

Operating manual

REFU*sol*

REFUsol 100K

Solar Inverter

Product | **REFUsol 100K**

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1 About this Manual

1.1 Scope of this Manual

This manual applies to the following products:

- **REFUsol 100K** Solar Inverter
- **REFUsol Decentral ConnectionBox**
- **REFUsol Central ConnectionBox**

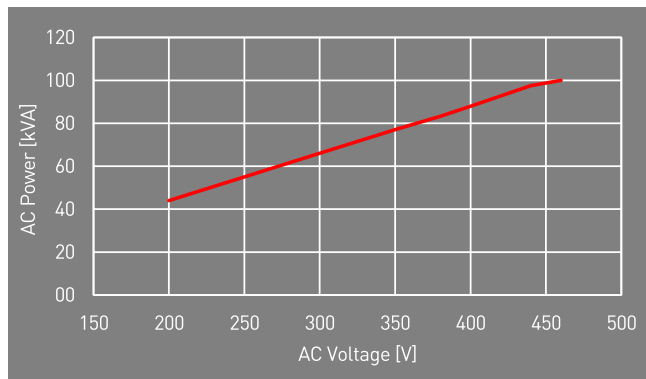


Fig. 1: Power rating depending on AC voltage

1.2 Target Group of this Manual

This manual is intended for installers, operators, service technicians and plant operators.

This manual contains basic information, to assemble the product safely and properly, to transport, to put into operation and to operate.

- ▷ Read this manual completely and in particular the chapter "Safety and Responsibility", before you work with the product.







1.3 Presentation of Information

To enable you to handle your product safely and quickly with these instructions, uniform warnings, symbols, designations and abbreviations are used.

1.3.1 Symbols

The following symbols indicate instructions which are intended to make the instructions easier to understand.


Tab. 1: Symbols/signs

Symbol	Meaning
	Useful information on the optimal and most economical use of the product.
	Prerequisite for an action that must be completed/executed beforehand.
	Single action step that is to be executed.
	Sub-step of an action step that is to be executed.
	Alternative action that can also be executed. Partially conditioned by other prerequisites.
1. 2. 3.	Numbered action instruction that is to be executed in the order listed.
	Result of the action instruction.
... > ...	Menu sequence in a software that is to be clicked one after the other.

1.3.2 Warnings in this Manual

Warnings in this manual indicate an action where there is a risk of personal injury or property damage. Always observe the measures described to avert the danger.

The warnings in this manual are presented in a box that contains the following information:

	SIGNAL WORD/WARNING CATEGORY
Type and source of danger	
Consequences of ignoring the warnings.	
▶ Measures required to avoid the danger.	

 DANGER

Leads directly to death or serious personal injury if ignored.

- ▶ Follow the warnings to avoid death or serious injury!

 WARNING

May result in death or serious personal injury if ignored.

- ▶ Follow the warnings to avoid serious injuries!

 CAUTION

May cause minor personal injury if ignored.

- ▶ Follow the warnings to avoid injury!

NOTICE

Can lead to property damage if ignored.

- ▶ Follow the warnings to avoid damage or destruction of the product!

2 Safety and Responsibility

The product has been manufactured in accordance with the generally accepted state of the art. Nevertheless, there is a risk of personal injury and property damage if you do not observe this chapter and the warnings in this manual.

- ▷ Read this manual thoroughly and completely before using the product.

2.1 Safety Guidelines

Installation, commissioning, and operation of the product must be carried out by (electrically) qualified personnel.

- ▷ Read all technical information and safety instructions before installing and using the product.

2.2 Rules for Safe Installation and Operation

- Do not attempt to install or operate the product without proper training.
- Ground the product properly.

- Ground the metal supporting frame of the PV modules using potential equalization.
- Only use class A PV modules according to IEC 61730.
- Connect all cables properly.
- Before switching on, check the AC and DC voltages and polarity. Observe the information on the data sheet or type plate.
- Take appropriate precautions to protect against electrostatic discharge (ESD).
- Always be careful around this equipment.
- Never remove the PowerUnit (inverter) cover.
- To ensure safe operation, carry out all work professionally, including transport, storage, assembly, installation and operation.

2.3 Symbols and Warnings on the Product

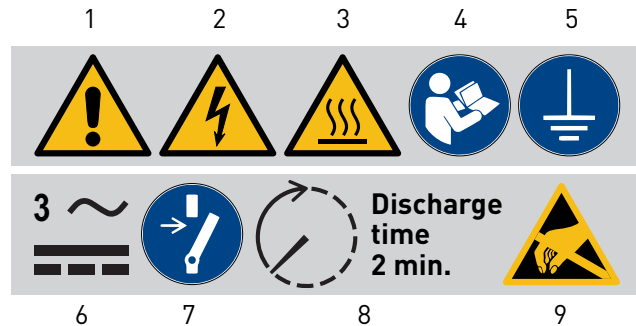


Fig. 2: Symbols on the product

- | | |
|---|--|
| 1 General warning | 7 Unlock before maintenance or repair |
| 2 Warning of electrical voltage | 8 Discharge time of 2 minutes |
| 3 Warning of hot surface | 9 Warning of a device's susceptibility to electrostatic discharge |
| 4 Follow the instructions before use | |
| 5 Ground before use | |
| 6 Warning of electrical voltage on AC and DC side. All strings on the DC side are live | |

2.4 Designated Use

The **REFUso1 100K**, is a solar inverter, which transforms the direct current generated by the PV generator (photovoltaic modules) into alternating current and can feed it into mains supply.

The **REFUso1 100K** complies with protection class IP65 (ConnectionBox: IP54) and can be used indoors and outdoors.

The **REFUso1 100K** is only intended for use with the corresponding central or decentral ConnectionBox.

2.5 Requirements for Electricians

The activities described in this manual require basic knowledge of the electrical system, the associated technical terms and the relevant technical rules. To ensure safe use, these activities may therefore only be carried out by an appropriate specialist or a trained person under the supervision of a specialist.

A skilled person is a person who, on the basis of his professional training, his knowledge and experience as well as his knowledge of the relevant regulations, can

assess the work assigned to him, recognize possible dangers and take suitable safety measures.

2.6 General Safety Instructions

- ▷ Observe the valid regulations for accident prevention and environmental protection.
- ▷ Observe the safety regulations and regulations of the country in which the product is used.
- ▷ Only use products in technically perfect condition.
- ▷ Observe all notes on the product.
- ▷ Persons installing, operating or maintaining products must not be under the influence of drugs or medication.
- ▷ Use only accessories and spare parts approved by REFU Elektronik GmbH in order to exclude a personal hazard due to unsuitable spare parts.
- ▷ Observe the technical data and ambient conditions specified in the manual.
- ▷ Do not put the product into operation until it has been determined that it complies with country-specific rules, regulations, safety regulations/certificates and application regulations.

2.7 Five Safety Rules When Working on Electrical Systems

Disconnect electrical systems (lock and tag) according to the five safety rules:

- ▷ Unlock and disconnect completely.
- ▷ Secure against re-connection.
- ▷ Check that there is no voltage (DC and AC).
- ▷ Carry out earthing and short-circuiting.
- ▷ Provide protection against adjacent live parts.

3 Technical Description

3.1 ConnectionBox Central/Decentral



Fig. 3: Available variants: central and decentral

3.2 Components of the Decentral Connection-Box

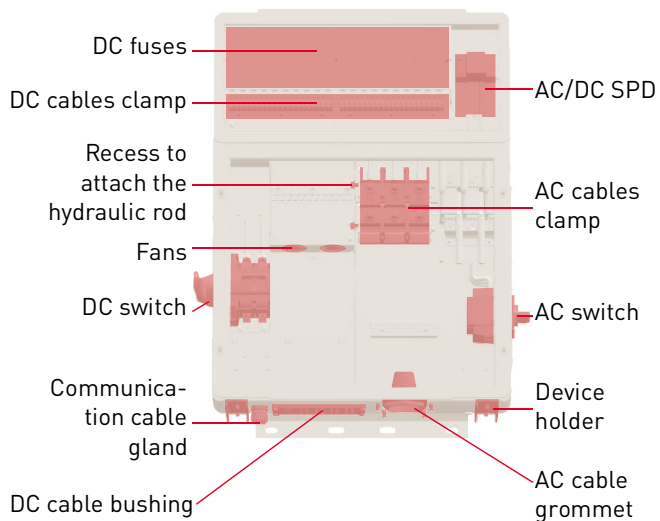


Fig. 4: Components of the decentral ConnectionBox

3.3 Components of the Central ConnectionBox

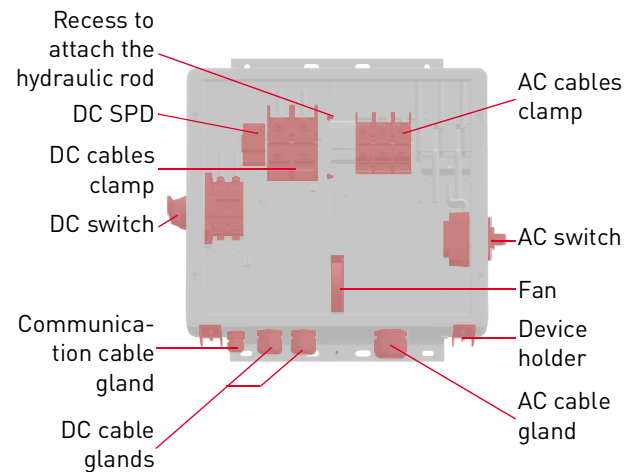


Fig. 5: Components of the central ConnectionBox

3.4 Device Size and Distances

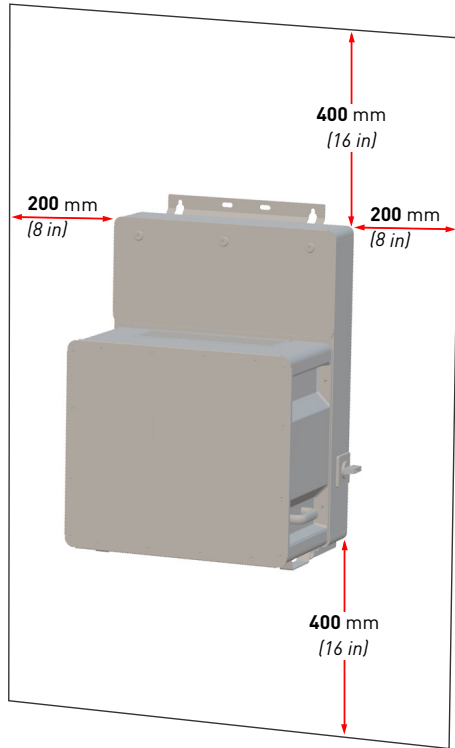


Fig. 6: Installation site: distances/free space

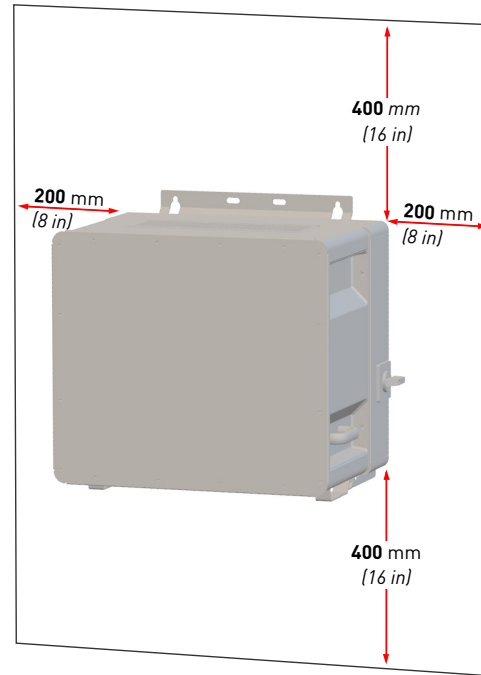


Fig. 7: Installation site: distances/free space

The inverter can be installed vertical or horizontal. For horizontal outdoor installation, mount the inverter at an angle of 10° (or greater).

