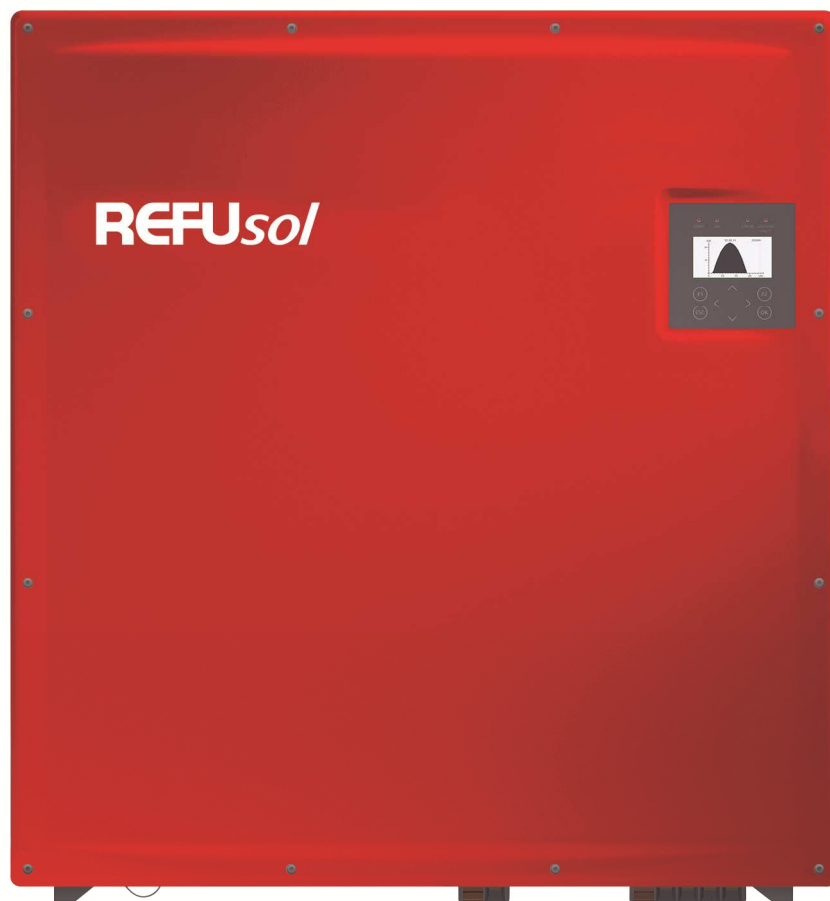




# Installation and Operating Manual

## REFU sol 40K / 46K-MV

English



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REFU Elektronik GmbH assumes no liability in the event of damage as a consequence of the failure to observe the warning instructions in these operating instructions or of improper usage.

The operating, maintenance and safety instructions are to be read carefully prior to installation and commissioning.

The installation, commissioning and safety-related check must be undertaken by a qualified electrician.

Error-free and safe operation of the device requires proper and professional transport, storage, assembly, and installation, as well as careful operation and maintenance.

Only accessories and spare parts approved by the manufacturer are permitted.

Technical modifications to the device are not permitted.

Adherence to the safety regulations and provisions of the country in which the inverter will be used are to be observed.

For European countries, the valid EU guidelines are to be observed when using the inverter.

The environmental conditions, technical calculation data and connection conditions of the grid operator given in the product documentation must be upheld.

The technical data, calculation, connection and installation conditions are to be derived from the product documentation and must be observed under all circumstances.

No liability is assumed for damages in connection with force majeure and disaster situations.

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# 1 About this Installation and Operating Manual

These operating instructions form part of the product.

- ⇒ Read the Installation and Operating Manual carefully before installing and using the product.
- ⇒ Keep the operating instructions readily available with the device for the entire service life of the product.
- ⇒ Provide all future users of the device access to the operating instructions.

## 1.1 Symbols and Markup

☑	Prerequisite
⇒	One-step instruction
1.	Multiple-step instruction
•	Bulleted list
<b>Highlighting</b>	Highlighting within a text
↪	Result

## 1.2 Warning Notices

### 1.2.1 Layout of a Warning Notice

**⚠ SIGNALWORD / WARNING INSTRUCTIONS CATEGORY**

**Type and source of danger**

Consequences if the warning is not observed

⇒ Required action to avoid the risk

### 1.2.2 Categories of Warning Notices



**⚠ 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!



This symbol represent important notes concerning potential harm to people, this unit, or associated equipment.

## 1.3 Information



**Note:**

A **notice** describes information which is important for the optimum and cost-effective operation of the equipment.

## 2 Safety Information

### 2.1 Designated Use

The REFU<sup>sol</sup> 40K / 46K-MV inverter, also referred to in these operating instructions as the inverter, is a solar inverter, which transforms the direct current generated by the PV generator (photovoltaic modules) into alternating current and feeds this into the power supply network.

The 40K is connected as a transformerless inverter directly to the low voltage supply network.

The connection of the 46K-MV is connected via an isolating transformer to the medium-voltage supply network.

The inverter has been constructed according to the current state of technology and in line with the rules of technical safety.

Both inverters meet the requirements of degree of protection IP65 and can be used indoors and outdoors.

An agreement of the network operator for connection and operation of the inverter for low voltage network or medium voltage network must be present.

The technical design of the network connection, the required additional electrical equipment and to the applicable connection and installation conditions should be clarified in this regard in advance.

Any other use is not considered to be a designated use. The manufacturer accepts no liability for any damage resulting from this.

### 2.2 Qualification of Personnel

Target group for these instructions are professionals who can assess the assigned tasks due to their professional training, knowledge and experience as well as knowledge of the relevant provisions and recognize possible dangers.

Electrical work must only be carried out by qualified electricians.

Only suitably trained and qualified personnel are allowed to work on this inverter. Personnel are regarded as being qualified if they are sufficiently familiar with the assembly, installation, and operation of the product as well as with all warnings and safety measures set out in these operating instructions.



## 2.3 Dangers Arising from Misuse



### **⚠ DANGER**

#### **Danger to life from electric shock**

- ⇒ Device may only be installed and serviced by qualified specialist technical personnel.
- ⇒ Only class A modules according to IEC 61730 must be used.
- ⇒ The PV generator must be free of earth potential.
- ⇒ The PV generator must be designed in accordance with the technical data of the inverter.
- ⇒ Every power supply line must be equipped with an appropriate AC-disconnecting device.
- ⇒ A consumer must never be switched between an inverter and line protection switch.
- ⇒ Access to the shutdown mechanism must always be free.
- ⇒ Installation and commissioning must be carried out properly.



### **⚠ DANGER**

#### **Danger to life from electric shock**

**After the device has been switched off, the interior may still contain life-threatening voltage**

- ⇒ Do not open inverter.
- ⇒ Discharge time is at least 15 minutes.



### **⚠ DANGER**

#### **Danger to life from high discharge current**

- ⇒ It is essential to ensure an earthing connection has been established prior to connection to the supply current circuit.

## 2.4 Protection against Contact with Electrical Parts



### DANGER

#### Danger to life, danger of injury due to high electrical voltage

- ⇒ Installation of the inverter must only be carried out by trained specialist personnel. In addition, the installer must be accredited by the responsible utility company.
  - ⇒ General assembly and safety stipulations relating to working on high current facilities must be followed.
  - ⇒ Before switching on, a check must be made to ensure that the plugs are firmly in place (locked).
  - ⇒ Before plugging or unplugging the DC plug, always disconnect the connection to the PV generator.
  - ⇒ The feeder must be isolated and secured against being switched on again before working at the AC grid.
- 

## 2.5 Protection against Magnetic and Electromagnetic Fields during Operation and Assembly

Magnetic and electromagnetic fields found in the immediate vicinity of live conductors can pose a serious risk to persons with cardiac pacemakers, metallic implants and hearing aids.



### DANGER

#### Danger to health for persons with pace-makers, metallic implants, and hearing aids in direct proximity to electrical equipment

- ⇒ Persons with cardiac pacemakers and metallic implants may not enter areas in which electrical devices and parts are being assembled, operated or commissioned.
  - ⇒ Should people wearing cardiac pacemakers need to enter such areas, the decision as to whether this is permitted is to be made by a doctor beforehand. Immunity from interference of cardiac pacemakers that have already been implanted or will be in future varies greatly, meaning that there are no generally applicable rules in this respect.
  - ⇒ Persons with metal implants or metal splinters, as well as those with hearing aids, must ask a doctor before entering such areas, as impairments to health are to be expected.
-

## 2.6 Protection against Contact with Hot Parts

### ⚠ CAUTION



#### Danger of burns caused by hot surfaces on housings

At an ambient temperature of 45 °C, the upper part of the housing as well as the refrigeration unit can reach a surface temperature of more than 75 °C.

- ⇒ Do not touch the housing surface near to heat sources.
- ⇒ Allow the device to cool down for 15 minutes before touching the surface of the device.

## 2.7 Protection during Handling and Assembly

### ⚠ WARNING













#### Danger of injury during improper handling caused by crushing, shearing, cutting, striking, and lifting

- ⇒ The weight of the inverter is 75.6 kg!
- ⇒ Follow the general setup and safety regulations for handling and assembly.
- ⇒ Use suitable assembly and transportation equipment.
- ⇒ Avoid trap and crush injuries by taking suitable precautions.
- ⇒ Only use suitable tools. Use special tools where this is prescribed.
- ⇒ Use lifting equipment and tools in a technically correct manner.
- ⇒ If necessary, use suitable protective equipment (for example, goggles, safety footwear, protective gloves).
- ⇒ Do not stand under hanging loads.
- ⇒ Remove any liquids onto the floor immediately to avoid the danger of slipping.

## 2.8 Please Note Before Starting Up

- In the event of installation in France, the device must be furnished with the warning sticker laid down by UTE C 15-712-1. The warning stickers are included in delivery.
- Problem-free and safe operation of the inverter is conditional upon due and specialized transportation, storage, assembly and installation as well as careful operation and maintenance.
- Only use accessories and spare parts approved by the manufacturer.
- Adherence must be ensured to the prescriptions and stipulations regarding safety of the country in which the inverter is to be used.
- The ambient conditions stated in the product documentation must be observed.
- In the planning and installation of the PV system, the technical design data, installation and safety of the PV module manufacturer must be observed.
- Starting up is prohibited until the entire system meets the national regulations and safety rules regarding use.
- Operation is only permitted with adherence to the national EMC prescriptions for the present use case.
- The manufacturer of the equipment or machine is responsible for ensuring compliance with the thresholds required by the respective national regulations.
- For European countries, the EU Directive 2014/30/EU (EMC Directive) and 2014/35/EU (LVD Directive) is to be observed when using the inverter.
- The technical data, connection and installation conditions are to be taken from the product documentation and must be observed under all circumstances.
- During installation, operation, maintenance and repair the following standards must be observed:
  - EN 50110-1: Operation of electrical installations - Part 1: General requirements
  - EN 50110-2: Operation of electrical installations - Part 2: National annexes
  - IEC 60364-1: Low-voltage electrical installations - Part 1: Fundamental principles, assessment of general characteristics, definitions
  - IEC 60364-7-712: Low-voltage electrical installations - Part 7-712: Requirements for special installations or locations - Photovoltaic (PV) power systems
  - IEC 61730-1: Photovoltaic (PV) module safety qualification. Part 1: Requirements for construction
  - IEC 62109-1: Safety of power converters for use in photovoltaic power systems - Part 1: General requirements
  - IEC 62109-2: Safety of power converters for use in photovoltaic power systems - Part 2: Particular requirements for inverters
  - IEC 82/749/CD: Grid connected PV systems - Minimum requirements for system documentation, commissioning tests and inspection
  - IEC 62305-1: Protection against lightning - Part 1: General principles
  - IEC 61439-1: Low-voltage switchgear and controlgear assemblies - Part 1: General rules
  - IEC 61643-11: Low-voltage surge protective devices - Part 11: Surge protective devices connected to low-voltage power systems - Requirements and test methods

2.9 Additional Symbols and Warning Notices on the Inverter

	<p>Indication of PV system</p>
	<p>General warning sign</p>
	<p>Warning of electrical voltage</p>
	<p>Hot surface! The housing can get hot during use.</p>
	<p>This symbol advises that the user handbook must be read before the device is used.</p>
	<p>The inverter must be earthed before use.</p>
	<p>Before beginning of work switch unit free of voltage.</p>
<p>3N  </p> <p><b>Dual supply</b> <b>Multiple DC-supply</b></p>	<p>Warning of electrical voltage on DC and AC side. All solar strings on the DC side are at voltage.</p>
 <p><b>Discharge time longer than 15 min</b></p>	<p>Discharging time of the device longer than 15 minutes.</p>

## 3 Description of Device

### 3.1 Operating Mode

The REFUsol 40K / 46K-MV transforms the direct current generated by photovoltaic (PV) modules into alternating current and feeds this into the public grid.

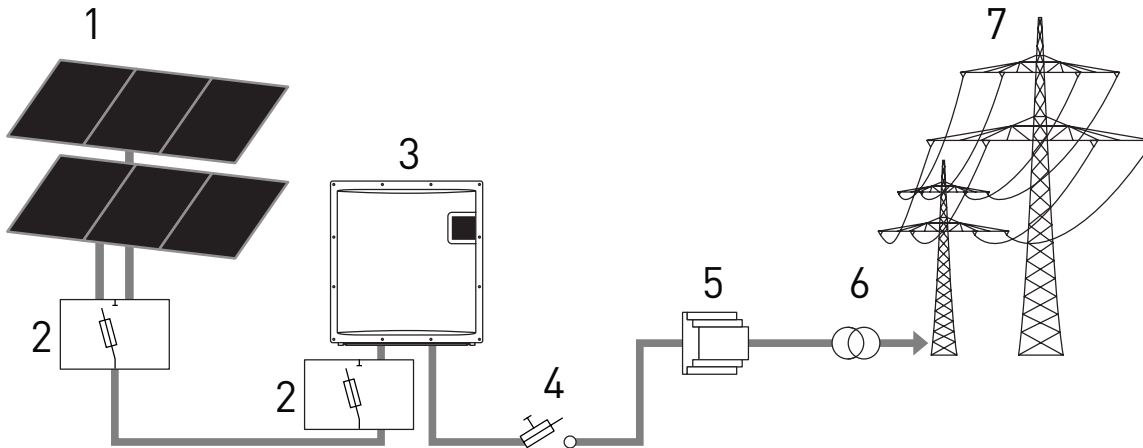


Figure 1: How it works: a grid-connected PV system with photovoltaic inverter

- 1 PV modules
- 2 Solar string combiner box
- 3 REFUsol 40K / 46K-MV photovoltaic inverter
- 4 Fuse switch disconnect or circuit breaker
- 5 Grid Protection
- 6 Isolation transformer is required for medium-voltage network
- 7 Low or medium-voltage AC grid

### 3.2 Infrastructure Requirements

Additional required equipment	40K at the low voltage network	40K/46K-MV at the medium voltage network
DC load break switch	integrated*	integrated*
AC load break switch	necessary	necessary
Central grid protection device (VDE-AR-N 4105)	necessary	necessary
LV-/MV-Transformer	not necessary	necessary

\*local regulation might require an additional DC switch at the external DC combiner box.

