



REFUso/ – Solar Inverter REFUso/ 012K to 024K-UL

Installation Instructions

Version 02.2

REFUso/

Title	REFUso [®] – Solar Inverter - Installation Instructions REFUso [®] is a registered trademark of REFUso/ Inc.
Purpose	This manual describes how to install devices of the REFUso [®] inverter line. It provides information <ul style="list-style-type: none"> • on initial operation of the REFUso[®] • on fault messages with references to causes and their remedies This manual is valid as of December 2012

Version history

Identification of version status	Status	Comments
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Liabilities	The data herein only gives a general description of the inverter and does not guarantee or assure any specific characteristics. We reserve the right to make changes to the product, this manual and the delivery options of the product at any time with or without notice.
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1 Important safety instructions for the REFUSol/ Solar Inverter

1.1 Save these instructions

This document contains important information concerning instructions for Model(s) 804R012 REFUSol/ 012K, 804R016 REFUSol/ 016K, 804R020 REFUSol/ 020K and 804R024 REFUSol/ 024K which shall be followed during installation, operation and maintenance.

This document must always be kept with the equipment it was delivered with.

In the text content that follows, the short form “the inverter” is used for “REFUSol/ Solar Inverter”.

1.2 Introduction

Observe the following important information prior to initial operation of the inverter to avoid physical injury and/or damage to property. These safety instructions must be followed at all times.

Carefully read all documents included with the inverter prior to initial operation.

This also applies to the safety instructions and all other user instructions before carrying out any type of work on the REFUSol-equipment. If no user instructions are available for a particular device, contact REFUSol/ Inc. to arrange the immediate dispatch of these documents to the person(s) responsible for safe operation of the device.

All electrical installations shall be carried out in compliance with all local and national electrical codes, NEC/CE Code specifications and applicable standards like ANSI/NFPA 70 for the United States and CANADA.

This manual does not cover specific details of other devices like PV (Photovoltaic) modules that are or may be connected to the REFUSol/ solar inverter.

Request information of such, and/or other connected devices directly from the respective manufacturers.

Enclose this manual and all safety instructions in the event of sale or transfer of the inverter.

1.3 Explanations of signal words and safety symbols

Safety information and safety messages are presented in this manual following the requirements of ANSI2 535.-6- 2011.



This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury and death.



Indicates a hazardous situation which, if not avoided, will result in death or serious injury



Indicates a hazardous situation which, if not avoided, could result in death or serious injury



Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury



Is used to address practices not related to personal injury



Electrical hazard. To avoid electric shock, do not open the inverter.

Dangerous residual voltage might still be present inside even after the inverter has been switched off. Installation should be performed by qualified licensed electricians only.



Avoid burns.

- The inverter can get hot during operation.
- Do not touch.



WARNING

Incorrect handling of these devices, non-observance of warnings and incorrect use of safety devices and the inverter can result in injury and/or in extreme cases death.



WARNING

Danger of electric shock. Do not open the inverter. Even after the inverter has been switched off, dangerous voltage can still be present inside it.

1.3.1 Stickers and labels on the devices

The following symbols are used as markings on the product with the following meanings:



Warning against dangerous voltage. The inverter works with high voltages. All installation work on the inverter must be carried out as described in this documentation.



The inverter can get hot during operation. Avoid all contact with hot parts of the inverter during operation.



Observe the operating and installation instructions. Read the manual before installation and operation. Observe all safety instructions and all installation and operating procedures.



Grounding, ground



UL 1741 is the standard according to which UL certifies the use of the REFUSol inverter with distributed energy resources. Additionally, the inverter has been tested for interconnection with electric power systems according to IEEE 1547. The REFUSol inverter is intended to be installed in accordance with the NEC, NFPA 70.

1.4 Hazards caused by incorrect use

⚠ DANGER

High electrical voltage.

- High electrical voltage and high working current. Risk of fatal or serious injury through electric shock.
- High electric voltage through incorrect connection. Risk of fatal or serious injury through electric shock.
- High leakage current! It is essential to provide a grounding connection prior to connecting to the power supply circuit.
- Use the inverter only as directed. It employs high voltage and high working current which can be fatal.
- Installation only by licensed electricians. Avoid potentially fatal wrong connections.

⚠ WARNING

High leakage current.

- It is essential to provide a grounding connection prior to connecting to the power supply circuit.

⚠ CAUTION

Hot surfaces possible on the inverter housing.

- Risk of injury.
- Risk of burning.
- Risk of injury through incorrect handling.
- Risk of injury through crushing, shearing, cutting or bumping.



Electromagnetic radiation.

- The electromagnetic radiation of the REFUSOL 12-24K-UL Inverters is equal to standard household equipment. There are no special precautions required for persons with pacemakers, metallic implants and hearing aids.

1.5 General Information

1.5.1 Intended use

The REFUSOL solar inverter is a ready-for-connection inverter unit for photovoltaic systems. All other applications are regarded as non-specified use and therefore prohibited. The manufacturer shall not be liable for any resulting injury or damage due to such prohibited use. All liability for any use and any resulting injury or damage due to such non-specified and prohibited use, shall lie with the person or persons who use the inverter in such prohibited manner.

1.5.2 Qualified personnel

The associated REFUSOL/system must only be set up and operated in conjunction with this documentation. Commissioning and operation of a device/system must only be carried out by qualified personnel. Qualified personnel is defined as licensed and authorized electricians who in addition have read and fully understood all of the technical information and the safety instructions contained in these installation instructions manual

1.5.3 Target group

These installation instructions are designed for qualified personnel. To be qualified, the respective personnel must have received instruction and appropriate training and must have proven capabilities and knowledge required to operate this inverter.

Qualified personnel include:

- Authorized operators
- Service personnel
- Only sufficiently trained and qualified personnel are permitted to work on this inverter. All personnel working on this inverter must be sufficiently familiar with the operation of the device and with all warnings and precautionary measures in accordance with the installation and operating instructions.

1.5.4 Safekeeping of REFUSOL documents and manuals

Keep all REFUSOL documents and manuals in a safe place for easy and quick access.

Observe all the steps that follow. Failure to do so will void the warranty.

- All electrical installation must be carried out in compliance with local and national NEC ANSI / NFPA 70 specifications.
- Prior to initial operation, all instructions in this manual shall be read through in their entirety.
- Trouble-free and safe operation of this inverter requires correct and professional transport, storage, assembly, installation and careful operation and maintenance.
- Only use Original Equipment Manufacturer (OEM) spare parts and accessories.
- Observe all safety regulations and specifications of the country and locality in which the inverter is used.
- Observe all ambient conditions specified in this manual.

- Warranty will be void if upper inverter lid is opened!
- Initial operation is prohibited until the complete system installation complies with national specifications and safety regulations.
- Operation is only permitted if the national EMC specifications relating to the application are observed.
- The REFUSol/ complies with Part 15 B EMI / EMC emissions of the FCC guidelines. The device can emit high frequencies and shall be installed according to the specifications. Otherwise it can cause interference with radio communications.
- The technical data, the connection and installation conditions described in this manual must be observed in all circumstances.

1.6 Hazards when touching electrical parts



This section only relates to devices and components of devices with voltages higher than 50 V.

When electrical devices are operated, dangerous voltages are present in certain components. Touching live parts with a voltage above 50 V can result in life-threatening electric shocks.



High electrical voltage. Risk of fatal or serious injury through electric shock.

- The installation of the inverter must only be carried out by qualified technical personnel. Furthermore, the installer must have certification from the responsible utility company.
- Installation, maintenance and/or repair of the inverter must only be carried out by personnel trained and qualified to work with electrical devices.
- The general setup and safety regulations for work on heavy-current equipment must be obeyed.
- Before you energize the equipment, make sure that all conductors are properly and firmly attached.
- The connecting cables of the PV generator should only be removed when the DC disconnect at the inverter is at "OFF". Before pulling the mains plug, the mains power cable must be disconnected and secured against reactivation.
- The installer must observe all of the above-mentioned items at all times.

1.7 Hazardous hot parts

CAUTION

Hot surfaces possible on device enclosure. Risk of injury. Risk of burning



- Avoid burns. Do not touch the device. The enclosure can get hot. At an ambient temperature of 113 F (45 °C), the enclosure surface and heat sink can reach 167 °F (75 °C).
- Before touching the device surface, allow it to cool down for 15 minutes

1.8 Setting the country code

NOTICE

Selected country codes can only be changed by Service.

- After setting and confirming the country code, you can no longer alter the country code yourself.
- This also applies to devices that are, or were, in operation. In accordance with the specifications, the country code can only be changed by factory trained service personnel.

NOTICE

Revocation of operating license.

- If the inverter is operated with the wrong country code, the utility company can revoke the operating license. We shall assume no liability in such cases.
- Observe the rules and requirements of the respective utility company.

1.9 Hazards during handling and assembly

WARNING

Avoid injury during handling and assembly.

- Observe the general setup and safety instructions on handling and assembly given in Chapter 3.5.
- Never stand below suspended loads.

⚠ CAUTION

Risk of injury through incorrect handling. Risk of injury through crushing, shearing, cutting, bumping and lifting.

- The inverter has a weight of 108 lbs.(49kg).
- Be careful to avoid jamming and crushing injuries.
- Only use the correct tools.
- If necessary, wear the appropriate protective equipment (e.g. eye protection, safety shoes, and protective gloves).
- Remove any fluids from the floor to prevent slipping.

1.10 Disposal



Dispose of packaging and replaced parts in accordance with the specifications of the country in which the device is installed.

Never dispose of the inverter with household waste.

REFUso/ Inc. recommends keeping the device packaging for possible return.

2 Description of the REFUSol solar inverters 012K-UL to 024K-UL

2.1 Device description

The REFUSol solar inverters 012K-UL to 024K-UL are DC / AC utility grid-connected, three-phase solar inverters without a transformers.

Heat is dissipated by means of convection. An internal temperature monitoring system protects the device against exceeding the permissible ambient temperature. The inverter is designed so it does not need to be opened for installation. To connect the DC and AC lines, only the lower lid has to be opened. The upper lid should never be opened or the warranty will be voided.

The inverter has an integrated DC disconnect as per IEC 60947-183 and UL 508B. This facilitates code compliant installations. For communication, the inverter offers the conventional RS485 and Ethernet interfaces.

An illuminated graphic display presents the feed-in power progression and other operating data in a clearly arranged manner. In addition, an 8-button control panel below the display makes operation and navigation extremely easy. The REFUSol inverter provides NEMA 3R / NEMA 4 protection and is permitted for outdoor installations.

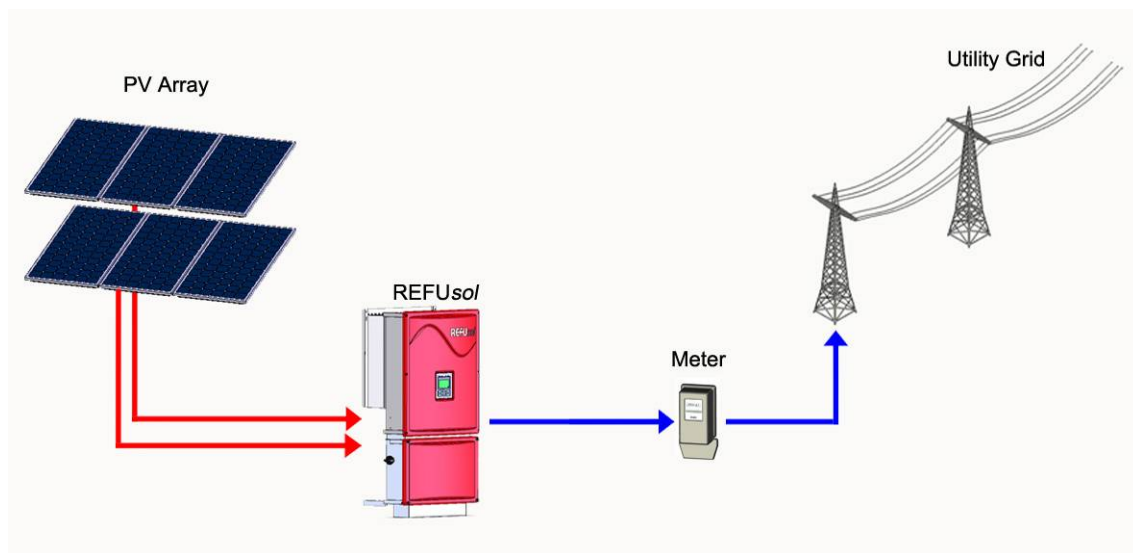


Fig. 1 REFUSol/inverter installed in a utility-interactive PV system

NOTICE

Installation requirements.

- Installation requirements vary from one utility company to another. Consult a representative of the local utility before setting up and installing a PV system.






2.2 Anti-islanding protection

"Islanding" occurs when the inverter continues to feed power to a de-energized AC main circuit. The

anti-islanding protection within the REFUSol inverters complies with IEEE 1547 standards.

2.3 Scope of supply, REFUSol/ 012K to 024K-UL

The inverter package includes the wall-mount bracket and the accompanying bag, item No. 0031653, with the following contents:

Plug part, 4-pin => RS485 2 pieces FMC 1.5/ 4-ST-3.5-RF Part number: 0027522	
Rated voltage U_N	150V
Rated current I_N	8 A
AWG/kcmil	24-16
Plug part, 5-pin => for irradiation sensor MCVR 1.5/ 5-ST-3.5 Part number: 0032103	
Rated voltage U_N	300V
Rated current I_N	8 A
AWG/kcmil	30-14
Phillips-head screw, 2 pieces, for securing the inverter to the wall-mount bracket	5x 20...V 
plain washer, 3 pieces, shape B	 M 8
Wall support, 2 pieces	
Hexagon-head screws for the wall support, 2 pieces	M5x16

2.4 Device outer dimensions REFUso/ 012K to 024K-UL

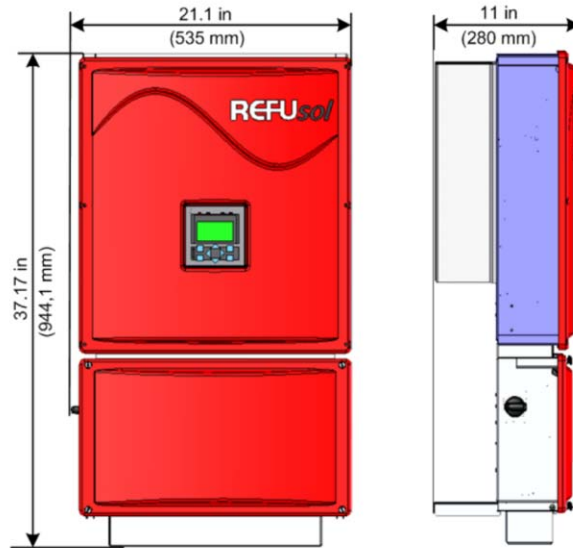


Fig. 2 Dimensions of the REFUso/ 012K-UL to 024K-UL

2.5 Reverse current through module effects

NOTICE

Reverse current.

- Reverse currents may cause damage to the equipment.

Reverse currents are fault currents that only occur in PV systems that consist of strings connected in parallel. Short circuits in individual modules or in cells of a module, or a double ground fault can cause the open-circuit voltage of the affected string to decrease to a degree that the intact strings connected in parallel force a reverse current through the defective string. This can lead to excessive heating and thus destruction of the string.

The reverse current can also cause secondary damage. To avoid such damage to PV systems, appropriate precautions should be taken. There are basically two different kinds of cases:

1. A PV system that is designed to ensure that reverse current flowing in the event of a fault, which, in the worst case, consists of the total of short-circuit current of all intact strings, does not lead to destruction of the damaged string, nor does it cause any secondary damage. Of particular importance here is the current carrying capacity of the system components (plug connectors, cables) and the reverse current resistance of the modules. These details should be provided on the data sheet from the panel manufacturer.
2. A properly designed PV system ensures that reverse current occurring in the event of a fault does not exceed the destruction limit. In this case, each string must be fused individually by series connected fuses. In the event of a fault, this causes the string to be separated from the intact string, thus avoiding destruction.

The inverter is equipped at both DC Terminal Boards with string fuses (24x type KLKD 15A, Field adjustable up to 20A) to ensure that no dangerous reverse currents can occur in the event of a short-circuit. For the design of the string fuses, refer to chapter 3.8 Criteria for correct selection of the string fuses (3.8)

2.6 Control panel

The graphic display integrated on the front side with 128x64 pixels permits real-time presentation of important data, e.g. feed-in power or yield data. Input is via the 8-button control panel. The control panel lights up the first time a button is pushed and switches itself off automatically.

