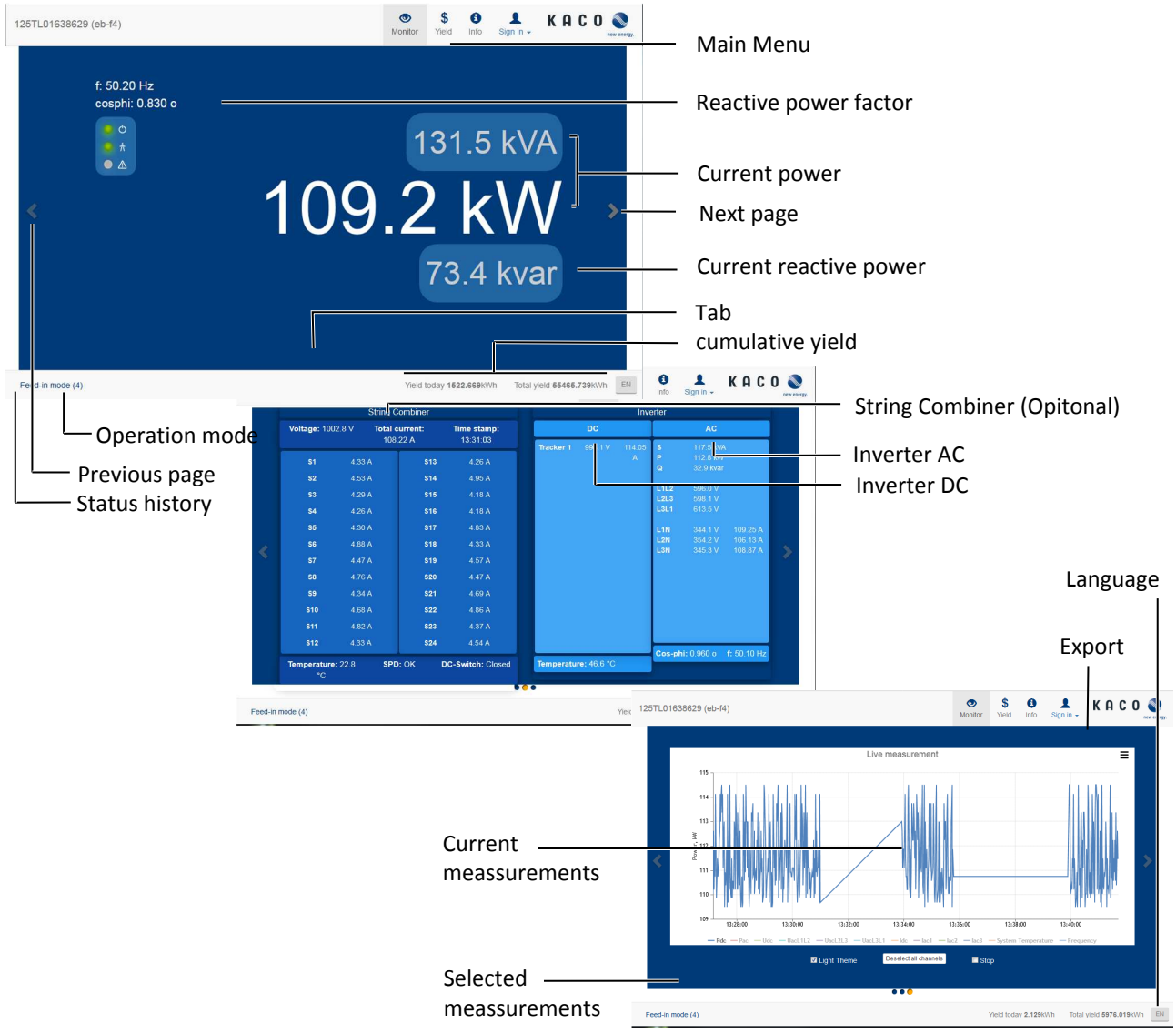


Fig. 51: Monitoring interface

Area	Description
Basic layout - 1st tab	Displays the current reactive power factor Displays the current output
Basic layout - 2nd tab	Displays AC and DC voltages
Basic layout - 3rd tab	Current measurement values with export function

Tab. 4: Description of the areas

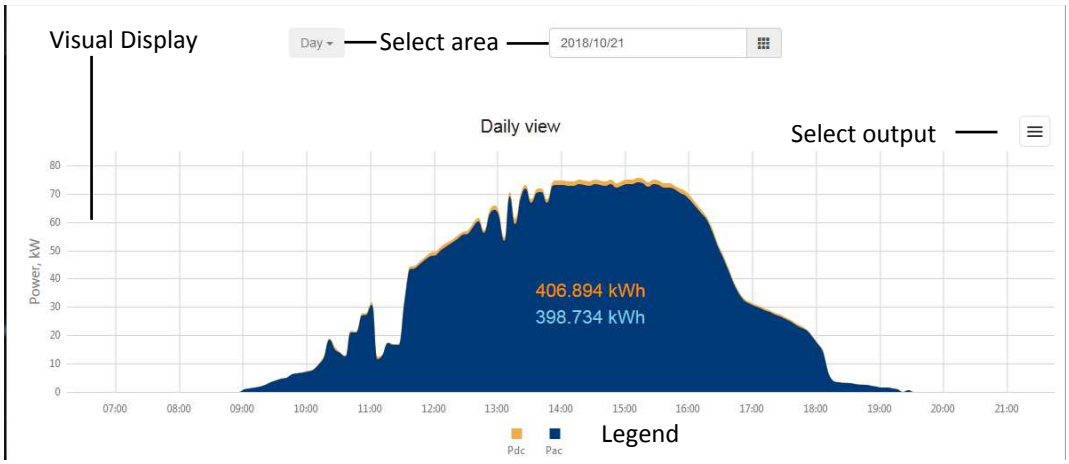


Fig. 52: Interface for evaluating the yields

Area	Description
Selection area	Filtering options for daily and annual values
Visual representation	Graphical bar chart
Legend	Meaning of color coding

Tab. 5: Description of the areas

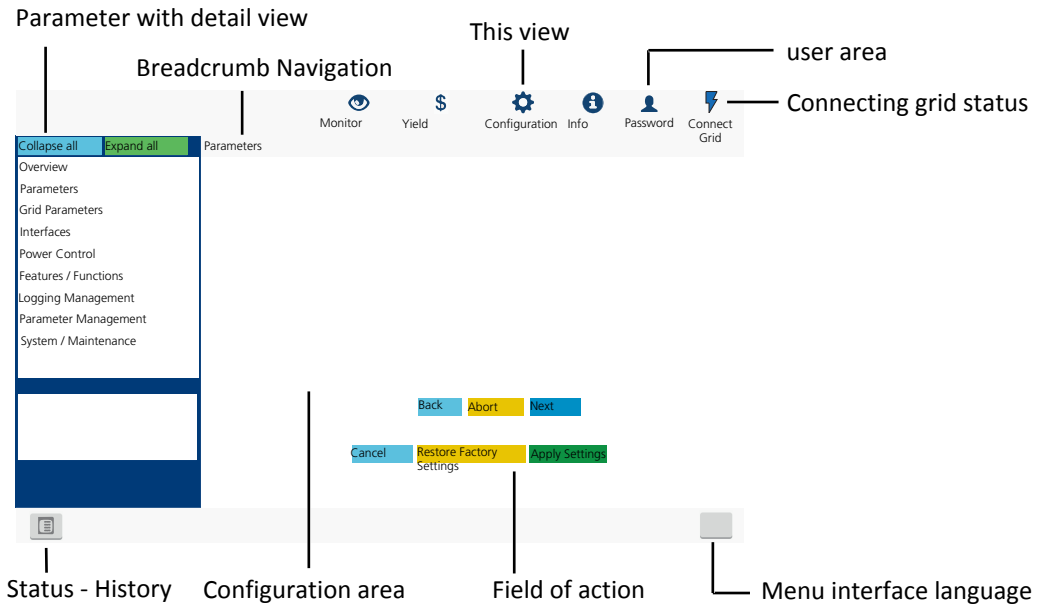


Fig. 53: Parameterization interface

Area	Description
Menu bar	Menus and commands for operating the interface.
Tool bar	

Area	Description
Scope of application	Displays parameter values, graphs or input options relative to the view, function and parameter selected.
Navigation area	Displays the user level and error messages. Enables selection of connected interfaces. Enables selection of devices connected at the interface. Enables selection of functions in relation to the parameter selected.

Tab. 6: Description of the areas

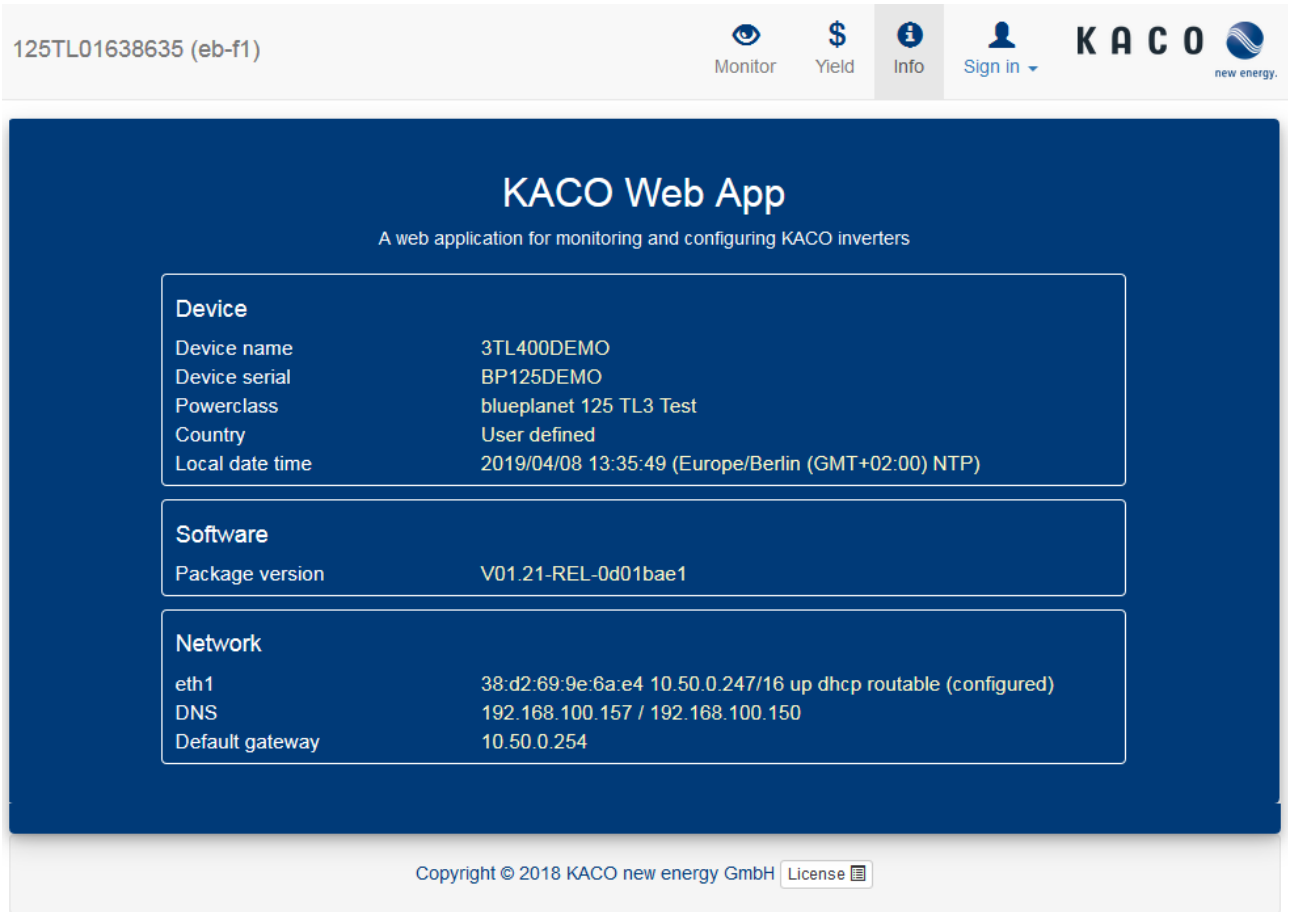


Fig. 54: Device and hardware information interface

Area	Description
Device	Displays the serial number, device name, grid type, local installation location and time
Software	Displays the firmware package installed
Network	Displays the current grid parameters

Tab. 7: Description of the areas

9.4 Menu structure

NOTE

Protection of special parameters using a password:

- As soon as the password has been activated, this also applies to external change requests (e.g. via MODBUS or other external interfaces).
- You will be asked to enter the password if you would like to change a protected parameter. Once you have entered the password, protection will be disabled for all protected parameters (including the password protection setting) for 15 minutes. Protection is reactivated automatically after this time has elapsed.
- If you attempt to disable a protected parameter group, you will have to enter the password first unless it was entered earlier in the session.
- As soon as a set of configuration parameters has been exported, the password is part of this configuration.
- If the configuration has been imported into another device, then the other device will have the same protection status. If the other device already had protection and the password for the new configuration is different, then the new configuration will be rejected.

NOTE

We recommend using an up-to-date Firefox or Chrome browser or the default browser that is available on the mobile terminal devices to configure the device via the web interface.

9.4.1 Yield via web user interface

Country-spec. Settings	Level	Display/ settings	Action in this menu/meaning
	1 2 3 4	Daily view	**NOTE: Displays the recorded operating data graphically.** ☞ Select a day. ⇨ The web interface shows the selected data.
	1 2 3 4	Weekly view	**NOTE: Displays the recorded operating data graphically.** ☞ Select a week. ⇨ The web interface shows the selected data.
	1 2 3 4	Monthly view	Displays the recorded operating data graphically. ☞ Select a month. » The web interface shows the selected data.
	1 2 3 4	Yearly view	Displays the recorded operating data graphically. ☞ Select a year. ⇨ The web interface shows the selected data.
	1 2 3 4	Total view	Displays the total yield up to now.
	1 2 3 4	Export / print Print PNG | PDF | JPEG | SVG | GIF	**NOTE: Opportunity to print out or save the chart.** 1 Select an output format. 2 Specify the storage location.