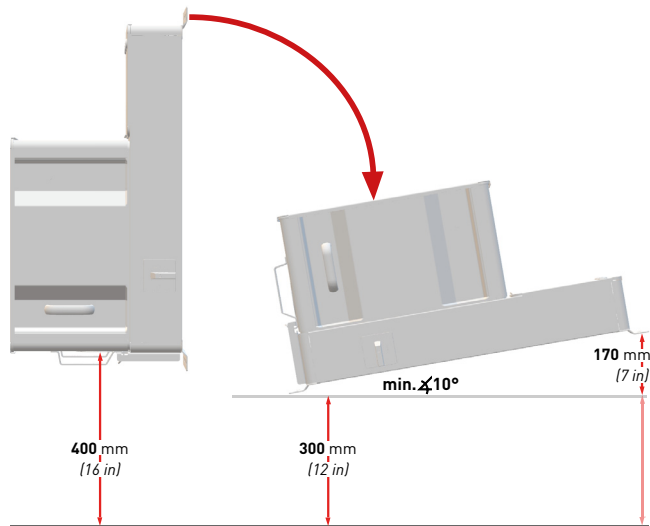


Fig. 8: Vertical and horizontal installation (decentral)

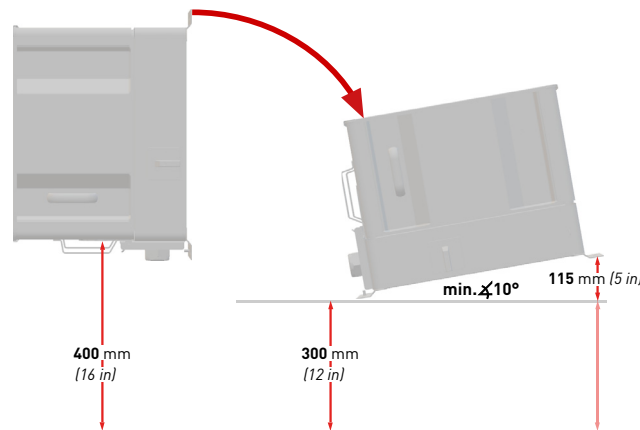


Fig. 9: Vertical and horizontal installation (central)

3.5 Mounting Location

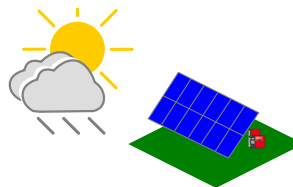


Fig. 10: Installation recommendation for protection against direct sunlight and rain

3.6 Dimensions

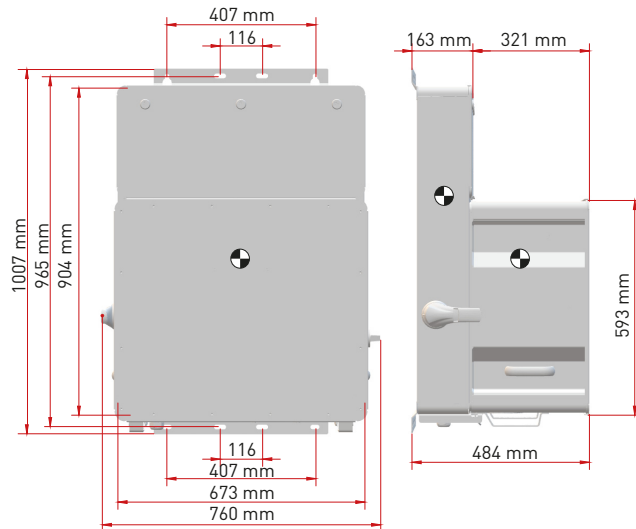


Fig. 11: Dimensions inverter with decentral ConnectionBox

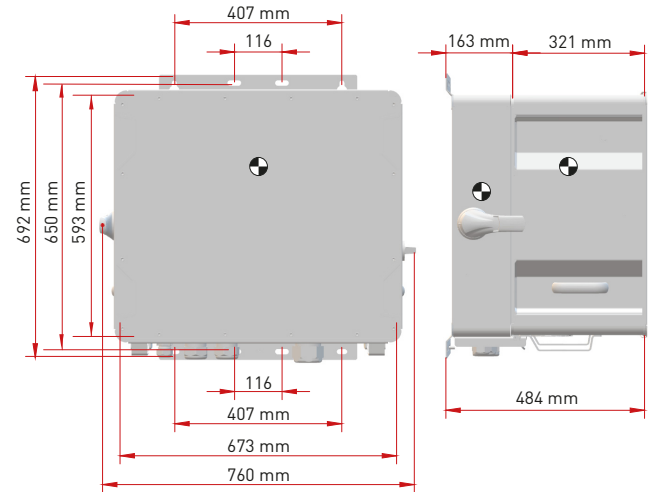


Fig. 12: Dimensions inverter with central ConnectionBox

3.7 Functionality of the Inverter

The *REFUsol100K* converts the DC voltage generated by the photovoltaic modules into AC voltage and feeds it into the low or medium voltage grid.

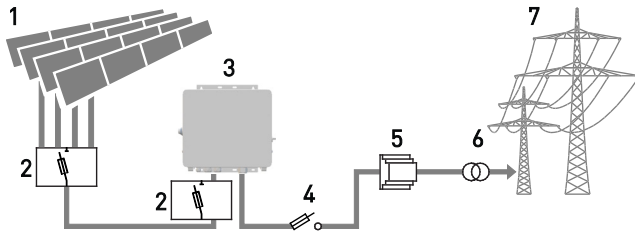


Fig. 13: Grid-connected PV system with photovoltaic inverter

- 1 Photovoltaik (PV) modules
- 2 Solar string combiner box
- 3 Photovoltaic inverter
- 4 AC protection (fuse switch disconnecter or circuit breaker)
- 5 Grid protection
- 6 Isolation transformer is required for medium-voltage grid
- 7 Low or medium-voltage AC grid

3.8 Requirements for the Infrastructure

Additional required equipment	at low voltage network	at medium voltage network
DC load break switch	integrated ¹⁾	integrated ¹⁾
AC load break switch	necessary	necessary

Central grid protection device with section switch (VDE-AR-N 4105, VDE-AR-N 4110)	necessary	necessary
LV-/MV-Transformer	not necessary	necessary

¹⁾ Local regulation might require an additional DC switch at a external DC combiner box.

The following points are to be considered when planning the infrastructure:

- The **REFUsol 100K** can feed into the low-voltage grid and the medium-voltage grid.
- The power supply line must be equipped with an appropriate AC disconnecting device.
- The **REFUsol 100K** is not equipped with internal potential isolation.
- If connected with the medium-voltage-grid, it must be operated with electrically isolating transformers.
- The transformer must be selected according to the specific site of use and the relevant regulations must be taken into account: Hazardous substances

ordinance, ordinance on installations for handling substances hazardous to water, chemicals prohibition ordinance, technical instructions for noise protection, and regional building regulations.

Specification of medium voltage transformer

Mains transformer according to EN 50588-1

Switching group Dyn5 or Dyn11

4 Installation

4.1 General Warnings

DANGER

High voltage

Danger to life due to electric shock.

The product operates at high voltages:

- ▶ All work on the product must be carried out by electrically qualified persons only.
- ▶ If the inverter is tilted forward on rainy or snowy days or the connection box is opened, take suitable protective measures to prevent water from entering the connection box. If it is not possible to take protective measures, do not tilt the inverter forward or open the connection box.



DANGER**High voltage**

Danger to life due to high voltages that can cause lethal electric shocks are present in the live components of the inverter.

- ▶ Always disconnect the inverter from voltage sources before performing any work on it.
- ▶ Observe a waiting time of 2 minutes.

**DANGER****High voltage**

Danger to life due live parts can remain energized after isolation.

- ▶ Disconnect electrical systems according to the 5 safety rules (see chapter 2.7).

**CAUTION****Hot surfaces**

Risk of burns due to hot surfaces.

The product can get hot during operation.

- ▶ Avoid contact during operation.
- ▶ Allow the product to cool down sufficiently before carrying out any work.

**4.2 Auxiliary Means and Tools**

- Wrench 13 mm
- Wrench 16 mm
- Wrench 18 mm
- Slotted screwdriver 10 mm
- Lockout-tagout kit
- Voltage tester
- Spirit level

4.3 Unpacking the ConnectionBox

- ▷ Open the packaging and remove the ConnectionBox with the help of two people.

4.4 Mounting the ConnectionBox

There are three possibilities for mounting the ConnectionBox. Pole mounting with two suitable pole clamps, wall mounting, or horizontal mounting with an angle of 10° (or greater).

The fixing material is not included in the scope of delivery.

4.4.1 Mounting the ConnectionBox Vertically

- ✓ Requirements according to IEC 60364-7-712 for special systems or locations for photovoltaic power supply systems were considered in the planning.
- 1. Mark the drill holes according to the following drawing.

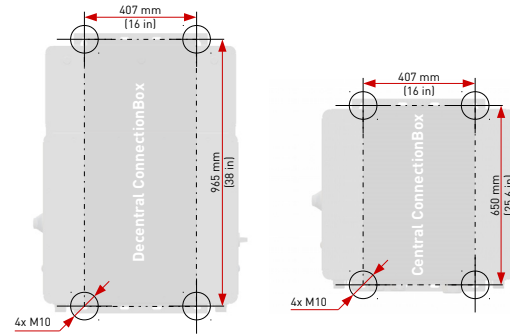


Fig. 14: Mounting dimensions

2. Drill the holes and insert anchors.
3. Screw screws with a minimum diameter of 8 mm into the upper plugs at a distance of 8 mm from the mounting surface.
4. Hook the ConnectionBox into the two upper screws and press it against the wall.
5. Screw the lower screws into the dowels.
6. Tighten all screws.

