



Operating manual

REFUenergy

REFUstore 50K ... 100K

Battery Inverter

Product | **REFUstore 50K...100K**

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1 About this Manual

1.1 Scope of this Manual

This manual applies to the following products:

- **REFUstore 50K...100K** Battery Inverter
- **REFUstore 50K...100K ConnectionBox**

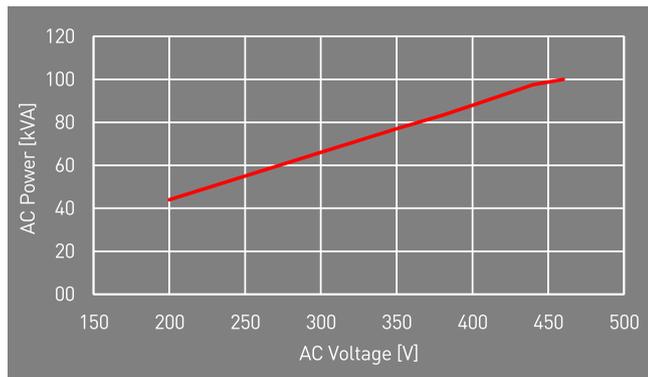


Fig. 1: Power rating depending on AC voltage

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 this unit 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 this equipment without proper training.
- Ground the product properly.

- 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

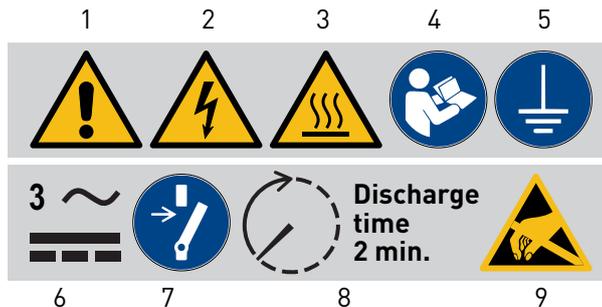


Fig. 2: Symbols on the product

- | | |
|---|--|
| 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 *REFUstore 50K...100K* is a battery inverter for charging or discharging a battery system.

The *REFUstore 50K...100K* is used to convert alternating current (AC) into direct current (DC) or to convert direct current (DC) into alternating current (AC) connected to a low voltage or medium voltage grid.

The *REFUstore 50K...100K* complies with protection class IP65 (ConnectionBox: IP54) and can be used indoors and outdoors.

The *REFUstore 50K...100K* is only intended for use with the corresponding *REFUstore 50K...100K 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 Components of the ConnectionBox

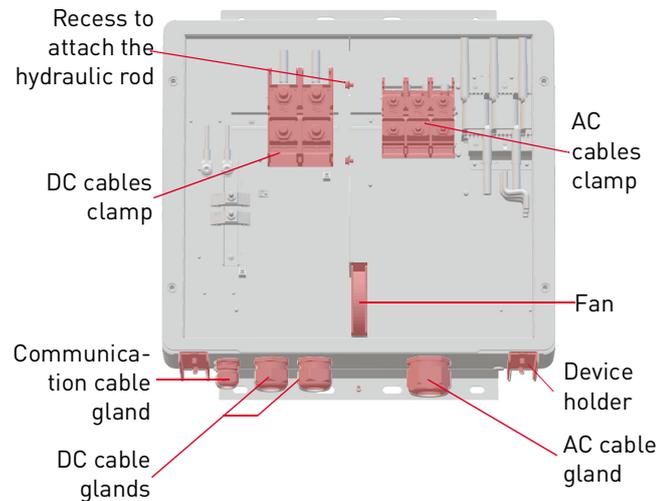


Fig. 3: Components of the ConnectionBox

3.2 Device Size and Distances

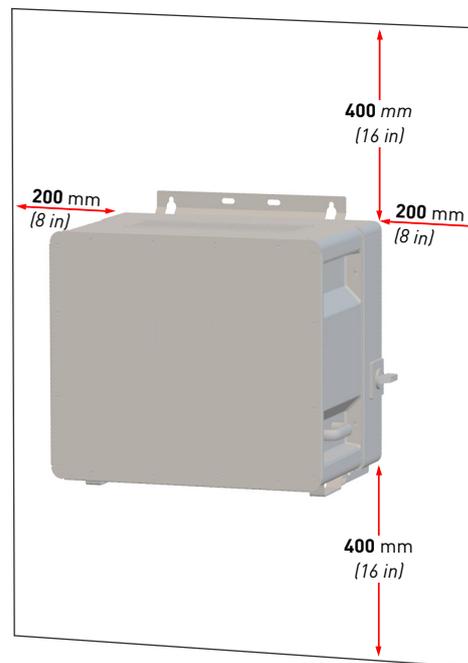


Fig. 4: Installation site: distances/free space

The inverter can be installed vertical or horizontal. If the inverter is installed horizontally outdoors, mount the inverter at an angle of 10°.

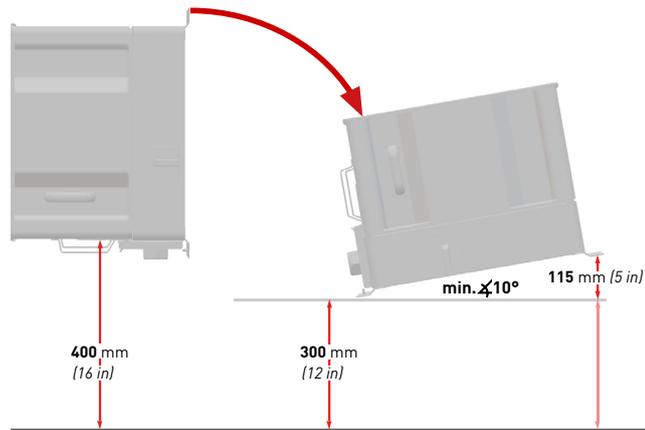


Fig. 5: Vertical and horizontal installation (10° outdoors)