9.4.2 Configuration via web user interface

Country-spec. Settings	Level	Display/ settings	Action in this menu/meaning
	1 2 3 4	Overview	Input screens for basic settings
	1 2 3 4	Language (11 languages)	1 Select the desired language for the user interface. 2 Confirm the action field.
	1 2 3 4	Localization Status	1 Select the current date and enter the time or press the button "Sync with client device now". 2 Select a time zone. 3 Activate the NTP server and assign a name. 4 Obtain NTP server settings from DHCP. 5 Specify the temperature unit. 6 Confirm the action field.
	1 2 3 4	Miscellaneous	1 Enter the device name. 2 Enter the degree of longitude and latitude of the installation location. 3 Enter the plant ID. 4 Confirm the action field.
	1 2 3 4	DC Parameter	Input screens for generator and string collector.
	1 2 3 4	String Combiner	**NOTE: Opportunity to configure a string collector.**
		String combiner monitoring Status	☞ Select the monitoring function when the string collector is connected.
		Serial number of the allocated string collector	1 Enter the serial number once the device has been installed. **NOTE: The serial numbers of the string collector that are not connected directly to the device are entered on the segment controller.**
		Baud rate & number of data capture units 4800 - 115200	1 Specify the baud rate and capture interval. 2 If necessary, enter the number of the data capture unit.
		Unit address	1 Specify the IP address of the string collector. 2 Specify the number of monitored strings.
		Unit channels	3 Confirm the action field.
	1 2 3 4	Constant voltage mode	**NOTE: Opportunity to deactivate the MPP seek mode in order to operate the device with a constant DC voltage.**
		Constant voltage 875 – 1300 [V]	☞ Set value for constant voltage control.
		Constant voltage mode Off | On	1 Activate or deactivate the constant voltage controller. 2 Confirm the action field.
	1 2 3 4	DC starting voltage 1000 – 1450 [V]	**NOTE: The device begins feed-in as soon as this DC voltage is present.** 1 Set the starting voltage. 2 Confirm the action field.

Country-spec. Settings	Level	Display/ settings	Action in this menu/meaning
		Insulation resistance ⚙ 60 – 2000 [kOhm]	1 Set threshold value (in 1 kOhm steps) at which the insulation monitor reports a fault. 2 Confirm the action field.
		Grid Parameters	Input screens for network parameters
		Country & Grid type	**NOTE: This option influences the country-specific operating settings of the device. Please consult KACO Service for further information.** **NOTE: Configuration:.** Configuration via web user interface [See section 9.4.2 Page 62] ☞ Select country and grid type.
		Nominal grid voltage & Nominal grid frequency Password protection Status	☞ Specify optional nominal grid voltage. **NOTE: The device switches off if the grid frequency deviates from the nominal grid voltage by more than 9.5Hz.** 1 Select optional nominal grid frequency. 2 Activate optional password protection. 3 Confirm the action field.
		FRT (Fault Ride Through)	**NOTE: The device supports dynamic grid stabilization (Fault Ride-Through).**
		Operation mode – On | Off	☞ Select a control process. On: Activates dynamic grid support using dynamic reactive current. Off: Deactivates dynamic grid support using dynamic reactive current. Dynamic grid support remains active on account of immunity to interference.
		Settings | Manual |Predefined zero current	☞ Select a control process. Manually: All parameters can be configurated independently. Predefined zero current Dynamic grid support active on account of immunity to interference and zero current feed-in. During a voltage incident, the current in the inverter is reduced to zero. All parameters are pre-configured, only the activation threshold for zero current has to be configurated. Dynamic grid support active on account of immunity to interference and fast feeding of residual current. The inverter feeds additional reactive current according to the formulae (2) and (4). Dynamic grid support using a fast feeding of residual current [See section 10.4.2 Page 71]
		Priority – Reactive current limitation | Dynamic reactive current	☞ Select a control process. Reactive current priority: Dynamic grid support active on account of immunity to interference and dynamic reactive current. The device feeds additional reactive current according to the formulae (2) and (4) Dynamic grid support using a fast feeding of residual current [See section 10.4.2 Page 71] Dynamic reactive current Dynamic grid support active with active power priority on account of immunity to interference and dynamic reactive current. The device feeds in as much active power as possible. If, as a result of this, the maximum continuous current is not achieved, the device supplies additional reactive current according to the formulae (2) and (4) Dynamic grid support using a fast feeding of residual current [See section 10.4.2 Page 71] up to the maximum continuous current.

Country-spec. Settings	Level	Display/ settings		Action in this menu/meaning
	1 2 3 4	Constant k positive sequence dip & Constant k positive sequence swell k 0 -10 2		☞ Set amplification factor k for the pos. sequence for drop and increase in the grid voltage. **NOTE: Amplification factor for the positive sequence used in the calculation of the reactive current using formulae (1) and (2) & (3)** Dynamic grid support using a fast feeding of residual current [See section 10.4.2 Page 71].
	1 2 3 4	Constant k negative sequence dip Constant k negative sequence swell k 0 – 10 2		☞ Set amplification factor k for the neg. sequence for drop and increase in the grid voltage. Amplification factor for the negative sequence used in the calculation of the reactive current using formulae (2) and (4) Can be configured independently for drops and spikes. Dynamic grid support using a fast feeding of residual current [See section 10.4.2 Page 71]
	1 2 3 4	Dead band 0 - 100 [% Uref] 10.0		☞ Set dead band in %. **NOTE: Dynamic grid support through dynamic reactive current activated in the case of voltage events with a voltage change greater than the dead band.**
	1 2 3 4	Dynamic reactive current only Off | On		**NOTE: With activated FRT mode, the pre-fault reactive current can be added.** ☞ If necessary, activate pre-fault reactive current. Off: The reactive current according to the formulae (2) and (4) Dynamic grid support using a fast feeding of residual current [See section 10.4.2 Page 71] is fed in as additional reactive current. The means that the current reactive current is taken into consideration before the voltage incident and the sum of the pre-fault and additional reactive current is fed in. ON: The reactive current according to the formulae (2) and (4) Dynamic grid support using a fast feeding of residual current [See section 10.4.2 Page 71] is fed in as absolute reactive current. This means that the reactive current is the only current to ever be fed in irrespective of the reactive current prior to the voltage incident.
	1 2 3 4	Dead band mode Mode 1 | Mode 2		☞ Select dead band mode for the active control process. Mode 1: When calculating the reactive current, the value of the dead band is not subtracted from the amount of voltage change. Formula (2) applies to overvoltage and undervoltage incidents Dynamic grid support using a fast feeding of residual current [See section 10.4.2 Page 71] Mode 2: When calculating the reactive current, the value of the dead band is subtracted from the amount of voltage change. As such, Ib=(Δu1-tb)*k*IN applies to overvoltage and undervoltage incidents
	1 2 3 4	Reference voltage 80 - 108 [% Unom] 100		**NOTE: Nominal value of phase neutral conductor voltage for grid. This value is used as a reference for the normalization of Δu. Adjustable in the range from level 1 undervoltage protection to level 1 overvoltage protection.** ☞ Set reference voltage for the active control process.

Country-spec. Settings	Level	Display/ settings		Action in this menu/meaning
	1 2 3 4	Minimum static voltage range ⚙ 0 – 137.2 [% Unom] & Maximum static voltage range ⚙ 0 – 137.2 [% Unom] Password protection Status		☞ Set voltage range for the active control process. **NOTE: Dynamic grid support through dynamic reactive current is activated in the case of voltage events with voltages outside the normal voltage range and disabled when the voltage returns to the normal voltage range.** 1 Activate optional password protection. 2 Confirm the action field.
	1 2 3 4	Enhanced Island Detection		Grid operators require shutdown of the device with islanding detection **NOTE:** Enhanced island detection [See section 10.6 Page 74] **NOTE: .**
	1 2 3 4	ROCOF operation mode passive Off | On		☞ Activate passive grid influence by application of a frequency.
		ROCOF operation mode active Off | On		☞ Activate active grid influence by application of a frequency.
	1 2 3 4	Pulse period repetition time ⚙ 40 – 6000 [ms]		☞ Define period for detection.
	1 2 3 4	ROCOF threshold stage 1 value ⚙ 0.1 – 6.0 [Hz / s] ROCOF threshold stage 2 value ⚙ 0.1 – 6.0 [Hz / s]		☞ Define threshold for ROCOF
		ROCOF threshold stage 1 time ⚙ 0.10 – 5.00 [s] ROCOF threshold stage 2 time ⚙ 0.10 – 5.00 [s]		☞ Define time value for ROCOF.
	1 2 3 4	ROCOF proportionality factor ⚙ -5000 – 5000 [‰ / Hz] Status		1 Define the proportionality factor. 2 Confirm the action field.
	1 2 3 4	Power gradient limitation		**NOTE: Opportunity to limit power in the case of an increasing and decreasing grid frequency.**
		Operating mode Status		☞ Select operating mode.
		Increasing gradient ⚙ 1 – 65534 [%/min]		☞ Set the gradient.
		Falling gradient ⚙ 1 – 65534 [%/min] Password protection Status		1 Set the gradient. **NOTE: This percentage relates to the nominal frequency.** 2 Activate optional password protection. 3 Confirm the action field

Country-spec. Settings	Level	Display/ settings	Action in this menu/meaning
	1 2 3 4	Connection Conditions	**NOTE: Precise switch-on conditions should be specified relative to the grid conditions.**
		Min. conn. voltage after grid mon. 10 – 110 [% Unom] / & Max. conn. voltage after grid mon. 90 – 126.6 [% Unom]	☞ Specify switch-on voltage range after grid error.
		Min. conn. frequency after grid mon. 45 – 65 [Hz] / & Max. conn. frequency after grid mon. 45 – 65 [Hz]	☞ Specify switch-on frequency range after grid error.
		Min. conn. voltage after grid failure 10 – 110 [% Unom] / & Max conn. voltage after grid failure 90 – 126.6 [% Unom]	☞ Specify switch-on voltage range after grid error
		Min. conn. frequency after grid failure 45 – 65 [Hz] / & Max. conn. frequency after grid failure 45 – 65 [Hz]	☞ Specify switch-on frequency range after grid error.
		Monitoring grid voltage 1 - 1800 [s] & Monitoring PV voltage 1 - 1800000 [ms]	☞ Specify the time for monitoring the grid voltage and PV voltage.
		Waiting time after grid failure 1 - 1800 [s] Password protection Status	1 Set waiting time after grid error. 2 Activate optional password protection. 3 Confirm the action field.
	1 2 3 4	Trip Settings	**NOTE: Activate shutdown according to generic parameters, frequency or voltage.**
	1 2 3 4	Generic parameters	**NOTE: Opportunity to activate standard protective shutdown**
		Trip as intentional delay Status	1 If necessary, activate delayed trip-off. 2 Activate optional password protection. 3 Confirm the action field.

Country-spec. Settings	Level	Display/ settings		Action in this menu/meaning
	1 2 3 4	Frequency		**NOTE: Opportunity to monitor frequency trip-off**
		Trip underfrequency monitoring Status		☞ Activate, if necessary.
		Number of underfrequency trip-off levels 1- 5		☞ Specify the number of support levels.
		Underfrequency trip-off 42.5 – 65 [Hz] / & underfrequency trip-off time for levels 1 to 5 0 – 120000 [ms]		**NOTE: If the grid frequency is within the deactivation range for the duration of the deactivation time, then the function is deactivated.** ☞ Specify the range and trip-off time.
		Trip overfrequency monitoring Status		☞ Activate, if necessary.
		Number of overfrequency trip-off levels 1- 5		☞ Specify the number of support levels.
		Overfrequency trip-off 45.0 – 67.5 [Hz] / & overfrequency trip-off time for levels 1 to 5 0 – 120000 [ms] Password protection Status		**NOTE: If the grid frequency is within the deactivation range for the duration of the deactivation time, then the function is deactivated.** 1 Specify the range and trip-off time. 2 Activate optional password protection. 3 Confirm the action field.

Country-spec. Settings	Level	Display/ settings		Action in this menu/meaning
	1 2 3 4	Voltage		**NOTE: Opportunity to monitor voltage trip-off**
		Trip undervoltage monitoring Status		☞ Activate, if necessary.
		10 minute mean value 110 – 126.6 [% Unom] Number of undervoltage trip-off levels 1- 5		1 Adjust the monitoring range. 2 Specify the number of support levels.
		Undervoltage trip-off 10 – 100 [% Unom] / & Undervoltage trip-off time for levels 1 to 5 0 – 120000 [ms]		☞ Specify the range and trip-off time.
		Trip overvoltage monitoring Status		☞ Activate, if necessary.
		Number of overvoltage trip-off levels 1- 5		☞ Specify the number of support levels.
		Overvoltage trip-off 100 – 125 - 150 [% Unom] / & Overvoltage trip-off time for levels 1 to 5 0 – 120000 [ms]		1 Specify the range and trip-off time. 2
		10 minute mean value password protection Status Password protection Status		1 Activate optional password protection for 10 minute mean value. 2 Activate optional password protection. 3 Confirm the action field.
	1 2 3 4	Transient overvoltage protection 114.8 - 148.0 [% Unom] Password protection Status		**NOTE: Opportunity to set the overvoltage protection.** 1 Set the overvoltage protection. 2 Activate optional password protection. 3 Confirm the action field.
	1 2 3 4	Interfaces	↳	Input screens for configuring the interfaces.
	1 2 3 4	Network	↳	Opportunity to configure the installed network.
	1 2 3 4	IP Settings		**NOTE: Parameterization of network access.**

Country-spec. Settings	Level	Display/ settings	Action in this menu/meaning
	1 2 3 4	DHCP Status	☞ Activate or deactivate the DHCP. On: Once the DHCP server becomes available, the IP address, subnet mask, gateway and DNS server are automatically applied and the aforementioned menu items are filled in. Off: Apply settings manually.
	1 2 3 4	IP Address	☞ Allocate a unique IPv4 address in the network.
	1 2 3 4	Subnet Mask	☞ Assign a subnet mask.
	1 2 3 4	Default gateway	☞ Enter IPv4 address of the gateway.
	1 2 3 4	DNS server settings via DHCP Status	☞ Activate or deactivate the DNS server from the DHCP. On: Once the DHCP server becomes available, the IP address is automatically applied and the aforementioned menu items are filled in. Off: Apply settings manually.
	1 2 3 4	Primary DNS & Secondary DNS (optional)	1 Enter IPv4 address of DNS server. 2 Confirm the action field.
	1 2 3 4	Web Settings HTTP Port HTTPS Port	**NOTE: Opportunity to set up the http ports.** ☞ Set up the port at which the webserver can be reached. 1 Set up the safe port at which the webserver can be reached. 2 Confirm the action field.
	1 2 3 4	Modbus port	☞ Set up network port.
	1 2 3 4	Modbus read access Status	☞ Allow Modbus TCP read access.
	1 2 3 4	Modbus write access Status	☞ Allow Modbus TCP write access. Enabling the write access allows system critical settings to be changed over Modbus TCP. Really enable write access? ☞ Confirm the action field.
	1 2 3 4	MQTT Broker IP Broker port	**NOTE: The MQTT protocol supports the advanced functions between the Segment Controller and the device (in particular, firmware updates, distribution of device configurations).** 1 Displays the IP address transmitted by the Segment Controller. **NOTE: The standard settings allow for successful communication with the Segment Controller.** 2 Confirm the action field.
	1 2 3 4	Cloud / Portal [4] Web portal Off | Meteocontrol | Colt QoS | User-defined 1-4: 900 – 86400 [s] 3600 [ms]	**NOTE: Opportunity to set up the Cloud portal** ↻ Your IT infrastructure must be adequately protected. 1 Select the portal or overwrite user-defined memory locations. 2 Specify logging interval. 3 Confirm the action field. Off: The connection to the web portal is deactivated. Meteocontrol: The device attempts to connect to the meteocontrol web portal. User-defined 1-4: The device attempts to log on via a user-defined portal that you set up subsequently.

