

KACO new energy.

blueplanet 87 TL3 US GEN2
blueplanet 92 TL3 US GEN2
blueplanet 105 TL3 US GEN2
blueplanet 110 TL3 US GEN2
blueplanet 125 TL3 US GEN2
blueplanet 137 TL3 US GEN2
blueplanet 150 TL3 US GEN2
blueplanet 155 TL3 US GEN2
blueplanet 165 TL3 US GEN2
S, XL - Grid Support Interactive Inverter

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.

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Legal provisions

The information contained in this document is the property of KACO new energy GmbH. Publication of this document, in whole or in part, is subject to the written consent of KACO new energy GmbH.

Definitions on product designations

In this Operating instructions, the product "Photovoltaic Grid-Tie Inverter" is referred to as "device" for ease of reading.

Trademarks

All trademarks are recognised, even if not explicitly identified as such. A lack of identification does not mean that a product or designation/logo is free of 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.

More details on this topic and a list of the open source software used, as well as the corresponding license texts, can be found in the web interface information display under "License List".

Change history

The following table documents all changes to this document. If you have any questions about a specific version, please contact KACO customer service.

Version	Date	Modified chapters	Description of the change	Release
01	*07.04.2026*	All	Initial release	*[ZOE]*

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Photovoltaic feed-in inverter

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1 General information

1.1 About this document



⚠ WARNING

Improper handling of the device can be hazardous!

1. You must read and understand the manual in order to install and use the device safely.

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 required for the registration and approval of your system are included with the manual.

Storing the documents

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

– The current version of the manual can be downloaded from .

English translation of German original

This document has been produced in several languages. The German-language version is the original version. All other language versions are translations of the original version.

This document is valid for the following types of device from firmware version: V6.1.4.9

Previous versions with older firmware can be found in the respective archive folder: [See section 9.6.1 Page 83]

Modules *[KACO art. no.]*	blueplanet 87.0 TL3 GEN2 M1 WM OD USF0 / blueplanet 87.0 TL3 GEN2 M1 WM OD USFX	[1002227 / 1002228]
UL1741 Supplement B	blueplanet 92.0 TL3 GEN2 M1 WM OD USG0 / blueplanet 92.0 TL3 GEN2 M1 WM OD USGX	[1002229 / 1002230]
	blueplanet 105 TL3 GEN2 M1 WM OD USG0 / blueplanet 105 TL3 GEN2 M1 WM OD USGX	[1002231 / 1002232]
	blueplanet 110 TL3 GEN2 M1 WM OD USK0 / blueplanet 110 TL3 GEN2 M1 WM OD USKX	[1002362 / 1002364
	blueplanet 125 TL3 GEN2 M1 WM OD USP0 / blueplanet 125 TL3 GEN2 M1 WM OD USPX	[1002233 / 1002234]
	blueplanet 125 TL3 GEN2 M1 WM OD USK0 / blueplanet 125 TL3 GEN2 M1 WM OD USKX	[1002235 / 1002236]
	blueplanet 125 TL3 GEN2 M1 WM OD USP0-S / blueplanet 125 TL3 GEN2 M1 WM OD USPX-S	[1002400 / 1002401]
	blueplanet 137 TL3 GEN2 M1 WM OD USP0 / blueplanet 137 TL3 GEN2 M1 WM OD USPX	[1002364 / 1002365]
	blueplanet 150 TL3 GEN2 M1 WM OD USQ0 / blueplanet 150 TL3 GEN2 M1 WM OD USQX	[1002237 / 1002238]
	blueplanet 155 TL3 GEN2 M1 WM OD USP0 / blueplanet 155 TL3 GEN2 M1 WM OD USPX	[1002239 / 1002240]
	blueplanet 165 TL3 GEN2 M1 WM OD USQ0 / blueplanet 165 TL3 GEN2 M1 WM OD USQX	[1002241 / 1002242]

1.2 More information

Links to more detailed information can be found at www.kaco-newenergy.com

Document title	Type of document
Technical data sheet	Product flyer
Modbus© protocol RS485 protocol reactive power control	Instructions for use

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Document title	Type of document
SunSpec Information Model Reference SunSpec Information Model Reference KACO	Excel files for the software version with the Application Note "Modbus Protocol" https://kaco-newenergy.com/downloads/
Software package	Files for the current software version
EU Declaration of Conformity Country-specific certificates Certificates for specific assemblies	Certificates

1.3 Layout of Instructions

1.3.1 Symbols used

	General warning sign (ISO 7010 W001)		Fire and explosion hazard
	Electrical voltage		Burn hazard
	Protective earth (PE)		Capacitor discharge

1.3.2 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.

1.3.3 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.

1.3.4 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

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⇨ Final outcome

1.3.5 Visualization in images & graphics

1. Item numbers with localization lines
2. Localization table and reference in the text to the item numbers acc. to item 1
3. Sequence of action steps with item numbers in the circle.
4. Reference in the text to the sequence of action steps.

1.4 Target group

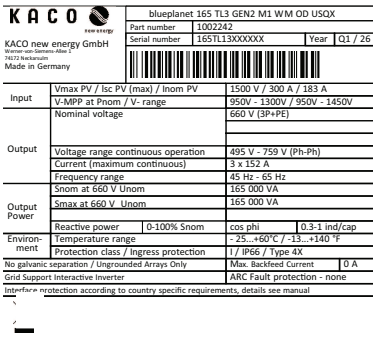
All activities described in the document may only be carried out by specially trained personnel with the following qualifications:

- Knowledge about how an inverter functions and operates
- Knowledge of the Modbus specifications
- Knowledge of the SunSpec Modbus specifications
- 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.
- Failure to follow the prescribed instructions may invalidate the manufacturer's warranty. If you are uncertain about anything, please contact your local KACO service team.

1.5 Identification

For service and other installation-specific requirements, the nameplate is located on the right-hand side of the product and contains the following information:

- Product name
- Part number
- Serial number
- Date of manufacture
- Technical Data


KACO new energy GmbH
Made in Germany

blueplanet 165 TL3 GEN2 M1 WM OD USQX

	Part number	1002242
	Serial number	165TL13XXXXXX Year Q1 / 26
Input	Vmax PV / Isc PV (max) / Inom PV	1500 V / 300 A / 183 A
	V-MPP at Pnom / V- range	950V - 1300V / 950V - 1450V
	Nominal voltage	660 V (3P+PE)
Output	Voltage range continuous operation	495 V - 759 V (Ph-Ph)
	Current (maximum continuous)	3 x 152 A
	Frequency range	45 Hz - 65 Hz
Output Power	Snom at 660 V Unom	165 000 VA
	Smax at 660 V Unom	165 000 VA
	Reactive power 0-100% Snom	cos phi 0.3-1 ind/cap
Environment	Temperature range	-25..+60°C / -13..+140 °F
	Protection class / Ingress protection	I / IP66 / Type 4X
No galvanic separation / Ungrounded Arrays Only		Max. Backfeed Current 0 A
Grid Support Interactive Inverter		ARC Fault protection - none
Interface protection according to country specific requirements, details see manual		

Fig. 1: Name plate

1.6 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: 3013153



Fig. 2: Warning sticker

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2 Safety



⚠ 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.

1. Observe all safety regulations and current technical connection specifications of the responsible power supply company.
2. The device may only be opened and serviced by an authorized electrician.
3. Switch off the grid voltage by turning off the external circuit breakers.
4. Capacitor discharge time: Wait at least 5 minutes before opening.
5. Do not touch the cables and/or terminals/busbars when switching the device on and off.
6. 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.
- Observe the safety instructions on the product and in this manual.
- Switch off all voltage sources and secure them against being inadvertently switched back on before performing visual inspections and maintenance.
- When taking measurements on the live device:
  - Do not touch the electrical connections
  - Remove all jewelery from wrists and fingers
  - Ensure 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.

⚠ CAUTION

Damage to the device from electrostatic discharge

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

1. Observe the ESD protective measures.
2. Earth yourself before touching a component by touching a grounded object.

[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

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⚠ WARNING

Inverter-OFF wiring (NA protection)

The system operator is responsible for restricting access to the inverter OFF signal wiring to authorized and qualified specialist personnel at all times.

The following protective measures must be implemented:

1. Laying the inverter OFF signal wiring in closed housings or cable ducts with restricted access.
2. Clear labeling of all inverter OFF signal lines and terminals.
3. Restriction of physical access to the wiring connection points to qualified and authorized personnel.
4. Implementation of organizational access regulations to prevent unauthorized access.

NOTE: Failure to restrict access to the inverter OFF wiring can lead to significant safety and operational risks.

2.1 Keep these instructions



⚠ 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.

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



⚠ 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.

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



⚠ 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.

1. The device is only permitted to be put into operation by a specialist.
2. Unauthorized persons must not be able to access 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.



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

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⚠ 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.

1. Disconnect the connection line at the switch box or string combiner via the DC isolator switch.
2. The DC connection is intended exclusively for PV generators. Other sources fall within the scope of improper operation (e.g. batteries).
3. Only touch the PV generator cables on the insulation. Do not touch the exposed ends of the cables.
4. Avoid short circuits.
5. Do not connect any strings with a ground fault to the device.
6. The device must not be operated with negatively or positively earthed PV modules.



⚠ DANGER

When deactivating the `night shut-off` ("Q on Demand" operation), a high DC voltage can continue to be present not only on the string combiner but also on the device, even though the string combiner is switched off.

1. In case of maintenance, the device must also be deenergized on the AC-side.
2. We recommend attaching an appropriate hazard warning on the string combiner.



⚠ WARNING

Hazard when using unsuitable fixing materials!

If unsuitable fixing materials are used, the device could fall and persons in front of the device may be seriously injured.

1. Use only fixing materials that are suitable for the mounting base. The fastening materials supplied are only to be used for masonry and concrete.
2. Only install the device in an upright hanging position.



⚠ WARNING

Risk of burns from hot housing components

Housing components could heat up during operation.

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



⚠ WARNING

Risk of burns from hot surface

Heat sinks become very hot during operation.

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

⚠ CAUTION

Impact hazard, risk of breakage to the device!

1. Pack the device securely for transport.
2. Carefully transport the device using the transportation pallet.
3. Do not subject the device to shocks.

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⚠ 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.

1. If the device is exposed to gases, it must be installed in a location that is visible.
2. Perform regular visual inspections.
3. Immediately remove any moisture from the housing.
4. Ensure that there is sufficient ventilation at the installation location.
5. Immediately remove dirt, especially on vents.
6. Failure to observe these instructions may result in damage to the device which is not covered by the warranty.

⚠ 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.

1. Seal off any screw fittings using sealing covers.
2. Prior to installation, check the inner area for condensation and if necessary, allow it to dry sufficiently before installation.
3. Immediately remove any moisture from the housing.

⚠ CAUTION

Damage to the device from electrostatic discharge

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

1. Observe the ESD protective measures.
2. Earth yourself before touching a component by touching a grounded object.

NOTE

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

1. Do not attempt to rectify faults that are described here (in the troubleshooting chapter). Contact our Customer Service department. Only carry out maintenance activities that are described here.
2. Log each maintenance activity in the "Service" menu item: "Service Log" (exception: "User" interface) [See section 9.4.2 Page 57]
3. The device should be checked for proper operation by a qualified electrician at regular intervals and if you experience problems, you should always contact the system manufacturer's Service department.

2.2 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. [2]

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 the grid connection, the requirements of the grid operator must be implemented. In addition, the approval for the grid connection might be made dependent on approval from the competent authorities.

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

The name plate must be permanently attached to the product and must be in legible condition.

Any use other than or beyond the intended use is considered improper use and may void the product warranty. This includes:

- Use of a distribution system that is not described (grid type)
- Use of sources other than PV-strings.
- Mobile use
- Use in hazardous (explosive) locations
- Use in direct sunlight, rain, storms, or other harsh environmental conditions
- Outdoor use in environmental conditions that exceed the limits stated in the technical specifications >Environmental data.
- Operation outside the specifications defined by the manufacturer
- Direct connection to the Internet (without using a firewall/VPN)
- Overvoltage of more than 1,500 V at the DC connection
- Modification of the device
- Island mode operation

2.3 Protection features

The following monitoring and protection functions are integrated into the device:

- RCMU (Residual Current Monitoring Unit)
- Overvoltage conductor/varistor to protect the power semiconductors from high-energy transients on the grid and generator side
- Device temperature monitoring
- EMC filter to protect the product against high-frequency grid interference
- Grid-side varistors to earth for protection of the product against burst and surge impulses
- Islanding detection (anti-islanding protection) in accordance with applicable standards
- IMI (Isolation Monitoring Interrupter) detection of a generator insulation fault.

NOTE

Overvoltage conductors / varistors influence the insulation resistance test when the device is connected

If the device is connected, the overvoltage conductors / varistors contained in the device have an impact on the electrical system insulation resistance test as per HD 60364-6 / IEC 60364-6 Low-voltage installations- Part 6: Verification.

IEC 60364-6 6.4.3.3 describes two options for this case. The first option is to disconnect devices with an overvoltage conductor or, if this is not practicable, then the test voltage can be reduced to 250 V.

[2] **WARNING! The device is not intended for use in residential areas and cannot ensure adequate protection of radio reception in such environments.**

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2.4 Protection Against Cyber Attacks

This chapter describes the cybersecurity features and responsibilities associated with the device throughout its entire life-cycle. It is intended for installers, system operators, and service technicians and follows a defense-in-depth approach in accordance with IEC 62443-4-2.

Additional information is available under [See section 8.3 Page 44]. For information on Inverter OFF wiring, see Connecting external grid protection components.

2.4.1 User Cybersecurity Responsibilities

NOTE

When logging in as "Installer", a new password must be set for both the "Installer" and "User" accounts.

The browser should not save or cache passwords, especially for security-sensitive applications related to this product.

Storing passwords in the browser creates a risk of unauthorized access and data breaches.

Only approved enterprise password managers should be used; browser-based password storage must not be used.

For secure operation, operators must:

- Change the default login credentials immediately after commissioning.
- Assign a strong password during the first login: minimum 12 characters including uppercase and lowercase letters, numbers, and special characters.
- Assign appropriate user roles and permissions (Installer, Operator, Service Technician).
- Disable unused interfaces (RS485).
- Restrict physical access to the inverter and connected components.
- Route the Inverter OFF signal wiring inside locked enclosures or protected cable ducts.
- When commissioning via the static IP address (CON700, 169.254.1.1), disconnect the connection after commissioning has been completed.

2.4.2 Software & Firmware Updates

The process for creating, signing, and distributing firmware packages is governed under an ISO/IEC 27001-certified management system. This includes access control for signing keys, documented change management, and audit trails for every release approval.

Only digitally signed firmware packages provided by KACO new energy may be installed.

Firmware updates can be performed via:

- Web interface (Service menu -> Firmware-Update See table : Configuration via web user interface [Page 79] sowie [See section 9.6 Page 82])
- USB media (FAT32 formatted, mx. 4 GB)
- Segment controller (e.g. blue'Log XC/XM) in the system network.

NOTE

Details about the software update process can be found in the corresponding application note on our website.

2.4.3 Logging & Monitoring

The device generates local log files that can be accessed through the web interface or via USB.

- The logs contain events, alarms, and security-related records. [See section 11.9 Page 117]
- Operators should integrate the device logs into SCADA, PPC, or blue'Log XC systems to ensure continuous monitoring.
- In the event of a security incident, export the log files and forward them to the KACO support team. Export is available via the Service menu See table : Configuration via web user interface [Page 80].

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Integration into SIEM/SCADA/PPC:

- Operators should integrate device logs into SCADA, PPC, or blue'Log XC systems.
- In the event of a security incident: Export the log files as a service package (Service menu → "See table : Export Service Package [Page 79]", under [See section 9.4.2 Page 57]) and forward them to the KACO support team.

2.4.4 End of Life and Decommissioning

Before disposing of or reselling the device:

- Disconnect all communication connections.
- Reset the device to factory settings.
- Delete all user data and configuration files.
- Ensure environmentally responsible disposal in accordance with the WEEE Directive (2012/19/EU).

2.4.5 Support and Lifecycle Commitment

As a customer, you receive comprehensive support in the following areas:

- Extended support may be available through separate service agreements.
- You will be informed about critical security updates through official KACO communication channels.

2.4.6 CRA Security Commitments

In accordance with the EU Cyber Resilience Act (CRA), the following commitments apply:

- Security support (updates and vulnerability management) is provided in accordance with the CRA requirements.
- Instructions for secure configuration are included in this manual.
- A dedicated security contact is available for reporting security incidents and vulnerabilities.

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3 Device description

3.1 Mode of operation

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

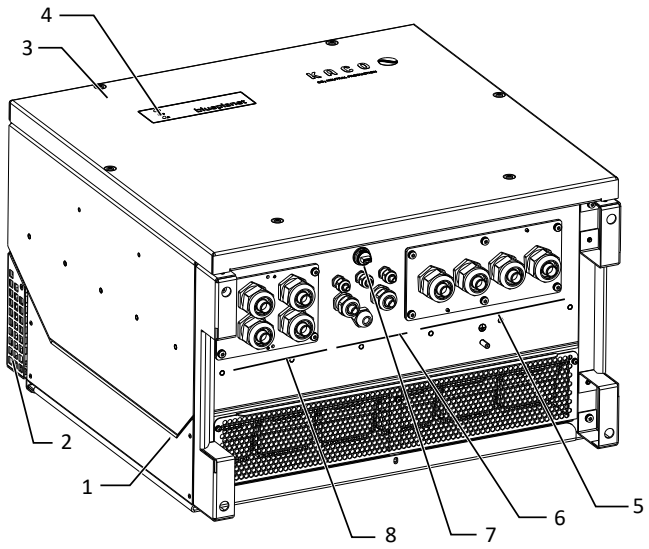


Fig. 3: Device diagram - S version

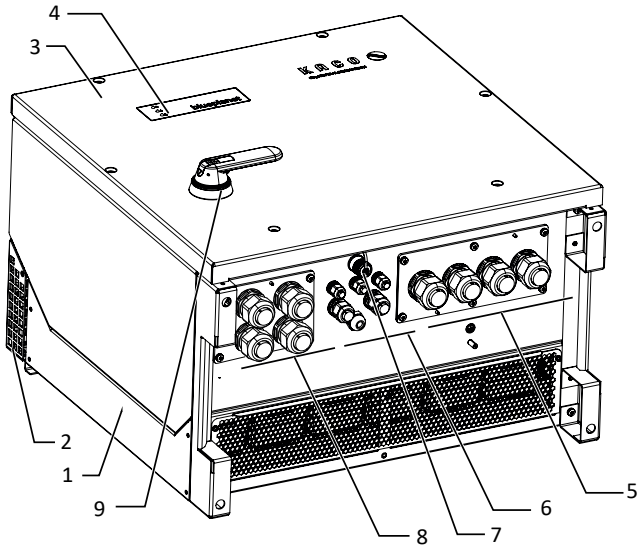


Fig. 4: Device diagram - XL version

Legend

1	Housing	6	Interface / cable feed-through
2	Upper cover	7	USB socket
3	Cover	8	DC connection / cable feed-through
4	Status indicator	9	DC isolator switch (not present in S version)
5	AC connection / cable feed-through		

3.2.1 Mechanical components

DC isolator switch (not present in S version)

The DC isolator switch is located on the housing door. of the device. The DC isolator switch is used to disconnect the device from the PV generator in order to carry out service.

Disconnecting the device from the PV generator

☞ Switch the DC isolator switches from 1 (ON) to 0 (OFF).

Connecting the device to the PV generator

☞ Switch the DC isolator switches from 0 (OFF) to 1 (ON).

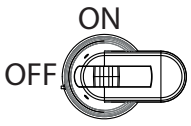


Fig. 5: DC isolator switch

3.2.2 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.

3.2.3 Interfaces

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

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Ethernet interface

Monitoring can occur directly on the device using the integrated Ethernet interface. A local web server is installed in the device for this purpose. This can also be used to request measured values remotely.

For monitoring a system comprising several inverters, we recommend you use an external data logging and monitoring system.

Ethernet ports

The device is equipped with two switched Ethernet ports, allowing multiple devices to be connected in series when a line topology is preferred.

RS485-Interface

The device features two RS485-Interfaces. This allows communication to take place using daisy-chain operation. Data loggers that cannot be connected via Ethernet can be connected to an RS485 interface.

USB interface

The device is equipped with a USB Type-A connector located on the communication board. The USB interface is rated for a power supply of 5 V / 500 mA.

Use the USB interface to read out stored operating data, load firmware updates or device configurations using a FAT32-formatted USB stick (max. 4GB).

A connection to the unit's internal web server can be established via a plugged-in USB Wi-Fi stick. In addition to commissioning, service information and firmware updates, more extensive configurations are also possible via the web interface.

"Inverter Off" input / DRM0 for Australia

In addition to the internal protection functions, the internal interface switches can also be controlled via the "Inverter Off" input.

If a Powador-protect is used as the central interface protection device, suitable KACO inverters can be disconnected from the public utility grid in a single-fault-safe manner using the internal interface switches instead of separate interface switches. To do so, connect each inverter installed in the photovoltaic system to the Powador-protect.

For information on installation and operation, refer to this manual, the Powador-protect operating instructions, and the Powador-protect application note available on the KACO website.

Instead of a Powador-protect, a third-party interface protection device may also be connected to the "Inverter Off" input to control the internal interface switches.

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3.3 Plant layout

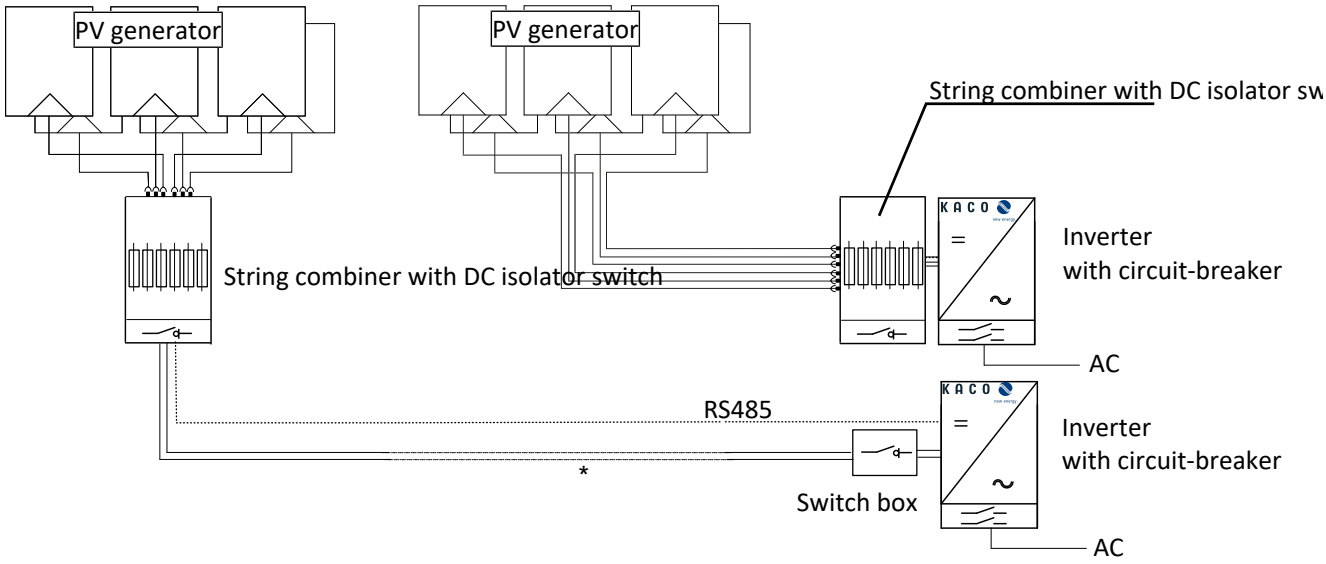


Fig. 6: Circuit diagram with a short or long supply cable to the inverter

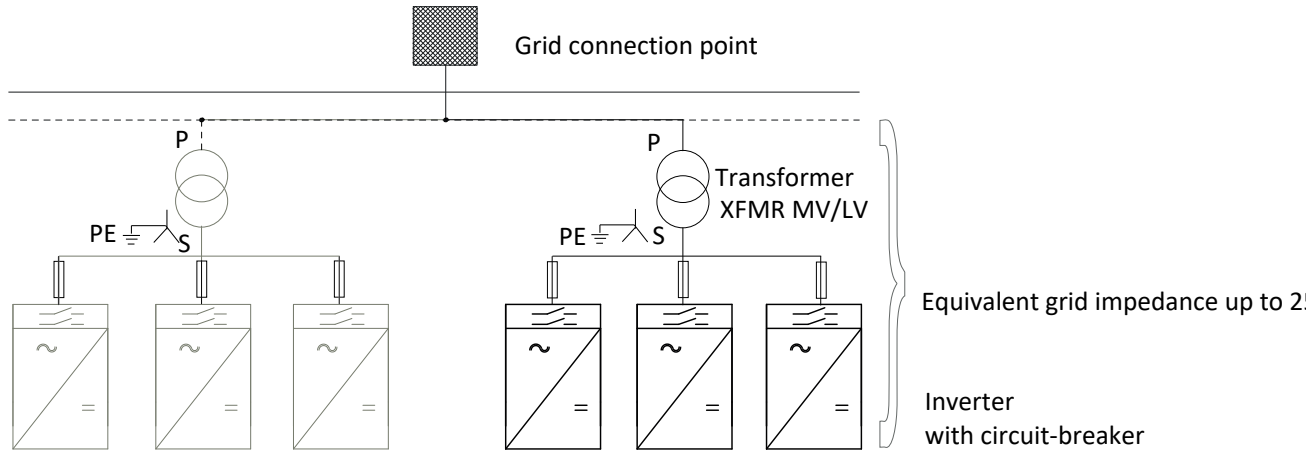


Fig. 7: Circuit diagram from the grid connection point to the inverter

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 connected to the KACO device to bundle the DC strings. *) If the supply line from the PV generator to the device is longer, the string combiner can also be installed near the PV generator. An integrated DC isolator switch provides DC-side isolation.
Switch box	A switch box with integrated DC isolator switch provides the DC-side isolation at the inverter.
Inverter with circuit-breaker	The PV generator is connected to the device's DC connection.
Transformer	All three phases must be connected to the medium-voltage transformer or medium-/high-voltage transformer. The total impedance of the transformer substations must be less than 25%. **NOTE: Grounding is provided at the accessible neutral point (Dy5). For further information, refer to the application note "Grid Type and Impedance Requirements..."**
Point of common coupling (PCC)	Clean PV power is supplied at the point of common coupling (PCC).

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4 Technical data

4.1 Electrical data

DC input data	87.0 TL3	92.0 TL3	105 TL3	110 TL3 US	125 TL3	125 TL3 @600 V
Maximum recommended PV generator power	130.5 kW	138 kW	157.5 kW	165 kW	187.5 kW	
MPPrange@Pnom	560 V–1,300 V	580 V–1,300 V		705 V - 1.300 V		875 V–1,300 V
Operating range	560 V–1,450 V	580 V - 1.450 V		705 V - 1.450 V		875 V–1,450 V
Rated voltage	600 V	620 V		730 V		900 V
Starting voltage	645 V	675 V		805 V		1,000 V
Open circuit voltage [3]	1,500 V					
Nominal DC current (Inom) [4]	160 A		183 A	160 A	183 A	160 A
Number of strings	1-2					
Number of MPP trackers	1					
Max. DC current (ISC max.)	300 A					
Input source feedback current	0 A					
Polarity safeguard	no					
String fuse	no					
Overvoltage protection	1 + 2					

DC input data	125 TL3 US-S	137 TL3	150 TL3	155 TL3 US	165 TL3
Maximum recommended PV generator power	187.5 kW	205.5 kW	225 kW	232.5 kW	247.5 kW
MPPrange@Pnom	875 V–1,300 V		960 V–1,300 V	875 V–1,300 V	950 V–1,300 V
Operating range	875 V–1,450 V		960 V–1,450 V	875 V–1,450 V	960 V–1,450 V
Rated voltage	900 V		1,000 V	900 V	1,000 V
Starting voltage	1,000 V		1,100 V	1,000 V	1,100 V
Open circuit voltage	1,500 V				
Nominal DC current (Inom)	160 A			183 A	
Number of strings	1-2				
Number of MPP trackers	1				
Max. DC current (ISC max.)	300 A				
Input source feedback current	0 A				
Polarity safeguard	no				
String fuse	no				

[3] A brief open circuit voltage of up to 1600 V_{dc} (max. 15 hours a year) is admissible for the device.

Due to the brief open circuit voltage exceedance, there is no guarantee that the integrated overvoltage protection will work correctly if the ambient temperature is > 40°C.

[4] The "Nominal PV current (Inom)" is the maximal theoretical value for operation with full power when the feed-in power is low. The device is limited to the maximum AC power.

The "Max. PV current ($ISC_{max.}$)" together with the open circuit voltage (U_{DCmax}) defines the characteristic of the connected PV generator. This is the relevant value for string design and represents the absolute maximum limit for inverter protection. The connected PV generator must be designed in such a way that the maximum PV current is less than or equal to the ISC_{max} of the device under all foreseeable conditions and therefore complies with IEC 61730 Class A. Under no circumstances may the design lead to a short-circuit current greater than the ISC_{max} of the device [See section 7.6.2 Page 32].

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DC input data	125 TL3 US-S	137 TL3	150 TL3	155 TL3 US	165 TL3
Overvoltage protection	1 + 2				

AC output data	87.0 TL3	92.0 TL3	105 TL3	110 TL3 US	125 TL3	125 TL3 @600 V
Rated power @ nominal voltage (x KVA@30°C/40°C/50°C)	87 kVA	92 kVA	99.9 kVA	110 kVA	125 kVA	
Max. apparent power	87 kVA	92 kVA	105 kVA	110 kVA	125 kVA	137.5 kVA
Rated voltage	380 V (3P+PE)	400 V (3P+PE)	380 V (3P+PE) ; 400 V (3P+PE); 415 V (3P+PE)	480 V (3P+PE)		600 V (3P+PE)
Voltage range: continuous operation	285 V–437 V	300 V–460 V	285 V–478 V	360 V–552 V		450 V–690 V
Rated current	3 x 132.3 A		3 x 144.5 A	3 x 132.3 A	3 x 150.5 A	3 x 120.3 A
Max. continuous current	3 x 132.3 A		3 x 152 A	3 x 132.3 A	3 x 152 A	3 x 132.3 A
Contribution to peak short-circuit current ip	212 A		260.8 A	212 A	260.8 A	212 A
Initial short-circuit alternating current (Ik" first single period effective value)	137 A		157 A	137 A	157 A	137 A
Short-circuit alternating current duration (max output fault current)	132.3 A		152 A	132.3 A	152 A	132.3 A
Inrush current	5 A [RMS (20 ms)]					
Rated frequency	50/60 Hz					
Frequency range	45–65 Hz					
Reactive power	0-100% Snom					
cos phi	0.3–1 ind/cap					
Number of feed-in phases	3					
Distortion factor (THD)	< 3%					
Overvoltage protection	Base					

AC output data	125 TL3 US-S	137 TL3	150 TL3	155 TL3 US	165 TL3
Rated power @ nominal voltage (x KVA@30°C/40°C/50°C)	125 kVA	137 kVA	150 kVA	155 kVA	165 kVA
Max. apparent power	125 kVA	137.5 kVA	150 kVA	155 kVA	165 kVA
Rated voltage	600 V (3P+PE)		660 V (3P+PE)	600 V (3P+PE)	660 V (3P+PE)
Voltage range: continuous operation	450 V–690 V		495 V–759 V	450 V–690 V	495 V–759 V
Rated current	3 x 120.3 A	3 x 132.3 A	3 x 131.2 A	3 x 149.5 A	3 x 144.5 A
Max. continuous current	3 x 120.3 A	3 x 132.3 A		3 x 152 A	3x 152 A
Contribution to peak short-circuit current ip	212 A			260.8 A	
Initial short-circuit alternating current (Ik" first single period effective value)	137 A			157 A	
Short-circuit alternating current duration (max output fault current)	132.3 A			152 A	
Inrush current	5 A [RMS (20 ms)]				
Rated frequency	50/60 Hz				

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AC output data	125 TL3 US-S	137 TL3	150 TL3	155 TL3 US	165 TL3
Frequency range	45–65 Hz				
Reactive power	0-100% Snom				
cos phi	0.3–1 ind/cap				
Number of feed-in phases	3				
Distortion factor (THD)	< 3%				
Max. voltage range (up to 100 s)	750 V		825 V	750 V	825 V
Overvoltage protection	Base				

4.2 General data

General data	87.0 TL3	92.0 TL3	105 TL3	110 TL3 US	125 TL3	125 TL3 @600 V
Max. efficiency	98.9%		98.89%	99.1%	98.98%	99.2%
European efficiency	98.6%		98.56%	98.8%	98.73%	99.0%
Self consumption: Standby	< 10 W					
Feed-in from	> 200 W					
Circuit design	transformerless					
“Inverter Off” signal trip-off time	10 ms					
Protection class / over voltage category	I / III (AC) II (DC)					
Grid monitoring	Country-specific					
Distribution system	TN-C system, TT system, Solid grounded wye					
Safety	EN 62109-1, EN 62109-2					
Interference immunity/ interference emission/ grid feedback	EN 61000-6-1, EN 61000-6-2, EN 62920 - Class A / EN 61000-6-4, EN 62920 - Class A, EN 55011 - group 1 Class A / EN 61000-3-11, EN 61000-3-12					
*	+ UL62109-1, UL1741, Sup A/B			+ UL62109-1, UL1741, Sup B	+ UL62109-1, UL1741, Sup A/B	

General data	125 TL3 US-S	137 TL3	150 TL3	155 TL3 US	165 TL3
European efficiency	99.0%			98.89%	98.96%
Max. efficiency	99.2%			99.10%	99.14%
Self consumption: Standby	< 10 W				
Feed-in from	> 200 W				
Circuit design	transformerless				
“Inverter Off” signal trip-off time	10 ms				
Protection class / over voltage category	I / III (AC) II (DC)				
Grid monitoring	Country-specific				
Distribution system	TN-C system, TT system, Solid grounded wye				
Safety	EN 62109-1, EN 62109-2				
Interference immunity/ interference emission/ grid feedback	EN 61000-6-1, EN 61000-6-2, EN 62920 - Class A / EN 61000-6-4, EN 62920 - Class A, EN 55011 - group 1 Class A / EN 61000-3-11, EN 61000-3-12				
*	+ UL62109-1, UL1741, Sup B		+ UL62109-1, UL1741, Sup A/B		

Mechanical data	87.0 TL3 - 165 TL3
Display	LEDs

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Mechanical data	87.0 TL3 - 165 TL3
Controls	Web server
Menu languages	EN; DE; FR; IT; ES; PL; NL; PT; CZ; HU; SL; TR; RO; DA
Interfaces	2x Ethernet, USB, 2x RS485
Communication	TCP/IP, Modbus TCP based on Sunspec / RS485 (KACO protocol)
Q on Demand	yes
Potential-free relay	yes (integrated switch)
DC isolator switch	no / yes (XL version)
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	28,30 inch x 28,30 inch x 18,11 inch
Weight	172 lb

4.3 Environmental data

Environmental data	87.0 TL3	92.0 TL3	105 TL3	110 TL3 US	125 TL3	125 TL3 @600 V
Installation height	9842 ft (Derating at 6561 ft)					
Installation distance from coast	>1640 ft					
Ambient temperature	-13 °F - 140 °F					
Ambient temperature (storage)	-13 °F - - 140 °F					
Power derating from	> 113 °F		> 95 °F	> 113 °F		
Humidity range (non-condensing)	100%					
Protection rating (installation location)	IP66 /NEMA 4X					
Pollution level outside the enclosure	3					
Pollution level inside the enclosure	2 (reduced by IP 66 Housing)					
Item number	1002227 / 1002228	1002229 / 1002230	1002231 / 1002232	1002362 / 1002363	1002235 / 1002236	1002233 / 1002234
Name on nameplate	blueplanet 87 TL3 GEN2 M1 WM OD USF0 / blueplanet 87 TL3 GEN2 M1 WM OD USFX	blueplanet 92 TL3 GEN2 M1 WM OD USG0 / blueplanet 92 TL3 GEN2 M1 WM OD USGX	blueplanet 105 TL3 GEN2 M1 WM OD USG0 / blueplanet 105 TL3 GEN2 M1 WM OD USGX	blueplanet 110 TL3 GEN2 M1 WM OD USK0 / blueplanet 110 TL3 GEN2 M1 WM OD USKX	blueplanet 125 TL3 GEN2 M1 WM OD USK0 / blueplanet 125 TL3 GEN2 M1 WM OD USKX	blueplanet 125 TL3 GEN2 M1 WM OD USP0 / blueplanet 125 TL3 GEN2 M1 WM OD USPX

Environmental data	125 TL3 US-S	137 TL3	150 TL3	155 TL3 US	165 TL3
Installation height	9842 ft (Derating at 6561 ft)				
Installation distance from coast	>1640 ft				
Ambient temperature	-13 °F - - 140 °F				
Power derating from	> 113 °F	> 95 °F			
Humidity range (non-condensing)	100%				

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Environmental data	125 TL3 US-S	137 TL3	150 TL3	155 TL3 US	165 TL3
Protection rating (installation location)	IP66 /NEMA 4X				
Pollution level outside the enclosure	3				
Pollution level inside the enclosure	2 (reduced by IP 66 Housing)				
Item number	1002400 / 1002401	1002364 / 1002365	1002237 / 1002238	1002239 / 1002240	1002241 / 1002242
Name on nameplate	blueplanet 125 TL3 GEN2 M1 WM OD USP0-S / blueplanet 125 TL3 GEN2 M1 WM OD USPX-S	blueplanet 137 TL3 GEN2 M1 WM OD USP0 / blueplanet 137 TL3 GEN2 M1 WM OD USPX	blueplanet 150 TL3 GEN2 M1 WM OD USQ0 / blueplanet 150 TL3 GEN2 M1 WM OD USQX	blueplanet 155 TL3 GEN2 M1 WM OD USP0 / blueplanet 155 TL3 GEN2 M1 WM OD USPX	blueplanet 165 TL3 GEN2 M1 WM OD USQ0 / blueplanet 165 TL3 GEN2 M1 WM OD USQX

4.4 Accessories

Accessory articles	KACO order no.
KACO blueplanet DC-Breaker	1001860
Bending box	1001917 (absolutely mandatory for UL market!)