3.3 Dimensions

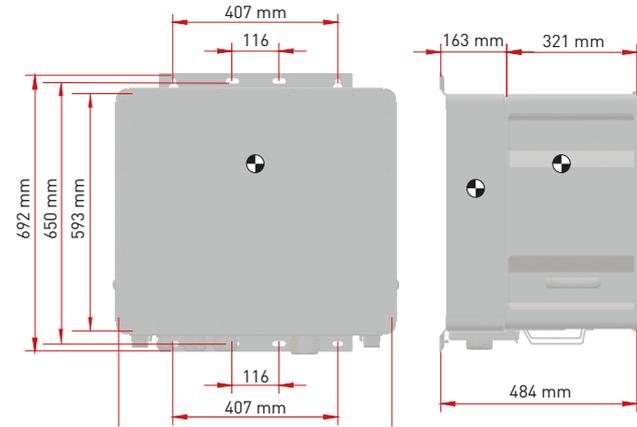


Fig. 6: Dimensions PowerUnit with ConnectionBox

3.4 Communication and Network Management

- | | |
|-----------------------------------|--|
| 1 Low or medium voltage grid | 5 Energy management system |
| 2 Power meter | 6 Battery (or batteries) |
| 3 Energy flow direction sensor | 7 Battery management system (or systems) |
| 4 Battery inverter (or inverters) | |

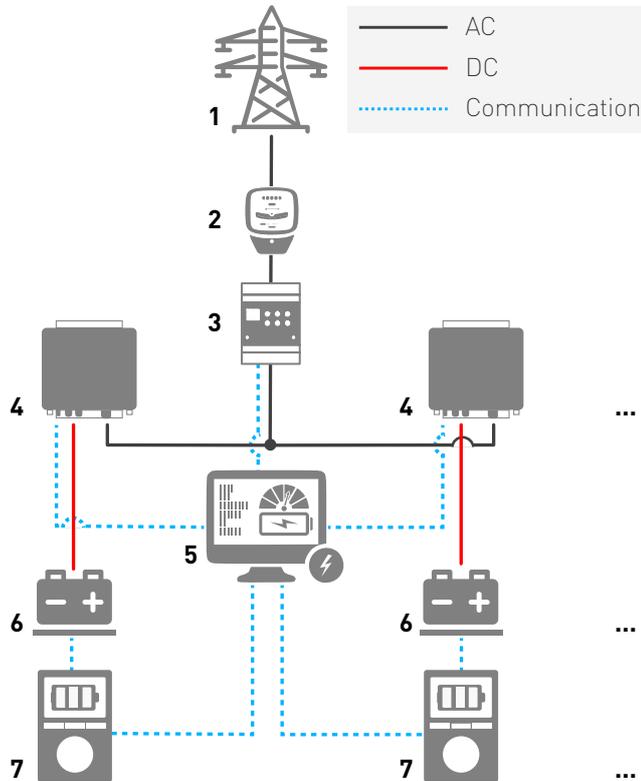


Fig. 7: Communication in parallel operation

3.5 Requirements for the Infrastructure

Additional required equipment	at low voltage network	at medium voltage network
DC load break switch	necessary	necessary
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

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

- The **REFUstore 50K...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 battery system includes its own monitoring (battery management system) and a circuit breaker with load switching capacity.
- The **REFUstore 50K...100K** is not equipped with inter-

- nal 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 System and Site Requirements

- ✓ Take into account the minimum distances around the inverter.
- ✓ Prolonged exposure to direct sunlight can cause an internal temperature rise, leading to power derating of the device. It is recommended to install a sunshade to mitigate the thermal impact of irradiation.
- ✓ Install a 200 A fuse as a short-circuit protection element between the battery system and the battery inverter.
- ✓ If the optional function "DC precharging" is not available, install an external precharge unit and a DC switch.
- ✓ Install the ConnectionBoxes so that the built-in safety switches are freely accessible.

4.3 Auxiliary Means and Tools

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

4.4 Unpacking the ConnectionBox

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

4.5 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.

4.5.1 Mounting the ConnectionBox Vertically

- ✓ Local requirements or legal regulations for battery systems were considered in the planning.
1. Mark the drill holes according to the following drawing.

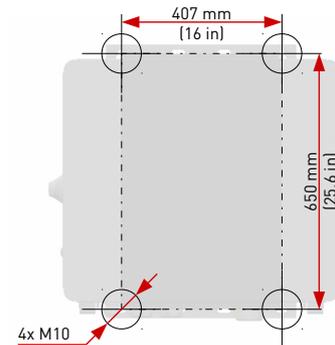


Fig. 8: Mounting dimensions

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.

4.5.2 Mounting the ConnectionBox Horizontally

- ✓ Local requirements or legal regulations for battery systems were considered in the planning.
1. Mount the mounting rails as shown in Figure 8. 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 5).
 - b) To obtain a 10° angle, the distance from the top of the ConnectionBox to the floor is 415 mm.
 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.

4.5.3 Mounting the ConnectionBox on a Pole

- ✓ Local requirements or legal regulations for battery 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.

4.6 Connect DC and AC Cables

Tab. 2: Stud connection

Type	DC terminal	AC terminal
Cable type	Single wires	Cable bundle
Cable lugs DIN 46234 and DIN 46235	2 pole 35 ... 185 mm ²	3 pole 35 ... 120 mm ²

Tab. 2: Stud connection

Size for lug connection	M12	M10
Tightening torque	14 ... 31 Nm	10 ... 20 Nm
Cable gland	M50	M63
Cable gland diameter	27 ... 35 mm	34 ... 45 mm
Stud size for potential equalization	M8	
Minimum cross section for the potential equalization	6 mm ²	

1. Prepare the cables, grounding cables, and lay it to the connection area.
2. Insert the AC and DC cables individually through the cable glands.
3. Connect the potential equalization with the M8 grounding bolt with a tightening torque of 20 Nm.



Fig. 9: Potential equalization

4. Connect DC and AC cables to the terminals.

4.7 Communication Connections

The *REFUstore 50K...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 lower right corner of the inverter's back side.

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

Ethernet

- 2 Ethernet ports integrated for Ethernet daisy chaining.
- Distance of 100 m between each inverter.
- When inverter not started, it will pass through the ethernet communication.
- Standard RJ45 plugs and standard crimping tools can be used.
- RJ45 plug is IP65 save even without cable connec-

tion.

- Supports line, ring, and star Ethernet topologies.