Country-spec. Settings	Level	Display/ settings	Action in this menu/meaning
	1 2 3 4	RS485	**NOTE: Opportunity to parameterize the RS485 interface.**
		RS485 address	**NOTE: The address must not be the same as that of any other device or a data logger.** ☞ Assign a unique RS485 bus address to the device. Bus termination is carried out on the HMI board by means of a dip-switch ☞ Confirm the action field.
	1 2 3 4	Power Control	Input screens for power regulation
	1 2 3 4	Power Limitation	**NOTE: The output power of the device can be set permanently to a lower value than the maximum output power by the internal power limitation. This may be necessary in order to limit the maximum power rating of the plant at the grid connection point, upon the grid operator's request.**
	1 2 3 4	Internal	**NOTE: Opportunity to limit the power internally**
		Power Limitation Status	☞ Specify the activation status.
	1 2 3 4	Maximum apparent power Slim 1000 – 1370000 [VA]	**NOTE: The max. apparent power limits the internal power of the device.** Power limitation [See section 10.2 Page 68]. ☞ Set the value using the slider.
	1 2 3 4	Maximum active power Plim 1.0 - 100.0 [% Slim] Password protection Status	The max. active power limits the internal power of the device. Power limitation [See section 10.2 Page 69] **NOTE: .** 1 Enter the value or set the value using the slider. 2 Activate optional password protection. 3 Confirm the action field.
	1 2 3 4	External	**NOTE: The output power of the device can be set permanently to a lower value than the maximum output power by the external power limitation.**
		Power Limitation Status	☞ Specify the activation status.
		AC fallback active power 0 – 100 [%Plim]	☞ Set the fallback power.
		Fallback time 60 – 43200 [ms]	☞ Set the fallback time.
	1 2 3 4	Output gradient limitation increase & Output gradient limitation decrease 1 - 65534 [% / min]	☞ Specify the increasing and decreasing output gradient.
	1 2 3 4	Settling time 200 – 60000 [ms] Password protection Status	1 Specify the settling time. 2 Activate optional password protection. 3 Confirm the action field.

Country-spec. Settings	Level	Display/ settings	Action in this menu/meaning
		Reactive Power Control (RPC)	**NOTE: Activate the reactive power process in the mode menu.**
		Mode Cos-phi const. | Q const. | Cos-phi(P/Pn) | Q(U) Password protection Status	 1 Select a control process. 2 Activate optional password protection. 3 Confirm the action field.
		Cos-phi constant	**NOTE: Define the cos φ NOTE: constant.**
		cos-phi const. 0.3 - 1	☞ Determine the prescribed shift factor.  **NOTE: When there is a cos ϕ constant, the specified shift factor Q=P*tan φNOTE: is set permanently by the device. In doing so, the reactive power level is calculated in line with Q=P*tan φNOTE: . If the specification is changed, the new value is adopted by way of a filter in a muted manner. The settling time is 1s with the transient response of a first-order filter (PT-1) with a time constant of Tau=200ms.**
		Output gradient limitation increase & Output gradient limitation decrease 1 - 65534 [% / min]	 **NOTE: In addition to configuring the transient behavior using the settling time corresponding to a first-order filter, the reactive power setting can be determined by a maximum gradient - maximum change in the reactive power per time period.** 1 Maximum change in the reactive power %Smax/min in the event of a change to over-excited mode. 2 Maximum change in the reactive power %Smax/min in the event of a change to under-excited mode.
		Settling time 200 - 60000 [ms] 1000 Password protection Status	 1 Set the settling time in the event of an abrupt change in the reactive power target value (e.g. caused by a voltage jump). The transient behavior corresponds to a first-order filter (PT-1) with settling time = 5Tau. 2 Activate optional password protection. 3 Confirm the action field.
		Q constant	**NOTE: Define the Q constant.**
		Q constant 0 – 100%	☞ Set the reactive power Q (in %) to a fixed value.  **NOTE: When there is a Q constant, the specified reactive power value is set permanently by the device. If the specification is changed, the new value is adopted by way of a filter in a muted manner. The settling time is 1s with the transient response of a first-order filter (PT-1) with a time constant of Tau=200ms.**
		Under-excited | over-excited	☞ Select the type of phase shift. **NOTE: Under-excited relates to inductive load, over-excited relates to capacitive load.**
		Output gradient limitation increase & Output gradient limitation decrease 1 - 65534 [% / min]	 **NOTE: In addition to configuring the transient behavior using the settling time corresponding to a first-order filter, the reactive power setting can be determined by a maximum gradient - maximum change in the reactive power per time period.** 1 Maximum change in the reactive power %Smax/min in the event of a change to over-excited mode. 2 Maximum change in the reactive power %Smax/min in the event of a change to under-excited mode.

Country-spec. Settings	Level	Display/ settings		Action in this menu/meaning
	1 2 3 4	Settling time 200 - 60000 [ms] 1000 Password protection Status		1 Set the settling time in the event of an abrupt change in the reactive power target value (e.g. caused by a voltage jump). The transient behavior corresponds to a first-order filter (PT-1) with settling time = 5Tau. 2 Activate optional password protection. 3 Confirm the action field.
	1 2 3 4	Cos-phi		**NOTE: More detailed information can be found in** Reactive power control [See section 10.3 Page 69] ☞ Define the standard characteristic curve with 3 nodes.
	1 2 3 4	Lock-In voltage 10 – 124.8 [% Unom]		☞ Set the voltage above which control is activated.
	1 2 3 4	Lock-Out voltage 10 – 124.8 [% Unom]		☞ Set the voltage below which control is deactivated.
	1 2 3 4	Settling time 0.2s – 30s		PLEASE NOTE! Settling time: It the target value changes as a result of activating or deactivating the function by way of lock-in and lock-out voltage or changing the active power, then the new target value is set within 10s with the transient response of a first-order filter (PT-1) with a time constant of Tau=2s. ☞ Set the settling time in the event of an abrupt change in the reactive power target value.
	1 2 3 4	Output gradient limitation increase & Output gradient limitation decrease 1 - 65534 [% / min]		**NOTE: In addition to configuring the transient behavior using the settling time corresponding to a first-order filter, the reactive power setting can be determined by a maximum gradient - maximum change in the reactive power per time period.** 1 Maximum change in the reactive power %Smax/min in the event of a change to over-excited mode. 2 Maximum change in the reactive power %Smax/min in the event of a change to under-excited mode.
	1 2 3 4	Number of nodes 2 - 10		**NOTE: The maximum number of configurable nodes depends on the selected grid type.** ☞ Specify the number of nodes.
	1 2 3 4	1st node … 10th node Power | Reactive power | Excitation 0-100% 0.3 - 1 Over-excited | under-excited Password protection Status		☞ Specify the power factor for the 1st , 10th ... node as a percentage of the maximum power. **NOTE: For the 1st node, the power must be 0%; for the last node, the power must be 100%. The power values of the nodes must increase continuously.** ☞ Specify the **NOTE: cos φ** of the node. ☞ If a reactive power not equal to 1 is selected: Select the type of phase shift. **NOTE: Over-excited relates to a capacitive load, under-excited relates to an inductive load.** 1 Activate optional password protection. 2 Confirm the action field.
	1 2 3 4	Q(U)		**NOTE: Define Q(U).**
	1 2 3 4	Lock-In power 0 – 100 [%] S_{max}		☞ Set the active power as % of rated power above which control is activated.

Country-spec. Settings	Level	Display/ settings		Action in this menu/meaning
	1 3 3 4	Lock-Out power ⚙ 0-20 [%] S_{max}		☞ Set the active power as % of rated power below which control is de-activated.
	1 3 3 4	Lock-In time ⚙ 0 – 60 [s] Lock-Out time ⚙ 0 – 60 [s]		☞ Set the length of time that the active power must remain above the lock-in / lock-out power level before control is activated.
	1 3 3 4	Dead time ⚙ 0 -10 [ms]		☞ Set the intentional delay for the start of the Q(U) function. **NOTE: If the voltage switches from a characteristic curve section with Q=0 to a characteristic curve section with Q≠0 under active control, then the reactive power setting process is delayed by the set dead time. Once the dead time has expired, the control circuit is no longer subject to a delay and the set settling time determines the transient behavior.**
	1 3 3 4	Output gradient limitation increase & Output gradient limitation decrease ⚙ 1 - 65534 [% / min]		**NOTE: In addition to configuring the transient behavior using the settling time corresponding to a first-order filter, the reactive power setting can be determined by a maximum gradient - maximum change in the reactive power per time period.** 1 Maximum change in the reactive power %Smax/min in the event of a change to over-excited mode. 2 Maximum change in the reactive power %Smax/min in the event of a change to under-excited mode.
	1 3 3 4	Settling time ⚙ 1 – 120 [s]		☞ Set the response speed of the Q(U) control.
	1 3 3 4	Minimum cos-phi Q1 - Minimum cos-phi Q4 ⚙ 0 – 1		**NOTE: In the event of a significant voltage deviation, the maximum reactive power adjustment range can be limited by a minimum cos ϕ in order to prevent an excessive reactive power supply and, as a result, a significant reduction in the maximum active power that can be fed in.** ☞ Enter the minimum cos φ factor for quadrants 1 and 4.
	1 3 3 4	Q(U) active curve ⚙ 1 - 4		☞ Select the active curve. **NOTE: Up to 4 characteristic curves can be configured independently and one of them can be activated for regulation each time.**
	1 3 3 4	Priority mode ⚙ Q-Priority | P-Priority		☞ Set priority for reactive power - Q or active power - P. **NOTE: When it comes to P priority, the reactive power adjustment range is limited subject to the active power that is currently available and fed in.**
	1 3 3 4	Number of nodes 2 - 10		**NOTE: The maximum number of configurable nodes depends on the selected grid type.** ☞ Specify the number of nodes.

Country-spec. Settings	Level	Display/ settings		Action in this menu/meaning
	1 2 3 4	Node 1- Node 10 Power / Excitation / Voltage 0 – 100 [%]		☞ Set the reactive power of the node as a percentage of the maximum power.
		Over-excited | under-excited		☞ Select the type of phase shift. **NOTE: Over-excited relates to a capacitive load, under-excited relates to an inductive load.**
		0 – 100 [% Unom]		☞ Enter the voltage of the node in volts. **NOTE: The voltage values of the nodes must increase continuously. For voltages below the 1st node and voltages above the last node, the reactive power value of the 1st or last node is used each time.**
	1 2 3 4	Frequency dependent power reduction		**NOTE: Activate frequency-dependent power reduction in the P(f) menu.**
Not for IL, IT	1 2 3 4	P(f) operation mode Off | Mode 1 | Mode 2		**NOTE: More detailed information can be found in** Regulating active power [See section 10.5 Page 73] ☞ Specify the operation mode.
	1 2 3 4	P(f) gradient 0 – 200 [%/ Hz]		☞ Set gradient of power limit function with increasing frequency in % / Hz. This percentage relates to the nominal frequency of 50 Hz.
	1 2 3 4	P(f) gradient in the case of a decreasing frequency 0 – 200 [%/ Hz]		☞ Specify gradient in the case of a decreasing frequency as a $\%_0$(per thousand) / minute (if mode "1" or mode "2" is active).
	1 2 3 4	P(f) activation threshold 45 Hz – 70 Hz		☞ Specify activation threshold (if mode 1 or mode 2 is active, this menu item is displayed permanently for IT and IL!) **NOTE: The function is activated if the activation threshold is exceeded. In mode 2 this value also serves as a deactivation threshold.**
	1 2 3 4	P(f) minimum deactivation frequency 45 – 61.5 [Hz] / & P(f) maximum deactivation frequency 45 – 70 [Hz]		☞ Specify the maximum and minimum deactivation frequency in Hz.
Not for IL, IT	1 2 3 4	P(f) deactivation time 0 – 3600 [s]		☞ Specify time for power reduction (if mode 1 is active)
	1 2 3 4	P(f) intentional delay 0 – 5000 [ms]		☞ Set the power limitation delay in seconds (if mode 1 or mode 2 is active, this menu item is displayed permanently for IT and IL!).
	1 2 3 4	P(f) deactivation gradient 1 – 60000 [% / min]		☞ Specify deactivation gradient in $^0/_{00}$ (per thousand) / minute (if mode "1" or mode "2" is active, this menu item is displayed permanently for IT and IL!).
	1 2 3 4	Output gradient limitation increase & Output gradient limitation decrease 1 - 65534 [% / min]		☞ Specify the increasing and decreasing output gradient.