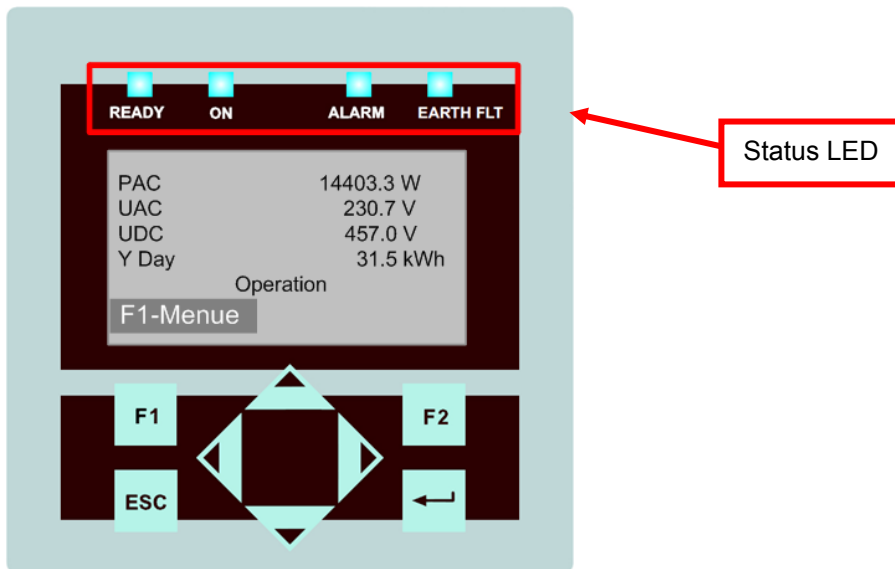


Fig. 3 Control panel

F1Menu display.

◀▶: Function in menu: Navigation within the menu level (previous menu, next menu)

Function with parameter change: Position left, position right (decade jump).

▲▼: Selection of menu level (level up, level down)

ESC Fault acknowledgment, menu level back, exit input menu without saving

↵: Confirmation of menu selection and input.

2.7 Internal data logger

The inverter contains an internal data logger, which makes parallel recording of measured values in the form of parameters possible. The data logger is designed as a circular buffer. When the memory is full, the oldest data is overwritten. In the standard delivered equipment, 16 measurement channels are logged.

Logging cycle	Storage time
1 minute	6 month
5 minutes	2.5 years
10 minutes	5 years (maximal value)

3 Installation

3.1 Unpacking the inverter

CAUTION

Avoid injury during installation.

- Wear your personal protective equipment (eye protectors, safety shoes and protective gloves).
- The inverter is heavy (108 lbs) therefore be careful during installation.
- Use suitable transport and lifting devices.
- Failure to observe this can result in injury through crushing, shearing, cutting or bumping.

The inverter is top-heavy and, to facilitate transport, has been placed upside down into the transport box. When you open the box at the top (correctly placed with top arrows pointing upwards), you see the bottom of the device (device connection box). Several handles are mounted at both sides of the inverter. Use handles 1 and 2 to remove the inverter from the box. When the inverter is pulled out and unpacked, the cardboard flap remains attached to the inverter housing and can be used as a base on the floor. This prevents damage to the lid.

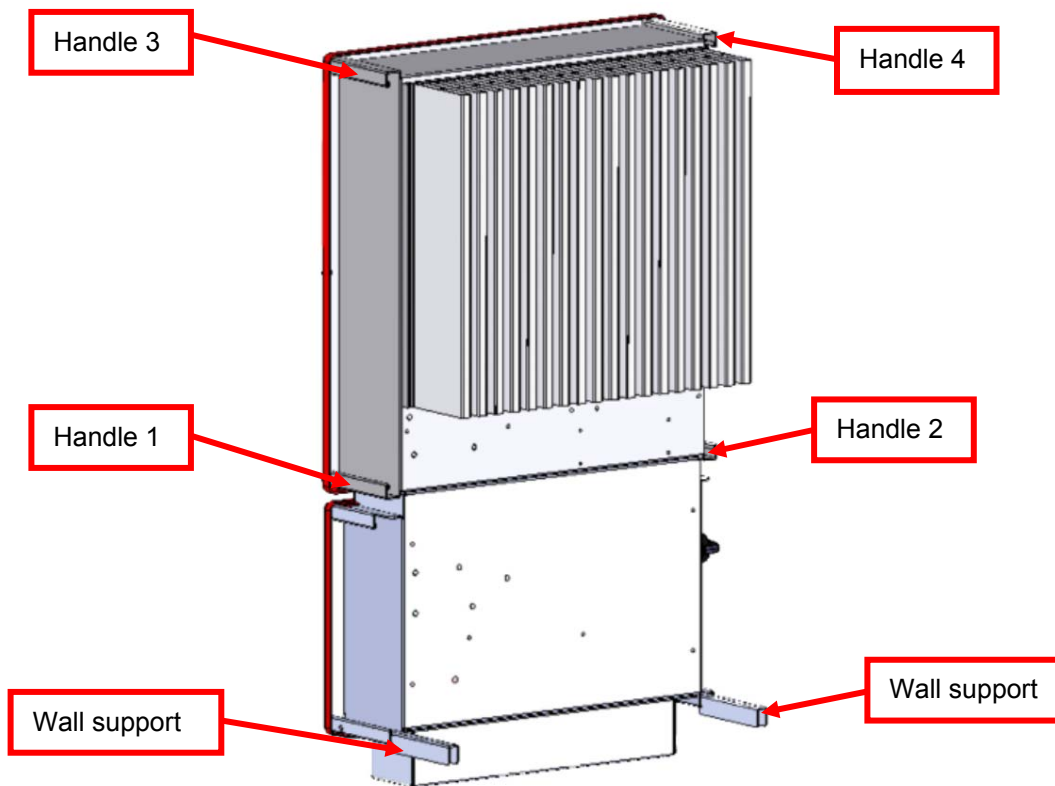


Fig. 4 REFUSol/012K to 024K-UL, location of handles

3.2 Assembly location requirements

3.2.1 Requirements for the installation site

CAUTION

Maintain free and safe access to all devices during installation and service to avoid accidents.

NOTICE

Do not impair the convection cooling.

- Never install the devices above one another
- Never cover the cooling fins of the heat sink as this might cause overheating of the inverter and will void the warranty

The inverter has convection cooling and is designed for vertical wall installation using the supplied self-centering mounting plate.

- Choose a location out of direct sunlight, in the shade for installation.
- Only install vertically on a stable wall or metal construction because the inverter weighs 108 lbs. (49 kg).
- Check for sufficient load-bearing capacity of the wall and the fasteners.
- Observe all applicable building codes
- Maintain a minimum clearance of 30m (approximately 100 ft.) from any combustible materials.
- For easy use and operation, install the inverter in a way that the display is located approximately 160 cm (approximately 63 in.) above the ground.
- Outdoor installation is permitted (degree of protection NEMA 3R/ NEMA 4)
- To assure the necessary heat dissipation, the following minimum clearances from the ceiling, wall or neighboring devices must be observed.

Minimum clearance	lateral	6 inches (150 mm)	top	20 inches (500 mm)	bottom	20 inches (500 mm)
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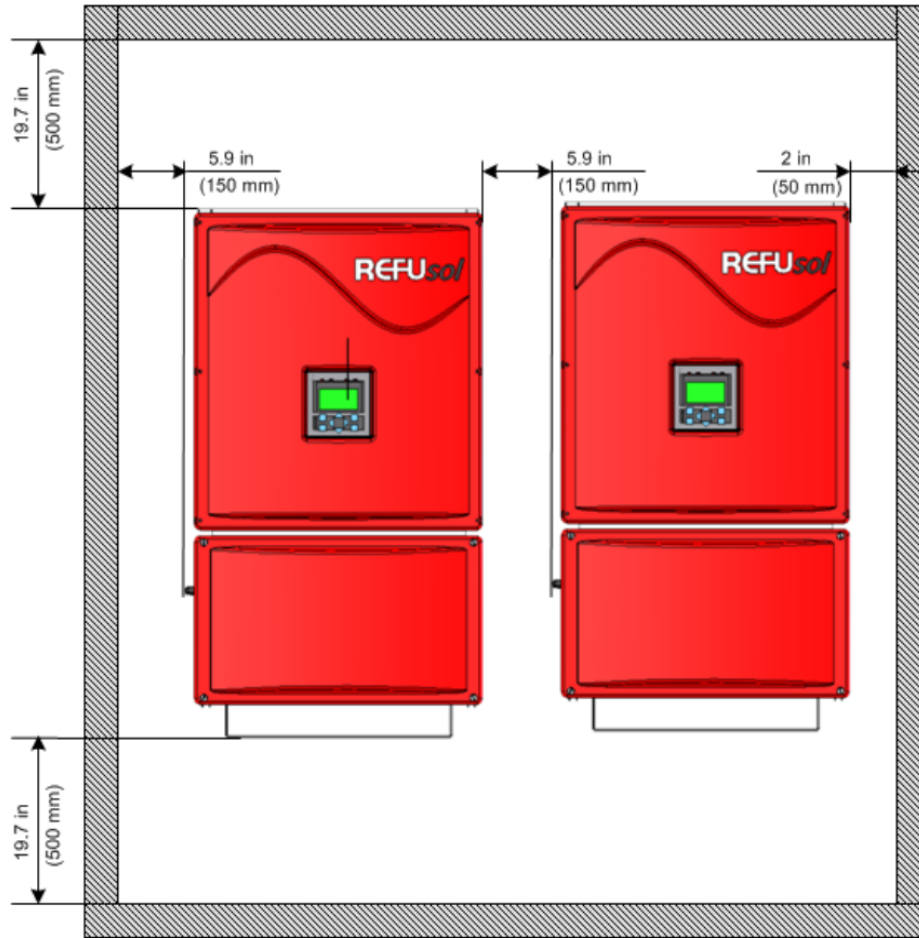


Fig. 5 Minimum clearances

CAUTION REFUSOL devices must never be installed above one another because this would impair the convection cooling.

3.3 Transport

Keep the device(s) dry and clean when transported and, wherever possible, in the original packaging. Only transport in ambient temperatures between -13 F (-25 °C) and +158 F (+70 °C). Temperature fluctuations of more than 35 F (20 °C) per hour are not permitted.

3.4 Storage

NOTICE

Storage

- The inverter contains electrolytic capacitors.
- The capacitors can be stored at a temperature of 104 F (40 °C) for a maximum of 2 years without voltage.
- If a storage period of 2 years is exceeded, contact Service at REFUSol/ Inc. before system connection of the inverter.

Store the devices in clean and dry rooms, ideally in their original packaging. The storage temperature must be between – 13 F (–25 °C) and +158 F (+70 °C). Temperature fluctuations of more than 35 F (20 °C) per hour are not permitted.

3.5 Assembly of REFUSol/ 012K to 024K-UL

⚠ DANGER

Installation errors can cause fires, explosion or electrocution!

- Never install the inverter on or near combustible building materials.
- Never install the inverter in areas where highly flammable materials are stored.
- Never install the inverter in areas where explosion risks exist.
- Make sure that you do not drill into any power cables during installation.
- Two persons are required to safely install this 108 lbs inverter.
- To avoid accidental burning by the hot inverter during operation, choose a location where unintentional contact can be avoided.

⚠ CAUTION

Do not subject the edge of the lid to loads during assembly.

- Never hold the inverter by the lid.
- Move the inverter only with the four handles.
- Non observance of these requirements can result in inverter malfunctions or even serious injury caused by crushing, shearing, cutting, bumping or fire

3.5.1 Mounting position and mounting material

The inverter may be mounted to a concrete wall or a metal framework. The mounting position must be chosen with regard to support stability, access to display, minimum clearances (see Fig. 5) and general heat dissipation.

- The required support stability is determined with regard to:
 - Weight of one inverter = 49 kg. (108 lbs)

- Number of inverters
- Safety margin to mounting weight according to local requirements for wall mounted equipment
- A convenient access to the display is given, if the mounting plate is attached to the support with a distance between floor and mounting plate upper end of approximately 200cm (approximately 79in.). An elevated mounting position is permitted if easy access to the display via a ladder, an aerial platform or equivalent is provided.
- For minimum clearances refer to chapter 3.2.1 Requirements for the installation, Fig. 5 Minimum Clearances
- For general heat dissipation, the mounting position should be chosen in a shaded and freely ventilated area.
- The mounting material for inverter mounting (wall plug and screw for concrete or block walls, bolt and nut for metal framework) must be chosen with respect to:
 - Weight of one inverter = 49 kg. (108 lbs)
 - Number of single mounting points per inverter (wall plug with screw for walls, bolt and nut for metal framework)
 - Safety margin to mounting weight per single mounting point according to local requirements for wall mounted equipment

Example: Inverter weight = 49 kg. (108 lbs), number of single mounting points per inverter = 4, safety margin = 100%

Example calculation: $49 \text{ kg. (108 lbs)} / 4 = \text{approximately } 12,5 \text{ kg (28 lbs)} + 100\% = \text{approximately } 25 \text{ kg (56 lbs)}$

3.5.2 Installation of mounting plate

- When the mounting position is determined, draw a horizontal and level line approximately 40cm (approximately 16 in.) above the intended display position.
- At the determined mounting position hold the mounting plate with its upper end (the end with mounting hooks) to the line.
- Mark the holes with a pencil.
- Remove the mounting plate
- Drill pilot holes with an adequate sized drill.
- According to Fig. 6 attach the mounting plate with adequate mounting material (see chapter 3.5.1). As required use adequate washers.
- Prepare the inverter for installation and install the wall support (spacers) according to Fig. 8.
- Attach the inverter with the heat sink to the mounting plate in a way, that the mounting hooks of the mounting plate insert in to the holes at the upper end of the heat sink and that the lower end of the heat sink rests on the support angel on the mounting plate lower end (see Fig. 7).
- Fasten the heat sink to that position with the use of the enclosed 2 metric screws (M5x20) and the 2 enclosed washers (M 8).