RS485 / Modbus RT

- RJ45 ports can be used for RS485 communication.
- Daisy-chain for long distance networks or 3rd party datalogger & controls (superordinate EMS control)
- Automatically switches between TCP/IP (Ethernet) and Modbus (RS458) communication.
- Several communication speed available, up to 115 000 bps.
- Communication parameters can be easily set through REFUset application.
- Supports RS485 bus (line) topologies.

4.8 Connect RS485/LAN

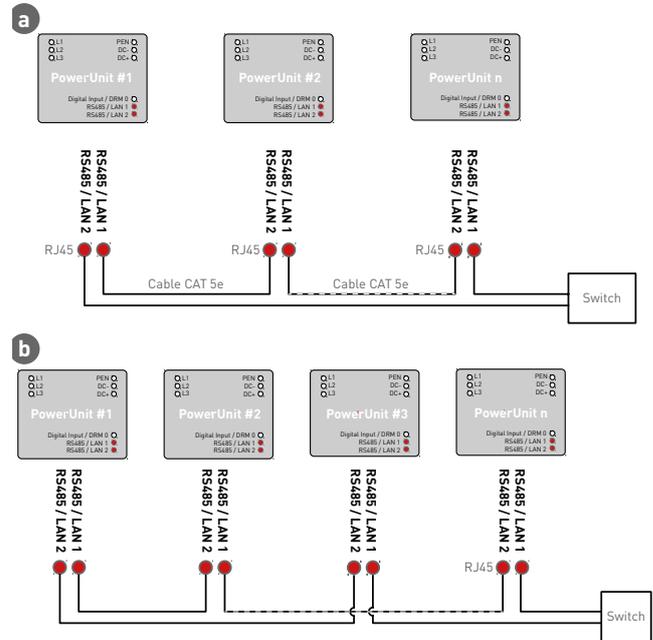


Fig. 10: Wiring of communication cables
(a. less than 100 m and b. over 100 m)

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



Fig. 11: Connection area: communication cable gland

1. Unscrew the cable gland.
2. Thread the screw head of the cable gland into the communication cable.
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. Screw the cable gland tight by hand.
6. Seal unused openings of the cable gland with the supplied plugs.

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 1000 m.
- You can connect up to 25 inverters for RS485, and up to 25 inverters for each ethernet daisy-chain line.

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 against lightning's and overvoltage by the means of external Surge Protection devices.

4.9 RJ45 Connector Cabling

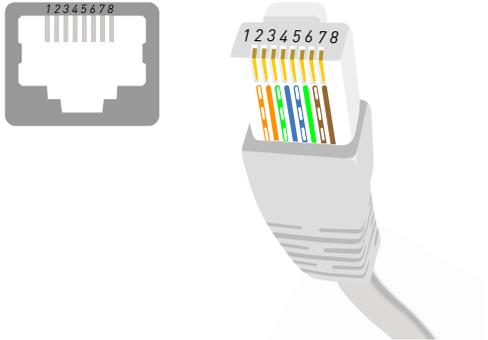


Fig. 12: Pin assignment on RJ45 plug

Tab. 3: Pin assignment

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

4.10 Setting up the Communication

4.10.1 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. 4: 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 (Standard Setting) (in Multimode, you cannot use USS address 0 and 2)

Tab. 5: RS485 interface settings

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

Tab. 5: RS485 interface settings

Data bits	8
Stop bits	1

4.10.2 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.

Tab. 6: IP standard settings

Parameter	Value
IP Address	192.168.130.30
Standard gateway	192.168.1.1
Net mask	255.255.0.0
DNS Server	0.0.0.0

4.10.3 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.

4.11 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.

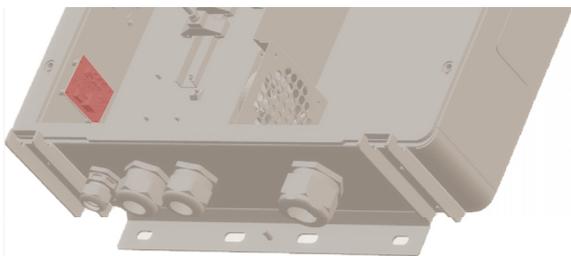


Fig. 13: Connection terminal (X5) on the adapter board

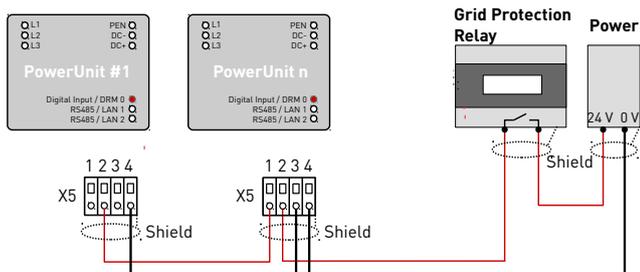


Fig. 14: Wiring and pin assignment for the remote off signal

Tab. 7: Pin assignment X5

Pin	Function
1	Control signal output 0 V = power lock
2	Control signal input 24 V = power release
3	Ground output
4	Ground input

Tab. 8: Conductor types and cross-sections

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 screw driver 0.4 x 2.5).

NOTICE

- ▶ The Digital Inputs draws approx. 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 can be configured to another value.
- ▶ Configure the function with REFUset PC or REFUset mobile app.

4.12 Testing Electrical Safety

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

4.13 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 inverter clamps.
- ∨ 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. 15: Unpacking the PowerUnit

4.14 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 16.

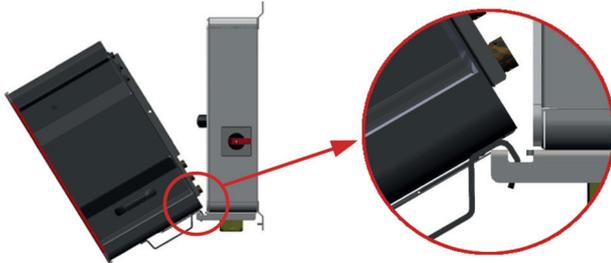


Fig. 16: Hooking PowerUnit onto ConnectionBox

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 17.