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

- The 40K can feed into the low-voltage grid and the medium-voltage grid.
- The 46K-MV can only feed into the medium-voltage grid.
- The 5-wire power supply line must be equipped with an appropriate AC disconnecting device.
- The 40K/46K-MV is not equipped with internal potential isolation.
- If the 40K/46K-MV is connected with the medium-voltage-grid, it must be operated with electrically isolating transformers.
- No other equipment may be connected between the transformer and inverters.

The following standards and technical regulations are also to be observed:

IEC 60364-4-41	Protection: Protection against electric shock
IEC 60364-4-43	Protection for safety - Protection against overcurrent
IEC 60364-5-52	Selection and erection of electrical equipment - wiring systems
BDEW	Technical Guidelines
VDN	Technical Guidelines

For the REFUsol 40K / 46K-MV an isolating transformer with the following specifications is required:

Specification of medium voltage transformers	40K	46K-MV
Rated power	40 kVA	46 kVA
Rated voltage OS	Depends on grid connection point	
Rated voltage US	3 x 400 V PE + N	3 x 460 V PE + N
Frequency	50/60 Hz	50/60 Hz
Short-circuit voltage $u_k$	Depends on grid connection point	
Switching group	Dyn5 or Dyn11	Dyn5 or Dyn11

### 3.3 Features of REFUsol 40K / 46K-MV

The REFUsol 40K / 46K-MV inverter is a transformer-less, three-phase solar inverter, which has a particularly high efficiency at any operating point.

Heat is dissipated only by convection. The internal temperature control prevents the device from exceeding the permissible ambient temperature.

The inverter is designed such that the device does not have to be opened for assembly and connection work. The inverter provides communication interfaces for RS485 and Ethernet. The communication protocol is Modbus and Sunspec compliant.

An illuminated graphical display shows the development of the feed-in power and other operating data in a clearly arranged manner. An 8-key control panel below the display also provides excellent control and navigation convenience. Based on its design in protection class IP 65, the inverter can be installed at almost any outside location. The inverter has extensive safety and security features. For details, refer to Technical Data.



### 3.4 External Dimensions

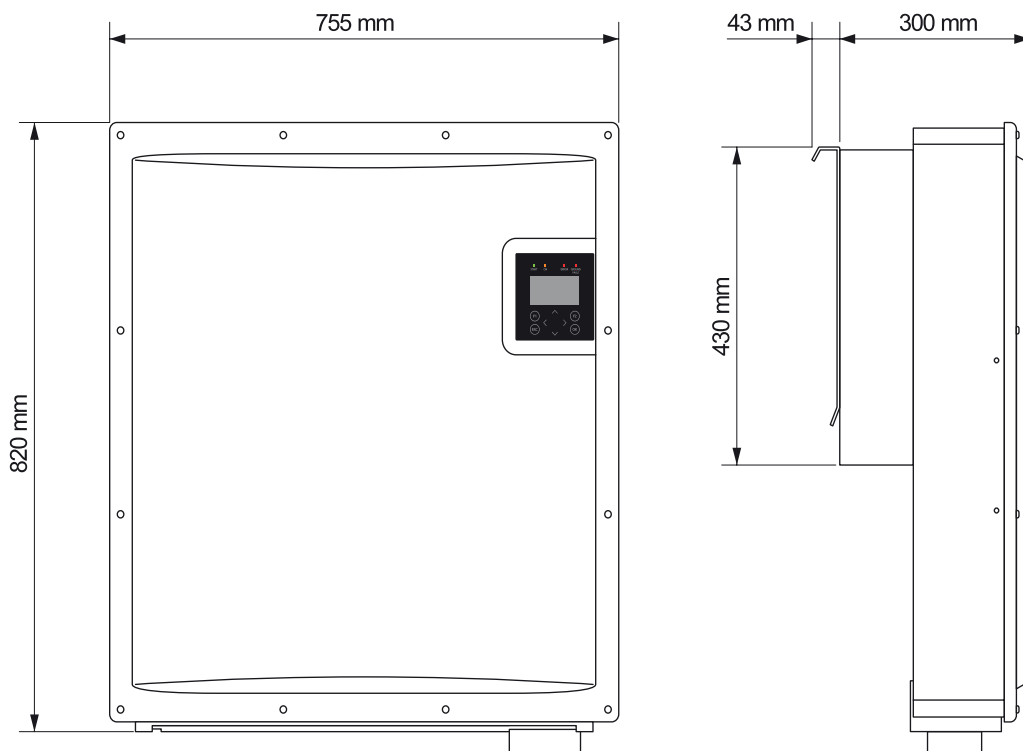


Fig. 2: External dimensions



### 3.5 Block Diagram

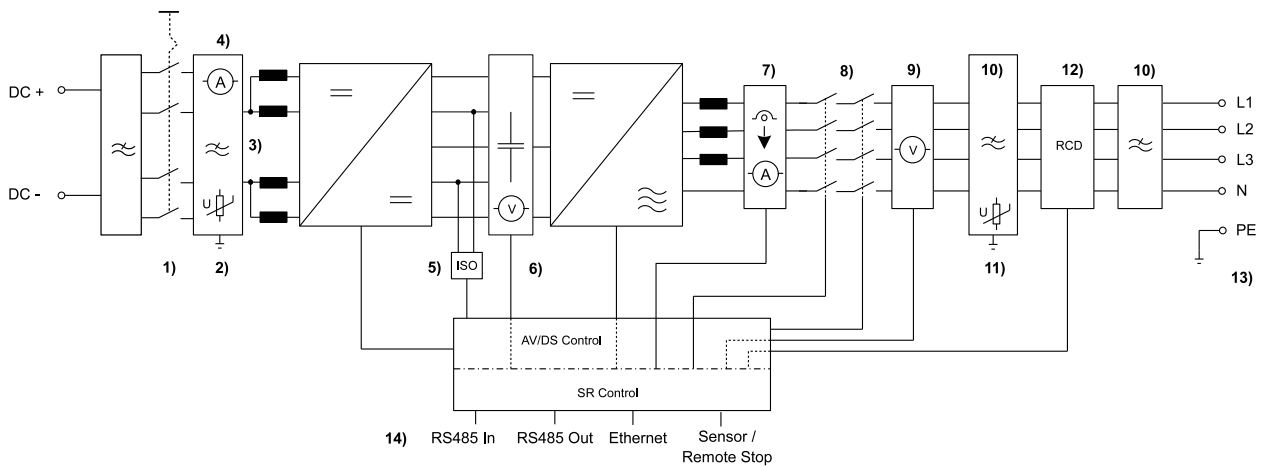


Fig. 3: Block diagram

- 1) DC switch
- 2) DC overvoltage protection
- 3) DC EMC filter
- 4) DC current measurement
- 5) Isolation monitoring
- 6) DC voltage measurement
- 7) AC current measurement
- 8) AC grid relays (redundant)
- 9) AC voltage and frequency measurement
- 10) AC EMC filter
- 11) AC overvoltage protection
- 12) Fault current monitoring, Type 2
- 13) Protective earth connection
- 14) Interfaces (Ethernet, RS485, Sensors, remote stop)

### 3.6 Control Panel

The graphical user interface which is integrated on the front of the device and comprises 128 x 64 pixels can be used to display the operation data, such as the feed-in power or yield. The parameters required are selected and entered on the 8-key control panel. The control panel is illuminated when a key is pressed and turns dark automatically.

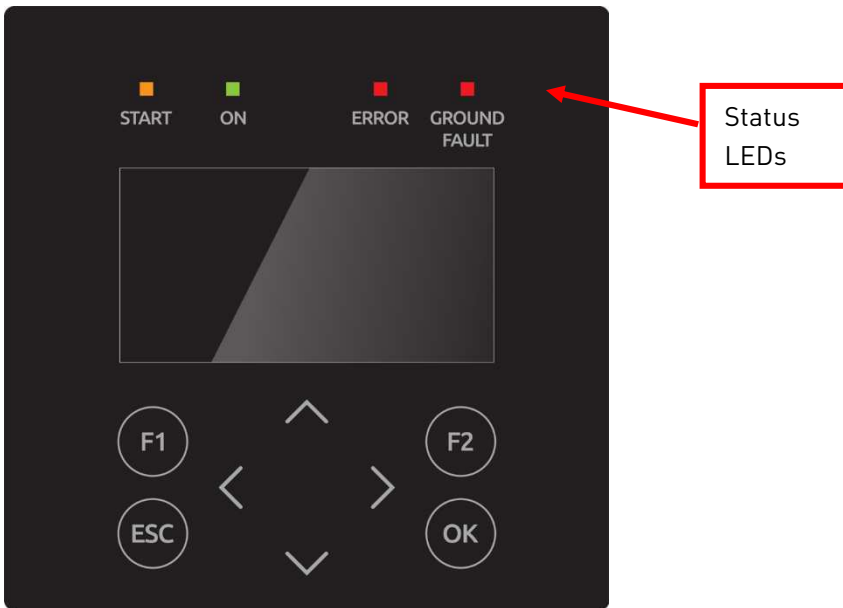


Fig. 4: Control panel

### 3.7 Internal Data Logger

The inverter features an internal data logger that allows measured values to be simultaneously recorded in the form of parameters. If the storage capacity is full, the oldest data is overwritten. With the default setting on delivery, the data logger logs 16 measuring channels, which can be displayed and analyzed by REFUlog.

Recording cycle	Storage time
1 minute	2.5 years
2 minutes	5 years
5 minutes	12.5 years
10 minutes	25 years

## 4 Installation

### 4.1 Assembly Site Requirements



#### **⚠ DANGER**

##### **Danger to life due to explosion**

⇒ Do not install inverter in areas with risk of explosion.



#### **⚠ DANGER**

##### **Danger to life due to fire**

- ⇒ Do not install inverter on flammable materials. Uphold fire protection class according to NFPA regulation.
- ⇒ Do not install inverter in areas where easily flammable materials are stored.
- ⇒ Under no circumstances are the cooling fins of the heat sink to be covered.



#### **⚠ WARNING**

##### **Danger of accident**

⇒ When installing and servicing, unrestricted and safe access to the devices must be ensured.

The following requirements of the installation site must be upheld:

- Only vertical installation is permitted as otherwise the cooling of the device cannot be guaranteed (convection cooling).
- 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.
- A fixed wall or a metal construction is necessary for installation. The weight of an inverter amounts up to **75.6 kg**. Relevant construction regulations must be observed.
- The device is to be mounted at an appropriate distance from combustible materials.
- Installation in non-ventilated ended cabinets and enclosures is not allowed because the unit in operation emits heat.
- To allow for the heat dissipation required, keep the following minimum distances from the ceiling and wall as well as from neighbouring devices:

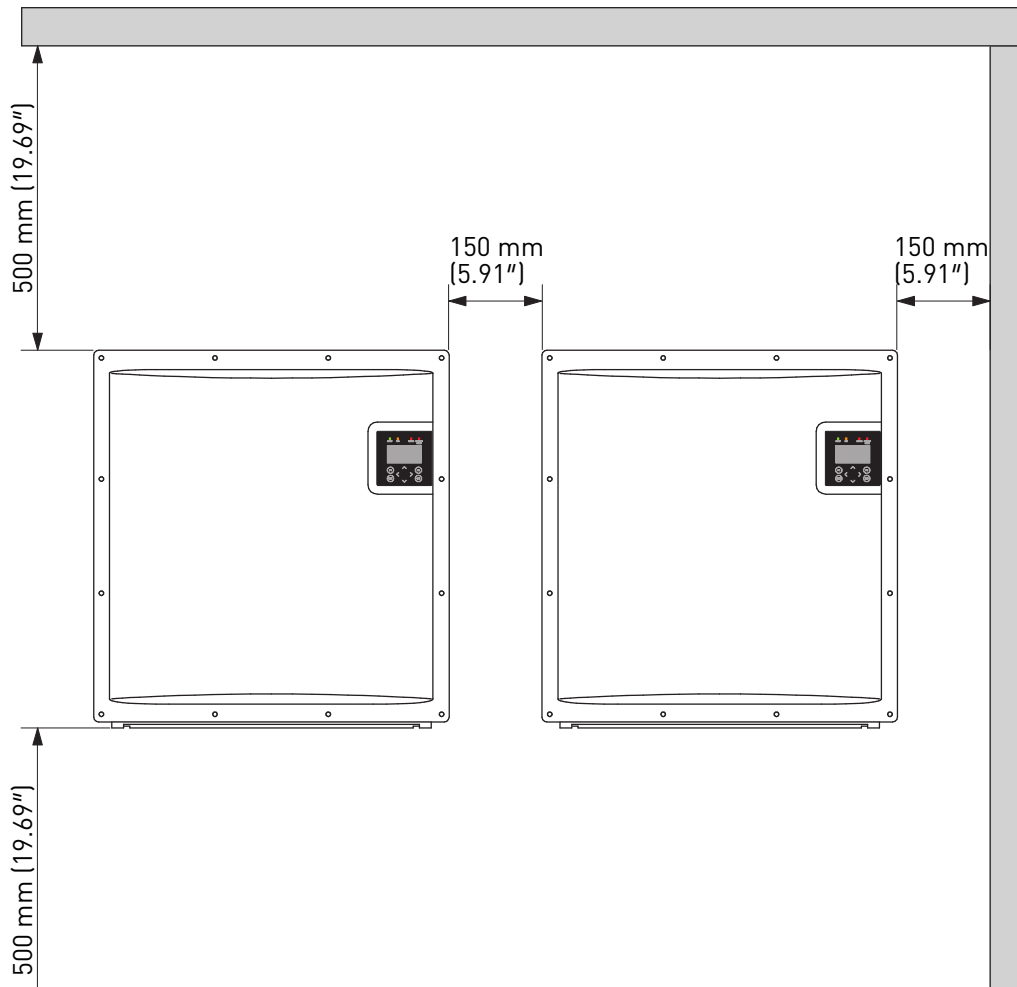


Fig. 5: Minimum distances

The device is best operated if the display is at eye level.