Accessory articles	KACO order no.
Bending box	1001917
AC inverter input plate kit	1001882 (double row) / 1001906 (M63/32)
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

Accessory articles	KACO order no.
Replacement fuses (10x85mm 1500V 5A PID)	1001883

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5 Transportation and Delivery

Every product 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 Checking the scope of supply

- Inverter
- Mount
- Installation kit
- Manual [online] / Quickguide [multi-language]

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 device

⚠ CAUTION

Impact hazard, risk of breakage to the device!

1. Pack the device securely for transport.
2. Carefully transport the device using the transportation pallet.
3. Do not subject the device to shocks.

For safe transportation of the product, use the hand recesses in the carton.

Packaging	Folding cardboard box
Height x width x depth	32,67 inch x 30,70 inch x 21,65 inch
Total weight	191 lb

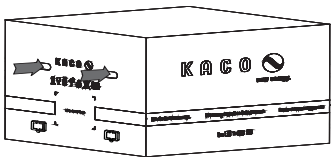


Fig. 8: Transporting the device

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.

Sym-bol	Screw head con-tour	Sym-bol	Screw head contour
W	External hex	A	Internal hex
T	Torx	S	Slot

Tab. 2: Tool abbreviations key

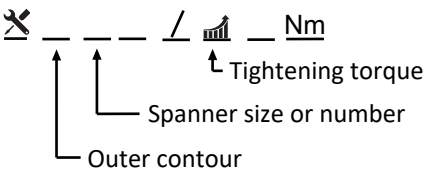


Fig. 9: Presentation format

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6 Assembly 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.

1. 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.

1. If the device is exposed to gases, it must be installed in a location that is visible.
2. Perform regular visual inspections.
3. Immediately remove any moisture from the housing.
4. Ensure that there is sufficient ventilation at the installation location.
5. Immediately remove dirt, especially on vents.
6. 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.
- In outdoor areas, KACO new energy recommends protecting the device from direct weather exposure and sunlight. This should be carried out by means of constructional measures (e.g. wind breaks) in order to reduce thermal heating of the components, premature derating and more extensive wear of the fans.

Mounting surface

- with sufficient load-bearing capacity (at least 4 times the device weight)
- accessible for installation and maintenance work
- Must be made out of heat-resistant material (up to 194 °F)
- flame-retardant
- Minimum clearances to be observed during installation: [See figure 18 [▷ Page 26]

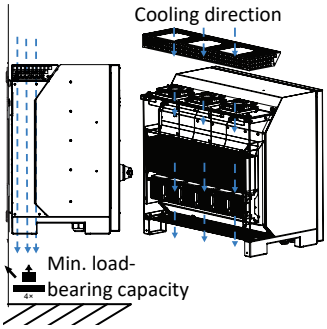


Fig. 10: Load-bearing capacity & cooling direction

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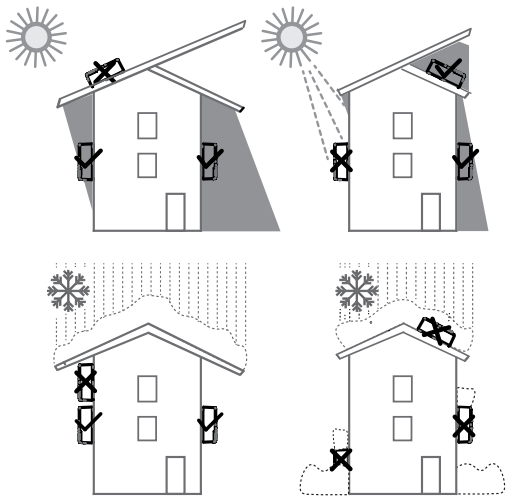


Fig. 11: Device for outdoor installation

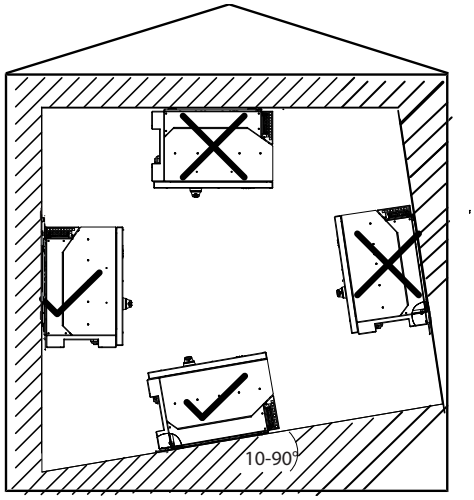


Fig. 12: Permissible installation location

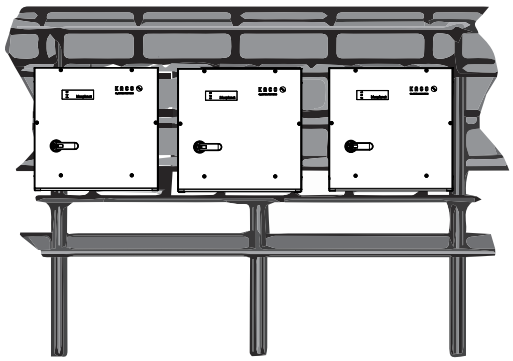


Fig. 13: Free-standing installation beneath PV system

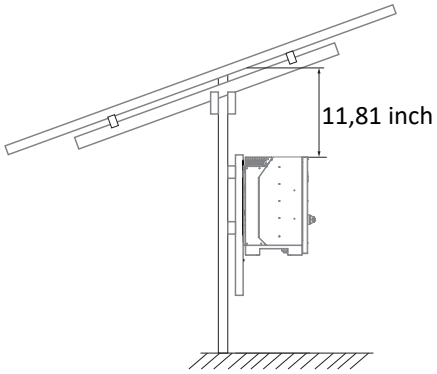


Fig. 14: Mounting advice for installation beneath PV system

6.2 Unpacking the device



⚠ 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).

1. Only lift the device using the openings provided.
2. The device must be transported and installed by at least 3-4 persons.
3. Be mindful of the weight of the device and use aids to secure it.

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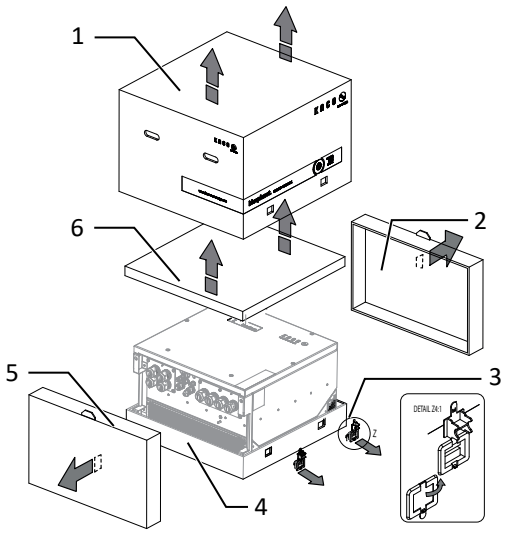


Fig. 15: Opening the packaging

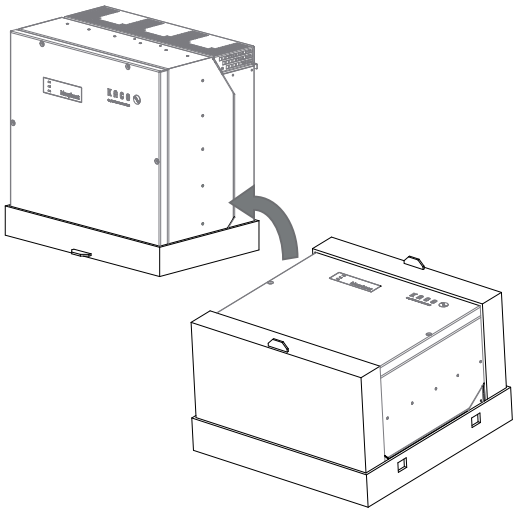


Fig. 16: Setting the device upright

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

↻ 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.

6.3 Fastening the mount



⚠ WARNING

Hazard when using unsuitable fixing materials!

If unsuitable fixing materials are used, the device could fall and persons in front of the device may be seriously injured.

1. Use only fixing materials that are suitable for the mounting base. The fastening materials supplied are only to be used for masonry and concrete.
2. Only install the device in an upright hanging position.

↻ Carton containing the mounting bracket and mounting hardware removed from the packaging and opened.

1. Verify the installation surface and minimum clearance height according to the specified dimensions.
2. Mark the mounting bracket position on the wall using the supplied template.

. **NOTE: The minimum clearances between two devices, as well as between the device and the ceiling or floor, are already taken into account in the drawing.**

3. Secure the mounting bracket to the wall using the appropriate mounting hardware supplied in the mounting kit.

. **NOTE: Ensure that the mounting bracket is correctly oriented.**

⇨ Proceed with installing the device.

EN-US

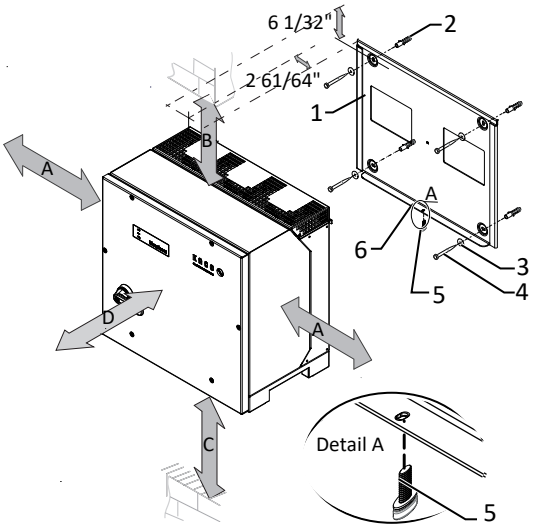


Fig. 17: Minimum clearances for wall mounting

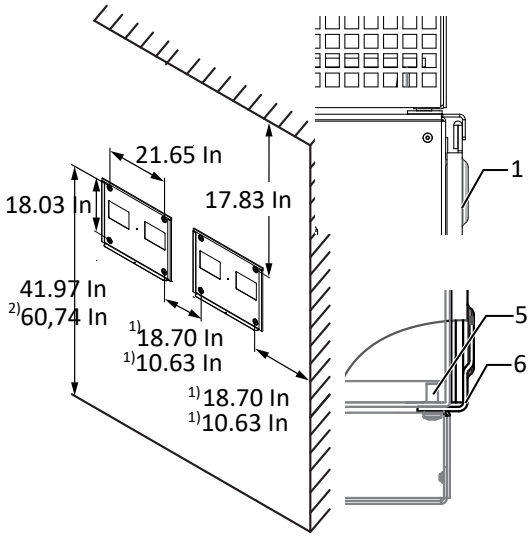


Fig. 18: Wall mounting

Key			
1	Mount	4	Screw for mounting (4x) SW 13 / [See section 6.3 Page 25]
2	Fastening anchors [S12-Ø0.47 In /3,54 In]	5	Screw for securing purposes (1x)
3	Lock washer	6	Bracket to store the device
A	Minimum clearance: 4.72 In	1)	Minimum clearance excluding device:10.63 In
	Recommended clearance: 15.75 In	1)	Recommended clearance excluding device:18.70 In
B	Minimum clearance: 11.81 In	-	-
C	Minimum clearance: 19.69 In	-	-
D	Recommended clearance: 39.37 In	2)	Recommended clearance with DC breaker:60,74 In

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.

1. The device must be transported and installed by at least 3-4 persons.
2. Only ever raise the device vertically using the openings provided.
3. Use a climbing aid for the chosen installation height.
4. Wear safety gloves and safety shoes when lifting and lowering the device.



NOTE

Power reduction due to heat buildup!

Failure to observe the recommended minimum clearances may cause the device to reduce its output power due to inadequate ventilation and the resulting heat buildup.

1. Maintain the specified minimum clearances and ensure adequate heat dissipation.
2. During operation, do not place any objects on top of the device enclosure.
3. After installation, ensure that no foreign objects obstruct heat dissipation.

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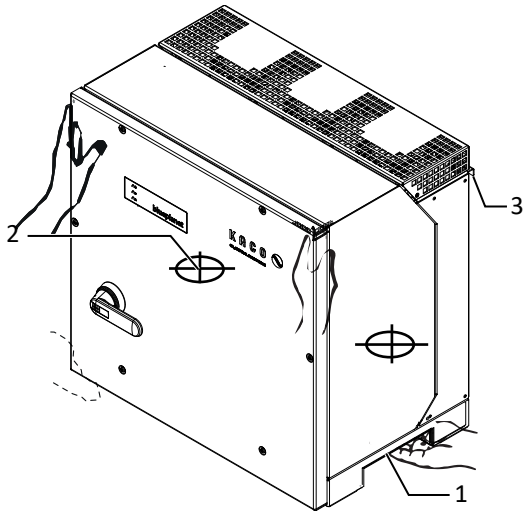


Fig. 19: Lifting the device by the opening

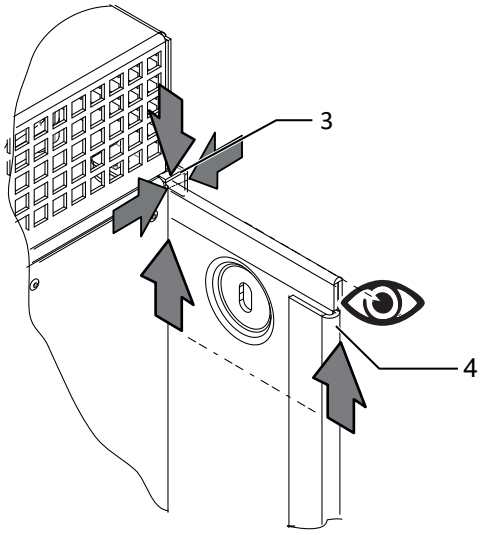


Fig. 20: Fitting the device onto the mount

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

Lifting and mounting the device

↻ The mount has been installed.

1. Raise the device using the lower side recesses and support it on the head side. Observe the device's center of gravity!

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

2. Insert the device into the upper mounting bracket using the mounting flange. Lower the device completely onto the lower bracket until it sits flush against the mounting bracket at the rear [See figure 18 [Page 26].
3. Insert the supplied screw through the mounting bracket tab and secure the device to prevent it from being lifted off [T30 / 17.70 In-lbs] [See figure 17 [Page 26].

. **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.

1. Seal off any screw fittings using sealing covers.
2. Prior to installation, check the inner area for condensation and if necessary, allow it to dry sufficiently before installation.
3. Immediately remove any moisture from the housing.

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7 Installation

7.1 General

↻ **NOTE: S version: The device is shut down externally at the string collector.**

1. Switch the DC isolator switch from 1 (ON) to 0 (OFF).
2. Press in the safety catch (1) from behind.
3. Attach the hanging lock (2) to the safety catch.

. **DANGER! A measurement in a live state may be required for tests. Only appropriately qualified electricians authorized by the mains supply network operator are permitted to open and maintain the device.**

. **DANGER! Observe all safety regulations for preventing contact with live parts.**

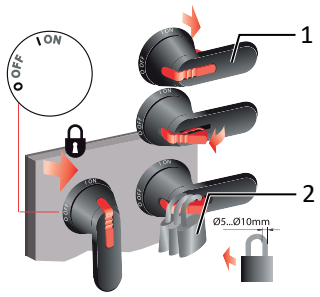


Fig. 21: Secure the DC isolator switch to prevent it from being switched back on

1 Switch with securing bracket
2 Padlock

7.2 Opening the housing

↻ The device has been installed on the mount.
↻ Wipe any moisture off the frame of the housing cover using a cloth.

☞ Undo the 6 screws (2) and carefully remove the housing cover (1) [✕T_25]

☞ Take care not to damage or soil the seals and fibre optics when setting down the housing cover.

⇨ Proceed with the installation of the device.

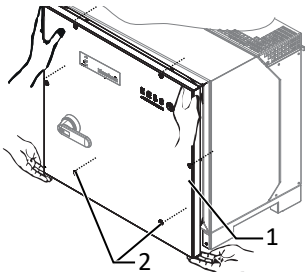


Fig. 22: Removing the housing cover

7.3 Surveying the connection area

The AC supply connection point is located inside the enclosure. The DC input source is also connected inside the enclosure.

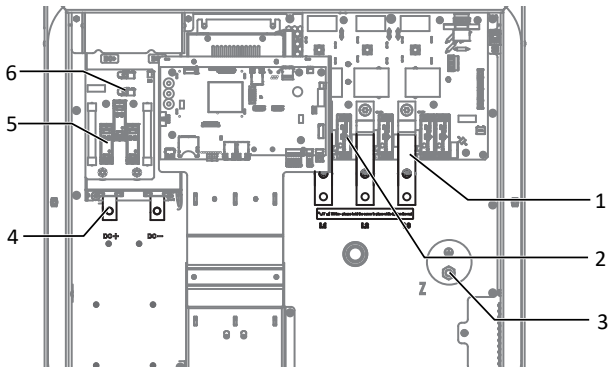


Fig. 23: Connection area on DC side (left) / AC side (right)

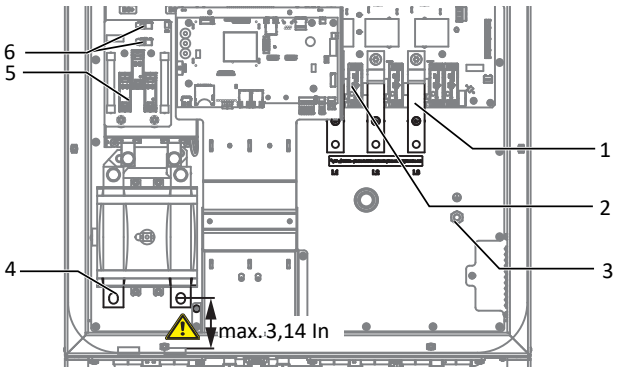


Fig. 24: Connection area (XL version)

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

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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 rating of the device; cable length; type of cable 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 [5]
Min. cable cross-section	in accordance with local installation standards
Diameter of cable for cable fitting	0,63 - 1,10 inch
Length of insulation to be stripped off	Depending on the cable lug
Cable lug Ø connection bolt	Bore for M10 screw
Tightening torque	265.50 In-lbs
Connection type	Cable lug (use the appropriate cable lug depending on the cable material!)
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)	max. 250A
Fitting for AC connection	M40
Torque for cable fitting	88.5 In-lbs
DC-side	
Max. cable cross-section	450 kcmil
Min. cable cross-section	in accordance with 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 cable
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

[5] Option: 50 mm² (1/0 AWG) with two-row AC conductor routing (2 × 5 conductors). The optionally available two-row input plate is required for this purpose! [See section 4.4 Page 21]

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DC-side	
Torque for cable fitting	88.5 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
Tightening torque protective conductor connection	88.5 In-lbs
Ethernet connection type	RJ45

7.5 Connecting the device to the mains supply



⚠ WARNING

UL50E NEMA Type 4x not guaranteed!

Ingress of condensation, dust or vermin can lead to short-circuiting/overheating or even failure of the device.

1. Tighten **all** cable/sealing plug/housing screw connections to the **specified torques**.
2. If cable glands are not used, the sealing plugs must be retained with the specified torques.
3. The applicable torque values are given in the respective installation steps or in the table [See section 7.4.1 Page 29]

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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 In - 1,10 In is available on the device.
↻ Time required for AC connection: 30 min
↻ The nominal grid voltage matches the "VAC nom" specification on the name plate.

1. For improved accessibility: Unfasten the AC input plate using the 6 screws [🔧 T_30]
2. Unfasten the cable fitting for AC connection and PE earth (ground [🔧W_46].
3. Remove sealing plug.
4. Insert the AC cables into the cable fittings..
5. Strip the insulation from the AC cables.
6. Strip the insulation from individual wires for L1 / L2 / L3 (ABC) and PE (ground) so that the stranded wire and insulation can be pressed into the cable lug shaft.
. **CAUTION! Risk of fire due to chemical corrosion. Cable lugs must be suitable for the conductor material and copper busbars being used.** [6]
7. Press on cable lug.
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.
. Fasten the input plate using the 6 screws [🔧T_30 / 53.10 In-lbs
NOTE: When using metal screw connections, toothed discs must be placed underneath to create an enclosure earthing.

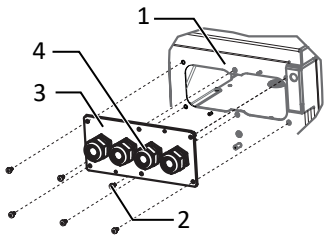


Fig. 25: Removing the AC input plate

1 Housing base - AC-side
2 Screws for mounting
3 Input plate
4 Cable fitting

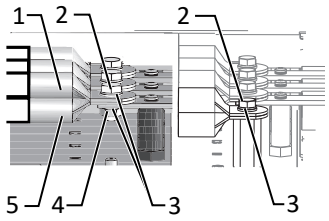


Fig. 26: Preparing the AC connection

1 Ring cable lug (top)
2 Bolt
3 Lock washer
4 Nut
5 Ring cable lug (bottom)

7.5.2 Making the grid connection

↻ **4-pole connection, TN, TT system** is prepared.

1. Slacken the nut and lock washer at the marked earthing point.
2. Lay the grounding cable onto the grounding point. Secure it with the nut and lock washer provided [🔧W_17 / 88.50 In-lbs]. [7]
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 / 265.52 In-lbs].
4. Check that all connected cables are fitted securely.
5. Tighten AC cable fittings [🔧W_46 / 88.50 In-lbs].

⇨ The device is now connected to the power grid.

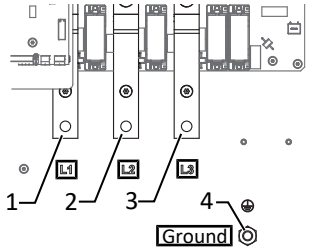


Fig. 27: 4-Pole AC grid connection

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

[6] 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.

[7] If the connection is made in a TN-C grid, connect the PEN grounding cable to the ground earthing point.

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NOTE

Selection of the residual current device (RCD)

If an external residual current device (RCD) is required by the installation regulations, a Type A residual current device (RCD) must be used.

When using a Type A RCD, the insulation threshold in the "DC Parameters" menu must be set to greater than or equal to (≥) 200 kΩ [See section 9.4.2 Page 57].

If you have any questions regarding the appropriate RCD type, please contact your installer or KACO new energy Customer Service.

7.6 Connecting the PV generator to the device

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

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.

1. Disconnect the connection line at the switch box or string combiner via the DC isolator switch.
2. The DC connection is intended exclusively for PV generators. Other sources fall within the scope of improper operation (e.g. batteries).
3. Only touch the PV generator cables on the insulation. Do not touch the exposed ends of the cables.
4. Avoid short circuits.
5. Do not connect any strings with a ground fault to the device.
6. The device must not be operated with negatively or positively earthed PV modules.

Ensuring that there is no ground fault

1. Measure the DC voltage between the earth potential (PE) and the positive cable of the DC source.
2. Measure the DC voltage between the protective earth (PE) and the negative cable of the DC source.
   ⇨ 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 DC source.
5. Measure the electrical resistance between the protective earth (PE) and the negative cable of the DC source.
   ⇨ In addition, ensure that the DC source 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.

1. Observe limit values in accordance with the technical data.

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NOTE

Dimensioning the PV generator

The device is designed with a reserve of DC short-circuit current resistance. This allows for oversizing of the connected PV generator. The absolute limit for the PV generator is the value of the max. short-circuit current ($ISC_{max.}$) and the max. no-load voltage ($U_{DCmax.}$). See footnote under [See section 4.1 Page 17]

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.

1. Disconnect the connection line at the switch box or string combiner via the DC isolator switch.
2. The DC connection is intended exclusively for PV generators. Other sources fall within the scope of improper operation (e.g. batteries).
3. Only touch the PV generator cables on the insulation. Do not touch the exposed ends of the cables.
4. Avoid short circuits.
5. Do not connect any strings with a ground fault to the device.
6. The device must not be operated with negatively or positively earthed PV modules.

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

NOTE

Use of suitable cable lug sizes

Devices with DC switch have a limited connection space [See section 7.3 Page 28]. The maximum cable lug length of 3,78 In extends into the cable gland, which means that the function and use must be ensured [See figure 32 [Page 35].

1. For the UL market, a larger connection space is required by the standards. For this purpose, the DC input plate must be replaced by an external bending box (see Accessories chapter in the Technical data).

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Remove the pedestal and DC input plate on the inverter

↻ The inverter is securely installed.

1. Unfasten the left-hand pedestal from the housing base of the inverter and place in inverter packaging. [T_30].
2. Unfasten the input plate from the housing base of the inverter and make available for component. [T_30].
3. Set the screws for fastening the components to one side.

⇨ The inverter is ready for component assembly.

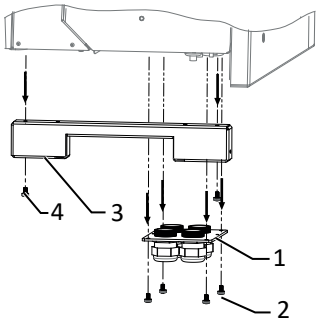


Fig. 28: Removing the pedestal and DC input plate

1 Input plate
2 Fastening screws
3 Pedestal
4 Fastening screws

Installing the bending box

↻ Left-hand pedestal and input plate removed..

1. Unfasten the housing cover of the inverter using the 6 screws and remove carefully [T_25]
2. Lift the component by the DC input opening of the inverter and mount it provisionally from below using the 4 screws that have been set to one side.
3. Tighten the fastening screws in a diagonally opposite sequence. [T_30 / 44.25 In-lbs]

⇨ The component is securely installed. Proceed with the DC connection.

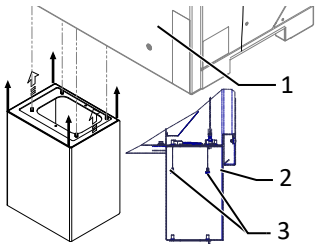


Fig. 29: Mounting the component on the inverter

1 Housing cover on inverter
2 Component
3 Fastening screws

Fitting the pedestal and DC input plate

↻ DC connection to inverter established.

1. Take the pedestal out of the component packaging.
2. Lift the pedestal into position behind the component and secure using the screws provided. [T_30 / 44.25 In-lbs]
3. Lift the input plate onto the mounting surface of the component and fasten it onto the housing using the recessed screws provided. [T_30 / 44.25 In-lbs]
4. Tighten the cable fittings used. [W_46 / 88.50 In-lbs]

⇨ The component has now been installed.

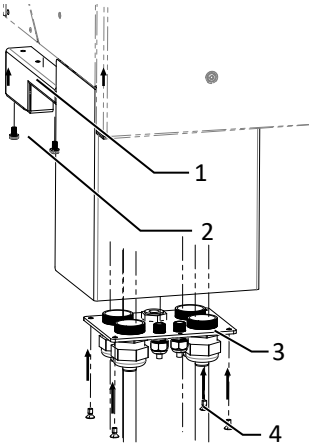


Fig. 30: Fitting the pedestal and DC input plate

1 Short pedestal
2 Fastening screws [M6]
3 Input plate
4 Fastening screws [M6]

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↻ DC source checked for ground faults.
↻ DC cable with 2 x 1 or 2 x 2 conductors is available at the device.
↻ DC polarity verified before connecting to the device.

1. Disconnect the connection cable from the switchbox or string combiner using the DC disconnect switch.
2. For improved accessibility: Loosen the DC input plate by removing the four screws [T_30].
3. Loosen the cable gland for the DC connection [W_46].
4. Remove the sealing plug from the cable gland being used.
5. Strip the outer jacket from the DC cables and route them through the cable gland.
6. Strip the DC conductors for M10 ring terminals so that both the conductor strands and insulation can be securely crimped inside the terminal barrel.

. **CAUTION! Fire hazard due to chemical corrosion. The ring terminals must be suitable for the conductor material used and for copper busbars.** [8].

. **WARNING! Risk of short circuit due to incorrectly sized ring terminals! Observe the specified dimensions when selecting the ring terminals.** [See figure 32 [Page 35]

7. Crimp the ring terminals onto the DC conductors. When crimping, ensure that the ring terminal is oriented according to its final installation position.

. **CAUTION! Due to the limited clearance distance, use heat-shrink tubing* (dielectric strength ≥ 6 kV/mm). This prevents transient overvoltage.**

8. Guide the shrink tubing over the uninsulated crimping point and a maximum of 0.79 $^{+0/-0.08}$ inch over the cable insulation and shrink-fit using manual shrink-fitting equipment.

. Fasten the input plate with the 4 screws [T_30 / 53.10 In-lbs]
NOTE: If metal screw connections are used, toothed washers must be placed underneath to create the housing ground connection.

⇨ DC cable configured. Proceed with the connection to the DC filter or DC switch.

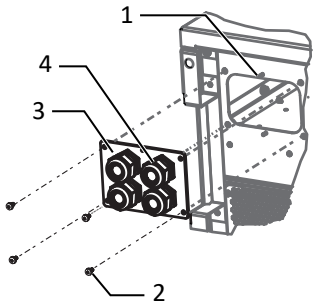


Fig. 31: Removing the DC input plate

1 Housing base – DC side
2 Screws for mounting
3 Input plate
4 Cable fitting

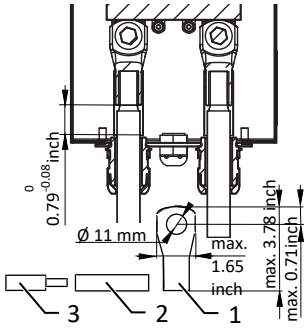


Fig. 32: Configuring the DC cable

1 Cable lug
2 Shrink tubing*
3 DC cable

Connecting the DC cable to the DC filter

↻ DC cables fitted with M10 ring terminals [max. width b 1,65 In].

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 / 265.52 In-lbs].
2. Check that the connected cables are fitted securely.
3. Tighten cable fittings [W_46 / 88.50 In-lbs].

⇨ The device is connected to the PV generator.

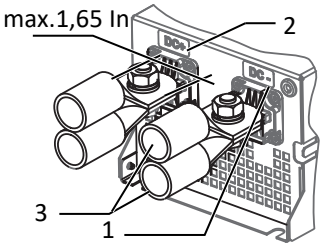


Fig. 33: DC connection with 2 DC+/- inputs

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

[8] 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.

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Connecting the DC cable to the DC switch

1. For installation of the DC cables, use a torque wrench as well as the included open-ended wrench for counter-resistance.
2. Pre-fit DC cable pair with the pre-installed screw and counternut onto the DC+ and DC busbar of the DC switch.
3. **Option for 2 cable pairs**: Insert spacer sleeve between 2 DC cables and pre-assemble in pairs with the provided screw and counternut onto the DC+ and DC busbar of the DC switch.
4. Slide the DC input plate up onto the housing base and secure. [T_30 / 53.10 In-lbs]
5. Secure the screws and counternuts onto the DC+ and DC busbar of the DC switch. [W_16/17] / 265.52 In-lbs]
6. Tighten the cable screw fitting. [W_46 / 88.50 In-lbs]

⇨ The device is connected to the DC source.