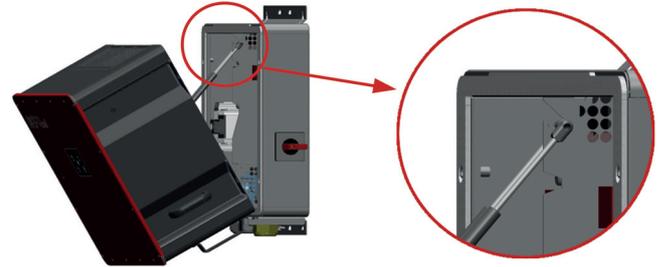


Fig. 17: Hooking hydraulic rod in the recess of the ConnectionBox when mounted vertically

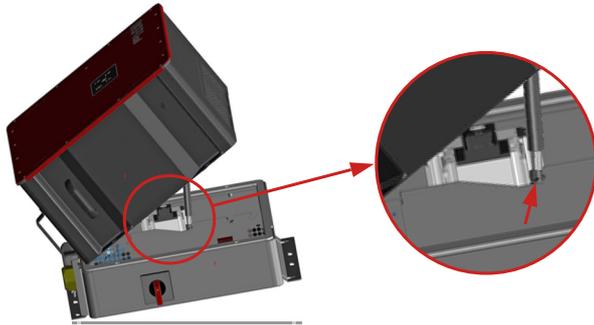


Fig. 18: Brace the hydraulic rod in the recess of the ConnectionBox when mounted horizontally

⇒ Further assembly can be continued by one person.

4.15 Connecting AC, DC and PEN

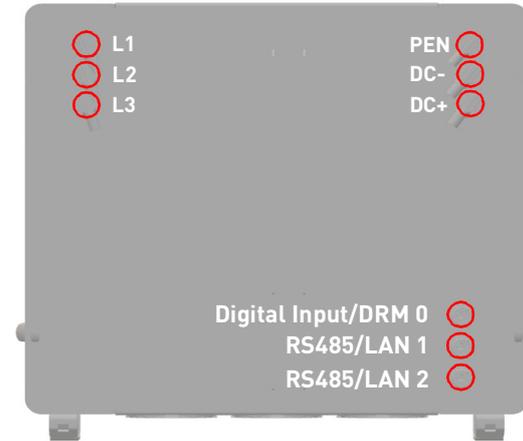


Fig. 19: Connection area of the inverter: L1–3, PEN, DC-/+, Digital Input and RS485/LAN 1–2

- ✓ 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.

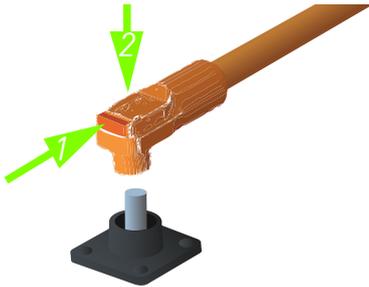


Fig. 20: Cable connector

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.

4.16 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 of each battery string connected.
- ▷ Check the maximum voltage of each battery string connected.
- ▷ Check the AC voltage.

NOTICE

Property damage

- ▶ Before the DC side is switched on, inverters of device type 420P0xx.020 must be pre-charged. The recommended precharge resistor can be found in the technical data (see page 32).

5.2 Startup

- ▷ Switch on the AC circuit breaker, if applicable.
- ▷ Switch on the DC circuit breaker, if applicable.

When activated, the inverter completes the following steps.

1. Internal tests (i.e. relais test).
2. Check the connection conditions for the AC grid and the battery (DC) voltage.
3. *REFUstore 50K...100K* starts operation.



Fig. 21: Display panel

Tab. 9: Indicator and keys of the display panel

Indicator/Key	Description
 BATTERY	BATTERY indicator (DC) On: DC voltage sufficient; ready for feeding Fast flashing: DC power not sufficient Slow flashing: DC voltage is too high or too low Off: No DC voltage
 GRID	GRID indicator (AC) On: AC grid is ok Fast flashing: Inverter is in the activation state Slow flashing: AC grid check in progress Off: AC grid not connected

Tab. 9: Indicator and keys of the display panel

Indicator/Key	Description
	<p>Bluetooth key On: Connected Slow flashing: Ready for Connection Fast flashing: Connecting Off: No connection</p>
	<p>FAULT indicator On: Inverter in error state and not feeding in Flashing: User-off mode Off: No error</p>
	<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 BATTERY indicators flash alternately.

Tab. 9: Indicator and keys of the display panel

Indicator/Key	Description
Initialization state	Right and left indicators flash alternately during startup.
State "No Grid Code selected"	The FAULT indicator is permanently off, the GRID and BATTERY indicators flash alternately.

5.3 Configuring Inverters with the Mobile App REFUset

With the mobile app REFUset for iOS or Android platforms, all necessary settings can be made.

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

- Country of installation
- Grid code (if more than one for the selected country)
- 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 on the Apple's App Store for iOS devices and on Google's Play app for Android devices.
- ✓ GPS and Bluetooth is active and permissions set for the App
 1. Switch on the AC circuit breaker, if applicable.
 2. Turn on your mobile Bluetooth and GPS mode.
 3. Start the REFUset app on your mobile device.
 4. Press the Bluetooth button on the PowerUnit's display panel.

- ⇒ PowerUnit is paired automatically and shown in the REFUset app. Bluetooth button illuminates blue.

5.4 Configuring Inverters with the REFUset PC Software

With the PC software REFUset, firmware updates can be carried out and country-specific inverter parameters can be set. The connection between PC and inverter can be established via Ethernet or USB (via a USB-RS485 converter).

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 Operation and Control

Each **REFUstore 50K...100K** inverter must be connected to a separate Battery rack. The external Energy Management System (EMS) is communicating with each Battery rack’s Master BMS and with each inverter independently. Additionally, the EMS can control an external AC circuit breaker and other components in the system. There is no direct connection between the **REFUstore 50K...100K** inverter and the BMS, therefore, the EMS system is the overall control master unit of the system.

The inverter uses Modbus commands according to the SunSpec/MESA standard.

With the 420P0xx.020 product variant, the 24 V supply of the control board is provided only via the DC supply. A minimum DC voltage of 280 VDC is required for this purpose.