## 4.2 Transport

The devices must be transported under clean and dry conditions, if possible in their original packaging. The transport temperature must be between  $-25 - +60$  °C. Permissible variations in temperature may not exceed  $20$  °C ( $68$  °F) per hour.

## 4.3 Storage

The devices must be stored in clean and dry premises, if possible in their original packaging. The storage temperature must be in the range of  $-25 - +60$  °C. Permissible variations in temperature may not exceed  $20$  °C ( $68$  °F) per hour.

**Note:**

The inverter contains electrolytic capacitors which can be stored for no more than 1 year and at a storage temperature of  $\leq 40\text{ °C}$  /  $\leq 104\text{ °F}$  while in a de-energized state. If the storage time has been exceeded, please contact contact REFU Elektronik GmbH Service before connecting the inverter to your system!

## 4.4 Check delivery

The scope of delivery includes the following:

- Solar Inverter REFUsol 40K / 46K-MV
- Wall mounting plate
- 2 x mounting eyes for the handling of the device with a crane
- 1 x adapter housing for AC connection with seal element
  - 1 x DIN 63 cable gland with reducing insert
  - 4 x M5 self-locking nuts
- 1 x adapter housing for DC connection with seal element
  - 2 x DIN 25 cable glands with reducing insert
  - 4 x M5 self-locking nuts
- 3 x M5x12 ISO14583 A2 mushroom head bolts for fixing of the inverter at the wall mount

The screws for attachment to the wall are not included.

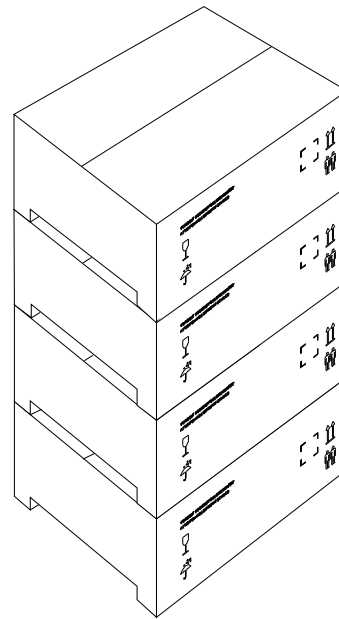
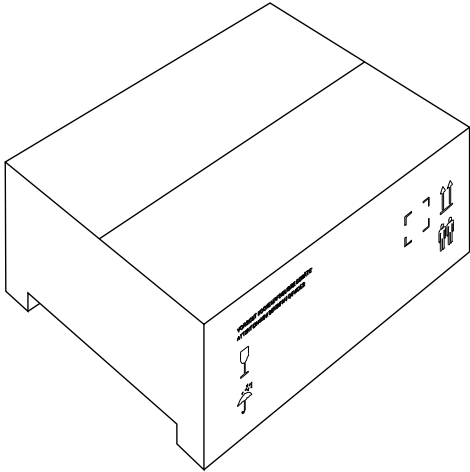
## 4.5 Unpacking the Device

**NOTICE**

**Exposure to moisture, dust, or debris while unmounted in a non-vertical orientation poses a risk of ingress**

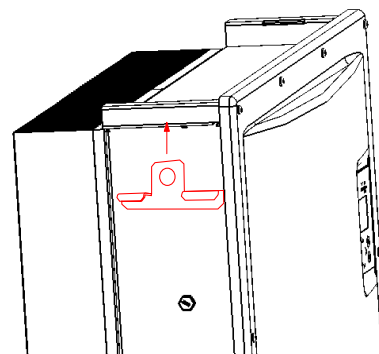
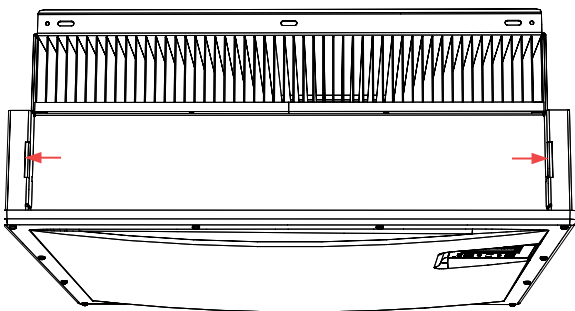
⇒ Only unpack the device when it is to be installed. Failure to do so voids your warranty!

The device is delivered in a cardboard box:

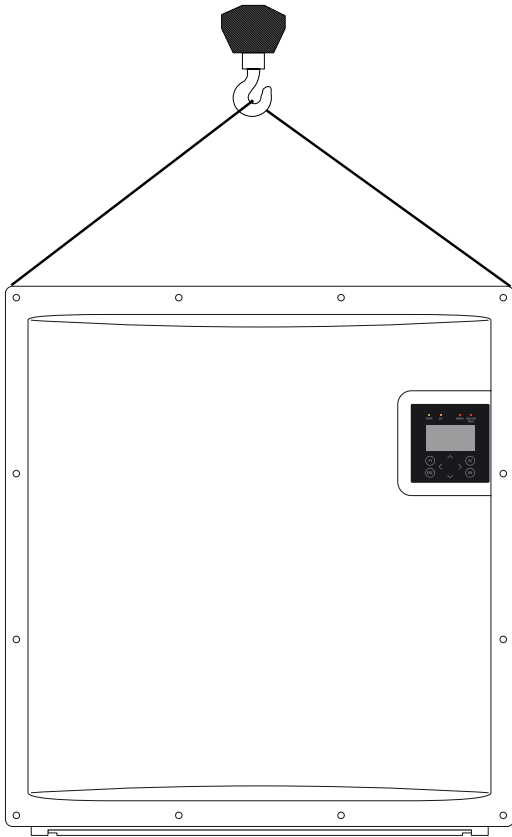


They can be stacked up to a maximum of 4 boxes high.

1. Open the box.
2. Take out the wall mount plate.
3. Take out the corner protection at the top of the inverter.
4. Fix the lifting eye plates into the slot (see red arrows):



5. Carefully lift the inverter out of the box with a crane or with 2 persons. Keep the product weight of 75.6 kg in mind!



## 4.6 Installation



### ⚠ CAUTION

#### Danger of injury

- ⇒ Do not use the cover to hold the device. Only use the four holding grips to move the device.

### NOTICE

#### Danger of damage to property

- ⇒ Do not use the cover to hold the device. Only use the four holding grips to move the device.
- ⇒ When designing the attachment of the wall-mounting plate, take the product weight of **75.6 kg** into account.
- ⇒ Do not open device. Opening the device voids the warranty.

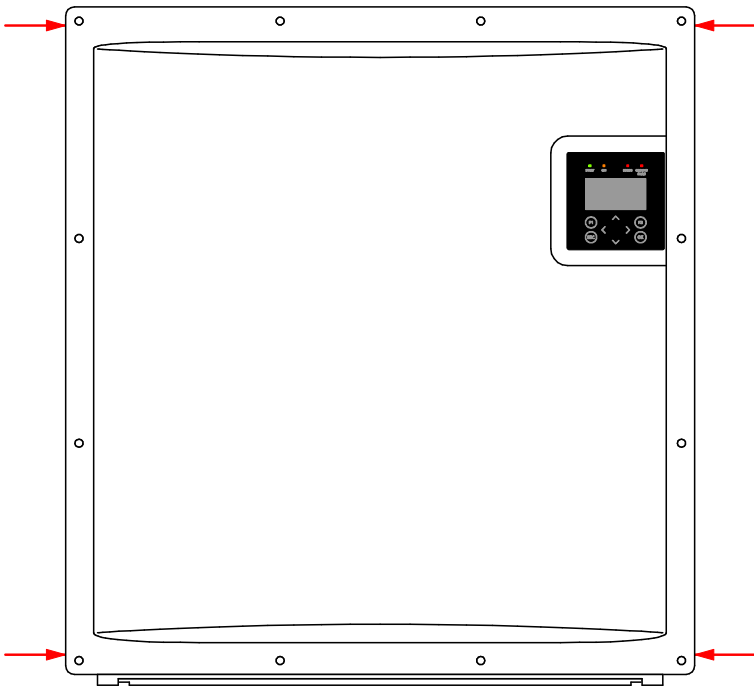


Fig. 6: Handles on the inverter

The inverter is mounted using the wall-mounting plate which is included in the scope of delivery.

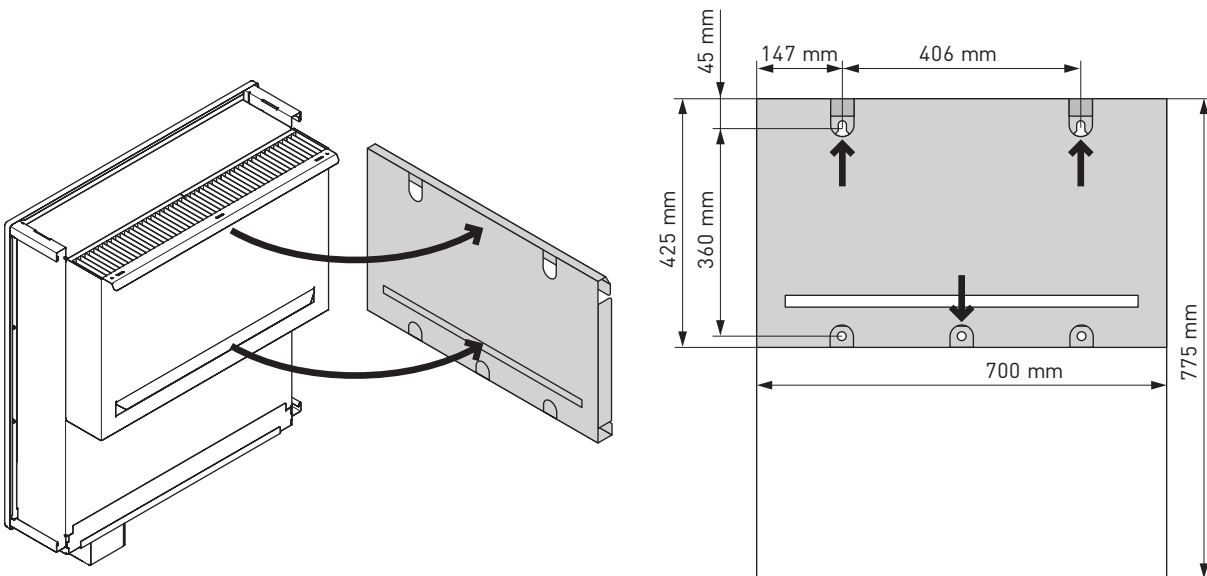


Fig. 7: Mounting the inverter

1. Use the wall bracket to mark the positions of the holes to be drilled.
2. Attach the wall-mounting plate to the wall using maximal 5 screws. The screws for attachment to the wall are not included. Screws with a diameter of 10 mm (3/8") must be used.
3. Attach the lower clip into the slit of the wall mounting-bracket and apply the upper clip.
4. Attach the inverter with the 3 screws included (M5x20) at the top of the wall-mounting bracket (red arrows).



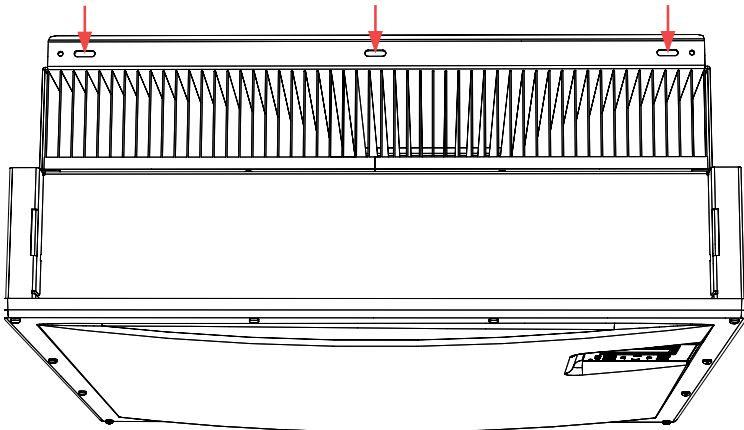


Fig. 8: Attaching with 3 screws

5. Tighten to torque of 2.5 Nm (1.8 ft lbs).
6. In order to avoid adhesive residue on the inverter, remove the display protection immediately after installation.

## 4.7 Device Connectors

The following figure shows the DC switch and connectors of the inverter on its bottom side:

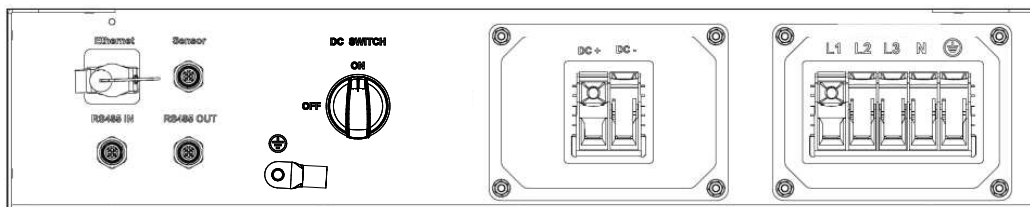


Fig. 9: Device connectors

The inverter is provided with the following connectors, as seen from left to right, top to bottom:

- Ethernet interface
- Sensor (irradiation, temperature or remote shutdown signal)
- RS485 connections (IN and OUT)
- Inverter earthing connection
- DC Connection for Solar Generator (DC+, DC-)
- AC Grid Connection (L1, L2, L3, N, PE)

## 4.8 Grounding

### DANGER

**Danger to life from electric shock!**



- ⇒ The inverter must be earthed with the grounding bolt, otherwise a potential difference can build up, causing a risk of electric shock!

The inverter features a threaded bolt at the left bottom side for additional grounding. Grounding is intended to ensure optimum overvoltage protection. The cross section for the ground must be 16 mm<sup>2</sup> (AWG 5) for copper and 25 mm<sup>2</sup> (AWG 3) for aluminum. Depending on the function and use of the additional ground wire other wire sizes may be required depending on the local regulation.

The maximum permissible torque for the grounding screw is 10 Nm (7 ft lbs).