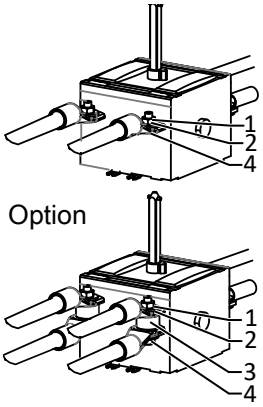


Fig. 34: Fit DC cables to switch

1 Nut
2 Lock washer
3 Spacer sleeve
4 Fixing screw

Connect PID regeneration

↻ PID cable is ready for use.

1. Unfasten the PID cable fittings on the component. [W_20]
2. Pass PID cable via cable fittings on the component into the connection area of the inverter.
3. Position PID cable correctly to the connection point on the DC filter and secure with cable tie and connect [See PID kit installation instructions]
4. Align PID cable at zero potential and secure cables with cable fittings. [W_20 / 13,27 In-lbs]

⇨ Connection prepared for PID box.

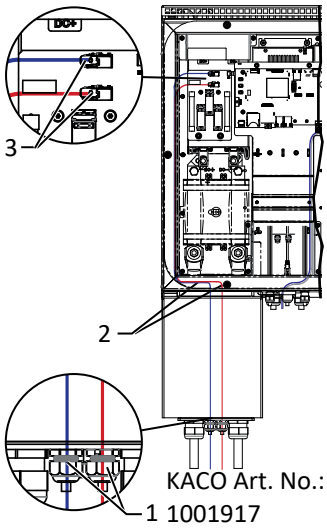


Fig. 35: Guide PID cable through bending box

1 Cable fitting
2 PID cable
3 Spring-type connection terminal

EN-US

7.7 Inserting the overvoltage protection

AC Surge Protection

↻ Ensure that the AC/DC supply is de-energized and the device is open [See section 7.2 Page 28].

↻ Upon initial delivery, remove the intermediate mounting frame from the AC surge protection module.

☞ Place the intermediate mounting frame onto the AC surge protection base and snap it into place.

NOTE: Different AC surge protection modules are used. The designation on the PCB must match the module designation (GTD/MOV).

1. Insert the AC surge protection modules individually into the AC surge protection base. See the installation instructions in the [See section 4.4 Page 21] package.
2. Ensure that all protective devices are securely seated.
. Remove the SPD monitoring jumper to enable automatic monitoring. **IMPORTANT! This monitoring function is activated only after both steps have been completed: remove the jumper and enable "AC/DC SPD Monitoring" [**See table : Configuration via web user interface [Page 78]**]. If either of these two steps is omitted, the monitoring function remains inactive** without **generating an error message.**

⇨ Continue with the installation of the device.

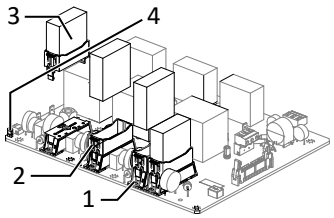


Fig. 36: Retrofitting the AC overvoltage protection

1 AC overvoltage base
2 AC intermediate mounting frame
3 AC overvoltage protection module (4 slots)
4 SPD monitoring jumper

DC Surge Protection

↻ **NOTE: Ensure that the AC/DC supply is de-energized.**

. **NOTE: The keying of the base socket must match the keying of the module.**

1. Insert the DC surge protection modules individually into the DC base socket. See the installation instructions in the [See section 4.4 Page 21] package.
2. Lock the new modules using the locking tab.
. Remove the SPD Monitoring jumper to enable automatic monitoring. **IMPORTANT! This monitoring function is activated only after both steps have been completed: remove the jumper and enable "AC/DC SPD Monitoring"** See table : Configuration via web user interface [Page 78]**. If either of these two steps is omitted, the monitoring function remains inactive** without **generating an error message.**
3. Ensure that all protective elements are securely seated.

⇨ Continue with the installation of the device..

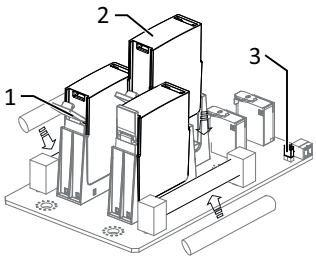


Fig. 37: Inserting overvoltage modules

1 DC base
2 DC overvoltage protection module (3 slots)
3 Jumper

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Installing RS485 Surge Protection

↻ Ensure that the AC/DC supply is disconnected.
↻ Open the device [See section 7.2 Page 28].

. **NOTE: Clip the RS485 surge protection base element onto the designated position on the DIN rail from bottom to top, as shown in the drawing.**

1. The following color coding must be observed for the internal/external RS485 cable:
   Data A => White (WH); Data B => Blue (BU); GND => Violet (VT)
2. Connect the internal RS485 cable to the surge protection base. [See the installation instructions in the [See section 4.4 Page 21] package]

. **NOTE: If both the RS485 input and output are connected externally, the output terminals of the surge protection base must be connected twice.**

3. Route the RS485 cable through the interface cable gland into the connection area.
4. Strip the RS485 cable sheath [approx. 20 mm] and strip the individual conductors [8 mm].
5. Connect the outgoing cable with the RS485 connector (supplied with the surge protection kit) to the RS485 base element and plug the RS485 connector into the RS485 socket on the communication board.
6. Secure the outgoing cable using the cable guide.
7. Insert the RS485 surge protection module into the base.
8. Ensure that the protective element is securely seated.

⇨ Continue with the installation of the protective components.

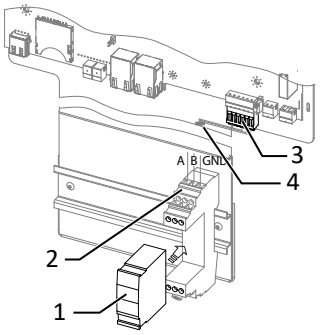


Fig. 38: Inserting the RS485 overvoltage protection

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

Ethernet Surge Protective Device (SPD) Installation

↻ Verify that the AC and DC circuits are de-energized.
↻ Device open [See section 7.2 Page 28].

1. Snap the Ethernet Surge Protective Device (SPD) onto the DIN rail from top to bottom.
2. Connect the supplied Ethernet cable to an Ethernet port on the communication board. See the installation instructions in the [See section 4.4 Page 21] package.
3. Route the Ethernet cable through the designated cable gland and plug it into the Ethernet Surge Protective Device (SPD).

⇨ Continue with the installation of the device..

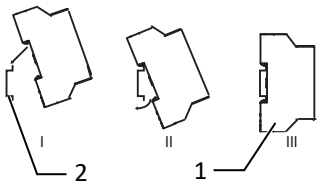


Fig. 39: Inserting the Ethernet overvoltage protection

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

7.8 Establishing equipotential bonding

NOTE

Use of the housing grounding

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. Strip the cable for equipotential bonding.
2. Furnish the stripped cable with an M8 ring cable lug.
3. Lay the cable for equipotential bonding onto the grounding point and attach with an additional M10 screw and lock washer [W_15/ 132.76 In-lbs].
4. Check that the connected cable is fitted securely.

⇨ The housing is included in the equipotential bonding.

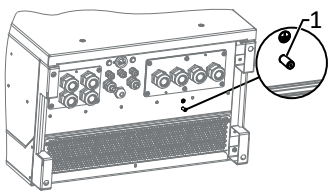


Fig. 40: Additional earthing point

1 Earthing bolt

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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.

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

⚠ CAUTION

Damage to the device from electrostatic discharge

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

1. Observe the ESD protective measures.
2. 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.

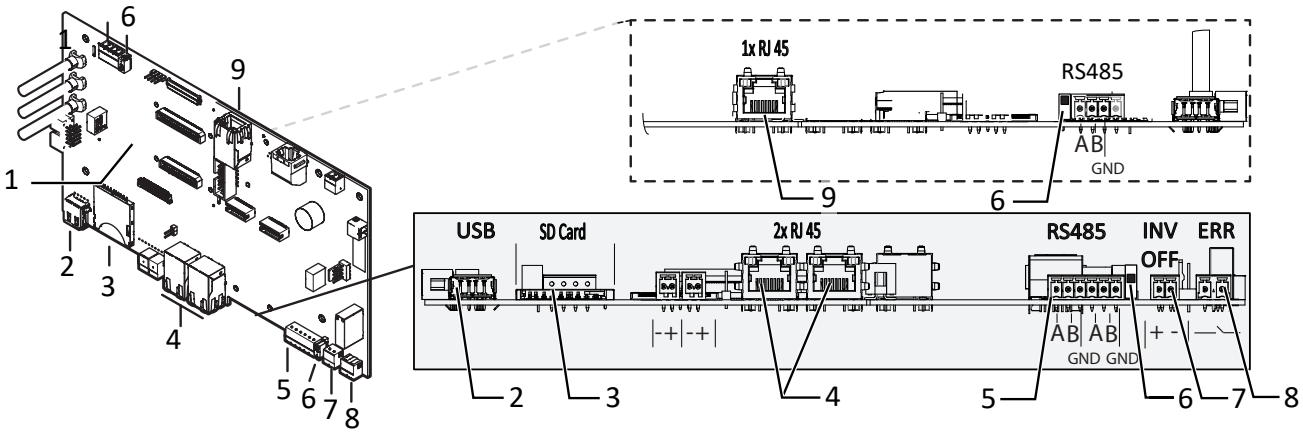


Fig. 41: Communication circuit board (HMI board)

1	Communication circuit board	6	DIP switch - activate terminator (2x)
2	USB socket	7	INV OFF - connection for external grid protection component - 24V(+/- 20%) / 1A (at least 15mA)
3	SD slot	8	ERR – fault signal relay
4	Ethernet for network connection DHCP	9	Ethernet – only for starting up by means of static IP ([See section 8.4.2 Page 46])
5	RS485 - default		

⚠ WARNING

UL50E NEMA Type 4x not guaranteed!

Ingress of condensation, dust or vermin can lead to short-circuiting/overheating or even failure of the device.

1. Tighten **all** cable/sealing plug/housing screw connections to the **specified torques**.
2. If cable glands are not used, the sealing plugs must be retained with the specified torques.
3. The applicable torque values are given in the respective installation steps or in the table [See section 7.4.1 Page 29]

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7.9.2 Inserting and laying the cables

1. Observe the instructions on the recommended cable for the interface used.
2. Unfasten the cover on the cable fitting [🔧W_20].
3. Feed the signal cable into the connection area.

⇨ Signal cable inserted.

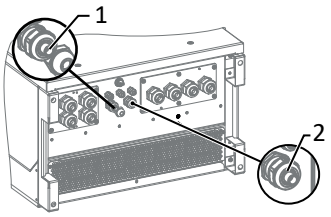


Fig. 42: Inserting signal cables

1 Cable fitting for routing the Ethernet cable
2 Cable fitting for routing the signal cable

Inserting the Ethernet cable

1. Unfasten and remove the cover on 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. Feed the connection cables into the connection area.

⇨ Ethernet cable inserted.

7.9.3 Connecting via Ethernet

NOTE

Feed-in of the communication line

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

Note the type of network cable

Use a shielded (F/UTP or S/FTP) network cable of at least Category 6. In installations where cables run in close proximity to power conductors or in electromagnetically demanding environments, Category 6A is recommended. The maximum cable length between two devices is 100 m (328 ft). The Ethernet port supports autosensing — both crossover and straight-through cables with RJ45 connectors can be used.

↻ Connecting cable inside the device.

1. Plug in an Ethernet cable at one of the two Ethernet ports on the communication circuit board.
2. Check that the connecting cable is fitted securely.

⇨ Connect additional signal 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.

7.9.4 Connecting the RS485 bus

NOTE

Observe line polarity

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.

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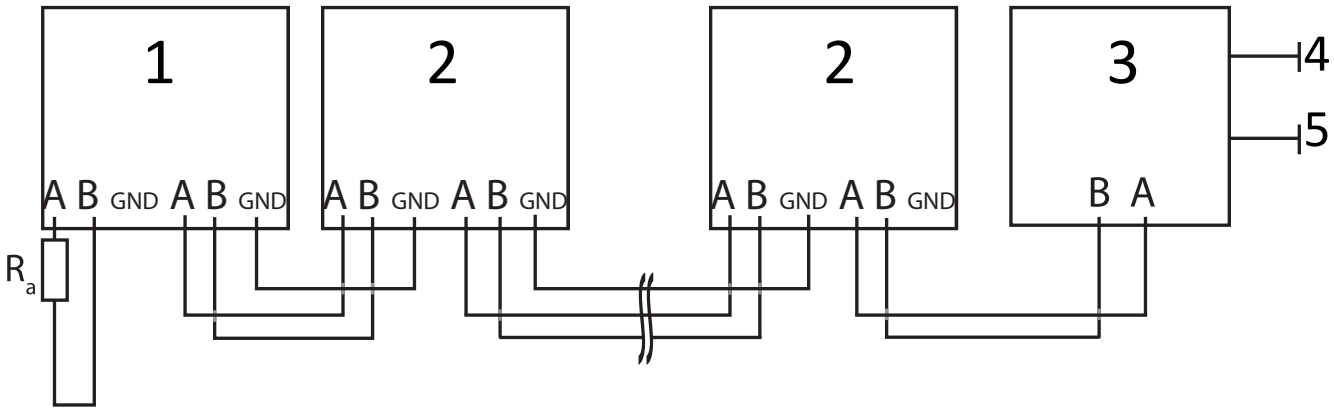


Fig. 43: RS485 interface wiring diagram

1 Inverter, terminal unit	4 Communication
2 Inverter	5 Power supply
3 Data monitoring unit	

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, (2x2) max. 20 AWG Gray twisted pair for dry and damp indoor spaces, (2x2) max. 20 AWG

↻ To avoid interference during data transmission:
- Observe the connection of DATA+ and DATA- wire pairing.
- Do not lay the RS485 bus cable close to the live DC/AC cables.

1. Loosen the cable fitting [W_20]
2. Thread the connection cables through the cable fitting.
3. To place the shield, strip the RS485 data cable at the position of the shield clamp up to the wire mesh (approx. 20mm).
4. Connect the connection cable to the corresponding connection terminals.
5. Connect to all inverters and the data monitor device in this way:
   - Wire A (-) to wire A (-) and wire B (+) to wire B (+)
   - GND to GND.
6. Tighten cable fittings [W_20 / 13,27 In-lbs].

. **WARNING! Ensure IP66 protection! See warning message in** [See section 7.5 Page 30]

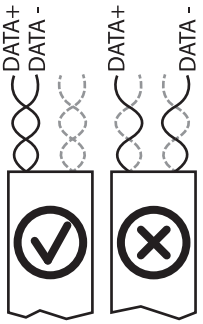


Fig. 44: Assignment of twisted-pair wires

NOTE

Configuration of the RS485 bus devices

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.

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⇨ RS485 connection made. Lay signal cable correctly.

7.9.5 Connecting the fault signal relay

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_20]
2. Thread the connection cables through the cable fitting.
3. Attach the connection cables to the terminals. [See section 7.9.1 Page 39]
4. Tighten cable fitting [W_20 / 13,27 In-lbs].

. **WARNING! Ensure IP66 protection! See warning message in** [See section 7.5 Page 30]

7.10 Sealing the connection area

↻ The grid connection has been prepared.

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

⇨ The device has been mounted and installed.

⇨ Put the device into operation.

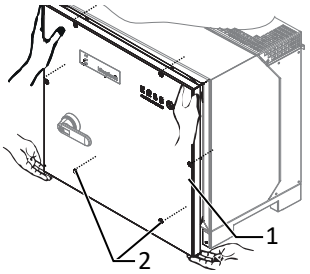


Fig. 45: Closing the housing cover

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8 Start-up

8.1 Requirements



⚠ 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.

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

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



NOTE

Wi-Fi-enabled device required

A mobile terminal device with Wi-Fi interface is required in order to put the device into operation

The following functions are only available via the WEB interface:

1. Initial start-up
2. Parameterization
3. Reset to factory defaults.



NOTE

Use of a suitable web browser

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.



⚠ 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.

1. Disconnect the connection line at the switch box or string combiner via the DC isolator switch.
2. The DC connection is intended exclusively for PV generators. Other sources fall within the scope of improper operation (e.g. batteries).
3. Only touch the PV generator cables on the insulation. Do not touch the exposed ends of the cables.
4. Avoid short circuits.
5. Do not connect any strings with a ground fault to the device.
6. The device must not be operated with negatively or positively earthed PV modules.

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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.

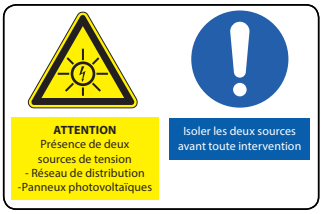


Fig. 46: Adhesive label UTE_C15-712-1

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.

1. Attach the supplied sticker next to the name plate on the device housing where it is clearly visible.
2. Please refer to the Powador-protect application note in the download area on our website. Here you will find the associated "Demand response modes" listed in the "Referencing for power control" chapter.

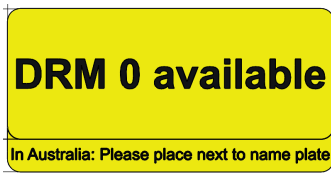


Fig. 47: Sticker DRM 0 for Australia

8.3 Network topologies

Plant segmentation

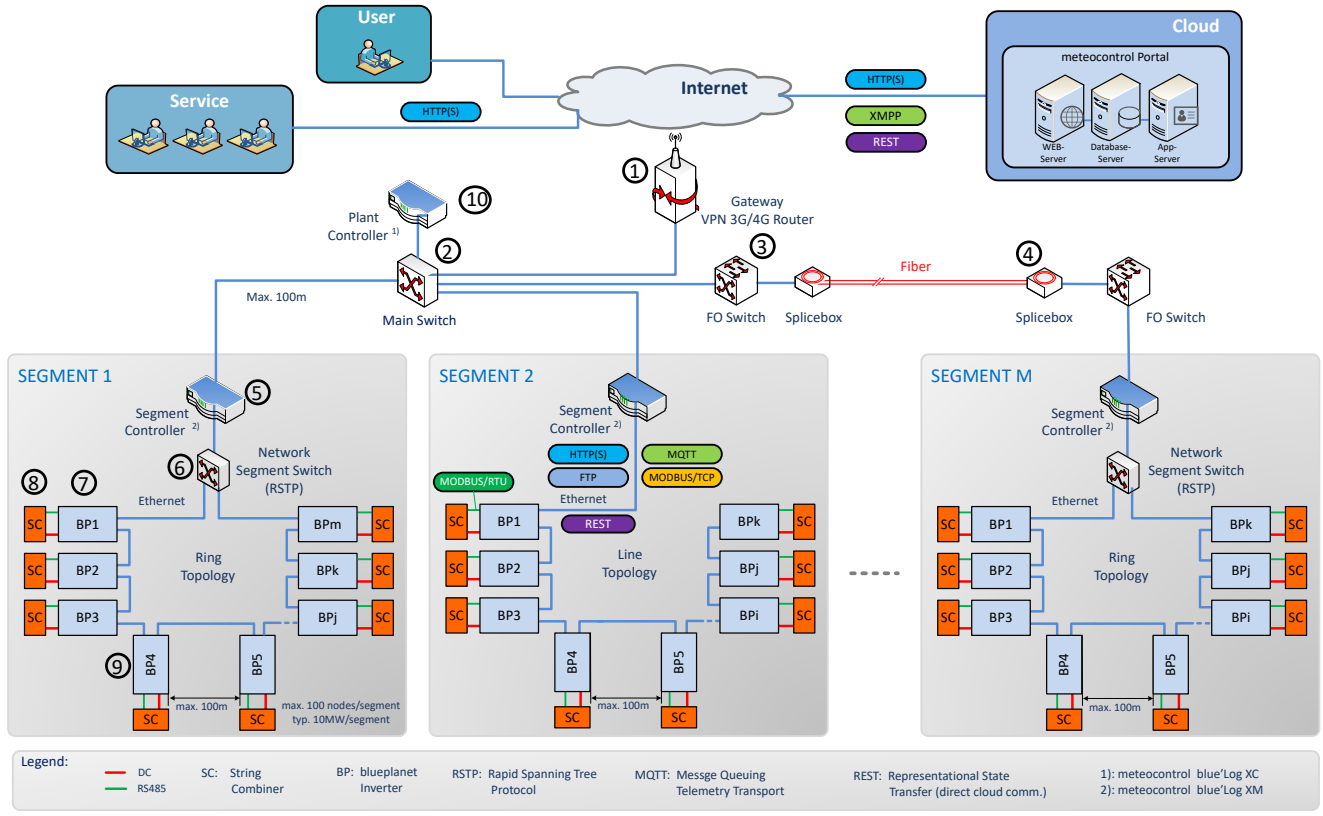


Fig. 48: Segmentation of a plant

1	Gateway VPN 3G/4G router	6	Network segment switch
2	Main network switch	7	Inverter
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	10	Plant Controller

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NOTE

Protection for your system against cyber attacks

The Internet and communication systems **not** under the responsibility of KACO new energy must **include comprehensive protection measures** – such as (but not limited to) **VPNs** – and follow the latest cybersecurity best practices to ensure the security of the systems.

While a gateway to the Internet, a data logger and one instance for the higher-ranking power control are generally sufficient in smaller systems, larger systems must be divided into separate network segments because there are certain limits with regard to the number of manageable nodes for monitoring/control.

This figure shows one possible configuration for multiple segments. Depending on the local site conditions, a different placement of the components may be more suitable (e.g., positioning the Segment Controller centrally and connecting the segment via a fiber optic link).

Immediately downstream of the VPN gateway router is the Main network switch, to which the Segment Controllers are connected. Depending on the size of the installation (distance from the Main network switch to the Segment Controller >100 m), it may also be necessary to connect remote segments via a fiber optic connection.

Within a segment, KACO devices can be connected in an Ethernet daisy chain using the integrated switch, with the Segment Controller connected to the first device in the chain. This topology is illustrated in Segment 2. A Segment Controller can manage up to 100 nodes. A node is any data source monitored by the Segment Controller.

(Example: 45 pairs consisting of inverter and string combiner (90 nodes) + 10 reserve nodes for other substation/segment data sources)

If additional redundancy is required, the KACO devices can also be connected in a ring topology using an appropriately configured Network Segment Switch (supporting the Rapid Spanning Tree Protocol "RSTP"). The Segment Controller is then also connected to this switch. This configuration is shown as an example in Segments 1 and M.

As can be seen in the figure, a string combiner is assigned to each KACO device. In terms of communication, these are connected to the device directly via an RS485 cable (green cable – note connection port in [See section 7.9.1 Page 39]). To this end, MODBUS RTU is used as a communication protocol.

The monitoring of the string combiner is also carried out via the Segment Controller, whereby the KACO device undertakes the role of a MODBUS gateway. The string combiner must be coupled using a DC-Combiner. There is no restriction as the compatibility depends on the segment controller and string combiner selected. (e.g. blue´Log is compatible with Weidemüller DC-Combiner)

When a blue´Log device is used, the only 3rd party string combiner device currently available, which can also be addressed in this manner via the Segment Controller, comes from "Kernel Sistemi".

Depending on the network load, the device can support up to 10 Modbus clients.

8.4 Start-up options

Option 1: Locally managed start-up via Wi-Fi	Installation technician connects to a KACO inverter via Wi-Fi. Installation wizard carries out start-up steps interactively.
Option 2: Locally managed LAN connection	Installation technician connects to a KACO inverter via LAN. Installation wizard carries out start-up steps interactively.
Option 3: 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 4: 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 5: Centralised start-up via Segment Controller	A device configuration that is available on the Segment Controller can be uploaded to several KACO inverters.

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	The devices are ready for operation once the configuration is activated.

Start-up variants for individual devices or system segments

8.4.1 Start-up via Wi-Fi

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

The following figure provides an example of the structure of a KACO device with string combiner (SC) and external network connection

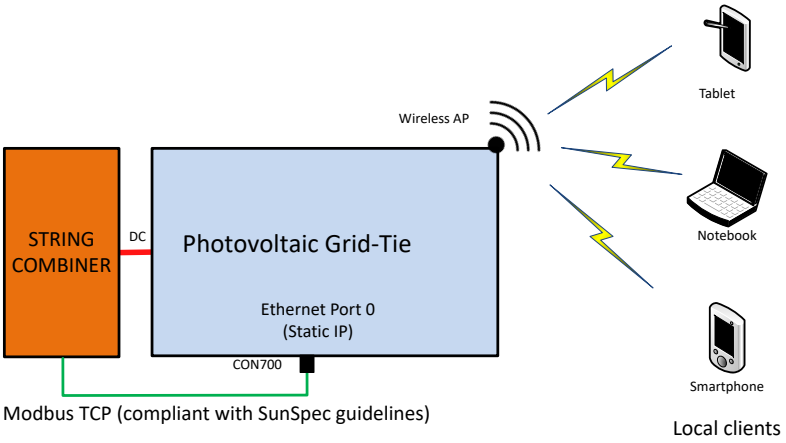


Fig. 49: Start-up via a direct Wi-Fi connection

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

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

Connecting to the KACO Device via Wi-Fi

☞ Insert the USB Wi-Fi dongle into the device and connect your notebook or mobile device to the access point generated by the device. The Wi-Fi SSID corresponds to the device serial number printed on the nameplate.

☞ Name of access point: <Device designation serial number> (e.g. "bp87-<serial number>" or "bp150-<serial number>")

1. Password: kacowifi
2. Launch a web browser on the end device and enter either the server name a) or the server address b):

☞ http://192.168.1.1

☞ Confirm the entry.

⇨ The device configuration page is displayed.

1. At the Login/register icon, log in as:
2. User name: user/Installer
3. Password: (assigned in step 1 [See section 9.1 Page 50])
4. Confirm authorization via `Anmelden`.

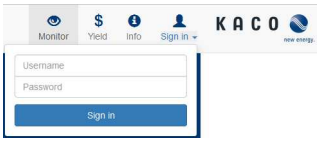


Fig. 50: Login screen

8.4.2 Start-up via LAN connection

The following figure provides an example of the structure of a KACO device with string combiner (SC) and external network connection

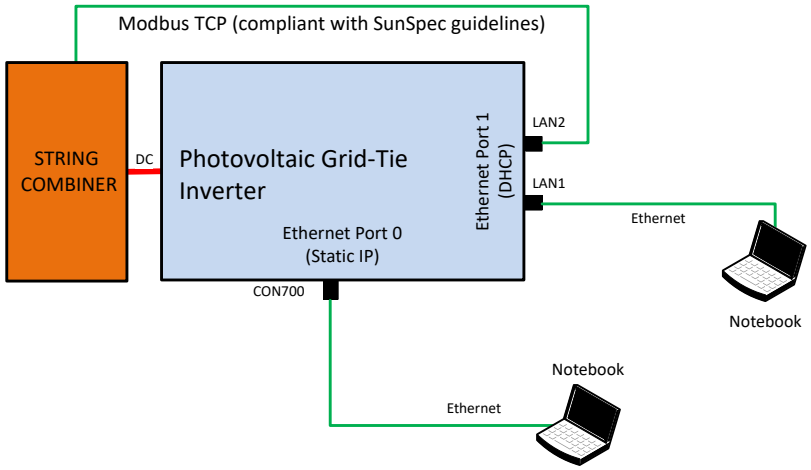


Fig. 51: Start-up via Ethernet

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 Wi-Fi.
2. The device has 3 Ethernet ports on the communication board that can be used:

– 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.

– 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.

. **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. Launch the browser on the terminal device and enter the IP address of the device:
2. http://<IP address of device> (if ports LAN1 or LAN2 have been used)
3. 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 ([See section 9.2 Page 52]).

2. If the configuration is valid, the parameters are transferred.

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

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8.4.4 Starting up a network

The following figure provides an example of the structure of a KACO device with string combiner (SC) and external network connection

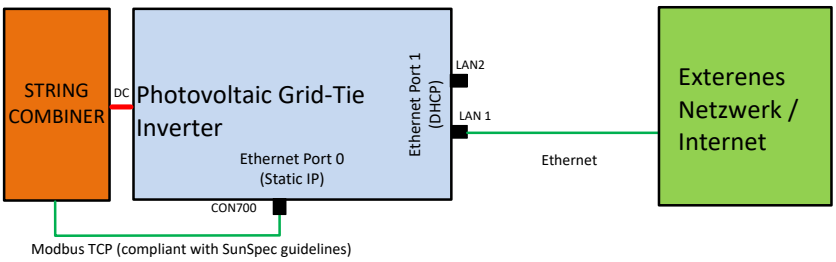


Fig. 52: Start-up via a network without Segment Controller

Application

If the device is to be integrated into an existing network, then the configuration shown in the 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)

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.

Establishing a connection to the KACO device

1. 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!**

2. Use a functioning Ethernet slot on the external network end.
3. It may be necessary to take additional IT configuration measures in the external network so that the device is assigned an IP address.
4. 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.

5. 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 name-serial number>, such as:

↻ http://bp125-125TL01234567 *bzw*. http://bp87-87-0TL01234567 [9]

☞ If this is unsuccessful, please use the fully qualified domain name instead:
http://bp125-125TL01234567<DomainnameExternesNetzwerk> or http://bp87-87-0TL01234567<DomainnameExternesNetzwerk>

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.

[9] If the device serial number features a "." dot, then this "." dot is replaced with a "-" dash in the host name as, according to RFC229, host names must not contain any "." dots.

For local host names, only characters in the range [a-z], [A-Z] and the minus character are permitted.

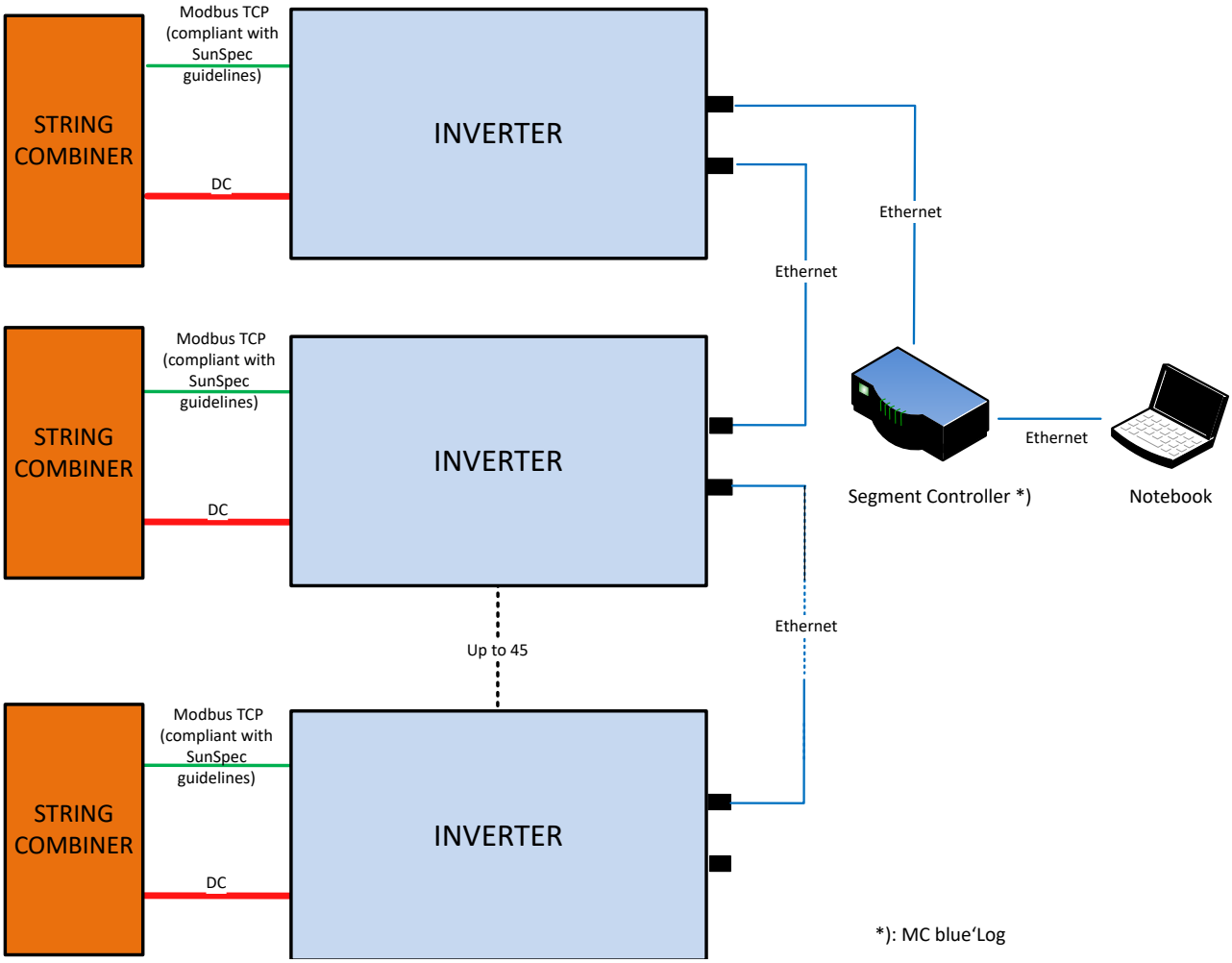


Fig. 53: Start-up via Segment Controller

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 cannot be connected to one another via the network during start-up. [10]

Once start-up is complete (assignment of the devices to individual segment controllers) they can be connected in the network by means of a `Main network 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.

[10] Note: Otherwise all inverters would be visible for the respective Segment Controller.

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9 Configuration and operation

9.1 Initial start-up

During initial commissioning, the installation wizard is launched directly (provided that the device is still in its factory state and commissioning has not yet been performed).

The installation wizard can also be launched again at a later time to make changes to the original configuration.

NOTE

Ensure DC power supply during initial start-up

The DC power supply must be guaranteed during initial start-up. [11]

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

During initial start-up, the installation wizard is called up directly (if the device is still in the delivery state and start-up has not yet been carried out).

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

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

Step: Authorization

↻ The installation wizard has been started or restarted.

1. Enter the `Password*` for the plant user and confirm that it is correct.
2. Enter the `Password*` for the plant installer and confirm that it is correct.
3. Confirm the action field.

⇨ The `Next` button advances to the next installation step.

*) The password must be at least 12 characters long and contain characters from at least three of the following four categories: uppercase letters, lowercase letters, numbers, and special characters.
The use of passwords that are changed regularly is recommended.

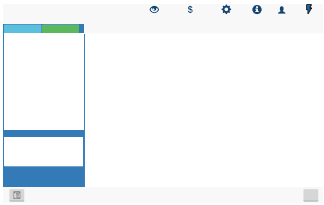


Fig. 54: Menu item: [See section 9.4.2 Page 57]

Step: Language selection

↻ Access to the wizard has been granted.