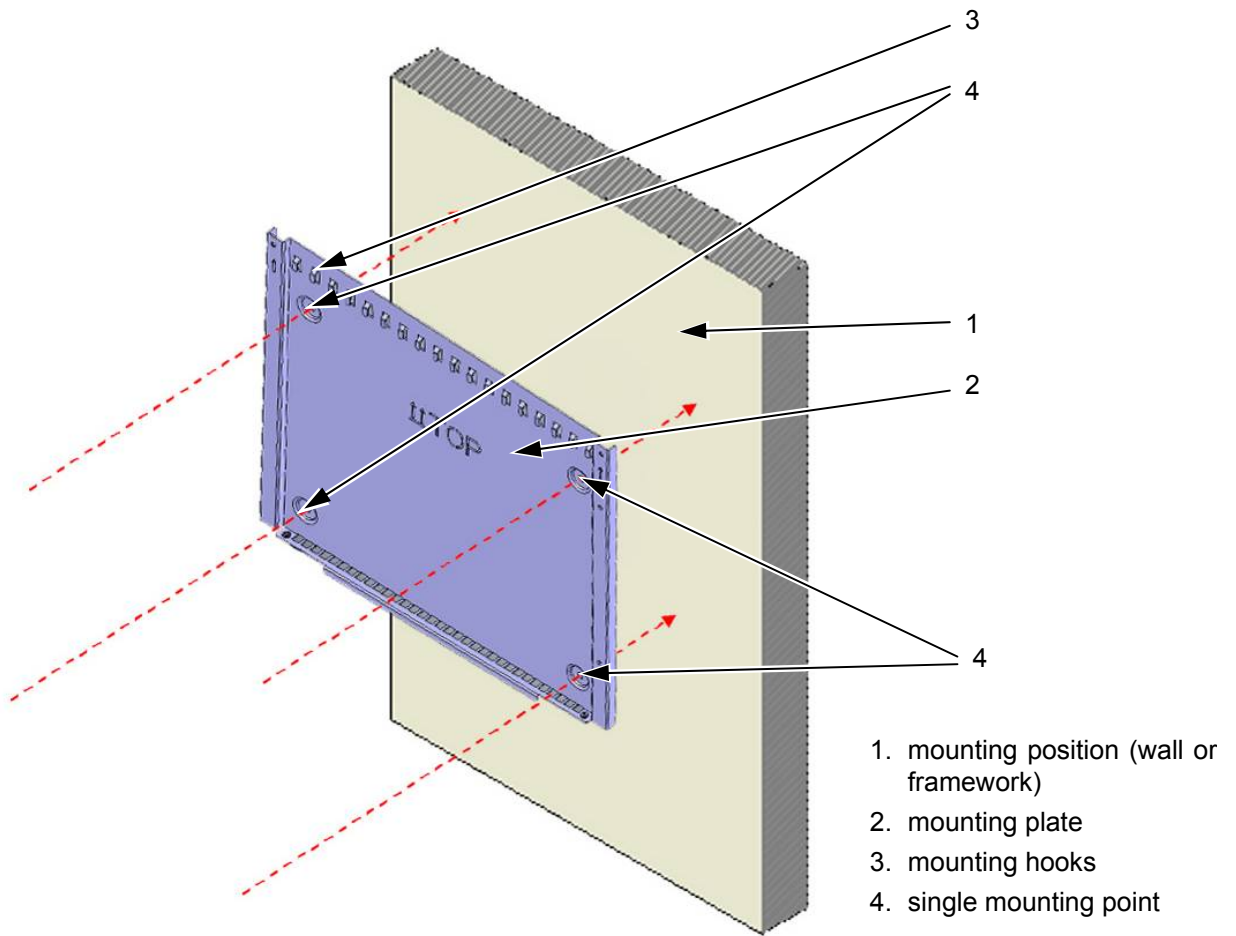


Fig. 6 Installation of mounting plate

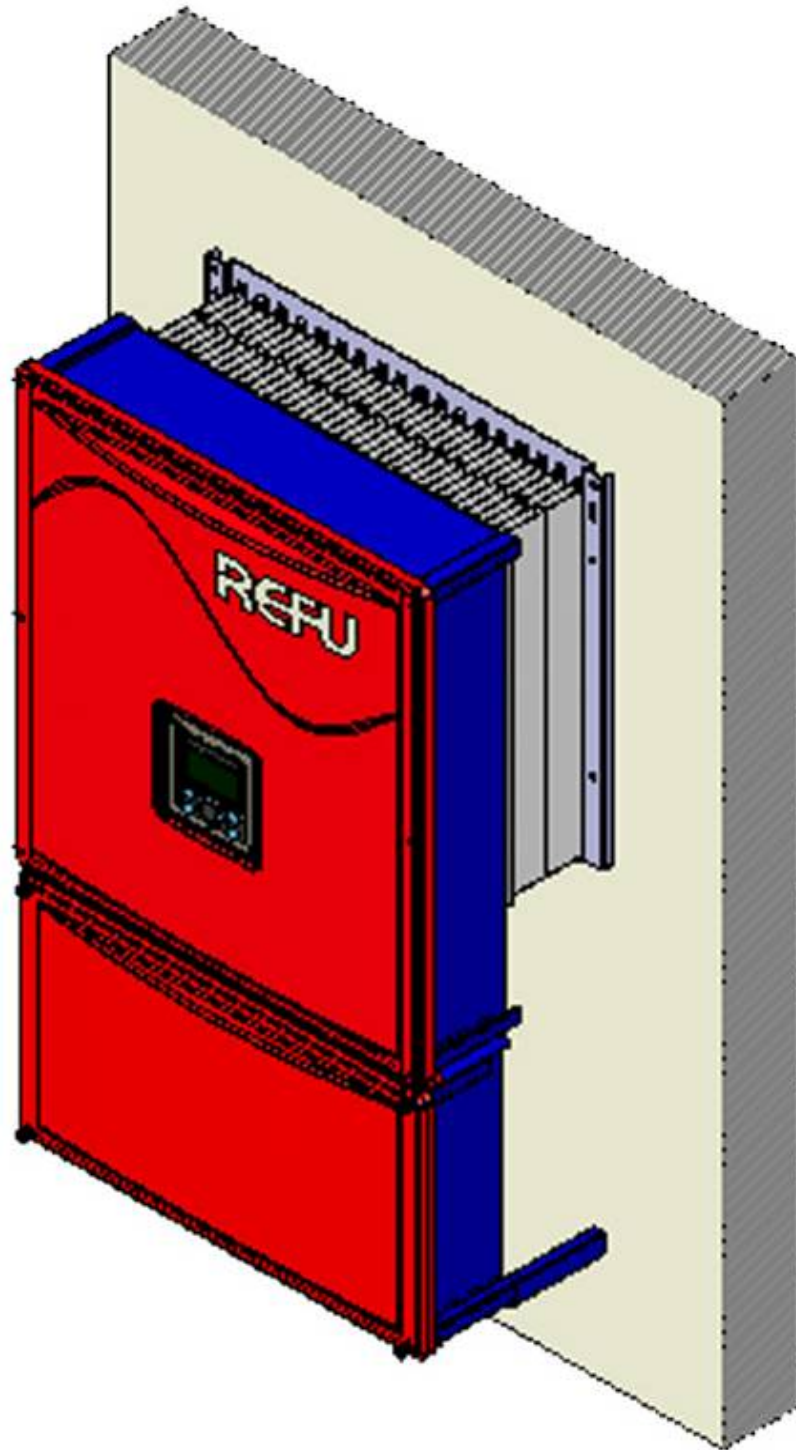


Fig. 7 Installation of inverter

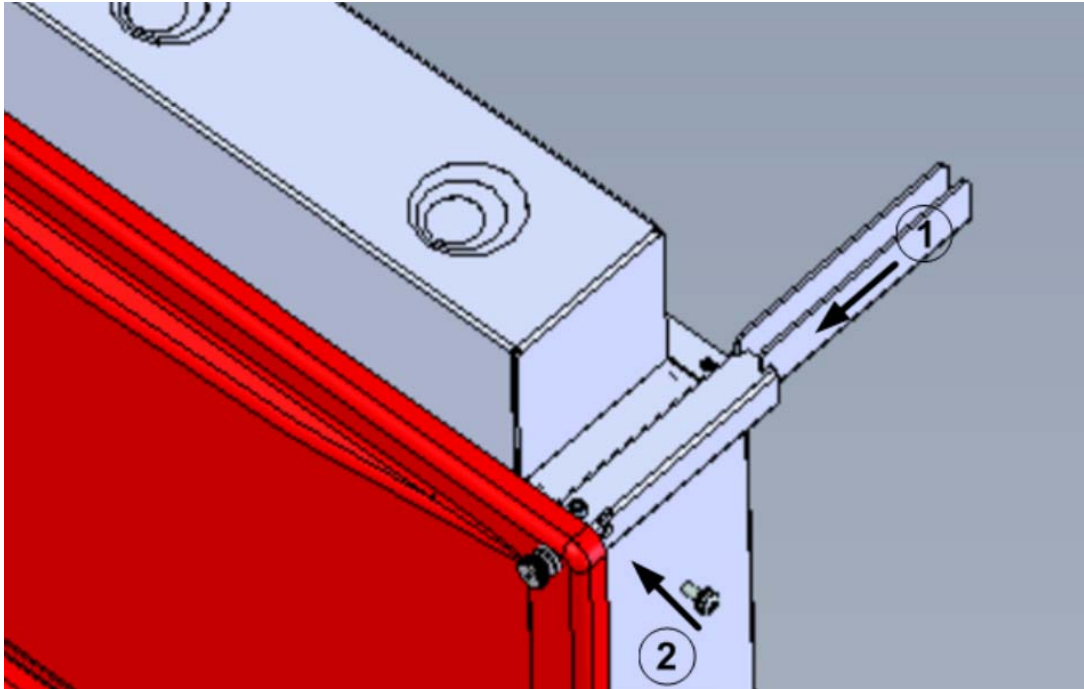


Fig. 8 Installation of wall support

3.6 Block diagram REFUso/ 012K to 024K-UL

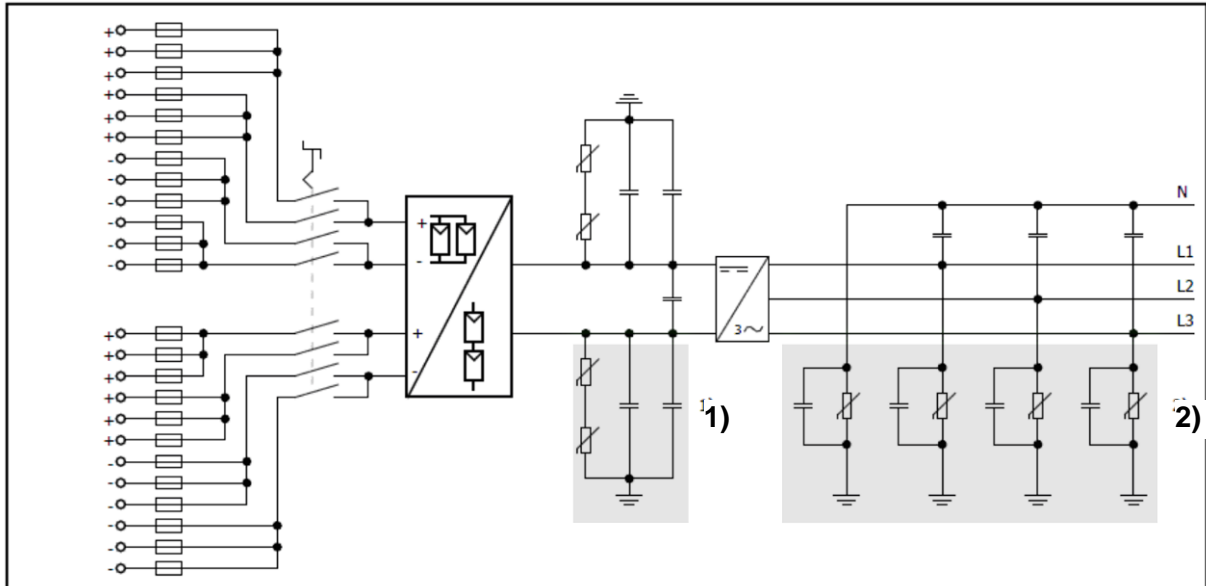


Fig. 9 Block diagram REFUso/ 012K to 024K-UL

- 1) Overvoltage protection DC SPD type 3
- 2) Overvoltage protection AC SPD type 3

3.7 Electrical connections, overview

NOTICE

Any intusion of water during assembly and installation of the REFUso/ inverter can result in damage.

- Do not open the connection box of the REFUso/ if it is raining or if humidity levels are high (> 95%).
- Touching the components can result in electrostatic discharge and can lead to damage to components.
- All electrical installations must be carried out in accordance with local and national NEC/CE specifications and standards ANSI/NFPA 70 for USA and CANADA.

For insertion of the DC and AC conductors, knockouts corresponding to the cable outside diameter and the screwed cable gland should be punched out from in the inverter lower cable entry plate, see Fig. 10.

To open the connection box:

- Loosen the 4 affixed spring loaded screws of the connection box cover.
- Carefully open the lid of the connection box smoothly.
- Punch knockouts in the lower cable entry plate corresponding to the cable outside diameter and the screwed cable gland for insertion of the string cables of the PV generators and the AC connection in the inverter. For details, see Fig. 10.

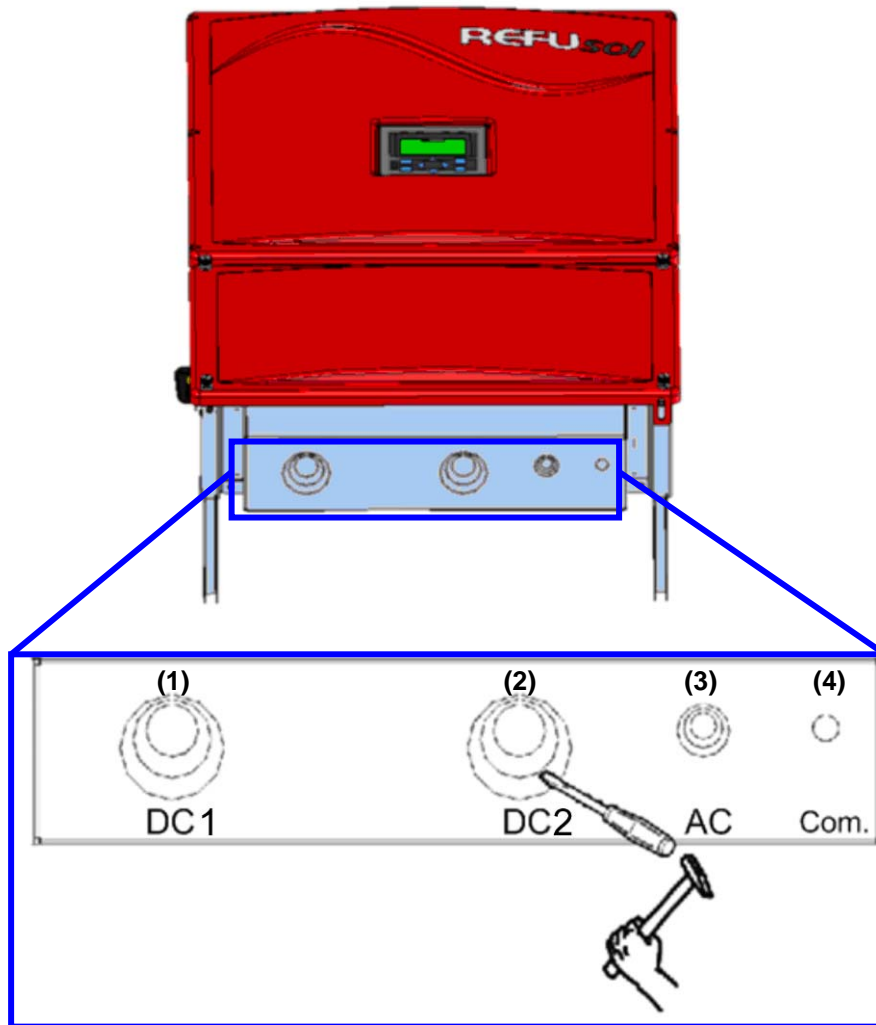


Fig. 10 Possible knockouts for cable feed through on the bottom of the connecting box

1- Knockouts for 2"; 1 ½ " and 1" conduit DC connection.

2- Knockouts for 2"; 1 ½ " and 1" conduit DC connection.

3- Knockouts for 1"; ¾ " and ½ " conduit AC connection.

4- Knockout for ½ " conduit for data communication.

REFUSol recommends to use the supplied knockouts and not drill additional holes.



- **Two separate raceways are required and must be used to bring the DC conductors to the DC Terminal Boards, one for DC1 and one for DC2.**
- For further information please refer to the NEC Code.

To assure the NEMA 3R protection, use the conduits connector or cable glands with rubber seal. REFUSol/ Inc. recommends conduit connectors or cable glands with rubber seal so that NEMA 3R protection is provided; see Fig. 11.



Fig. 11 Sample of EMT conduit connector with rubber gasket (rubber gasket not shown)

The following illustration shows the connections of the inverter in the connection box.

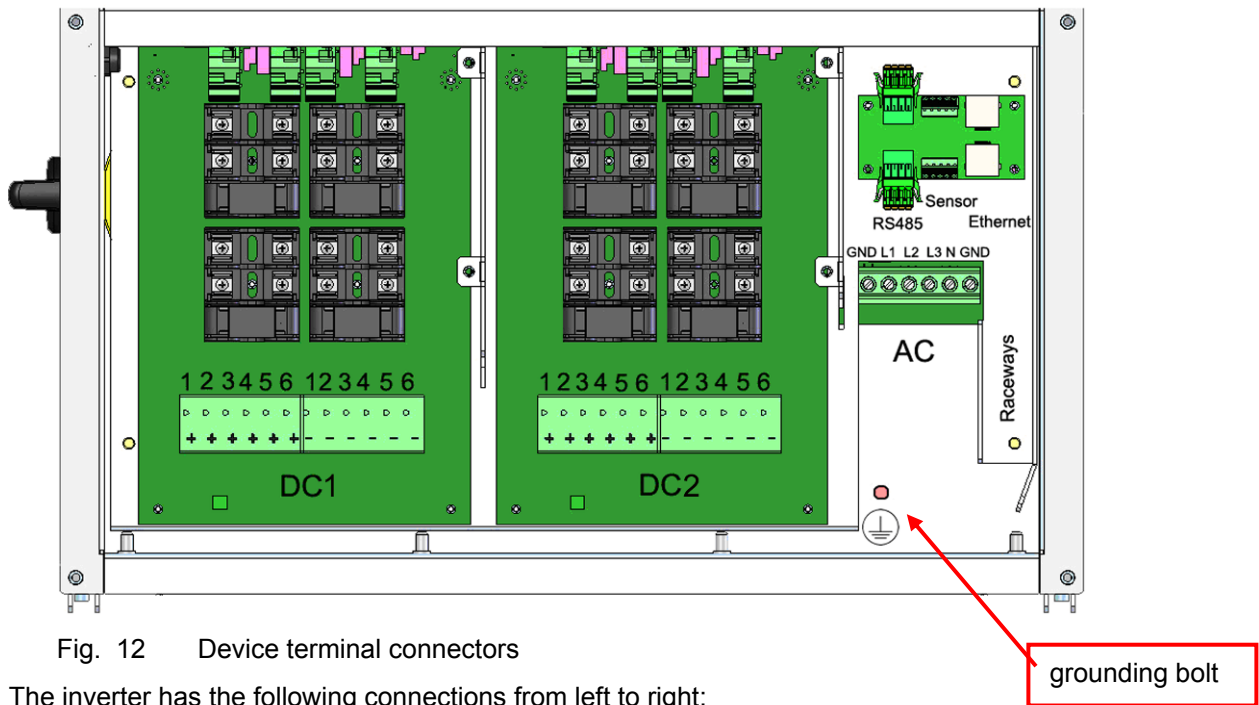


Fig. 12 Device terminal connectors

The inverter has the following connections from left to right:

- 2 x DC Terminal Boards (DC1 and DC2)
- AC mains connection

- RS485 connections (IN and OUT)
- Analog input (SENSOR)
- Ethernet interface connection (RJ45)

3.8 DC connection on solar inverter



High voltage on DC cables.

- High electrical voltage and high working current. Risk of fatal or serious injury through electric shock.

3.8.1 Dimensioning of the DC cables



Electrical installations.

- All electrical installations must be carried out in accordance with local and national NEC/CE Code specifications and standards ANSI/NFPA 70 for USA and CANADA.

