Bonfiglioli
Vectron

RPS 450

Operating Instructions
Photovoltaic Inverter
30 kWp ... 170 kWp

Bonfiglioli
power, control and green solutions

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This document

Dear customer,
This user manual describes the solar inverter type **RPS 450** by BONFIGLIOLI VECTRON GmbH (in the following referred to as solar inverter) and its use.
The user manual contains important information on how the solar inverter can be used safely, properly and efficiently. Compliance with this user manual contributes to avoiding risks, minimizing repair cost and downtimes and increasing the reliability and service live of the solar inverter. For this reason, make sure you read the user manual carefully.

In case any problems occur which are not covered by this user manual sufficiently, please contact the manufacturer.

Warranty and liability

BONFIGLIOLI VECTRON would like to point out that the contents of this user manual do not form part of any previous or existing agreement, assurance or legal relationship. Neither are they intended to supplement or replace such agreements, assurances or legal relationships. The manufacturer's obligations are exclusively specified in the relevant purchase contract. This contract also contains all and any warranty regulations which may apply to the relevant scope of supply. These contractual warranty provisions are neither extended nor limited by the specifications contained in this documentation.
The manufacturer reserves the right to correct or amend the specifications, product information and omissions in these operating instructions without notice. The manufacturer shall not be liable for any damage, injuries or costs which may be caused by the aforementioned reasons.

In addition to that, BONFIGLIOLI VECTRON excludes any warranty/liability claims for any personal and/or material damage if such damage is due to one or more of the following causes:

- inappropriate use of the solar inverter,
- non-compliance with the instructions, warnings and prohibitions contained in this user manual,
- unauthorized modifications of the solar inverter,
- insufficient monitoring of parts which are subject to wear,
- maintenance work not carried out properly or not carried out in due time,
- catastrophes by external impact and Force Majeure.

Obligation

This user manual must be read before commissioning. Anybody entrusted with tasks in connection with the

- transport and/or unloading,
- assembly,
- installation of the solar inverter and
- operation of the solar inverter

must have read and understood the user manual and, in particular, the safety instructions in order to protect himself/herself and prevent the solar inverter from being damaged.

Copyright

Storage

This user manual is an integral component of the solar inverter. It must be stored such that it is accessible to operating staff at all times. In case the solar inverter is sold to other users, this user manual must also be handed over.

1 General safety instructions and information on use

The chapter "General safety instructions and information on use" contains general safety instructions for the Operator and the Operating Staff. At the beginning of certain main chapters, some safety instructions are included which apply to all work described in the relevant chapter. Special work-specific safety instructions are provided before each safety-relevant work step.

1.1 Terminology

Operator
This is the entrepreneur/company who/which operates the solar inverter and uses it as per the specifications or has it operated by qualified and instructed staff.

Operating Staff
The term Operating Staff covers persons instructed by the Operator of the solar inverter and assigned the task of operating it.

Qualified staff
The term Qualified Staff covers staff who is assigned special tasks by the Operator of the solar inverter, e.g. transport, installation, maintenance and service/repair and troubleshooting. Based on their qualification and/or know-how, qualified staff must be capable of identifying defects and assessing functions.

Qualified electrician
The term Qualified Electrician covers qualified and trained staff who has special technical know-how and experience with electrical installations. In addition, Qualified Electricians must be familiar with the applicable standards and regulations and must be able to assess the assigned tasks properly and identify and eliminate potential hazards.

Instructed person
The term Instructed Person covers staff who was instructed and trained about/in the assigned tasks and the potential hazards that might result from inappropriate behavior. In addition, instructed persons must have been instructed in the required protection provisions, protective measures, the applicable directives, accident prevention regulations as well as the operating conditions and verified their qualification.

Expert
The term Expert covers qualified and trained staff who has special technical know-how and experience relating to solar inverter. Experts must be familiar with the applicable government work safety directives, accident prevention regulations, guidelines and generally accepted rules of technology in order to assess the operationally safe condition of the solar inverter.