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.

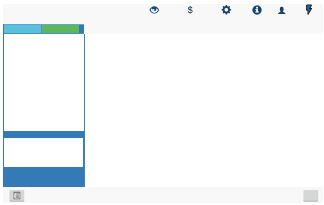


Fig. 55: Menu item: [See section 9.4.2 Page 57]

Step: 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.

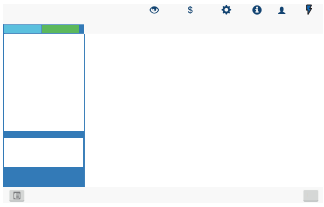


Fig. 56: Menu item: [See section 9.4.2 Page 57]

[11] It is only possible to configure the grid parameters with DC voltage. The further parameters can also be configured with a present AC voltage.

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Step: Power limitation

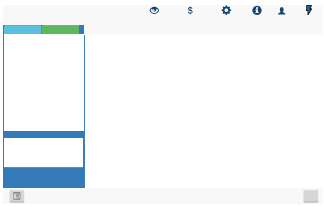


Fig. 57: Menu item: [See section 9.4.2 Page 57]

↻ The country and grid type have been selected.

. **NOTE: The permanent power limitation of the maximum active and apparent power for the generation plants is agreed between the grid operator and plant operator.**

1. If necessary, activate `power limitation`
2. Set the `Maximum apparent power` and `Maximum active power`.
3. If necessary, activate `Password protection`.
4. Confirm the action field.

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

Step: Network parameters

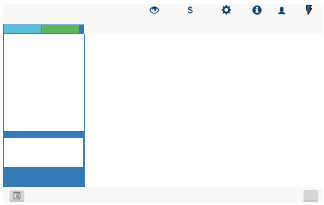


Fig. 58: Menu item: [See section 9.4.2 Page 57]

↻ 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 as this would then be part of the configuration and ultimately all inverters in the same segment would be assigned the same IP address.**

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: Localization

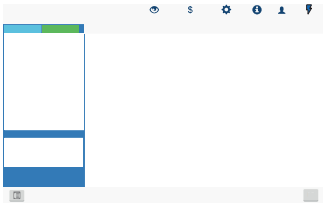


Fig. 59: Menu item: [See section 9.4.2 Page 57]

↻ The network parameters have been set up.

1. Set the `date`, `time and time zone` or arrange for synchronization with the client.
2. **NOTE: An NTP server needs to be activated for synchronization purposes** [12]
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: ModBus

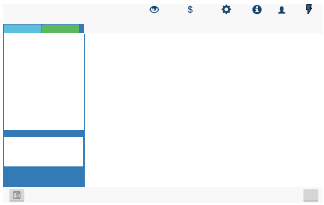


Fig. 60: Menu item: [See section 9.4.2 Page 57]

↻ 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.

Step: String combiner

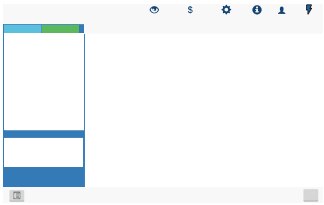


Fig. 61: Menu item: [See section 9.4.2 Page 57]

↻ Modbus has been specified.

1. If available, activate `string combiner monitoring`.

. **NOTE: When a blue´Log device is used, the only 3rd party string combiner device currently available, which can also be addressed in this manner via the Segment Controller, comes from "Kernel Sistemi".**

2. Set other parameters.
3. Confirm the action field.

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

[12] 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.

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Step: Optional parameters

↻ Modbus has been specified.

. **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.

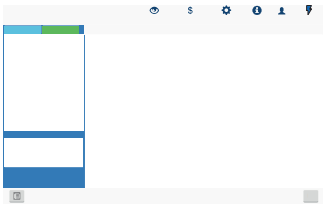


Fig. 62: Menu item: Only on the installation wizard!

Step: Finalizing the installation

↻ Optional parameters have been set.

1. Generate installation report (includes a list of all relevant parameters for acceptance purposes)
2. Specify a name for the device installation report.
3. Confirm the action field.

NOTE: All of the settings can also be transferred to another device in the same series (provided that no individual parameters are required, e.g. static IP address).

1. Optional: Export current device settings to the client.
2. Device configuration completed successfully. Please click "Finalize" to put the device into operation.

⇨ The initial installation is now complete. Set access to device(s) and "connect network" via the user area AC.

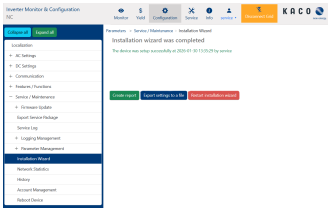


Fig. 63: Menu item: Only on the installation wizard!

9.2 Signal elements

The 3 LEDs on the device show the different operating states. The LEDs can display the following states:

 LED illuminated

 LED flashing

 LED not illuminated

Operating status	LED status	Description
		
Start		The green "`Operating`" LED is illuminated when AC and DC voltage is present. If the LED is flashing, internal communication between the components is being established. When the LED stops flashing, the device is ready to feed in. If the LED continues to flash for a long time, there is an internal communication error.
Feed-in start		The green "`Operating`" LED is illuminated. The green "`Feed-in`" LED is illuminated after the country-specific waiting period*. The device feeds into the grid. You can hear the circuit-breaker / interface switch switch on. **NOTE: Both LEDs are also illuminated in Q on Demand operation mode.**
Feed-in mode with reduced power		The green "Operating" LED is illuminated. The green LED "Feed" is flashing because one of the modes: internal power reduction, external power reduction, external reactive power request or standalone mode is active.

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Operating status	LED status	Description
		The device feeds into the grid. You can hear the circuit-breaker / interface switch switch on.
Non-grid feed mode		The green "Operating" LED is illuminated.
Fault		None of the LEDs is illuminated or the red "Fault" LED is illuminated. Fault in the AC/DC source Conditional special cases: – There is no DC voltage present (e.g. DC isolator switch open) – DC voltage too low (< starting voltage) DC voltage is present (> starting voltage), but communications connection between the front end (operating unit) and back end (control unit) is faulty, or interrupted.

The 3 LEDs also signal the **firmware update process** when a USB stick is inserted. The LEDs can assume other states for this purpose:

 LED flashing quickly

 LED flashing slowly

 LED flashing alternating

Operating status	LED status	Description
		
Procedure in progress		The green "Operating" LED is illuminated when the device is ready for use. **Note:** When updating via the web server and a USB stick is inserted in parallel, the unit remains inactive until the USB stick is removed or then performs a reset and restarts.
Procedure has commenced (initialization)		The green "Operating" LED and the green "Feed-in" LED are flashing **quickly yet alternately**. **Note:** The procedure will last up to 5 min for firmware updates or up to 30 secs for parameter updates.
Process is initiated (update)		The green "Operating" LED and the green "Feed-in" LED are flashing **quickly**.
Procedure completed successfully.		The green "Operating" LED and the green "Feed-in" LED are flashing **slowly and in tandem**. **Note:** Check the new SW version via the web interface [See section 9.3 Page 54].
Fault		The red "Fault" LED is **flashing slowly**. **Note:** The procedure has not been completed successfully or a time limit has elapsed. **Important:** If the USB stick is removed during the initialization phase, a device fault is triggered. Inserting the USB stick initiates a device restart.
No fault		No fault present.

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9.3 User interface

NOTE

Tolerances of displayed measured values

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/monitor may deviate from the values on the grid operator's feed-in meter by up to 15%.

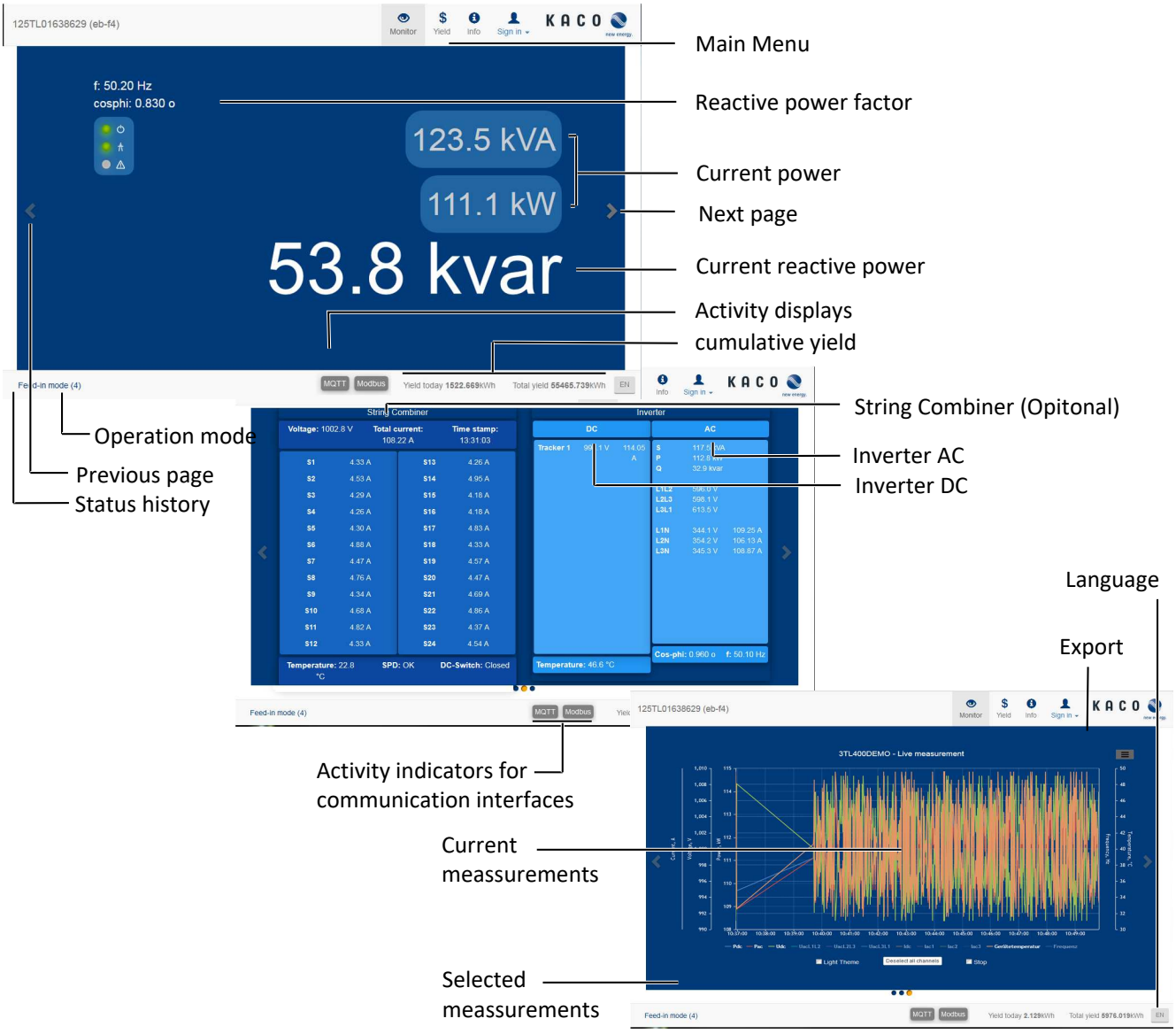


Fig. 64: Monitoring interface

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. 3: Description of the areas

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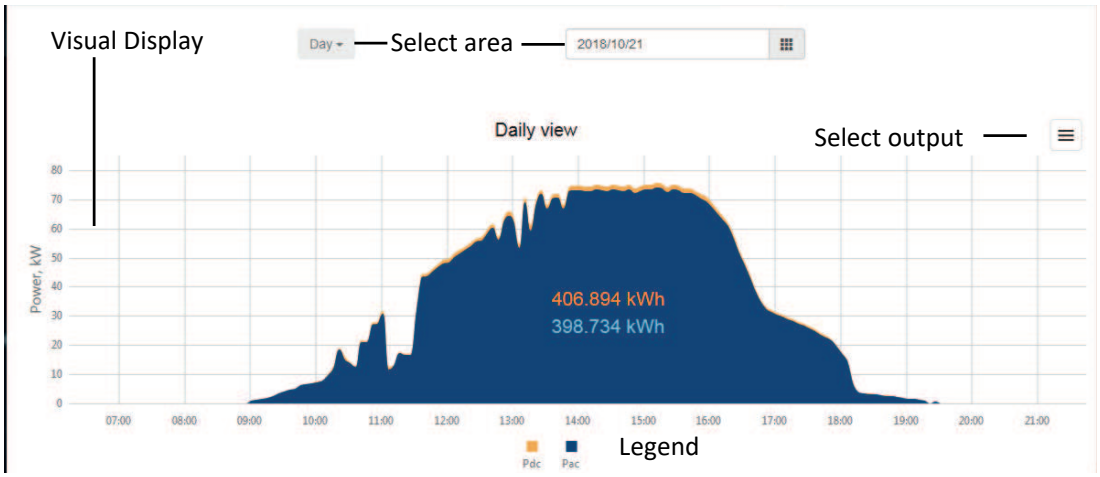


Fig. 65: Interface for evaluating the yields

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

Tab. 4: Description of the areas

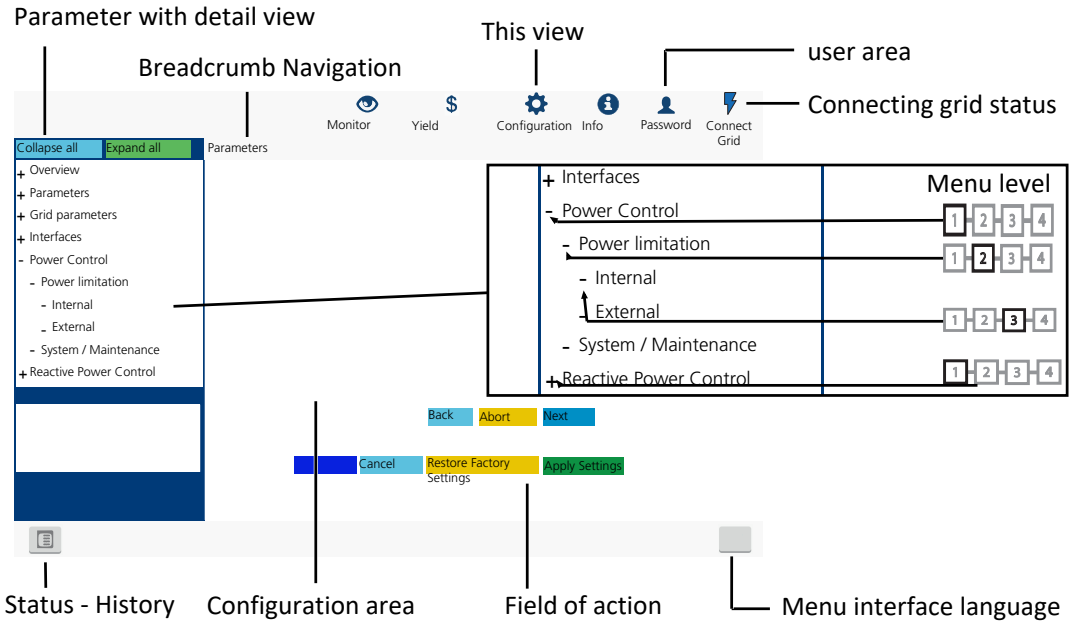


Fig. 66: Parametrization interface

Area	Description
Menu bar Tool bar	Menus and commands for operating the interface.
Area of use	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. 5: Description of the areas

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Fig. 67: 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. 6: Description of the areas

9.4 Menu structure

NOTE

Use of a suitable web browser

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.

Symbols used

1 2 3 4	Menu level (0,1,2,3)		Password-protected menu (password can be requested from KACO customer service)
	[See section 9.3 Page 54]		
	Submenu		
INSTALLER	Setting only in Installer interface	SERVICE	Setting only in Service interface
	Display		Option box
			Setting range
	Option menu		Default value
			Interval

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9.4.1 Yield via web user interface

Country-spec. Settings	Level	Display/ Setting	Action in this menu/meaning
		Daily view	Displays the recorded operating data graphically. ☞ Select a day. ⇨ The web interface shows the selected data.
		Weekly view	**NOTE: Displays the recorded operating data graphically.** ☞ Select a week. ⇨ The web interface shows the selected data.
		Month display	Displays the recorded operating data graphically. ☞ Select a month. ⇨ The web interface shows the selected data.
		Yearly view	Displays the recorded operating data graphically. ☞ Select a year. ⇨ The web interface shows the selected data.
		Total view	Displays the total yield up to now.
		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/ Setting	Action in this menu/meaning
		Overview	Input screens for basic settings
		Localization ☑ Status	1. Select the desired language for the user interface. 2. Select the current date and enter the time or press the button "Sync with client device now". 3. Select a time zone. 4. Specify the temperature unit. 5. Enter the device name. 6. Enter the degree of longitude and latitude of the installation location. 7. Enter the plant ID. 8. Confirm the action field.
		AC Settings	Input screens for grid parameters.
		Country & Grid type	**NOTE: This option influences the country-specific operating settings of the device. Please consult KACO Service for further information.** 1. Select country and grid type. 2. Observe the note for [See section 9.4.2 Page 81]
		Nominal grid voltage & Nominal grid frequency ☑ 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. Confirm the action field.

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Country-spec. Settings	Level	Display/ Setting	Action in this menu/meaning
INSTALLER	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**
	1 2 3 4	Trip with intentional delay Check to enable	1. If necessary, activate delayed trip-off. 2. Confirm the action field.

EN-US

Country-spec. Settings	Level	Display/ Setting	Action in this menu/meaning
		Frequency	**NOTE: Opportunity to monitor frequency shutdown.**
		Trip underfrequency monitoring Status	☞ Activate if necessary. **NOTE: If the grid voltage drops below 20% of Un, the underfrequency monitoring is deactivated.**
		Number of trip underfrequency levels 1- 5 / 1 / 1	☞ Specify the number of support levels.
		Trip underfrequency level 1 45 – 65 [Hz] / 47.5 [Hz] / 0.01 Trip underfrequency time level 1 0– 120000 [ms] / 100 [ms] / 1	**NOTE: If the grid frequency is within the deactivation range for the duration of the deactivation time, then the function is deactivated.** ☞ Define range and trip-off time.
		Trip underfrequency level 2 - 5 42.5 – 65 [Hz] / 47.5 [Hz] / 0.01 Trip underfrequency time level 2 – 5 0– 100000 [ms] / 100 [ms] / 1	
		Trip overfrequency monitoring Status	☞ Activate if necessary.
		Number of trip overfrequency levels 1- 5/ 2 / 1	☞ Specify the number of support levels.
		Trip overfrequency level 1 45.0– 66 [Hz] / 51.5 [Hz] / 0.01 Trip overfrequency time level 1 0 – 120000 [ms] / 100 [ms] / 1	**NOTE: If the grid frequency is within the deactivation range for the duration of the deactivation time, then the function is deactivated.** 1. Define range and trip-off time. 2. Confirm the action field.
		Trip overfrequency level 2 – 5 45,0– 66 [Hz] / 51.5 [Hz] / 0.01 Trip overfrequency time level 2 – 5 0 – 120000 [ms] / 100 [ms] / 1	

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Country-spec. Settings	Level	Display/ Setting	Action in this menu/meaning
	1 2 3 4	Voltage	**NOTE: Option to monitor the voltage shutdown**
	1 2 3 4	Trip undervoltage monitoring Status	☞ Activate if necessary.
	1 2 3 4	Number of trip undervoltage levels 1- 5 / 2 / 1	☞ Specify the number of support levels.
	1 2 3 4	Trip undervoltage level 1 10 – 100 [% U_{nom}] / 80 [% U_{nom}] / 0.1 Trip undervoltage time level 1 0–120000 [ms] / 1000 [ms] / 1	☞ Define range and trip-off time.
	1 2 3 4	Trip undervoltage level 2 – 5 10 – 100 [% U_{nom}] / 45 [% U_{nom}] / 0.1 Trip undervoltage time level 2 – 5 0–120000 [ms] / 300 [ms] / 1	
	1 2 3 4	Trip overvoltage monitoring Status	☞ Activate if necessary.
	1 2 3 4	Number of trip overvoltage levels 1- 5 / 2 / 1	☞ Specify the number of support levels.
	1 2 3 4	Trip overvoltage level 1 100 – 125 [% U_{nom}] / 110.0 [% U_{nom}] / 0.1 Trip overvoltage time level 1 0–120000 [ms] / 100 [ms] / 1	1. Define range and trip-off time. 2. Confirm the action field.
	1 2 3 4	Trip overvoltage level 2 – 5 100 – 125 [% U_{nom}] 114.8 [% U_{nom}] / 0.1 Trip overvoltage time level 2 to 5 0–120000 [ms] / 100 [ms] / 1	

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Country-spec. Settings	Level	Display/ Setting	Action in this menu/meaning
		10 min. average	**NOTE: Monitors deviations in the 10-minute average voltage value.**
			☞ Enable if required.
		10-minute average grid voltage monitoring Status 10 minutes average 100 – 125 [% Unom] / 125.0 0.1 %	☞ Set the voltage threshold as a percentage using the averaged value.
		Generic parameters	**NOTE: Opportunity to activate standard protective shutdown**
		Trip with intentional delay Check to enable	1. If necessary, activate delayed trip-off. 2. Confirm the action field.
		Frequency	**NOTE: Provides the option to monitor frequency trip settings.**
		Trip underfrequency monitoring Status	☞ Enable if required. **NOTE: If the grid voltage drops below 20% of Un, underfrequency monitoring is disabled.**
		Trip underfrequency level 1 45 – 65 [Hz] / 47.5 [Hz] / 0.01 Trip underfrequency time level 1 0–120000 [ms] / 100 [ms] / 1	**NOTE: If the grid frequency remains within the deactivation range for the specified deactivation time, the function is disabled.** ☞ Define the range and trip time.
		Trip overfrequency monitoring Status	☞ Enable if required.
		Trip overfrequency level 1 45.0–66 [Hz] / 51.5 [Hz] / 0.01 Trip overfrequency time level 1 0 – 120000 [ms] / 100 [ms] / 1	**NOTE: If the grid frequency remains within the deactivation range for the specified deactivation time, the function is disabled.** 1. Define the range and trip time. 2. Confirm the action field.
		Island Detection	**NOTE: Grid operators require shutdown of the device with islanding detection. More detailed information at:** [See section 10.5 Page 107]
		Mode Off / ROCOF / ROCOF enhanced / Password protection	**NOTE: This function is active in the factory setting and may only be deactivated in standalone islanding operation (without grid).** 1. Select mode and note menu items. 2. Activate password protection if necessary. 3. Confirm the action field.

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Country-spec. Settings	Level	Display/ Setting		Action in this menu/meaning
	1 2 3 4	ROCOF threshold stage 1 value ⚙ 0.1 – 6.0 [Hz / s] / ◓ 0.1 ROCOF threshold stage 2 value ⚙ 0.1 – 6.0 [Hz / s] / ◓ 0.1		☞ Define threshold for ROCOF.
		ROCOF threshold stage 1 time ⚙ 100 – 5000 [ms] / ◓ 0.1 ROCOF threshold stage 2 time ⚙ 100 – 5000 [ms] / ◓ 0.1		☞ Define time value for ROCOF.
	1 2 3 4	ROCOF enhanced		**NOTE: Active detection after exceeding the first frequency threshold.**
	1 2 3 4	ROCOF threshold stage 1 value ⚙ 0.1 – 6.0 [Hz / s] / ◓ 0.1 ROCOF threshold stage 2 value ⚙ 0.1 – 6.0 [Hz / s] / ◓ 0.1		☞ Define threshold for ROCOF.
		ROCOF threshold stage 1 time ⚙ 100 – 5000 [ms] / ◓ 0.1 ROCOF threshold stage 2 time ⚙ 100 – 5000 [ms] / ◓ 0.1		☞ Define time value for ROCOF.
	1 2 3 4	ROCOF proportionality factor ⚙ -5000 – 5000 [‰ / Hz / s] / ◌ -20 / ◓ 1 ☑=Status		1. Define the proportionality factor. 2. Confirm the action field.
	1 2 3 4	Ramp Rate Limitation		**NOTE: Opportunity to limit power in the case of an increasing and decreasing nominal power/maximum power.**
		Operation mode ☑=On | Off		☞ Select operating mode.
		Increasing gradient & Decreasing gradient ⚙ 1 – 65534 [%/min] / ◌ 65534 / ◓ 1		☞ Set gradient. This percentage relates to the nominal power/maximum power. ☞ Confirm the action field.

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Country-spec. Settings	Level	Display/ Setting	Action in this menu/meaning
	2	Connection Conditions	**NOTE: Precise connection conditions should be specified relative to the grid conditions.**
	2	Min. conn. voltage after grid mon. 10 – 110 [% Unom] / 94.8 / 0.1 & Max. conn. voltage after grid mon. 90 – 125 [% Unom] / 110.0 / 0.1	☞ Specify switch-on voltage range after grid error.
	2	Min. conn. frequency after grid mon. 45 – 65 [Hz] / 47.5 / 0.01 & Max. conn. frequency after grid mon. 45 – 65 [Hz] / 50.05 / 0.01	☞ Specify switch-on frequency range after grid error.
	2	Min. conn. voltage after grid failure 10 – 110 [% Unom] / 94.8 / 0.1 & Max conn. voltage after grid failure 90 – 125 [% Unom] / 110.0 / 0.1	☞ Specify switch-on voltage range after grid error.
	2	Min. conn. frequency after grid failure 45 – 65 [Hz] / 47.50 / 0.01 & Max. conn. frequency after grid failure 45 – 65 [Hz] / 50.05 / 0.01	☞ Specify switch-on frequency range after grid error.
	2	Monitoring time PV voltage 1000 - 1800000 [ms] / 60000 / 1000 **&** Monitoring time grid voltage 1000 - 1800000 [ms] / 60000 / 1000 **&**	☞ Specify the time for monitoring the grid voltage and PV voltage.
	2	Waiting time after grid failure 1000 - 1800000 [ms] / 60000 / 1000 Status	1. Set waiting time after grid failure. 2. Activate optional password protection. 3. Confirm the action field.

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Country-spec. Settings	Level	Display/ Setting	Action in this menu/meaning
INSTALLER	1 2 3 4	Active Power Control	**NOTE: The output power of the device can be set permanently to a lower value than the maximum output power via the active power regulation.**
	1 2 3 4	Internal	**NOTE: Option for internal power limitation as required by the grid operator to limit the maximum power rating of the system at the grid connection point. More detailed information at:** [See section 10.4.1 Page 104]
	1 2 3 4	Power limitation Check to enable	☞ Specify the activation status.
	1 2 3 4	Maximum apparent power Slim 1000 - 125000 / [See section 4 Page 17] [VA] / 0.1 [VA]	**NOTE: The max. apparent power limits the internal power of the device.** ☞ Enter the value or set the value using the slider.
	1 2 3 4	Maximum active power Plim 1.0 – 100.0 [% Slim] / 100[% Slim] / 0.1	**NOTE: The max. active power limits the internal power of the device.** ☞ Enter the value or set the value using the slider.

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Country-spec. Settings	Level	Display/ Setting	Action in this menu/meaning
		External	**NOTE: The parameters set here are used if no valid external power or reactive power setpoints are received via the communication interface or if communication fails for the set fallback time.** **NOTE: A communication failure has occurred if no valid "Enable" signal or no updated external setpoint is received within the set fallback time.**
		Power limitation Check to enable	☞ Specify the activation status. **NOTE: If the function is activated, external specifications for active power are taken into account and set to defined fallback values in the event of a fault.** **NOTE: If the function is deactivated, there is no automatic power fallback in the event of a communication failure**
		AC fallback active power 0 – 100 [%Plim] / 100 [%Plim] / 1	☞ Set fallback power. **NOTE: Defines the active power to which the device reverts in the event of a communication failure.** **NOTE: If no valid external setpoint is received within the configured fallback time, the power is limited to the configured fallback power.** **NOTE: The fallback power is used taking into account other active limitations (e.g. mains-side limit values or device protection functions).**
		Fallback time 0 – 43200 [s] / 300 [s] / 1	☞ Set the fallback time for the external power specification. **WARNING! After the set fallback time has elapsed without a valid external specification, external setpoints for cos-phi, Q and P are set to the configured fallback values (cos-phi constant, Q-constant or AC active fallback power), respectively. During the fallback time, the device operates with the last valid setpoint that was received.** **WARNING! If the fallback time is set to 0 s, external specifications are not reset (continued operation with last received setpoint).** **WARNING! The fallback time is set for each valid external telegram.**
		Output gradient limitation increase & Output gradient limitation decrease 1 – 65534 [% Slim / min] / 65534 [% Slim / min] / 1	☞ Set maximum power increase. **NOTE: Limits the maximum rate of change for power increases in normal operation and when returning from the fallback power to external specifications.** ☞ Set gradient limitation for the fallback case. **NOTE: If the value is set to 65534, there is no separate ramp limitation for the fallback case.**
		Settling time (3 Tau) 120 – 36000 [ms] / 120 [ms] 10 Status	**NOTE: The displayed value refers to 3 Tau according to the current standards.** This setting only affects the display of the transient behavior. The actual control behavior of the device remains unchanged. 1. Specify the settling time. 2. Confirm the action field.

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Country-spec. Settings	Level	Display/ Setting	Action in this menu/meaning
		Operating mode ☑☰ON | OFF	☞ Switch on the function for monitoring the system.
		Activation delay time ⚙ 0 – 5000 [ms] / ◦ 0 [ms] ◓ 1	☞ Set the control delay. **NOTE: Time delay for activating the function after the activation frequency threshold has been exceeded in the case of overfrequency events with a rising edge or underfrequency events with a falling edge.**
		Settling time (3 Tau) ⚙ 120 – 13200 [ms] / ◦ 120 [ms] ◓ 10	☞ Set the settling time in the event of an abrupt change in the rated power target value.
		P(f)	**NOTE: Activate frequency-dependent power reduction in the P(f) menu.**
Not for IL, IT		Operating mode ☑☰ Off | Mode 1 | Mode 2 | Mode 3	☞ Specify the operation mode. **NOTE: Mode 1 = Hysteresis active – Limit; Mode 2 = Hysteresis inactive – Limit; Mode 3 = Hysteresis inactive – Set**
		Power reference at underfrequency ☑☰ Actual power | Nominal power Power reference at overfrequency ☑☰ Actual power | Nominal power	1. Specify control method with underfrequency. 2. Specify control method with overfrequency.
		Dynamic gradient mode ☑☰ On | Off	☞ Activate dynamic gradient. **NOTE: Gradient "Feed-in/charging with over/under frequency" is not displayed.**
		Gradient at overfrequency (feed-in) ⚙ 0 – 200 (%/Hz) ◦ 40 (%/Hz) Gradient at underfrequency (feed-in) ⚙ 0 – 200 (%/Hz) ◦ 40 (%/Hz)	1. Specify gradient for feed-in with overfrequency. 2. Specify gradient for feed-in with underfrequency.
		Activation threshold at underfrequency ⚙ 40 – 50 [Hz] / ◓ 0.01 [Hz] Activation threshold at overfrequency ⚙ 50 – 60 [Hz] ◓ 0.01 [Hz]	1. Set the frequency thresholds for activating the power limitation with undervoltage. 2. Frequency thresholds for activating the power limitation with overvoltage.
		Gradient in the case of a decreasing frequency ⚙ 0 – 200 [% Pref/ Hz] / ◦ 40 [% Pref/ Hz] / ◓ 1	☞ Specify gradient in the case of a decreasing frequency as a ‰ (per thousand) / minute (if mode "1" or mode "2" is active).
Not for IL, IT		P(f) deactivation time ⚙ 0 – 6,000,000 [ms] / ◦ 0 [ms] / ◓ 1000 [ms]	☞ Specify time for power reduction (if mode 1 is active).

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Country-spec. Settings	Level	Display/ Setting	Action in this menu/meaning
	1 2 3 4	P(f) deactivation gradient 0 – 65,534 [% Smax / min] / 10 / 1	☞ Specify deactivation gradient.
	1 2 3 4	P(f) intentional delay 0 – 5000 [ms] / 0 [ms] 1	☞ Set delay of the power limitation.
	1 2 3 4	Deactivation range lower limit 45 – 61.5 [Hz] / 0.01 & Deactivation range upper limit 45 – 70 [Hz] / 0.01	☞ Set the lower and upper deactivation range in Hz. **NOTE: Only evaluated in mode 1.** The function is deactivated if the frequency returns to the range between the minimum and maximum deactivation threshold and remains in this range for the duration of the deactivation time.
	1 2 3 4	Activation delay time 0 – 5000 [ms] / 0 [ms] 1	☞ Set the control delay. **NOTE: Time delay for activating the function after the activation frequency threshold has been exceeded in the case of overfrequency events with a rising edge or underfrequency events with a falling edge.**
	1 2 3 4	Deactivation delay 0 – 500 [ms] / 0 [ms] / 1	☞ Set the control delay. **NOTE: Time delay for deactivating the function after the activation frequency threshold has been exceeded on the rising edge during overfrequency events or on the falling edge during underfrequency events.**
	1 2 3 4	Output gradient limitation increase & Output gradient limitation decrease 1 – 65534 [% P_{lim} / min] / 65534 [% P_{lim} / min] / 1	☞ Specify increasing and decreasing output gradients.
	1 2 3 4	P(f) settling time (3 Tau) 120 – 36000 [ms] / 120 [ms] 10 status status	1. Set the P(f) settling time mode. 2. Confirm the action field.
	1 2 3 4	Deact. lim. time after fault 0 – 1000 [s] / 0 [ms] / 1000 [s]	☞ After the end of the fault, the change in active power is limited to the set gradient for the specified time. **NOTE: Only evaluated in mode 2&3.**
	1 2 3 4	Deact. grad. incr. after fault & Deact. grad. decr. after fault 0 – 65,534 [% / min] / 10 [% / min] / 1	☞ Limits the change in active power after the end of the fault. **NOTE: Only evaluated in mode 2 & 3.**
	1 2 3 4	P(U)	**NOTE: Activate voltage-dependent power reduction in the P(U) menu.**
	1 2 3 4	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.