4.4.2 Mounting the ConnectionBox Horizontally

- ✓ Requirements according to IEC 60364-7-712 for special systems or locations for photovoltaic power supply systems were considered in the planning.
1. Mount the mounting rails as shown in Figure 14. Ensure that the ConnectionBox has an angle of at least 10°.
 - a) Maintain a distance of at least 300 mm from the floor in the connection area (see Figure 8/9).
 - b) To obtain a 10° angle, the distance from the top of the ConnectionBox to the floor is 415 mm for the central ConnectionBox and 470 mm for the decentral ConnectionBox.
2. Insert screws with a minimum diameter of 8 mm into the mounting rails.
 3. Lift the ConnectionBox with two people and hook it into the two upper screws.
 4. Screw on the two upper screws with counter nuts by hand.
 5. Lift the ConnectionBox with two persons at the bottom and hook it into the two lower screws.

6. Screw on the lower screws with counter nuts by hand.
7. Tighten all screws.

4.4.3 Mounting the ConnectionBox on a Pole

- ✓ Requirements according to IEC 60364-7-712 for special systems or locations for photovoltaic power supply systems were considered in the planning.
 - ✓ Two mounting bridges, round steel clamps or mounting rails each permissible for the weight are provided for the mast mounting.
- ▷ Fixing takes place according to the procedure described in the previous chapters.

4.5 Wiring DC and AC Cables (Central ConnectionBox)

Tab. 2: Stud connection

Type	DC Terminal	AC Terminal
2 x cable lugs DIN 46234	10 ... 185 mm ²	6 ... 120 mm ²
2 x cable lugs DIN 46235	25 ... 185 mm ²	16 ... 120 mm ²
Cable lug to DIN 46234	10 ... 240 mm ²	6 ... 150 mm ²

Tab. 2: Stud connection

Cable lug to DIN 46235	25 ... 240 mm ²	16 ... 150 mm ²
Stud size for spade connection	M12	M10
Tightening torque	14 ... 31 Nm	10 ... 20 Nm
Stud size for potential equalization		M8
Minimum cross section for the potential equalization		6 mm ²

1. Prepare the cables, grounding cables and insert it through the cable glands.
2. Connect the PE conductor.
3. Connect the three AC conductors.
4. If an N conductor is present, isolate the N conductor and place it securely in the ConnectionBox protected against contact.
5. Tighten the union nut of the cable gland to ensure tightness and strain relief.
6. Connect the potential equalization conductor with ring cable lug to the PE threaded bolt (M8).

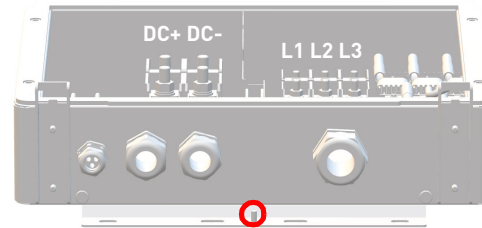


Fig. 15: Potential equalization (Central ConnectionBox)

7. Insert the DC cables through the cable glands and connect them to the terminals.
8. Tighten the union nut of the cable gland to ensure tightness and strain relief.

4.6 Wiring AC Cables (Decentral Connection-Box)



Fig. 16: AC connection area: Cable grommet

Tab. 3: Stud connection

Type	AC Terminal
2 x cable lugs DIN 46234	10 ... 185 mm ²
2 x cable lugs DIN 46235	25 ... 185 mm ²
Cable lug to DIN 46234	10 ... 240 mm ²
Cable lug to DIN 46235	25 ... 240 mm ²
Stud size for spade connection	M12
Tightening torque	14 ... 31 Nm
Stud size for grounding cable (PEN)	M10

1. Loosen the screws of the cable grommet and remove the cable grommet.
2. Measure the cable diameter of the AC cable with a calliper gauge.
3. Mark the cable grommet and cut it off to the previously determined diameter.
4. Prepare the AC cable for connection and insert it through the cable grommet.
5. Check the sealing of the cable grommet.
6. First connect the protective conductor (PEN).

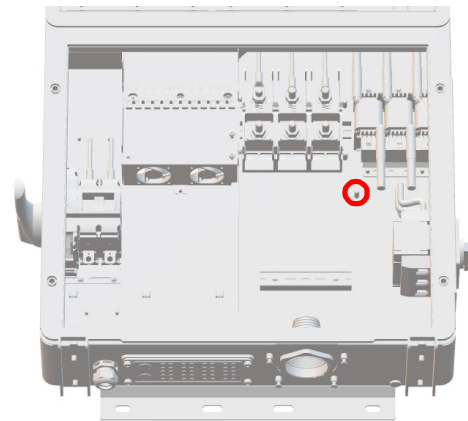


Fig. 17: Grounding cable (PEN)

7. If an N conductor is present, isolate the N conductor and place it securely in the ConnectionBox protected against contact.
8. Connect AC cables. Tighten the cable lugs (50–240 mm²) of the AC cables with a tightening torque of 14 Nm.

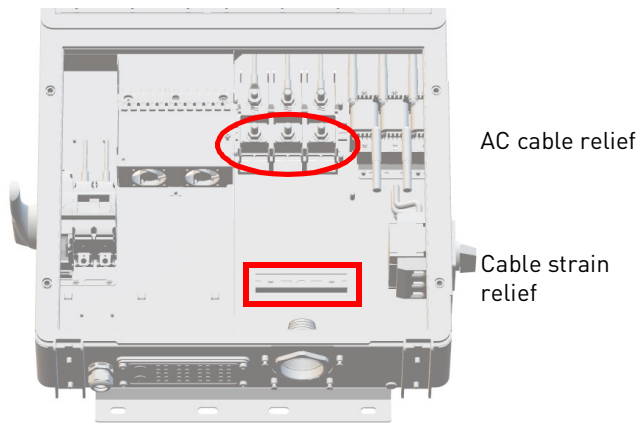


Fig. 18: AC cables clamp and cable strain relief

9. Tighten the multi cable grommet screws with a tightening torque of 2.5 Nm.
10. Mount the strain relief of the AC cables.
11. Install a protective cover on the ConnectionBox if the PowerUnit is not installed immediately.

4.7 Wiring DC Cables (Decentral Connection-Box)

Tab. 4: Conductor type

Conductor types	solid	flexible	stranded
Diameter	0.5 ... 16 mm ²	0.5 ... 16 mm ²	6 ... 16 mm ²
Stripping length	18 mm		

1. Open the DC fuse area using a double-bit key as seen in below image.

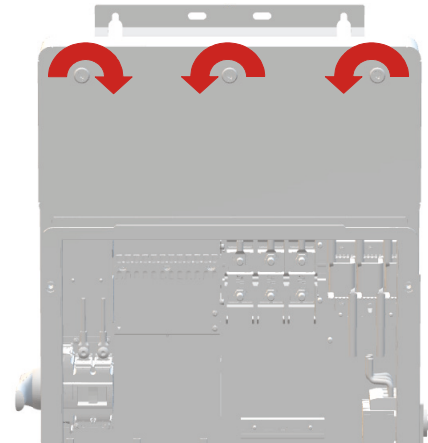


Fig. 19: Key rotation for accessing DC connections and fuses

2. Prepare the DC cables and the potential equalization conductor and lay it to the connection area.



Fig. 20: DC connection area: cable bushing

3. Insert a small hole into the cable bushing membrane with a screwdriver.

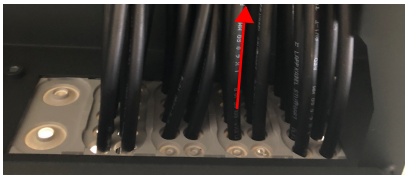


Fig. 21: Insert the DC cables through the cable bushing

4. Insert the potential equalization conductor and DC cables individually through the resulting holes. Ensure tightness and strain relief.
5. Connect the potential equalization conductor with ring cable lug to the PE threaded bolt (M8).



Fig. 22: Potential equalization (Decentral ConnectionBox)

6. Route the DC cables as shown in the Connection-Box. To connect the DC cables, lift the orange lever on the connection terminal, insert the cables and release the lever.
For compatible DC cable sizes, refer Table 4.
7. Check the safe contact of the DC conductors.

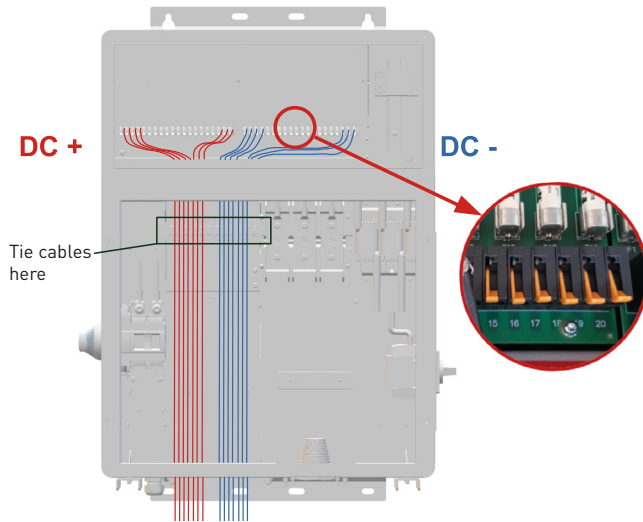


Fig. 23: DC cable routing for decentral ConnectionBox

8. Fasten DC cables to the strain relief rail with cable ties.
9. Check the tightness of all cables.

4.8 Checking String Fuses

PV String Fuses are used to protect the PV strings from back currents in a failure condition (i.e. ground fault). The ConnectionBox is pre-equipped with PV string fuses gPV with 1 100 V and 15 A Rating. The format is 14 x 51 mm.

NOTICE

The installer is responsible for the correct sizing of the fuses in regards to the solar panels specifications and national or normative regulations.

⚠ WARNING

- ▶ Change the string fuses only using the fuse pliers when DC and AC connections are de-energized.

⚠ WARNING

Even with the DC switch off, the DC string terminals and string fuses still carry lethal voltage!

- ▶ Pull the fuse cautiously out of the fuse holder in order not to damage them. Try to pull one side, then the other side to reduce the force.