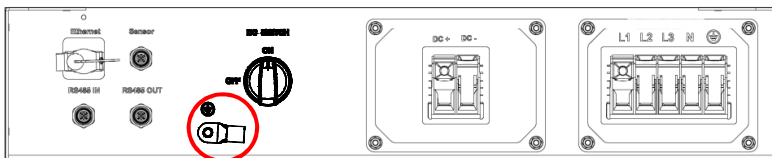


Fig. 10: Grounding bolt

M8 grounding bolt

## 4.9 Residual Current Protection

### Note:



The photovoltaic power supply inverters without transformers meet the fault protection requirements according to IEC 60364-7-712 and CEI 64-8/7 can be operated with a type A residual-current circuit breaker.

The rated leakage current should be at least 300 mA per inverter.

## 4.10 AC Grid Connection

### DANGER

**Risk of electric shock and fire caused by high discharge current**



- ⇒ Before connecting the device to the supply circuit, establish a ground - connection by means of the labelled ground stud!

## NOTICE

To ensure the **IP65** protection class, use the provided connection housing. To prevent any penetration of moisture and dirt, unused inputs and outputs must be properly closed.

Failure to do so could void your warranty!

The following mains systems are allowed:

- TN-C-S-Net
- TN-S-Net

The connection to the power supply must be via a 5-wire line. For safety reasons, the PE protective conductor must always be connected.

The power supply line must be equipped with an appropriate line protection. More information regarding the power connection you will find in the Technical Data. Reducing factors must be taken into account if circuit breakers are connected in series. Always observe the following standards:

IEC 60364-4-41	Protection: Protection against electric shock
IEC 60364-4-43	Protection for safety - Protection against overcurrent
IEC 60364-5-52	Selection and erection of electrical equipment - wiring systems
BDEW	Technical Guidelines
VDN FNN	Technical Guidelines

The respective national standards, technical regulations and local installation and connection requirements are complied with.

- Check the line voltage. It must be within the technical data for that device. If the line voltage is different, contact your local network operator.
- The design and the cross-section of the mains connection cable must be chosen in such a way that they can withstand the expected requirements during operation and the line losses are as low as possible. The following points must be observed:
- The cable material must be selected according to the installation location, the type of installation, and according to the national regulations.
- A strain relief must be installed for the mains supply.

### 4.11 Grid Line Impedance

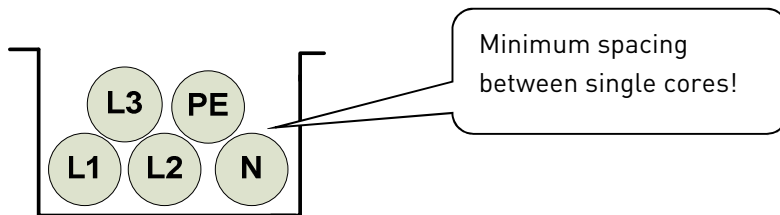
For better efficiency, large line cross-sections in single cables are increasingly used for power supply lines, especially if local conditions require long supply lines.

In large-scale plants, it is recommended as a best practice to locate the inverters in close proximity to the step-up transformer. If the inverters are located in a decentralized fashion, with long distances to the transformer, the higher AC cable inductance can lead to increasing line impedances. This can lead to voltage distortions and error messages with regards to:

- Grid overvoltage (long cable)
- Increased operating noise of the inverters (short cable)

To avoid these disadvantageous conditions, twisted lines should be used for power supply if possible. If laying of twisted lines is not possible, the following requirements must be met for single cores:

- Lay single cores next to each other.
- It is not allowed to lay single cores in closed, magnetically conducting materials (e.g., sheet steel pipe).
- If laid in open cable ducts, single cores should be laid such that the spacings between them are as small as possible.



**Note:**

To avoid unnecessary loss of energy yield, the sum total of the resistive and inductive voltage drop on the power supply line at nominal load should not exceed 1 % of the line voltage.

## 4.12 DC Connection of the Solar Generator



**⚠ DANGER**

**Danger to life due to high voltages from active PV strings**

- ⇒ Before connecting the PV strings, connect the inverter to the power supply and additional ground connection.
- ⇒ The connection of the PV strings must always be carried out de-energized.

The inverter has a single DC input for connecting the solar generator. The module strings must be combined in a separate DC string combiner box.

The DC terminals can be used with aluminum and copper wires. Please also check the installation instruction of Phoenix Contact.

**DC+ DC-**

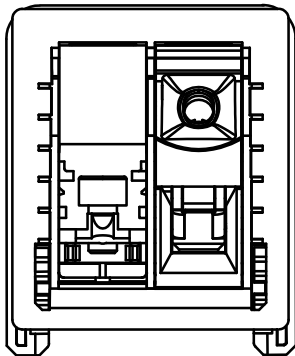


Fig. 11: DC connection Phoenix Contact TW50

- Before connecting the PV strings an isolation measurement must be taken.
- Whenever it is switched on, the inverter automatically checks the insulation of the PV generator. If the isolation resistance measurement is outside of the acceptable threshold, the inverter switches off automatically. The inverter can only be started once the PV generator isolation error has been removed.
- Be absolutely sure to verify proper polarity when connecting the PV strings. Any inappropriate connection of individual strings may damage the PV generator.
- The inverter is protected by an integrated polarity reversal protection diode.
- Install a strain relief for the DC connections.

The PV generator may not exceed the following operational characteristics under any circumstances!

Device type	40K	46K-MV	48K-UL
Max. DC voltage at each input	1000 V		
Max. short-circuit current DC input	160 A		
Max. DC operating current	84 A	82 A	84 A

#### NOTICE

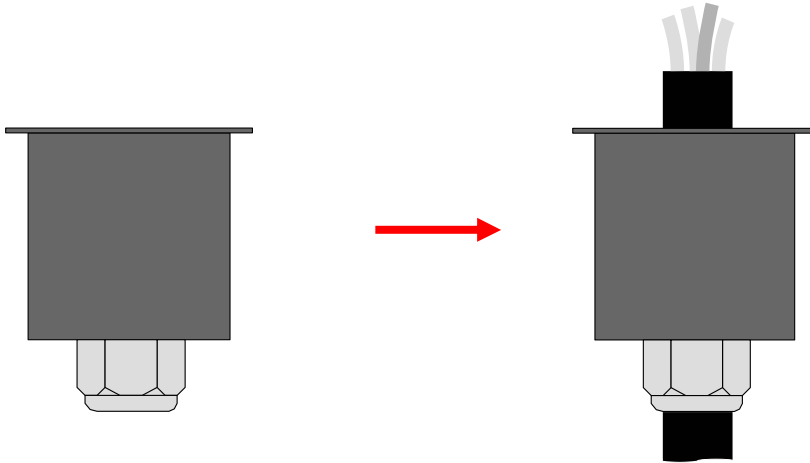
Reverse currents are fault currents that only occur in PV arrays with paralleled strings. Given short circuits of individual modules or cells in a module, the open circuit voltage of the string in question can drop so far that the intact parallel strings will drive a reverse current through the defective string. This may result in significant heating and therefore to destruction of the string.

⇒ Therefore, each string must be separately protected by a string fuse. In the event of a failure, this isolates the string from the intact strings so that destruction is prevented.

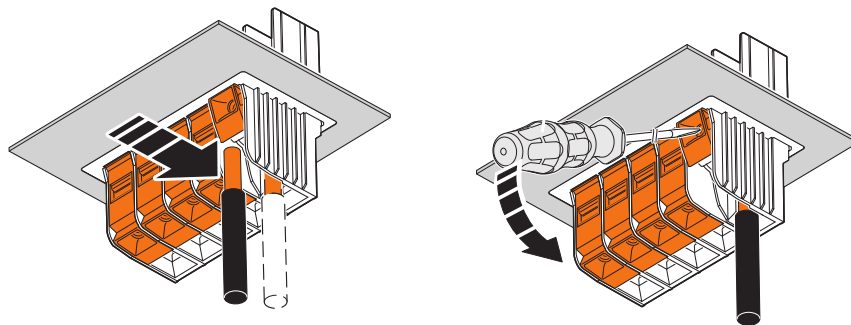
## 4.13 Phoenix T-LOX Knee Lever Connection

The terminal for DC and AC connection is suitable for use with conductors from 10 mm<sup>2</sup> ... 50 mm<sup>2</sup>.

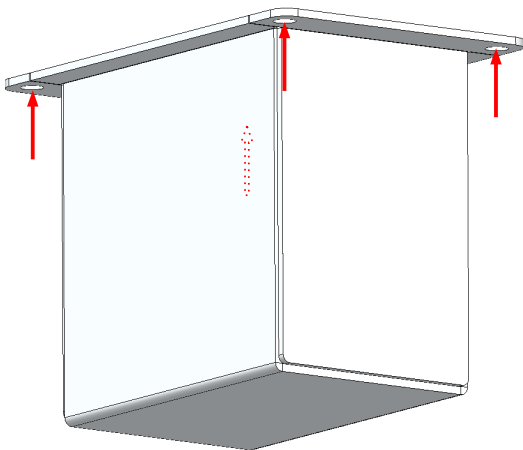
1. Put the cable through the cable gland into the connection housing.
2. Remove 90 mm of the cable sheath.
3. Remove 20 mm of the conductor insulation.



4. Place the sealing element on top of the connection housing.
5. For aluminum conductors: Grease stripped areas with contact grease.
6. Place the conductor on the installed inverter as far as it will go into the clamping point.
7. To clamp the clamping point, insert a screwdriver in the round opening on the orange cover and tilt it forwards.



8. Lift the connection housing onto the inverter housing, fitting it into four threaded bolts of the inverter housing.



9. Tighten the four M5 nuts of the connection housing with tightening torque 2,8 Nm.
10. Tighten cap nut of cable gland with 30 Nm.
11. Check whether the connection area is properly installed and waterproofed.

## 4.14 Interface Port RS485

The RS485 interface supports the USS (Universal Serial Interface Protocol) and Modbus/Sunspec protocols, which can be used for transmission of data, for example, to a data logger of a remote monitoring system.

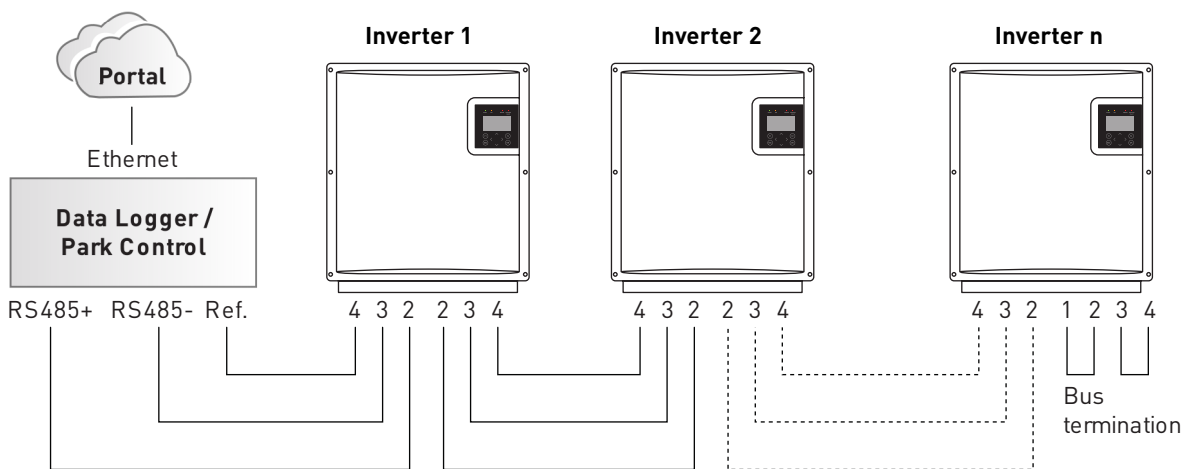


Fig. 12: Standard interface

When using this interface, please note that each device using the bus requires a unique address.

The bus termination is made by means of wire jumpers on RS485 OUT to the last bus user (inverter "n").

Pin	Signal
Pin 1	(only used for termination)
Pin 2	RS485 +
Pin 3	RS485 -
Pin 4	Reference

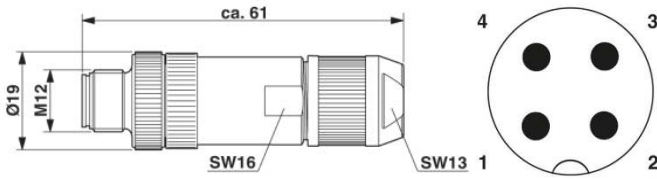


Fig. 13: Connector M12 x 1 straight, shielded; pole arrangement: male M12, 4 pins, A-coded, view of male connector side

### NOTICE

In order to ensure IP 65 protection and the required and declared conformity with the domestic EMC standard a PHOENIX CONTACT type M12MS SACC-4SC SH plug and a shielded cable must be used. The outer diameter of the connecting cable can be max. 8 mm.

Failure to observe this can lead to damage to the inverter and therefore void the warranty.

The plug pair can be ordered at REFU Elektronik GmbH with Art. No. 922001.

## 4.15 Ethernet Interface Connection

The Ethernet interface supports Modbus TCP/IP protocol, and is Sunspec compliant, which can be used for transmission of data, for example, to a data logger of a remote monitoring system. Daisy-chaining of devices is not supported. Each inverter must be connected to an ethernet switch, in parallel.

Please use an Ethernet cable with S/FTP design (shielded foiled twisted pair) and Phoenix Contact plug type Quickon VS-08-RJ45-5-Q/IP67.

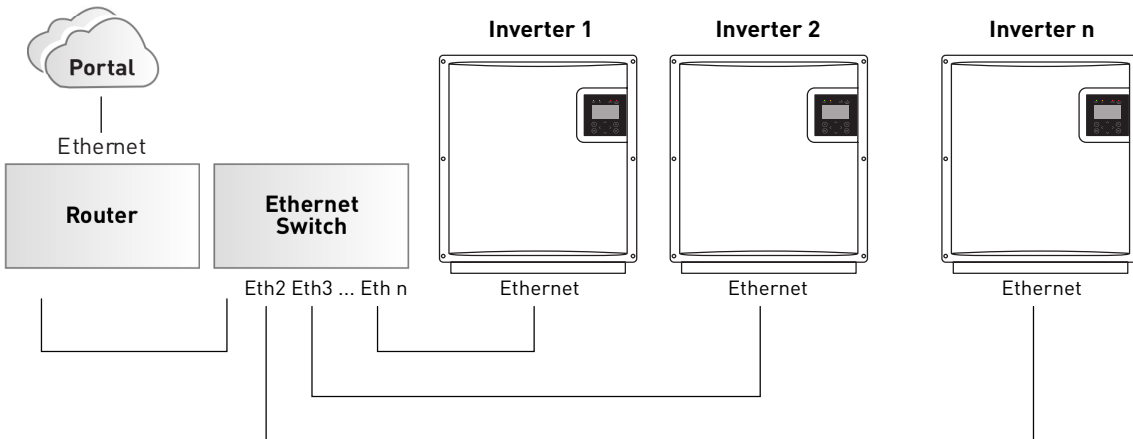


Fig. 14: Ethernet interface

### NOTICE

In order to ensure IP 65 protection, the plug type mentioned above must be used. Failure to observe this can lead to damage to the inverter and therefore void the warranty.