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Country-spec. Settings	Level	Display/ Setting	Action in this menu/meaning
		Reference power ☑☰ Actual power | Nominal power	☞ Select the power-dependent control method.
		Evaluated voltage ☑☰ Maximum phase voltage | Positive sequence voltage	☞ Select the voltage to be rated. Specifies which voltage is evaluated in a three-phase system.
		Hysteresis mode ☑☰ Off | On	**NOTE: Hysteresis mode affects the shutdown response of P(U).** ☞ Activate the mode.
		Deactivation gradient ⚙ 0 – 65534 [% / min] / ◦ 65534 [% / min] / ◓ 1	☞ Set gradients for the voltage limitation.
		Deactivation time ⚙ 0 – 60000000 [ms] / ◦ 0 [ms] / ◓ 1000 [ms]	☞ Specify the time for voltage reduction.
		Output gradient limitation increase & Output gradient limitation decrease ⚙ 1 – 65534 [% P_{lim} / min] / ◦ 65534 [% P_{lim} / min] / ◓ 1	☞ Specify increasing and decreasing output gradients.
		Settling time (3 Tau) ⚙ 600 – 72000 [ms] / ◦ 1200 [ms] ◓ 10	☞ Specify the settling time.
		Priority mode ☑☰ P(f) Priority | P(U) Priority	☞ Set priority.
		Active curve ⚙ 1 - 5	☞ Select the active curve. **NOTE: Up to 5 characteristic curves can be configured independently and one of them can be activated for regulation each time.**
		Number of nodes ⚙ 2 – 5	☞ Specify the number of nodes.
		Power ⚙ 0.0 – 100.0 [% Pref] / ◦ 100 [% Pref] / ◓ 1	☞ Specify power for 1st, 5th ... Node as a percentage of the maximum power.
		Voltage ⚙ 80.0 – 125.0 [%Unom] / ◦ 112 / ◓ 0.1 ☑☰ Status	1. Specify voltage for 1st, 5th ... node as a percentage of the maximum voltage. 2. Confirm the action field.

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Country-spec. Settings	Level	Display/ Setting	Action in this menu/meaning
	1 2 3 4	Power Rampup	**NOTE: Power ramp-up is used to ramp up the power gradually. More detailed information at:** [See section 10.4.2 Page 105]
	1 2 3 4	Power rampup gradient 1 – 3000 [% / min] / 10 [% / min] / 1	☞ Set increase.
	1 2 3 4	Rampup on every connect Rampup on first connect Rampup after grid failure Check to enable	1. Activate the option. 2. Confirm the action field.
INSTALLER	1 2 3 4	Reactive Power Control	**NOTE: Activate the reactive power process in the mode menu. More detailed information at:** [See section 10.1 Page 85]
	1 2 3 4	Mode Specification cos-phi | Specification Q | Cos-phi(P/Plim) | Q(U) | Q(P)	1. Select a control process. 2. Confirm the action field.
	1 2 3 4	Cos-phi constant	**NOTE: Define the cos ϕ constant.**
	1 2 3 4	Cos-phi constant 0,3 – 1 / 1 / 0,001	☞ Determine the specified power factor.
	1 2 3 4	Power gradient increase & Power gradient decrease 1 – 65534 [% P_{lim} / min] / 65534 [% P_{lim} / min] / 1	1. Maximum change in the reactive power %P_{lim}/min in the event of a change to overexcited mode. 2. Maximum change in the reactive power %P_{lim}/min in the event of a change to underexcited mode.
	1 2 3 4	Settling time (3 Tau) 600 – 72000 [ms] / 10000 [ms] 10	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). 2. Confirm the action field.
	1 2 3 4	Q constant	**NOTE: Define the Q constant.**
	1 2 3 4	Priority mode Q-Priority | P-Priority	☞ Set priority.
	1 2 3 4	Q constant 0 – 100 [% Slim] / 0 [% Slim] / 0.1	☞ Set the reactive power Q to a fixed value.
		underexcited | overexcited	☞ Select the type of phase shift. **NOTE: Under-excited relates to inductive load, over-excited relates to capacitive load.**
	1 2 3 4	Output gradient limitation increase & Output gradient limitation decrease 1 – 65534 [% P_{lim} / min] / 65534 [% P_{lim} / min] / 1	1. Maximum change in the reactive power %P_{lim}/min in the event of a change to overexcited mode. 2. Maximum change in the reactive power %P_{lim}/min in the event of a change to underexcited mode.

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Country-spec. Settings	Level	Display/ Setting	Action in this menu/meaning
		Settling time (3 Tau) ⚙ 600 – 72000 [ms] / ◦ 10000 [ms] ◠ 10	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). 2. Confirm the action field.
		Cos-phi(P)	**NOTE: Define the cos ϕ (P).**
		Lock-In voltage ⚙ 10 – 126.6 [% Unom] / ◦ 80 [% Unom] / ◠ 0.1	☞ Set the voltage above which control is activated.
		Lock-Out voltage ⚙ 10 – 126.6 [% Unom] / ◦ 80 [% Unom] / ◠ 0.1	☞ Set the voltage below which control is deactivated.
		Power gradient increase & Power gradient decrease ⚙ 1 – 65534 [% P_{lim} / min] / ◦ 65534 [% P_{lim} / min] / ◠ 1	1. Maximum change in the reactive power %P_{lim}/min in the event of a change to overexcited mode. 2. Maximum change in the reactive power %P_{lim}/min in the event of a change to underexcited mode.
		Settling time (3 Tau) ⚙ 600 – 72000 [ms] / ◦ 10000 [ms] ◠ 10	☞ Set the settling time in the event of an abrupt change in the reactive power target value.
		Number of nodes ⚙ 2 - 10	**NOTE: The maximum number of configurable nodes depends on the selected grid type.** ☞ Specify the number of nodes.
		Node 1- Node 10 Power Curve 1 ⚙ 0-100% [% Slim] / ◦ 0 , 50 , 100 % [% Slim] / ◠ 1	☞ Power factor for 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.**
		Cos-phi Curve 1 ⚙ 0.3 – 1 ind/cap / ◦ 1 / ◠ 0.001	☞ Specify the cos ϕ of the node.
		overexcited | underexcited ☑ Status	☞ 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.** ☞ Confirm the action field.
		Q(P)	**NOTE: Define Q(P).**
		Power gradient increase& Power gradient decrease ⚙ 0 – 65535 [% Slim] / ◦ 65535 [% Slim] / ◠ 1	☞ Specify the increasing and decreasing power gradient.
		Settling time (3 Tau) ⚙ 120 – 180000 [ms] / ◦ 3600 [ms] / ◠ 10	☞ Set the settling time in the event of an abrupt change in the rated power target value.
		Number of nodes ⚙ 2 - 10	**NOTE: The maximum number of configurable nodes depends on the selected grid type.** ☞ Specify the number of nodes.

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Country-spec. Settings	Level	Display/ Setting	Action in this menu/meaning
		Node 1- Node 10 Power Curve 1 ⚙ 0-100% [% Slim] / ◦ 0 , 50 , 100 % [% Slim] / ◓ 1	☞ Power factor for 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.**
		Q - Curve 1 ⚙ 0,3 – 1 [ind/cap] / ◦ 1 / ◓ 0.001	☞ Specify the Q-curve of the node.
		overexcited | underexcited ☑ Status	☞ If a reactive power not equal to 1 is selected: Select the type of phase shift. **NOTE: Overexcited relates to a capacitive load, underexcited relates to an inductive load.** ☞ Confirm the action field.
		Q(U)	**NOTE: Define Q(U).**
		Lock-In power ⚙ 0 – 100 [% Slim] / ◦ 20[% Slim] / ◓ 1	☞ Set the active power as % of rated power above which control is activated.
		Lock-Out power ⚙ 0-100 [% Slim] / ◦ 5 [%Slim] / ◓ 1	☞ Set the active power as % of rated power below which control is deactivated.
		Lock-In time ⚙ 0 – 60,000 [ms] / ◦ 30,000 [ms] / ◓ 1,000 [ms] Lock-Out time ⚙ 0 – 60,000 [ms] / ◦ 30,000 [ms] / ◓ 1 [ms]	☞ Set the length of time that the active power must remain above the lock-in / lock-out power level before control is activated.
		Dead time ⚙ 0 -10,000 [ms] / ◦ 0 [ms] / ◓ 1	☞ Set the intentional delay for the start of the Q(U) function.
		Output gradient limitation increase & Output gradient limitation decrease ⚙ 1 – 65534 [% P_{lim} / min] / ◦ 65534 [% P_{lim} / min] / ◓ 1	1. Maximum change in the reactive power %P_{lim}/min in the event of a change to overexcited mode. 2. Maximum change in the reactive power %P_{lim}/min in the event of a change to underexcited mode.
		Settling time (3 Tau) ⚙ 600 – 72000 [ms] / ◦ 10000 [ms] ◓ 10	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). 2. Confirm the action field.
		Minimum cos-phi Q1 - Minimum cos-phi Q4 ⚙ 0 – 1 / ◦ 0 / ◓ 0,001	☞ Enter the minimum cos ϕ factor for quadrants 1 and 4.
		Voltage dead band ⚙ 0 – 5 [% Uref] ◦ 0.0 ◓ 0.1	☞ Set voltage dead band in %.

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Country-spec. Settings	Level	Display/ Setting		Action in this menu/meaning
		Q(U) Offset (temporary) U offset ⚙ -100 -100 [% Slim] / ◦ 0.0 [%Slim] / ◓ 0.1 Q offset ⚙ -100 -100 [% Slim] / ◦ 0.0 [%Slim] / ◓ 0.1		☞ Set the intended Q or U offset for the function. **NOTE: The voltage offset is added to the measured voltage. Accordingly, the sign must be inverted if the curve is shifted.**
		Q minimum ⚙ 0 – 100 [% Slim] / ◦ 0 [% Slim] / ◓ 0.1		☞ Set the reactive power Q to a minimum value.
		⚙ underexcited | overexcited		☞ Select the type of phase shift. **NOTE: Under-excited relates to inductive load, over-excited relates to capacitive load.**
		Q maximum ⚙ 0 – 100 [% Slim] / ◦ 0 [% Slim] / ◓ 0.1		☞ Set the reactive power Q to a maximum value.
		⚙ underexcited | overexcited		☞ Select the type of phase shift. **NOTE: Under-excited relates to inductive load, over-excited relates to capacitive load.**
US, UD		Autonomous adjustment Vref ☑ Check to enable		☞ When autonomous adjustment is activated, the reference voltage of the reactive power function is adjusted to the measured voltage using a PT1 filter. This dynamically shifts the Q(U) characteristic curve.
US, UD		Time constant Vref adjustment ⚙ 300 – 5000 [s] ◦ 300 s		☞ Set the time constant for adjusting the dynamic reference voltage.
		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.**
		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.**
		Number of nodes ⚙ 2 - 10		**NOTE: The maximum number of configurable nodes depends on the selected grid type.** ☞ Specify the number of nodes.

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Country-spec. Settings	Level	Display/ Setting		Action in this menu/meaning
		Node 1- Node 10 Power / Excitation / Voltage 0 – 100 [% Slim] / 43.6[% Slim] / 0.1		☞ Set the reactive power of the node as a percentage of the maximum power.
		overexcited | underexcited Status		☞ Select the type of phase shift. **NOTE: Over-excited relates to a capacitive load, under-excited relates to an inductive load.**
		0 – 125.0 [% Unom] / 90 … 110.0 [% Unom] / 0.1 [% 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.**
		FRT (Fault Ride Through)		**NOTE: The device supports dynamic grid stabilization. More detailed information at:** [See section 10.3 Page 100]
		Operating 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.
		Setting | Manual |Predefined zero current		☞ Select a control process.
		Priority – Reactive current limitation | Active current priority		☞ Select a control process.
		Constant k positive sequence dip & Constant k positive sequence swell k 0 – 10 2 0.1		☞ Set amplification factor k for the pos. sequence for drop and increase in the grid voltage.
		Constant k negative sequence dip Constant k negative sequence swell k 0 – 10 2 0.1		☞ Set amplification factor k for the neg. sequence for drop and increase in the grid voltage.
		Dead band 2 – 120 [% Uref] 10.0 0.1		☞ Set dead band in %.
		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.
		Dead band mode Mode 1 | Mode 2		☞ Select dead band mode for the active control process.
		Reference voltage 80.0 – 110.0 [% Unom] 100 0.1		☞ Set reference voltage for the active control process.

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Country-spec. Settings	Level	Display/ Setting	Action in this menu/meaning
		Minimum operating voltage deactivation 0.0 – 100 [% Unom] 0.1 & Maximum operating voltage deactivation 100.0 – 125.0 [% Unom] 0.1	☞ Set voltage range for the active control process.
		Minimum operating voltage activation 80 – 100 [% / Unom] / 80 [% / Unom] / 1 & Maximum operating voltage activation 100 – 110 [% / Unom] / 108.0 [% / Unom] / 1	☞ Set voltage range for the active control process.
		Zero current activation undervoltage 0 – 90 [%Unom] 0.1 Zero current activation overvoltage 110 – 141.8 [% Unom] 0.1	☞ Set voltage threshold for zero current mode. If one or more phase/phase or phase/neutral conductor voltages move below or above the configured threshold, the inverter changes to zero current mode. The total current is regulated to virtually zero.
		Reactive current limitation 0 – 100 [% Imax] / 100 [% Imax] / 1	☞ Set the reactive power limitation.
		Minimum support time 1,000 – 15,000 [ms] / 5,000 [ms] 10	☞ Set the minimum support time.
		Overvoltage protection	**NOTE: Shutdown carried out within a grid cycle.**
		Transient overvoltage protection 114.8 – 127.5 [% Unom] / 127.5 / 0.1 %	1. Set the transient overvoltage protection. 2. Confirm the action field.
		External grid protection disconnection	**NOTE: Option to detect the external grid protection devices**
		External Grid Protection No device | Powador-protect | third-party device	☞ Select the device.

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Country-spec. Settings	Level	Display/ Setting	Action in this menu/meaning
		Powador-protect	**NOTE: Configures the grid shutdown via a Powador-protect connected to the "INV OFF" 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 "INV OFF" input. ☞ 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.
		3rd party device	**NOTE: Configures the grid shutdown via an external device connected to the digital input of the device**
		3rd party device name	☞ Enter the name of the external device.
		3rd party device operation mode On | Off	☞ Select operating mode. **On:** The digital signal of the external device must be present on the digital input so that the device does not shut down. **Off**: The device does not check whether an external system is integrated into the PV system.
INSTALLER		DC Settings	Input masks for DC source (PV generator/battery)
		Constant voltage control	**NOTE: Opportunity to deactivate the MPP seek mode in order to operate the device with a constant DC voltage.** **NOTE: With activated constant voltage control and "Q on Demand" function, energetic recovery may develop on the PV generator. Please observe the module manufacturer's instructions and approval.**
		Constant voltage mode Off | On	☞ Activate or deactivate the constant voltage controller.
		Constant voltage ⚙ / ◦ [See section 4 Page 17] [V] / ◓ 1 [V]	1. Set value for constant voltage control. 2. Confirm the action field.
		DC starting voltage ⚙ / ◦ [See section 4 Page 17] [V] / ◓ 1 [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.
		Insulation resistance ⚙ 100 – 2000 [kohm] / ◦ 300 [kohm] / ◓ 1[kohm]	1. Set threshold value at which the insulation monitor reports a fault. 2. Confirm the action field.
		Communication	Input screens for configuring the interfaces.
		Ethernet	**NOTE: Opportunity to parametrize the Ethernet interface.**
		IP Settings	**NOTE: Parameterization of network access.**

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Country-spec. Settings	Level	Display/ Setting		Action in this menu/meaning
	1 2 4	DHCP ☑ Check to enable		☞ 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 4	IP Address		☞ Allocate a unique IPv4 address in the network.
	1 2 4	Subnet Mask		☞ Assign a subnet mask.
	1 2 4	Default gateway		☞ Enter IPv4 address of the gateway.
	1 2 4	DNS server settings via DHCP ☑ Check to enable		☞ Activate or deactivate the DNS server from DHCP. **On**: Once the DHCP server becomes available, the IP address is automatically applied and the aforementioned menu options are filled out. **Off**: Apply settings manually.
	1 2 4	Primary DNS & Secondary DNS (optional)		1. Enter IPv4 address of DNS server. 2. Confirm the action field.
	1 2 4	Modbus		**NOTE: Option to set the Modbus port.**
	1 2 4	Modbus TCP / UDP Activation ☑ Check to enable		☞ Allow Modbus TCP / UDP reading access.
	1 2 4	Modbus TCP / UDP Write access ☑ Check to enable		☞ 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 4	Modbus TCP / UDP Port		☞ Set up network port.
	1 2 3 4	MQTT		**NOTE: The MQTT protocol is used to implement the advanced functions between the Segment Controller and the inverter (in particular, firmware updates, distribution of device configurations etc.).**
	1 2 4	Broker IP		1. Displays the IP address transmitted by the Segment Controller.
	1 2 4	Broker port		. **NOTE: The standard settings allow for successful communication with the Segment Controller.** 2. Confirm the action field.
	1 2 3 4	NTP		**NOTE: An NTP server receives its accurate time information from a precise time source and makes it available to other devices on the network via the NTP protocol.**
	1 2 4	NTP Server ☑ Check to enable		1. Obtain server addresses via DHCP or enter them under NTP Server 1&2. Activate server if necessary. 2. Confirm the action field.
	1 2 4	NTP server 1		☞ Enter the server address.
	1 2 4	NTP server 2		☞ Enter an alternative server address.

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Country-spec. Settings	Level	Display/ Setting	Action in this menu/meaning
	1 2 3 4	RS485 address	**NOTE: Allows configuration of the RS485 interface. The RS485 (CON901) parameters are fixed (as with all KACO inverters): 9600 baud, 8N1, and cannot currently be changed via the web interface.** **NOTE: The address must not duplicate the address of another device or 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.
		Baud rate ⚙ 9600 *8N1*	☞ Set the transmission and polling interval.
		Enable RS485 configuration commands ☑ Check to enable	☞ Enabling this option allows communication via RS485 for a period of 24 hours. **NOTE: Access is automatically disabled after 24 hours.** **NOTE: Only commands enabled by the "**Enable RS485 configuration commands **NOTE: " command are affected. Other commands, such as those used by meteocontrol, are not affected.** ☞ Confirm the action field.
	1 2 3 4	Protocol ⚙ KACO Legacy **or** Modbus RTU	☞ Define communication protocols. **NOTE: The selection ensures that communication can only take place via the existing commands.** ☞ Confirm the action field.
	1 2 3 4	Modbus RTU	☞ Set up network port.
	1 2 3 4	Modbus RTU Write access ☑ Check to enable	1. Allow Modbus RTU write access. 2. Confirm the action field.
	1 2 3 4	Features / Functions	**NOTE: Input screens for advanced device functions**

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Country-spec. Settings	Level	Display/ Setting	Action in this menu/meaning
	2 3 4	String combiner	**NOTE: Opportunity to configure a string combiner.**
		String collector monitoring ☑ Deactivated | By inverter and segment controller / SCADA system | By Segment Controller / SCADA System	☞ Activate monitoring function, if necessary.
		Serial number of the assigned string combiner	☞ Enter serial number after installation of the device. **NOTE: The serial numbers of the string combiner that are not connected directly to the device are entered on the segment controller.**
		Baud rate & number of data capture units ⚙ 9600 *8n1*	1. Specify transmission and detection intervals. 2. Enter the number of data acquisition units as necessary.
		⚙unit address ⚙ Unity channels	1. Specify IP address of the string combiner. 2. Specify the number of monitored strings. 3. Confirm the action field.
	2 3 4	SPD monitoring	**NOTE: Provides the ability to verify the installed Surge Protective Device (SPD) and display the corresponding status messages**
	3 4	SPD monitoring AC SPD monitoring DC ☑ Check to enable	1. Enable SPD monitoring. 2. Confirm the action. **Prerequisite: The SPD Monitoring jumper must be removed** [See section 7.7 Page 37]**; otherwise, enabling this function here will have no effect.**
	2 3 4	Q on Demand (reactive power on request)	**NOTE: Only activate the function with the express permission of the network operator. Additional conditions:** **- No PID solution connected to the device.** **- Constant voltage regulator in the device is deactivated**. See table : Configuration via web user interface [Page 75]
	3 4	Night Shutdown ☑ Check to enable	1. "Q on Demand" function is activated by deactivating the night shutdown. 2. Transfer function to memory. 3. Pay attention to the information window and, if necessary, activate the function with the "OK" button. **NOTE: The reactive power settings currently specified are used. Power-dependent functions are not used.** **NOTE: If the AC is disconnected during the night, the function will not be available until the next day.**
	2 3 4	Digital inputs / outputs	**NOTE: Opportunity to configure the fault signal relay [ERR].**
	3 4	Relay ☑ Positive logic | Negative logic ☑ inactive | active	1. Select the type of logic. 2. Select the form of activity. 3. Confirm the action field.

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Country-spec. Settings	Level	Display/ Setting	Action in this menu/meaning
	2 3 4	RCMU / optional (residual current monitoring unit)	**NOTE: Function for monitoring residual currents and insulation resistances on the DC side of the device. The integrated RCMU (also known as "AFI") measures the insulation resistance when the device starts up and continuously monitors the residual current during operation. If a fault current is detected, the AC relays are opened and the device displays Prolog status 78 "Resid. current shutdown (AFI)".**
	1 2 3 4	RCMU monitoring ☑ Check to enable	☞ Define the activation status of the RCMU monitoring. **NOTE: When the function is active, the residual current on the DC side is continuously monitored in accordance with IEC 62109-2. The shutdown occurs within 0.3 s for a sudden increase of 30 mA, within 0.15 s for 60 mA and within 0.04 s for 150 mA. The threshold value for the insulation resistance is set to 300 kΩ as standard and can be adjusted between 100 and 2000 kΩ.**
	1 2 3 4	String combiner logging interval ⚙ 10 [sec] 1, 5, 10, 15, 30, 60 [min]	☞ Specify the time period between 2 log data recordings.
	1 2 3 4	Firmware update	**NOTE: Opportunity to update the device. Parameter data are not overwritten when the firmware is updated.**
	1 3 3 4	Instant Update	1. Select and confirm the firmware update file with the "Browse..." button 2. Load the firmware with the "Upload" button. 3. Note: During the entire update process, the AC and DC supply of the inverter must be ensured. A loss of supply may damage the device. Continue with update?
	1 2 3 4	Service	**NOTE: Opportunity to specify the service interval.**
	1 3 3 4	Service Log	**NOTE: Display of all logged installations. You should also add all maintenance activities manually via the "Service" and "Installer" interfaces.** 1. Enter additional service activities (exception: "User" interface). 2. Export service logs, if necessary.
	1 3 3 4	Export Service Package	**NOTE: Opportunity to send an error log to KACO new energy.** ☞ Press the Export button and send the file to our service staff.
	1 1 3 4	Logging Management	**NOTE: Input screens for log and service data and default settings.**
	1 3 4	Settings	Specify the interval for data capture and base meters.
	1 2 3 4	User logging interval ⚙ 1 | 5 | 10 | 15 [minutes] / ◦ 5	☞ Specify the time period between 2 log data recordings. **NOTE: Setting and time until memory is overwritten: 1 min – 5 days; 5 min – 4.5 years; 10 min – 9 years; 15 min – 14 years.**

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Country-spec. Settings	Level	Display/ Setting	Action in this menu/meaning
		Service logging interval 1 – 120 [sec] / 10 [sec] / 1	☞ Specify the time period between 2 log data recordings. **NOTE: Setting and time until memory is overwritten: 1 sec – 9 days; 10 sec – 92,5 days; 120 sec - 1110 days**
		DC-DSP logging interval 1 – 120 [sec] / 10 [sec] / 1	☞ Specify the time period between 2 log data recordings. **NOTE: Setting and time until memory is overwritten: 1 sec – 9 days; 10 sec – 92,5 days; 120 sec - 1110 days**
		PCU logging interval 1 – 120 [sec] / 10 [sec] / 1	☞ Specify the time period between 2 log data recordings. **NOTE: Setting and time until memory is overwritten: 1 sec – 9 days; 10 sec – 92,5 days; 120 sec - 1110 days**
		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) | lac 1 (A) | lac2 (A) | lac3 (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.
EU US - Only Sup. B		blueplanet web	☞ **NOTE: Option to transmit live measurements to the KACO Portal**
EU US - Only Sup. B		Web portal Check to enable	☞ Activate continuous transmission.
EU US - Only Sup. B		Logging interval 900 – 86400 [s] 900 [s]	☞ Specify measuring interval.
EU US - Only Sup. B		Transfer interval 900 – 86400 [s] 900 [s]	1. Specify transfer interval. 2. Confirm the action field.
		Parameter Management	**NOTE: Option to reset configured values and the import and export of specific parameters.**
		Factory setting	1. Compare all parameters / country-specific parameters / network-specific parameters with default setting. 2. If necessary, reset the parameters by clicking on the "Restore" button.
		Config. export.	1. Exporting parameters for device-independent settings / Export all settings. 2. Select the parameters for export into a file or the plant manager.
		Import Configuration	1. Select the parameter file using the "Browse" button. 2. Import the parameters by clicking on the "Upload" button.
		Password protection Country selection | Connection conditions | Island Detection | FRT (Fault Ride Through) | ... | ... |	1. Opportunity to set up password protection for individual parameters. 2. Confirm the action field.

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Country-spec. Settings	Level	Display/ Setting	Action in this menu/meaning
	1 2 3 4	Installation Wizard	**NOTE:** The installation wizard is described in the chapter [See section 8.4 Page 45]. When the installation process is complete, the text: Installation wizard was completed appears
	1 3 3 4	Network Statistics	**NOTE: Sent and received data packets indicator** ☞ Press Refresh.
	1 3 3 4	Remote Access	When remote access is enabled, KACO can access the device remotely and assist you. ☞ Activate on request.
	1 2 3 4	History	**NOTE: Displays all of the actions performed in the system and on the web interface.**
INSTALLER	1 2 3 4	Account Management	1. Enter your Username. 2. Enter your new user-defined Password. **NOTE: The following is specific to KACO: Following initial start-up, it is necessary to** Change password
	1 3 4 4	Fan test ☑ internal fan ☑ external fan	**NOTE: Allows testing of the internally and externally installed fans in test mode.** ☞ Enable test mode to record the fan speed. After switching modes, refresh the display. **NOTE:** Do not forget to deactivate test mode when you have finished.
	1 2 3 4	Reboot Device	**NOTE: Transfer safety-related parameters to a storage medium.** ☞ If necessary, re-start the device.

NOTE

Validity for associated certificate according to country settings

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

1. that the relevant certificates are only valid if the corresponding country settings have been selected.
2. that all configured grid parameters must be configured in accordance with the requirements of the grid operators.
3. 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.

NOTE

Validity of the setting values shown

Setting values that follow the pictogram ⚙ only refer to the blueplanet 125 TL3/NX3 device type with the "user defined" country setting. For your device, refer to the slider on the web interface.

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.

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7. Assign DNS server.
8. Save your settings.

9.6 Performing a firmware update

NOTE

Methods for carrying out firmware updates

Firmware updates can be carried out using one of the following methods, depending on the installation environment:

1. via a USB data carrier with firmware package installed
2. via **Ethernet (FTP)**
3. via a **BlueLog device** using **FTP** or **MQTT**.
4. Before carrying out an update, make sure that the firmware used is **suitable for the respective device type**.

⚠ CAUTION

Interruption or parallel execution of software updates during an ongoing update process!

An intervention or cancellation during the update can lead to system inconsistencies, loss of function or an inoperable device. In this case, a service call or device replacement may be necessary.

✓ The software update is carried out in several phases and may include automatic system restarts. The system cannot be updated while this is in progress.

1. During the entire software update process, do not start any further updates, do not change any settings, and do not interrupt the process manually. Do not operate the system again until the update is complete.

NOTE

Ensure DC power supply during initial start-up

The DC power supply must be guaranteed during initial start-up. [13]

The sequence of the settings required for initial start-up is pre-set 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.

1. Never disconnect the DC and AC power supply for or during a firmware update.
2. Do not remove the USB stick during a firmware update.

NOTE

Observe waiting time for firmware update

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

Performing a firmware update

You can upload the current firmware to the devices directly via the web interface. Refer to the menu items under "`Firmware Update`" See table : Configuration via web user interface [▶ Page 79]

[13] It is only possible to configure the grid parameters with DC voltage. The further parameters can also be configured with a present AC voltage.

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The firmware can be found on the website kaco-newenergy.com under `Downloads` / `Software`.

There is the **option** of updating the firmware at the USB socket of the device. Observe the following procedure:

↻ Ensure that the power supply is connected.
↻ Pay attention to signal elements (LEDs) and statuses during the process.
↻ Note the description of the LED states during the process. [See section 9.2 Page 52]

1. Load the firmware from the KACO website onto a FAT32-formatted USB stick.
2. Insert the USB stick into the USB port of the device.

⇨ The update process starts once the firmware has been validated and the status LEDs flash to indicate this.

3. When the status LEDs "Operating" and "Feed-in" LED **flash slowly at the same time**, **remove** the USB stick.
4. Once the update has been successfully completed, all 3 LEDs light up briefly several times and the device restarts.
5. Remove the USB stick from the USB socket.
6. Checking the firmware version on the Info web interface. [See section 9.3 Page 54]
7. If an error occurs, the update procedure must be repeated.

⇨ Update process completed successfully.

9.6.1 Access to archive folders

↻ You have officially signed up via mykaco.com already registered. If not, please catch up via our mykacocom-kundenportal .

1. In the login screen, enter your full email address and password.
2. Now check if you have access to the archive folder shown in the graphic.

⇨ In the archive you will find all previous document versions as well as already expired certificates for your device.

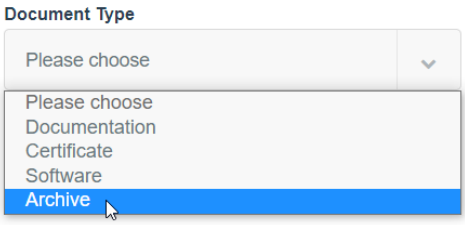


Fig. 68: Archive folder for previous documents

9.7 Access via Modbus

NOTE

Update rate of the Modbus measured values in parallel operation

The measured values provided via Modbus are transmitted with an update rate of approx. **1 second**. The values can also be filtered for stabilization. This can result in a time delay compared to rapid changes in performance.

In **PV or storage systems with several inverters operated in parallel**, especially if control is only carried out at the **grid connection point**, this delay must be taken into account when designing the higher-level control system.

A suitable external measuring solution may need to be provided for highly dynamic control requirements.

NOTE

Required usage information for remote access

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.

↻ Firmware version of device is identical to the specifications of the Sunspec® Modbus®.
↻ **NOTE: The device supports MODBUS/TCP and conventional SUNSPEC models. If there are concerns over security, write access can be deactivated.**

1. Enable the entry `Network - Modbus TCP - Operation mode` / `Network services - Modbus TCP - Operation mode` in the menu on the device or on the web interface.
2. If necessary, allow `write access`.
3. Set up the `Port` for access. [Default: `502`]

⇨ Access via Modbus enabled.

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10 Specifications

10.1 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%.

10.1.1 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.