In the 421Pxx0.010 product variant, in contrast, the 24 V supply is additionally provided via the AC mains. When the booting is completed, the inverter is in stand-by mode. In order to start charging or discharging of the battery, the operation mode has to be set: start, stop, enter standby, exit standby.

- ▷ Set the operating state with PCSSetOperation.

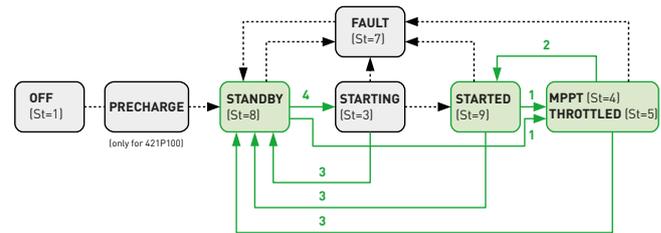


Fig. 22: REFUstore State Machine

Green fields is operation status which can be used by the external control. Green numbers indicate the “PCSSetOperation” register.

For details, please refer to the separate available document “Operation and Control of *REFUstore 50K...100K*”.

In order to control the charging / discharging state set the required value in the field *WMaxLimPct*. + values indicate discharging and - values charging. Values are to be entered as a percentage of the full power. After entering the percentage set the parameter *WMaxLim_Ena* to 1 to enable.

Tab. 10: *PCSSetOperation*;

Sunspec Model No. 64800, Offset: 7

REFU Parameter No. 991

ID	Value	Description
Default State	0	No Command
START	1	Start the PCS
STOP	2	Stop the PCS
ENTER STANDBY	3	Enter Standby Mode
EXIT STANDBY	4	Exit Standby Mode

Tab. 11: *Inverter Status (St)* (read only)
Sunspec Model No. 103, Offset: 38

ID	Value	Description
OFF	1	The inverter is in operation, the IGBTs are locked/no power enabled, and the relays are open. (other conditions: Initializing, Update, NoCountry selected)
STARTING	3	The inverter is connecting to the grid.
MPPT	4	The inverter is operating with maximum power. The IGBTs are active and the AC relays are closed.
THROTTLED	5	The inverter is in operation with an active derating function. The IGBTs are active and the AC relays are closed.
FAULT	7	The inverter is in fault state. The IGBTs are locked and the AC relays are open.
STANDBY	8	The inverter is initialised but not connected to the AC grid. The IGBTs are locked and the AC relays are open.
STARTED	9	The inverter is connected to the AC grid. The IGBTs are locked and the AC relays are closed.

7 Technical Data

7.1 PowerUnit

Tab. 12: Technical data *REFUstore 50K...100K*

DC DATA	REFUstore 88K, 100K			REFUstore 50K		
Operation mode	100 kVA @ 480 VAC	88 kVA @ 400 VAC	83 kVA @ 380 VAC	50 kVA @ 400 VAC	50 kVA @ 380 VAC	2nd life application
Article no. Article no. (with integrated DC precharge)	420P088.020 421P100.010			420P050.020 421P050.010		
Maximum voltage DC	1 000 V					
Nominal voltage DC	750 V	620 V	600 V	620 V	600 V	U _{dc} + 50
DC voltage range at nominal power	700–900 V	585–900 V	555–900 V	585–900 V	555–900 V	1.46 x U _{ac}
DC start-up open circuit voltage (charging)	700 V	585 V	555 V	585 V	555 V	1.46 x U _{ac}
Max. operational current DC	153 A	153 A	153 A	153 A	87 A	153 A
DC connection PowerUnit-to-ConnectionBox	1 plus, 1 minus: Connector with button activated coupling					
AC DATA						
Apparent power	100 kVA	88 kVA	83,3 kVA	50 kVA	50 kVA	0.222 x U _{ac}
Rated voltage 3-phase, U _{ac}	480 V	400 V	380 V	400 V	380 V	180–400 V
Voltage range AC	180 ... 528 V					
AC grid connection / grid types	3-phases, PE / TT, TN-C, TN-C-S, TN-S					
Nominal power factor / range	1 / 0.3i ... 0.3c					

Tab. 12: Technical data *REFUstore 50K...100K*

DC DATA	REFUstore 88K, 100K				REFUstore 50K	
Rated frequency	50, 60 Hz					
Frequency range	45 – 65 Hz					
Maximum AC current, I _{max}	128 A					
Maximum AC short circuit current	64 A rms (3 period average)					
Inrush current (peak / duration)	25 A / 0.5 ms					
Maximum THD	< 3 %					
Maximum efficiency	98.4 %	98.4 %	98.3 %	98.4 %	98.4 %	96.8 %
Maximum admissible external AC fuse	160 A, gG, U _n = 500 V					
Maximum permissible DC fuse	200 A, gRU _n = 1 000 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. temperature for nominal power	45 °C					
Ambient temperature	-25 ... +60 °C					
Relative air humidity	0 ... 100 %					
Maximum elevation, above sea level	3 000 m					
Noise level	< 70 dBA					
Environment classification (IEC 60721-3-4)	4K4H					

Tab. 12: Technical data *REFUstore 50K...100K*

DC DATA	REFUstore 88K, 100K	REFUstore 50K
Type of protection PowerUnit (IEC 60529)	IP65	
Installation type	indoor, cabinet, outdoor, vertical / horizontal / pole mounting	
PROTECTION FUNCTIONS		
Grid monitoring	voltage, frequency, passive and active anti-islanding, DC injection	
Grid separation	gate block / redundant grid relays	
Residual current monitoring (RCD)	Type 2	
Compatibility external RCD	Type A / Type B	
Protection class (IEC 62109)	1	
Overvoltage category (IEC 60664-1)	DC: II / AC: III	
DC precharge	420P0xx.020: no (external required) / 421Pxx0.010: yes (integrated)	
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 PowerUnit	69 kg	
CERTIFICATES	All certificates are available at www.refu.com	

Tab. 12: Technical data *REFUstore 50K...100K*

DC DATA	REFUstore 88K, 100K	REFUstore 50K
EU Directive	2014/30/EU, 2014/35/EU	
Product	IEC 62109-1, IEC 62109-2, IEC 62116, IEC 61727, IEC 62477-1, IEC 61439-2, 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 4105:2018-11, VDE-AR-N 4110:2018-11, TOR D4, Önorm E 8001-4-712, UTE C15-712-1, EN 50438	