The plug can be ordered from REFU Elektronik GmbH with Art. No. 922002.



## 5 Commissioning

Before commissioning the inverter, be sure the following steps have been completed:

- ☑ Measurements tests were performed and summarized in a test report:  
The grounding connection has been checked.  
Isolation of strings to ground has been checked.
- ☑ Functional tests were performed and summarized in a test report:  
The correct grid code (IEEE 1547 or IEEE 1547a) is selected.
- ☑ If applicable, further requirements and technical rules need to have been considered in this context (e.g. Authority Having Jurisdiction (AHJ)).

### 5.1 Switching on the Device at Initial Start-up

- ☑ The electrical system to be connected was prepared according to the five safety rules.



#### **⚠ DANGER**

##### **Risk of death by electric shock**

Disconnect electrical systems according to the 5 safety rules:

- ⇒ Disconnect mains.
- ⇒ Prevent reconnection.
- ⇒ Test for absence of harmful voltages.
- ⇒ Ground and short circuits.
- ⇒ Cover or close of nearby live parts.

- ☑ The grounding and DC connection of the inverter/combiner box is installed.

1. Connect PV strings to the inverter or combiner box.
2. Check that all connections and covers are securely fastened.
3. Turn on DC voltage across switch separator.
4. Close the inverter's AC branch circuit breakers.

☞ If at the DC input of the inverter sufficient voltage is present, the inverter starts operation.



#### **Note:**

The control panel, including its status indicators, display, and operator keys, is only active when the PV generator is supplying sufficiently voltage.

## 5.2 Switching on the Device after Replacement

- ☑ The electrical system to be connected was prepared according to the five safety rules.



### **DANGER**

#### **Risk of death by electric shock**

Disconnect electrical systems according to the 5 safety rules:

- ⇒ Disconnect mains.
- ⇒ Prevent reconnection.
- ⇒ Test for absence of harmful voltages.
- ⇒ Ground and short circuits.
- ⇒ Cover or close of nearby live parts.

1. Remove any covers and barriers to adjacent live parts.
2. Remove any temporary short-circuit or grounding jumpers previously installed in the DC and/or AC system conductors.
3. Connect PV strings to the inverter or combiner box.
4. Checking of the AC and DC voltages applied on the connection.
5. Remove LOTO devices in accordance to the site owner's electrical safety procedures.
6. Switch the DC combiner box disconnect switch to the "ON" position.
7. If applicable, close the inverter's DC equipment disconnecting means.
8. Close the inverter's AC branch circuit breakers.

⚡ If at the DC input of the inverter sufficient voltage is present, the inverter starts operation.



#### **Note:**

The control panel, including its status indicators, display, and operator keys, is only active when the PV generator is supplying sufficiently high voltage.

### 5.3 Disconnecting Device Power

#### DANGER

##### Risk of death by electric shock



Disconnect electrical systems according to the 5 safety rules:

- ⇒ Disconnect mains.
- ⇒ Prevent reconnection.
- ⇒ Test for absence of harmful voltages.
- ⇒ Ground and short circuits.
- ⇒ Cover or close of nearby live parts.

1. To stop the operation of the inverter push on the inverter's control panel ESC and OK at the same time.
2. Open the inverter's AC branch circuit breakers.
3. Switch the DC combiner box disconnect switch to the "OFF" position.
4. If applicable, open the inverter's DC equipment disconnecting means.
5. Secure separators against being switched back on. Install LOTO devices in accordance to the site owner's electrical safety procedures.
6. Wait 15 minutes until capacitors are discharged.
7. Determine absence of voltage, observe stored energy and discharge time in the intermediate circuit.
8. If applicable, install short-circuit or grounding jumpers in the DC and AC supply side.
  - ↪ Inverter is de-energized and out of service.

### 5.4 Setting the Country Code and the Menu Language

When switching on for the first time an initial configuration is necessary.

The country code defines the country-specific grid monitoring parameters. The menu language is automatically set when the country code is selected. The menu language can subsequently be selected as desired at any time, independent of the country abbreviation set in the menu. The country code is not set on delivery.

#### NOTICE

**The selected country code can only be changed by service personnel.**

After the initial setting and confirmation of the country code the country code can only be altered within 40 hours. This is also valid for replacement devices. The country code can then only be changed by authorized service personnel.

## NOTICE

### Cancellation of the operating license!

Operating the inverter with the wrong country code can lead to the withdrawal of the interconnection agreement from the energy supplier.

We assume no liability for the consequences of an incorrectly set country code!

#### 5.4.1 Set Country Code/Grid Guideline

The following window appears on the display after initial switch on of the DC voltage and prompts you to set the country code. You can choose from among the offered countries.



1. Use the **^** and **v** keys to select the country code which is specific for your country and your location. The menu language is selected simultaneously with the country code. However, the menu language can later be changed independently of the country code.
2. Press **OK** to confirm. Then the grid feed guideline given by the energy supplier must be selected.



3. Select valid grid feed guideline with **^** and **v** buttons.
4. Press **OK** to confirm.

#### 5.4.2 Accepting the Country Code

To be certain, you will be asked whether you wish to accept the country code. After accepting the country code it can only be changed within 40 hours.



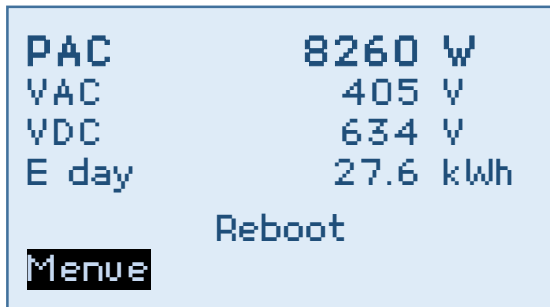
Only confirm the country code if you are absolutely sure it is correct.

If you are not sure, press **ESC** to cancel your selection and correct the selection.

If the country code is to be accepted, then confirm with **OK**.

A restart then takes place:

⇒ "ERROR" and "GROUND FAULT" status LEDs flash red alternately.



```
PAC      8260 W
VAC      405 V
VDC      634 V
E day    27.6 kWh
          Reboot
Menu
```

## 5.5 Device Start

- Solar modules are irradiated with sufficient sunlight.
- Country code is set.
- Time and date is set.

The following procedure follows:

Self-test	All status LEDs are lit for approx. 6 seconds
Check	"START" status LED lights orange.
Activation	"START" status LED lights orange/LED "ON" flashes green.
Feed in	"ON" status LED lights green/normally all other status LEDs are off.

## 5.6 Control Panel

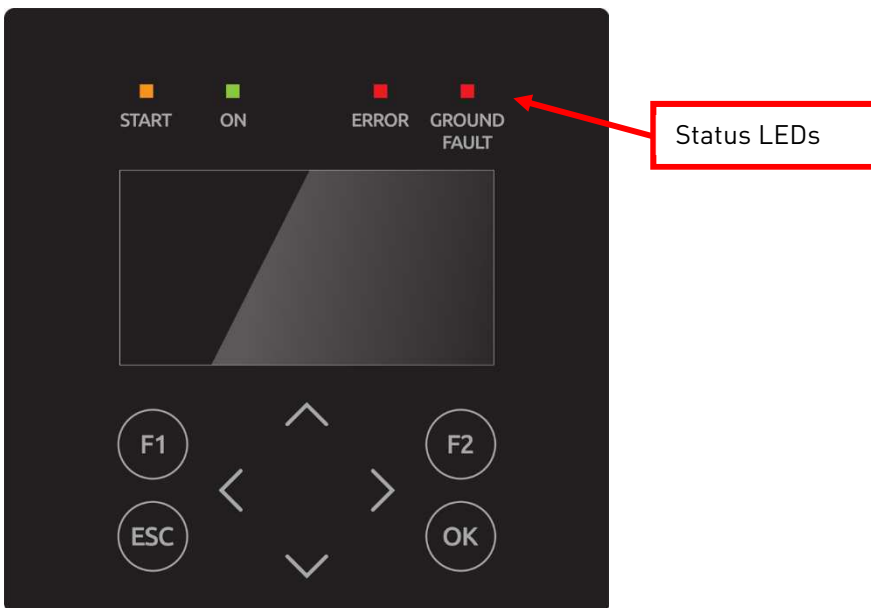


Fig. 15: Control panel with status LEDs, display and keys

F1	Displays the Menu
F2	In basic display: Reboot of display "Energy / x kWp" display: Input of standardized (normalized) data
↔	Function in the menu: Navigation within the menu level (previous menu, next menu). Function while parameters are edited: digit to the left, digit to the right (decade jump)
^v	Selection within the menu.
ESC	Acknowledge failures and exit from menu level, exit from input menu without entering data
OK	Confirm the selected menu (next menu level) and entered data.

## 5.7 Basic Screen

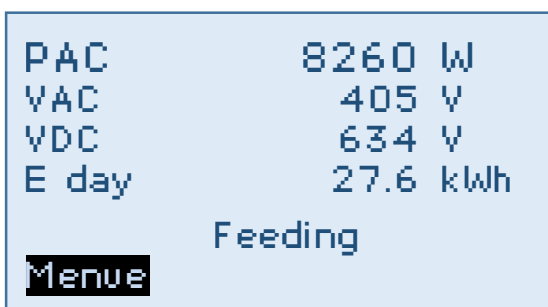


Fig. 16: Operating mode display

PAC = Current feed power in Watts (W)

VAC = Line voltage in Volts (V)

VDC = Solar cell voltage in Volts (V)

E day = Energy yield of the day in kWh

## 5.8 Graphical Display

Press the **◀** arrow key once to display the development of the day's feed power.

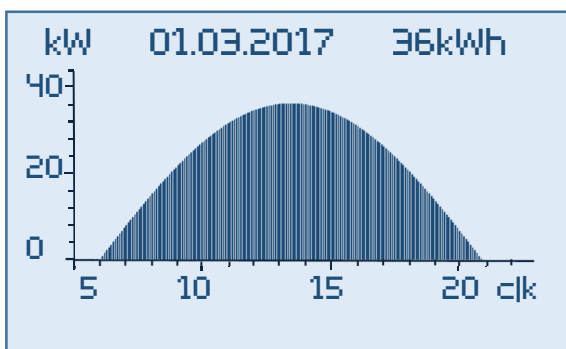


Fig. 17: "Today's" feed power display

Press the **▼** arrow key to display the development of the previous days.

Press the **ESC** key to return to the basic screen display.

## 5.9 Energy Yield Data Display

Press the **▶** arrow key to display the current yield data and the operating hours having currently elapsed.

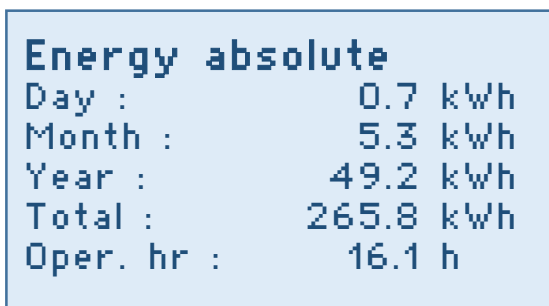


Fig. 18: Energy yield absolute display

## 5.10 Standardized Energy Yield Data Display

Press the **➤** arrow key, then the **▼** arrow key to display the development of standardized energy yield data.

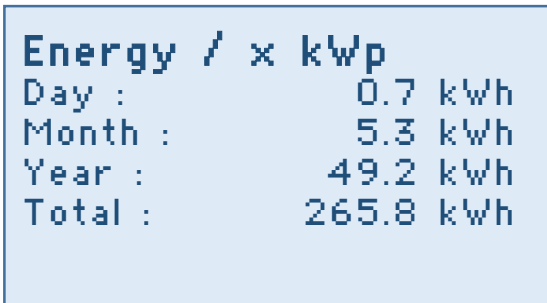


Fig. 19: Energy yield normalized on the display

Press the **ESC** key to return to the basic screen display.

### 5.10.1 Input of Standardized Data

To change the normalization, press the **F2** key and enter the currently connected PV generator power as follows:

- ↔** keys:            Press the **◀** key to select the digits before the point.  
                         Press the **➤** key to select the digits after the point.
- ^** key:             Press the **^** key to increment the selected digit by 1.
- ▼** key:             Press the **▼** key to decrement the selected digit by 1.

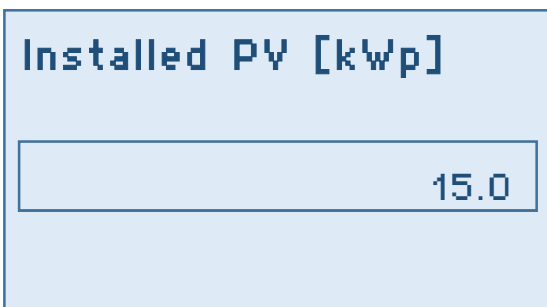


Fig. 20: Standardized data input display

Press the **OK** key to apply the set value.