Observe the following requirements when selecting the type and cross-section of the DC cable:

- The spring terminal (SPT 16/6-H-10-ZB) included as standard in the delivery permits the connection of a 12...8 AWG (4 mm² -10 mm²) cable, conductor type copper (Cu), 194 F (90 °C).
- Use only stranded or fine stranded wire. Use PV-Wire if exposed!

The following operating data must never be exceeded by the PV generator in any circumstances:

Device type	012K-UL	016K -UL	020K-UL	024K-UL
Max. DC voltage per each terminal board	500 V			
Max. DC current per each terminal board	27.5 A	33 A	37.5 A	40 A

The different devices types 012K-UL, 016K -UL, 020K-UL and 024K-UL are equal in the size and shape of the casing and the AC- generation. The only differ in the number and size of the internal power units.

Two x 6 DC fused terminal boards (DC1 and DC2) are available for connecting the PV generator. Make sure to balance the voltage and current from the PV strings between the two fused terminal boards. This is absolutely necessary to stay within the 30 A / pole maximum current carrying capacity of the DC disconnect.

The following illustration shows the terminal boards for the electrical connections

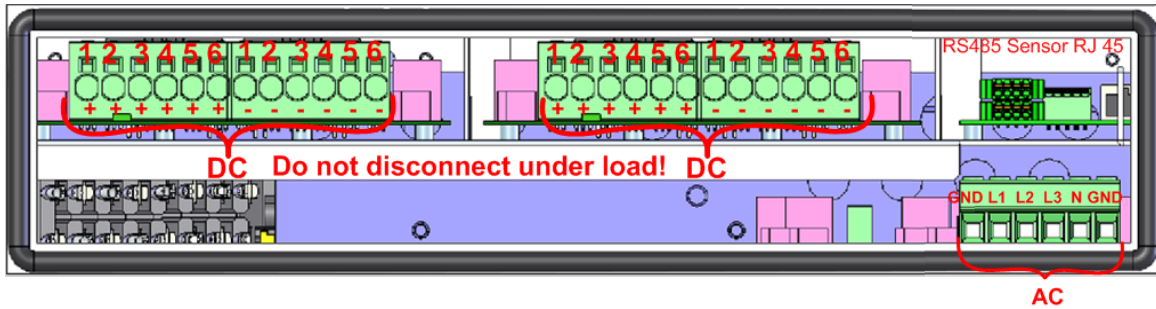


Fig. 13 Terminal Boards for electrical connections of REFUsol/012K - UL to 024K-UL

NOTICE

DC input and AC output circuits, system grounding.

- The DC input and AC output circuits are isolated from the enclosure.
- System grounding, if required by Section 250 of the National Electrical Code, ANSI/NFPA 70, is the responsibility of the installer.
- The Photovoltaic System Grounding shall be installed per the requirements of Section 690.41 through 690.47 of the National Electrical Code, ANSI/NFPA 70 and is the responsibility of the installer.

For wiring installations the National Electrical Code, ANSI/NFPA 70 wiring methods are to be used.

3.8.2 Connection examples:

WARNING

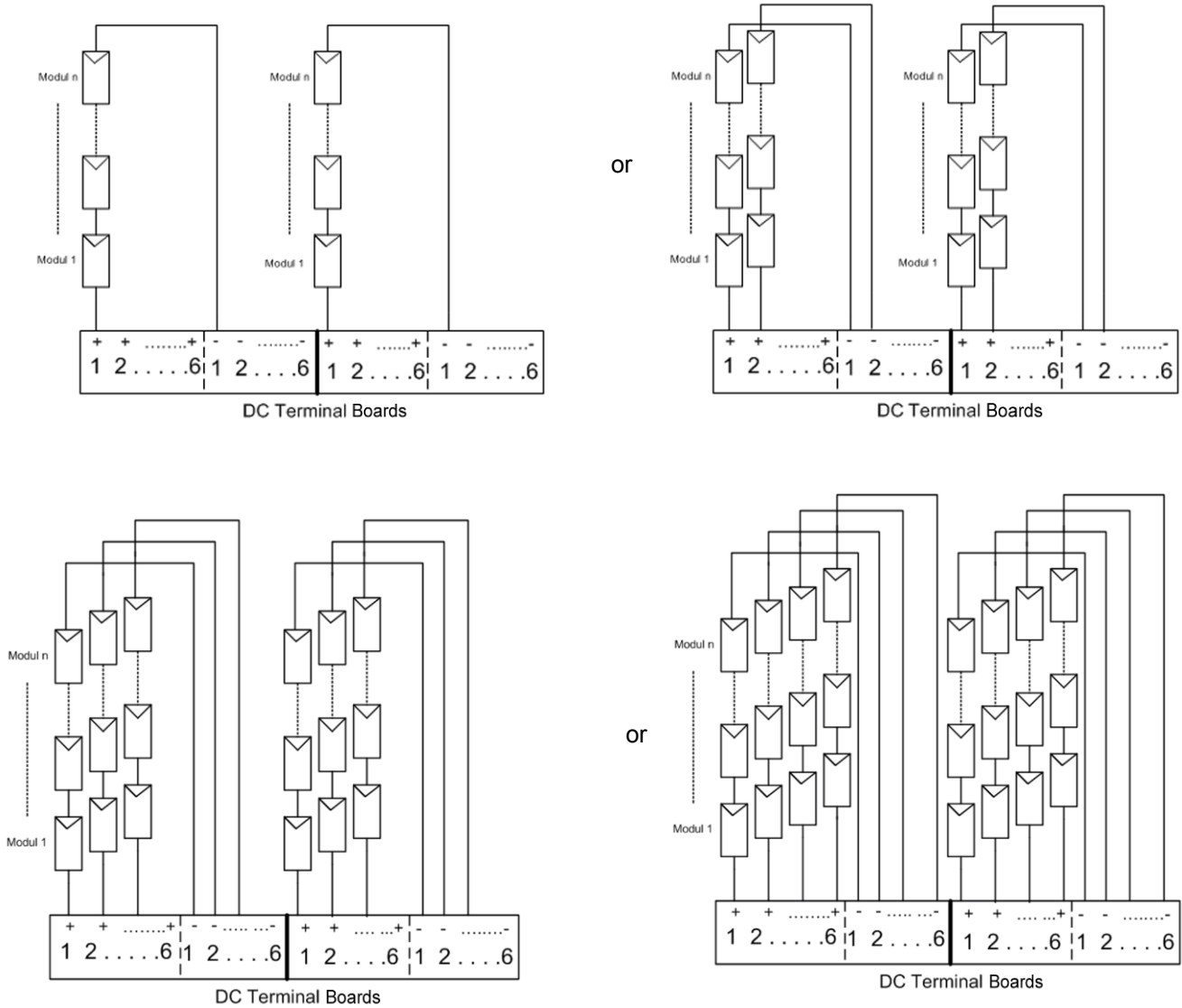
Installation of transformer less solar inverters.

- The installation of transformer less solar inverters requires an ungrounded PV-Array and needs to be installed with accordance to NEC 690.35.

NOTICE

PV generator output.

- Ensure that the output of the PV generator is distributed evenly on both terminal blocks (DC inputs).



3.8.3 Criteria for correct selection of the string fuses

NOTICE

Size of string fuses.

- The size of the string fuses must not exceed the series fuse rating of the PV module, i.e. 15A, which is specified on the data sheet of the PV module.
- If there are no specifications on the series fuse rating in the data sheet, contact the PV module manufacturer.

General:

The use of string fuses in the inverter also serves to protect the solar modules. A decisive factor for fuse protection of solar modules is the maximum short-circuit current of the respective solar module.

The following criteria for the use of string fuses must be met for every connected string:

- $I_N > 1.56 \times I_{sc}$
- $I_N < 2.00 \times I_{sc}$
- $V_N \geq 600 \text{ V}_{DC}$

I_N : Rated current of the string fuse

I_{sc} : Short-circuit current of the string under standard test conditions (STC)

V_N : Rated voltage of the string fuse

Effects of the use of string fuses with a trip-value smaller than the rated load:

In the case of string fuses with a smaller trip-value, the rated fuse current is lower than the short-circuit current of the solar modules.

Result:

In the case of increased irradiation, such as "edge of cloud effect" the irradiation could cause the panel(s) to produce more current than normal and blow the fuse.

3.9 DC connection, PV generator

**High voltage on DC cables.**

- High electrical voltage and high working current. Risk of fatal or serious injury through electric shock.
- High voltage can kill.
- DC cables carry high voltage and high current.
- Only licensed electricians are allowed to work on electrical connections.
- Connect the inverter to ground and to the mains before connecting the PV strings.
- Connect only when strings are de-energized or in the dark when the strings are not active. They might otherwise carry life threatening voltage.
- Check and make sure the open-circuit voltage does not exceed 500 V.
- Connect the separate equipment grounding conductor from the grounding bolt to an earth ground.

- Check for proper polarity is correct when connecting the PV strings. Incorrect connection of individual strings can result in damage to module strings.
- The inverter is protected by an integrated inverse-polarity protection diode. Protect the connections against accidental removal.
- Check and make sure that proper conduits and cable glands suitable for the cable diameter are used otherwise there might not be NEMA 3R housing protection.
- Make sure that when you replace string fuses that the strings are fully de-energized and the DC disconnect is in the OFF position.

3.9.1 PV and DC grounding

The PV frames require an equipment grounding conductor and should be connected to the main system grounding electrode conductor, grounding electrode, or supplemental grounding system per NEC requirements.

Determine the appropriate grounding method with the responsible authority having jurisdiction.

3.9.2 Grounding the PV modules

The inverter is a transformerless inverter. For this reason, it has no galvanic isolation. Neither the (+) pole nor the (-) pole of the modules connected to the inverter can be grounded. Only the array or PV module frame must be grounded.

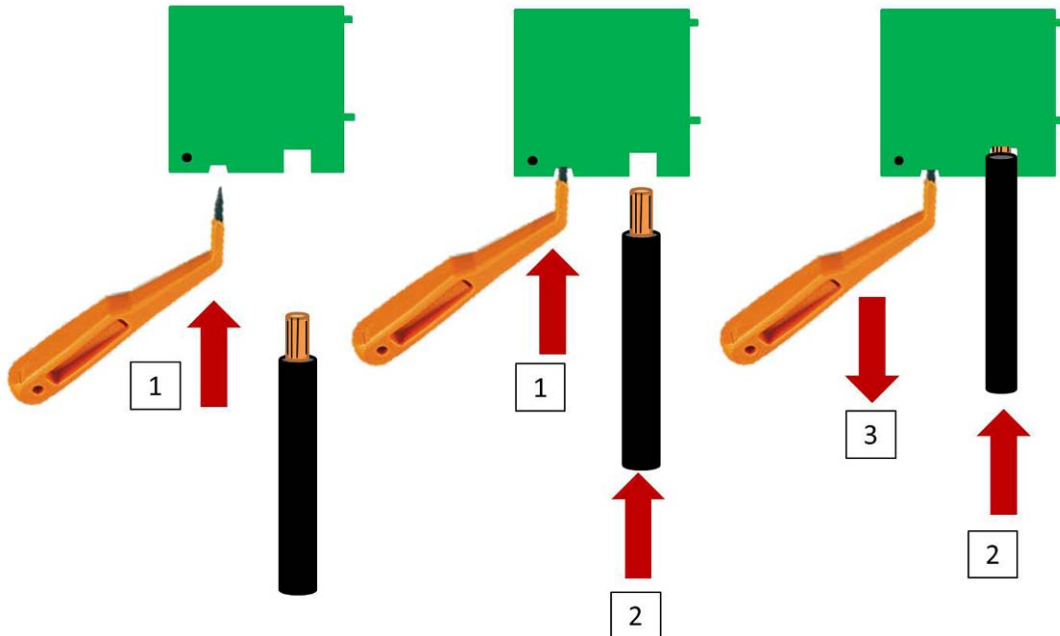
3.10 DC connecting cable



High voltage on DC cables.

- High electrical voltage and high working current! Risk of fatal or serious injury through electric shock.
 - High voltage can kill.
 - DC cables carry high voltage and high current.
 - Only licensed electricians to work on the connections.
-
- Guide all DC connections directly from below to the inverter and attach them without connectors to the terminals.
 - Protect all cable entries physically with conduits or cable glands.
 - Use only UL Listed rainproof, or wet location hubs complying with UL 514B for entry into conduit hubs.

Connect the DC lines as follows:



1. Place insulated installation tool (Top Job Tool) in the slot provided on the spring terminal and press the tool to open the spring terminal.
2. Guide the stripped wire into the provided slot on the spring terminal.
3. Remove the tool when the spring terminal is closed and the cable is secured.

(Top Job Tool - REFUSol/ Inc. part # 0039999)

Tip: REFUSol/ Inc. recommends to perform a pull test to ensure proper termination of wire!

NOTICE

Wire gauge.

- To select the required wire gauge, refer to the Article 310 of the NEC.

3.11 PV insulating fault detection and open circuit

The inverter automatically checks the insulation of the PV generator every time it is switched on. If the insulation is damaged, the inverter shut down automatically. In this case, it is essential to eliminate the insulating fault of the PV generator before connecting the PV generator to the inverter again.

3.12 Connection to mains

⚠ DANGER

High voltage on AC cables.

- High voltage can kill.
 - Cables carry high voltage and high current.
 - Only licensed electricians to work on the connections.
 - Connect the ground circuit at the marked terminals before connecting to the mains.
 - Disconnect the mains, de-energize, have de-energization confirmed and secure circuit breaker against reactivation before connecting the inverter to an AC power line.
- All connections must be carried out in accordance with local and national specifications of NEC, ANSI / NFPA 70.
 - The NEC requires the device to be connected in its own electric circuit.
 - No other devices are permitted to be connected to the same circuit (NEC section 690-64 (b) (1)).
 - The NEC also specifies a restriction with regard to the size of solar inverters and the manner in which the solar inverter is connected to the power mains.
 - Make sure you read NEC section 690-64 (b) (2) for all details.
 - Remove the four screws with spring lock washers on the housing lid of the connection box.
 - Carefully open the lid of the connection box.

NOTICE

Handle lid with care.

- Handle lid with care to avoid damage. Even minor damage to the lid can cause inadequate sealing between the lid and the connection box. Moisture can penetrate and damage the sensitive electronic components.
- Guide all AC cables from below to the inverter and attach them without connectors to terminals.
 - Protect all cable entries physically with conduits or cable glands.
 - For conduit hubs, use only UL Listed rainproof, or wet location hubs complying with UL 514B for entry into the enclosure.
 - Use only wire or fine-wire cables. The feed-through AC terminal block allows for the connection of 5 x #6 - 10 AWG (6 mm² - 16 mm²) cable, conductor type: copper (Cu), 194 °F (90°C).
 - Push the cable through a conduit or a cable gland into the inverter connection box.
 - Connect the grounding conductor to one of the terminals marked "GND".
 - Connect the grid side conductors, L1,L2,L3 and Neutral to the AC terminal block.(see fig.14).
 - Tighten the screw terminals and torque them clockwise to a value between 1.2 Nm (approx.

10.62lbf in) and 1.5 Nm (approx. 13.28lbf in).

- Make sure the mains connection lines are equipped with suitable line protection. For further information, refer to chapter 7.
- Observe the derating conditions in case automatic circuit breakers are mounted side by side.
- In addition check with your power company for
 - the relevant technical and special specifications
 - Authorization for installation before starting.
- Check the mains voltage. The maximum is 304.7V (phase to neutral conductor). If the mains voltage is higher, contact the local utility company. The mains line is placed on the feed-through terminal block (MKDS 10 HV) installed on the inverter in accordance with the diagram. Make sure the cables are screwed in securely.

NOTICE

Ferrules with insulating collars.

- If ferrules with insulating collars are used, ensure that the insulation of the ferrules is not inserted in the clamping area of the terminal.

The following illustration shows the AC terminal board of the inverter in the device connection box.

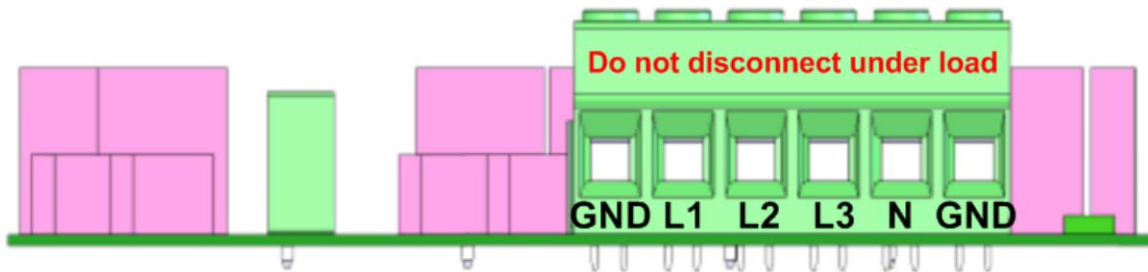


Fig. 14 Mains connection

3.13 Wire gauge for mains connection

NOTICE

NEMA 3R protection.

- To guarantee the NEMA 3R protection, appropriate conduits or cable glands with rubber seals, must be used.
- REFUSol/ Inc. recommends conduits or cable glands with rubber seals exclusively.
- Do not install the inverter at high air humidity levels (> 95%). Moisture inside the connection box can cause corrosion and damage to the electronic components.