Country-spec. Settings	Level	Display/ settings		Action in this menu/meaning
	1 2 3 4	P(f) settling time ⚙ 0.2 – 2.0 [s] Password protection ☑ Status		1 Set the reaction speed of the control (if mode "1" or mode "2" is active, this menu item is displayed permanently for IT and IL!). 2 Activate optional password protection. 3 Confirm the action field.
	1 2 3 4	Voltage-dependent		**NOTE: Activate voltage-dependent power reduction in the P(U) menu.**
	1 2 3 4	P(U) operation mode ☑ Off | On		☞ Activate the control process. Off: Deactivates dynamic grid support using dynamic reactive current. Dynamic grid support remains active on account of immunity to interference.
	1 2 3 4	Reference power ☑ Instantaneous power | Nominal power		☞ Select the power-dependent control method.
	1 2 3 4	Rated voltage ☑ Maximum phase voltage | Positive sequence voltage		☞ Select the voltage to be rated.
	1 2 3 4	Hysteresis mode ☑ Off | On		**NOTE: Hysteresis mode affects the shutdown response of P(U). [** Regulating active power [See section 10.5 Page 72]] ☞ Activate the mode.
	1 2 3 4	Deactivation gradient ⚙ 0 - 65534 [% / min]		☞ Set gradient of voltage limit function with decreasing power in % / min. This percentage relates to the reference power set.
Not for IL, IT	1 2 3 4	Deactivation time ⚙ 0 – 60000000 [ms]		☞ Specify the time for voltage reduction
	1 2 3 4	Output gradient limitation increase & Output gradient limitation decrease ⚙ 1 - 65534 [% / min]		☞ Specify the increasing and decreasing output gradient.
	1 2 3 4	Settling time ⚙ 100 – 1200000 [ms]		1 Specify the settling time. 2 Confirm the action field.
	1 2 3 4	Active curve ⚙ 1 - 4		☞ Select the active curve. **NOTE: Up to 4 characteristic curves can be configured independently and one of them can be activated for regulation each time.**

Country-spec. Settings	Level	Display/ settings	Action in this menu/meaning
	1 2 3 4	Number of nodes ⚙ 2- 5	☞ Specify the number of nodes.
		Power ⚙ 0.0 -100.0 [%]	☞ Specify the power for the 1st , 5th ... node as a percentage of the maximum power. **NOTE: For the 1st node, the power must be 0%; for the last node, the power must be 100%. The power values of the nodes must increase continuously.**
		Voltage ⚙ 0.0 -126.0 [%] Password protection Status	1 Specify the voltage for 1st , 5th ... node as a percentage of the maximum voltage. 2 Activate optional password protection. 3 Confirm the action field.
	1 2 3 4	Delta P	**NOTE: Opportunity to regulate active power**
		Operating mode Status	☞ Select operating mode.
		Active power ⚙ -100.00 - +100.00 [%] Password protection Status	1 Set the active power. 2 Activate optional password protection. 3 Confirm the action field.
	1 2 3 4	Features / Functions	**NOTE: Input screens for advanced device functions**
	1 2 3 4	External grid protection	**NOTE: Opportunity to detect the external grid protection devices.**
		External grid protection Status	☞ Select the device.
		Password protection Status	1 Activate optional password protection. 2 Confirm the action field.
	1 2 3 4	Reactive Power Only (RPO)	**NOTE: Opportunity to actively supply reactive power**
	1 2 3 4	RPO Q constant ⚙ 0 – 100%	☞ Set the reactive power specification
		RPO Q constant excitation ⚙ Over-excited | under-excited	☞ Select the type of phase shift.
	1 2 3 4	RPO Fallback time ⚙ 3-10000000 [s]	1 Enter the fallback time in seconds. 2 Activate the action field.

Country-spec. Settings	Level	Display/ settings	Action in this menu/meaning
	1 2 3 4	Powador-protect	PLEASE NOTE: Configures the support on for grid shutdown by a Powador-protect connected to the digital input of the device.
		Powador-protect operation mode Auto | On | Off	↻ Auto/On: A Powador-protect is operating in the photovoltaic plant and is connected to the device at the digital input/output. ☞ Set the operating mode for Powador-protect. Auto: The device automatically detects a Powador-protect integrated into the photovoltaic plant. On: The digital signal of the Powador-protect must be present at the digital input of the device for the device to start with feed-in. Off: The device does not check whether a Powador-protect is integrated into the PV plant.
	1 2 3 4	SPD monitoring	**NOTE: Opportunity to check the overvoltage protection with appropriate status messages.**
		SPD monitoring Status Password protection Status	1 Activate overvoltage protection. 2 Activate optional password protection. 3 Confirm the action field.
	1 2 3 4	Digital IO modules	**NOTE: Opportunity to use digital inputs/outputs via an expansion module (KACO accessory)**.
		DIO1 DIO2 DIO3 DIO4	↻ Expansion module detected at one of the two slots. 1 Select the logic of the 4 channels. 2 Confirm the action field.
	1 2 3 4	Relay	**NOTE: Opportunity to configure the fault signal relay [ERR].**
		Relay Positive logic | Negative logic inactive | active	1 Select the type of logic. 2 Select the form of activity. 3 Confirm the action field.
	1 2 3 4	Logging Management	**NOTE: Input screens for log and service data and default settings.**
	1 2 3 4	Settings	Specify the interval for data capture and base meters.
	1 2 3 4	User logging interval 1 | 5 | 10 | 15 [minutes]	☞ Specify the time period between 2 log data recordings.
	1 2 3 4	Service logging interval 0 – xxx [s]	☞ Specify the time period between 2 log data recordings.
	1 2 3 4	Yield counter 0 – xxx [kWh]	**NOTE: Opportunity to enter yield data when exchanging a device.** ☞ Enter the meter reading in the input field.
	1 2 3 4	Operating hour counter 0 – xxx [hour]	**NOTE: Opportunity to transfer the operating hours of a replacement device.** 1 Enter the hours in the input field. 2 Confirm the action field.

Country-spec. Settings	Level	Display/ settings	Action in this menu/meaning
	1 2 3 4	Analyze Log Data	**NOTE: All measurement data can be transferred to a USB stick by making individual and multiple selections.**
		User logs cosPhi | fac (Hz) | Iac 1 (A) | Iac2 (A) | Iac3 (A) | idc (A) | Qac (var)	1 Select a date in the calendar. 2 Select measurement data from the dropdown field. 3 Update the measurement data. 4 Move the selected measurement data to the storage device or move the data selectively.
	1 2 3 4	Parameter management	**NOTE: Opportunity to reset configured values and the import and export of specific parameters.**
	1 2 3 4	Factory setting	1 Compare country-specific / network-specific parameters with default setting. 2 If necessary, reset the parameters by clicking on the "Restore" button.
		Export the configuration	1 Displays all parameters that can be exported. 2 Assign a password. 3 Select the parameters for exporting to a file or the plant manager.
		Import the configuration	1 Select the parameter file by clicking on the "Browse" button. 2 Import the parameters by clicking on the "Upload" button.
	1 2 3 4	Password protection Country selection | Connection conditions | Advanced islanding detection | FRT | ... | ... |	1 Opportunity to set up password protection for individual parameters. 2 Confirm the action field.
	1 2 3 4	System / Maintenance	**NOTE: Fundamental system and maintenance data with the initial start-up installation assistant.**
	1 2 3 4	Firmware update	**NOTE: Opportunity to update the device. Parameter data are not overwritten when the firmware is updated.**
	1 2 3 4	Settings	**NOTE: Settings for updating the firmware via remote access.**
		Allow remote firmware update Status	☞ Activate remote access for updates. Enter `firmware update URL` . 1 Enter `user name` and `password`. 2 Specify the `start` and `end time` for the update. 3 Confirm the action field.
	1 2 3 4	Instant Update	1 Select and confirm the firmware update file via Browse... 2 Perform the upload.
	1 2 3 4	Check for Available software packages	↻ Network connection available. 1 Checks for available device updates online using the existing network connection. 2 Start the firmware update by clicking the button.
	1 2 3 4	Installation Wizard	PLEASE NOTE: The installation assistant is described in the Chapter-**NOTE:** Start-up options [See section 8.4 Page 34]. When the installation process is complete, the text: Installation wizard completed appears

Country-spec. Set-tings	Level	Display/ settings	Action in this menu/meaning
	1 2 3 4	Service	**NOTE: Opportunity to specify the service interval.**
	1 2 3 4	Service Status Date | Yield | Date v Yield (first in)	1 Specify the service sequence. 2 Specify the service by date. 3 Specify the service by yield [kwh]. 4 Confirm the action field.
	1 2 3 4	Service Log	**NOTE: Display of all logged installations.** ☞ Export service logs, if necessary.
	1 2 3 4	History	**NOTE: Displays all of the actions performed in the system and on the web interface.**
	1 2 3 4	Account Management	1 Enter your User name. 2 Enter your new user-defined Password. **NOTE: Following initial start-up, it is necessary to** Change password **NOTE: that is specific to KACO**
	1 2 3 4	Restart the Device	**NOTE: Transfer safety-related parameters to a storage medium.** ☞ If necessary, re-start the device.

NOTE

With regard to the selection of country settings, KACO new energy attests:

- that the relevant certificates are only valid if the corresponding country settings have been selected.
- that all configured grid parameters must be configured in accordance with the requirements of the grid operators.
- that the configuration of parameters using IEEE 1547: 2003 table 1 is possible but is only permitted if it is requested by the grid operators.

9.5 Monitoring the device

↻ You have connected the device to the network.

1 When using a DHCP server: Activate DHCP.
2 For manual configuration (DHCP off):
3 Open the Settings/Network menu.
4 Assign a unique IP address.
5 Assign a subnet mask.
6 Assign a gateway.
7 Assign DNS server.
8 Save your settings.

9.6 Carry out firmware update

NOTE

The DC power supply must be guaranteed during initial start-up.

The sequence of the settings required for initial start-up is preset in the configuration assistant.

⚠ CAUTION

Damage to the device from incorrect power supply

The update can fail if the power supply is interrupted during the update process. Parts of the software or of the device itself can then be damaged.

› Never disconnect the DC and AC power supply for or during a firmware update.

› Do not remove the USB stick during a firmware update.

NOTE

The firmware update can take several minutes. The "Operating" LED flashes during the update process. The device may restart several times.

9.7 Access via Modbus

NOTE

In order to make use of the Modbus functionality, we recommend using the “SunSpec-Modbus-Interface” specification we have made available for the firmware version installed on your device.

Follow the description in the document “Modbus-Protokol.pdf” in order to use the two Excel files with a high level of process reliability.

↻ Check whether one of the devices represents the terminal unit.

☞ Only activate the terminating resistor on the communication circuit board of the terminal unit using the DIP switch Connecting the interfaces [See section 7.9 Page 28].

» Close the connection area or connect “inverter off”.

9.8 Multi-function button

The two multi-function buttons on the underside of the device allow new firmware to be loaded on-site, configurations to be loaded, network parameters to be reset and the device to be connected to and disconnected from the grid.

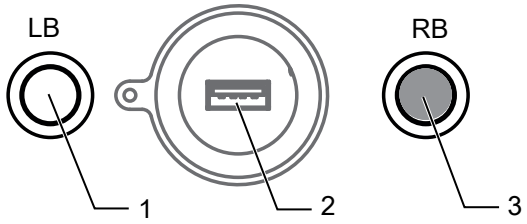


Fig. 55: Control elements on underside of device

1	Multi-function button on left	3	Multi-function button on right
2	Cover for USB port		

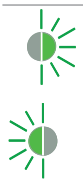
Depending on how long the buttons are held down for and the chosen button combination, multiple functions are available. The flashing sequence of the status LEDs on the front side of the housing provides information about each of the functions initiated by way of the multi-function buttons.

The following principles are applied when keys and LEDs are used:

- Briefly pressing the right-hand multi-function button (~ 0,5 s) serves to confirm that the desired function should commence.
- If the Operating LED and the Feed-in LEDs are flashing quickly and in tandem (~ 0,2 s), this indicates that a function has commenced.
- If the Operating LED and the Feed-in LEDs are flashing quickly yet alternately (~ 0,2 s), this indicates that a function is being performed (for functions that take a long time to complete, such as firmware updates).
- If the Operating LED and the Feed-in LEDs are flashing slowly and in tandem (~ 1 s), this indicates that a function has been completed successfully.

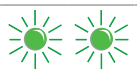
- If the Fault LED is flashing slowly (~ 1 s), this indicates that a function has not been completed successfully or a timeout has occurred at the confirmation stage.

Depending on how long the buttons are held down for and the chosen button combination, multiple functions are available. Information is provided by way of the flashing sequence of the 3 status LEDs on the housing cover.

Signal	Symbol	LED status	Meaning	Note
		"Operating" LED illuminated	Procedure in progress	
		"Operating" LED and "Feed-in" LEDs flashing in tandem	Procedure completed successfully.	
		"Operating" LED and "Feed-in" LEDs flashing quickly and in tandem	Procedure has commenced.	
		"Operating" LED and "Feed-in" LEDs flashing quickly yet alternately	Procedure has commenced.	The procedure will: last up to 10 mins for firmware updates or up to 30 secs for parameter updates.
		"Fault report" LED flashing quickly	The procedure has not been completed successfully or a time limit for pressing a button again has elapsed.	
		"Fault report" flashing slowly		
			No fault	

9.8.1 Operation

Firmware update / configuration import using multi-function buttons

Action / step sequence	LB	RB				Notifications / function
☞ Insert a USB stick featuring the firmware update package or a configuration file into the USB port.						The import is aborted if none of these files are found.
-						**NOTE: Valid file found.**
☞ Briefly (< 1 sec) press the right-hand function button to commence the procedure.						Confirm that the procedure should commence.
-						Procedure is carried out.
-						Procedure completed. USB stick can be removed.
☞ Remove the USB stick.						-

Action / step sequence	LB	RB				Notifications / function
-						**NOTE: Once the USB stick has been removed, the device reboots and features the updated data.**
NOTE: If a button is not pressed within 15 secs: no valid file found.						Procedure is aborted. USB stick can be removed.
NOTE: Procedure failed.						USB stick can be removed.

Setting the network parameters to the factory defaults using the multi-function buttons

Action / step sequence	LB	RB				Notifications / function
☞ Press the left-hand function button (> 5 secs) to commence the procedure.						
-						
☞ Release the function key.						
☞ Press the right-hand function button (~0.5 secs) to commence the procedure.						Procedure is carried out.
-						Procedure completed. Network settings have been reset.
NOTE: If a button is not pressed within 15 secs: Procedure aborted.						

Connecting the device to the grid using the multi-function buttons

Action / step sequence	LB	RB				Notifications / function
NOTE: Starts from status "Device disconnected"						
☞ Press the right-hand function button (> 5 secs) to commence the procedure.						
-						
☞ Release the function key.						
☞ Briefly (< 1 sec) press the right-hand function button to commence the procedure.						Procedure is carried out.
-						Procedure in progress. Device is connected to the grid.
-						**NOTE: Device is on the grid!**
NOTE: If a button is not pressed within 15 secs: Procedure aborted.						

Disconnecting the device from the grid using the multi-function buttons

Action / step sequence	LB	RB				Notifications / function
☞ Press the right-hand function button (> 5 secs) to commence the procedure.						

Action / step sequence	LB	RB				Notifications / function
☞ Release the function key.						
☞ Briefly (< 1 sec) press the right-hand function button to commence the procedure.						Procedure is carried out. Device is disconnected from the grid.
-						**NOTE: Device is disconnected from the grid.**
NOTE: If a button is not pressed within 15 secs: Procedure aborted.						.