4.9 Installing the Surge Protection Devices SPD (optional)

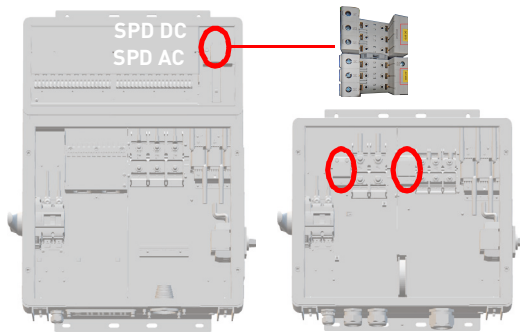


Fig. 24: Surge protection device adapters

- ▷ Insert the optional surge protection module (SPD) into the appropriate adapter rail until it clicks. Make sure that AC and DC SPD are not interchanged and plugged in correctly. This can be seen from the setting pin on the backside of the surge protection module.

4.10 Communication Connections

The *REFUsol 100K* is equipped with RS485 and Ethernet communication ports for an easy integration into monitoring and control systems.

The RS485 and Ethernet (100BaseT) is mapped on the same RJ45 connectors (RS485/LAN 1...2), located at the PowerUnit's back side.

The inverters can be connected in daisy chain, using a single Ethernet cable CAT 5e (or better) between each inverter.

For redundancy purposes, you can also connect the last with the first inverter as a ring topology. Alternatively, they can all be connected separately to a switch.

Inverters in night mode or with non-functional control boards are automatically by-passed to always ensure a working bus system.

4.11 Connect RS485/LAN

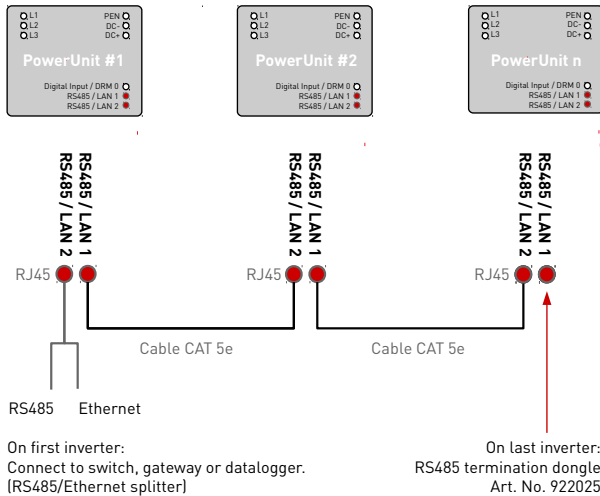


Fig. 25: Wiring of communication cables

- ✓ The cables are fed through the cable gland at the bottom of ConnectionBox, and then connected to the PowerUnits interfaces:



Fig. 26: Connection area: communication

1. Unscrew the union nut of the cable gland.
2. Insert the communication cable into the union nut of the cable gland.
3. Push the communication cable through the rubber seal until there is sufficient cable to the connectors.
4. Connect the communication cables. Make sure that the cables are not mounted on tension.
5. Seal unused openings of the cable gland with the supplied plugs.
6. Tighten the union nut of the cable gland hand-tight.
7. Check tightness and strain relief.

Notes:

- The maximum length for the Ethernet bus is 100 m between each two inverters.
- The maximum total length for the RS485 bus is typically up to 1 000 m.

- You can connect up to 25 inverters for RS485, and up to 25 inverters for each Ethernet daisy-chain line.
- For the RS485 bus, you have to terminate the last inverter in the chain with the RJ45 termination adapter (120 Ω).
- If you want to use both bus systems in parallel, you have you use the Ethernet/RS485 splitter on the first inverter.

NOTICE

- ▶ Only connect the communication cable to the assigned two RJ45 ports with labels “RS485/LAN 1” and “RS485/LAN 2”. The RJ45 port with label “Digital Input” carries 24 VDC. Connecting any communication cable to this port can damage the inverters and connected equipment.
- ▶ For RS485 masters (data-loggers, park controllers etc.), only connect the four RS485 signals to this equipment.
- ▶ It is recommended to protect communication lines with external surge protection devices against overvoltage caused by lightning.

4.12 RJ45 Connector Cabling

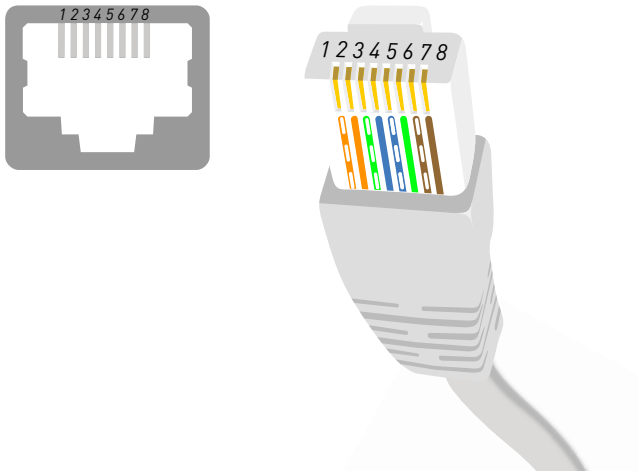


Fig. 27: Pin assignment on RJ45 plug

Tab. 5: Pin assignment

Pin	1	2	3	4	5	6	7	8
Ethernet	TX+	TX-	RX+				RX-	
RS485				Data+	Data-		Ref+	Ref-

4.13 Setting up the Communication

4.13.1 RS485 Network

- ✓ Assign a unique RS485 ID for each inverter in the chain using REFUset app between 1 and 31.
Factory default ID is 0.

Tab. 6: Protocol types

No.	Protocol Type
1	REFU USS protocol (preset)
2	(not used)
3	Meteocontrol USS
4	Modbus RTU Sunspec (address 0 cannot be used – address 0 is automatically set to address 1)
5	Multimode USS/Modbus RTU Sunspec (default setting) (in Multimode, you cannot use USS address 0 and 2)

Tab. 7: RS485 interface settings

Parameter	Value
Baud rate	57600 (preset and recommended)
Parity	even
Handshake	no

Tab. 7: RS485 interface settings

Data bits	8
Stop bits	1

4.13.2 Ethernet Network

- ✓ DHCP is activated by default, so each inverter will receive the configuration automatically from the switch or gateway.
- ✓ If you change the mode to manual, you have to assign an unique IP address, net mask, standard gateway and optionally the DNS server during the REFUset commissioning wizard.
- ✓ Before changed network settings become active, you need to restart the inverter.
 1. To restart the inverter, set the DC switch to the OFF position.
 2. Wait for 60 s and then shift the DC switch to the ON position.

Tab. 8: IP standard settings

Parameter	Value
IP Address	192.168.130.30
Standard gateway	192.168.1.1

Tab. 8: IP standard settings

Net mask	255.255.0.0
DNS Server	0.0.0.0

4.13.3 Ethernet Direct Connection

- ✓ In order to use **REFUset**, all inverter can be reached on its permanent fall-back IP address of 169.254.130.30, irrespectively of your PC IP configuration.

4.14 Connect Remote Off Signal (DRM 0)

The power output of the inverter can be enabled or disabled using the remote shutdown signal (external 24 V voltage signal). Normally, the remote shutdown signal is supplied by a mains protection relay that protects the grid voltage and -frequency is monitored independently from the inverter. The connection for the remote off signal is located on the adapter board at terminal X5.

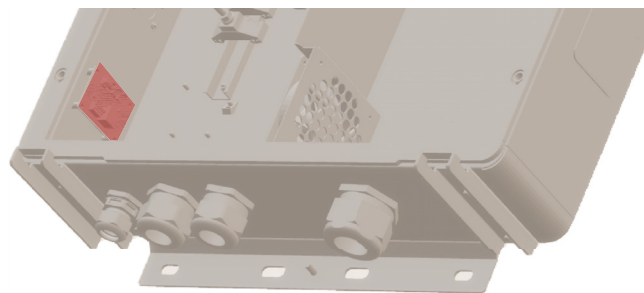


Fig. 28: Connection terminal (X5) on the adapter board

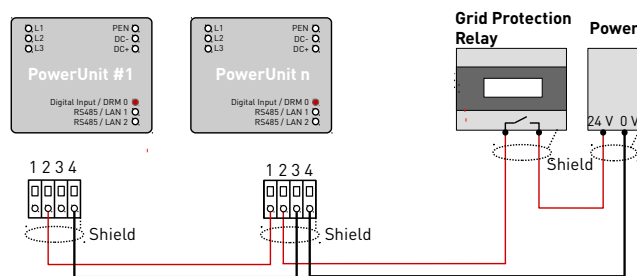


Fig. 29: Wiring and pin assignment for the remote off signal

Tab. 9: Pin assignment X5

Pin	Function
1	Control signal output
2	Control signal input
3	Ground output
4	Ground input

0 V = power lock
24 V = power release

Tab. 10: Cable types

Type	Cross-section
Conductor cross section solid	0.2 ... 1.5 mm ²
Conductor cross section flexible	0.2 ... 1.5 mm ²
Conductor cross section flexible, with ferrule	0.25 ... 0.75 mm ²
Conductor cross section US	24 ... 16 AWG

1. Strip the cable by 8 mm before connecting.
2. Connect the cable to the Push-in Terminal (tool-less, or screwdriver 0.4 x 2.5).

NOTICE

- ▶ The Digital Inputs draws approximately 7 mA. Use a power supply which can supply sufficient current, depending on the number of inverters connected in parallel.
- ▶ The standard switch off time is 50 ms. It is customizable.
- ▶ This function has to be configured by *REFUset* mobile app or PC software.

4.15 Testing Electrical Safety

- ▷ For commissioning, check the ConnectionBox and its connections according to IEC 62446-1.

4.16 Unpacking the PowerUnit

- ▷ With two persons pull out the PowerUnit by the handles. Make sure that the connection area is not damaged and that the PowerUnit stands stable on the device holder.
- ▽ If applicable, carefully cut the packaging completely with a cutter knife. Please note that this means that the packaging can no longer be reused.

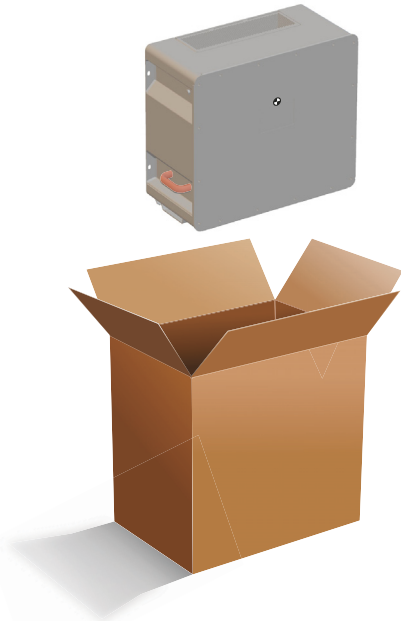


Fig. 30: Unpacking the PowerUnit

4.17 Hooking in the PowerUnit

Ensure following conditions prior to hooking in the PowerUnit:

- ✓ Ambient conditions are dry.
 - ✓ Protective cover of the ConnectionBox is removed.
 - ✓ Unpack the PowerUnit carefully and inspect contact connections on the rear side for any damages.
1. Lift the PowerUnit with the help of 2 people with one hand on the handle and one hand on top of the inverter.
 2. Carefully insert the PowerUnit into the device holder of the ConnectionBox as seen in figure 31.