Select the wire gauge of the mains connection wire so that line losses are as low as possible. The design of the AC lines and terminals according to NEC is similar to the DC area with the exception that the second 125% factor is not used: $I_{outmax} \times 125\% \times (1/De-rating)$. To facilitate processing, a fine-wire line is recommended for the feed line for all cross-sections.

3.14 Residual current protection

For socket outlet circuits up to 20 A (indoor areas), in outdoor areas up to 32 A used by non-electrical technicians, RCDs (residual-current-operated protective device) are legally required.

NOTICE

Differential protection.

- The inverter transformerless photovoltaic mains feed-in inverters meet the requirements with regard to differential protection in accordance with NEC, ANSI / NFPA 70 and can be operated with a residual-current-operated protective device (FI/RCD) of type A without impairing protection and the inverter itself.

3.15 Interface connection RS485 for communication

RS485 OUT		RS485 IN	
Pin 1	Bus termination +	Pin 1	Reference +
Pin 2	RS485 OUT	Pin 2	RS485 IN
Pin 3	RS485 OUT	Pin 3	RS485 IN
Pin 4	Bus termination -	Pin 4	Reference -

* Bus termination (wire jumper)

Insert the communication and control wires from below with conduits or cable glands. The communication wires shall be installed in the cable ducts provided (see Fig. 10). The connection technology will guarantee easy assembly. Ethernet, RS485 (IN and OUT) and Analog (Sensor) terminals are provided.

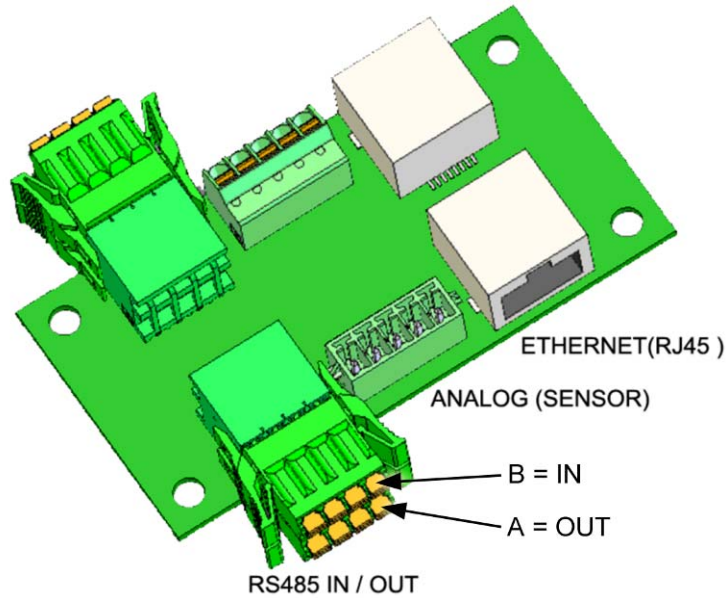


Fig. 15 **Communication interface RS485, Analog (Sensor), Ethernet (RJ45)**

- **RS485**

The RS485 interface supports the USP protocol (Universal Serial Protocol), which can be used for data transmission, e.g. to a data logger of a remote monitoring system.

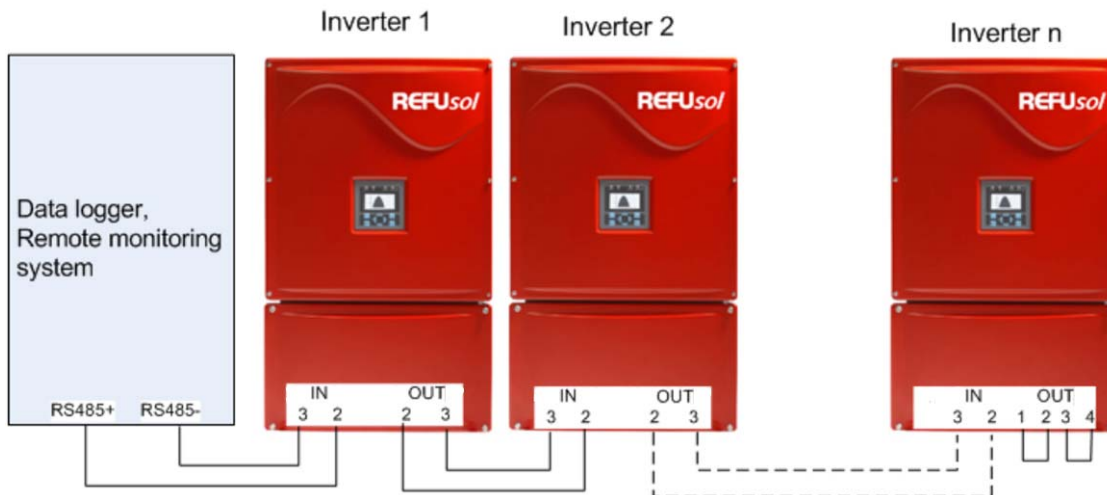


Fig. 16 **Connection – standard interface**

During operation of this interface, note that every bus user must have a unique address.

The bus termination on the last bus user (inverter "n") needs to be jumpered on terminal A (out) in between (1-2) and (3-4) as shown in Fig.16!

- **Ethernet**

Use an Ethernet cable of S/FTP design (Shielded Foiled Twisted Pair).

3.16 Observance of the specifications for inverter operation in mains systems

The inverter has been tested and certified by UL.

Certification is based on the safety standard "UL 1741 for PV and battery inverters" which, for the first time, also contains requirements for transformer less inverters. The inverter meets the requirements of UL 1998 in terms of software-controlled components and complies with both the IEEE-929-2000 connection recommendations and application requirements of photovoltaic inverters in mains systems as well as the IEEE 1547 standard for operation of divided resources with electrical mains systems.



Actions prior to connection to the mains.

- Contact your Utility Company or other appropriate authorities before connecting the inverter to the mains.

4 Grounding



Danger of electric shock.

- Electric shock can kill.
- To avoid the risk of injury, or damage to the equipment, ensure ground is connected on AC terminal block.

Grounding is accomplished in two ways:

- A Protective Earth (PE) feed-through terminal block (MKDS 10 HV) is available in the AC connection area. Among other things, the grounding is provided to assure optimum overvoltage protection. The gauge of the AC grounded conductor must be sized in accordance with Table 250.122 of the NEC.
- A GND stud bolt is available in the connection box below the mains connection (see Fig. 12). Among other things, the grounding is provided to assure optimum overvoltage protection. The gauge of the Equipment Grounding Conductor (EGC) must be sized in accordance with Table 250.122 of the NEC. Install the grounding line as far away as possible, and not directly parallel, to the mains feed line.



Further information on grounding.

- For further information on appropriate grounding, see NEC section 250.

4.1 Ground Fault Protection

4.1.1 Insulation Resistance Detection

Since the inverter is connected to ungrounded PV arrays, it has an Insulation Resistance Detection circuit that measures the DC insulation resistance between the PV array inputs and earth ground prior starting.

4.1.2 PV Array Isolation Monitor Interrupter (IMI)

An Isolation Monitor Interrupter is used to limit ground fault and back-feed current to the array and the protective earth connection. This device limits the current of isolation fault hazards by restricting the ability of the unit to connect to the grid when the system exceeds the limits stated in UL1741. Additionally, the PV array Isolation Monitor Interrupter monitors for sudden changes in the isolation fault current as outlined in UL1741. This differential current detection device is sensitive to all types of currents, and is designed in accordance with the requirements of VDE 0126 for RCMU automatic switching devices integrated into inverters

If a Ground Fault occurs the Inverter will disconnect and will start-up with the standard 5 minute cycle once the fault is cleared!

5 Commissioning and Operation

⚠ DANGER

During operation, high voltages are present in the inverter.

- High voltage during operation can kill.
- High leakage current can lead to electric shock and fires.
- Establish a ground connection before connecting to the mains.
- Only licensed electricians are to work on the inverter.
- All work must be performed as described in this manual.
- Don't touch inverter, avoid accidental burning.

Check and make sure that prior to initial operation of the inverter the following conditions are met:

- Mains connection set up correctly
- PV strings correctly connected
- Ground connection established
- Connections secured against unintentional removal

Check and make sure that before disconnecting the terminals of the PV generator the following conditions are met:

- DC disconnect of the device(s) set to "OFF"
- DC cables of the PV generator are de-energized
- Mains feed line disconnected
- Voltage supply secured against reactivation

5.1 Switching on the Inverter

NOTICE

The control panel.

- The control panel is only active with the DC voltage switched on.
- The control panel with status displays, display and operating buttons is only active with the DC voltage switched on because the electronics of inverter are supplied exclusively from the DC side.

NOTICE

The DC disconnect.

- The rating of the DC Switch is: Voltage: 600 V, Current: 30 A/pole, 4 double poles.

- To make sure that the mains voltage is present at the inverter, insert the external mains fuse or close the line circuit breaker.
- Move the DC disconnect at the device to the “ON” position.
- The inverter will only start up with the connected PV panel after the DC disconnect is activated.

5.2 Setting country code and menu language

- The country code determines the country-specific mains monitoring parameters.
- The menu language is set automatically when the country code is selected. Following this, the menu language can be freely selected at any time in the menu independently of the country code.
- There is no factory pre-set country code. After setting and confirming the country code, you can no longer alter the country code yourself. This also applies to devices that are, or were, in operation. The country code, once selected and confirmed can only be changed by Factory trained service personnel.
- If any REFUSol/ solar inverter is operated with the wrong country code, the utility company might revoke the operating license. The manufacturer disclaims all liability for operation of any REFUSol/ solar inverter with the wrong country code.

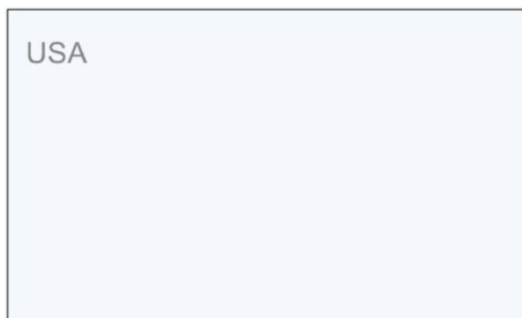
NOTICE

Initial operation.

- Initial operation of any of our devices is prohibited until the complete system complies with all national laws and safety regulations and is signed off.

5.2.1 Setting the country code

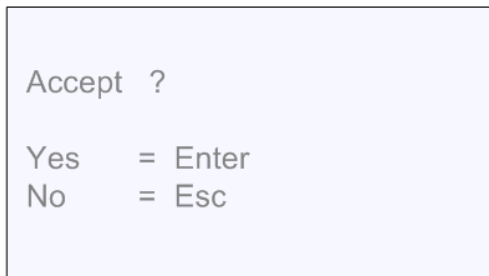
Immediately after the DC voltage is switched on, the following window appears on the display requesting you to confirm country code. You can choose one of the named countries. The term "country code", however, is not shown in the menu. The display lights up the first time you press the button.



1. Select the country code for your location using the buttons "▲" and "▼".
 - Selection of the country code automatically sets the menu language
 - The menu language can be changed in the menu at any time.
2. Press "↵" to confirm.

5.2.2 Confirming the country code

For safety reasons, a prompt appears asking whether you wish to confirm the country code. After the country code has been adapted, it can no longer be changed except by the manufacturers service personnel.

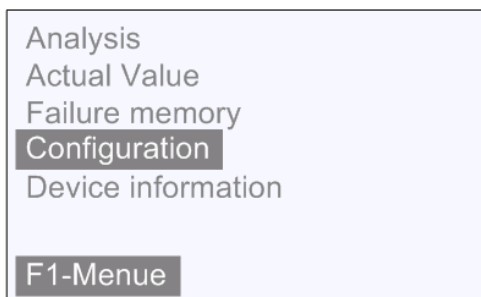


- Only confirm the country code if you are certain it is correct.
- If you are in doubt, press the "ESC" button to cancel. In this case you cannot put the inverter into operation, nor can you continue working in the menu.
- If you wish to confirm the country code, confirm by pressing "↵".

5.2.3 Changing the menu language

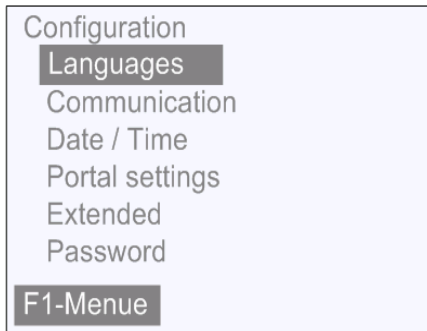
The language selection has no effect on the country code. Proceed as follows to change the menu language:

1. Press the "F1" button to call up the menu.
2. Use the "▼" and "▲" buttons to select the fourth menu item: Configuration.



3. Press "↵" to confirm.

- Use the "▼" and "▲" buttons to select the first menu item: Languages.



- Press "↵" to confirm.
- Use the "▼" and "▲" buttons to select the desired menu language:
- Press "↵" to confirm.
The menu switches to the desired language.
The display is initially empty.
- Press the "ESC" button to return to the menu.

5.3 Activating the inverter

- To make sure that the mains voltage is present at the inverter insert the external mains fuse or close the line circuit breaker.
- Move the DC disconnect at the device to the "ON" position.

Assuming that the solar modules are receiving sufficient sunlight and no fault is pending, the following sequence, which you can follow on the display of the control panel, can be expected:

- Self-test:
 - ⇒ All status lamps light up for approximately 6 seconds
- The initialization procedure is started:
 - ⇒ Status LED Ready flashes
 - Display text:
 - ⇒ Pac feed-in power in Watt (W)
 - ⇒ Uac mains voltage in Volt (V)
 - ⇒ Udc solar cell voltage in Volt (V)
 - ⇒ Status Initialization

Fig. 17 **Display Initialization**

- The initialization procedure is complete:
 - ⇒ Status LED "READY" lit continuously
 - Display text:
 - ⇒ Pac feed-in power in Watt (W)
 - ⇒ Uac mains voltage in Volt (V)
 - ⇒ Udc solar cell voltage in Volt (V)
 - ⇒ Switched off

Fig. 18 **Activating inverter display**

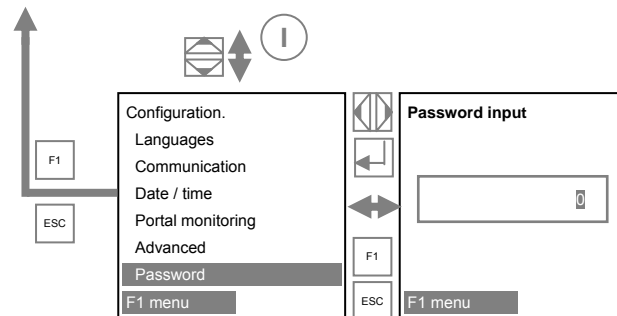
- With solar cell voltage > 200 V, the switch-on procedure starts up:
 - ⇒ Status LED "READY" lights up, status LED "ON" flashes
- Display text:
 - ⇒ Pac feed-in power in Watt (W)
 - ⇒ Uac mains voltage in Volt (V)
 - ⇒ Udc solar cell voltage in Volt (V)
 - ⇒ Activation
 - ⇒ For initial operation, this procedure can take up to one hour; in normal operation up to approximately 3 minutes.
- Feed-in operation:

- ⇒ Status LED "ON" lit continuously, status LED "READY" goes off
- Display text:
 - ⇒ Pac feed-in power in Watt (W)
 - ⇒ Uac mains voltage in Volt (V)
 - ⇒ Udc solar cell voltage in Volt (V)
 - ⇒ y day Yield for day in (kWh)
 - ⇒ Operation
- Check time of day:
 - If the electronics are without supply voltage for a long period (approximately 2 weeks), it is possible that the time is no longer correct. Therefore, before switching on, check the time and adjust it if necessary as follows:
 - Call up the menu with the F1 button.
 - Use the arrow button ▼ to select the "Configuration" menu item and select with ↵ / ▶.
 - Use the arrow button ▼ to select the "Date / Time" menu item and select with ↵ / ▶.
 - Use the arrow buttons ▶ ◀ to set day, month, year, hour, minutes and seconds one after the other.
 - Press " ↵ " to confirm.

5.4 Password input

The customer password is often required for configuration and changes to the default parameters. Presently, the customer password is set in the factory to 72555. This password is set to all inverters.