7.2 ConnectionBox

Tab. 13: Technical Data ConnectionBox

TYPE	CBBS 88K (1000V-BR)
Art. No.	940P300.0000
Max. DC voltage	1 000 V
Max. DC current	155 A
DC switch	no
DC connection (+ / -)	ring terminal block 50 ... 240 mm ²
Rated AC voltage	180 to 400 V
Max. AC current	128 A
AC connection L1, L2, L3, PEN	L1-L3: M12, PEN: M8, bolt terminals 50 ... 150 mm ²

Tab. 13: Technical Data ConnectionBox

Protection class (IEC 60529)	IP54
Dimensions W × H × D	750 × 692 × 166 mm
Weight	25 kg

7.3 External DC Precharge (only 420P0xx.020)

Tab. 14: Technical Data external DC precharge for 420P0xx.020

Input capacity of the inverter	630 μ F
Minimum total precharge resistance	400 Ω
Recommended resistance per pole	200 Ω
Starting current @ 750 V DC	1.875 A
Duration of the precharging	1.26 s

8 Single Line Diagrams

8.1 REFUstore without DC-Precharging

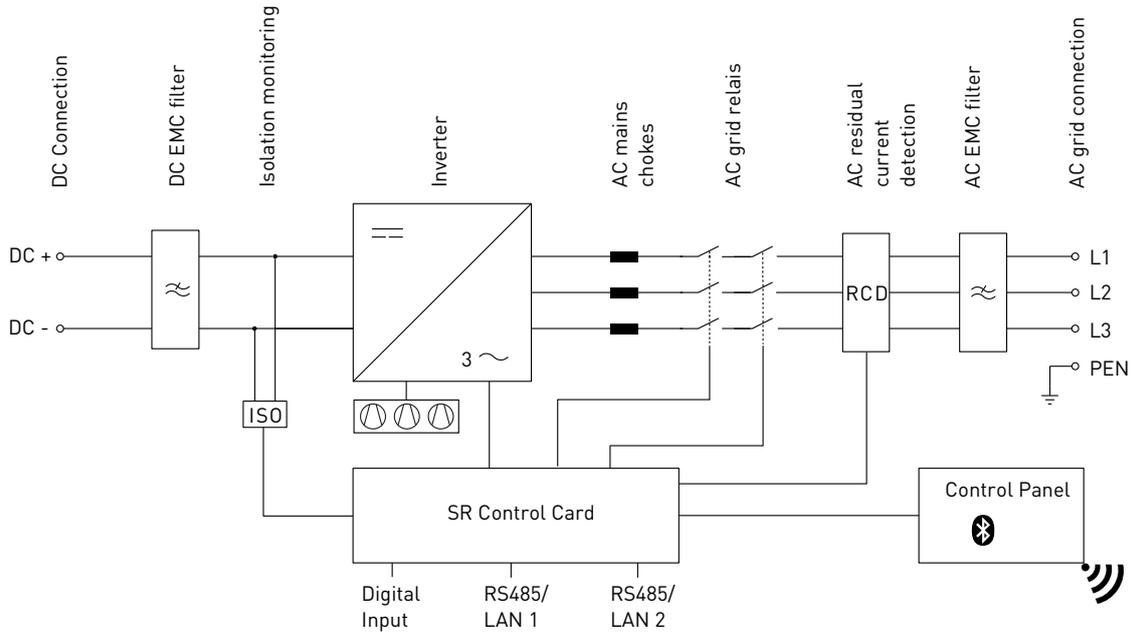


Fig. 23: Single line diagram REFUstore 88K (420P088.020) and REFUstore 50K (420P050.020)

8.2 REFUstore with DC-Precharging

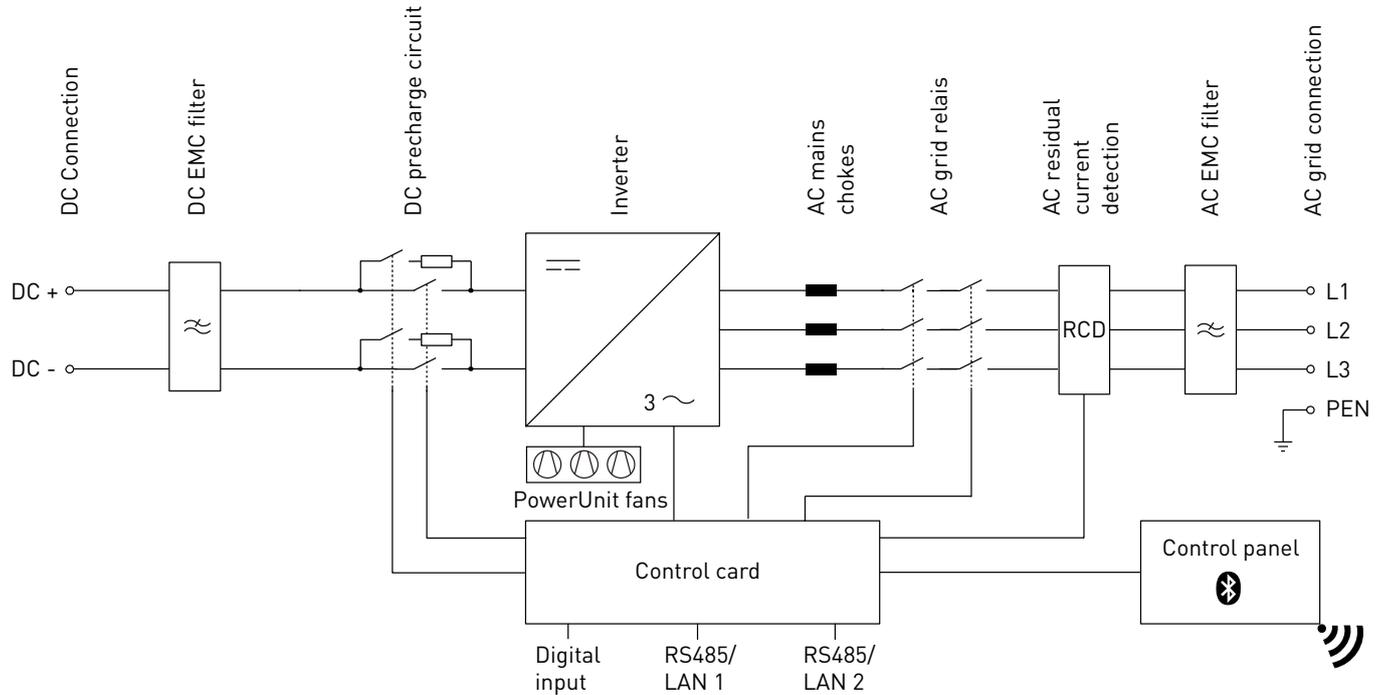


Fig. 24: Single line diagram REFUstore 100K (421P100.010) and REFUstore 50K (421P050.010)