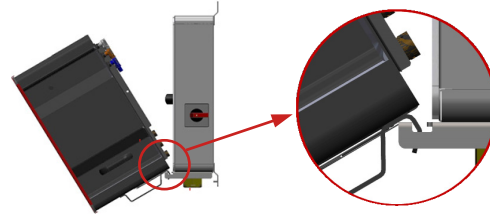


Fig. 31: Hooking PowerUnit onto ConnectionBox

3. One person should hold the PowerUnit in place while the 2nd person should hook the hydraulic rod into the slot in the ConnectionBox as seen in figure 32.

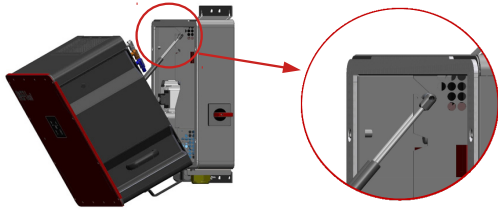


Fig. 32: Hooking the hydraulic rod in the recess of the ConnectionBox when mounted vertically

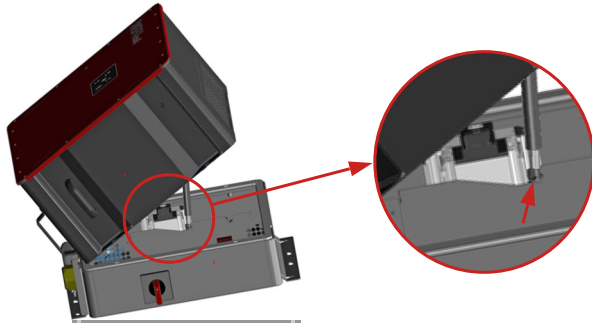


Fig. 33: Brace the hydraulic rod in the recess of the ConnectionBox when mounted horizontally

⇒ Further assembly can be continued by one person.

4.18 Connecting AC, DC and PEN

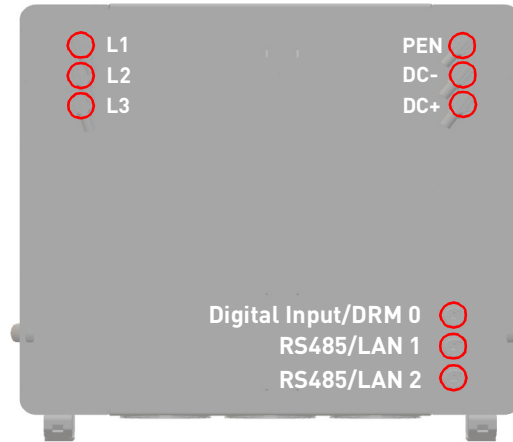


Fig. 34: Connection area of the inverter: L1-3, PEN, DC-/+, Digital Input and RS485/LAN 1-2

- ✓ The electrical systems is disconnected according to the 5 safety rules.
- ✓ DC switch is turned off.
- ✓ AC switch is turned off.

▷ Press the plug latching and insert the plug into the connector socks, until it makes a clicking noise.

a) Start with the connecting of protective earth (PEN, green/yellow).

b) Connect the AC and DC lines according to their markings (DC-, DC+, L1, L2, and L3) to the ConnectionBox.

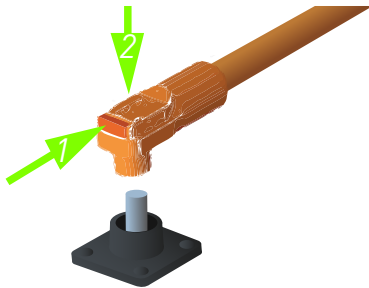


Fig. 35: Cable connector

c) Connect the Ethernet cable of the ConnectionBox adapter board (X6) to the digital input of the PowerUnit (Digital Input/DRM 0).

d) Make sure that the plugs are engaged.

4.19 Closing and Fixing the PowerUnit

1. Carefully press the PowerUnit in its intended place and hold it. Make sure that the cables are not pinched or damaged when closing.
2. Tighten the M8 screws hand-tight.
3. Tighten all four M8 bolts crosswise with a tightening torque of 20 Nm.

5 Commissioning

5.1 Before Startup

- ✓ The first commissioning is based on the locally applicable installation regulations.
- ▷ Check the polarity and voltage of each string connected.

5.2 Startup

- ▷ Close AC switch (if present).
- ▷ Close DC switch.

The *REFUso1100K* will indicate the startup by a flashing green light.

1. Internal tests (i.e. relais test).
2. Grid conditions are within the allowed range.
3. Sufficient PV voltage and power.
4. *REFUso1100K* start to export power to the public grid.

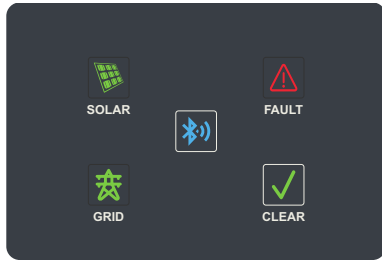







Fig. 36: Display panel

Tab. 11: Indicator and keys of the display panel

Indicator/Key	Description
 SOLAR	<p>SOLAR indicator</p> <p>On: DC voltage sufficient; ready for feeding</p> <p>Fast flashing: DC power not sufficient</p> <p>Slow flashing: DC voltage is too high or too low</p> <p>Off: No DC voltage</p>
 GRID	<p>GRID indicator</p> <p>On: Grid is ok (feeding in if SOLAR is on and ERROR is off)</p> <p>Fast flashing: Inverter is in the activation state</p> <p>Slow flashing: Grid check in progress</p> <p>Off: Grid not connected</p>
	<p>Bluetooth key</p> <p>On: Connected</p> <p>Slow flashing: Ready for connection</p> <p>Fast Flashing: Connecting</p> <p>Off: No connection</p>
 FAULT	<p>FAULT indicator</p> <p>On: Inverter in error state and not feeding in</p> <p>Flashing: User-off mode</p> <p>Off: No error</p>

Tab. 11: Indicator and keys of the display panel

Indicator/Key	Description
	<p>CLEAR key</p> <ul style="list-style-type: none"> ▶ To acknowledge an error, press the key briefly (less than 5 seconds). ▶ Press and hold the key for more than 5 seconds to enable or disable user clearance (test mode). When the mode is active, the Clear key and Fault indicator flash rapidly at the same time.
Update state	The FAULT indicator is permanently on, the GRID and SOLAR indicators flash alternately.
Initialization state	Right and left indicators flash alternately during startup.
State "No Grid Code selected"	The FAULT indicator is permanently off, the GRID and SOLAR indicators flash alternately.

5.3 Configuring Inverters with the Mobile App REFUset

You can use the mobile app *REFUset* for iOS or for Android platforms to do all necessary settings.

At the first start-up of the *REFUso1 100K*, *REFUset* will show the initial inverter setup screen for these settings:

- Country of installation
- Grid code (grid guidelines, with multiple selection)
- Nominal grid voltage

Optional settings:

- Permanent Power limitation
- Remote Stop Signal
- Network settings RS485
- Network settings Ethernet

REFUset also offers more functionality like error log file, performance data diagrams and extended settings.

NOTICE

- ▶ For certain settings, you need a personal password, which is provided from REFU Elektronik GmbH on request.

- ✓ **REFUset** is installed on your mobile device.
- REFUset** is available via Apple's App Store for iOS devices and Google's Play app for Android devices. GPS and Bluetooth need to be active and permissions set for the App
1. Turn on the DC switch.
 2. Turn on the AC switch.
 3. Turn on your mobile Bluetooth and GPS mode.
 4. Start the **REFUset** app on your mobile device.
 5. Press the Bluetooth button on the inverter's display panel.
- ⇒ Inverter is paired automatically and shown in the **REFUset** app. Bluetooth button illuminates blue.

5.4 Configuring Inverters with the PC Software REFUset

You can upgrade the firmware of the inverters and change country-specific parameters of the inverter with the PC software **REFUset**. You can connect the PC with the inverters via Ethernet or USB using a RS485-USB converter.

For extended settings, you will receive a personal password on request from the REFU Service.

Functions

- Firmware update
 - Export of inverter data
 - Feed-in conditions voltage and frequency
 - Ramp starting time in the event of a grid error
 - Average voltage monitoring
 - Phase conductor voltage monitoring
 - Frequency-dependent power reduction
 - Actual voltage monitoring (rapid disconnection)
 - Actual frequency monitoring
 - Reactive power ($\cos \varphi$)
 - Power-up time
 - K factor (fault ride through)
- REFUset can be downloaded from www.refu.com.

6 REFUlog – Monitoring portal

The *REFU*sol 100K inverter can be connected to the monitoring portal REFUlog using direct Ethernet connection to the internet, or via RS485 and the REFUcontrol data-gateway.

Once an internet connection is established, the inverter will automatically start to send data to REFUlog every 5 minutes. The sending interval can be changed with the configuration tool REFUset.

To view the inverter data, open www.refu-log.com with your browser and login or register as a new user.

You can use the activation code provided on the type label of the inverter to assign one or more inverter to a PV system. REFUlog is also available as mobile app for Android and iOS.