Enter the password as follows:



Customer password is: 72555

5.5 Navigation via the control panel

5.5.1 Navigation display

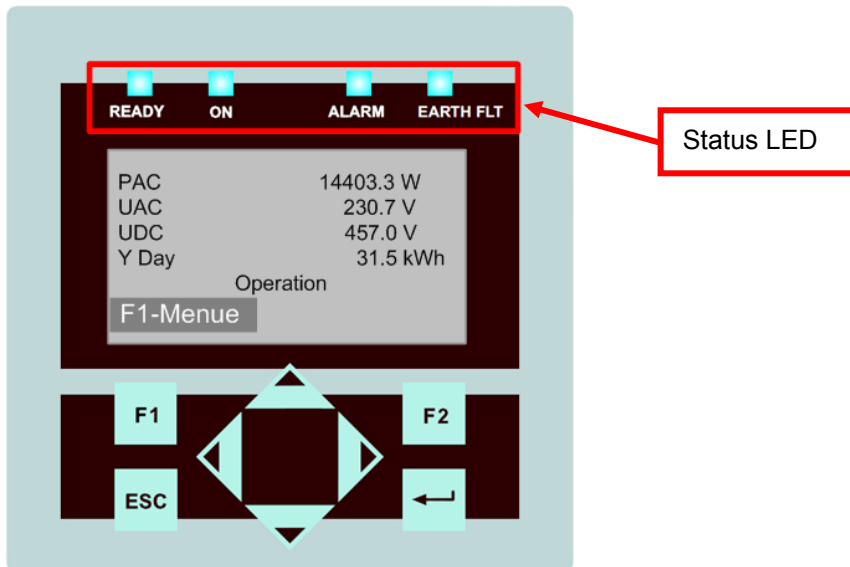


Fig. 19 Navigation display:

F1 Menu display.

◀▶: Function in menu: Navigation within the menu level (previous menu, next menu)

Function with parameter change: Position (digit) left, position (digit) right.

▲▼: Selection of menu level (level up, level down)

ESC Fault acknowledgment, menu level back, exit input menu without saving

↵: Confirmation of menu selection and input.

5.5.2 Basic screen display

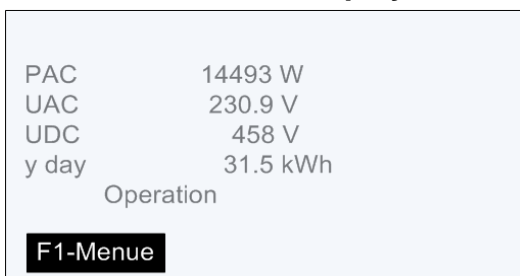


Fig. 20 Operation display

Pac = current feed-in power in Watt (W)

Uac = mains voltage in Volt (V)

Udc = solar cell voltage in Volt (V)

Y day = Yield for day in (kWh)

5.5.3 Graphic display

Press the arrow button ◀ one time; the progression of the day's feed-in power is displayed.

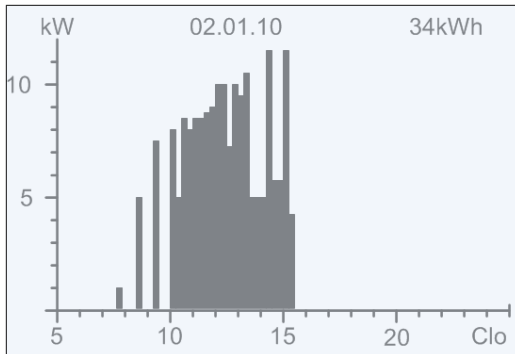


Fig. 21 Display feed-in power for "Today"

Press the arrow button ▼ one time; the progression of the feed-in power for the previous days is displayed.

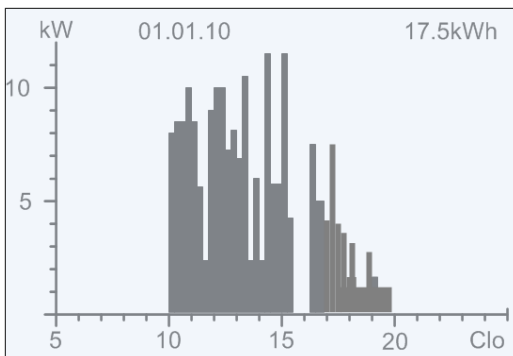


Fig. 22 Display of feed-in power for "Yesterday"

Press the ESC button; the basic screen is displayed again.

5.5.4 Display of yield data

Press the arrow button ▶ one time; the current yield data and the operating hours accumulated up to that point are displayed.

Yield absolute		
Day:	36.2	kWh
Month:	864.2	kWh
Year:	956.6	kWh
Total:	956.6	kWh
Oper. hr:	313.1	h

F1-Menue

Fig. 23 **Display of absolute yield data**

5.5.5 Display of normalized yield data

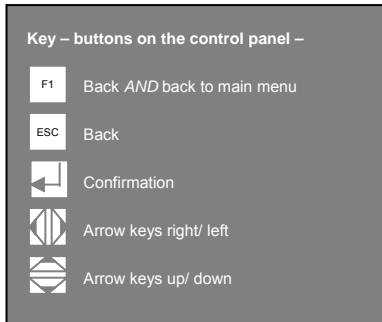
With the REFUSOL 12-UL to 24K-UL Solar Inverters, the expression “normalized yield data” is used for a special form of scaling.

As every inverter has its particular rated power, the internal calculations are based on the actual (system) power defined by the number of solar modules to the particular converter and the form of interconnection of these solar modules (combination of parallel and series connection).

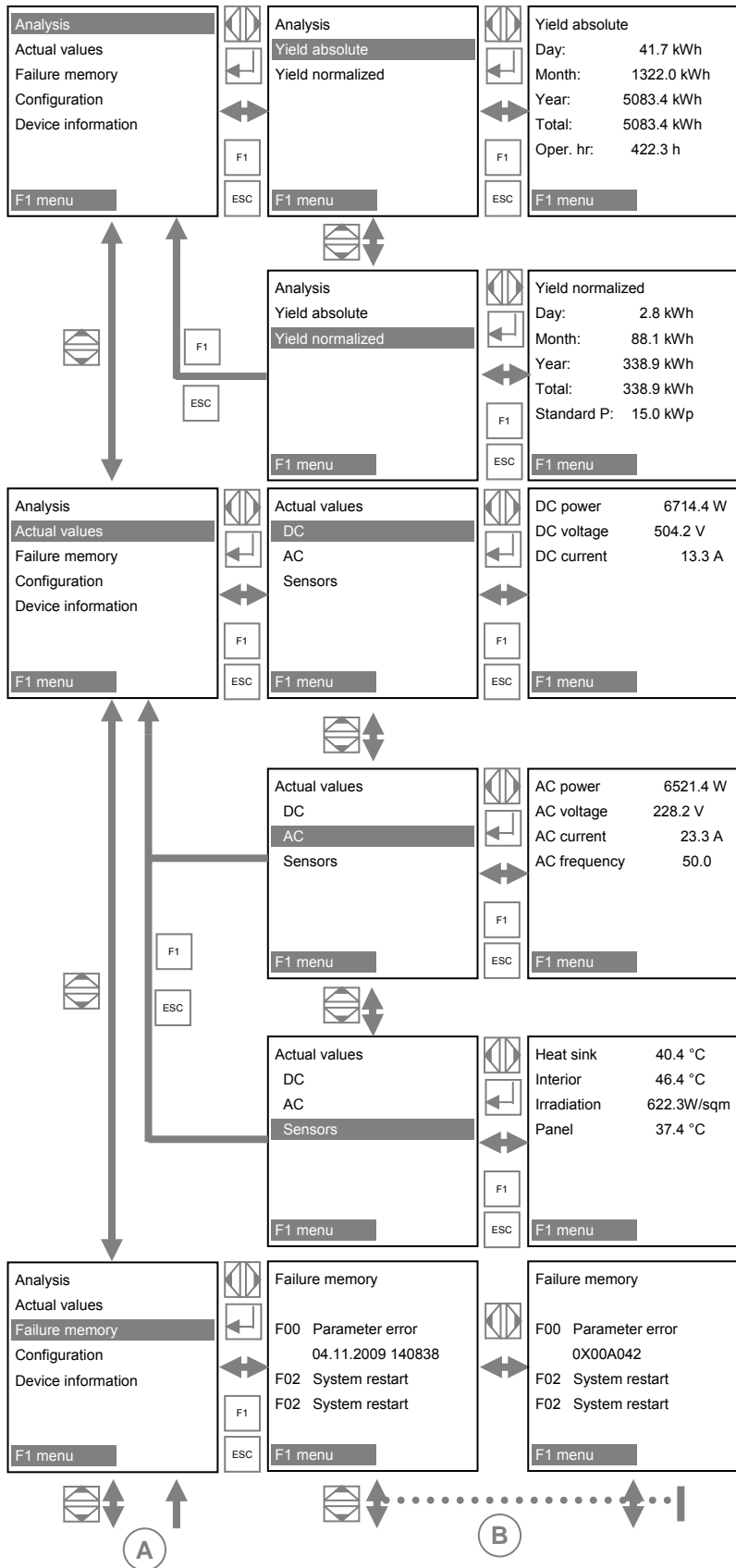
5.6 Menu structure

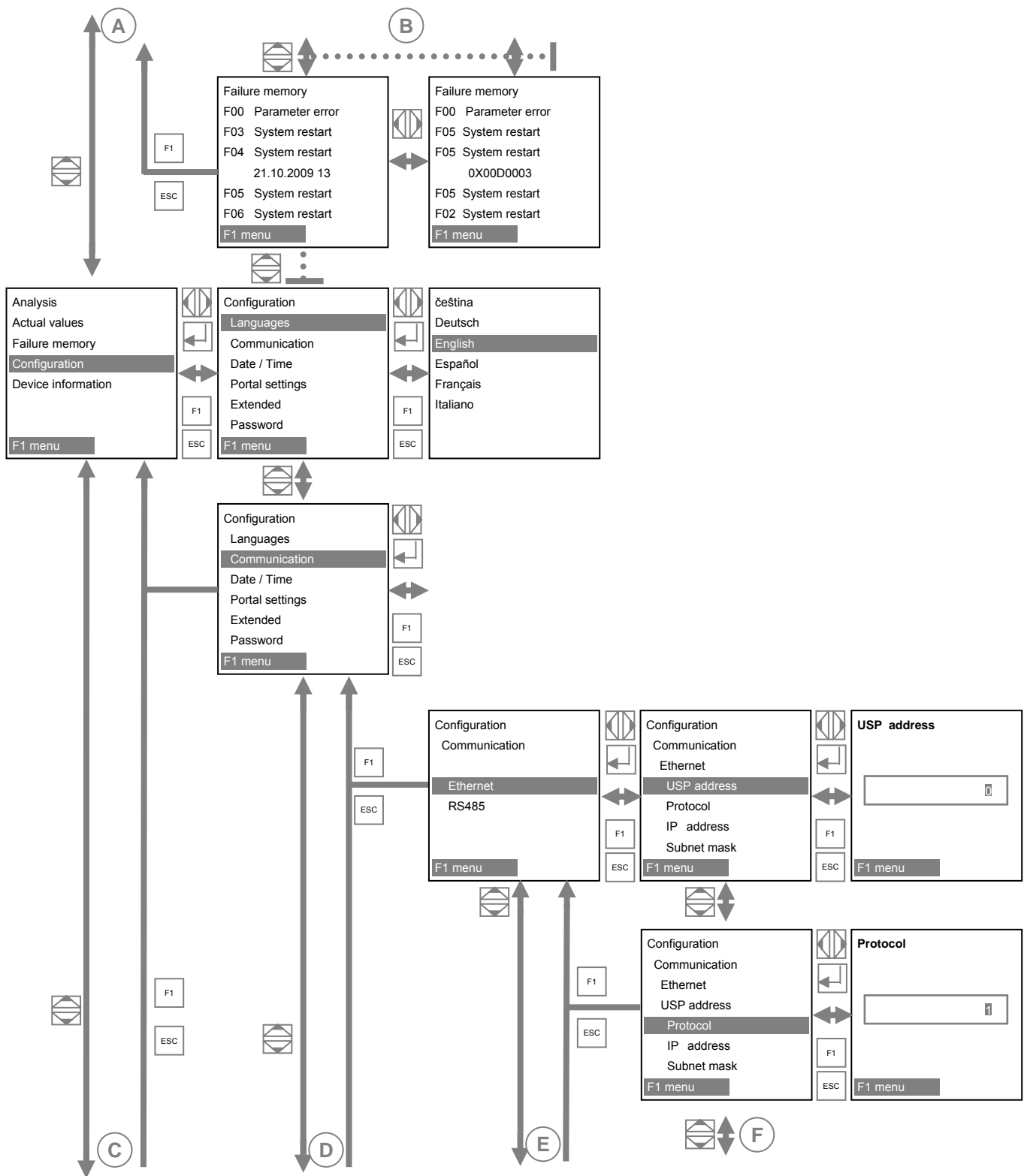
The menu structure facilitates switching to the individual information and setting displays.

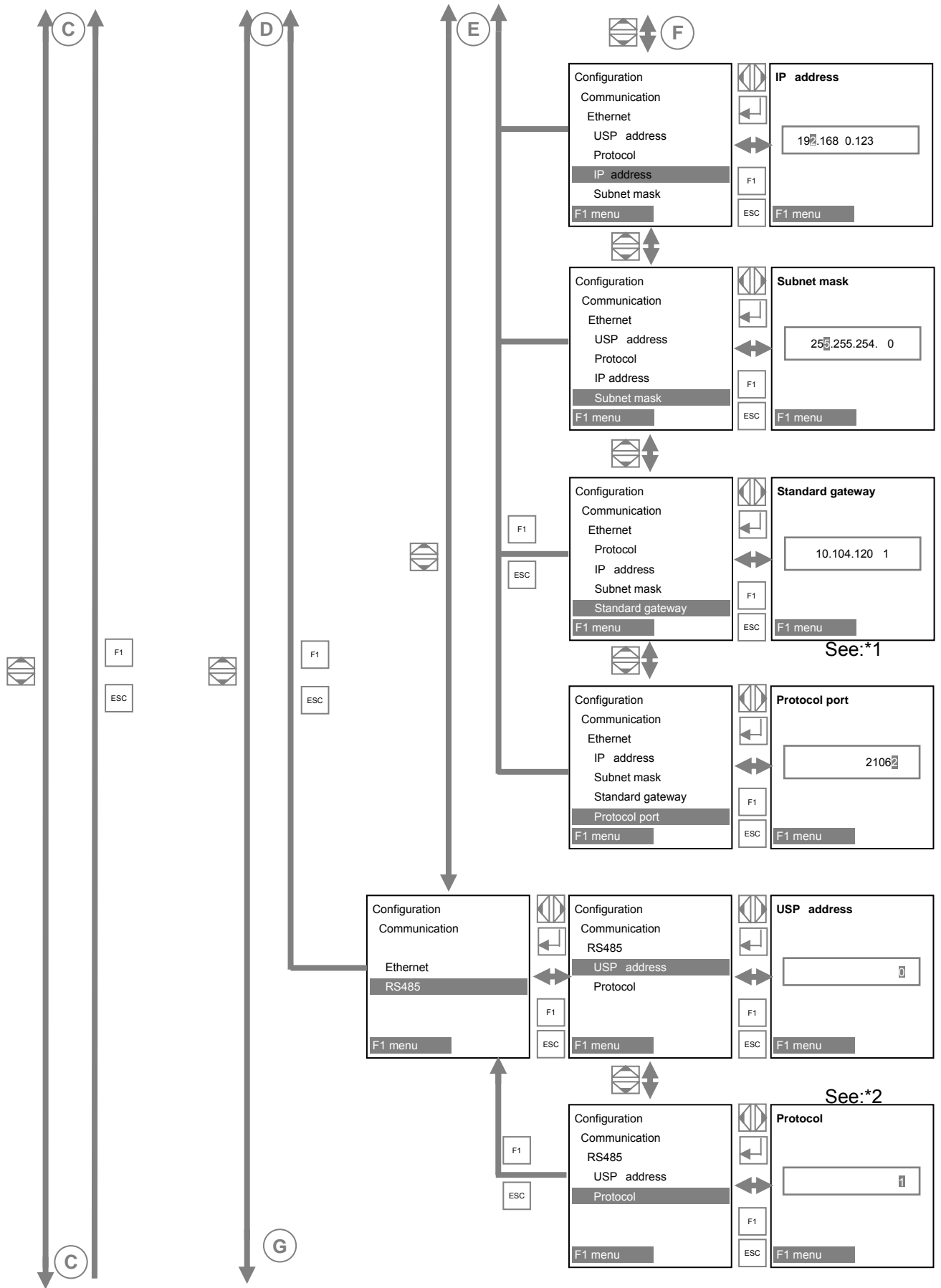
Buttons:

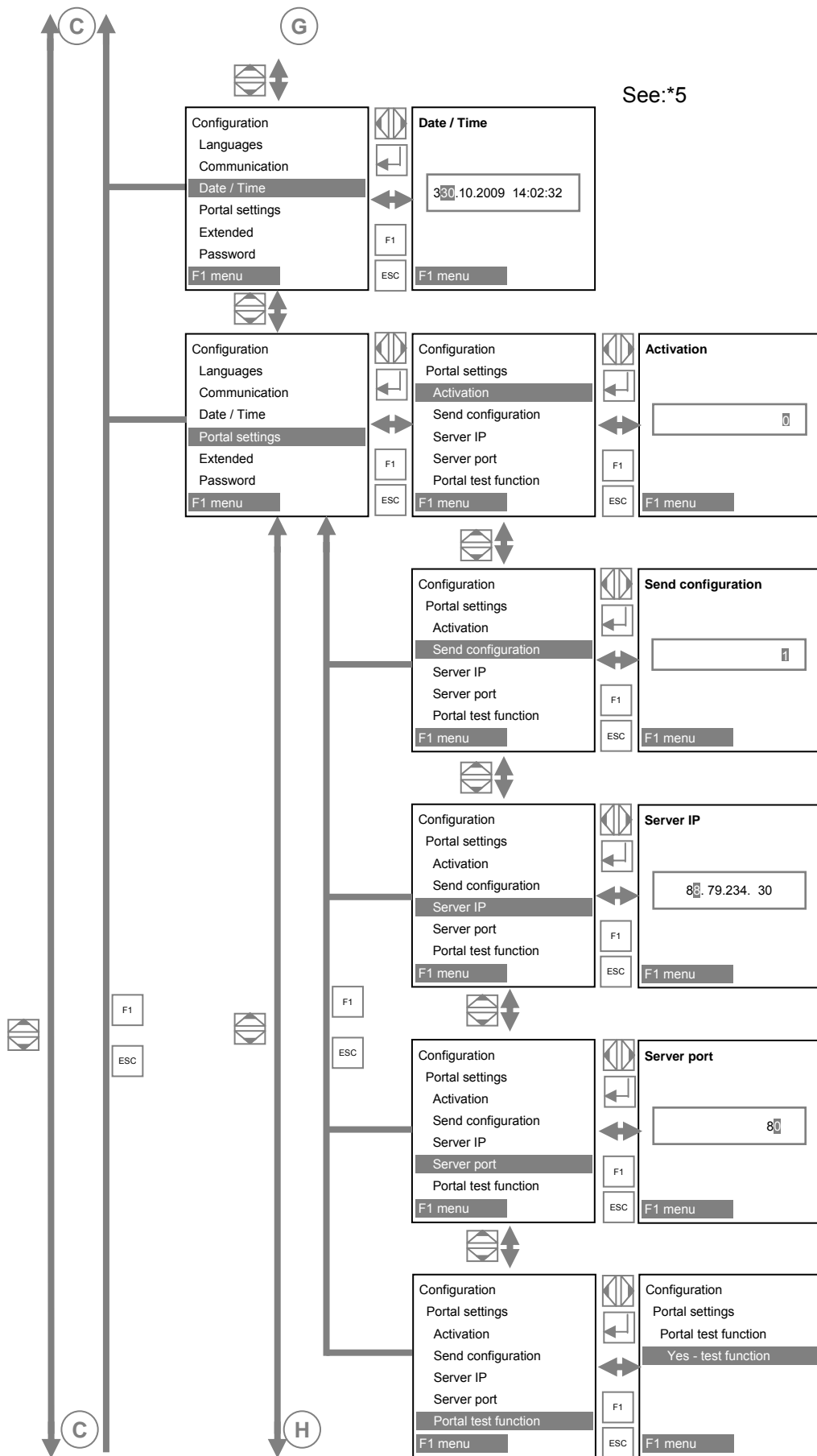


Menu guide

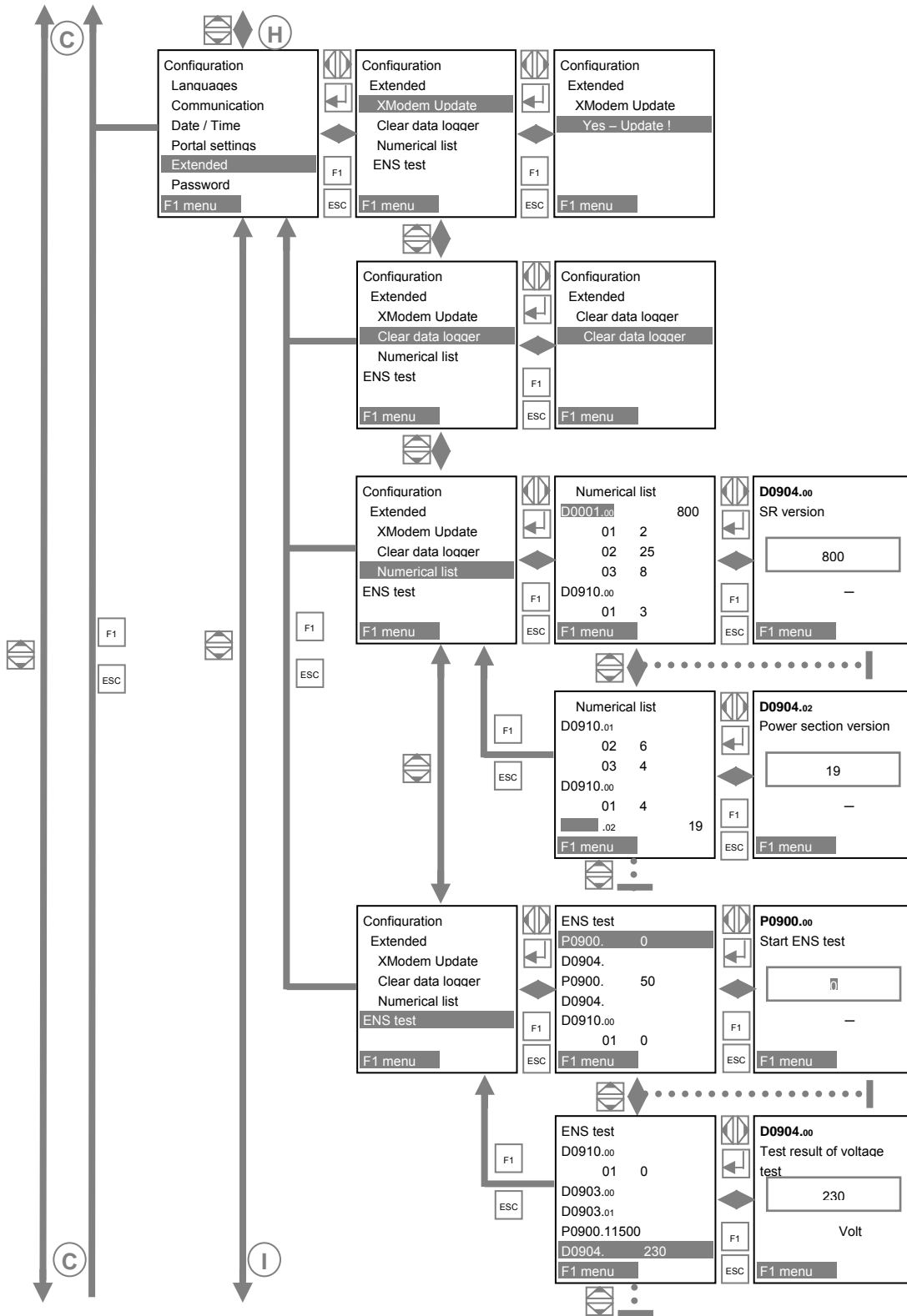


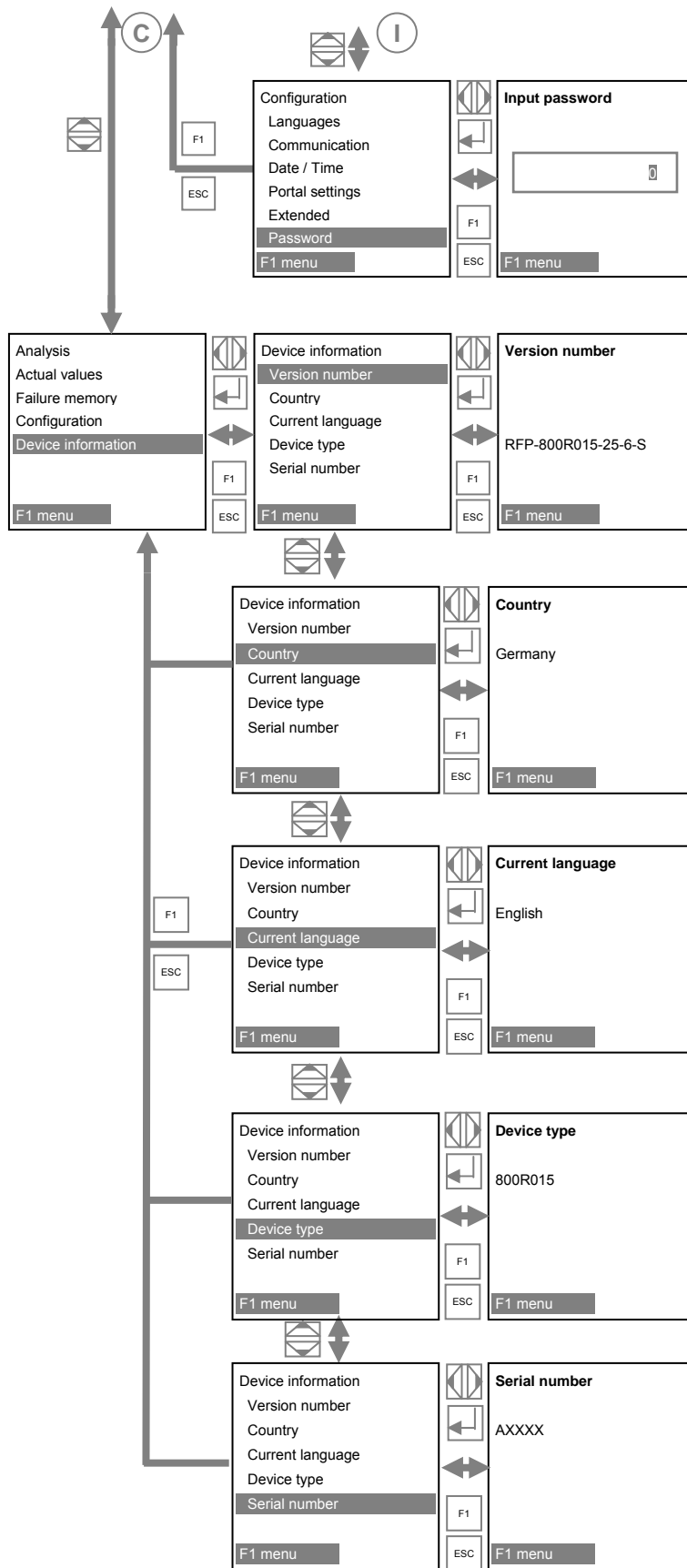






See:*5





Detail explanations

***1. Communication via Ethernet**

USP address:

Set at the factory and cannot be changed.

Protocol:

Enter 0 or 1

0 = RTP protocol

1 = USP and RTP protocol

Protocol port:

Input 1024....65535; Default setting 21062.

Port number is required for communication via Ethernet.

***2. Communication via RS485**

USP address:

Input 1 – 31

Address is necessary to communicate via the RS485 with the inverter.

Note

If this value (address) is changed and is to be saved, the inverter must be restarted. The new address is then active.

Protocol query via Ethernet:

Input 1, 2 and 3

1. USP and RTP protocol

2. For using a 3rd party monitoring equipment

3. For using a 3rd party monitoring equipment

***3. Portal monitoring**

Activation:

Enter 0 or 1

Parameter Off/ On

***4. Send configuration**

Enter 0 or 1

0 = no configuration data in queue

1 = configuration data is being sent.

***5. Server IP**

Display of the IP address

***6. Server port**

Display of port number from web server.

***7. Portal test function**

Enter "Yes"

A data package will be sent to the web server (portal).

There is no return message!

To verify the correct transmission of data package (package dispatch), call the manufacturer service: REFUSol/ Inc. Service

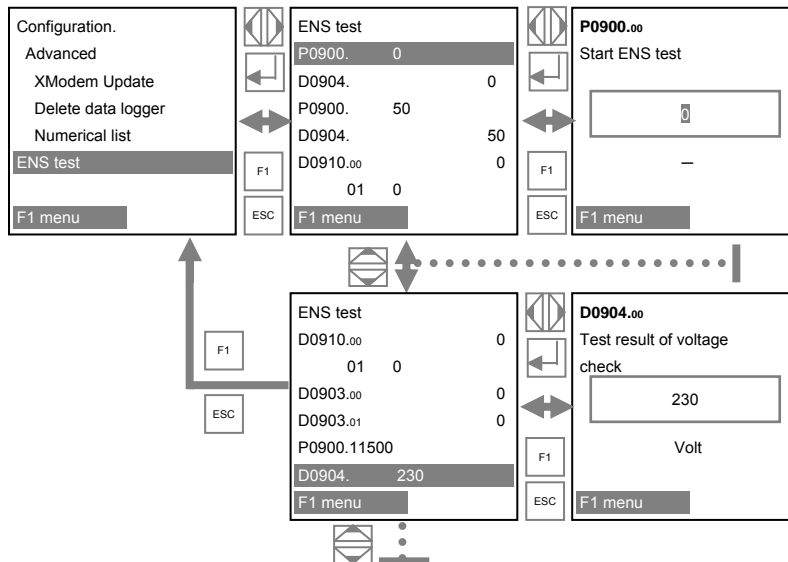
5.7 ENS test

The ENS (Electrical Network/Mains Separation) test is carried out to test the equipment behavior in case of loss of mains.



ENS test.

- If the inverter is disconnected from the mains and the ENS test is being carried out, no result will be achieved. Device restart is necessary.



Performing the ENS test:

- Set P0900 to "1" → Start of the ENS test
- P0901 indicates the status of the ENS test
- P0908 provides information on the frequency ramp (in mHz/s) and can be adjusted
- P0902 displays the progression of the simulated frequency
- P0910.00 displays the measurement time until the frequency lower limit was reached
- P0910.01 displays the measurement time until the frequency upper limit was reached
- P0903.00 displays the frequency value that led to shutdown at the lower limit
- P0903.01 displays the frequency value that led to shutdown at the upper limit
- P0909 provides information on the voltage ramp (in mV/s) and can be adjusted
- P0904 displays the progression of the simulated voltage
- P0910.02 displays the measurement time until the voltage lower limit was reached
- P0910.03 displays the measurement time until the voltage upper limit was reached
- P0905.00 displays the voltage value that led to shutdown at the lower limit
- P0905.01 displays the voltage value that led to shutdown at the upper limit

Status list of the ENS test:

- | | |
|-----------|--|
| 0 | Initialization / ready to start |
| 1 ... 3 | Frequency test for lower frequency limit |
| 4 ... 6 | Frequency test for upper frequency limit |
| 7 ... 9 | Voltage test for lower voltage limit |
| 10 ... 12 | Voltage test for upper voltage limit |
| 13 | ENS test complete |

6 Fault correction

6.1 Self-test fault messages

Following initialization routine, the inverter carries out a self-test. The individual parts of the system, e.g. firmware and data record, are checked and data is imported from the power control (PCB). If there is a fault, the type of fault will indicate, what corrective measures have to be taken to correct it.



Wording “grid” in fault messages.

- Depending on the software version, in some messages the word “grid” is used instead of the word “mains”. In this cases the word “grid” has the same meaning as the word “mains”.

6.2 Temporary failure

When certain faults occur, the inverter disconnects temporarily from the mains. This is called a temporary failure.

In contrast to faults, the "temporary failure" is automatically acknowledged by the inverter and a new switch-on attempt is made automatically if the message is no longer pending.

Temporary failure is indicated by flashing of the red LED alarm on the control panel and is saved power-failure safe in the failure memory. See the section on faults.

For examples refer to chapter 5.5 List of fault messages.

6.3 Faults

During operation, permanently programmed and parameterized limit values are monitored continuously. In order to protect the inverter power section against damage, it will be disconnected from the voltage if a limit value is exceeded or a fault occurs. However, DC and AC voltage can still be present. The corresponding fault message appears in the display.

The fault is indicated by the red LED "alarm" being continuously lit on the control panel.

The failure memory stores fault messages safe of power-failures. The failure memory is called up via the display. The failure memory stores the last 100 faults. The last fault is in memory position S0, the oldest in S100. A new fault is always saved in memory position S0 and, at the same time, the fault in memory position S100 is removed.

For examples refer to chapter 5.5 List of fault messages.

6.4 Fault clearance

After a shutdown due to a fault, reactivation of the inverter is locked until the fault is acknowledged. As long as the cause of the fault still exists, acknowledgment is not possible. The fault can only be acknowledged after the cause has been eliminated.

⇒ To acknowledge the fault message, press the ESC button or switch the inverter off at the DC

switch, wait a short while and then switch it on again.

6.5 List of fault messages

Fault number	Fault text	Description	Action
0A0001	Controller voltage 1	Boost converter of the positive intermediate circuit could not regulate sufficiently	Wait until the controller has stabilized again.
0A0002	Controller voltage 2	Boost converter of the negative intermediate circuit could not regulate sufficiently	Wait until the controller has stabilized again.
0A0003	Controller voltage 3	Asymmetry in intermediate circuit low	Wait until the controller has stabilized again.
0A0004	Controller voltage 4	Asymmetry in intermediate circuit high	Wait until the controller has stabilized again.
0A0005	Controller voltage 5	Dropping of positive intermediate circuit below mains peak value	Wait until the controller has stabilized again.
0A0006	Controller voltage 6	Dropping of negative intermediate circuit below mains peak value	Wait until the controller has stabilized again.
0A0007	Controller voltage 7	Dropping of positive intermediate circuit voltage below limit value P0024.0	Wait until the controller has stabilized again.
0A0008	Controller voltage 8	Positive intermediate circuit voltage exceeds limit value P0024.1	Wait until the controller has stabilized again.
0A0009	Controller voltage 9	Dropping of negative intermediate circuit voltage below limit value P0024.0	Wait until the controller has stabilized again.
0A000A	Controller voltage 10	Negative intermediate circuit voltage exceeds limit value P0024.1	Wait until the controller has stabilized again.
0A000B	Controller voltage 11	Positive boosted intermediate circuit voltage exceeds limit value P0024.1	Wait until the controller has stabilized again.
0A000C	Controller voltage 12	Negative boosted intermediate circuit voltage exceeds limit value P0024.1	Wait until the controller has stabilized again.