1.2 Designated use

The solar inverter is designed according to the state of the art and recognized safety regulations.
Applied standards:

- 2006/95 EC Low voltage directive
- DIN EN 50178 Electronic equipment for use in power installations
- 2004/108/EC Electromagnetic compatibility
- EN 61000-6-2 Electromagnetic compatibility, Immunity for industrial environments
- EN 61000-6-4 Electromagnetic compatibility, Emission for industrial environments

However, use of the device still holds risk for life and limb of operating staff or other persons as well as the risk of damaging the solar inverter and/or other tangible assets. Only use the solar inverter if it is in a technically perfect condition and in compliance with its designated use, aware of the risks involved, taking the required safety measures and in compliance with this user manual.
The solar inverter may only be used in photovoltaic applications for converting the electrical power generated by photovoltaic generators and feeding it into the supply grid. Any other use, connection of other generator types, shall be considered as not in compliance with the designated use. The manufacturer shall not be held liable for any damage resulting from such non-compliance. The sole risk shall be borne by the operator.
For the performance limits of the solar inverter, refer to chapter 4 "Technical data".

1.3 Misuse

Any use other than that described in "Designated use" shall not be permissible and shall be considered as misuse.
The following is not permitted:

- use by uninstructed staff,
- use of the device while it is not in perfect condition,
- without protection enclosure (e.g. doors, covers),
- without safety equipment or with safety equipment deactivated.

The manufacturer shall not be held liable for any damage resulting from such misuse. The sole risk shall be borne by the operator.

1.3.1 Explosion protection

The solar inverter is an IP 20 protection class device. For this reason, use of the device in explosive atmospheres is not permitted.

1.4 Residual risks

Residual risks are special hazards involved in handling of the solar inverter which cannot be eliminated despite the safety-compliant design of the device. Residual risks are not obviously identifiable and can be a potential source of injury or health hazard.

Electrical hazard

- Danger of contact with energized components due to a defect, opened covers or enclosures or improper working on electrical equipment.
- Danger of contact with energized components in solar inverter if no external disconnection device was installed by the customer.
- Danger of contact with still energized DC link capacitors.

Electrostatic charging

- Danger of electrostatic charging in case of equipotential bonding defect.

Thermal hazards

- Risk of accidents due to hot surfaces such as heat sink, transformer, fuse, sine filter.

Danger of tilting during transport

- Center of gravity is not the middle of the solar inverter.

1.5 Safety and warning signs at solar inverter

- Comply with all safety instructions and danger information provided on the solar inverter.
- Ensure that all safety instructions and danger information provided on the solar inverter are/is complete and legible.

1.6 Warning information and symbols used in the user manual

1.6.1 Hazard classes

The following hazard identifications and symbols are used to mark particularly important information:

⚠ DANGER

Identification of immediate threat holding a **high** risk of death or serious injury if not avoided.

⚠ WARNING

Identification of immediate threat holding a **medium** risk of death or serious injury if not avoided.

⚠ CAUTION

Identification of immediate threat holding a **low** risk of minor or moderate physical injury if not avoided.

NOTE

Identification of a threat holding a risk of material damage if not avoided.

1.6.2 Hazard symbols

Symbol	Meaning	Symbol	Meaning
	General hazard		Suspended load
	Electrical voltage		Hand injury
	Danger of crushing		Hot surfaces

1.6.3 Prohibition signs

Symbol	Meaning	Symbol	Meaning
	No persons with pacemakers		Fire, open flames forbidden
	No switching; it is forbidden to switch the machine, assembly on		No smoking

1.6.4 Personal safety equipment

Symbol	Meaning
	Wear body protection.

1.6.5 Recycling

Symbol	Meaning
	Recycling, to avoid waste, collect all materials for reuse.

1.6.6 Grounding symbol

Symbol	Meaning
	Ground connection

1.6.7 ESD symbol

Symbol	Meaning
	ESD: Electrostatic Discharge (can damage components and assemblies)

1.6.8 Information signs

Symbol	Meaning
	Tips and information making using the solar inverter RPS 450 easier.

1.7 Marking of text passages

Special passages in the user manual are marked by the following symbols:

- Marking of lists.
- Marking of instructions and information in safety instructions.

1.8 Conformity

The declaration of conformity will be supplied by the manufacturer upon request.