7 Technical Data

7.1 PowerUnit

Tab. 12: Technical data REFUsol 100K

DC DATA				
Operation mode	83 kVA @ 380 VAC	88 kVA @ 400 VAC	100 kVA @ 460 VAC	100 kVA @ 480 VAC
Art. No.	880P100.020			
DC max. voltage	1 100 V			
DC nominal voltage	600 V	620 V	695 V	725 V
MPPT range at nominal power	555 ... 900 V	585 ... 900 V	665 ... 900 V	700 ... 900 V
DC operating range	555 ... 1 000 V	585 ... 1 000 V	665 ... 1 000 V	700 ... 1 000 V
DC start-up open circuit voltage	595 V	625 V	720 V	750 V
Max. DC operational current	154 A	155 A	155 A	155 A
Max. short circuit current I_{SC} of PV system	250 A			
Max. short circuit current I_{SC} per string input	25 A			
Max. DC/AC power ratio	150 %			
Backfeed current	0 A			

Tab. 12: Technical data REFUsol 100K

DC DATA				
DC nominal power	85.5 kW	90.5 kW	102.5 kW	102.5 kW
MPP tracker	1			
DC connection PowerUnit-to-ConnectionBox	1 Plus, 1 Minus: Connector with button activated coupling			
AC DATA				
AC nominal power	83.3 kVA	88 kVA	100 kVA	100 kVA
AC rated voltage	380 V	400 V	460 V	480 V
AC nominal voltage	315, 380, 400, 415, 440, 460, 480 V			
AC voltage range	180 ... 528 V			
AC grid connection / grid types	3 phases, PE / TN-C, TN-S, TN-C-S, TT			
Nominal power factor / range	1 / 0.3i ... 0.3c			
Rated frequency / frequency range	50, 60 Hz / 45 ... 65 Hz			
Max. AC current	128 A			
Max. AC short circuit current	64 A [3 period average]			
Inrush current (peak / duration)	25 A / 0.5 ms			
Max. THD	< 3 %			

Tab. 12: Technical data REFUsol 100K

DC DATA				
Max. efficiency	98.3 %	98.4 %	98.7 %	98.7 %
European efficiency	97.9 %	98 %	98.5 %	98.5 %
Night-time power loss	< 1 W			
Maximum admissible external AC fuse	160 A, gG, U _N = 500 V			
Peak current (I _p) / Initial short circuit current (I _k) according to IEC 60690-0	128 A / 325 A			
AC connection PowerUnit-to-ConnectionBox	connector with Button Activated Coupling			

AMBIENT CONDITIONS	
Cooling	Smart active cooling
Max. temp. for nominal power	45 °C
Ambient temperature	-25 ... +60 °C
Rel. air humidity	0 ... 100 %
Max. elevation, above sea level	3 000 m
Noise level	< 70 dBA

Environment classification (IEC 60721-3-4)	4K4H
Type of protection PowerUnit / ConnectionBox (IEC 60529)	IP65 / IP54
Installation type	indoor, outdoor, vertical / horizontal / pole mounting
PROTECTION FUNCTIONS	
Grid monitoring	voltage, frequency, passive and active anti-Islanding, DC injection
Grid separation	gate block / redundant grid relay
Residual Current Monitoring (RCD) / Isolation monitoring	Type 2 / yes
Compatibility external RCD	Type A / Type B
Protection class (IEC 62109-1)	1
Overvoltage category (IEC 60664-1)	DC: II / AC: III
GENERAL DATA	
Topology	transformerless
DC pole grounding	not allowed
Status display / keys	4 LED's (DC status, AC status, Fault, Bluetooth®) / 2 Keys (Connect, Clear)
Interfaces	2 × ethernet daisy-chain / 2 × RS485, Bluetooth® BLE, 1 x remote off signal

Communication protocols	Sunspec (Modbus TCP, Modbus RTU), USS (Ethernet, RS485)
Dimensions PowerUnit W x H x D	673 × 626 × 321 mm
Weight inverter	69 kg
CERTIFICATES	All certificates are available at www.refu.com
EU directive	2014/30/EU, 2014/35/EU
Product	IEC 62109-1, IEC 62109-2, IEC 62116, IEC 61727, IEC 61683, IEC 62477-1, IEC 61439, ETSI EN 300 328 V.2.1.1
EMC	IEC 61000-6-2, IEC 61000-6-4
Environment	IEC 60068-2-1, -2-2, -2-30, -2-78, -2-14, -2-6, -2-27, -3-2, -2-75, IEC 60529, IEC 60034-9
Grid Codes	DIN VDE V 0126-1-1, VDE AR-N 4105, TOR D4, Önorm E 8001-4-712, UTE C15-712-1, VDE AR-N 4105:2018, VDE AR-N 4110:2018, EN 50438

7.2 ConnectionBox Variants

Tab. 13: Technical data ConnectionBox Variants

		Decentral ConnectionBox	Central ConnectionBox
Type		CBID 100K (1100V-PMH-DCS)	CBIC 100K (1100V-R-DCS)
Art. No.		937P211.0001	936P001.0000
INPUT	Rated DC voltage	1 100 V	
	Max. current per input / total	25 A/250 A	250 A/250 A
	DC connection	20 strings push-in clamp 6 ... 16 mm ²	ring terminal block 50 ... 240 mm ²
	DC fuses (+ / -)	order separately (Art. No. 922028)	order separately (Art. No. 922028)
	DC circuit breaker	integrated	integrated
	DC overvoltage protection	order separately (Art. No. 922021/22)	order separately (Art. No. 922021/22)
OUTPUT	Rated AC voltage	180 to 480 V	180 to 480 V
	AC overvoltage protection	order separately (Art. No.922023/24)	-
	Max. AC current	128 A	128 A
	AC connection	L1-L3: M12, PEN: M10, bolt terminals 50 ... 240 mm ²	L1-L3: M10, PEN: M8 (min. 6 mm ²), bolt terminals 50 ... 150 mm ²
Dimensions W × H × D		760 × 1007 × 166 mm	760 × 692 × 166 mm
Weight		40 kg	25 kg

8 Single Line Diagrams

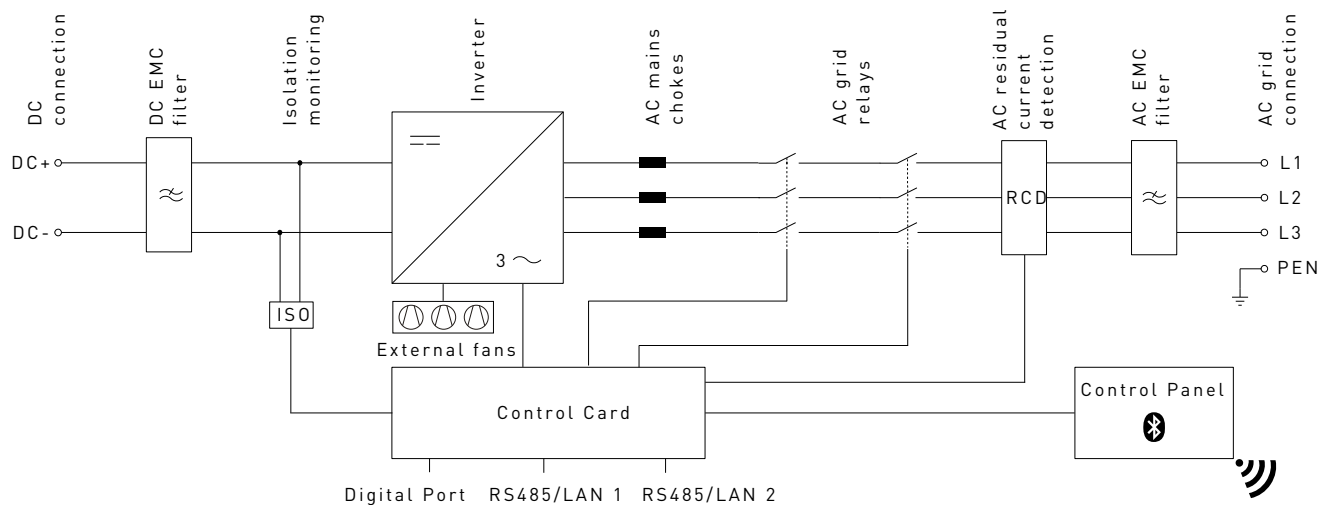


Fig. 37: Single line diagram PowerUnit

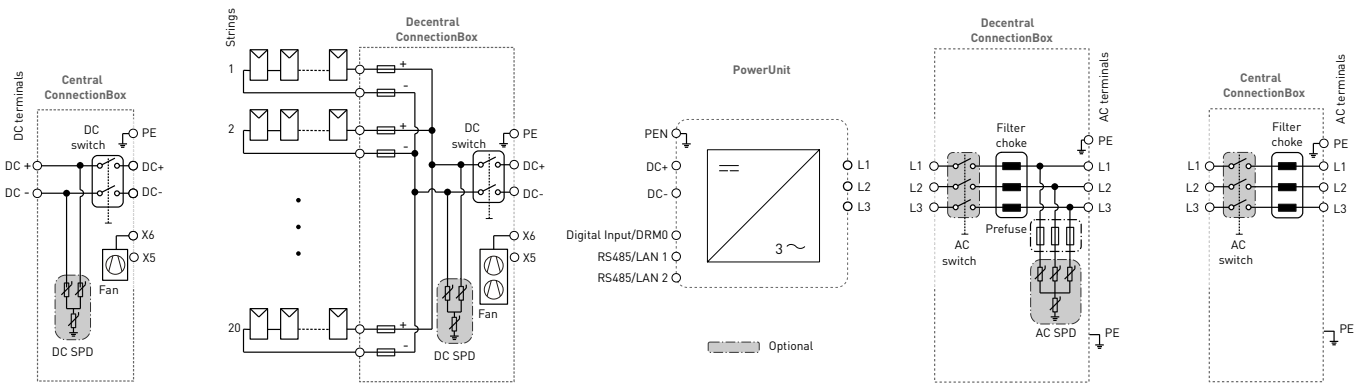


Fig. 38: Single line diagram ConnectionBox variants

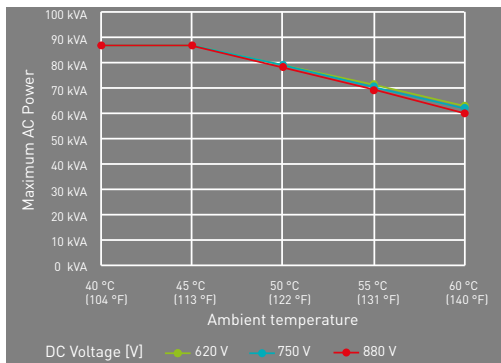


Fig. 39: Temperature derating curves

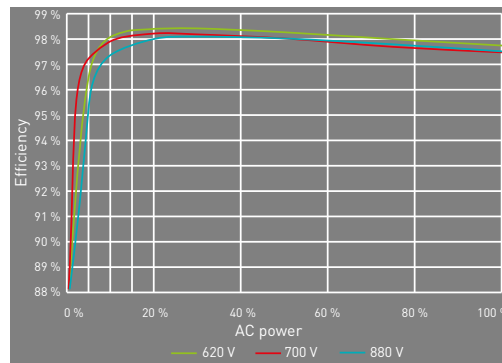


Fig. 40: Efficiency curves

9 Maintenance

i The maintenance intervals are manufacturer's recommendations, which may have to be shortened due to extreme environmental conditions.

9.1 General Warnings

DANGER

High voltage

Danger to life due to electric shock.