10 Specifications

10.1 Operating power range depending on grid voltage

The device can be operated within the respective fixed voltage range provided. The maximum apparent power is stated in the following table. In the event of undervoltage determined by the maximum continuous current subject to the grid voltage.

KACO blueplanet 87.0 TL3 M1 WM OD IIF0 Voltage $U_{N:}$ 380V	KACO blueplanet 92.0 TL3 M1 WM OD IIG0 Voltage $U_{N:}$ 400V	KACO blueplanet 110 TL3 M1 WM OD IIK0 Voltage $U_{N:}$ 270V / 480V	KACO blueplanet 125 TL3 M1 WM OD IIP0 Voltage $U_{N:}$ 600V	KACO blueplanet 137 TL3 M1 WM OD IIP0 Voltage $U_{N:}$ 600V	KACO blueplanet 150 TL3 M1 WM OD IIQ0 Voltage $U_{N:}$ 660V	Maximum apparent power [p.u.]
-	-	-	≥ 600	-	-	1.10
≥ 380	≥ 400	≥ 480	545	≥ 600	≥ 660	1.00
361	380	456	520	570	622	0.95
342	360	432	492	540	590	0.90

Tab. 8: Maximum continuous apparent power depending on grid voltage

The following figures show the reactive power operating range subject to active power and the apparent power operating range subject to the grid voltage for various devices.

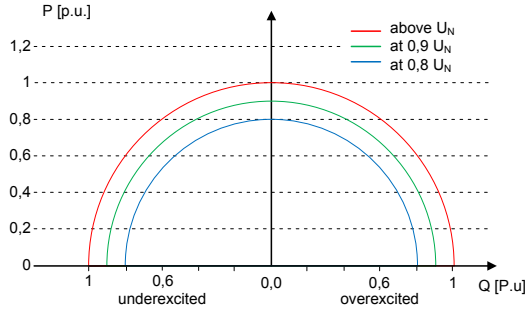


Fig. 56: P-Q operating range for bp 150 TL3 (Q_{max}=S_{max})

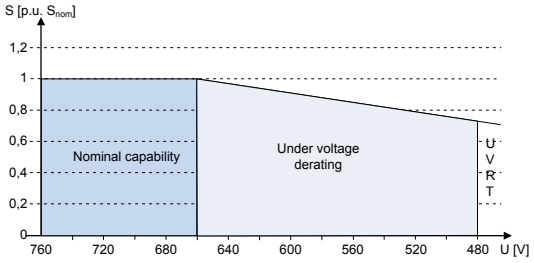


Fig. 57: Apparent power subject to the grid voltage bp 150TL3

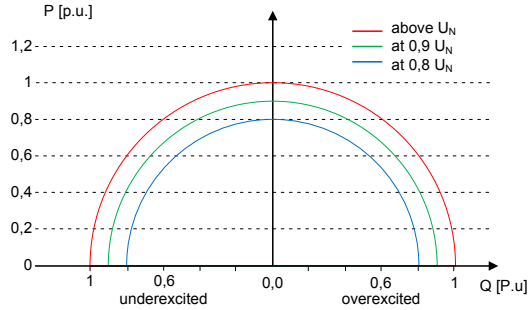


Fig. 58: P-Q operating range for bp 137 TL3 (Q_{max}=S_{max})

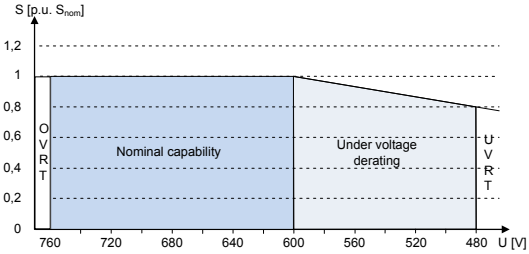


Fig. 59: Apparent power subject to the grid voltage bp 137TL3

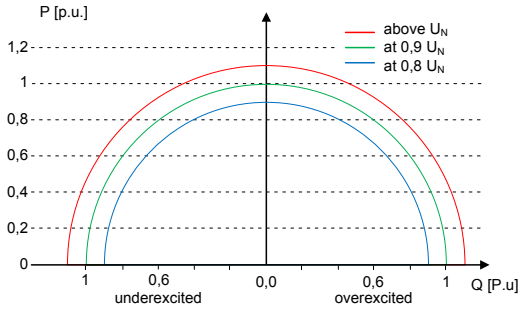


Fig. 60: P-Q operating range for bp 125 TL3 (Q_{max}=S_{max})

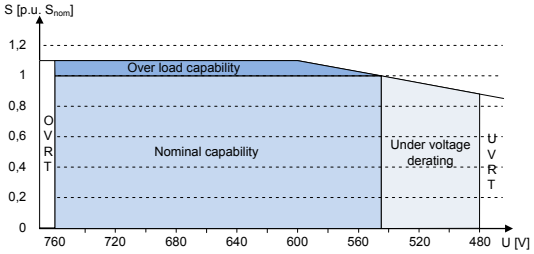


Fig. 61: Apparent power subject to the grid voltage bp 125TL3

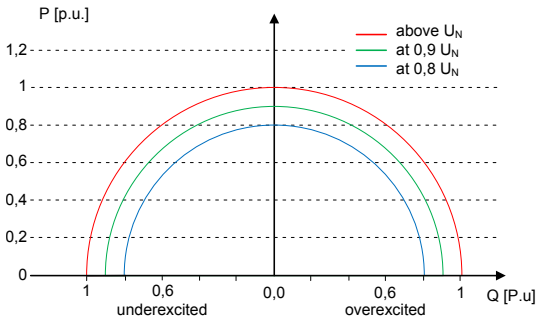


Fig. 62: P-Q operating range for bp 110 TL3 (Q_{max}=S_{max})

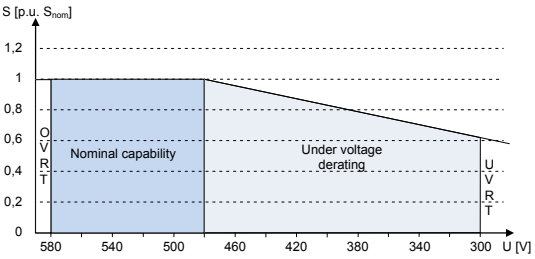


Fig. 63: Apparent power subject to the grid voltage bp 110TL3

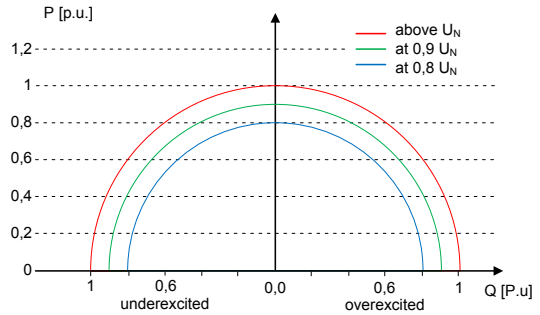


Fig. 64: P-Q operating range for blueplanet 92.0TL3 (Q_{max}=S_{max})

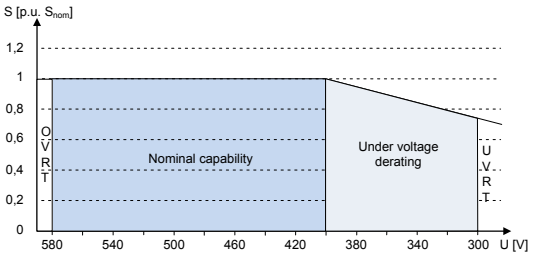


Fig. 65: Apparent power subject to the grid voltage bp 92.0TL3

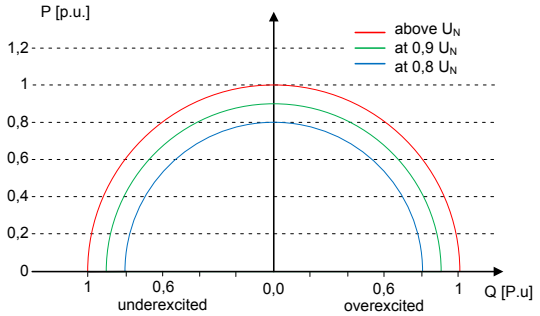


Fig. 66: P-Q operating range for blueplanet 87.0TL3 (Qmax=Smax)

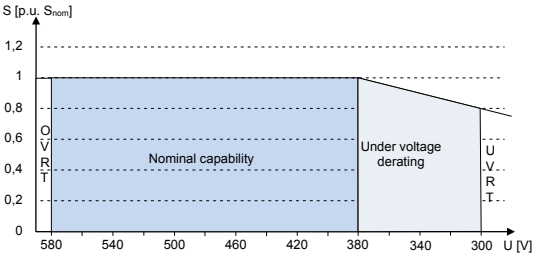


Fig. 67: Apparent power subject to the grid voltage bp 87.0TL3

10.2 Power limitation

Setting the maximum apparent power S_{lim}

The connection power for a plant is agreed between the grid operator and plant operator. The device capacity of a plant can be set to the exact agreed value using the S_{lim} settings. To ensure that the load on the device in the plant is uniform, we recommend distributing the performance reduction evenly across all devices.

- The maximum feed-in power S_{Emax} is thus reduced to the set value S_{lim}.

Setting the maximum active power P_{lim}

Some grid connection rules insist that the agreed reactive power be started up from every operating point of the plant without a reduction in the current active power. Considering the fact that the blueplanet 87.0 TL3 to 150 TL3 has a semi-circular P-Q operating range, a reduction in the active power is required during operation at maximum active power because an apparent power reserve is not available. By adjusting P_{lim}, the maximum active power can be restricted in order to ensure that the agreed reactive power can be delivered from any active power operating point.

The maximum feed-in active power P_{Emax} is thus reduced to the set value P_{lim}.

10.3 Reactive power control

Reactive power can be used in electrical energy supply networks to bolster the level of voltage. As such, feed-in inverters can contribute to statistical voltage stability. Reactive power brings about a voltage drop at the inductive and capacitive components of the equipment which can either bolster or reduce the level of voltage. If the generating plant draws inductive reactive power while active power is being fed in, part of the voltage swing caused by the active power feed can be compensated for by the supply of reactive power.

This reactive power mode and the respective control process are specified by the grid operator. If no control process has been specified, then the plant should be operated using a reactive power specification of 0%.

The following functions for controlling the reactive power are implemented in the devices listed above:

- cos-φ constant
- Q constant
- cos-φ /(p/pn)
- Q(U) 10 nodes
- Reactive power is prioritized in each method. The maximum possible active power that can be fed in is reduced in line with the P-Q operating range when a specific reactive power level is specified ([See figure 56] [▶ Page 67] - [See figure 66] [▶ Page 68]).

cos φ constant

When there is a cos φ constant, the specified shift factor cos φ is set permanently by the inverter. In doing so, the reactive power level is set in line with Q=P*tan φ dependent on power output which produces the specified shift factor cos φ consistently. If the specification is changed (e.g. via communications interfaces), the new value is adopted by way of a filter and a gradient limit in a muted manner. The settling time and gradient limit are adjustable.

Q constant

When there is a Q constant, the specified reactive power value is set permanently by the inverter. If the specification is changed (e.g. via communications interfaces), the new value is adopted by way of a filter and a gradient limit in a muted manner. The settling time and gradient limit are adjustable.

cos φ/(P/Pn)

When it comes to cos φ/(P/Pn), the cos φ and, deduced from this, the reactive power value are calculated continuously as a function of the current power level. This function ensures that grid support is provided by the reactive power when a significant voltage boost is anticipated due to a high feed level.

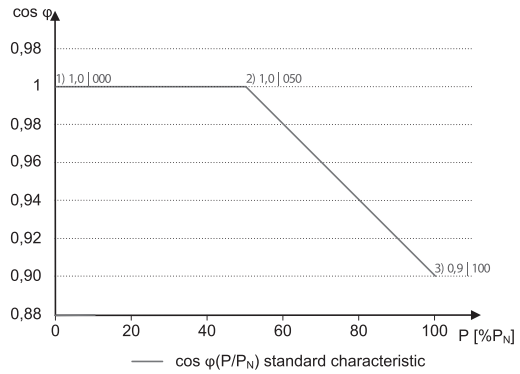


Fig. 68: cos φ/(P/Pn) standard characteristic curve with 3 nodes

In this case, a characteristic curve [See figure 68] [▶ Page 70] is specified which can be used to configure up to 10 nodes, value pairs for active power and cos φ. The active power is entered as a % in relation to the nominal power. Other parameters allow you to limit functionality and to limit activation to certain voltage ranges.

It the specification is changed (e.g. as a result of activating or deactivating the function by way of lock-in and lock-out voltage or changing the active power), then the new value is adopted by way of a filter and a gradient limit in a muted manner. The settling time and gradient limit are adjustable.

Q(U)

When it comes to Q(U), the reactive power value is calculated continuously as a function of the grid voltage. This function ensures that grid support is provided by the reactive power as soon as the voltage actually deviates from the target voltage.

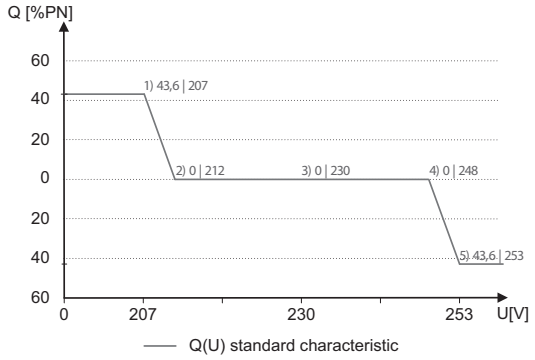


Fig. 69: Q(U) standard characteristic curve with 5 nodes

In this case, a characteristic curve [See figure 69] [▶ Page 70] is specified which can be used to configure up to 10 nodes, value pairs for voltage and reactive power. Other parameters allow you to limit functionality and to limit activation to certain voltage ranges as well as parametrize the transient response.

The positive phase sequence voltage is used to calculate the reactive power target value for three-phase units.

A closed-loop control circuit is established for the device from Q(U). The amplification of this control circuit changes subject to the effective grid impedance. A very significant amplification of this control circuit may result in an oscillation tendency. The plant operator is responsible for using suitable settings for Q(U) control in consultation with the grid operator. Sections of the curve with a gradient of more than 24%Smax/1%Unom should be avoided or should only be applied to grids with a large Skv/SA ratio (Skv mains short-circuit power, SA plant power).