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

Maximum Apparent Power [p.u.]	**bp 87 TL3** Nominal Voltage U_N: 380 V	**bp 92 TL3** Nominal Voltage U_N: 400 V	**bp 105 TL3** Nominal Voltage U_N: 400 V	**bp 110 TL3** Nominal Voltage U_N: 270 V / 480 V	**bp 125 TL3** Nominal Voltage U_N: 480 V	**bp 125 TL3** Nominal Voltage U_N: 600 V	**bp 125 TL3(S)** Nominal Voltage U_N: 600 V	**bp 137 TL3** Nominal Voltage U_N: 600 V	**bp 150 TL3** Nominal Voltage U_N: 660 V	**bp 155 TL3** Nominal Voltage U_N: 590 V	**bp 165 TL3** Nominal Voltage U_N U_N: 630V
1,10	-	-	-	-	-	≥ 600	-	-	-	-	-
1,00	≥ 380	≥ 400	≥ 380	≥ 480	≥ 475	545	≥ 545	≥ 600	≥ 660	≥ 590	≥ 630
0,95	361	380	361	456	450	520	520	570	627	560	599
0,90	342	360	342	442	430	492	492	540	590	530	567
0,85	323	340	323	408	404	464	464	510	561	502	536

Tab. 7: Maximale dauerhafte Scheinleistung in Abhängigkeit der Netzspannung

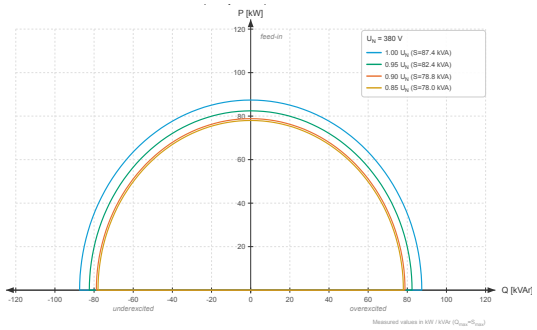


Fig. 69: P-Q operating range for bp 87.0 TL3 (Q_{max}=S_{max})

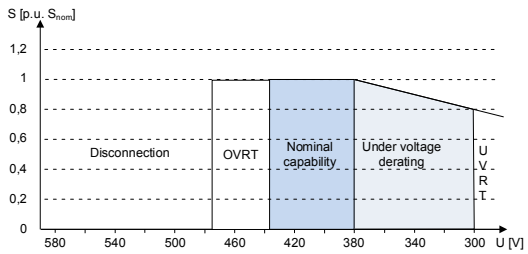


Fig. 70: Apparent power subject to the grid voltage for bp 87.0 TL3

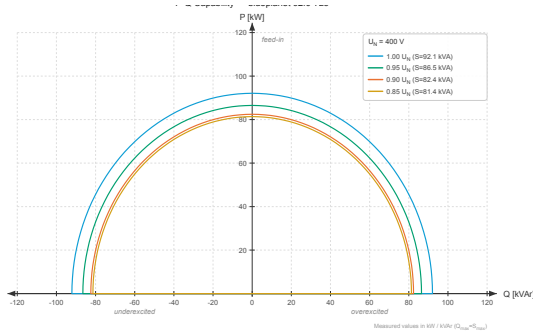


Fig. 71: P-Q operating range for bp 92.0 TL3 (Q_{max}=S_{max})

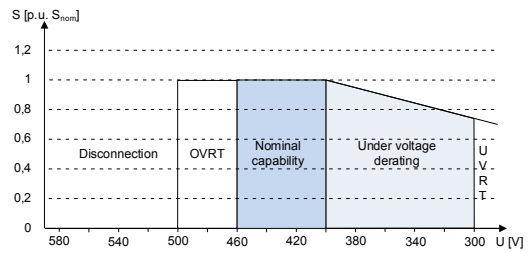


Fig. 72: Apparent power subject to the grid voltage for bp 92.0 TL3

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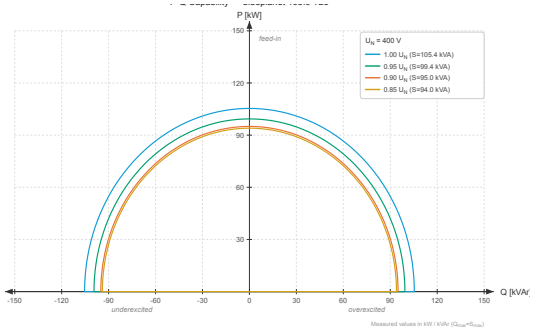


Fig. 73: P-Q operating range for bp 105 TL3 (Q_{max}=S_{max})

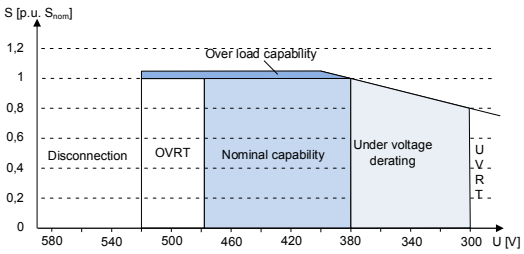


Fig. 74: Apparent power subject to the grid voltage for bp 105 TL3

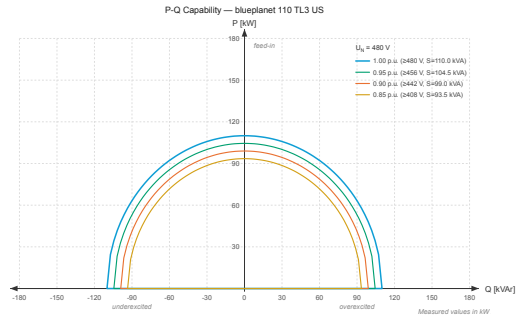


Fig. 75: P-Q operating range for bp 110 TL3 US (Q_{max}=S_{max})

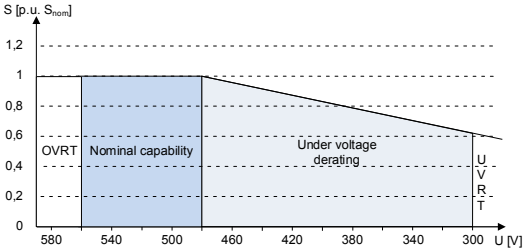


Fig. 76: Apparent power subject to the grid voltage for bp 110 TL3 US

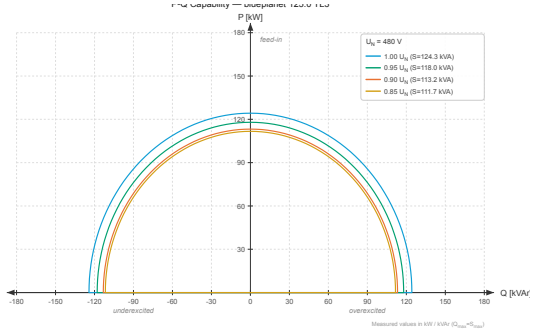


Fig. 77: P-Q operating range for bp 125 TL3 US (Q_{max}=S_{max})

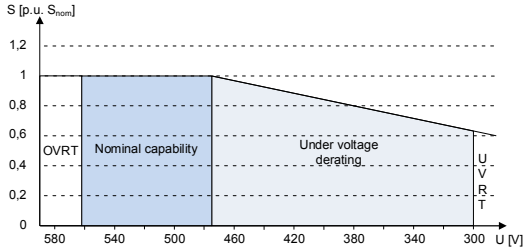


Fig. 78: Apparent power subject to the grid voltage for bp 125 TL3 US

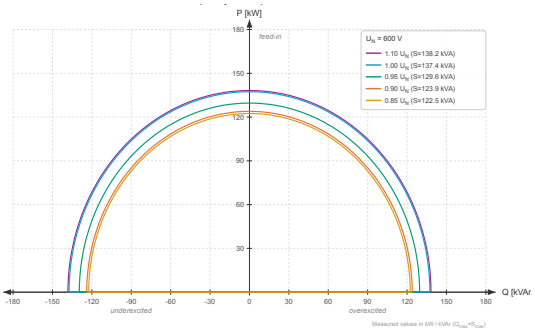


Fig. 79: P-Q operating range for bp 125 TL3 (Q_{max}=S_{max})

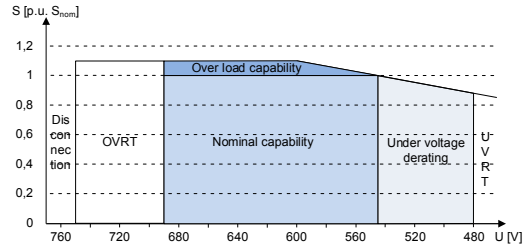


Fig. 80: Apparent power subject to the grid voltage for bp 125 TL3

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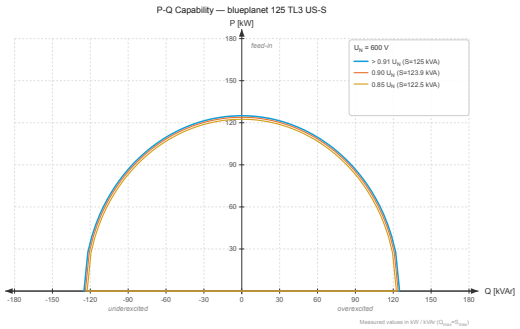


Fig. 81: P-Q Operating Range for bp 125 TL3 US-S (Q_{max}=S_{max})

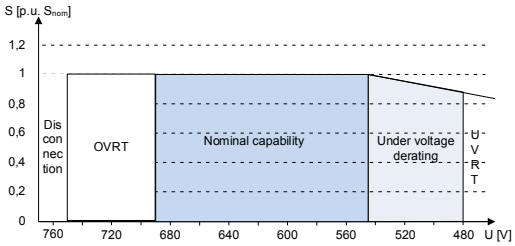


Fig. 82: Apparent Power as a Function of Grid Voltage for bp 125 TL3 US-S

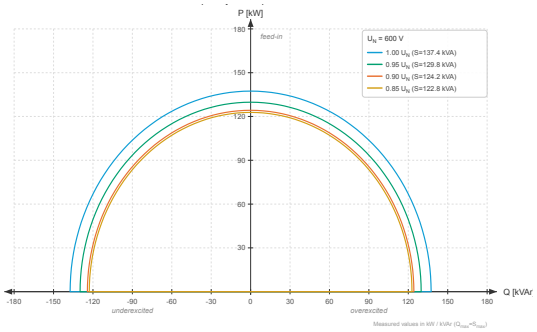


Fig. 83: P-Q operating range for bp 137 TL3 (Q_{max}=S_{max})

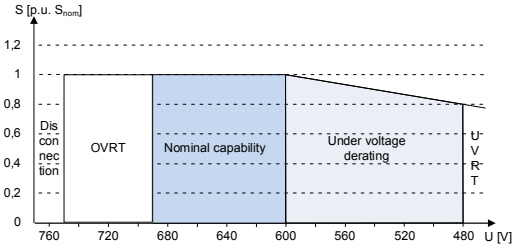


Fig. 84: Apparent power subject to the grid voltage for bp 137 TL3

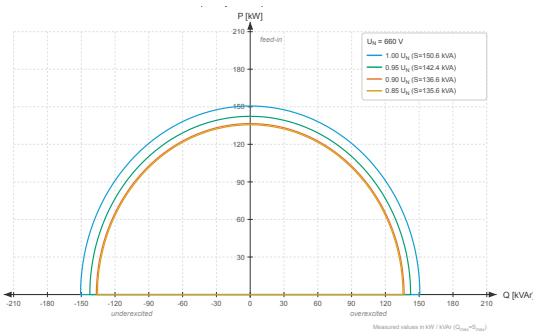


Fig. 85: P-Q operating range for bp 150 TL3 (Q_{max}=S_{max})

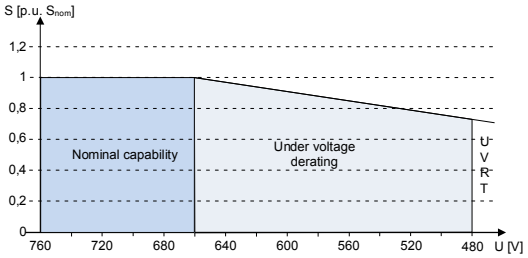


Fig. 86: Apparent power subject to the grid voltage for bp 150 TL3

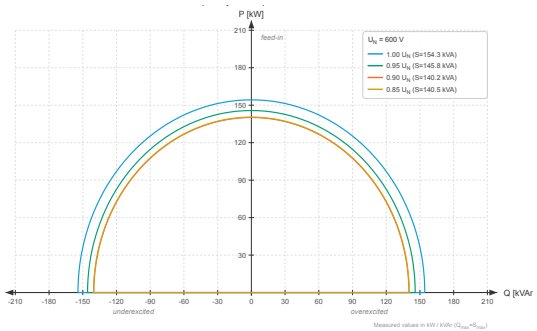


Fig. 87: P-Q operating range for bp 155 TL3 (Q_{max}=S_{max})

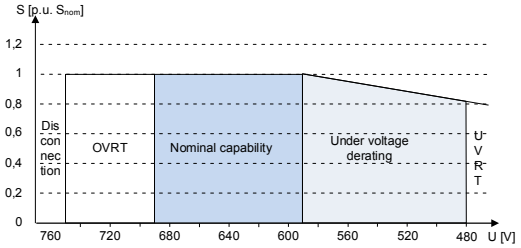


Fig. 88: Apparent power subject to the grid voltage for bp 155 TL3

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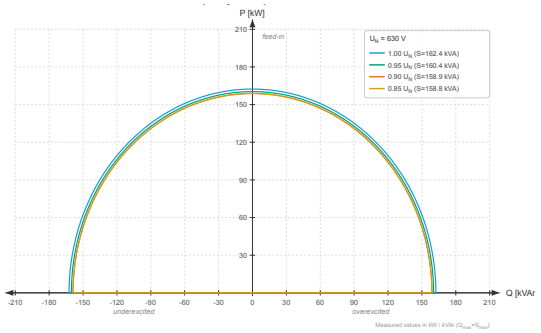


Fig. 89: P-Q operating range for bp 165 TL3 (Q_{max}=S_{max})

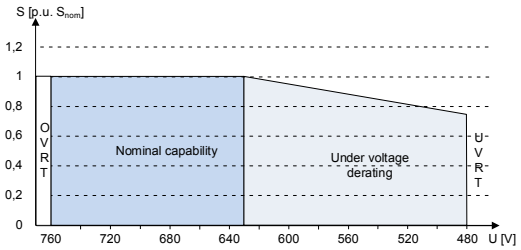


Fig. 90: Apparent power subject to the grid voltage for bp 165 TL3

10.1.2 Dynamics and accuracy

In all control methods 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 power 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 settling time corresponds to 3 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.

10.1.3 Reactive power functions

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

- cos ϕ constant
- Q constant
- cos ϕ (P)
- Q(U) 10 samples

NOTE: In the basic setting, reactive power is prioritized in each method, which can be deactivated accordingly. The priority can be selected when using the Q constant and the Q(U) mode. The maximum possible active power that can be fed in is reduced in line with the P-Q operating range when the maximum effective power is reached.

Model	Parameters	Scaling factor	R/RW	Area	Description
126.	ModEna	ModEna	RW	⚙ 0 / 1	The reactive power method that is selected in the device can only be indirectly activated/deactivated via Sunspec.

cos φ constant

In cos ϕ constant mode, the specified power factor is permanently set by the inverter. In doing so, the reactive power level is set in line with Q=P*tan ϕ as a function of the power that continuously generates the specified power factor. If the setting value is changed, the new value is adopted by way of a filter in a muted manner. The settling time is parameterizable and is 1s (this corresponds to 5 Tau (according to SunSpec, 3 Tau is ideal) with the transient response of a first-order filter (PT-1) with a time constant of Tau=200ms. The specified power factor can be configured on the display or by way of communication via the KACO RS485 protocol and MODBUS/SunSpec.

If the applicable grid code stipulates that the cos-ϕ should react to the target value slower than the configured Tau=200 ms by way of a defined gradient or settling time, this gradient or settling time must be implemented in the system control.

Model	Parameters	Scaling factor	R/RW	Area	Description
123.	OutPFSet cos-phi const.	OutPFSet_SF	RW	⚙ 1-0,3 [°]	Set the power factor to a certain % value.

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Model	Parameters	Scaling factor	R/RW	Area	Description
123.  Not implemented!	OutPFSet_WinTms Settling time	VArPCt_SF	RW	⚙ 1000 – 120000 [ms]	Set the settling time in the event of an abrupt change in the reactive power target value (e.g. caused by a voltage jump).
123. 	OutPFSet_RvrtTms Timeout		RW	⚙ 0 – 1000 [s]	Specifies the time after which the inverter, if it does not receive a new power factor specification, reverts to the previously applicable reactive power procedure. If the Timeout is set to 0 seconds, the transmitted power factor specification is permanently retained, even in the event of a communication timeout. Note: when the device is restarted, the timeout is reset to the set fallback time.

Q constant

In Q-constant mode, the specified reactive power value is permanently set by the inverter. If the constant is changed, the new value is adopted by way of a filter in a muted manner. The settling time and gradient limitation can be configured on the web user interface. The settling time is 1s with the transient response of a first-order filter (PT-1) with a time constant of Tau=200ms. The specified reactive power can be configured on the display or by way of communication via the KACO RS485 protocol and MODBUS/SunSpec.

If the applicable grid code stipulates that the reactive power should react to the target value slower than the configured Tau=200 ms by way of a defined gradient or settling time, this gradient or settling time must be implemented in the system control.

Model	Parameters	Scaling factor	R/RW	Area	Description
123. 	VArWMaxPct Q constant	VArPCt_SF	RW	⚙ 0-100 [$\%_{Pmax}$]	The setpoint of the reactive power can be adjusted depending on the set maximum active power.
123. 	VArPct_RvrtTms Timeout		RW	⚙ 0 – 1000 [s]	Specifies the time after which the inverter, if it does not receive a new reactive power specification, reverts to the previously applicable reactive power procedure. If the Timeout is set to 0 seconds, the transmitted reactive power specification is permanently retained, even in the event of a communication timeout. Note: when the device is restarted, the timeout is reset to the default value.

cos φ(P)

In the cos ϕ (Pn) operating mode, the setpoint value of cos ϕ and the setpoint for the reactive power derived from it are continuously calculated depending on the actual 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. In this case, a characteristic curve 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 set maximum apparent power Slim. Other parameters allow you to limit functionality and to limit activation to certain voltage ranges.

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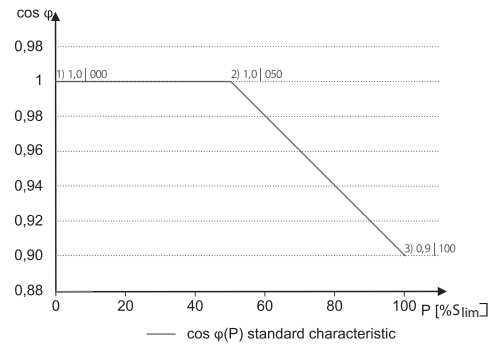


Fig. 91: cos ϕ (P) standard characteristic curve with 3 nodes

Q(U) 10 samples

When it comes to mode Q(U), the nominal value of the reactive power is continuously calculated depending on 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. In this case, a characteristic curve is specified which can be used to configure up to 10 nodes, consisting of 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 zero sequence voltage is used to calculate the reactive power target for three-phase units.

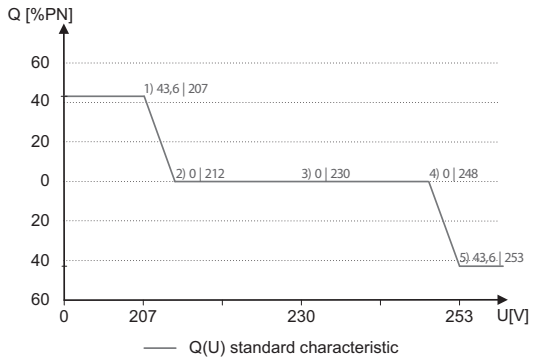


Fig. 92: Q(U) standard characteristic curve with 5 nodes

10.1.4 Parameters for reactive power control

Country-spec. Settings	Menu level	Display/ Setting	Action in this menu/meaning
		Mode ☑= Specification cos-phi | Specification Q | Cos-phi(P/Plim) | Q(U) | Q(P)	Select the active method for Reactive Power Control (RPC) and define the parameters in the respective method.
		Cos-phi constant	
		Cos-phi constant ⚙ 0,3 – 1 / 1 / 0,001	Specified power factor.
		☑= Over-excited | under-excited	Reactive power mode: Under-excited relates to inductive load, over-excited relates to capacitive load.
		Power gradient increasing & power gradient decreasing ⚙ 1 – 65534 [% P_{lim}/min] / 65534 [% P_{lim}/min] / 1	Maximum change in the reactive power %P_{lim}/min in the event of a change to overexcited mode. **NOTE: The gradient is overlaid with the settling time.**

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Country-spec. Settings	Menu level	Display/ Setting	Action in this menu/meaning
		Settling time ⚙ 1,000 – 120,000 [ms] / ◦ 1,000 [ms] ◠ 10	Determines the dynamic behavior in the event of a change in the cos ϕ set value. With a reactive power change, the cos ϕ is changed according to a PT-1 characteristic curve with a settling time of 3 Tau.
		Q constant	
		Q constant ⚙ 0 – 100 [% Slim] / ◦ 0[% Slim] / ◠ 0.1	Set as a percentage of the maximum reactive power.
		☑☰Under-excited | over-excited	Reactive power mode: Under-excited relates to inductive load, over-excited relates to capacitive load.
		Output gradient increase & Output gradient decrease ☑☰ increasing | decreasing ⚙ 1 – 65534 [% P_{lim}/min] / ◦ 65534 [% P_{lim}/min] / ◠ 1	In addition to configuring the dynamic behavior using the setting time corresponding to a first-order filter, the reactive power setting can be determined by a maximum gradient – this means the maximum change in the reactive power per time period. Maximum change in the reactive power %P_{lim}/min in the event of a change to overexcited mode **NOTE: The gradient is overlaid with the settling time.**
		Settling time ⚙ 1,000 – 120,000 [ms] / ◦ 1,000 [ms] ◠ 10	Determines the dynamic behavior in the event of a change in the Q target value. With a change of the reactive power or the lock-in and lock out voltage, the Q is changed according to a PT-1 characteristic curve with a settling time of 3 Tau.
		Cos-phi(P)	
		Lock-in voltage 10 – 126.6 [% Unom] / ◦ 80 [% Unom] / ◠ 1 [0.1]	The control function is enabled above this voltage.
		Lock-out voltage ⚙ 10 – 126.6 [% Unom] / ◦ 80 [% Unom] / ◠ 0.1	The control function is disabled below this voltage.
		Power gradient increasing & power gradient decreasing ⚙ 1 – 65534 [% P_{lim}/min] / ◦ 65534 [% P_{lim}/min] / ◠ 1	Maximum change in the reactive power %P_{lim}/min in the event of a change to overexcited mode. **NOTE: The gradient is overlaid with the settling time.**
		Settling time ⚙ 1000 – 120000 [ms] / ◦ 5000 [ms] ◠ 10	Determines the dynamic behavior in the event of a change in the cos ϕ set value. With a change of the active power or the lock-in and lock out voltage, the cos ϕ is changed according to a PT-1 characteristic curve with a settling time of 3 Tau.
		Number of nodes ⚙ 2 – 10	Specify the number of nodes for the cos ϕ/(p/pn) characteristic curve.
		Number of nodes ⚙ 2 – 10	Specify the number of nodes for the Q(P) characteristic curve.
		1st node … 10th node ⚙ 0V - Max. voltage in continuous operation	Power of the node as a percentage of the maximum power. 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. Note: Storage inverters only for feed-in operation

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Country-spec. Settings	Menu level	Display/ Setting	Action in this menu/meaning
		⚙1 – 0,3 / ◦ 1 / ◓ 0.001	Reactive power of the node as a percentage of the maximum power.
		⚙ Over-excited | under-excited	Reactive power mode: Under-excited relates to inductive load, over-excited relates to capacitive load.
		Q(U) 10 samples	
		Lock-in power ⚙ 0 – 100 [% S_{lim}] / ◦ 20 [% S_{lim}] / ◓ 1	Power threshold, function is activated if limit value is exceeded.
		Lock-out power ⚙ 0 – 100 [% S_n] / ◦ 5 [% S_n] / ◓ 1	Power threshold, function is activated if limit value is undershot.
		Lock-In time ⚙ 0 – 60,000 [ms] / ◦ 30,000 [ms] / ◓ 1,000 [ms]	Length of time that the active power must remain below the lock-in power level before control is deactivated.
		Lock-Out time ⚙ 0 – 60,000 [ms] / ◦ 30,000 [ms] / ◓ 1,000 [ms]	Length of time that the active power must remain below the lock-out power level before control is deactivated.
		Downtime ⚙ 0 -10,000 [ms] / ◦ 0 [ms] / ◓ 1	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 setting time determines the transient behavior.
		Output gradient increase & Output gradient decrease ☐= ☑= increasing | decreasing ⚙ 1 – 65534 [% P_{lim}/min] / ◦ 65534 [% P_{lim}/min] / ◓ 1	In addition to configuring the dynamic behavior using the setting time corresponding to a first-order filter, the reactive power setting can be determined by a maximum gradient – this means the maximum change in the reactive power per time period. Maximum change in the reactive power %P_{lim}/min in the event of a change to overexcited mode **NOTE: The gradient is overlaid with the settling time.**
		Settling time ⚙ 1000 – 120000 [ms] / ◦ 2000 [ms] ◓ 10	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 setting time = 3 Tau. **NOTE: The settling time is overlaid with the increasing and decreasing gradient.**
		Min. cos-phi Q1 - Min. cos-phi Q4 ⚙ 0 – 1 / ◦ 0 / ◓ 0,001	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.
		Q1	Minimum cos ϕ in overexcited operating mode (in-feed).
		Q4	Minimum cos ϕ in underexcited operating mode (in-feed).
		Q2	Minimum cos ϕ in overexcited operating mode (charge).
		Q3	Minimum cos ϕ in underexcited operating mode (charge).

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Country-spec. Settings	Menu level	Display/ Setting	Action in this menu/meaning
		Voltage dead band ⚙ 0 – 5 [% Uref] ◦ 0.0 ◓ 0.1	The control is activated above this voltage.
		Q(U) Offset (temporary) U offset ⚙ -100 -100 [% Slim] / ◦ 0.0 [%Slim] / ◓ 0.1 Q offset ⚙ -100 -100 [% Slim] / ◦ 0.0 [%Slim] / ◓ 0.1	Power threshold, function is activated if limit value is exceeded.
	1 2 3 4	Q minimum ⚙ 0 – 100 [% Slim] / ◦ 0 [% Slim] / ◓ 0.1	☞ Set the reactive power Q to a minimum value.
		⚙ Under-excited | over-excited	☞ Select the type of phase shift. **NOTE: Under-excited relates to inductive load, over-excited relates to capacitive load.**
	1 2 3 4	Q maximum ⚙ 0 – 100 [% Slim] / ◦ 0 [% Slim] / ◓ 0.1	☞ Set the reactive power Q to a maximum value.
		⚙ Under-excited | over-excited	☞ Select the type of phase shift. **NOTE: Under-excited relates to inductive load, over-excited relates to capacitive load.**
US, UD		Autonomous adjustment Vref	The autonomous adjustment of the reference voltage enables a dynamic reactive power function. As a result, the reference voltage of the Q(U) characteristic curve is dynamically adjusted to the grid voltage via a PT1 filter.
US, UD		Time constant Vref adjustment ⚙ 300 – 5000 [s] ◦ 300 s	The time constant defines the control speed at which the reference voltage of the Q(U) characteristic curve is equalized to the grid voltage.
		Priority mode ☑ Q priority | P priority	P-priority can be selected as an alternative to the standard setting Q-priority. When it comes to P-priority, the reactive power adjustment range is limited subject to the limited apparent power of the inverter and the active power that is currently available and fed in.
		Active curve ⚙ 1 – 4 / curve 1 TMP / curve 2 / curve 3 / curve 4	Up to four characteristic curves can be configured independently and one of them can be activated for regulation each time.
		Number of nodes ⚙ 2 – 10	Specify the number of nodes for the Q(U) characteristic curve.
		1st node … 10th node ☑ **Power** | Voltage | Excitation ⚙ 0 – 100 [% S_{lim}] / ◦ 43.6 [% S_{lim}] / ◓ 0.1	Power of the node as a percentage of the maximum power. 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.
		☑ Power | **Voltage** | Excitation ⚙ 0 – 125 [% S_{lim}] / ◦ 43.6 [% U_{nom}] / ◓ 0.1	Voltage of the node in volts The voltage values of the nodes must increase continuously. At 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.

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Country-spec. Settings	Menu level	Display/ Setting	Action in this menu/meaning
		Power | Voltage |**Excitation** ⚙ Over-excited | under-excited	Reactive power mode: Under-excited relates to inductive load, over-excited relates to capacitive load.

10.2 Regulating active power

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.

The transient response of the control methods is determined by a PT-1 filter. In this case, the settling time corresponds to 3 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.

Methods for active power regulation

Methods for regulating 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 interconnected grid.

The device makes use of the following functions in order to regulate the active power. These are described in the following section:

- P target value (MPPT(communication)) [See section 10.2.1 Page 94]
- P limit (communication) [See section 10.2.2 Page 94]
- P(U) (characteristic curve) [See section 10.2.3 Page 95]
- P(f) (characteristic curve) [See section 10.2.4 Page 97]

10.2.1 P target value

NOTE: A change to PSet only becomes effective if the associated Enable write command is transmitted in the same write operation.

The function "P target value" is integrated into the MPP tracking of the inverter on all PV inverters. The P target value is continuously re-calculated on the basis of the MPP tracking algorithm.
The model 704 (DER AC Controls) also fulfills the current market requirements.

10.2.2 P limit

NOTE: A change to PLim only becomes effective if the associated Enable write command is transmitted in the same write operation.

The function "P limit" is available for limiting the maximum feed-in power. If necessary, this can be used to reduce the maximum possible feed of an inverter, e.g. for managing bottlenecks for the operator of the distribution grid.

P limit is only available via the MODBUS/SunSpec inverter model 123 `Immediate Inverter Controls` and via RS485 communication. You can find detailed information on the communication protocol at www.kaco-newenergy.de in the "Software" subsection of the "Downloads" section.

When a target value is received for P limit, the output power of the inverter is limited to the specified power value. If the limit value is changed, the new value is adopted by way of a filter and a gradient limitation. The current power may be below the specified limit value because the available power (PV) or the target power value (storage) may be below the specified limit value. Depending on the inverter series, the settling time and gradient limitation may be adjustable.

Model	Parameters	Scaling factor	R/RW	Area	Description
123	`WMaxLimPct` Power limitation	`WMaxLimPct_SF`	RW	⚙ 0 – 100 [%]	Set the power limitation to a certain % value.
123	`WMaxLimPct_RvrtTms` Timeout		RW	⚙ 0 – 1000 [s]	Specifies the time after which the inverter, if it does not receive a new power limitation, will cancel it.

Model	Parameters	Scaling factor	R/RW	Area	Description
					If the `Timeout` is set to `0` seconds, the transmitted power limitation is permanently retained, even in the event of a communication timeout. Note: when the device is restarted, the `timeout` is reset to the default value.

If the applicable grid connection guidelines call for the active power to be adjusted to the target value with a defined gradient or a defined settling time, then the device can be configured in such a way that this gradient is adhered to. In addition, the gradient can also be implemented on the plant controller. This second solution is to be used for all other inverters.

10.2.3 Voltage-dependent power reduction P(U)

If it is not possible to compensate adequately for increase in voltage in the upstream distribution network by intake 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. P(U) control is implemented as an absolute power limit. The actual power of the inverter may vary freely below this limit due to a possible fluctuation in the available power or the target value, but at no time increases above the absolute power limit.

[See figure 93 [▶ Page 95] and [See figure 94 [▶ Page 95] are two examples of configuration. In figure 1 without hysteresis, the function is activated as soon as the voltage exceeds the configured voltage of data point 1 (dp1). The power limit follows the characteristic curve, a straight line between dp1 and dp2. The function is deactivated as soon as the voltage falls below dp1. In [See figure 94 [▶ Page 95], the function is activated as soon as the voltage exceeds the configured voltage of dp2. In this case, dp1 does not result in activation of the function because the power limit remains at 100%. The power limit follows the characteristic curve, a straight line between dp2 and dp3. However, because hysteresis is activated, the power limit is not increased when the voltage drops. The function is deactivated as soon as the voltage falls below dp1.

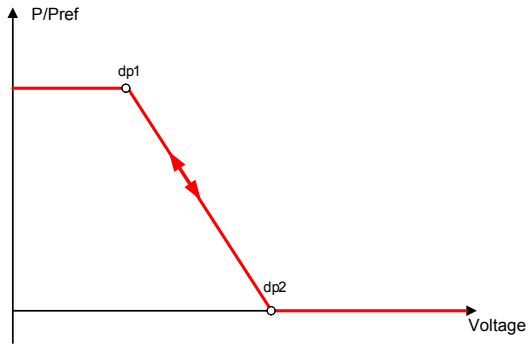


Fig. 93: Example characteristic curve without hysteresis

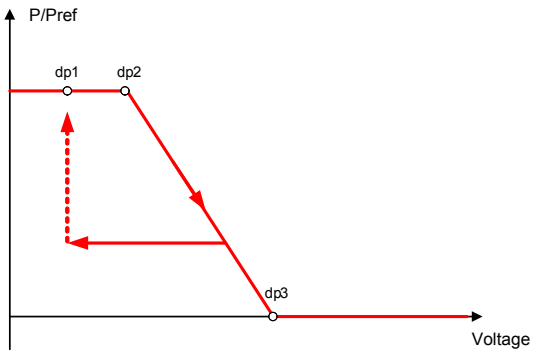


Fig. 94: Example characteristic curve with hysteresis and a deactivation threshold below the activation threshold

10.2.3.1 Parameters for P(U)

Country-spec. Settings	Menu level	Display/ Setting	Action in this menu/meaning
	1 2 3 4	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.
		Reference power ☑ Actual power | Nominal power	Specifies the power reference for the characteristic curve. 100 % here corresponds to the nominal power or the actual power at the time the function was activated, the time when the voltage passes the configured node.

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Country-spec. Settings	Menu level	Display/ Setting	Action in this menu/meaning
	1 2 3 4	Evaluated voltage ☑ Maximum phase voltage | Positive sequence voltage	☞ Select the voltage to be rated. Specifies which voltage is evaluated in a three-phase system.
		Hysteresis mode ☑ Off | On	**Off:** In non-hysteresis mode, the active power is increased immediately with dropping voltage. **On:** In hysteresis mode, the power is not increased with dropping voltage. .
		Deactivation gradient ⚙ 0 – 65,534 [% / min] / 100 [% / min] / 1	If the available power is above the actual output at the time of deactivation, the power increase back to the maximum power is limited. The limitation is implemented by an absolute power limitation that increases with a continuous gradient up to the maximum power. The actual power of the inverter may vary freely below this limit due to a possible fluctuation in the available power or the target value, but at no time increases above the absolute power limit.
		Deactivation time ⚙ 0 – 60000000 [ms] / 100 [ms] 1	Only evaluated with activated hysteresis mode: Monitoring time during which the voltage must remain below the lowest configured node before the function is deactivated.
		Output gradient limitation increase & Output gradient limitation decrease ⚙ 1 – 65,534 [%/Min] / 65,534 [%/min] / 1	Specifies the dynamic response on changing the active power for power increase. With a voltage change, the active power is changed with the specified gradient. The gradient is overlaid with the settling time. Specifies the dynamic response on changing the active power for power decrease. With a voltage change, the active power is changed with the specified gradient. The gradient is overlaid with the settling time.
		Settling time ⚙ 1000 – 120000 [ms] / 2000 [ms] / 10 [ms]	Determines the dynamic behavior in the event of a change in the active power set value. With a voltage change, the active power is changed according to a PT-1 characteristic curve with a settling time of 3 Tau. **Note:** The settling time is overlaid with the increasing and decreasing gradient.
	1 2 3 4	Active curve ⚙ 1 - 5	☞ Select the active curve. **NOTE: Up to 5 characteristic curves can be configured independently and one of them can be activated for regulation each time.**
		Number of nodes ⚙ 2 - 5 Power ⚙ 0.0 – 100.0 [% P_{ref}] / 100.0 [% P_{ref}] / 0.1 Voltage ⚙ 80.0 – 126.0 [% U_{nom}] / 112.0 [% U_{nom}] / 0.1	up to 5 support points definable The power value of the first and last value pair is also used as the maximum or minimum active power value that is valid across the limits of the characteristic curve.

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10.2.4 P(f)

Adjusting the active power P(f) in the event of overfrequency

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.

PV systems must adapt their feed-in power relative to the frequency deviation. In the event of overfrequency, the power adjustment is determined by a maximum feed-in limit. The actual power of the inverter may vary freely below this limit due to a possible fluctuation in the available power or the target value, but at no time increases above the absolute power limit.

$$P_{max-limit} = P_M + \Delta P$$

Fig. 95: Equation 1

$$\Delta P = g \cdot P_{ref} \cdot (f_1 - f)$$

Fig. 96: Equation 2

Equation 1 [See figure 95 [▶ Page 97] defines the maximum limit with ΔP according to Equation 2 [See figure 96 [▶ Page 97], P_M the actual power at the moment of activation and P_{ref} the reference power. In the case of PV inverters from KACO, P_{ref} is defined as P_M, the current power at the time of activation. f is the current frequency and f_1 is the specified activation threshold.

$$\Delta P = \frac{1}{s} \times \frac{(f_1 - f)}{fn} \times Pref$$

Fig. 97: Equation 3

$$g = \frac{1}{s \cdot f_n}$$

Fig. 98: Equation 4

In some standards, the power adjustment is not defined by a gradient (g), but by a slope (s), as given in equation 3 [See figure 97 [▶ Page 97]. The slope s can be converted into a gradient g according to equation 4 [See figure 98 [▶ Page 97].

During an overfrequency event, the frequency f is above the activation threshold f_1. Consequently, the expression (f_1 – f) is negative and ΔP corresponds to a reduction in the feed-in power.

The measurement accuracy of the frequency is greater than 10 mHz.

The specific mode of operation of the function is specified by the grid operator or by the applicable standards or grid connection directives. The configurability of the function makes it possible to adhere to a wide range of standards and directives. Certain configuration options are not available in some country settings because the pertinent standards or grid connection directives prohibit adjustments.