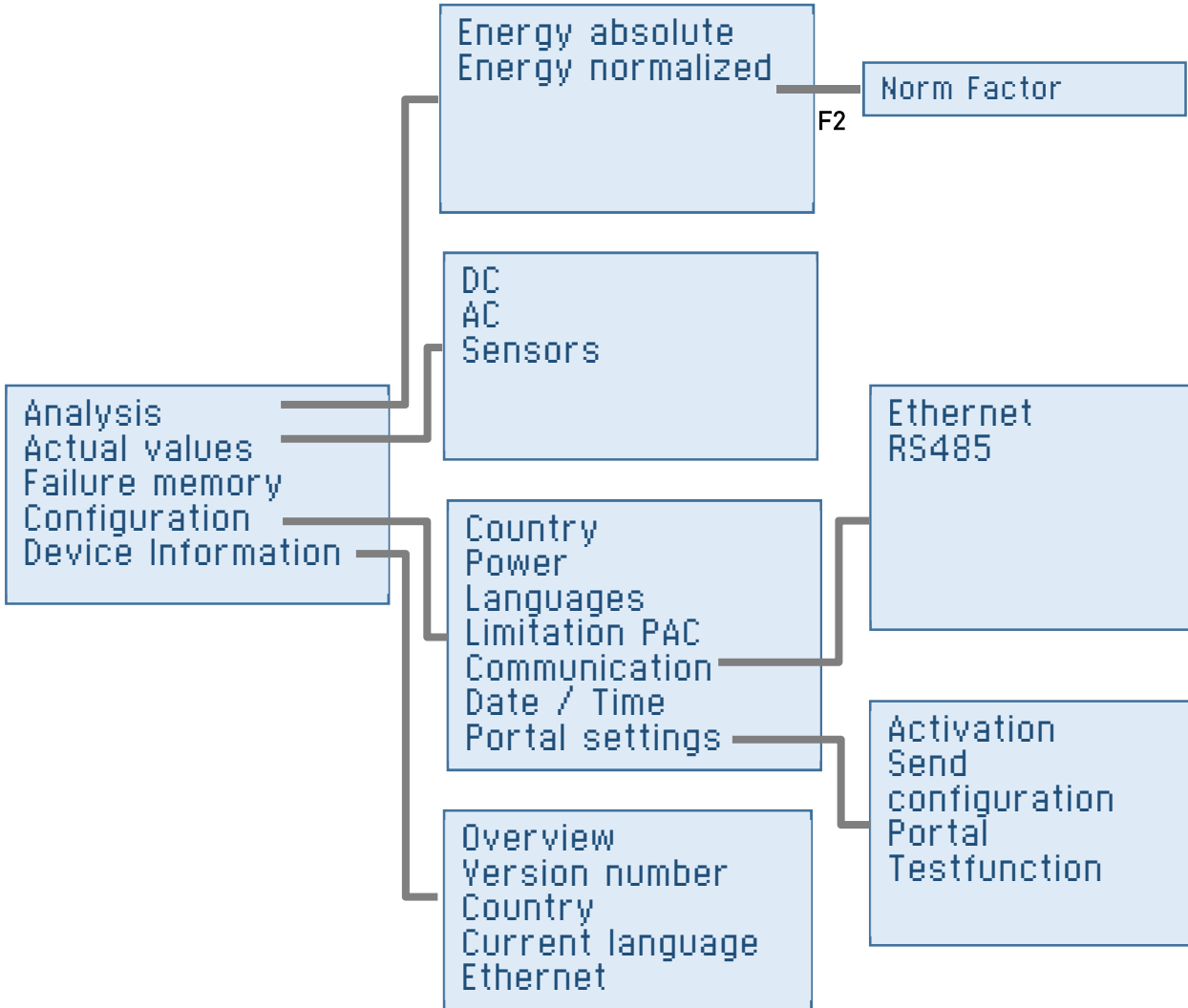
Press the **ESC** key to discard the value and display the previous “normalized yield” level.

Press the **F1** key to display the menu.



### 5.11 Menu Structure

The menu structure serves as a support to change to the individual information displays and setting displays.

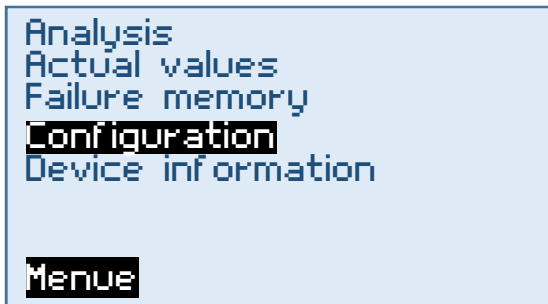


## 6 Configuration

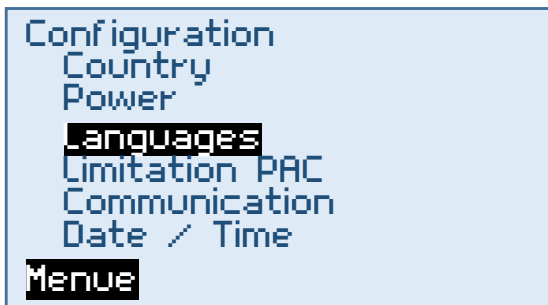
### 6.1 Changing the Menu Language

The language selection has no effect on the country code. Proceed as follows to change the menu language:

1. Press **F1** to open the menu.
2. Use the **▼** and **▲** keys to select the fourth menu item "Configuration".



3. Press **OK** to confirm.
4. Use the **▼** and **▲** keys to select the first menu item "Languages".



5. Press **OK** to confirm.
6. Use the **▼** and **▲** keys to select the desired menu language.
7. Press **OK** to confirm.
  - ↗ The menu switches to the selected language. The display is initially empty.
8. Press **ESC** to return to the menu.

### 6.2 Limitation of the Power Output

Proceed as follows in order to limit the power output of the inverter:

1. Using the **F1** key, select the menu item "Configuration" and confirm with the **OK** key.
2. Select the sub-menu "PAC Limit" and confirm with the **OK** key.
3. Enter the invert power output as percentage of the nominal power and confirm with the **OK** key.

↗ The power limit is immediately applied.

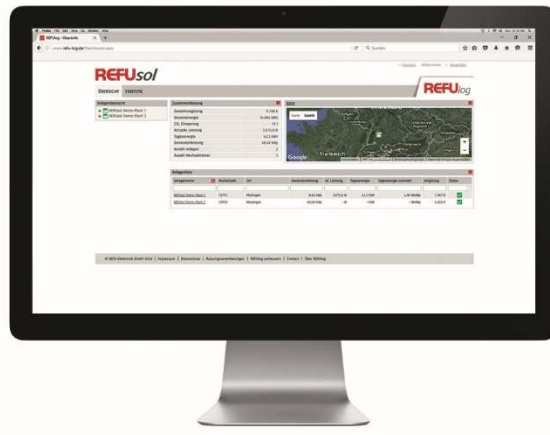
## 6.3 Monitoring with REFUlog

The REFU<sup>sol</sup> 40K / 46K-MV 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](http://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.



## 6.4 REFUset – PC Configuration Tool

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 φ)

- Power-up time
- K factor (fault ride through)

REFUset can be downloaded from [www.refu.com](http://www.refu.com).

## 6.5 Communication via Ethernet

The settings for the Ethernet communication can take place either manually or automatically (via DHCP). Manually is the default setting.

### 6.5.1 Automatic Setting via DHCP

1. Navigate to Menu **Configuration > Communication > Ethernet > DHCP**.
2. Enter "1" in DHCP input field.
3. Press **OK** to confirm.
4. Restart inverter by opening and re-closing the DC switch.

⇒ The settings for IP address, subnet mask, standard gateway and DNS are automatically taken from the DHCP server, e.g. the router.

### 6.5.2 Manual Setting

In order to ensure a trouble-free operation, all values must be given by the responsible network administrator and individually set in each inverter.

1. Navigate to **Configuration > Communication > Ethernet > IP address**.
2. Enter IPv4 address. The IPv4 address is arbitrary, but must be consistent throughout the subnet.  
Default value: **192.168.130.30**
3. Press **OK** to confirm.
4. Navigate to **Configuration > Communication > Ethernet > Subnet mask**.
5. Enter IPv4 mask. The IPv4 mask is arbitrary, but must be consistent throughout the subnet  
Default value: **255.255.0.0**
6. Press **OK** to confirm.
7. Navigate to **Configuration > Communication > Ethernet > Standard gateway**.
8. Enter the address of the router that allows connection to the internet  
Default value: **192.168.1.1**
9. Press **OK** to confirm.
10. Navigate to **Configuration > Communication > Ethernet > DNS**.
11. Enter arbitrary IPv4 address of the superior DNS server  
Default value: **0.0.0.0**
12. Press **OK** to confirm.
13. Restart inverter.

## 6.6 Communication via RS485

For monitoring via RS485, you need to use REFUcontrol device to forward data to the monitoring portal REFUlog.

You need to assign an unique USS address to each connected inverter.

Addresses: 1 to 31

This address is required for communicating with the inverter via RS485.

⇒ After entering the address, restart the inverter to activate the new address.

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  
(in Multimode, you cannot use USS address 0 and 2!)

Baud rate: 57600 (preset and recommended)  
115200 (for short RS485 networks)

Parity: even

Handshake: no

Data bits: 8

Stop bits: 1

Protocol: REFU USS protocol

## 6.7 Portal Monitoring

To ensure the inverter sends data via Ethernet to the REFUlog monitoring portal, the portal monitoring must be active.

Open Menu Configuration > Portal Monitoring and enter the following value:

0 = Portal monitoring via Ethernet not active

1 = Portal monitoring via Ethernet active



### Notice

If the inverter is connected with RS485 to REFUcontrol, the setting 0 (Portal Monitoring via Ethernet not active) must be used!

## 6.8 Sending Config

### Menu Configuration > Portal monitoring > Config sending

The configuration data is required by REFUlog in order to recognise the inverter. If you want to send it manually, select the menu and set the parameter to 1. If the sending was successful, the parameter will be set back to 0 automatically.

## 6.9 Portal Test Function

### Menu Configuration > Portal monitoring > Portal Test

On request of our service, you can send a test data package to the portal. Open the menu and select „yes“.

## 7 Troubleshooting

### 7.1 Self-Test – Error Message

After the initialization routine, the system runs through a self-test. The individual parts of the system, such as firmware and dataset, are checked and data is read in from the power control board. If an error continues to be detected, possible remedial measures must be taken according to the type of error.

### 7.2 Transient Failure

In certain operating states the inverter goes temporarily offline.

Unlike malfunctions, “transient failures” are automatically acknowledged by the inverter which attempts to restart once the error no longer exists.

A transient failure is indicated by the red LED “ERROR” on the control panel flashing and remains stored in the fault memory even in the event of a power failure. .

### 7.3 Faults

Pre-configured and customizable limit values are continuously monitored during ongoing operation. In order to be protected, the inverter power section is isolated from voltage supply if a limit value is exceeded or if a failure occurs. However, the DC and AC voltages may still be available. The corresponding fault message appears in the display.

The fault is indicated on the control panel by the red “ERROR” LED emitting steady light.

Fault messages are stored in the fault memory, where they will remain even in the event of a power failure. The fault memory can be called up via the display. The last 100 faults are recorded in the fault memory. The latest fault is kept at memory location S0, the oldest at S100. A new fault is always stored to memory location S0. When this happens, any fault already at memory location S100 will be lost.

### 7.4 Fault Acknowledgement

After shutdown due to a fault, the device remains locked against reactivation until the fault is acknowledged. It is not possible to acknowledge the fault while the cause of the fault still exists. The fault can only be acknowledged after the cause of the fault has been eliminated.

- ⇒ To acknowledge the fault message, press the ESC key or turn the inverter off with the DC switch and wait min. 30 seconds to turn the inverter ON again.

## 7.5 List of Error Messages



### Note

Under certain weather conditions, condensation may form in the display. This is normal and causes no malfunction of the inverter.

Error Code	Text	Description	Action
90006	Grid overvoltage	Phase overvoltage (AC) has been detected.	Check the phase voltages (with a true RMS measurement device). If you consider the phase voltages to be in order, contact Service.
90007	Grid undervoltage	Phase undervoltage (AC) has been detected.	
90008	Overfrequency	The grid frequency has exceeded the limit value.	As long as the inverter is detecting an over or under-frequency: check the frequency of the phases. If you consider the frequencies to be in order, contact Service
90009	Underfrequency	The grid frequency has dropped below the limit value.	
9000A	DC link 3	DC-voltage measurement error.	Wait for the measurements to become stable again. If this takes more than 2-3h, please contact Service.
9000B	DC link 1	Imbalance low: Difference between the DC link voltages is too high.	
9000C	DC link 2	Imbalance high: Difference between the two boosted DC link voltages is too high	
9000D	DC link 4	The boosted DC-voltage has dropped below the mains peak value	
90010	DC link 5	The boosted DC link voltage is too high.	
90011	DC link 6	The DC link voltage is too high.	
90017	Communication LT	Communication malfunction between power section and control and regulation unit	The inverter will acknowledge the error automatically. If problem occurs repeatedly, contact Service
90018	Grid frequency LT	Power section has detected under/overfrequency	As long as the inverter is detecting a power section grid frequency: check the frequency of the phases. If you consider the frequencies to be in order, contact the Service
90019	Grid overvoltage LT	The power section has detected a phase overvoltage.	As long as the inverter is detecting a grid overvoltage or under voltage: check line voltages (with a true RMS measurement device). If you
9001A	Grid undervoltage LT	The power section has detected a phase undervoltage.	



Error Code	Text	Description	Action
			consider the line voltages to be in order, contact the Service.
9001B	RCD fault	The AFI-Board unit has detected a residual current. Leads to an immediately shutdown	Check system isolation. As long as you consider the isolation impedance to be in order, contact Service.
9001D	RCD warning		
90020	Initialisation C1	Initialisation has failed.	Restart inverter. If this does not rectify the error, contact Service.
90021	Initialisation C0		
90024	SR parameter error	Error in parameter initialisation. The device has been permanently shut down.	Please contact Service.
90029	Update fault	Update failed	The update has failed. Contact Service.
9002A	Keep Alive	Internal communication monitoring has determined a fault.	Please contact Service.
9002B	Update End	Update successful notification.	An update was successfully completed. The device will resume normal operation.
9002C	AntilandPhase Shift	Islanding of the connected grid section has been detected	Wait for the grid to become stable again
9002D	AntilandRocof		
9002F	FFS is read-only	Internal data can't be written anymore.	Please contact Service.
90030	DC share too high	The measured DC-Part in AC current exceed the defined limit.	
90031	ETH link lost	The Ethernet cable has been removed	Check the Ethernet cable on the device and the receiver (router, switch) for a correct fit. If the cables are correctly connected and should the notification still be there, please contact Service.
90032	Restart	The system has been rebooted.	Should these notifications occur repeatedly during daily operation, please contact Service.
90050	AC condition	AC switch on condition not fulfilled	Wait until the network is stable

Error Code	Text	Description	Action
90051	DC condition	DC switch on condition not fulfilled	Wait until the solar voltage is high enough
90052	User lock active	The inverter can't connect to the grid, as the User-lock has been set.	Deactivate user lock
90053	Communication SR	Internal communication problems	Fault is independently resolved after a few minutes. If not, switch device off and on again. If this does not resolve the problem, contact Service.
90054	Overvoltage 2	The phase voltage has exceeded the limit value of the voltage average monitor for too long.	As long as the inverter is detecting the voltage error: monitor line voltages (analyse grid). If you consider the line voltages to be in order, contact Service.
90055	Grid overvoltage	Line-to-line overvoltage (AC) detected	
90056	Grid undervoltage	Line-to-line undervoltage (AC) detected	
90057	Watchdog C0	Internal protection function is triggered.	Contact Service.
90058	Watchdog C1		
90059	LT Firmware	The software of the power section is defective.	
90060	FRT stability	Stability issue with the DC link detected.	Please contact the service if it happens repeatedly
90061	Update fault	This notification can be ignored.	No measures necessary.
90062	Fault ride through	Grid-instability which is handled with respect to the grid code standards.	
A0013	PM isolation RCD SR	The measured value of the residual currents are over the limits: Measured value >150 mA -> Trip within 20 ms Measured value >60 mA -> Trip within 130 ms Measured value >30 mA -> Trip within 280 ms	Check system isolation. If you consider the system isolation to be in order, contact Service.