Fault number	Fault text	Description	Action
0A000D	Grid overvoltage	<p>Detection of mains overvoltage (Automatic disconnection, control section)</p> <p>This fault indication is possibly caused by switching operation on the mains.</p>	<ol style="list-style-type: none"> 1. Wait until the situation settles or measure the mains voltage again. 2. Contact the grid operator if the mains voltage is not in the normal range. 3. Contact Service if the mains voltage is in the normal range.
0A000E	Grid undervoltage	<p>Detection of mains undervoltage (Automatic disconnection, control section)</p> <p>This fault indication is possibly caused by switching operation on the mains.</p>	<ol style="list-style-type: none"> 1. Wait until the situation settles or measure the mains voltage again. 2. Contact the grid operator if the mains voltage is not in the normal range. 3. Contact Service if the mains voltage is in the normal range.
0A000F	Grid overvolt. ext. conductor	<p>Detection of mains overvoltage on the external conductor (Automatic disconnection, control section)</p> <p>This fault indication is possibly caused by switching operation on the mains</p>	<ol style="list-style-type: none"> 1. Wait until the situation settles or or measure the mains voltage again. 2. Contact the grid operator if the mains voltage is not in the normal range. 3. Contact Service if the mains voltage is in the normal range.
0A0010	Grid undervolt. ext. conductor	<p>Detection of mains undervoltage on the external conductor (ENS, control section)</p> <p>This fault indication is possibly caused by switching operation on the mains</p>	<ol style="list-style-type: none"> 1. Wait until the situation settles or measure the mains voltage again. 2. Contact the grid operator if the mains voltage is not in the normal range. 3. Contact Service if the mains voltage is in the normal range.
0A0011	Grid frequency FLL	<p>Detection of a mains fault (ENS, control section)</p> <p>This fault indication is possibly caused by switching operation on the mains</p>	<ol style="list-style-type: none"> 1. Wait until the situation settles or measure the mains frequency and voltage again. 2. Contact the grid operator if the mains voltage is not in the normal range. 3. Contact Service if the mains voltage is in the normal range.
0A0012	Grid frequency	<p>Detection of a mains frequency fault (ENS, control section)</p> <p>This fault indication is possibly caused by switching operation on the mains</p>	<ol style="list-style-type: none"> 1. Wait until the situation settles or measure the mains frequency and voltage again. 2. Contact the grid operator if the mains voltage is not in the normal range. 3. Contact Service if the mains voltage is in the normal range.

Fault number	Fault text	Description	Action
0A0013	Gen. insulation AFISR	An insulating fault was detected during the system's automatic insulation test (ENS, control section)	Check the system's insulation and repair if necessary
0A0014	No country code	Country code is not set	Contact Service
0A0102	Overtemperature LT 1	Temperature in the right cooler section above limit value P0027.3	Allow inverter to cool down.
0A0103	Overtemperature LT 2	Temperature in interior (measuring probe, interior, top left) above limit value P0027.3	Allow inverter to cool down.
0A0104	Overtemperature LT 3	Temperature in interior (measuring probe, interior, bottom right) above limit value P0027.3	Allow inverter to cool down.
0A0105	Overtemperature LT 4	Temperature in the left cooler section above limit value P0027.3	Allow inverter to cool down.
0A0106	Supply voltage LT	Control voltage in power section faulty	Contact Service
0A0108	Grid frequency LT	Detection of a mains frequency fault (ENS, power section) This fault indication is possibly caused by switching operation on the mains	1. Wait until the situation settles or measure the mains frequency and voltage again. 2. Contact the grid operator if the mains voltage is not in the normal range. 3. Contact Service if the mains voltage is in the normal range.
0A0109	Grid overvoltage LT	Detection of mains overvoltage (ENS, power section) This fault indication is possibly caused by switching operation on the mains	1. Wait until the situation settles or measure the voltage again. 2. Contact the grid operator if the mains voltage is not in the normal range. 3. Contact Service if the mains voltage is in the normal range.
0A010A	Grid undervoltage LT	Detection of mains undervoltage (ENS, power section) This fault indication is possibly caused by switching operation on the mains	1. Wait until the situation settles or measure the voltage again. 2. Contact the grid operator if the mains voltage is not in the normal range. 3. Contact Service if the mains voltage is in the normal range.
0A010C	Gen. insulation LT	An insulating fault was detected during the system's automatic insulation test (ENS, power section)	Check the system's insulation and repair if necessary
0A010D	AFI fault	Fault current detection (ENS, power section)	AFI sensor failed, check PCB contacting. Call Service to replace if necessary.
0A010E	Device fault LT	Overload shutdown in power section	Acknowledge fault

Fault number	Fault text	Description	Action
0A0110	Solar voltage LT 1	Overvoltage shutdown in positive intermediate circuit (power section)	Check solar cell voltage
0A0111	Solar voltage LT 2	Overvoltage shutdown in negative intermediate circuit (power section)	Check solar cell voltage
0A0113	Country code incons. LT	Coding and subcoding for country of use do not match	Contact Service
0A0114	Gen. insulation AFILT	An insulating fault was detected during the system's automatic insulation test (ENS, power section)	Check the system's insulation and repair if necessary
0A0115	AFI warning	An insulating fault was detected during the system's automatic insulation test (ENS, power section)	Check the system's insulation and repair if necessary
0A0117	Insul. tester def.	Insulating testing unit is defective	Contact Service
0A0118	Voltage offset LT	Offset adjustment of the power section was outside the limits	Acknowledge fault
0A0119	Transformer LT	Failure of current sensors in power section detected	1. Acknowledge fault 2. Contact Service if this fault occurs several times
0A011A	Activation LT 1	Failure of a power branch in the boost converter	1. Acknowledge fault 2. Contact Service if this fault occurs several times
0A011B	Activation LT 2	Drop of intermediate circuit voltage below limit value P0024.0 (power section)	1. Acknowledge fault 2. Contact Service if this fault occurs several times
0A011C	Activation LT 3	Setpoint value for intermediate circuit symmetrization faulty	1. Acknowledge fault 2. Contact Service if this fault occurs several times
0A011D	Activation LT 4	Timeout, intermediate circuit symmetrization	1. Acknowledge fault 2. Contact Service if this fault occurs several times
0A011E	Activation LT	Timeout, intermediate circuit precharging	1. Acknowledge fault 2. Contact Service if this fault occurs several times
0x0A0120	Communication LT	Communication problem between control system and power section	Acknowledge fault Contact Service if fault occurs again
0x0A0121	DC offset	DC current in AC power supply	Acknowledge fault Contact Service if fault occurs again

Fault number	Fault text	Description	Action
0x0A200D	Overtemperature 6	Temperature in inverter too high This fault indication is possibly caused by one or more of the following: <ul style="list-style-type: none"> ▪ Over temperature shutdown of SR ▪ Cooler temperature has exceeded 80°C (176°F). ▪ Interior temperature has exceeded 75 °C (167°F). 	Allow inverter to cool down.
100001	Ethernet connection 1	Ethernet connection setup unsuccessful	Check Ethernet connection
100002	Ethernet connection 2	Ethernet disconnection	Check Ethernet connection
100003	Ethernet connection 3	There is no 100 Mbit/s Ethernet connection	Set up Ethernet connection with 100 Mbit/s.

7 Options or optional equipment

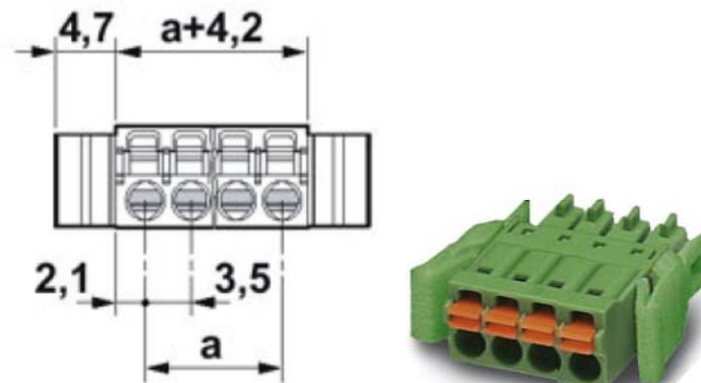
7.1 Irradiation and temperature sensor

The inverter provides an analog interface for irradiation and temperature sensors. For information concerning availability and technical data on specific sensors, contact REFUSol/ Inc. on the address given at the front pages of this document.

NOTICE

Plug with grid flange.

- The sensor line shield must be applied at pin 2 and pin 5.
- If the temperature input is not used, a jumper must be wired between pin 4 and pin 5.
- Alternatively, the jumper can also be wired at the intermediate terminal point (cable extension).



(dimensions given in millimeter (mm))

Fig. 26 **Plug part with grid flange, grid 3.5 mm ; Number of poles: 4, spring-force connection**

7.2 Remote monitoring

For remote monitoring the following option is available:

- Developed by the manufacturer, REFUlog is a monitoring portal for monitoring and recording solar system data. Further information and details are available in the operating instructions with the document number: BA_REFULOG_V0x.x_EN.

This document can also be downloaded on the homepage www.refusol.com

7.3 Data logger parameters

The following parameters are used for setting the internal data logger

Parameter number	Parameter designation	Description
P450.00	Data logger switched on	<ul style="list-style-type: none"> Switches the data logger on or off. 0 = switched off. 1 = switched on. Data is now recorded regularly
P451.00	Data logger time interval	<ul style="list-style-type: none"> Contains the time interval (60 / 300 / 600 s) during which the data logger saves data.
P452.00 - 39	Parameter number Data logger	<ul style="list-style-type: none"> Contains a list of all parameter numbers that are to be recorded. This only works in conjunction with the indices (P453.x). Parameter numbers that do not exist are ignored.
P453.00 - 39	Indices data logger	<ul style="list-style-type: none"> Contains a list of all indices for the parameter numbers that are to be recorded. This only works in conjunction with the parameter numbers (P452.x). Parameter numbers that do not exist are ignored.

8 Technical data

8.1 Solar inverter REFUSOL 012K to 024K-UL

Power Classification	REFUSOL 012K	REFUSOL 016K	REFUSOL 020K	REFUSOL 024K
DC data				
Recommended PV power	14.4 kW	19.2 kW	24 kW	27.84 kW
Max. DC voltage	500 V			
MPPT range	125450 V	125450 V	125 450 V	125450 V
Min. voltage for full rated output power	225 V	250 V	275 V	300 V
Startup voltage	200 V			
Max. DC current	2 x 27.5 A	2 x 33 A	2 x 37.5 A	2 x 40 A
MPP tracking	One fast, precise MPP tracker			
Number of DC-connections	12			
DC fuses	24 x type KLKD 15 A (field adjustable up to 20A)			
Internal overvoltage protection	Surge protected device (SPD) type 3			
AC data				
Rated AC power	12.0 kVA	16.0 kVA	20.0 kVA	23.2 kVA
Max. AC active power	12.0 kW	16.0 kW	20.0 kW	23.2 kW
AC grid connection	3 AC 480 V WYE+N ± 10%, 60 Hz			
VAR control (cos φ)	Nominal value: 1 (field adjustable 0.95i ... 1 ... 0.95c)			
Max. AC current	14.5 A	19.3 A	24.1 A	27.9 A
Max. Branch Circuit OCP	20 A	25 A	35 A	35 A
Distortion factor THD	<3%			
Max. efficiency	98.2%			
CEC Efficiency	97.5%	97.5%	97.5%	98%
Power fed to mains starting at	20 W			
Power Consumption	Standby<0.5 W			
Internal overvoltage protection	Surge protected device (SPD) type 3			
Interfaces				
Ethernet interface	1 x RJ45 plug socket			
RS485 interface	1 x IN / 1 x OUT Circular connector FMC 1.5/ 4-ST-3.5-RF			
Cooling, ambient conditions, EMC				
Cooling	Natural convection			

Power Classification	REFUSOL 012K	REFUSOL 016K	REFUSOL 020K	REFUSOL 024K
Ambient temperature	-13 °F to + 131 °F (-25 °C to + 55 °C)			
Storage temperature	-13 °F ... + 158 °F (-25 °C ... +70°C)			
Site Elevation	Up to 6,562 ft (2000 m) above sea level before derating			
Noise	< 45 dB			
Emitted interference	FCC Part 15 Subpart B, Class B			
Certificate	Certified to UL 1741 and UL 1998 Standard (for US and Canada) by Underwriters Laboratories			
Interference resistance	IEEE C37.90.2			
Anti-islanding	In accordance with IEEE 1547 and UL 1741			
Environmental classification	4K4H according to DIN IEC 721-3-3			
Automatic disconnection	According to IEEE 1547			
Mechanical system				
Type of protection	Electronics: NEMA 4		Connection box: NEMA 3R	
Dimensions	21 / 35 / 11 inches (535 mm / 895 mm / 280 mm)			
Width / Height / Depth	21 / 37 / 11 inches (535 / 940 / 280 mm) with extension box			
Weight	108 lbs. (49 kg)			

8.2 Trip limits / Trip times

Nominal frequency	Trip limit	Trip times
60 Hz	OverFrequency TripPoint > 60.5 Hz	max. 0.16s
	UnderFrequency Trip Point < 59.3 Hz	

Voltage	Trip limit trip voltage	Line-to-neutral	Trip voltages line-to-line	Trip times
480 V	Undervoltage, Fast, Trip Point <88%	243.9 V	423 V	max. 0.16s
	Undervoltage, Slow, Trip Point <88%	243.9 V	423 V	max. 1s
	OverVoltage, Fast, Trip Point > 10%	304.7 V	528 V	max. 0.16s
	OverVoltage, Slow, Trip Point > 10 %	304.7 V	528 V	max. 2 s

9 Contact

If you have any questions on project planning with the REFUso/ solar inverters, contact:

REFUso/, Inc.

48025 Fremont Blvd.

Fremont, CA 94538 USA

+1-408-775-7744

info-usa@refusol.com

www.refusol.com

When contacting REFUso/ Inc., please provide the following details:

- Exact description of the fault, possibly the HEX code of the fault (e.g. P0017.00).
- To record data, we recommend that you use the fault protocol included with the REFUso/, which can also be downloaded at www.refusol.com
- Nameplate data:

REFUso/ REFU Solar Electronics, Inc.
 10 South 3rd Street
 San Jose, CA 95113 USA
 info-usa@refusol.com
 Phone: +1 408-775-7388

UL US LISTED
 Utility-Interactive
 3-Phase Inverter
 4MG2

Type: **804R024 .000 REFUSOL 024K** Date: 12/11

Max. input voltage	500 Vdc	Operating output line voltage range	423 - 528 Vac
Range of input operating voltage	125 - 480 Vdc	Nominal output line voltage	3AC 480V + N
DC MPP range (full power)	300 - 450 Vdc	Operating output frequency range	59.3 - 60.5 Hz
Max. input current total	2 x 40.0 Adc	Nominal output frequency	60 Hz
Operating temperature range	-20... +55 °C	Max. output current	3 x 27.9 Aac
Enclosure electronics	Type 4	Max. output power	23200 W
Enclosure connection box	Type 3R	Output power factor	0.95 i ... 0.95 c
Max. ambient temp for full out power	+40 °C	Nominal output power factor	1

*For more details and for tightening torque, allowable wire size and type, see the operator's manual

Serial No.: 090000021

Made in USA
 PEG
 E337591

10 Certificates

For relevant certificates refer to the homepage of REFUso/ Inc. www.refusol.com.

11 Glossary

AC

Abbreviation for "Alternating Current"

DC

Abbreviation for "Direct Current"

Derating

A controlled reduction in performance, usually dependent on component temperatures. Compared with the (also common) practice of completely shutting down the inverter, derating has a less drastic effect on the external mains.

Solar Inverter

A device for converting the direct current (DC) from the PV generator into alternating current (AC), which is used by most normal household devices, and especially for feeding energy into an existing supply mains.

Maximum Power Point "MPP"

The operating point (current / voltage) of the PV generator at which the highest possible performance under the prevailing conditions is achieved. The actual MPP changes constantly, depending on the level of solar irradiation, cell temperature, etc.

MPP tracker

A device that adjusts the voltage and current of a PV generator so that it operates at its Maximum Power Point "MPP"

PV

Abbreviation for "photovoltaic" describing the conversion of solar energy into electrical energy. This normally refers to all installed and electrically connected PV modules in a PV system.

String

Describes a group of series-connected PV modules

12 Notes

REFU*sol*, Inc.

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Fremont, CA 94538 USA

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info-usa@refusol.com

www.refusol.com

Part. No.: 0031979