10.4 FRT

Dynamic grid support (Fault Ride Through)

A generator plant's ability to remain immune to voltage drops and voltage spikes in the supply system is a key element in establishing a reliable energy supply. Immunity to interference ensures that brief disruptions do not result in a loss of generation capacity in a larger range of an interconnected grid. Grid support by a fast feeding of residual current also limits the spatial extent of the incident.

With its dynamic grid support by way of immunity, the device has this characteristic. The ability to remain on the grid is particularly relevant. The protective settings also determine the device's ability to remain on the grid or not. Protective settings take the upper hand over the capacity of immunity to interference.

10.4.1 Dynamic grid support by way of immunity to interference

Voltage drop above the limit curve in can be overcome without the need for shutdown from the grid. The feed-in power remains constantly within the limits of the maximum continuous current of the inverter.

If a reduction in power occurs, the power is brought back up to the pre-fault level within 100 ms of the voltage returning.

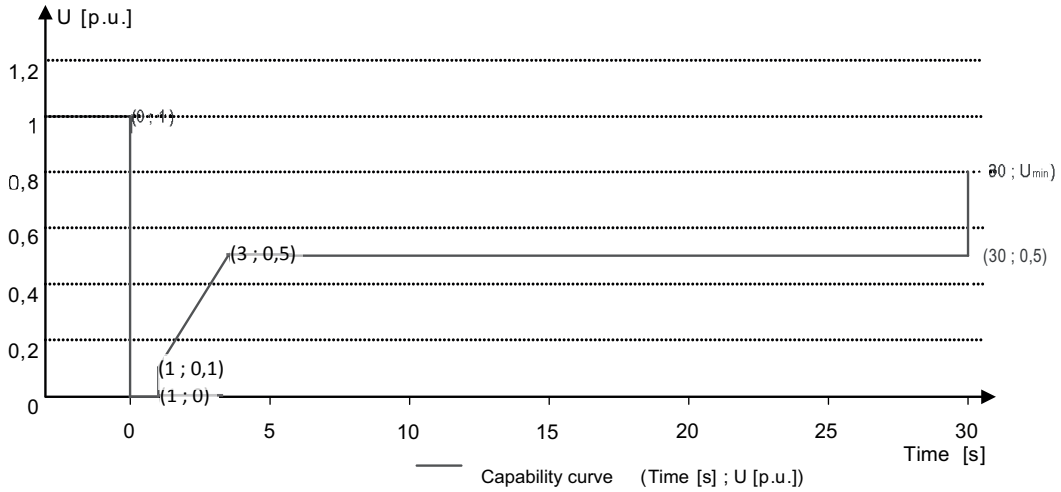


Fig. 70: Immunity to interference characteristic curve relative to the nominal voltage (p.u.) of the blueplanet 125.0TL3

The inverters can be overcome to voltage spikes as long as the voltage level does not remain above the specified continuous voltage range for longer than 100 s or go beyond the short-term maximum voltage (up to 100 s). The specific values for each inverter can be found in the manual.

10.4.2 Dynamic grid support using a fast feeding of residual current

The device has the following characteristics with regard to dynamic grid support using dynamic reactive current (from software 5.5x or 1.2x and higher).

When dynamic grid support using a fast feeding of residual current is activated, then residual current is fed in in addition to the immunity to interference properties against drops and spikes described above.

The inverter adapts its current feed as soon as a drop or spike incident occurs in order to bolster the grid voltage. The support takes place in the event of voltage drop in the form of over-excited reactive current (corresponds to a capacitive load), in the event of voltage spike in the form of over-excited reactive current (corresponds to an inductive load). In the reactive current priority mode, the effective current is reduced to the extent necessary to comply with the limits of the maximum continuous current of the inverter.

A drop or spike is detected if either the normal voltage range setting is exceeded by at least one phase-phase or phase neutral conductor voltage, or if an abrupt change in the positive or negative phase sequence voltage greater than the dead band setting occurs. The extent of the abrupt change in voltage with regard to the positive and negative phase sequence voltage equates to the difference between the pre-fault voltage and the actual voltage based on the reference voltage. The pre-fault voltage is calculated as a 50-period mean value.

$$\Delta u = \frac{U - U50per}{Uref} \qquad (1)$$

The reactive current is adapted using a response time of <20 ms and a transient time of <60 ms after the incident has occurred. Responses to changes in the voltage during the incident or to the voltage recovery at the end of the incident take place with the same dynamic.

The formula for calculating the dynamic reactive current that is fed for the positive or negative phase sequence voltage is:

I_b=Δu*k*I_N, depending from the nominal current IN of the inverter	(2)

For the positive and negative phase sequence voltage, Δu equates to the difference between the pre-fault voltage and the current voltage based on the reference voltage. The pre-fault voltage is calculated as a 1-min mean value.

$$\Delta u = \frac{U - U1min}{Uref} \quad (3)$$

On account of the definition of a voltage jump in pre-norm EN50549-2 and in VDE-AR-N 4120 and VDE-AR-N 4110, it is typically the case that another voltage jump is detected when the incident is at an end, when the fault is rectified and when the voltage returns to a normal state. The result of this is that in an active operation mode a dynamic grid support using a fast feeding of residual current remains active even after the incident has passed and that reactive current is fed in according to the formulae°(2) and (3). Dynamic grid support using d fast feeding of residual current is then deactivated after a configurated minimum support time, usually 5 s.

10.5 Regulating active power

Methods for controlling the active power of feed-in inverters may be necessary for local management of load flows, for voltage stability in the distribution network and for ensuring the stability of the superimposed transport network.

The function "P constant" is available for managing load flows in a plant. If necessary, this can be used to reduce the feed of a photovoltaic inverter.

If it is not possible to compensate adequately for voltage excesses in the upstream distribution network by drawing on reactive power, it may be necessary to curtail the active power. In this case, P(U) control is available for making optimum use of the capacity of the upstream grid.

Feed-in inverters must assist with frequency stability in the grid. If the grid frequency leaves the normal tolerance range (e.g. ±200 mHz), then the grid will be in a critical state. In the event of overfrequency, there is a generation surplus, in the event of underfrequency, there is a generation deficit. In the case of overfrequency, photovoltaic systems and accumulators must reduce their effective feed-in power in relation to the increase in frequency. The P(f) function is available for this purpose.

That being said, the availability or the adjustability of the functions may be limited depending on the country setting selected. This is particularly true if the applicable grid connection guidelines make this restriction compulsory.

Dynamics / accuracy

In all of the control methods described below the specified target value at the inverter's connection terminals is adjusted using a stationary deviation of the reactive power of maximum 2% S_N. This maximum deviation always relates to the specified value as reactive power. If the shift factor cos ϕ is specified in the control method, then the deviation relates to the reactive power value brought about by the current power level.

The transient response of the control methods is determined by a PT-1 filter. In this case, the set settling time corresponds to 5 Tau, or in other words, achieving approx. 99% of the final value for a PT-1 filter. Subject to the control method selected, there are also other parameters that determine dynamic behavior.

P constant

The function "P constant" is available for managing load flows in a plant. If necessary, this can be used to reduce the feed of a photovoltaic inverter.

P constant has been conceived for use with Plant Controllers and is therefore only available via communication and cannot be adjusted on the display/web interface. When there is a P constant, the specified power value is set by the inverter. If the specification is changed (e.g. via communications interfaces), the new value is adopted by way of a filter and a gradient limit in a muted manner. The settling time and gradient limit are adjustable

Voltage-dependent power reduction P(U)

If it is not possible to compensate adequately for voltage excesses in the upstream distribution network by drawing on reactive power, it may be necessary to curtail the active power. In this case, P(U) control is available for making optimum use of the capacity of the upstream grid.

P(U) control reduces the active power that is fed in as a function of the grid voltage using a prescribed characteristic curve as a basis.

Operation modes:

Off: Function deactivated, there is no voltage-dependent adjustment of the power.

On: The active power is adjusted in line with the set P(U) characteristic curve and the current voltage.

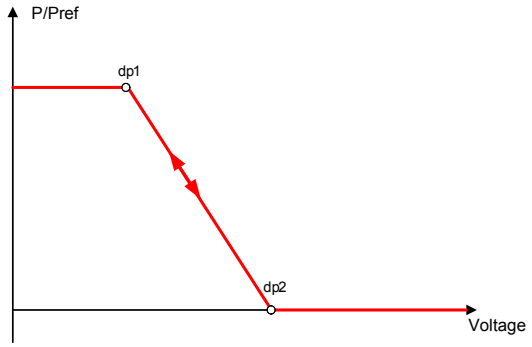


Fig. 71: P(U) characteristic curve without active hysteresis

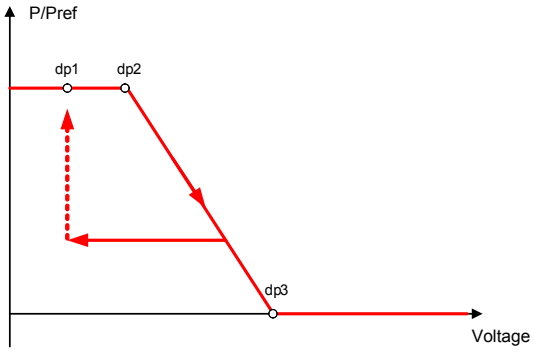


Fig. 72: P(U) characteristic curve with active hysteresis

Hysteresis On: The active power is adjusted in line with the set P(U) characteristic curve [See figure 71] [▶ Page 73] and the current voltage in the event of increasing voltage. In the case of decreasing voltage, the power level is kept constant until the voltage value of the first node cannot be reached.

If the deactivation threshold is below the activation threshold, then the P(U) characteristic curve can be configured with active hysteresis [See figure 72] [▶ Page 73].

Frequency-dependent power control P(f)

Feed-in inverters must assist with frequency stability in the grid. If the grid frequency leaves the normal tolerance range (e.g. ±200 mHz), then the grid will be in a critical state. In the event of overfrequency, there is a generation surplus, in the event of underfrequency, there is a generation deficit. In the case of overfrequency, photovoltaic systems and accumulators must reduce their effective feed-in power in relation to the increase in frequency. The P(f) function is available for this purpose. The measurement accuracy of the frequency is 10mHz.

The specific mode of operation of the function is specified by the grid operator. The configurability of the function makes it possible to meet a wide variety of grid operator requirements. Certain configuration options are not available in some country settings because the pertinent grid connection rules prohibit adjustments.

Operation modes:

Off: Function deactivated, there is no frequency-dependent adjustment of the power.

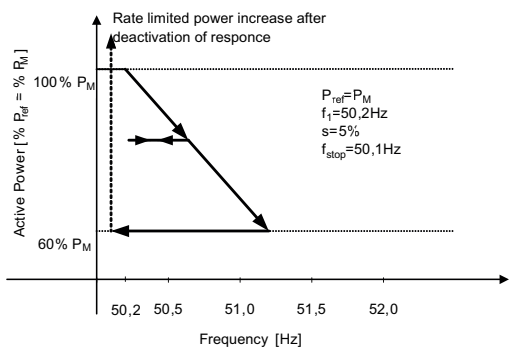


Fig. 73: P(f) function mode 1 with hysteresis

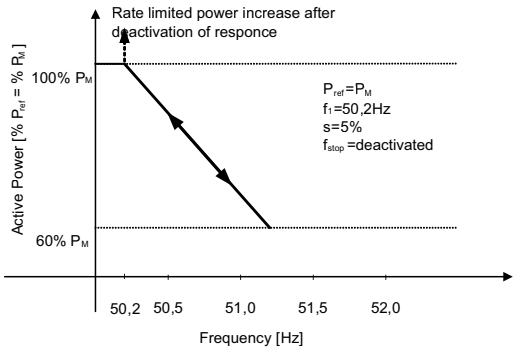


Fig. 74: P(f) function mode 2 without hysteresis, movement on the characteristic curve

Mode 1: If the activation threshold is exceeded, the current power level is determined as 100% and, on that basis, the active power is reduced in line with the set P(f) gradient. If the frequency decreases, the power level is kept constant in line with hysteresis [See figure 73] [▶ Page 73] until the frequency for the set deactivation time is within the set deactivation range.

Mode 2: If the activation threshold is exceeded, the current power level is determined as 100% and, on that basis, the active power is reduced in line with the set P(f) gradient. If the frequency decreases, the power level is increased immediately in line with the set P(f) gradient [See figure 74] [▶ Page 73].

Transient response: If the specification is changed (e.g. by a change in frequency), the new value is adopted by way of a filter and a gradient limit in a muted manner. The settling time and gradient limit are adjustable. With respect to grid stability, a quick settling time and deactivated gradient limit are favorable.

If, upon deactivation, the power level available is higher than the current feed-in power, then the feed-in power is increased up to the power level available in line with the set deactivation gradient.

Power gradient limitation

Quick changes in the power level can cause unwanted voltage fluctuations in the mains supply. If many plants increase their power levels in tandem and in an equally swift manner on account of an external event (e.g. protective tripping followed by reconnection), this can also cause load management issues for the grid operator. The power gradient of the devices can be restricted in order to prevent these issues from occurring.

Soft start-up

When the inverter is switched on, the increase in power is restricted by the set gradient. It is possible to configure whether the soft start-up should occur every time the device is switched on, only upon initial start-up each day or only upon start-up after the device has been switched off by grid protection. Due primarily to the fact that there is the risk that many plants could increase their power levels simultaneously after they have been switched off by grid protection, a soft start-up is usually only required for start-up after a device has been switched off by grid protection.

Normal operation power gradient

In the case of very large plants, it may also be necessary to restrict the change in power level during normal operation. If the set value (for increase and decrease in power level) and the solar irradiation change (for increase in power level), then the grid feed-in power is increased or decreased in line with the configured gradient. A limitation is not possible if the solar irradiation is reduced.

10.6 Enhanced island detection

Due to the nature of decentralized generation, the potential excites, that a disconnected part of the grid remains life in an unintended island due to the local generation in case of a balance of active and reactive load and generation in this part of the grid. The detection of unintended island formation is an important function of decentralized generating units and is related to the prevention of damage to equipment as well as safety of personnel.

Depending on the structure and the management of the distribution grid several dangers exist:

DANGER! In case of maintenance work in a distribution grid danger to personnel might be caused if the disconnected part of the grid remains live in an island. This is especially the case if not all safety rules are followed.

WARNING! If fast auto-reclosure is used in a distribution grid and the disconnected part of the grid remains live in an island, reclosure will likely happen in phase displacement what might cause damage to rotating machinery in the grid.

NOTE: In case of fault in a medium voltage grid, the faulted part of the grid is disconnected. If the fault has a significant resistance, the disconnected part of a medium voltage grid remains live in an island. Depending on the type of fault, but explicitly in case of a fault in the transformer, dangerous medium voltage might be accessible or is even present on low voltage appliances.