Error Code	Text	Description	Action
A0020	External cut-off	External monitoring has triggered a disconnection.	During the inverter detects an external cut-off: Verify external cut-off signal . Possible causes: wire breakage or wrong sensor selected. Refer to the manual for the right settings.
A0021	ARC fault detected	Arc fault detection has triggered a disconnection	Reset the arc fault detector. Press ESC on the Display.
A0022	Ext. OVGR Signal	External stop signal OVGR is detected.	During the inverter detects OVGR: Verify External stop signal OVGR. Possible causes wire breakage.
A0102	Overtemperature LT 1	Cooler overtemperature (right)	Check temperature of direct surroundings and reduce this as required.
A0103	Overtemperature LT 2	Interior overtemperature (left)	
A0104	Overtemperature LT 3	Interior overtemperature (right)	
A0105	Overtemperature LT 4	Cooler overtemperature (left)	
A0106	Supply voltage LT	Supply voltage at the power section is too low.	Please contact Service
A010C	PM isolation LT	Power section detects an isolation error on activation.	Check system isolation. If you consider the isolation resistance to be in order, contact Service.
A010E	Device fault LT	Power section hardware shutdown	Note: When did the error occur (precisely: day, kW output, time).
A0114	PM isolation RCD LT	Residual current measured from the power section exceeded the limits. residual current > Limit values of 20 mA, 130 mA, 280 mA respectively	Please contact Service
A0116	R-detect	0	Do nothing. The inverter will acknowledge the error automatically. If problem occurs repeatedly, contact Service.
A0117	Isolation test unit	Test isolation test is taking too long.	Please contact Service

Error Code	Text	Description	Action
A0118	Voltage offset LT	Offset adjustment values between power section and control and regulation unit divergent	
A011A	Activation LT 1	Voltage booster self-test failed.	Do nothing. The inverter will acknowledge the error automatically. If problem occurs repeatedly, contact Service.
A011B	Activation LT 2	DC link voltage drop during activation	
A011C	Activation LT 3	Target value for balancing is invalid.	
A011D	Activation LT 4	Balancing has failed.	Please contact Service
A011E	Activation LT 5	Voltage booster malfunction	
A011F	Parameter error LT 5	Faulty reading or writing process in power section memory	1.) Switch off device with DC disconnecter. 2.) Wait until the display has turned off completely. 3.) Switch on device with DC disconnecter. If this does not rectify the error, contact Service.
A0172	P24V LT aux. supply	P24V supply voltage at the power stack is too low.	Please contact Service
A0173	P5V LT aux. supply	P5V supply voltage at the power stack is too low.	
A0174	P15V LT aux. supply	P15V supply voltage at the power stack is too low.	
A0178	Temp. Sensor KR LT	checking open loop or short loop for temperature sensor cooler right	
A0179	Temp. Sensor IL LT	checking open loop or short loop for temperature sensor cooling interior left	
A017A	Temp. Sensor IR LT	checking open loop or short loop for temperature sensor cooling interior right	
A017B	Temp. Sensor KL LT	checking open loop or short loop for temperature sensor cooler left	
A017C	N15V LT aux. Supply	N15V supply voltage at the power stack is too low.	
A017D	Phase defect	an error has been detected in the power modules	

## 8 Options

### 8.1 Irradiation and Temperature Sensor

For recording the irradiation and the module temperature, an irradiation and temperature sensor can be connected to the sensor interface of the inverter. The recommended type is Si-13TC-T-K and can be ordered at REFU Elektronik GmbH with art. no. 922009. The sensor plug can separately be ordered with art. no. 922010.

The sensor comes with a 3 meter UV-resistant connecting line (5 x 0.14 mm<sup>2</sup>). The line can be extended with a 5 x AWG 23 (0.25 mm<sup>2</sup>) shielded line, max. 328 ft (100 m).

#### 8.1.1 Inverter Sensor Interface

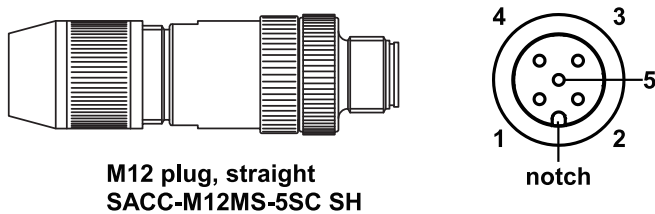


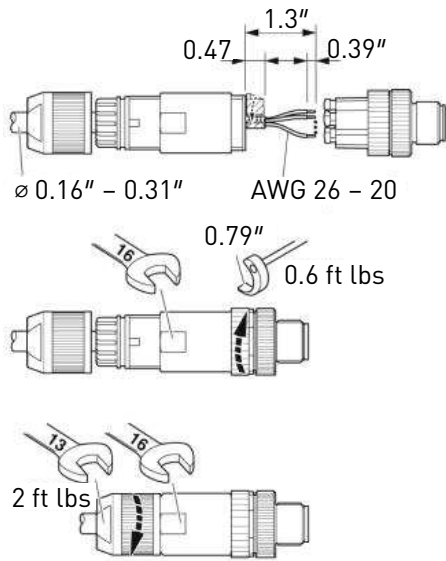
Fig. 21: Connector M12 x 1 straight, shielded; pole arrangement: male M12, 5 pins, A-coded, view of male connector side, PHOENIX CONTACT designation: SACC-M12MS-5SC SH

Inverter sensor pins	Signal
Pin 1	Supply voltage (24 VDC, max. 2 W)
Pin 2	Ground
Pin 3	Signal Input 1 (0-10 V)
Pin 4	Signal Input 2 (0-10 V)
Pin 5	Shield

#### 8.1.2 Sensor Type Si-13TC-T-K Cable

Sensor cable color	Signal
Red	Supply voltage (12-28 VDC)
Black	Ground
Orange	Measurement signal irradiation (0-10 V)
Brown	Measurement signal temperature (0-10 V)
Black, thick	Shield

## 8.1.3 Assembling of the Sensor Plug



## 8.1.4 Connection of the Sensor at the Solar Inverter

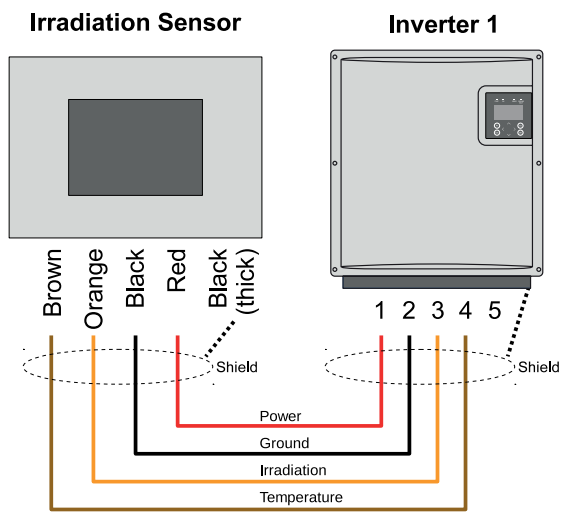


Fig. 22: Standard connection at a solar inverter (not applicable at AFCI variant)

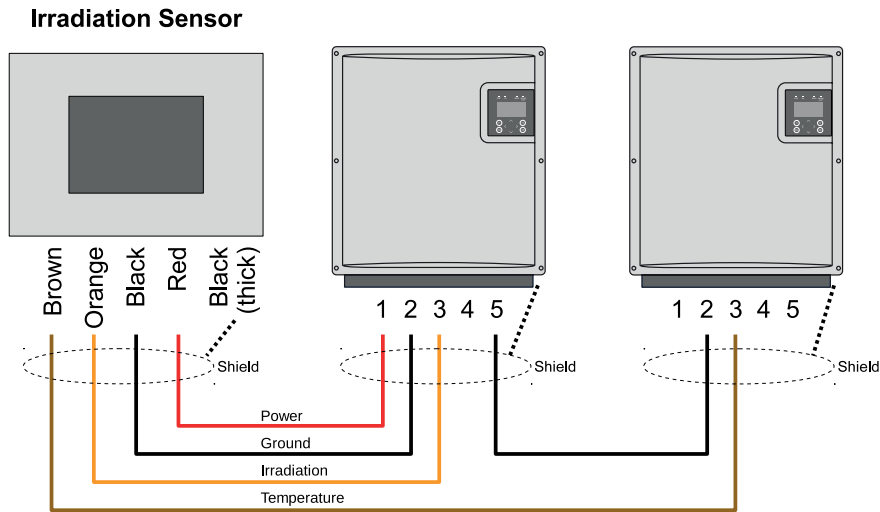


Fig. 23: Connection to two inverters (for AFCI variant)

In the AFCI variant, the irradiation and temperature sensor is connected individually to one inverter.

### 8.1.5 Configuration

The actual values of the sensor are shown on the display of the inverter at **Actual values > Sensor**.

The assignment of the sensor signals can be configured with PC software REFUset.

The data are recorded by the datalogger and are visible within REFUlog portal.



#### Note:

The shield of the sensor line (dotted line) must be applied to PIN 2 and PIN 5!  
The outer diameter of the connecting cable can be max. 8 mm.



#### Note:

If you do not use the temperature input, wire a jumper across PIN 4 and PIN 5.  
Alternatively, you can also wire the jumper to the intermediate terminal point (cable extension).

The actual values of the sensor can be viewed in **Actual values > Sensor**. The data continues to be recorded with the data logger and can be viewed via REFUlog.

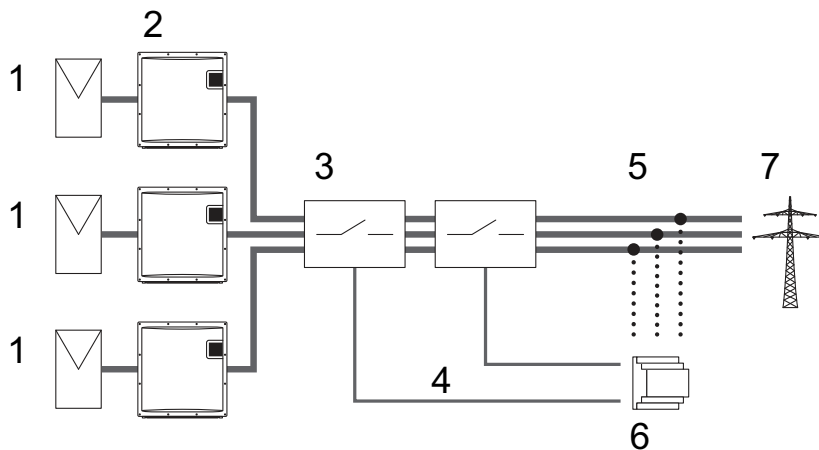
## 8.2 External Turn Off Signal

### 8.2.1 Overview

REFU<sub>sol</sub> solar inverters have an internal grid protection relay and section switch.

Depending on local connection, installation instructions and the selected line voltage level either the internal grid protection relay can be used with section switch, or an external grid protection relay must be used with section switch also.

It is also possible to combine the internal to the external grid protection relay.



- 1 Photovoltaic modules
- 2 Solar Inverter
- 3 Three phase, redundant section switch
- 4 Control line
- 5 Grid measurement
- 6 Grid protection device
- 7 Public grid

### 8.2.2 Function

The internal section switches of the inverter can be controlled by an external signal.

At a signal voltage between 7.5 and 10 V the inverter feeds into the grid. If the signal voltage falls below 7.5 V, an error message will occur and the inverter will stop to work within the configured switch of time.

Nominal voltage	10 VDC
Voltage (operation)	7.5 ... 10 VDC
Voltage (Stop)	0 ... 7.5 VDC
Standard switch-off time inverter	50 ms
Switch-off time range	50 ms ... 100 ms



8.2.3 Configurations

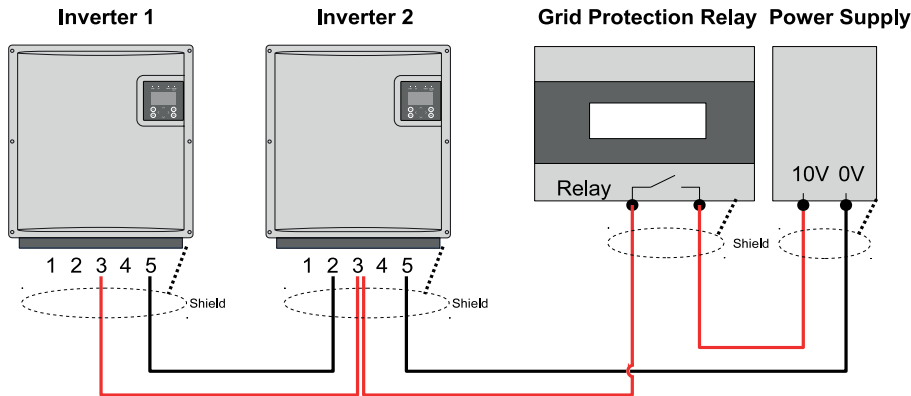


Fig. 24: Single external stop signal

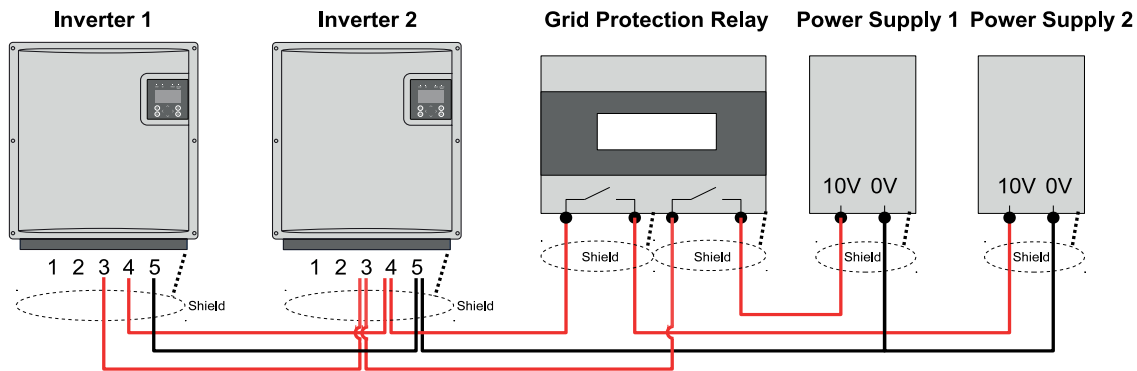


Fig. 25: Redundant external stop signal (does not apply to AFCI variant)