Adjusting the active power P(f) in the event of underfrequency

Some grid connection guidelines also require adjustment of the active power P(f) in the event of underfrequency. Due to the fact that PV systems are typically run at the maximum power point, there are no power reserves for increasing the power in the event of underfrequency.

However, in the event that the system power is reduced due to market regulation, it is possible to increase the active power up to the power level available. Because the inverter is unable to distinguish between P constant target values for obligatory bottleneck management by the grid operator and for market regulation, this needs to be implemented in the site-specific infrastructure of system control.

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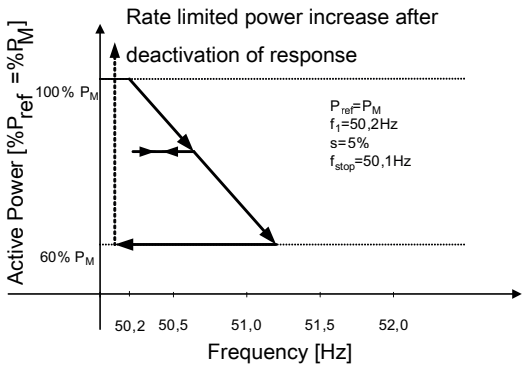


Fig. 99: Example behavior with hysteresis (mode 1)

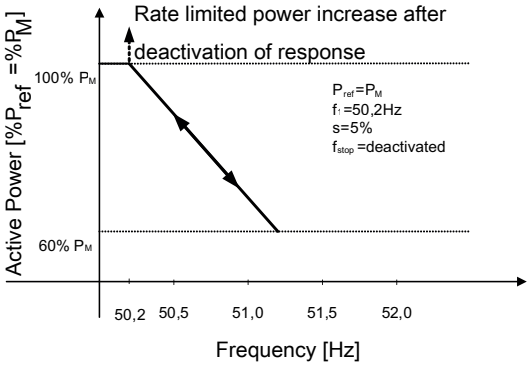


Fig. 100: Example behavior without hysteresis (mode 2)

10.2.4.1 Parameters for P(f)

Country-spec. Settings	Menu level	Display/ Setting	Action in this menu/meaning
		P(f) operation mode ☑ Off | Mode 1 | Mode 2 | Mode 3	Activate or deactivate function. **Mode 1:** With hysteresis activated – Limit **Mode 2:** Without hysteresis activated – Limit **NOTE: In mode 1 & 2, the power below or above the characteristic curve (depending on over- or underfrequency) is adjusted via a Pset command. Plim can also limit the power with an active P(f) characteristic curve.** **Mode 3:** Without hysteresis activated – Set **NOTE: In mode 3, the pre-fault power is stored and the power moves along this characteristic curve.**
		Dynamic gradient mode ☑ On | Off	☞ Activate dynamic gradient. **NOTE: Gradient "Feed-in/charging with over/under frequency" is not displayed.**
		Maximum dynamic gradient frequency ⚙ 50.22 – 70.5 [Hz] 🕭 0.01 [Hz] Minimum dynamic gradient frequency ⚙ 45 – 50 [Hz] 🕭 0.01 [Hz]	**Dynamic gradient maximum frequency:** If dynamic gradient mode is activated, the gradient is calculated in order to guarantee a linear power adjustment and reach the maximum charging power if the frequency rises to the maximum configured frequency. **Dynamic gradient minimum frequency:** If dynamic gradient mode is activated, the gradient is calculated in order to guarantee a linear power adjustment and reach the maximum feed-in power if the frequency drops to the minimum configured frequency.

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Country-spec. Settings	Menu level	Display/ Setting	Action in this menu/meaning
		Activation threshold at underfrequency 40 – 50 [Hz] / 40 [Hz] / 0.01 Activation threshold at overfrequency 50 – 60 [Hz] / 50.02 [Hz] / 0.01	**Activation threshold (f1) underfrequency:** Determines the frequency threshold for activating the function in case of underfrequency incidents. The active power adjustment is activated if the frequency falls below the configured value and mode 1 or 2 is activated. In mode 2, the function is deactivated if the frequency rises above the configured value. **Activation threshold (f1) overfrequency:** Determines the frequency threshold for activating the function in case of overfrequency incidents. The active power adjustment is activated if the frequency rises above the configured value and mode 1 or 2 is activated. In mode 2, the function is deactivated if the frequency falls below the configured value.
		Threshold Area lower limit [Hz] 40 – 50 [Hz] / 47.5 [%/Hz] / 0.01	Only evaluated in mode 1. The function is deactivated if the frequency returns to the deactivation range and remains in this range for the duration of the deactivation time.
		Threshold Area upper limit [Hz] 50 – 60 [Hz] / 50.5 [Hz] / 0.01	
		P(f) deactivation time 0 – 6000000 [ms] / 0 [ms] 1	Only evaluated in mode 1. The function is deactivated if the frequency returns to the range between the minimum and maximum deactivation threshold and remains in this range for the duration of the deactivation time.
		Deact. lim. time after fault 0 – 1000 [s] / 0 [ms] / 1000 [s]	Only evaluated in mode 2&3. After the end of the fault, the change in active power is limited to the set gradient for the specified time.
		Deact. grad. incr. after fault & Deact. grad. decr. after fault 0 – 65,534 [% / min] / 10 [% / min] / 1	Specifies the dynamic response on changing the active power for power increase and power decrease. Any change in active power is limited to the set value for the set duration.
		P(f) intentional delay 0 – 5000 [ms] / 0 [ms] 1	The activation of the function based on the activation threshold is delayed by the configured time. Note 1: This function is regarded as critical for the stability of the transmission grid and is therefore prohibited by several national grid connection regulations. Note 2: This function is stipulated as a requirement by some domestic grid connection directives in order to prevent any negative impact on island detection. However, P(f) has no negative impact on KACO's enhanced island detection.
		P(f) settling time 200 – 2000 [ms] / 200 [ms] 1	Determines the dynamic behavior in the event of a change in the active power limit. In the event of a change in frequency, the active power is altered subject to a PT-1 characteristic curve using a settling time of 3 Tau. The settling time is overlaid with the increasing and decreasing gradient.

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Country-spec. Settings	Menu level	Display/ Setting	Action in this menu/meaning
		Output gradient limitation increase & Output gradient limitation decrease 0 – 65,534 [%/Min] / 65,534 [%/min] / 1	Specifies the dynamic response on changing the active power for power increase and decrease. With a voltage change, the active power is changed with the specified gradient. **Note:** The gradient is overlaid with the settling time.
		P(f) deactivation gradient 1 – 65,534 [% S_{lim}/min] / 10 [% S_{lim}/min] / 1	If the available power is above the actual output at the time of deactivation, the power increase back to the maximum power is limited. The limitation is implemented by an absolute power limitation that increases with a continuous gradient up to the maximum power. The actual power of the inverter may vary freely below this limit due to a possible fluctuation in the available power or the target value, but at no time increases above the absolute power limit.

10.3 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.

10.3.1 Dynamic grid support by way of immunity to interference

Voltage drop above the limit curve (see figure below) 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.

The inverters can ride through voltage fluctuations as long as the voltage level does not remain above the continuous operating voltage range for more than 100 s and does not exceed the short-term maximum operating voltage range (up to 100 s). The specific values for each inverter can be found here.

The interface protection (voltage, frequency, anti-islanding) integrated in the inverter can be set within a range that permits the above behavior. However, if the interface protection setting limits the voltage-time characteristic curve, then the interface protection will trip and interrupt the ride-through as configured.

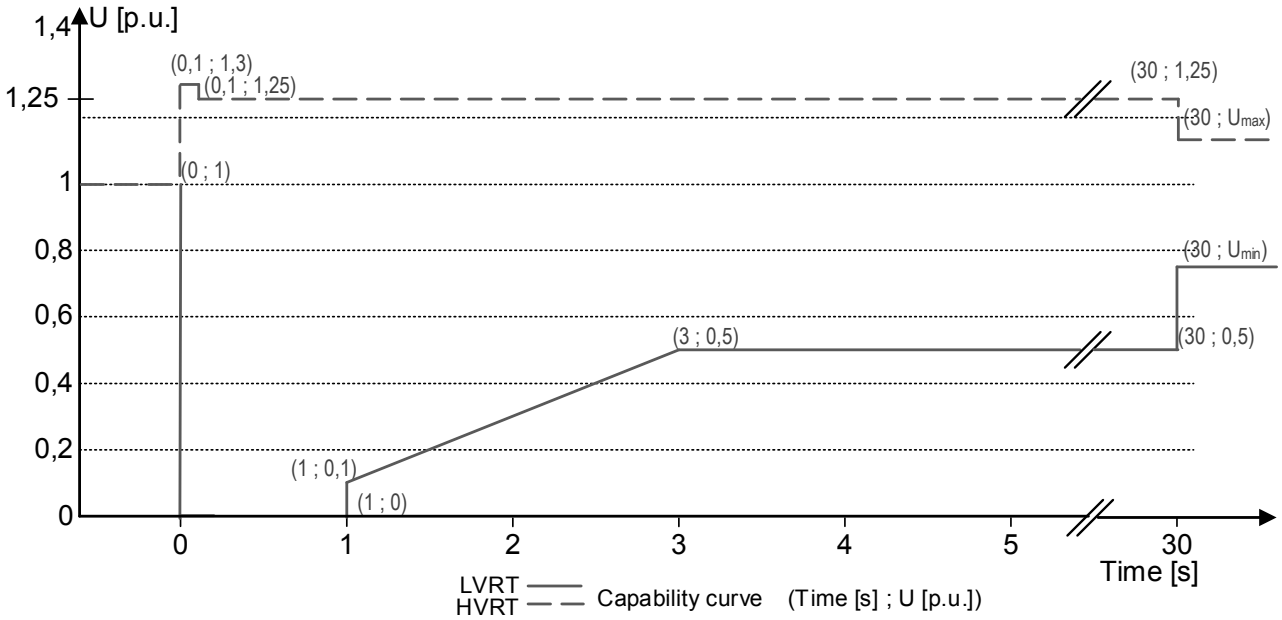


Fig. 101: Immunity to interference characteristic curve relative to the nominal voltage

10.3.2 Dynamic grid support using a fast feeding of residual current

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 dip or swell is detected if either the normal operating voltage range setting is exceeded by at least one phase-phase or phase-PE voltage, or if a voltage jump in the positive or negative sequence component greater than the dead band setting occurs. The magnitude of the voltage jump of the positive and negative sequence corresponds 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-periods mean value.

$$\Delta u = \frac{U - U50per}{Uref}$$

Fig. 102: Formula n° 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:

$$I_b = \Delta u * k * I_{max}$$

Fig. 103: Formel Nr. 2 , abhängig vom Dauerstrom Imax des Wechselrichters

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 max. reference voltage. The pre-fault voltage is calculated as a 1-min mean value.

$$\Delta u = \frac{U - U1min}{Uref}$$

Fig. 104: Formula n° 3

On account of the definition of a voltage jump in EN 50549-2 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

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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 configured minimum support time, usually 5 s.

If the zero current threshold is exceeded, the inverter stops feeding current into the grid. If the inverter feeds in reactive power before the fault occurs, the reactive power is reset to the value prior to the fault Q after the fault has ended using the settling time set in the activated reactive power control mode.

$$I = (\Delta u_1 - tb) * k * I_{max}$$

Fig. 105: Formula n° 4

10.3.3 Parameters for FRT

Country-spec. Settings	Menu level	Display/ Setting	Action in this menu/meaning
	1 2 3 4	FRT (Fault Ride Through)	**NOTE: The device supports dynamic grid stabilization. More detailed information at:** [See section 10.3 Page 100]
		Operating mode – On | Off Setting | Manual |Predefined zero current	**Setting: Manual** All parameters can be configured independently. **Setting: 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 configured.
		Priority – Reactive current limitation | Active current priority	**Priority: Reactive current priority** 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 formulas (2) and (4). **Priority: Effective current priority** Dynamic grid support active on account of immunity to interference and fast feeding with active current priority. The inverter feeds in as much active power as available. If, as a result of this, the maximum continuous current is not achieved, the inverter supplies additional reactive current according to the formulas (2) and (4) up to the limit of continuous current.
		Zero current threshold undervoltage Zero current threshold overvoltage 0 – 80 [% Unom] / 10 [% Unom] / 0.1 108 – 129 [% Unom] / 125 [% Unom] / 0.1	If one or more phase/phase or phase/neutral conductor voltages move above the configured threshold, the inverter changes to zero current mode. The total current is regulated to virtually zero.
		Reference voltage 80 – 110 [% Unom] / 100 [% Unom] / 0.1 [Unom]	Nominal value of the phase/neutral conductor voltage used as a reference voltage for formula (1) and (3). Adjustable in the range from level 1 undervoltage protection to level 1 overvoltage protection.
		Constant k negative sequence dip Constant k negative sequence swell k 0 – 10 / 2 / 0.1	Amplification factor for the negative sequence used in the calculation of the reactive current using formulas (2) and (4). Can be configured independently for drops and spikes.

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Country-spec. Settings	Menu level	Display/ Setting	Action in this menu/meaning
		Constant k positive sequence dip & Constant k positive sequence swell ⚙ k 0 – 10 / ◦ 2 / ◓ 0.1	Amplification factor for the positive sequence used in the calculation of the reactive current according to Equations (2) and (4). Can be configured independently for voltage dips and voltage swells.
		Dead band ⚙ 2 – 120 [% Uref] / ◦ 10.0 [% Uref] / ◓ 0.1	Dynamic grid support through fast feeding of residual current activated in the case of voltage events with a voltage change greater than the dead band.
		Reference voltage 80 – 110.0 [% Unom] / ◦ 100 [% Unom] / ◓ 0.1 & Minimum operating voltage activation 45 – 125.0 [% Unom] / ◦ 80 [% Unom] / ◓ 0.1 & Maximum operating voltage activation 45 – 125.0 [% Unom] ◦ 80 [% Unom] / ◓ 0.1	Dynamic grid support via fast feeding of residual current is activated on voltage events with at least one phase/phase or phase/neutral conductor voltage outside the configured normal operating voltage range. Dynamic grid support via fast feeding of residual current is deactivated when the voltage returns to the reference operating voltage range.
		Minimum operating voltage deactivation ⚙ 0 – max [V] ◓ 1 [V] & Maximum operating voltage deactivation ⚙ 0 – max [V] ◓ 1 [V]	Dynamic grid support via fast feeding of residual current is deactivated when the voltage is within the configured deactivation range. This parameter is only available for the country settings VDE 4105, CH 4105 and UD.
		Dynamic reactive current only ☑=Off | On	**Standard**: The reactive current according to the formulae (2) and (4) is fed as **additional** reactive current. The means that sum of the pre-fault and additional reactive current is fed in. **Only dynamic:** The reactive current according to the formulas (2) and (4) is fed in as absolute reactive current. This means that regardless of the reactive current before the voltage event, only the reactive current according to the formulas (2) and (4) is fed in during the voltage event.
		Dead band mode Mode 1 | Mode 2	**Mode 1**: When calculating the reactive current, the value of the dead band is not subtracted from the amount of voltage change. As such, formula (2) applies to overvoltage and undervoltage incidents. **Mode 2:** When calculating the reactive current, the value of the dead band is subtracted from the amount of voltage change. For overvoltage and undervoltage events, formula (4) therefore applies: $I = (\Delta u_1 - tb) * k * I_{max}$
		Reactive current limitation ⚙ 0 – 100 [% Imax] / ◦ 100 [% Imax] / ◓ 1	The reactive power component of the fast feeding of residual current is limited to permit a defined proportion of active power components.

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Country-spec. Settings	Menu level	Display/ Setting	Action in this menu/meaning
		Minimum support time ⚙ 1000 – 15000 [ms] / 5000 [ms] 🕭 10	If due to a voltage jump in accordance with formula (1) and the configured dead band is activated, the dynamic grid support is deactivated via fast feeding of residual current after the minimum support time elapses.
IL_L, IL-MV and UD.		Deactivation delay ⚙ 0 [ms] / 0 – 500 [ms] IL_LV / UD / 500 [ms] IL-MV / 🕭 1	Deactivates the dynamic power support after the desired delay as soon as the voltage returns to the normal operating range. This parameter is only available for the country settings IL_LV, IL-MV and UD.

10.4 Other grid-supporting functions that are effective in the case of active power

10.4.1 Permanent power gradient limitation

The maximum active and apparent power to be installed for a generation 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} and P_{lim} settings. To ensure that the load on the devices in the plant is uniform, we recommend distributing the performance reduction evenly across all devices.

Some grid connection rules insist that the agreed reactive power be supplied from every operating point of the plant without a reduction in the actual active power. Because KACO devices have the full P-Q operating range, a reduction in the active power is, however, 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 establish an apparent power reserve and ensure that the agreed reactive power can be delivered from any active power operating point. The graphic [See figure 106 [▶ Page 104] shows the appropriate P-Q operating range with a required example active power of 48% of the maximum apparent power of the plant or 43% of the maximum active power of the plant.

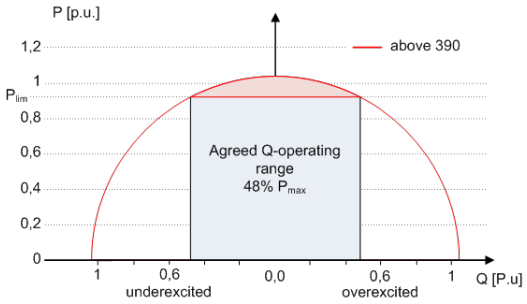


Fig. 106: P-Q operating range with limited active power (Qmax=Smax≠Pmax) for PV inverters

The power reduction parameters can be adjusted in SunSpec model DID123. During this process, you should also check whether internal and/or external power reduction is active.

Internal power limitation	Parameters for external power limitation	Parameters for power limitation
Status = active	Status = active	Parameters in SunSpec model 123:
Maximum apparent power S_{lim}=**100000 VA**		"WMaxLimPct" = 50% P_{lim} (**approx. 40000 W**) "WMaxLimPct_RvrtTms" = **60s** "WMaxLimPct_RmpTms" = **2s** "WMaxLim_Ena" = **1**
Maximum active power P_{lim}= **80% (approx. 80000 W)**	AC fallback active power Pfb = **75%** P_{lim} **(approx. 60000 W)**	
	PT1 settling time = 1s	

Tab. 8: Sample parameters for power limitation

If the ramp time "`WMaxLimPct_RvrtTms`" in the SunSpec model is specified as 0 s, then the internal output gradient is used. Otherwise, the set value will be used.

Irrespective of the communication protocol used, the settling time "`WMaxLim_Ena`" is used in order to transfer the new power value. Otherwise, the internally configured value will be used.

The additional ramp time "`WMaxLimPct_RmpTms`" specifies the jump time from a power value to the new power value.

The following formulae are used to calculate the gradient $S_{lim/min}$:

$$\text{GradientWattPerMin} = \frac{\left(\frac{WMaxLimPct}{100} \times Plim - Pactual\right)}{WMaxLimPct_{RmpTms}} \times 60 \times \frac{100}{Slim}$$

$$\text{GradientWattPerMin} = \frac{\left(\frac{50\%}{100} \times 80000\ W - 60000\ W\right)}{2\ s} \times 60 \times \frac{100}{100000 VA}$$

$$\textbf{GradientWattPerMin} = -600\ \%\ \boldsymbol{Slim}\ \boldsymbol{/min}$$

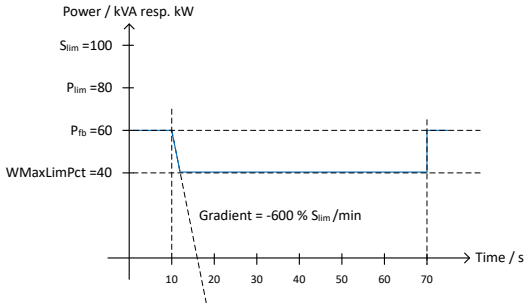


Fig. 107: Power gradient according to sample parameters and calculation

The following formulae are used to calculate the Q filter parameter and cos ϕ gradient:

$$\text{GradientVArPerMin} = \frac{\left(\frac{VArMaxPct}{100} \times Slim - Qactual\right)}{VArPct_RmpTms} \times 60 \times \frac{100}{Slim}$$

Fig. 108: Formula for calculating the Q filter parameter

$$\text{GradientVArPerMin} = \frac{\left(\frac{VArMaxPct}{100} \times Slim - Qactual\right)}{OutPFSet_RmpTms} \times 60 \times \frac{100}{Slim}$$

Fig. 109: Formula for calculating the cos ϕ gradient (internal power gradient)

10.4.1.1 Parameters for permanent power limitation

Country-spec. Settings	Menu level	Display/ Setting	Action in this menu/meaning
		Power limitation ☑ Check activation	Activate or disable the power limitation.
		Maximum apparent power (S_{lim}) 1000 – S_{max} [VA]	The apparent power is limited globally to the configured value in VA. As soon as S_{lim} has been configured, all of the active and reactive power control values will use S_{lim} as 100% instead of S_{max}.
		Maximum active power (P_{lim}) 1 – 100 [% S_{lim}]	Active power is limited globally to the configured value in % S_{lim}.

10.4.2 Soft start up / power ramp-up limiting

A soft start-up function is available to prevent the grid from being negatively impacted by a sudden increase in feed-in power from the inverters.

When the inverter is activated or 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.

The soft start up is implemented by an absolute power limitation that increases with a continuous gradient up to the maximum power. The actual power of the inverter may vary freely below this limit due to a possible fluctuation in the available power or the target value, but at no time increases above the absolute power limit.

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10.4.2.1 Parameters for soft start-up

Country-spec. Settings	Menu level	Display/ Setting	Action in this menu/meaning
	1 2 3 4	Power ramp	**NOTE: Power ramp-up is used to ramp up the power gradually.**
		Gradient ⚙ 1 - 600 [% / min]	Increase in power limitation. The maximum power limitation increases to 100% of the nominal power with the specified gradient.
		Rampup on every connect	The soft start ramp is activated each time the inverter is connected to the grid.
		Rampup on first connect	The soft start ramp is activated for the first connection of the inverter to the grid on a specific day or after a complete restart of the inverter (AC and DEC disconnected).
		Rampup after grid failure	The soft start ramp is activated when the inverter is connected to the grid after the internal interface protection is triggered or via the external grid protection connection (power protection).

10.4.3 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.

The function is not active for power changes defined by another grid support function, such as power recovery after Fault Ride Through, P(f), P(U).

10.4.3.1 Parameters for power gradient in normal operation

Country-spec. Settings	Menu level	Display/ Setting	Action in this menu/meaning
		Operating mode ⚙ On / Off	Activate or deactivate the power gradient limitation in normal operation.
		Increasing gradient ⚙ 1-65534 [% S_{max} / min]	The change in the active power is limited to a configured power increase gradient.
		Falling gradient ⚙ 1 – 65534 [% S_{max} / min]	The change in the active power is limited to a configured power decrease gradient.

10.5 Advanced islanding detection

Due to decentralized power generation, it is possible for a disconnected section of the grid to remain energized as an unintentional island if there is a local balance between load and generation within that section of the grid.

Detecting unintentional islanding is an essential function of distributed generation units. It helps prevent equipment damage and ensures personnel safety.

Due to the structure and operation of the distribution grid, several hazards may arise:

- During maintenance work on a distribution grid, personnel may be exposed to danger if the disconnected section of the grid remains energized as an island. This is especially true if all safety procedures are not followed.
- If fast automatic reclosing is used in a distribution grid and the disconnected section remains energized as an island, reclosing is likely to occur with a phase shift, which may damage rotating machines connected to the grid.
- In the event of a fault in a medium-voltage grid, the faulty section is disconnected. If the fault has significant impedance, the disconnected section of the medium-voltage grid may remain energized as an island. Depending on the type of fault, and particularly in the case of a transformer fault, hazardous medium voltage may become accessible, potentially even at low-voltage equipment.

Especially in the last example, very rapid disconnection of grid-connected units is required to collapse the unintentional island. At the same time, any detection method may cause nuisance tripping. Therefore, the industry continuously develops methods that provide fast and reliable detection while minimizing false trips.

Methods for islanding detection

The advanced islanding detection function uses a strategy based on the different characteristics of an interconnected grid and an islanded grid. This ensures reliable and rapid detection while minimizing nuisance tripping.

An interconnected grid is dominated by rotating machines; therefore, frequency is proportional to the active power balance and voltage is proportional to the reactive power balance. An islanded grid, on the other hand, behaves like a resonant circuit; therefore, frequency is proportional to the reactive power balance and voltage is proportional to the active power balance. The active islanding detection method recognizes this difference by monitoring grid behavior: it observes the natural fluctuations of the grid frequency and injects a minimal amount of reactive power proportional to the rate of change of frequency. At the moment an unintentional island forms, a positive feedback loop is established, enabling the device to detect the changed operating condition and disconnect from the grid. In the event of unintentional islanding, the device disconnects within a few hundred milliseconds, well below 1000 ms.

- The number of units connected in parallel does not affect the reliability of this function.
- The method minimizes its impact on the distribution grid.
- Under normal operating conditions, no measurable effects on harmonic distortion, flicker, or grid stability occur.

This detection method is combined with a two-stage monitoring of the passive Rate of Change of Frequency (ROCOF). If the grid ROCOF exceeds the configured trip threshold (Level 1) for the configured trip delay, the device enters zero-current mode. If the ROCOF exceeds the configured trip threshold (Level 2) for the configured trip delay, the device disconnects from the grid. In the event of unintentional islanding, the island is disconnected immediately. If the grid stabilizes—for example, because the ROCOF event was caused by a short-duration disturbance—the device responds according to the configured level: after a Level 1 event, it resumes normal operation within a few hundred milliseconds; after a Level 2 event, the configured reconnection conditions apply following shutdown.

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10.6 Q on demand

⚠ DANGER

When deactivating the `night shut-off` ("Q on Demand" operation), a high DC voltage can continue to be present not only on the string combiner but also on the device, even though the string combiner is switched off.

1. In case of maintenance, the device must also be deenergized on the AC-side.
2. We recommend attaching an appropriate hazard warning on the string combiner.

The "Q on Demand" function can also provide reactive power Q outside of feed-in mode (e.g. at night) for grid stabilization. The function is only available from the named firmware version onwards [See section 1.1 Page 4].

Important preconditions:

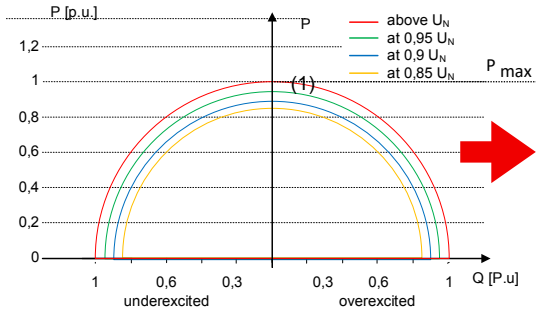
- "Night shutdown" function disabled in the menu
- Device is connected on the AC side
- Device was in feed-in mode.

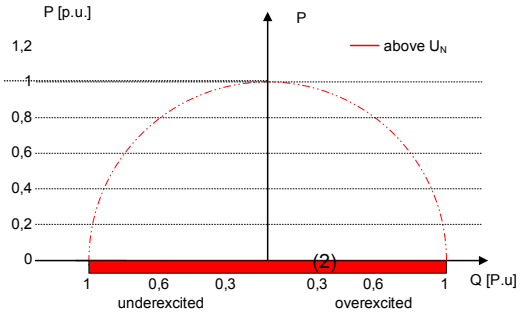
First priority is given to the specifications that the inverter receives from the grid operator via the park controller over Ethernet or RS485. Second priority is given to the parameters stored in the inverter for Q-constant and Q(U).

In the event of AC disconnection during "Q on Demand" mode outside of feed-in mode, it is only possible to use the "Q on Demand" function again after normal feed-in mode (with sufficient DC supply). The existing disabled "night shutdown" also remains active.

The following figures show normal operation in the P-Q operating range, during the day (feed-in mode) (1) and "Q on Demand" operation at night (2).

Only reactive power is generated at night. Inevitably, some active power is required for the internal power supply in order to maintain the pre-set reactive power functions in "Q on Demand" mode (see pos. 2 in the negative P range).
Reactive power control mode setting: See table : Configuration via web user interface [Page 69].





Legend

(1) Normal operation: Active power and reactive power provision at different voltages.

(2) Q on Demand function: Reactive power provision at nominal grid voltage outside feed-in mode.

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11 Maintenance and troubleshooting

11.1 Visual inspection

Inspect the product and cables for visible external damage and note the operating status display, where applicable. 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.



1. Only appropriately qualified electricians authorized by the mains supply network operator are permitted to open and maintain the device.
2. 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.

1. Do not attempt to rectify faults that are described here (in the troubleshooting chapter). Contact our Customer Service department. Only carry out maintenance activities that are described here.
2. Log each maintenance activity in the "Service" menu item: "Service Log" (exception: "User" interface) [See section 9.4.2 Page 57]
3. The device should be checked for proper operation by a qualified electrician at regular intervals and if you experience problems, you should always contact the system manufacturer's Service department.

11.2 Routine check

The maintenance measures listed in this chapter must be carried out at regular intervals in order to maintain the performance and service life of the device.

The following plan defines the recommended maintenance measures and their respective intervals. Compliance with the specified maintenance intervals is a prerequisite for maintaining warranty coverage.

WARNING! All maintenance work shall only be carried out by qualified electrical personnel. Before starting any work, the device shall be de-energized in accordance with the specified shutdown procedure, and a minimum waiting time of 5 minutes shall be observed.

11.2.1 Regular maintenance

No.	Category	Inspection Point	Description	Intervall Standard	Intervall Harsh Environment*	Criticality / Comment	Chapter - Ref.
1	Visual Inspection	Enclosure / Sealing	Inspect the enclosure, seals, and cable glands for damage and moisture.	12 months	6 months	Medium	[See section 7 Page 28]
2	Visual Inspection	Contamination / Air Passages	Inspect air inlets and outlets for dust, plant debris, insects, and deposits.	12 months	3 months	High / For Agri-PV installations, take into account increased contamination caused by mowing and soil cultivation.	[See section 11.3 Page 111]
3	Cooling	Fan Operation	Check the internal and external fans for proper operation, noise, and plausible running behavior.	12 months	6 months	High	[See section 11.3 Page 111]

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No.	Category	Inspection Point	Description	Intervall Standard	Intervall Harsh Environment*	Criticality / Comment	Chapter - Ref.
4	Electrical	AC Connection	Check for secure seating, overheating, corrosion, mechanical stress, and the condition of cable lugs.	12 months	6 months	High	[See section 7.5 Page 30]
5	Electrical	DC Connection / Strings	Check DC connections and cable condition	12 months	6 months	High	[See section 7.6 Page 32]
6	Electrical	Equipotential Bonding / Grounding	Inspect grounding and equipotential bonding connections.	12 months	6 months	High	[See section 7.8 Page 38]
7	Protection	Surge Protection	Check SPD status and the condition of the surge protection devices.	12 months	6 months	High	[See section 11.5 Page 113]
8	Operation	Fault Messages / Events	Review active and historical messages as well as service notifications.	6 months	3 months	High	[See section 11.9 Page 117]
9	Operation	Plausibility of Operating Values	Verify the plausibility of temperatures, status information, power feed-in, voltages, and currents.	6 months	3 months	High	[See section 9.4 Page 56]
10	Grid Behavior	Pset vs. Actual Power	Compare the setpoint and actual power and verify the response to power limitation.	12 months	6 months	High	[See section 10.2 Page 94]
11	Grid Behavior	Reactive Power Behavior	Verify the plausibility of Q control / power factor (cos ϕ) / Q(U) based on operating data.	12 months	6 months	High	[See section 10.1 Page 85]
12	Grid Behavior	Derating Behavior	Check and document thermal and voltage-related derating.	12 months	6 months	Medium	Erweitertes Datenblatt
13	Communication	Ethernet / RS485 / Remote Access	Check communication, logger / SCADA, and remote access.	12 months	6 months	Medium	[See section 8.3 Page 44]
14	Software	Firmware Version	Check the firmware version and evaluate whether an update is required.	12 months	6 months	Medium	[See section 9.3 Page 54]
15	Service	Back Up Log Data	Export and archive service and event logs.	12 months	6 months	Medium	[See section 9.4.2 Page 57]
16	Service	Back Up Parameter Set	Export and document the parameter set.	12 months	6 months	Medium	[See section 9.4.2 Page 57]
17	Documentation	Document Maintenance	Document findings, corrective actions, and replacement parts.	12 months	6 months	Medium	[See section 9.4.2 Page 57]

*) Harsh environment: Sandy locations, coastal proximity (< 500 m), high humidity, industrial environments with dust and/or gas exposure, continuously elevated ambient temperature > 45°C.

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11.3 Cleaning

11.3.1 Cleaning the housing

⚠ CAUTION

Risk of damage to the device during cleaning!

1. Do not use compressed air or high-pressure cleaners.
2. 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.
3. Remove dust from the ventilation inlets if necessary.

11.3.2 Cleaning the heat sink

⚠ WARNING

Risk of burns from hot surface

Heat sinks become very hot during operation.

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

NOTE

Refer to our service and guarantee conditions on our homepage.

✓ The cleaning intervals must be adapted to the environmental conditions of the installation site.

1. In sandy environments, we recommend cleaning the heat sinks and fans every three months.

↻ 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 [See section 11.4 Page 112].
2. Clean the free space between the cover and the heat sink using suitable brushes.
3. Clean the heat sink with a suitable brush.

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

⇨ Cleaning completed - if necessary, remount the fans.

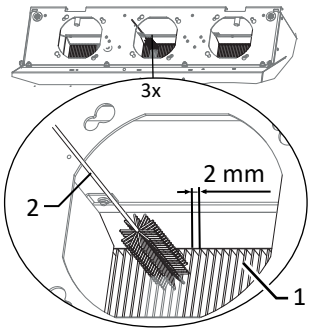


Fig. 110: Cleaning the cooling fins from above

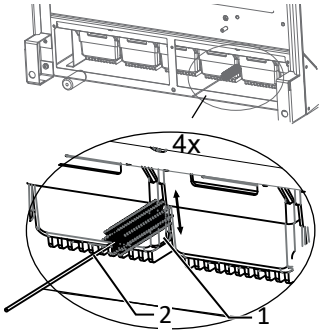


Fig. 111: Cleaning the cooling fins from below

1 Heat sinks / space between heat sinks

2 Brush (max. wire diameter 2mm)

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11.4 Replacing the fans

Removing the cover

↻ Ensure that the device is completely free of AC/DC voltage.