8.3 REFUstore 50K...100K with ConnectionBox

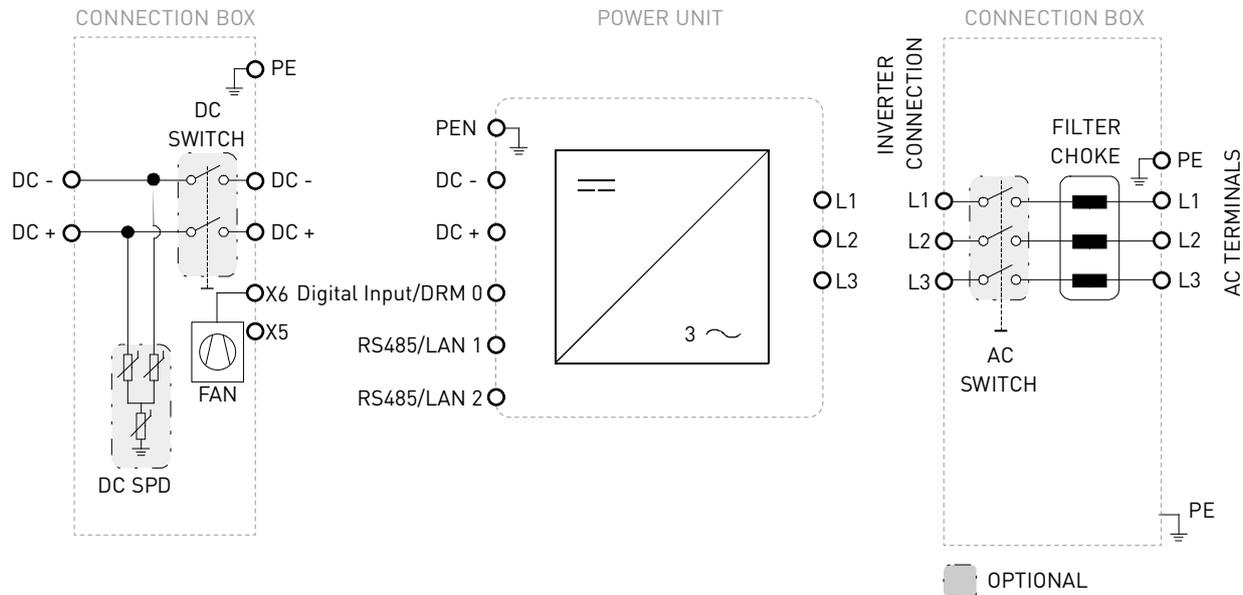


Fig. 25: Single line diagram REFUstore 50K...100K with ConnectionBox

8.4 System

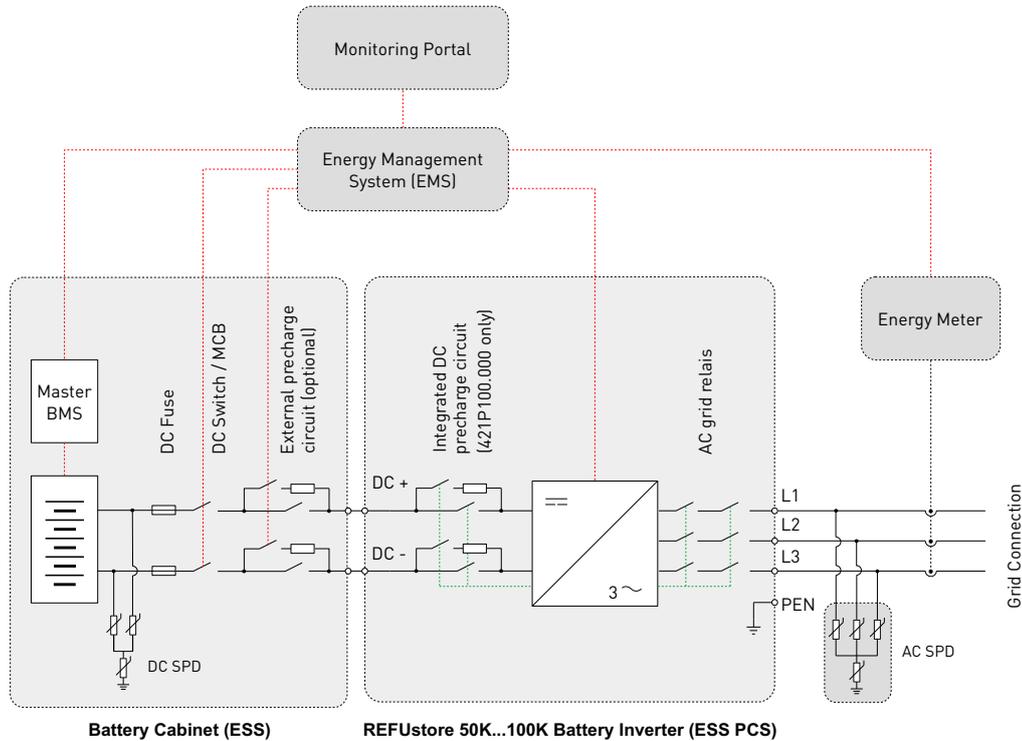


Fig. 26: Single line diagram Battery System with *REFUstore 50K...100K*

8.5 Temperature Derating

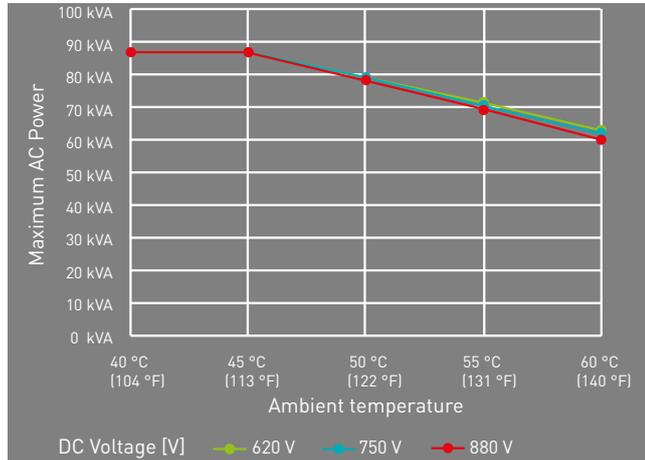


Fig. 27: Temperature derating curves

8.6 Efficiency

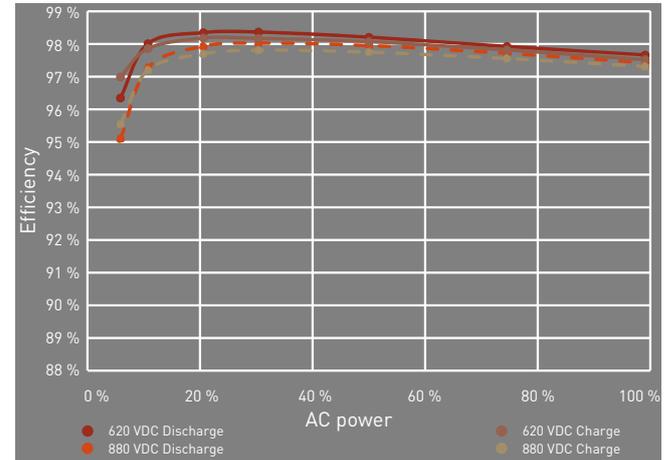


Fig. 28: Efficiency curves

9 Maintenance

-  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 PowerUnit 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 PowerUnit 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 PowerUnit.

- ▶ Always disconnect the PowerUnit 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 Fans

The fan can be easily replaced without opening the PowerUnit.

- ✓ 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 PowerUnit.
- 3. Remove the plug connectors.
- 4. Connect the new fan plate to the PowerUnit 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 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 Replacing the Sealing Gasket of the ConnectionBox

- ✓ 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. Replace the sealing gasket with a new one.
4. Carefully press the PowerUnit in its intended place and hold it. Make sure that the cables are not pinched or damaged when closing.
5. Tighten the M8 screws hand-tight.
6. Tighten all four M8 bolts crosswise with a tightening torque of 20 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 fan for function and operating noise.	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 panel or LEDs for function.	12 months
For the P421Pxx0.010 series: Test of the micro-fuses of the 24 V supply voltage. Open the DC switch and check the display panel function.	12 months
Checking warning notices (stickers) and if necessary replace the stickers	12 months

Activities to be performed	Interval
Documenting the operating environment and the device with a camera.	12 months
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*

* 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 the **REFUstore 50K...100K** in normal domestic waste. The **REFUstore 50K...100K** conforms to RoHS.

▷ REFU Elektronik GmbH takes the product 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 the electrical system 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.	<ul style="list-style-type: none"> ▶ 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.	<ul style="list-style-type: none"> ▶ Check the DC voltage of the electrical system. 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 the electrical system 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.	<ul style="list-style-type: none"> ▶ 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.	<ul style="list-style-type: none"> ▶ If the error persists, please contact REFU Service.
9002B	Update End	The firmware update was successfully completed.	For information only.

Error Code	Message	Description	Instructions
9002D	AntilandRocof	An island network was identified using the ROCOF 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.	
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.