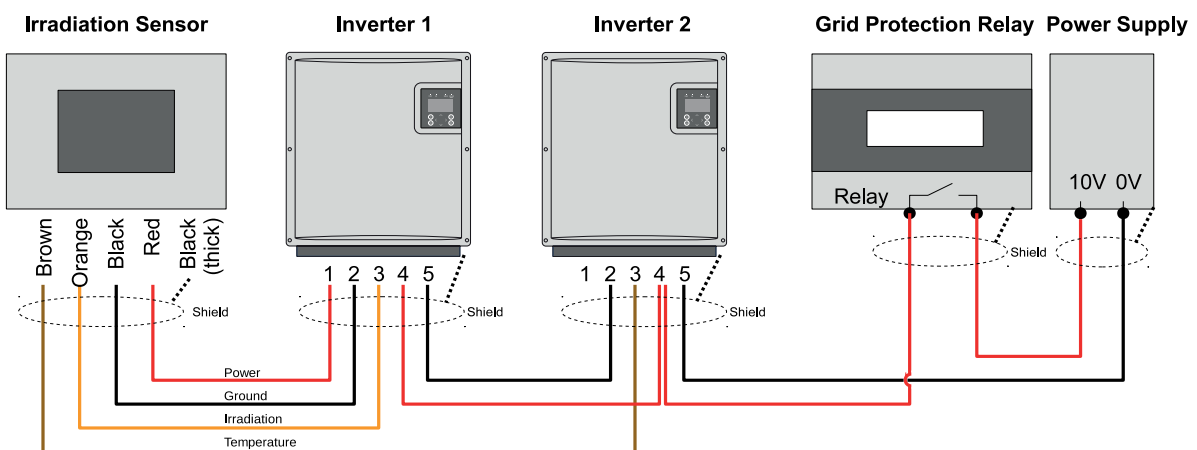


Fig. 26: Single external stop signal with sensor connected (does not apply to AFCI variant)

**Note:**

In order to ensure the function of the switch off signal, the sensor selection must be correctly set in the inverters.

The configuration of the inverter is possible with the REFUset tool. Other switch off times required by the utility, for example, or other voltage ranges can be configured here. It is also possible to deactivate the internal grid protection relay function of the inverter if an external grid protection relay is connected to switch off the inverter and if your grid supplier allows it.

## 8.2.4 Configuration

The sensor function can be configured at the inverter display at **Configuration > External Signal**.

It is also possible to perform the configuraton with REFUset. This PC tool allows to define different voltage ranges and switch-off times. The inverter integrated grid protection can be deactivated if authorized by the grid operator.

**⚠ DANGER**

**Risk of electric shock and fire caused by high discharge current.**

⇒ Before **connecting** the device to the supply circuit, establish a ground connection.

---

## 9 Maintenance

### 9.1 Maintain the Inverter

The cooling of the inverter is exclusively through natural convection, therefore the cooling system is maintenance free.

Periodically, based on site conditions, visual inspection of the cooling fins is recommended to identify any debris accumulation that could occur. If found, the debris must be removed to ensure that the convection cooling is not inhibited.

Cleaning with high-pressure cleaners is prohibited.

Annually, the DC switch has to be operated without electricity 5 times.

## 10 Decommissioning



### ⚠ CAUTION

#### Danger of injury

- ⇒ Do not use the cover to hold the device. Only use the four holding grips to move the device.

### NOTICE

#### Danger of damage to property

- ⇒ Do not use the cover to hold the device. Only use the four holding grips to move the device.
- ⇒ When decommissioning the inverter, take the 75.6 kg weight into account.
- ⇒ Do not open device. Opening the device voids the warranty.

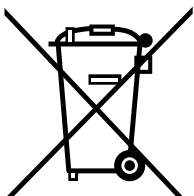
### 10.1 Remove Inverter

1. Deenergize the inverter completely.
2. Remove all cables from the inverter.
3. Loosen the 3 screws (M5x20) securing the inverter to the wall-mounting bracket.
4. Remove the inverter from the wall-mounting bracket.

### 10.2 Package Inverter

If possible, package the inverter in its original packaging or a similar packaging.

### 10.3 Disposal



Dispose of the packaging and replaced parts according to the rules applicable in the country where the inverter is installed.

Do not dispose of the inverter with normal domestic waste.

The inverter conforms to RoHS. That means that the device can be taken to municipal disposal sites for household appliances.

REFU Elektronik GmbH takes the inverter back completely. Please contact the Service team.

## 11 Technical data

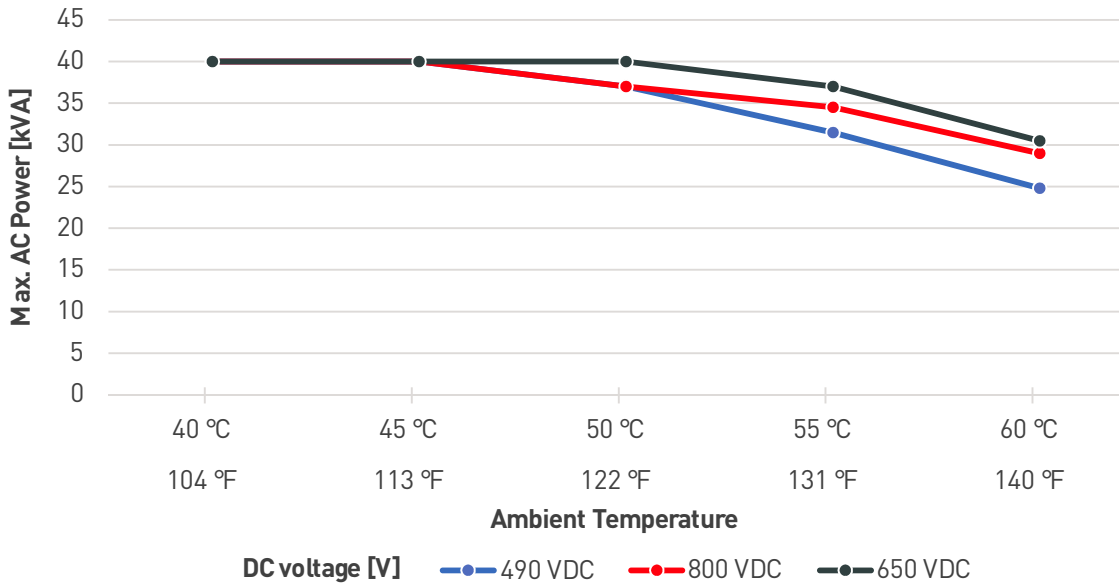
### 11.1 Inverter

TYP	REFU sol 40K	REFU sol 46K-MV
Art. No.	842P040.000 842P040.010	842P046.000 842P046.010
<b>DC DATA</b>		
Max. recommended PV power (kWp)	60	70
MPPT Range (V)	250 – 900	
MPPT Range at nominal power (V)	490 – 850	575 – 850
Max. voltage DC (V)	1000	
DC wake-up voltage (V)	200	
DC start voltage feed-in (V)	350	
Max. operational current DC (A)	84	82
Max. short circuit current $I_{sc}$ of PV system (A)	160	
Backfeed current (A)	0	
MPP trackers	1	
Number of DC inputs	1 x Plus, 1 x Minus	
DC input terminal	Phoenix Contact T-LOX knee lever connection TW50	
DC input cables	10 - 50 mm <sup>2</sup> (Aluminum / Copper)	
<b>AC DATA</b>		
AC Nominal power (kW)	40	46
Max. apparent power (kVA)	40	46
AC grid connection / Feed-in phases	L1, L2, L3, N, PE	
Nominal Power Factor / Range	1 / 0.8i – 0.8c	
Nominal voltage AC (V)	400	460
Voltage range AC (V)	320 – 480	368 – 529
Nominal Frequency / Frequency Range (Hz)	50, 60 / 45 – 65	
Max. AC current (A)	59	
Max. short-circuit current, AC- $I_{sc}$ (A)	17.53	
Max. THD (%)	< 3%	
Max. AC protection (A)	80	
AC circuit breaker	external	
Max. Efficiency (%)	98.2%	98.3%
European Efficiency (%)	97.8%	98.1%
MPPT Efficiency (%)	> 99.9%	

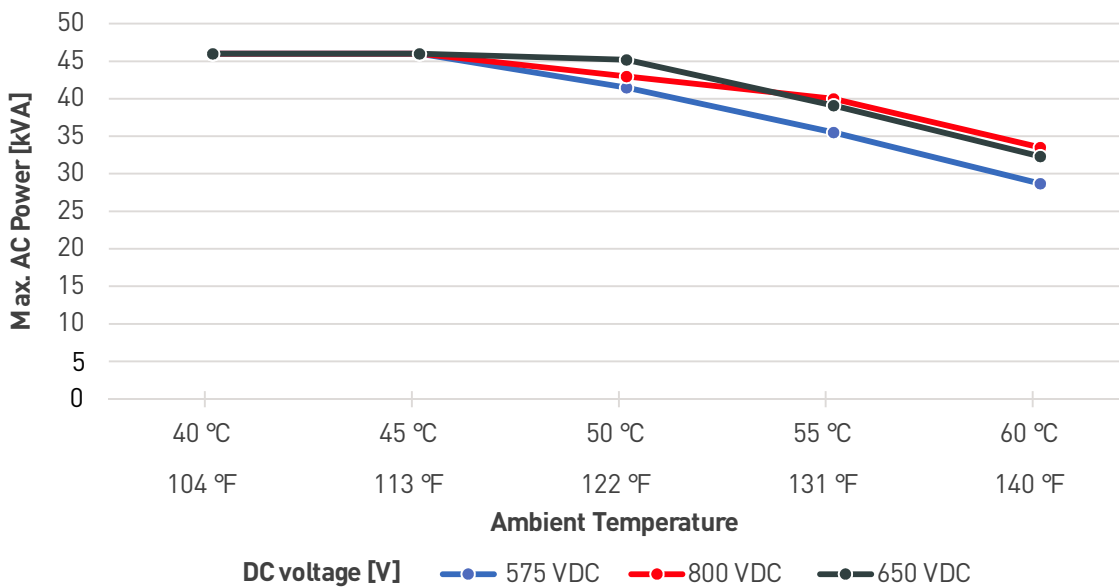
Feed-in from (W)	40
Self consumption night (W)	< 0.5
AC terminal	Phoenix Contact T-LOX knee lever connection TW50
AC cables	10 - 50 mm <sup>2</sup> (Aluminum / Copper)
<b>AMBIENT CONDITIONS</b>	
Cooling	natural convection
Ambient Temperature at nominal power (°C)	-25 – +45 °C
Ambient Temperature (°C)	-25 – +60 °C
Storage Temperature (°C)	-25 – +60 °C
Transport Temperature (°C)	-25 – +60 °C
Rel. Air humidity (%)	4 –100% (non-condensing)
Elevation (m above sea level)	4,000
Noise (dBA)	< 45
Environment classification (IEC 60721-3-4)	4K4H
Pollution degree (IEC 62109-6-3)	3
Type of protection (IEC 60529)	IP65
<b>SAFETY AND PROTECTION FUNCTIONS</b>	
DC circuit breaker	integrated
Isolation monitoring	yes
Overload behaviour	DC working point adjustment
String Fuses	external
Grid monitoring	Voltage, Frequency, Anti Islanding, DC injection
Residual Current Monitoring (RCD)	yes
Internal Overvoltage Protection (EN 61643-11)	Type 3, integrated
Protection Class (IEC 62103)	I
Overvoltage Category (EN 60664-1)	DC: II, AC: III
<b>GENERAL DATA</b>	
Interfaces	Ethernet, RS485, Sensor (Irradiation and Temperature Sensor / external stop signal)
Dimensions W x H x D (mm)	755 x 820 x 300
Packaging dimensions W x H x D (mm)	795 x 950 x 510
Weight (kg)	75.6

## 11.2 Temperature-Derating

### 11.2.1 Temperature-Derating REFUsol 40K



### 11.2.2 Temperature-Derating REFUsol 46K-MV



## 12 Certificates

### EU directives

Directive 2014/30/EU

Directive 2014/35/EU

### Safety

IEC 62109-1:2010 / IEC 62109-2:2011

DIN VDE V 0126-1-1:2013-08

IEC 62116:2014

IEC 61727:2004

IEC 61683:2000

IEC 60068-2-1:2007

IEC 60068-2-2:2007

IEC 60068-2-30:2005

IEC 60068-2-78:2001

EN 60529:1991 + A1:2000 + A2:2013

IEC 60364-7-712:2016

### EMC Immunity

EN 61000-6-1:2007

EN 61000-6-2:2005

### EMC Emissions

EN 61000-3-12:2011

EN 61000-3-11:2000

EN 61000-6-3:2011

EN 61000-6-4:2007 + A1:2011

### Grid Codes / Guidelines

AS/NZS 4777.2:2015, AS 4777.3-2005, AS/NZS 3100:2017

VDE AR-N 4105:2011

BDEW Mittelspannungsrichtlinie (medium voltage directive) TR3 Rev 23, TR4 Rev 7, TR8 Rev 6

CEI 0-16:2012, 0-16 V1:2013, 0-16 V3:2014

CEI 0-21:2012-06, V1:2012-12, V2:2013-12, 2014-09, V1:2014-12



## 13 Contact

Please address any questions on malfunctions or technical problems to:

Service-Hotline: +49 (0)7121 4332 - 333

(Monday - Thursday, 8 am to 5 pm, Friday 8 am to 4 pm)

### Online

Email: [service.energy@refu.com](mailto:service.energy@refu.com)

Website: [www.refu.com](http://www.refu.com)

### You should have the following data at hand:

- Exact description of the error with error code
- Device type
- Serial number
- Firmware version