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.

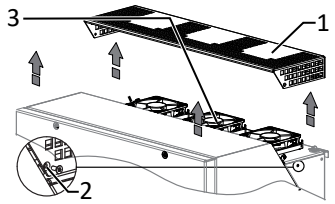


Fig. 112: Removing the cover

1 Cover
2 Fastening screw
3 Mounting clips
4 Fan

Dismounting the fan

↻ Replace fan time requirement: (10 min each fan) 30 min
↻ It has been ensured that there is no AC/DC voltage present.
↻ **DANGER! Risk of injury from starting fans: If the device is not completely disconnected from the voltage source, the fan may start up unexpectedly and sever or injure limbs. This may also cause damage to the fan and impair the functionality of the device.**
↻ 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.

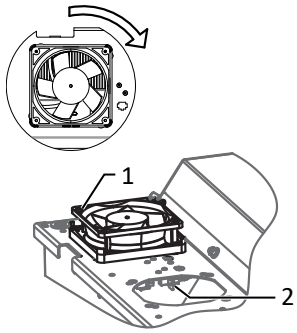


Fig. 113: Removing the fans

1 Fans
2 Connector

Installing the fans

↻ You have removed the defective fan.

1. Plug in the connector plug of the new fan at the connection socket provided within the housing and check the interlock.
2. Insert the replacement fan into the collar holder.
3. Turn the fan approx. 10° anticlockwise.
4. If necessary, insert another fan.

⇨ Fit the cover back in place.

Removing the interior fan

↻ Ensure that the device is completely free of AC/DC voltage.
↻ **DANGER! Risk of injury from starting fans: If the device is not completely disconnected from the voltage source, the fan may start up unexpectedly and sever or injure limbs. This may also cause damage to the fan and impair the functionality of the device.**
↻ Remove the housing cover. [See section 7.2 Page 28]

1. Wait until the interior fan is no longer turning.
2. Loosen the fastening screw from the circuit board.
3. Move the interior fan to the front area.
4. Unlock the power supply to the connector.
5. Detach the fan grille from the housing.
6. Remove dust and dirt particles from the housing.

⇨ Install the replacement fan.

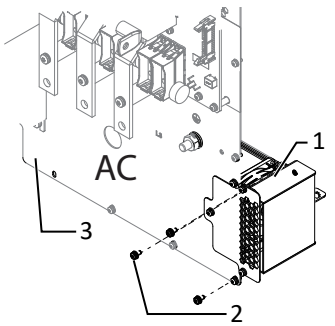


Fig. 114: Removing the interior fan

1 Interior fan
2 Mounting
3 Board

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Fitting the interior fan

NOTE: If an internal fan fails, an error message is displayed and the device limits its output to a maximum of 50% of the maximum possible output, unlike an external fan.

↻ You have removed the interior fan.

1. Slide the collar with the fan lengthways off the housing and lift it out.
2. Carefully pull the connected fan off the collar.
3. Press the replacement fan into the collar holder.
4. Plug the connector plug of the interior fan into the connection socket provided and check that it is locked.
5. Insert the collar with the fan into the housing and check that it is firmly seated.
6. Mount the fan grille on the housing.
7. Mount the ventilating plate on the board.

⇨ Interior fan successfully replaced.

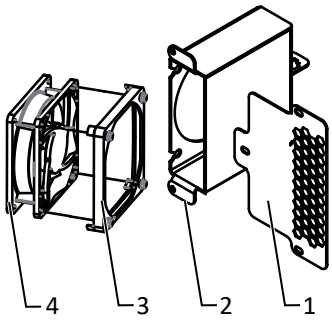


Fig. 115: Disconnecting the interior fan

1 Fan grille
2 Housing
3 Collar
4 Fan

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 / 17.70 In-lbs].

⇨ You may now start up the device [See section 8 Page 43].

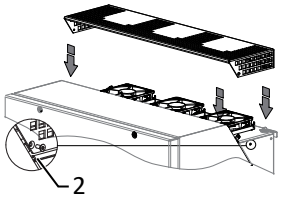


Fig. 116: Fitting the cover

2 Fastening screw

11.5 Replacing overvoltage protection

AC Surge Protection

↻ **NOTE: If the web interface displays the message "Surge protection module faulty", inspect the AC and DC modules and replace them if necessary.**

↻ **NOTE: Ensure that the AC/DC supply is de-energized.**

1. Device open [See section 7.2 Page 28].
2. Remove the defective modules from the intermediate mounting frame (1) and replace them with modules of the same type (2).

NOTE: Different AC surge protection modules are used. The designation on the PCB must match the module designation (GTD/MOV).

1. Insert the AC surge protection modules individually into the intermediate mounting frame.
2. Ensure that all protective devices are securely seated.

⇨ Continue with the installation of the device.

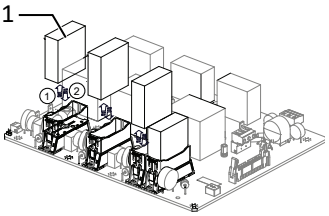


Fig. 117: Replacing AC Surge Protection

1 AC Surge Protection Module (4 Slots)

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DC Surge Protection

↻ **NOTE: If the web interface displays the message "Surge protection module faulty", inspect the DC and AC modules and replace them if necessary.**

↻ **NOTE: Ensure that the AC/DC supply is de-energized.**

1. Device open [See section 7.2 Page 28].
2. Release the defective modules using the locking tab.
3. Remove the defective modules individually from the DC base socket (1) and replace them with modules of the same type (2).

. **NOTE: The keying of the base socket must match the keying of the module.**

4. Insert the DC surge protection modules individually into the DC base socket.
5. Lock the new modules using the locking tab.
6. Ensure that all protective devices are securely seated.

⇨ Continue with the installation of the device.

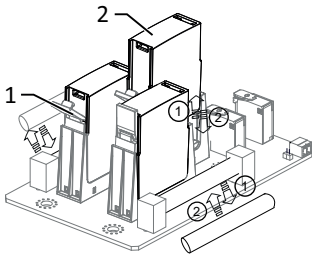


Fig. 118: Replacing Surge Protection Modules

1 Locking Tab
2 DC Surge Protection Module (3 Slots)

Replacing Ethernet Surge Protection

↻ **NOTE: If the surge protection module status indication displays "Fault", the module must be replaced.**

↻ **NOTE: Ensure that the AC/DC supply is de-energized.**

1. Device open Opening the Enclosure.
2. Loosen the cable gland on the Ethernet cable.
3. Disconnect the Ethernet cable from the lower or upper Ethernet port on the communication board.
4. Remove the Ethernet surge protection module from the DIN rail by unclipping it from bottom to top.
5. Replace the defective surge protection module with an identical module.
6. Connect the Ethernet cable.

⇨ Continue with the installation of the device.

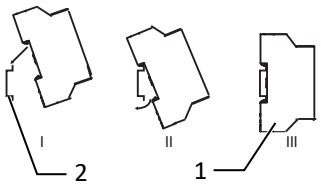


Fig. 119: Inserting the Ethernet overvoltage protection

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

Replacing RS485 Surge Protection

↻ **NOTE: If the surge protection module status indication displays "Fault", the module must be replaced.**

↻ **NOTE: Ensure that the AC/DC supply is de-energized.**

↻ Device open [See section 7.2 Page 28].

1. Remove the RS485 surge protection module from the base socket (1).
2. Insert an identical surge protection module (2).

⇨ Continue with the installation of the protective devices.

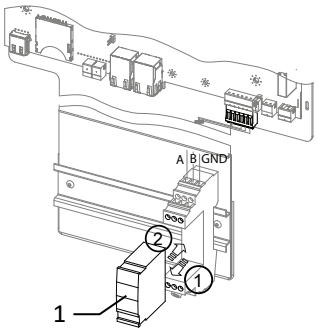


Fig. 120: Replacing RS485 Surge Protection

1 RS485 Surge Protection Module (Optional)

11.6 Shutting down for maintenance

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.

. **DANGER! The DC cables are still live**

⇨ After shutdown, wait 5 minutes before opening the device.

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11.7 Troubleshooting

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.

1. If a fault occurs, notify an appropriately authorized and qualified electrician or KACO new energy GmbH Service.
2. The operator can only carry out actions marked with a B.

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11.7.2 Rectifying the cause

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 device is displaying 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	

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Fault	Possible cause	Explanation/remedy	By
Even with high radiation levels, the device does not feed the maximum power into the grid.	Particular ambient conditions.	The device has derated due to excessive internal temperatures to prevent damage. Observe the technical specifications. Ensure unobstructed external convective cooling. 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 Messages

Many event messages indicate a fault in the grid. They are not operational faults of the device. The triggering levels are defined in standards, e.g. VDE0126-1-1. The device shuts down if the values exceed or fall below the approved levels.

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 Event messages

The following table lists the possible ProLog© status messages that the device can display by means of the LC display / web user interface and the LEDs.

No.	Event message	Explanation	Remedy	Pers.
_	0	Device waiting until the start voltage is reached.	PV modules must be sufficiently supplied with daylight => if necessary, remove covers.	-
1	Waiting for feed-in	Message will be displayed when the device is started. The generator voltage is lower than the starting voltage (pre)set on the device or the grid is still being checked for stability.	Start voltage set too high. => Check the DC configuration of the PV system and reduce the "Start voltage" in the menu if necessary.	-
2	Insufficient generator voltage / insufficient battery voltage	Insufficient generator voltage and power, status before the transition to night shutdown.	> Is the web user interface showing the correct voltage measured on the DC terminals? => If necessary, check the wire voltage individually. > XL version: Is the DC isolator switch switched off? => Switch off DC isolator switch > Is there DC polarity reversal? => Check polarity according to chapter 7.5. > Is the firmware completely installed? => Reinstall the firmware according to "Software-Update-Guide xxx".	-

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No.	Event message	Explanation	Remedy	Pers.
4	Yield counter for daily and annual yields are displayed	Message indicates regular feed-in mode. If irradiation is sufficient, MPP controls are used for feed-in to gain maximum yield.	Is the expected power not fed in? => Check open no-load voltage with multimeter and check PV system if: - DC polarity reversal is present - frequent power limitation due to undersizing - if constant voltage operation is active: check if no-load voltage is less than set constant voltage.	E
8	Self-test in progress	During the self-test before grid feed-in, the following sequence is run through: 1. S8 grid relay self-test 2. S79 ISO measurement 3. S8 filter relay self-test 4. S75 (load DC link) 5. S8 pre-synchronization 6. S4 feed-in	The events from the self-test can indicate the cause on the PV system or device. Observe the last displayed status.	-
10	Temperature in unit too high	The device was switched off due to overheating caused by lack of air circulation.	Were the minimum clearances for installation on the other side observed? => Check information in chapter 6. Was the device accidentally covered? =>Remove object or cool off the area. Is the fan or, if accessible, the heat sink contaminated? => Clean fan & heat sink according to chapter 11.2.	B B E
11		Power limitation: If the generator power is too high, the device limits itself to the maximum power (e.g. around noon if the PV generator capacity is too large).	see Status 8 in Remedy	-
17	"Powador-protect disconnection" or "External grid protection shutdown"	Due to a grid fault (e.g. under/overvoltage or under/overfrequency), a shutdown has been initiated by the higher level grid system protection. Set limit value was exceeded.	> Has the grid plant protection been supplied with power correctly? => Check the "grid parameters" on the grid plant protection. (external device) > Is the cabling routed correctly? => If external grid plant protection is not needed, it must be deactivated in the menu of the device. See chapter 9.4 "Menu structure".	E
18	Resid. current shutdown	The integrated all-current sensitive residual current circuit breaker has registered an impermissibly high leakage current to PE. Tripped with a jump of 30mA, 60mA & 150mA each with the corresponding shutdown times. The reconnection time is country-specific.	> Was the PE cable routed correctly or does this fault occur frequently when it rains? => Measure the insulation resistance of the system and ground the PE cable correctly, if necessary.	E
20	Power rampup active	Internal power limitation e.g.: "Ramp Up" 10 %/min The result when the power is increased with a ramp is country-specific (after P(f), restart, after grid error, after every connect)	This is required in the country-specific standard.	-
31	RCD module error	A fault has occurred in the all-current sensitive residual current circuit breaker.	N/A	-

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No.	Event message	Explanation	Remedy	Pers.
33	DC feed-in error	The DC proportion of the feed-in current is outside the permissible limit values.	When this is shown once, the system attempts a recalibration. When this is shown frequently or continuously, contact Service. Note: Because of the country-specific specification (e.g., Italy), the limit values for switching off are very low.	E
34	Internal communication error	A communication error has occurred in the internal data transmission.	If an installation technician is on site, the communication cable between the display board and the AC power unit should be checked for secure fit or a conventional CAT5 cable should be used for the check. Note: A high-temperature-proof cable is prescribed for use in the device. Please contact Service.	E
35	Protection shutdown SW	On account of a measured value that lies outside the permissible range, a shutdown has been performed to protect the device Possible reasons for shutdown: - Grid overvoltage (each phase is monitored) - Intermediate circuit overvoltage - Intermediate circuit asymmetrical - Grid current (each phase is monitored) - internal reference voltage	Does the fault only occur sporadically? How is the device connected on the grid end (heavily inductive grid (on the transformer itself))? -> If the system has its own transformer, the short-circuit voltage of the transformer provides information on the inductance of the grid for the system (4% short-circuit voltage is a very good value). SW from V3.14 also supports 8% and more. => update SW. If the error is present continuously, it can be assumed that there is a device fault -> Contact service department The error can be caused by poor connection/cabling on the AC side. Check all connection terminals from the device through to the grid connection. A fluctuating or missing AC voltage can indicate this connection problem.	K
36	Protection shutdown HW	Group message for all trip zone shutdowns.	Grid-related shutdown of the grid operator. The grid reconnects automatically. Please wait...	-
37	Unknown hardware	No valid version of the power unit was detected.	Restart of the device attempted? (Disconnect AC/DC - switch it back on after 5 minutes.) => If unsuccessful, contact Service.	-
38	Error: Generator Voltage too high Error: Battery overvoltage	The voltage of the PV generators has exceeded the permissible maximum value (limit values, see data sheet).	Are the PV-strings connected in series instead of in parallel? => Check PV voltage with suitable measuring device and check planning and assignment.	E
41	Grid failure undervoltage L1	The limit value is country-dependent. This is a legally required check of the network supplier.	Your installer should check the AC voltage at the terminals and AC wiring. If the settings in the menu are also correct, contact Service.	E
42	Grid failure overvoltage L1	See explanation in Status 41	See remedy in Status 41	E
43	Grid failure undervoltage L2	See explanation in Status 41	See remedy in Status 41	E
44	Grid failure overvoltage L2	See explanation in Status 41	See remedy in Status 41	E

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No.	Event message	Explanation	Remedy	Pers.
45	Grid failure undervoltage L3	See explanation in Status 41	See remedy in Status 41	E
46	Grid failure overvoltage L3	See explanation in Status 41	See remedy in Status 41	E
47	Grid failure phase-to-phase voltage	The phase angle between the individual phases of the three-phase supply network is not correct, possibly no three phase connection.	Measure the voltages on the device terminal and compare to the country-specific limit as appropriate. Check setting values in the parameters menu. Check the AC fuses: A phase may be missing. This fault can be caused by a poor connection/cabling on the AC side. Check all connection terminals from the inverter through to the grid connection. A fluctuating or missing AC voltage can indicate this connection problem.	B/K
48	Grid failure underfrequency	Measured value for grid frequency lies outside the permitted limit. Limit is country-specific.	Is the country setting correct? => Check setting values in the parameters menu. Your installer should check the AC connection and the connection to the device. Otherwise, contact Service.	E
49	Grid failure overfrequency	See explanation in Status 48	See remedy in Status 48	E
50	Grid failure average voltage	The grid voltage measurement according to EN 50160 (10 min. mean value) has exceeded the maximum permitted limit value.	In case of frequent occurrence, check the settings in the menu. > If applicable, was the firmware installed incorrectly? => Unpack firmware according to instructions in the download area.	E
56	SPI Remote shutdown	Remote-controlled shutdown by digital input. (e.g., CEI 0-21)	This was caused by the grid operator.	-
57	Waiting for reactivation	The waiting time following a fault is country-specific and can take several minutes.	Does the message appear frequently? => Find out the reason for the shutdown via error logs, Prolog status	-
58	Control board overtemp.	The temperature inside the device was too high. The device shuts down to avoid hardware damage.	This message only appears at high ambient temperatures (<60°C) > Has the power been checked? => Observe derating temperature according to data sheet > Is the fan or heat sink covered? => Clean device according to chapter 11.2.	E
59	Self-test error	A fault occurred during a self-test.	If the result also appears after a restart, contact Service.	E
60	Generator voltage too high Battery voltage too high	This can occur briefly with designs with high open circuit voltage and very low external temperatures and is a protective function of the device.	Are the PV-strings connected in series instead of in parallel? => Check PV voltage with suitable measuring device and check planning and assignment.	-
61	External limit x%	The grid operator requires an active power reduction. If only reactive power is specified, this message does not appear.	This is a requirement of the grid operator.	-
62	Standalone mode	N/A	N/A	-

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No.	Event message	Explanation	Remedy	Pers.
63	Frequency-dependent power change	) This requirement is country-dependent. The response can be configured. Normative requirements. No indication on display (behaves in the same way as normal feed-in mode status 4, therefore no flashing "Feed-in" LED). Can be viewed in service log files and via proLOG/portal. When certain country settings are activated, the frequency-dependent power change is activated.	This is a normative requirement.	-
64	Output current limiting	Power limitation because the max. permissible value for the feed-in current per phase has been reached.	That this is a normal safety function of the device due to the grid voltage being too low.	-
70	Fault in fan 1	Failure in the interior fan or the corresponding tacho signal. The power is reduced to 50% Pnom. All 3 LEDs light up on the device.	Is the fan jammed? => Service the fan according to chapter 11. For trained electricians: Are plugs connected correctly? Perform check.	E
71	Fault in fan 2	Failure in the 1st external fan or the corresponding tacho signal. The power is not reduced. This is done by way of temperature curtailment. All 3 LEDs light up on the device.	See remedy in Status 70	E
72	Fault in fan 3	Failure in the 2nd external fan or the corresponding tacho signal. The power is not reduced. This is done by way of temperature curtailment. All 3 LEDs light up on the device.	See remedy in Status 70	E
73	Standalone grid error	Standalone mode was detected.	Device was shutdown in PV system after event. Contact Service.	B
75	Self-test in progress	Self-test sequence is documented in S8.	See remedy in Status 8	-
78	Resid. current shutdown (AFI)	A static residual current causes the device to shut down. The shutdown threshold is determined by the power class and the relevant regulations. For devices in USA/Canada (with UL certification), the device can be reconnected a maximum of 4 times within 24h. F78 therefore stops once the 5th fault is triggered within 24h.	If the fault occurs in the event of precipitation, or high air humidity, this indicates an increased discharge current => check location in the system. Otherwise, contact Service.	E
79	Insulation measurement	Insulation resistance of the system is calculated before connection. More information in Status 19.	Normal device behavior In case of continuous persistence in this status, contact Service.	B
80	Insulation meas. not possible	Not possible to calculate the insulation resistance.	Solar installer to check the PV module installation. => If the message persists, contact Service.	E
81	Protect. shutdown grid volt. L1	Protection shutdown due to an excessively high grid voltage It is the live value which is decisive for the shutdown. As such, a single peak value is enough to cause a shutdown.	Does the message appear frequently? => The solar installer must check the installation and contact Service, if applicable.	E
82	Protect. shutdown grid volt. L2	See explanation in Status 81	See remedy in Status 81	E

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No.	Event message	Explanation	Remedy	Pers.
83	Protect. shutdown grid volt. L3	See explanation in Status 81	See remedy in Status 81	E
84	Protection shutdown undervolt. DC link	Display when the min/max. value of the intermediate circuit voltage is not reached. If the device stops feeding in, then there is a fault in the device. Otherwise, a highly inductive grid is responsible for this.	Is the location on the Ac-side to the device correct? => Check all connection terminals from the device through to the grid connection. A fluctuating or missing AC voltage can indicate this connection problem. Note: Check the AC-side wiring (transformer inductance capacity) N-conductor is theoretically permitted to have reduced specifications.	E
85	Protect. shutdown overvolt. DC link	See explanation in Status 84	See remedy in Status 84	E
86	Protect. shutdown DC link asymmetry	Protection shutdown due to excessive asymmetry of the two DC link halves	Is the message present after restarting the feed-in? => Contact Service.	E
87	Protection shutdown overcurrent L1	Protection shutdown due to an excessive grid current.	Is the AC wiring correct? => The current measurement may be incorrect. Contact Service.	E
88	Protection shutdown overcurrent L2	See explanation in Status 87	See remedy in Status 87	E
89	Protection shutdown overcurrent L3	See explanation in Status 87	See remedy in Status 87	E
91	Protect. shutdown drop 2.5V	Reference voltage outside the permissible range.	If this occurs repeatedly, contact Service.	-
97	Protection shutdown overcurrent HW	The protection shutdown has tripped due to an overcurrent to the grid. Triggered by a TripZone.	Restart of the device attempted? (Disconnect AC/DC - switch it back on after 5 minutes.) => If unsuccessful, contact Service.	E/K
100	Protect. shutdown HW overheating	See explanation in Status 97	See remedy in Status 97	B E
101	Temperature plausibility error	The individual temperatures in the device are compared with one another. This message appears if a certain limit value is exceeded.	If this occurs repeatedly, contact Service.	K
102	Plausibility fault efficiency	The degree of efficiency of the device must remain within certain limits.	If this occurs repeatedly, contact Service.	K
104	Plausibility fault AFI module	The device has shut down because of implausible internal measured values.	If this occurs repeatedly, contact Service.	K
105	Relay plausibility error	See explanation in Status 104	See remedy in Status 104	K
106	Plausibility error DCDC converter	See explanation in Status 104	See remedy in Status 104	K
107	Check surge protection device	Overvoltage protection device (if present in the device) has tripped and must be replaced. AC, DC & interfaces are monitored for triggered overvoltage protection. All 3 LEDs light up on the device.	Check overvoltage protection in the device. The overvoltage protection module has a corresponding function display. With a red function display, the overvoltage protection module must be checked, and replaced if necessary. The device continues to feed in.	K

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No.	Event message	Explanation	Remedy	Pers.
108	Grid failure overvoltage L1	Device has detected a fault on one phase and was shut down.	Are the settings in the menu according to the grid voltage correct? => After the check, visually inspect all connection terminals from the device through to the grid connection. A fluctuating or missing AC voltage can indicate this connection problem.	E
109	Grid failure overvoltage L2	See explanation in Status 108	See remedy in Status 108	-
110	Grid failure overvoltage L3	See explanation in Status 108	See remedy in Status 108	-
111	Grid failure undervoltage L1	See explanation in Status 108	See remedy in Status 108	-
112	Grid failure undervoltage L2	See explanation in Status 108	See remedy in Status 108	-
113	Grid failure undervoltage L3	See explanation in Status 108	See remedy in Status 108	-
125	Relay control error	The enable signal for the relay control is read back.	If this occurs repeatedly, contact Service.	K
126	AFI measurement technology error	N/A	N/A	-
127	AC voltage measurement technology error	N/A	N/A	-
128	Internal memory error 1	Write or read access fault to the internal RAM.	Restart of the device attempted? (Disconnect AC/DC - switch it back on after 5 minutes.) => If unsuccessful, contact Service.	B
129	Power reduction P(U)	Message present if the function P(U) sets the power level according to the specified parameters subject to the AC voltage.	This function can be requested by the grid operator, for example. If a request is not present, the function can be deactivated.	B
148	Error external memory 1	The device has internal permanent memories to store the hardware that is used, for example. The parameters for the operation are derived from there.	Restart of the device attempted? (Disconnect AC/DC - switch it back on after 5 minutes.) => If unsuccessful, contact Service.	B
150	Protect. shutdown drop 1.65V	Internal protection function to maintain the required measuring accuracy.	Restart of the device attempted? (Disconnect AC/DC - switch it back on after 5 minutes.) => If unsuccessful, contact Service.	B
158	Power limitation	Power limitation because the internal temperature is too high. The temperature is measured on the control board. This is a protective function of the device.	Check if the device is cooled: Heat sink clean and installation instructions observed according to the manual (distances)?	-
159	Waiting for configuration	The DSP is waiting for configuration data from the HMI.	The configuration of the device via the web user interface must be completely finished.	B
160	Error: Grid relay L1	The self-test detected a fault for the grid-side relay.	If this occurs repeatedly, contact Service.	-
161	Error: Grid relay L2	See explanation in Status 160	See remedy in Status 160	-
162	Error: Grid relay L3	See explanation in Status 160	See remedy in Status 160	-
163	Error: Grid relay N	N/A	N/A	-
164	Error: Filter relay L1	The self-test detected a fault for the relay in the device.	If this occurs repeatedly, contact Service.	-

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No.	Event message	Explanation	Remedy	Pers.
165	Error: Filter relay L2	See explanation in Status 164	See remedy in Status 164	-
166	Error: Filter relay L3	See explanation in Status 164	See remedy in Status 164	-
167	Error: Filter relay N	See explanation in Status 164	See remedy in Status 164	-
169	Error: AFI sensor	The AFI sensor is demagnetized prior to infeed. If this is not possible, this message appears	If this occurs repeatedly, contact Service.	-
170	Check overvoltage protection on DC-side	N/A	N/A	-
171	Check overvoltage protection on AC-side	N/A	N/A	-
172	Internal fan error	Failure of an interior fan or the corresponding tacho signal. The power is reduced to 50% Pnom. All 3 LEDs light up on the device.	Is the fan jammed? => If applicable, clean according to chapter "Maintenance". For trained electricians: Are plugs connected correctly?	-
173	External fan error	Failure of an external fan or the corresponding tacho signal. The power is reduced to 50% Pnom. All 3 LEDs light up on the device.	See remedy in Status 172	-
180	Pre-synchronization not possible	Adequate voltage pre-synchronization with the AC grid not possible.	Restart of the device attempted? (Disconnect AC/DC - switch it back on after 5 minutes.) => If unsuccessful, contact Service.	B
181	Insulation error, center	The insulation error is located close to the center of a PV string. The area covers +-15% of the half of the modules based on the total number of modules.	Is the insulation correct? => Check the insulation resistance of the system. Note: Insulation error messages following the update to V4.xy indicate insulation errors in the PV system, which were not previously detected. They must be rectified in order to operate the PV system safely.	E
182	Insulation error, minus	The insulation error is located between the center of a string and the minus terminal on the inverter. If the insulation error is located very close to the minus inverter terminal, then the error occurs even if the insulation error <150 kohm and is above the set value.	See remedy in Status 181	-
183	Insulation error, plus	The insulation error is located between the center of a string and the plus terminal on the inverter. If the insulation error is located very close to the plus inverter terminal, then the error occurs even if the insulation error is less than 150 kohm and is above the set value.	See remedy in Status 181	-
184	Protect. shutdown overcurrent L1 int.	Protection shutdown due to an excessively high grid current in the interleaved path (channel B) on phase Lx It is the live value which is decisive for the shutdown.	Restart of the device attempted? (Disconnect AC/DC - switch it back on after 5 minutes.) => If unsuccessful, contact Service.	-
185	Protect. shutdown overcurrent L2 int.	See explanation in Status 184	See remedy in Status 184	-
186	Protect. shutdown overcurrent L3 int.	See explanation in Status 184	See remedy in Status 184	-

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No.	Event message	Explanation	Remedy	Pers.
187	Fault in fan 4	Failure in the 3rd external fan or the corresponding tacho signal. The power is not reduced. This is done by way of temperature curtailment. All 3 LEDs light up on the device.	Is the fan jammed? For trained electricians: Are plugs connected correctly?	E
188	Semiconductor test not possible	The measurement or actuation of the semiconductors failed. If applicable, the integrated AC filter can no longer be discharged below 50 V.	Make sure there is no grounding problem. Disconnect the device on the AC and DC side. Observe the wait time on the warning sign. Switch the device on again. If this message is displayed again, contact Service.	B
189	Semiconductor module 1 in channel A defective	Semiconductor module x in channel A is defective or the corresponding filter relay does not close correctly.	Restart of the device attempted? (Disconnect AC/DC - switch it back on after 5 minutes.) => If unsuccessful, contact Service.	B
190	Semiconductor module 2 in channel A defective	See explanation in Status 189	See remedy in Status 189	-
191	Semiconductor module 3 in channel A defective	See explanation in Status 189	See remedy in Status 189	-
192	Semiconductor module 1 in channel B defective	Semiconductor module x in channel B is defective or the corresponding filter relay does not close correctly.	Restart of the device attempted? (Disconnect AC/DC - switch it back on after 5 minutes.) => If unsuccessful, contact Service.	-
193	Semiconductor module 2 in channel B defective	See explanation in Status 191	See remedy in Status 191	-
194	Semiconductor module 3 in channel B defective	See explanation in Status 191	See remedy in Status 191	-
195	DESAT failure	The DESAT of the IGBTs has tripped or the power supply (24 V) of the gate drivers is too low.	If this occurs repeatedly, contact Service.	-
203	Protect. shutdown grid volt. L1	Protective shutdown due to an excessively high grid voltage. It is the effective value which is decisive for the shutdown procedure.	Is the error displayed frequently? =>Check the installation again. Otherwise, contact Service. Note: Error can be caused by a poor location on the AC side. Check all connection terminals from the inverter through to the grid connection. A fluctuating or missing AC voltage can indicate this connection problem.	E
204	Protect. shutdown grid volt. L2	See explanation in Status 203	See remedy in Status 203	-
205	Protect. shutdown grid volt. L3	See explanation in Status 203	See remedy in Status 203	-
206	Protection shutdown overcurrent HW	AC overvoltage trip-off that was triggered by a hardware comparator.	If this occurs repeatedly, contact Service.	-
207	Detection of hardware detection failed: Control board	The data saved on the control card is erroneous.	Restart of the device attempted? (Disconnect AC/DC - switch it back on after 5 minutes.) => If unsuccessful, contact Service.	B

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No.	Event message	Explanation	Remedy	Pers.
208	Detection of hardware detection failed: AC power board	The data saved on the AC power board is erroneous.	See remedy in Status 207	B
209	Detection of hardware detection failed: AC relay board	The data saved on the AC relay board is erroneous.	See remedy in Status 207	B
216	Protect. shutdown HW - overvoltage DC link halves	One of the two DC link halves has exceeded the maximum value. Shutdown occurs by way of HW-detection and TripZone shutdown.	Restart of the device attempted? (Disconnect AC/DC - switch it back on after 5 minutes.) => If unsuccessful, contact Service.	B
217	Protect. shutdown HW - 24V supply voltage	The supply voltage in the device has exceeded its max. permitted value. Shutdown occurs by way of HW-detection and TripZone shutdown.	Restart of the device attempted? (Disconnect AC/DC - switch it back on after 5 minutes.) => If unsuccessful, contact Service.	B
224	External limitation	This is a relative specification of the desired active power adjustment.	N/A	-
225	Battery voltage too low	N/A	N/A	-
226	Inverter is manually disconnected from the grid	The device can be disconnected from the grid manually after logging in via the web user interface. This message then appears.	Activate the grid connection via the icon on the web user interface.	B
227	Protective shutdown current asymmetry	Protective shutdown that enables safe shutdown of the device in the event of (high-ohm) grid failures. Grid events can cause asymmetrical currents in the inverter. They are detected and shut down accordingly.	If this occurs repeatedly, contact Service.	-
228	Protective shutdown voltage asymmetry	Protective shutdown that enables safe shutdown of the device in the event of (high-ohm) grid failures. Grid events can cause asymmetrical voltages in the inverter. They are detected and shut down accordingly.	See remedy in Status 227	-
230	AC voltage limitation	This is a protective function of the device that allows it to be switched off quickly in case of incidents or switching operations at the medium voltage level.	Normative requirement of the grid operator	-
231	External active power value	External specification of a setpoint value for the fed-in active power. The fed-in active power can be increased or decreased with the grid support procedure. Grid support procedures thereby have a higher priority.	Normative requirement of the grid operator	-

NOTE

Event number not found?

Event numbers that are displayed in the device and not listed here generally require a service call by your installation partner.

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NOTE

Quick remedy through provision of the service package

If an event occurs irregularly, our service technician needs to have the service package stored on the device. You must download and send this under the menu item "Service" – "Export Service Package" See table : Configuration via web user interface [Page 79]

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12 Decommissioning and removal

12.1 Switching off the device



⚠ 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.

1. Observe all safety regulations and current technical connection specifications of the responsible power supply company.
2. The device may only be opened and serviced by an authorized electrician.
3. Switch off the grid voltage by turning off the external circuit breakers.
4. Capacitor discharge time: Wait at least 5 minutes before opening.
5. Do not touch the cables and/or terminals/busbars when switching the device on and off.
6. Keep the device closed when it is in operation.



⚠ WARNING

Risk of burns from hot housing components

Housing components could heat up during operation.

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

12.2 Disconnecting the connections

12.2.1 AC connection

↻ Ensure that the device is completely free of AC/DC voltage.
↻ 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 bolts due to the cable lug size, the AC cable on the cable lug should be disconnected.**

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

12.2.2 DC connection

↻ Ensure that the device is completely free of DC voltage.
↻ Housing cover removed and set to one side.

1. Disconnect cable from DC source at 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 line does not fit through the cable bolts due to the cable lug size, the DC line on the cable lug should be disconnected.**

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

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12.3 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.



1. Only appropriately qualified electricians authorized by the mains supply network operator are permitted to open and maintain the device.
2. 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 [See section 12.2.1 Page 128].
↻ DC connection disconnected [See section 12.2.2 Page 128].

1. Undo the cable fitting for Ethernet cables [W_29].
2. Undo the cable fitting for RS485 cables [W_20].
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.

12.4 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.

12.5 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.

12.6 Storing the device



NOTE

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.

1. Prior to installation, check the inner area for condensation and if necessary, allow it to dry sufficiently before installation.
2. Storage in accordance with the technical data > [See section 4.3 Page 20]

↻ The device is packaged.

1. Keep the device in its original packaging.
2. The packaging containing the device must not be tilted over or turned upside down.
3. Store the device in a dry place, in accordance with the ambient temperature range [See section 4.3 Page 20].
4. If the device has been stored for 6 months or longer, it must be completely inspected and tested by specialists before it can be put into operation.

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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.

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14 Service and warranty

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?
- Error code
- Module type and string circuit
- Consignment identification / Delivery address / Contact person (with telephone number)
- Information about the accessibility of the installation site

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15 Appendix



The text and figures reflect the current technical state at the time of printing. Subject to technical changes. No liability for printing errors.

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