The product operates at high voltages:

- ▶ All work on the product must be carried out by electrically qualified persons only.
- ▶ If the inverter is tilted forward on rainy or snowy days or the connection box is opened, take suitable protective measures to prevent water from entering the connection box. If it is not possible to take protective measures, do not tilt the inverter forward or open the connection box.



DANGER

High voltage

Danger to life due to high voltages that can cause lethal electric shocks are present in the live components of the inverter.

- ▶ Always disconnect the inverter from voltage sources before performing any work on it.
- ▶ Observe a waiting time of 2 minutes.



DANGER

High voltage

Danger to life due live parts can remain energized after isolation.

- ▶ Disconnect electrical systems according to the 5 safety rules (see chapter 2.7).



CAUTION

Hot surfaces

Risk of burns due to hot surfaces.

The product can get hot during operation.

- ▶ Avoid contact during operation.
- ▶ Allow the product to cool down sufficiently before carrying out any work.



9.2 Replacement

9.2.1 Replacing the PowerUnit Fan

The fan can be easily replaced without opening the inverter.

- ✓ Electrical systems are disconnected according to the 5 safety rules.
- 1. Loosen the 2 screws of the fan plate.
- 2. Remove the fan plate from the inverter.
- 3. Remove the plug connectors.
- 4. Connect the new fan plate to the inverter using the connectors.
- 5. Tighten the 2 new fan plate screws crosswise with a tightening torque of 0.6 Nm.
- 6. Check fans for function.

9.2.2 Replacing the Central ConnectionBox Fan

- ✓ Electrical systems are disconnected according to the 5 safety rules.
- 1. Loosen the 4 PowerUnit fixing screws. Make sure that the PowerUnit is pressed slightly in the direc-

tion of the ConnectionBox when the last screw is loosened.

- 2. Slowly pull the PowerUnit into the opposite direction. Make sure that the hydraulic rod is hooked in the ConnectionBox.
- 3. Lift the PowerUnit with the help of 2 people with one hand on the handle and one hand on top of the inverter.
- 4. Place the PowerUnit carefully on a dry and clean surface.
- 5. Remove the four expanding rivets of the ConnectionBox fan with suitable tools.
- 6. Pinch off both cable ties on the ConnectionBox rear wall.
- 7. Remove the plug connector to the adapter board and remove the defective fan.
- 8. Mount the new ConnectionBox fan with four new expanding rivets (4 x 9 mm). Pay attention to the orientation of the power supply cable.
- 9. Use two cable ties to secure the supply, Ethernet and sensor cables to the rear of the ConnectionBox.

10. Plug the supply cable of the ConnectionBox fan into the adapter board.
11. Lift the PowerUnit with the help of 2 people with one hand on the handle and one hand on top of the inverter.
12. Carefully insert the PowerUnit into the device holder of the ConnectionBox.
13. Check fan for function.
14. Carefully press the PowerUnit in its intended place and hold it. Make sure that the cables are not pinched or damaged when closing.
15. Tighten the M8 screws hand-tight.
16. Tighten all four M8 bolts crosswise with a tightening torque of 20 Nm.

9.2.3 Checking or Replacing the PV Fuses

Replace the fuses if the fuses are damaged or the fuse value is to be set depending on the type of photovoltaic module used.

- ✓ Electrical systems are disconnected according to the 5 safety rules.
- ✓ AC switch to the inverter is opened.

- ✓ DC switch is opened.
- ✓ Wait 2 minutes until the stored energy is discharged.
- ▷ If no additional DC switch is available to disconnect the live power from the photovoltaic generator, carry out maintenance work only at night.
 1. Open the locks of the DC fuse area.
 2. Remove the cover of the DC fuse section. Do not mechanically stress the PE connection to the cover.
 3. Check the fuses optically.
 4. If necessary, replace the fuses with new ones. Use the fuse pliers to remove the fuse. The fuse pliers is available as an option and can be ordered under Art. No. 922027.
 5. Check the function of the new fuse.
 6. Insert the new fuse into the fuse holder with the fuse pliers.
 7. Attach the cover and close the latches.

9.2.4 Replacing the DC Cable Bushing (decentral ConnectionBox)

A safe exchange of the DC cable bushing is only possible if no DC cables are connected.

- ✓ Electrical systems are disconnected according to the 5 safety rules.
 - ✓ External DC switch open.
 - ✓ All DC lines are disconnected and removed from the DC connection point.
1. Unscrew the four cable bushing screws.
 2. Lever out the cable bushing carefully
 3. Clean the cut-out.
 4. Attach the cable bushing on one side and slide it in on the other side until it snaps into place.
 5. Tighten the four cable bushing screws.

9.2.5 Replacing the Sealing Gasket of the ConnectionBox

- ✓ Electrical systems are disconnected according to the 5 safety rules.

1. Loosen the 4 inverter fixing screws. Make sure that the inverter is pressed slightly in the direction of the ConnectionBox when the last screw is loosened.
2. Slowly pull the inverter into the opposite direction. Make sure that the hydraulic rod is hooked in the ConnectionBox.
3. Replace the sealing gasket with a new one.
4. Carefully press the inverter in its intended place and hold it.
5. Tighten all four inverter screws crosswise with a tightening torque of 2.5 Nm.

9.3 Periodicity of Maintenance

Activities to be performed	Interval
Cleaning or replacement of the air outlet plate.	12 months*
Visual inspection of the heat sink and if necessary cleaning (after air outlet plate has been dismantled).	12 months*
Checking the interior of the ConnectionBox for dust deposits, dirt, moisture and water ingress from the outside.	5 years*

Activities to be performed	Interval
Checking the PowerUnit fans for function and operating noise.	12 months
Checking the ConnectionBox fans for function and operating noise.	12 months
Visual inspection of the ConnectionBox fuses (Decentral ConnectionBox).	12 months*
Checking the surge protection device (AC and DC side) and the external fuses for damage.	12 months
Checking the strength of the clamping connections of the power cables and re-tighten if necessary. Pay attention to discoloration/changes on the insulation and terminals. Replace damaged or corroded cable connections or contact elements.	12 months
Function test of the insulation monitoring.	12 months
Checking AC and DC voltages.	12 months
Checking starting behavior.	12 months
Checking the display field or LEDs for function.	12 months
Checking warning notices (stickers) and if necessary replace the stickers	12 months
Documenting the operating environment and the device with a camera.	12 months

Activities to be performed	Interval
Visual inspection of the operating conditions. Check minimum distance (2 m) to surrounding shrubs, hedges etc.	12 months*
Replacing the device fans, if fans are indicated as defect.	8 years*
Replacement DC fuses (Decentral ConnectionBox).	10 years*

* Shorter maintenance intervals may be required (depending on location and ambient conditions)

10 Disposal

Dispose of the packaging and replaced parts according to the rules applicable in the country where the product is installed. Do not dispose of the **REFUsoI 100K** with normal domestic waste. The **REFUsoI 100K** conforms to RoHS.

▷ REFU Elektronik GmbH takes the **REFUsoI 100K** back completely. Please contact the REFU Service team!

11 Troubleshooting

11.1 Error List

Error Code	Message	Description	Instructions
11005	Isolation Error	An insulation fault was detected during the self-test before grid connection.	<ul style="list-style-type: none"> ▶ Check measured value and limit value in REFUset. ▶ Check the installation of the inverter. ▶ Check PE connection. ▶ Check for faulty cables (e.g. damaged insulation). ▶ Check solar generator installation.
70004	Safety Relay Broken	The self-test of the safety relays could not be completed successfully.	<ul style="list-style-type: none"> ▶ Open and close the DC switch. ▶ If this error occurs more than once, contact REFU Service.
70005	Relay Test Bad Comm1	The self-test of the safety relays detected a communication problem.	
70006	Relay Test Bad Comm2		
70007	Relay Test Bad Comm3		
70008	Relay Test Bad Comm4		

Error Code	Message	Description	Instructions
90006	Grid overvoltage	At least one grid phase exceeds the configured overvoltage limit value for the configured duration.	<ul style="list-style-type: none"> ▶ Measure the voltage of all three phases with REFUset and a True-RMS meter. ▶ Check the configured voltage limit and the configured nominal voltage.
90007	Grid undervoltage	At least one grid phase falls below the configured undervoltage limit value for the configured duration.	
90008	Overfrequency	The grid frequency exceeds the configured limit value for the configured duration.	<ul style="list-style-type: none"> ▶ Measure the voltage of all three phases with REFUset and a True-RMS meter. ▶ Check the configured frequency limit and the configured nominal frequency.
90009	Underfrequency	The grid frequency falls below the configured limit value for the configured duration.	
9000B	DC link 1	The device has disconnected from the grid due to an imbalance in the internal DC voltage and is switched on again briefly.	▶ If this error occurs more than once, contact REFU Service.
90011	DC link 6	The device has disconnected from the grid due to a DC overvoltage in the input of the inverter. As soon as the measured open-circuit voltage is below the permitted limit value, the device switches on again automatically.	▶ Check the DC voltage of the solar generator. The voltage must be below 1 000 VDC for connection. The maximum DC open circuit voltage must not exceed 1 100 VDC.
90013	RCD Fail	The all-current sensitive residual current measurement has measured a relative or absolute exceedance of the set limit value.	<ul style="list-style-type: none"> ▶ Check measured value or limit value in REFUset. ▶ Check the installation of the inverter. ▶ Check PE connection. ▶ Check for faulty cables (e.g. damaged insulation). ▶ Check solar generator installation.

Error Code	Message	Description	Instructions
90020	Initialisation C1	The system initialization has not been completed successfully.	<ul style="list-style-type: none"> ▶ Update the device if a new firmware version exists. ▶ If the error persists, please contact REFU Service.
90021	Initialisation C0		
90024	SR parameter error	The device parameterization was not loaded during system initialization.	
90028	Update Start	Operation of the inverter has been interrupted to perform a firmware update. The device restarts automatically after a successful update.	▶ Wait until the update process is complete.
90029	Update fault	An error occurred repeatedly during the firmware update.	<ul style="list-style-type: none"> ▶ Download the correct firmware package again from the manufacturer's website and restart the update. ▶ If the error persists, please contact REFU Service.
9002A	Keep Alive	Internal communication is disrupted. The device is restarted automatically.	▶ If the error persists, please contact REFU Service.
9002B	Update End	The firmware update was successfully completed.	For information only.
9002D	AntilandRocof	An island network was identified using the RO-COF method. The device disconnects from the grid and restarts automatically after 30 s under normal grid conditions.	▶ Check the grid connection and measure the voltages with a True RMS meter.
9002E	Antiland Active	An island network was detected using the active method. The device disconnects from the grid and restarts automatically after 30 s under normal grid conditions.	