Especially for the last example very fast disconnection of the generating units to cause collapse of the forming island is necessary. At the same time any detection method of island formation might be subject to false tripping. The industry is therefore in constant research to develop methods that are fast and reliable and at the same time reliably prevent false tripping.

Enhanced island detection method

The new method by KACO new energy, enhanced island detection, employs a strategy to reliably detect island formation that is based on the difference in characteristic between an interconnected grid and an islanded grid, thus ensuring reliable fast detection and prevention of false tripping.

An interconnected grid is dominated by rotating machinery, as a consequence frequency is proportional to active power balance and voltage is proportional to reactive power balance. In contrast an islanded grid behaves like a resonant circuit, as a consequence frequency is proportional to reactive power balance and voltage is proportional to active power balance. The active enhanced island detection method detects this difference by monitoring the behavior of the grid. In case of formation of an island, the inverter disconnects within some 100 ms, well below 1000 ms.

- The number of parallel inverters does not affect the reliability of this function.
- This method also guarantees to minimize effects on the distribution grid.
- In normal operation no effects are observable on harmonic content, flicker and grid stability.

This detection method is combined with a two stage passive rate of change of frequency (ROCOF) observation. If the ROCOF of the grid exceeds the configured threshold of stage 1 for the configured disconnection time, the inverter switches to zero current mode. If the ROCOF of the grid exceeds the configured threshold of stage 2 for the configured disconnection time, the inverter disconnects. In case of an island, this will stop the island instantaneously. If the grid stabilizes, what might be the case if the ROCOF event was due to a short disturbance in the power grid, the inverter will resume normal operation. If stage 1 applies and the inverter switched to zero current mode, pre-event power will be resumed within 100ms. If stage 2 applies and the inverter disconnected, the configured reconnection conditions apply.

11 Maintenance and troubleshooting

11.1 Visual inspection

Inspect the device and the cables for visible external damage and note the operating status display of the device. In case of damage, notify your installer. Repairs may only be carried out by authorized electricians.

⚠ DANGER

Dangerous voltage due to two operating voltages

Severe injuries or death may occur if the cables and/or terminals/busbars in the device are touched. The discharge time of the capacitors is up to 5 minutes.

- › Only appropriately qualified electricians authorized by the mains supply network operator are permitted to open and maintain the device.
- › Before opening the device: Disconnect the AC and DC side and wait at least 5 minutes.

NOTE

There are components within the housing that may only be repaired by our customer service team.

Do not attempt to rectify faults that are described here (in the troubleshooting chapter). Get in touch with our customer service team. Only carry out maintenance activities that are described here.

The device should be checked for proper operation by a qualified electrician at regular intervals. Always contact the service team of the system manufacturer if you encounter any issues.

11.2 Cleaning

11.2.1 Cleaning the housing

WARNING! Do not use compressed air or high-pressure cleaners!

1. Use a vacuum cleaner or a soft brush to remove dust from the fan cover and from the top of the device on a regular basis.
2. Remove dust from the ventilation inlets if necessary.

11.2.2 Cleaning the heat sink

⚠ WARNING

Risk of burning due to hot surface

Heat sinks become very hot during operation.

- › Never touch the heat sinks after starting up the device.
- › Wait until a cooling time of at least 10 minutes has elapsed before starting the cleaning process.

↻ The fans need to be removed in order to clean the heat sink.

↻ Switch off the device and secure it to prevent it from being switched back on.

↻ Have a suitable brush at the ready for cleaning purposes.

1 Remove the hood and fans Replacing the fans [See section 11.3 Page 77].

2 Clean the space between the cover and heat sink with your chosen brush.

3 Clean the heat sink with a brush of your choice.

NOTE: Do not use any aggressive cleaning agents and make sure that no liquids come into contact with other components.

» The cleaning process is complete - reinstall any fans that had been removed.

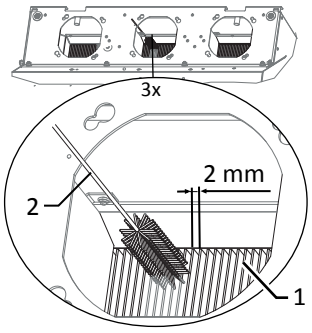


Fig. 75: Cleaning the cooling fins from above

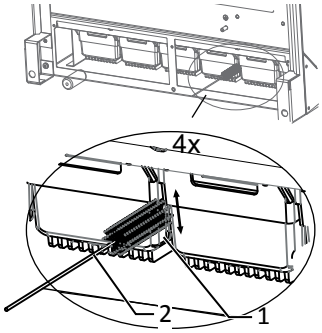


Fig. 76: Cleaning the cooling fins from below

1	Heat sinks / space between heat sinks
2	Brush (max. wire diameter 2mm)

NOTE

Refer to our service and guarantee conditions on our homepage.

✓ The cleaning intervals must be adapted to match the ambient conditions of the installation location.

› In sandy environments, we recommend cleaning the heat sinks and fans every quarter.

11.3 Replacing the fans

Removing the cover

↻ A check has been performed to ensure there is no AC/DC voltage present.

1 Remove the fastening screws on the cover from both sides [🛠_T20]

2 Lift up the cover from both sides and press it out of the mounting clips.

3 Set the cover to one side.

» Proceed with the cleaning or removal of the fans.

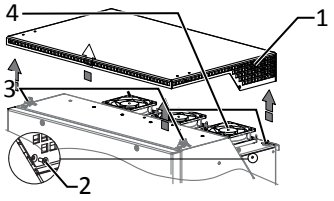


Fig. 77: Removing the cover

1	Cover
2	Fastening screw
3	Mounting clips
4	Fans

Removing the fans

↻ A check has been performed to ensure there is no AC/DC voltage present.

↻ Cover hood for fans removed.

1 Wait until the 3 fans have stopped rotating.

2 Rotate the defective fan through approx. 10° in the clockwise direction and remove it carefully using the collar.

3 Release the interlock and remove the connector plug from the inside of the housing.

4 Remove the fan.

5 If necessary, clean the heat sink from above.

» Install the replacement fan.

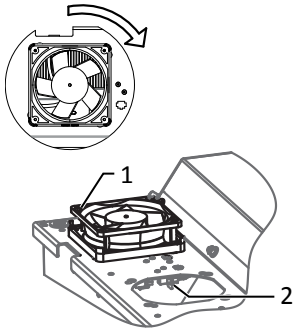


Fig. 78: Removing the fans

1	Fans
2	Connector

Fitting the cover

↻ The fan has been correctly installed and all impurities in the area of the cover have been removed.

1 Lift up the cover from both sides, place it on the mounting clips and carefully press it in.

2 Insert the fastening screws into the cover on both sides and tighten them [_T20 / 22 In-lbs].

» You may now start up the device Start-up [See section 8 Page 32].

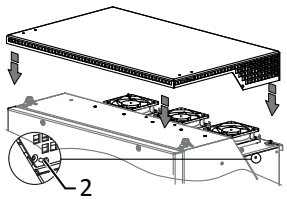


Fig. 79: Fitting the cover

2	Fastening screw

11.4 Replacing overvoltage protection

Replacing the DC overvoltage protection

☞ **NOTE: If the status "defective" appears in the status indicator of the overvoltage protection module, then it must be replaced.**

↻ **NOTE: A check has been performed to ensure there is no AC/DC voltage present.**

1 Open the device Opening the device [See section 7.2 Page 21].

2 Unlock the defective modules via the locking latch using a screwdriver.

3 Remove the defective modules one-by-one out of the DC base and replace with a module of the same type.

NOTE: The coding at the base plug-in position must match the coding on the module.

4 Insert the DC overvoltage protection modules into the DC base one after another.

5 Lock the new modules via the locking latch using a screwdriver.

6 Ensure that all protective elements are properly secured.

» Proceed with the installation of the device.

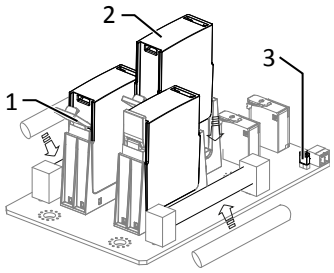


Fig. 80: Inserting overvoltage modules

1	DC base
2	DC overvoltage protection module (3 slots)
3	Short-circuit bridge

11.5 Shutting down for maintenance / troubleshooting

NOTE: Shutdown sequence

1 Switch off the grid voltage by turning off the external circuit breakers.

2 Disconnect the DC side using the DC isolator switch.

» After shutdown, wait at least 5 minutes before opening the device.

11.6 Disconnecting the connections

11.6.1 AC connection

↻ A check has been performed to ensure there is no AC/DC voltage present.

↻ Housing cover removed and set to one side.

1 Detach cables (L1/L2/L3) from the AC connection terminal [🔧W_17].

2 Detach the PE line from the earthing bolt [🔧W_17].

3 Loosen the cable fitting and pull the cables out through the cable fitting [🔧W_46].

NOTE: If the AC cable does not fit through the cable fitting due to the size of the cable lug, then the AC cable must be severed at the cable lug.

4 Place protective caps on the ends of the AC cables.

11.6.2 DC connection

↻ A check has been performed to ensure there is no DC voltage present.

↻ Housing cover removed and set to one side.

1 Detach the line ends from the PV generator at the DC+ and DC- busbar [🔧W_17].

2 Place the fastening elements back in the fittings bag.

3 Loosen the cable fitting and pull the DC cable through the cable fitting [🔧W_46].

NOTE: If the DC cable does not fit through the cable fitting due to the size of the cable lug, then the DC cable must be severed at the cable lug.

4 Place protective caps on the ends of the DC cables.

11.7 Faults

11.7.1 Procedure

⚠ DANGER

Lethal voltages are still present in the connections and cables of the device even after the device has been switched off and disconnected!

Severe injuries or death may occur if the cables and/or terminals/busbars in the device are touched.

› If a fault occurs, notify an appropriately authorized and qualified electrician or KACO new energy GmbH Service.

› The operator can only carry out actions marked with a B.

11.7.2 Rectifying faults

B = Action of the operator; E = The indicated work may only be carried out by an authorized electrician! ; K = The indicated work may only be carried out by a service employee of KACO new energy GmbH!

Fault	Possible cause	Explanation/remedy	By
The LEDs do not light up	Grid voltage not available	› Check whether the DC and AC voltages are within the permitted limits (see Technical Data)	E
		› Notify KACO Service.	E
The device stops feeding into the grid shortly after being switched on, even though there is sunlight present.	Defective circuit-breakers in the device	If the circuit-breakers are defective, the device will recognize this during the self-test.	K
		› Ensure that there is sufficient PV generator power.	E
		› If the grid separation relay is defective, have it replaced by KACO Service.	
		› Notify KACO Service.	
Device is active but not connected to the grid. A grid fault is displayed on the status LED.	Grid-feed is interrupted due to a grid fault.	Due to a grid fault (over/undervoltage, over/underfrequency), the device stopped the feed-in process and disconnected from the grid for safety reasons.	
		› Change the grid parameters within the permitted operating limits (see the "Start-Up" section).	E
The grid fuse trips.	The grid fuse capacity is too low.	In case of a high level of solar radiation, the inverter exceeds its rated current for a short period, depending on the PV generator.	
		› Select the capacity of the device’s pre-fuse to be somewhat higher than the maximum feed-in current (see the "Installation" section).	E
		› Contact the grid operator if the grid failure continues to occur.	E
The grid fuse trips.	Damage to the device's hardware.	If the grid fuse trips immediately when the device goes into feed-in mode (after the start-up period is complete), the device’s hardware is probably damaged.	
		› Contact KACO Service to test the hardware.	E
The inverter displays an impossible daily peak value.	Faults in the grid.	The device continues to operate as normal without losses to the yield, even when an erroneous daily peak value is displayed. The value is reset overnight.	
		› To reset the value immediately, switch the device off by disconnecting it from the grid and switching off the DC, then switch it back on.	E
Daily yields do not correspond to the yields on the feed-in meter.	Tolerances of the measuring elements in the device.	The measuring elements of the device have been selected to ensure maximum yields. Due to these tolerances, the daily yields shown may deviate from the values on the feed-in meter by up to 15%.	E
		› No action.	
Device is active but not connected to the grid.	Generator voltage too low; grid voltage or PV generator voltage unstable.	The PV generator voltage or power is not sufficient for feed-in (solar radiation is too low). The inverter checks the grid parameters before the feed-in process begins. The length of time it takes to switch back on again differs from country to country, depending on applicable standards and regulations, and may be several minutes. The starting voltage may have been set incorrectly.	
		› Adjust starting voltage in the Parameters menu if required.	E
		› No action	

Fault	Possible cause	Explanation/remedy	By
In spite of high radiation levels, the inverter does not feed the maximum power into the grid.	Particular ambient conditions.	Because the temperatures inside the unit are too high, the device reduces its power to prevent damage to the device. Note the technical data. Ensure that the convection cooling is not impeded from the exterior. Do not cover the cooling fins.	
		› Ensure sufficient cooling of the device.	B
		› Remove any foreign bodies that may be on the device.	B
		› Clean the cooling fins	E
	DC fuse defective	A generator string is disconnected from the device due to a defective fuse. Establish the cause of tripping by measuring all DC strings with a clip-on ammeter. - If there is no current flowing in a string, then the associated DC fuse is defective.	
		Check the no-load voltage and layout of the PV generator. Replace the damaged modules if necessary.	B, E
		› Replace the PV fuse with a fuse size that is of the same type.	

Tab. 9: Troubleshooting

11.8 Fault messages

Fault LED (red)	Status	Explanation	LED
🔴	FS (fault status)	· The fault relay has switched.	On
		· Feed-in was ended due to a fault.	
⚫	OS (operating status)	· The fault relay releases again.	Off
		· The device feeds back into the grid again after a country-specific time period.	

11.9 Troubleshooting

The following table lists the possible status and fault messages that the KACO devices (PV and battery) can display by means of the LC display / web interface and the LEDs.