Error Code	Message	Description	Instructions
90052	User lock active	The user lock is active.	<ul style="list-style-type: none"> ▶ Deactivate the user lock by pressing the "Clear" (PowerUnit) 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.	<ul style="list-style-type: none"> ▶ Measure the voltage of all three phases with REFUset and a True-RMS meter. ▶ Check the configured voltage average and the configured nominal voltage.
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.	<ul style="list-style-type: none"> ▶ Check the configured voltage limit and the configured nominal voltage.
90057	Watchdog C0	The internal firmware protection function has been triggered.	<ul style="list-style-type: none"> ▶ 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	–	No action necessary.
90062	Fault ride through	Indication of instabilities in the network, which must be passed through according to different country regulations.	
90071	DFLASH Fixed	–	

Error Code	Message	Description	Instructions
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	–	
90082	HW VPos feeding	The hardware protection has detected an impermissible overvoltage in the positive DC link.	
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		

Error Code	Message	Description	Instructions
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.	
9008C	HW error feeding	The hardware protection has detected a general error.	▶ 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	An internal communication problem has been identified. This leads to grid disconnection of the device and subsequent restart.	
9008F	ComTimeout Running	An internal communication problem has been identified. This leads to grid disconnection of the device and subsequent restart.	
90090	ComTimeout ParamInit	An internal communication problem has been identified. This leads to grid disconnection of the device and subsequent restart.	
90091	HeartBeat Safety	An internal communication problem has been identified. This leads to grid disconnection of the device and subsequent restart.	▶ If error occurs more than once, contact REFU Service.

Error Code	Message	Description	Instructions
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, L2, or L3 during the activation phase.	
A0185	HW I L2 activation		
A0186	HW I L3 activation		
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.

Error Code	Message	Description	Instructions
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.	
A018D	HW I L1 PreActiv	The hardware protection has detected an impermissible overcurrent in L1, L2, or L3 before the activation phase.	▶ Open and close the DC switch.
A018E	HW I L2 PreActiv		▶ If this error occurs more than once, contact REFU Service.
A018F	HW I L3 PreActiv		
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.

Error Code	Message	Description	Instructions
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.	<ul style="list-style-type: none"> ▶ 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.
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.	<ul style="list-style-type: none"> ▶ No action necessary. ▶ If the error still occurs, contact REFU Service.

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