Error Code	Message	Description	Instructions
9002F	FFS is read-only	The internal data storage is not possible due to a flash error.	▶ Please contact REFU Service.
90030	DC share too high	The measured DC-Part in AC current exceed the defined limit.	
90031	ETH link lost	The Ethernet connection was interrupted.	▶ Check all Ethernet cables in the system (on the inverter, router, switch, etc.) for correct connection and damage.
90032	Restart	A notice that the system is restarted.	▶ If these instructions occur more frequently in daily operation, please contact REFU Service.
90034	DC share too high	The measured DC component in the AC current is above the configured limit value. The device restarts automatically.	▶ Please contact REFU Service.
90050	AC condition	The AC switch-on condition has not yet been fulfilled (mains frequency, AC voltage).	▶ Wait until the network is stable.
90051	DC condition	The DC switch-on condition not yet fulfilled (DC voltage).	▶ Wait until the DC voltage is sufficient.
90052	User lock active	The user lock is active.	▶ Deactivate the user lock by pressing the "Clear" (REFU _{sol} 100K) key for at least 5 s.
90054	Overvoltage 2	The mean grid voltage is above the configured limit value of the voltage mean value monitoring.	▶ Measure the voltage of all three phases with REFU _{set} and a True RMS meter. ▶ Check the configured voltage average and the configured nominal voltage.

Error Code	Message	Description	Instructions
90055	Grid overvoltage	The phase phase voltage exceeds the configured limit value for the configured duration.	<ul style="list-style-type: none"> ▶ Measure the voltage of all three phases with REFUset and a True-RMS meter. ▶ Check the configured voltage limit and the configured nominal voltage.
90056	Grid undervoltage	The phase phase voltage falls below the configured limit value for the configured duration.	
90057	Watchdog C0	The internal firmware protection function has been triggered.	▶ Please contact REFU Service.
90058	Watchdog C1		
90059	LT Firmware	The LT/safety processor firmware is defective.	<ul style="list-style-type: none"> ▶ Download the correct firmware package again from the manufacturer's website and restart the update. ▶ If the error persists, please contact REFU Service.
90061	Update fault	–	
90062	Fault ride through	Indication of instabilities in the network, which must be passed through according to different country regulations.	No action necessary.
90071	DFLASH Fixed	–	
90072	DFLASH Reset	The device has lost important configuration parameters.	▶ Please contact REFU Service.
90073	Test Info	–	No action necessary.
90074	Test Noti	–	
90075	Test Temp Noti	–	

Error Code	Message	Description	Instructions
90082	HW VPos feeding	The hardware protection has detected an impermissible overvoltage in the positive DC link.	▶ Check DC voltage for permissible range.
90083	HW VNeg feeding	The hardware protection has detected an impermissible overvoltage in the negative DC link.	
90084	HW PowNok feeding	The hardware protection has detected a problem in the power supply of the switches.	▶ Open and close the DC switch. ▶ If error occurs more than once, contact REFU Service.
90085	HW DcUnsy feeding	The hardware protection has detected an impermissible asymmetry in the DC link.	
90086	HW driver feeding	The hardware protection has detected a problem in the circuit breaker driver.	
90087	HW overcurrent L1	The hardware protection has detected an impermissible overcurrent in L1, L2, or L3.	
90088	HW overcurrent L2		
90089	HW overcurrent L3		
9008A	IGBT overtemperature	The temperature of the IGBT's exceeds the permissible limit value.	▶ Do not run the inverter at full load at high ambient temperatures.
9008B	Air overtemperature	The temperature of the interior exceeds the permissible limit value.	

Error Code	Message	Description	Instructions
9008C	HW error feeding	The hardware protection has detected a general error.	<ul style="list-style-type: none"> ▶ If error occurs more than once, contact REFU Service.
9008D	HeartBeat Protection	An internal communication problem has been identified. This leads to grid disconnection of the device and subsequent restart.	
9008E	ComTimeout Error		
9008F	ComTimeout Running		
90090	ComTimeout ParamInit		
90091	HeartBeat Safety		
90092	Under Freq Safety	The grid frequency falls below the configured limit value for the configured time.	<ul style="list-style-type: none"> ▶ Measure the frequency of all three phases with REFUset and a True RMS meter ▶ Check the configured frequency limit and the configured nominal frequency.
90093	Over Freq Safety	The grid frequency exceeds the configured limit value for the configured time.	
90094	Under Volt Safety	The grid voltage falls below the configured limit value for the configured time.	<ul style="list-style-type: none"> ▶ Measure the voltage of all three phases with REFUset and a True RMS meter ▶ Check the configured voltage limit and the configured nominal voltage.
90095	Over Volt Safety	The grid voltage exceeds the configured limit value for the configured time.	
90096	Safety Test Noti	–	No action necessary.

Error Code	Message	Description	Instructions
90097	Safety general	There is a problem with the safety processor.	▶ Please contact REFU Service.
90098	Safety unknown		
90099	Safety APP NOK		
9009A	Watchdog safety		
9009B	Safety not running		
9009C	Safety unknown state		
9009D	SafetyParamInit NOK		
9009E	Safety APP start NOK		
9009F	Safety APP reset NOK		
900A0	Safety Error timeout		
900A1	Safety UpdateSpecial		
900A2	SMS island detected		

Error Code	Message	Description	Instructions
900A3	SafetyRelay 1 broken	The safety relay L1 is jammed.	▶ Please contact REFU Service.
900A4	SafetyRelay 2 broken	The safety relay L2 is jammed.	
900A5	SafetyRelay 3 broken	The safety relay L3 is jammed.	
900A6	MainRelay 1 broken	The safety relay L1 is jammed.	
900A7	MainRelay 2 broken	The safety relay L2 is jammed.	
900A8	MainRelay 3 broken	The safety relay L3 is jammed.	
900AA	External FAN NOK	The external fans do not work. The device automatically limits its power to keep the temperature of the device within a safe range.	▶ Replace the external fans according to the manual.
900AB	Internal FAN NOK	The internal fan does not work. The device automatically limits its power to keep the temperature of the device within a safe range.	▶ Please contact REFU Service.
900AC	Systemstart info	–	No action necessary.
A017D	Phase defect	The actual current value deviates from the set current value.	▶ Please contact REFU Service.
A017E	HW error activation	General hardware shutdown by the inverter during the activation phase. This error should be corrected automatically.	▶ If error occurs more than once, contact REFU Service.

Error Code	Message	Description	Instructions
A017F	HW VPos activation	The hardware protection has detected an impermissible overvoltage in the positive DC link during the activation phase.	▶ Check DC voltage for permissible range.
A0180	HW VNeg activation	The hardware protection has detected an impermissible overvoltage in the negative DC link during the activation phase.	
A0181	HW PowNok activation	The hardware protection has detected a problem with the circuit-breakers during the activation phase.	▶ If error occurs more than once, contact REFU Service.
A0182	HW DcUnsy activation	The hardware protection has detected an impermissible asymmetry in the DC link during the activation phase.	▶ Open and close the DC switch. ▶ If this error occurs more than once, contact REFU Service.
A0183	HW driver activation	The hardware protection has detected a problem in the circuit breaker driver during the activation phase.	
A0184	HW I L1 activation	The hardware protection has detected an impermissible overcurrent in L1 during the activation phase.	
A0185	HW I L2 activation	The hardware protection has detected an impermissible overcurrent in L2 during the activation phase.	
A0186	HW I L3 activation	The hardware protection has detected an impermissible overcurrent in L3 during the activation phase.	

Error Code	Message	Description	Instructions
A0187	HW error PreActiv	The hardware protection has detected a general error before the activation phase.	▶ If error occurs more than once, contact REFU Service.
A0188	HW VPos PreActiv	The hardware protection has detected an impermissible overvoltage in the positive DC link before the activation phase.	▶ Check DC voltage for permissible range.
A0189	HW VNeg PreActiv	The hardware protection has detected an impermissible overvoltage in the negative DC link before the activation phase.	
A018A	HW PowNok PreActiv	The hardware protection has detected a problem with the circuit-breakers before the activation phase.	▶ If error occurs more than once, contact REFU Service.
A018B	HW DcUnsy PreActiv	The hardware protection has detected an impermissible asymmetry in the DC link before the activation phase.	▶ Open and close the DC switch. ▶ If this error occurs more than once, contact REFU Service.
A018C	HW driver PreActiv	The hardware protection has detected a problem in the circuit breaker driver before the activation phase.	

Error Code	Message	Description	Instructions
A018D	HW I L1 PreActiv	The hardware protection has detected an impermissible overcurrent in L1 before the activation phase.	<ul style="list-style-type: none"> ▶ Open and close the DC switch. ▶ If this error occurs more than once, contact REFU Service.
A018E	HW I L2 PreActiv	The hardware protection has detected an impermissible overcurrent in L2 before the activation phase.	
A018F	HW I L3 PreActiv	The hardware protection has detected an impermissible overcurrent in L3 before the activation phase.	
A0190	Duty NOK	–	No action necessary.
A0191	RCD Selftest NOK	The self-test of the all-current sensitive residual current monitoring failed.	▶ Please contact REFU Service.
A0192	DCPrecharge under U	DC input voltage is too low for the precharge process.	<ul style="list-style-type: none"> ▶ Check connections. ▶ Open DC switch.
A0193	DCPrecharge NOK	Temporary failure: The DC precharge is incomplete.	<ul style="list-style-type: none"> ▶ Open and close AC and DC switches. ▶ If the error still occurs, contact REFU Service.
A0194	DCPrecharge warning	Temporary failure: The DC precharge is incomplete.	▶ Contact REFU Service.
A0195	DCPrecharge fault	A hardware defect could be present.	<ul style="list-style-type: none"> ▶ Open the AC and DC switches to disconnect the unit from power supply. ▶ If the error still occurs, contact REFU Service.

Error Code	Message	Description	Instructions
A0196	DC voltage too high	The unit was shut down after the DC input voltage exceeded the unit's rated voltage.	<ul style="list-style-type: none"> ▶ Measure DC voltage. ▶ Set the DC voltage value indicated on the type label. ▶ Acknowledge the error.
A0197	DC Overvoltage	DC overvoltage occurred.	<ul style="list-style-type: none"> ▶ Measure DC voltage. ▶ Set the DC voltage value indicated on the type label.
A0198	DC asymmetry	DC voltage unbalanced.	No action necessary.
A0199	DC voltage jump	An unacceptable DC voltage peak has occurred. The unit is in a safe mode for a short time to prevent damage to property.	No action necessary.
A019A	DC part timeout	Timeout in DC part component monitoring occurred.	<p>No action necessary.</p> <ul style="list-style-type: none"> ▶ If the error still occurs, contact REFU Service.

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