No.	Grid LED	LED	Text datenloggers HMI1 and HMI2	Fault description	Action	Pers.
			0			
2	⚫	⚫	Insufficient generator voltage / insufficient battery voltage!	Insufficient generator voltage and power, status before the transition to night shutdown.	-	-
4	⚫	⚫	Feed in at max. MPP	-	-	-
8	⚫	⚫	Self-test in progress	Checks the shutdown of the power electronics as well as the grid relay before feed-in mode.	-	-
9	⚫	⚫	Test mode	-	-	-
10	⚫	🔴	Temperature in device too high	In case of overheating, the inverter switches off. Possible causes: Overly high ambient temperature, fan covered, fault in the inverter.	Cool off the area around the inverter. Uncover the fans. Notify your authorized electrician!	B B E
11	⚫	⚫	Power limitation	Power limitation: If the generator power is too high, the inverter limits itself to the maximum power (e.g. around noon if the generator capacity is too large).	-	-

No.	Grid LED	LED	Text datenloggers HMI1 and HMI2	Fault description	Action	Pers.
17	●	●	HMI1: "Powador-protect disconnection" HMI2: "External grid protection shutdown"	The activated grid and system protection has been tripped.	Wait for reactivation. Notify your authorized electrician if the fault occurs repeatedly!	E
18	●	●	Resid. current shutdown (AFI)	Residual current was detected. The feed-in was interrupted.	Notify your authorized electrician.	E
20	✳	●	Power rampup active	-	-	-
21	●	●	Protection shutdown overcurrent DC1	-	-	-
31	●	●	AFI module fault	A fault has occurred in the all-current sensitive residual current circuit breaker.	-	-
33	●	●	DC feed-in error	The DC feed-in has exceeded the permitted value. This DC feed-in can be caused by grid conditions and may not necessarily indicate a fault.	Notify your authorized electrician if the fault occurs repeatedly.	E
34	●	●	Internal communication error	A communication error has occurred in the internal data transmission.	Notify your authorized electrician! Check the data cable.	E
35	●	●	Protect. shutdown SW	Protective shutdown of the software (AC overvoltage, AC overcurrent, DC link overvoltage, DC overvoltage, DC overtemperature).	No fault! Grid-related shutdown, the grid connects again automatically.	-
36	●	●	Protection shutdown HW	Protective shutdown of the hardware (AC overvoltage, AC overcurrent, DC link overvoltage, DC overvoltage, DC overtemperature).	No fault! Grid-related shutdown, the grid connects again automatically.	-
38	●	●	Generator voltage too high / fault: Battery overvoltage	The voltage of the DC generator is too high. The PV generator is configured incorrectly.	Notify your authorized electrician!	E
41	●	●	Grid failure undervoltage L1	The voltage of a grid phase is too low; the grid cannot be fed into. The phase experiencing failure is displayed.	Notify your authorized electrician!	E
42	●	●	Grid failure overvoltage L1	The voltage of a grid phase is too low; the grid cannot be fed into. The phase experiencing failure is displayed.	Notify your authorized electrician!	E
43	●	●	Grid failure undervoltage L2	The voltage of a grid phase is too low; the grid cannot be fed into. The phase experiencing failure is displayed.	Notify your authorized electrician!	E
44	●	●	Grid failure overvoltage L2	The voltage of a grid phase is too low; the grid cannot be fed into. The phase experiencing failure is displayed.	Notify your authorized electrician!	E
45	●	●	Grid failure undervoltage L3	The voltage of a grid phase is too low; the grid cannot be fed into. The phase experiencing failure is displayed.	Notify your authorized electrician!	E
46	●	●	Grid failure overvoltage L3	The voltage of a grid phase is too low; the grid cannot be fed into. The phase experiencing failure is displayed.	Notify your authorized electrician!	E

No.	Grid LED	LED	Text datenloggers HMI1 and HMI2	Fault description	Action	Pers.
47	●	●	Grid failure phase-to-phase voltage	The measured phase-to-phase voltage is outside of the tolerance limits.	Check software version (possible cancellation during upload) Notify KACO Service!	B/K
48	●	●	Grid failure underfrequency	Grid frequency is too low. This fault may be grid-related.	Notify your authorized electrician	E
49	●	●	Grid failure overfrequency	Grid frequency is too high. This fault may be grid-related.	Notify your authorized electrician	E
50	●	●	Grid failure average voltage	The grid voltage measurement according to EN 50160 has exceeded the maximum permitted limit value. This fault may be grid-related.	Notify your authorized electrician	E
57	●	●	Waiting for reconnect	Waiting time of the inverter after a fault.	Inverter does not switch on again until the country-specific time has elapsed.	-
58	●	●	Control board overtemp.	The temperature inside the device was too high. The inverter switches off to prevent damage to the hardware.	Provide for sufficient ventilation	E
60	●	●	Excessive generator voltage / excessive battery voltage	The inverter does not begin feeding into the grid until the PV voltage falls below a specified value.	-	-
61	✳	●	External limit	The inverter does not begin feeding into the grid until the PV voltage falls below a specified value.	-	-
63	●	●	Frequency-dependent power reduction	P(f)/frequency-dependent power reduction. Power reduction begins with the set thresholds.	-	-
64	●	●	Output current limitation	Output current limitation: The AC current is limited once the specified maximum value has been reached.	-	-
70	●	●	Fault in fan 1	The fan is malfunctioning.	Replace defective fan.	E
71	●	●	Fault in fan 2	-	Notify KACO Service!	E
72	●	●	Fault in fan 3	The fan is malfunctioning. If the fan is defective, the power is reduced to 50% so that the device is not destroyed.	Notify KACO Service!	E
73	✳	●	Standalone grid error	Standalone mode was detected.	-	-
78	●	●	Resid. current shutdown (AFI)	Residual current measured has exceeded the maximum permissible residual current. USA: Max. 4 repetitions of AFI self-test monitoring possible in any given day.	Notify KACO Service!	-
79	●	●	Insulation measurement	PV generator's insulation is being measured	-	-
80	●	●	Insulation meas. not possible	The insulation measurement cannot be performed because the generator voltage is too volatile.	-	-

No.	Grid LED	LED	Text datenloggers HMI1 and HMI2	Fault description	Action	Pers.
81	●	●	Protection shutdown grid voltage L1	Overvoltage has been detected on a conductor. An internal protective mechanism has disconnected the device to protect it against damage.	In case of repeated occurrence: Notify your authorized electrician!	E
82	●	●	Protection shutdown grid voltage L2	Overvoltage has been detected on a conductor. An internal protective mechanism has disconnected the device to protect it against damage.	In case of repeated occurrence: Notify your authorized electrician!	E
83	●	●	Protection shutdown grid voltage L3	Overvoltage has been detected on a conductor. An internal protective mechanism has disconnected the device to protect it against damage.	In case of repeated occurrence: Notify your authorized electrician!	E
84	●	●	Protection shutdown DC link undervoltage	A voltage deviation has been found in the DC link. An internal protective mechanism has disconnected the device to protect it against damage.	In case of repeated occurrence: Notify your authorized electrician!	E
85	●	●	Protection shutdown DC link overvoltage	A voltage deviation has been found in the DC link. An internal protective mechanism has disconnected the device to protect it against damage.	In case of repeated occurrence: Notify your authorized electrician!	E
86	●	●	Protect. shutdown unbal. DC link	Overvoltage has been found in the DC link. An internal protective mechanism has disconnected the device to protect it against damage.	In case of repeated occurrence: Notify your authorized electrician!	E
87	●	●	Protection shutdown overcurrent L1	A current that has been found on a conductor is too high. An internal protective mechanism has disconnected the device to protect it against damage.	In case of repeated occurrence: Notify your authorized electrician!	E
88	●	●	Protection shutdown overcurrent L2	A current that has been found on a conductor is too high. An internal protective mechanism has disconnected the device to protect it against damage.	In case of repeated occurrence: Notify your authorized electrician!	E
89	●	●	Protection shutdown overcurrent L3	A current that has been found on a conductor is too high. An internal protective mechanism has disconnected the device to protect it against damage.	In case of repeated occurrence: Notify your authorized electrician!	E
97	●	●	Protection shutdown overcurrent HW	Too much power has been fed into the grid. Complete disconnection of the device.	Notify authorized electrician / KACO Service!	E/K
100	●	●	Protection shutdown HW overtemperature	The device has been switched off because the temperatures in the housing were too high.	Check to make sure that the fans are working. Replace fan if necessary.	B E
101	●	●	Temperature plausibility error	The device has shut down because of implausible internal measured values.	Notify KACO Service!	K
102	●	●	Plausibility fault efficiency	The device has shut down because of implausible internal measured values.	Notify KACO Service!	K
105	●	●	Relay plausibility error	The device has shut down because of implausible internal measured values.	Notify KACO Service!	K
108	●	●	Grid failure overvoltage L1	Grid failure overvoltage on phase L1	-	-

No.	Grid LED	LED	Text datenloggers HMI1 and HMI2	Fault description	Action	Pers.
109	🔴	⚫	Grid failure overvoltage L2	Grid failure overvoltage on phase L2	-	-
110	🔴	⚫	Grid failure overvoltage L3	Grid failure overvoltage on phase L3	-	-
111	🔴	⚫	Grid failure undervoltage L1	Grid failure undervoltage on phase L1	-	-
112	🔴	⚫	Grid failure undervoltage L2	Grid failure undervoltage on phase L2	-	-
113	🔴	⚫	Grid failure undervoltage L3	Grid failure undervoltage on phase L3	-	-
114	⚫	🔴	Communication error DC/DC	Communication error	-	-
125	⚫	🔴	Relay control fault	Faulty AC relay	Notify KACO Service!	K
216	⚫	🔴	Protect. shutdown HW - overvoltage DC link halves	Protect. shutdown HW - overvoltage DC link halves	Disconnect the AC and DC supply. Wait 1 minute and switch on again.	B
217	⚫	🔴	Protect. shutdown HW - 24V supply voltage	Protect. shutdown HW - 24V supply voltage	Disconnect the AC and DC supply. Wait 1 minute and switch on again.	B

12 Decommissioning and removal

12.1 Switching off the device

⚠ WARNING

Risk of burns from hot housing components

Housing components could heat up during operation.

› Only touch the housing cover of the device during operation.

12.2 Uninstalling the device

⚠ DANGER

Dangerous voltage due to two operating voltages

Severe injuries or death may occur if the cables and/or terminals/busbars in the device are touched. The discharge time of the capacitors is up to 5 minutes.

› Only appropriately qualified electricians authorized by the mains supply network operator are permitted to open and maintain the device.

› Before opening the device: Disconnect the AC and DC side and wait at least 5 minutes.

↻ The device is switched off and a check has been performed to ensure that it is de-energized.

↻ AC cable disconnected AC connection [See section 11.6.1 Page 79].

↻ DC connection disconnected DC connection [See section 11.6.2 Page 79].

1 Undo the cable fittings for Ethernet cables [W_29].

2 Undo the cable fittings for RS485 cables [W_19].

3 Disconnect the plug from the communication circuit board.

4 Pull the interface cables out of the device.

5 Insert sealing plugs into all open cable fittings.

» The device has been uninstalled. Proceed with removal.

12.3 Removing the device

↻ Device has been switched off and uninstalled.

1 Remove the screw that prevents the device from being lifted off the mount.

2 Use the lateral openings and lift the device off the mount.

» The device has been removed. Proceed with packaging.

12.4 Packaging the device

↻ The device has been uninstalled.

1 If possible, always pack the device in the original packaging. If this is no longer available, an alternative is to use equivalent packaging.

2 You must be able to close the box completely and it must be able to accommodate the weight and size of the device.

12.5 Storing the device

⚠ CAUTION

Damage to property due to condensation build-up

If the device is stored incorrectly, condensation may build up within the device and impair the functionality of the device (e.g. due to storage that does not conform to the specified environmental conditions or if the device is transported from a cold environment to a warm environment for a brief period of time.

✓ Storage in accordance with the technical data > Environmental data [See section 4.3 Page 14]

› Check the interior space for any condensation water prior to electrical installation and, if necessary, allow it to dry out sufficiently.

↻ The device is packaged.

☞ Store the device in a dry place, in accordance with the ambient temperature range Environmental data [See section 4.3 Page 14].

13 Disposal

⚠ CAUTION

Risk to the environment if disposal is not carried out in the correct manner

For the most part, both the device and the corresponding transport packaging are made from recyclable raw materials.

Device: Do not dispose of faulty devices or accessories together with household waste. Ensure that the old device and any accessories are disposed of in a proper manner.

Packaging: Ensure that the transport packaging is disposed of properly.

14 Service and warranty

If you need help solving a technical problem with one of our KACO products, please contact our service hotline.

Please have the following information ready so that we can help you quickly and efficiently:

- Device name / serial number
- Date of installation / Start-up report
- Fault message indicated by status LEDs / Description of the fault / Did you notice anything unusual? / What has already been done to analyze the fault?
- Module type and string circuit
- Consignment identification / Delivery address / Contact person (with telephone number)
- Information about the accessibility of the installation site

You can find the following items and other information at our web site Kaco-newenergy:

- Our current warranty conditions,
- A complaint form,
- A form for registering your device. Please register your unit without delay. In this manner, you can assist us in providing you with the quickest service possible.

NOTE

The maximum length of the warranty is based on the currently applicable national warranty conditions.

15 Appendix

15.1 Scope of certification from third-party suppliers

Safety:	Safety of the device
INT	IEC 62109-1:2010
	IEC 62109-2:2011
	UL1741:2010Ed.2+R07Sep2016+R22Dec2017+R15Feb2018
UL	UL 1741 section 88-100 CRD
	CSA-C22.2 No. 62109-1
	CSA-C22.2 No. 62109-2
	UL1998:2013 ED.3

EMC:	Interference immunity
"Directive relating to electromagnetic compatibility"	EN 61000-6-1:2007
	Emitted interference
	CISPR 11:2015; EN55011:2015
	Secondary effects on the grid
	EN 61000-3-3:2008*
	EN 61000-3-2:2006*+A1:2009+A2:2009
	FCC Rules & regulations 47

Grid Code	Code
"Grid guidelines"	PO12.3; 4-Oct.2006
	RD1699/2011
	UNE 206006
	CEI 0-16 V3 2017-07
	BDEW
	FGW TR8 Rev.6, FGW TR4 ver.6, FGW TR3 ver.23
	MEA:2015
	PEA:2016
	UTE C 15-712-1: 2013
	DEWA: 2016 Version 2.0
	ÖNORM E8001-4-712:2009+A1:2014+A2:2016
	TOR D4:2016
	C10/11:2012-06
	IEEE 1547.1 Issued:2005/06/09
	AS 4777.2:2005
	AS 4777.3: 2005

Miscellaneous/environment/efficiency	Miscellaneous
	IEC 61727: 2004 IEC 62116: 2014
	Environment
	IEC60068-2-1, 2007. Environmental testing - Part 2-1 IEC60068-2-2, 20007. Environmental testing - Part 2-2 IEC60068-2-14, 2009. Environmental testing - Part 2-14
	Efficiency
	IEC 61683: 1999 EN50530:2008 CEC Efficiency

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