1.9 Directives and guidelines to be adhered to by the operator

The operator must follow the following directives and regulations:

- Ensure that the applicable workplace-related accident prevention regulations as well as other applicable national regulation are accessible to the staff.
- An authorized person must ensure, before using the solar inverter, that the device is used in compliance with its designated use and that all safety requirements are met.
- Additionally, comply with the applicable laws, regulations and directives of the country in which the solar inverter is used.

1.10 Operator's general plant documentation

- In addition to the user manual, the operator should issue separate internal operating instructions for the solar inverter. The user manual of the solar inverter must be included in the user manual of the whole plant.

1.11 Operator's/operating staff's responsibilities

1.11.1 Selection and qualification of staff

- Any work on the solar inverter may only be carried out by reliable staff. The staff must not be under the influence of any drugs. Note the minimum age required by law. Only employ qualified or instructed staff. Define the staff's responsibility in connection with all work on the solar inverter clearly.
- Work on the electrical components may only be performed by a qualified electrician according to the applicable rules of electrical engineering.

1.11.2 General work safety

- In addition to the user manual, any applicable legal or other regulations relating to accident prevention and environmental protection must be complied with. The staff must be instructed accordingly. Such regulations and/or requirements may include, for example, handling of hazardous media and materials or provision/use of personal protective equipment.
- In addition to this user manual, issue any additional directives that may be required to meet specific operating requirements, including supervision and reporting requirements, e.g. directives relating to work organization, workflow and employed staff.
- Do not change or modify the solar inverter in any way that might affect safety, unless such change or modification has been approved expressly by the manufacturer.
- Only use the solar inverter if the rated connection and setup values specified by the manufacturer are met. Only use original spare parts.
- Provide appropriate tools as may be required for performing all work on the solar inverter properly.

1.12 Organizational measures

1.12.1 General

- Train your staff in the handling and use of the solar inverter as well as the risks involved.
- Use of any individual parts or components of the solar inverter in other parts of the operator's plant is prohibited.

1.13 Handling and installation

- Do not commission any damaged or destroyed components.
- Prevent any mechanical overloading of the solar inverter. Do not bend any components and never change the isolation distances.
- Any use of damaged or destroyed components shall be considered as a non-compliance with the applicable standards.
- The solar inverter may only be installed in suitable operating rooms. The solar inverter is exclusively designed for installation in industrial environments.

1.14 Electrical connection

- The five safety rules must be complied with.
- Never touch terminals which are energized in operation because the capacitors may still be charged even if the device is switched off.
- When performing any work on/with the solar inverter, always comply with the applicable national and international regulations/laws on work on electrical equipment/plants.
- The cables connected to the solar inverter may not be subjected to high-voltage insulation tests unless appropriate circuitry measures are taken before.
- Connect the solar inverter only to supply grids suitable for this type of application.

1.14.1 The five safety rules

When working on/in electrical plants, always follow the five safety rules.

1. Isolate,
2. secure to prevent restarting,
3. check isolation,
4. earth and short-circuit,
5. cover or shield neighboring live parts.

1.15 Safe operation

- During operation of the solar inverter, always comply with the applicable national and international regulations/laws on work on electrical equipment/plants.
- Before commissioning and starting the operation, make sure to fix all covers and check the terminals and cables for tight fit. Check the additional monitoring and protective devices according to the applicable national and international safety directives.
- Never open the solar inverter during operation, nor perform any connection work. Only work on the solar inverter while it is deenergized.
- Solar inverters are energized with high voltage during operation, include rotating parts (fans) and have hot surfaces. Any unauthorized removal of covers, improper use, wrong installation or operation may result in serious injuries or material damage.
- Even some time after shutdown of the solar inverter, certain components, e.g. heat sink, transformer, fuse, filter may have a high temperature. Don't touch any surfaces directly after shutdown. Wear safety gloves where necessary.
- In order to avoid accidents or damage, only qualified staff and electricians may carry out the work such as installation, commissioning or setup.
- In the case of a defect of terminals and/or cables, etc., immediately disconnect the solar inverter from mains supply and the PV generator.
- Persons not familiar with the operation of solar inverter as well as children must not have access to the solar inverter. Do not bypass nor decommission any protective facilities.

1.16 Maintenance and service/troubleshooting

- Perform the maintenance work and inspections prescribed by the user manual carefully, including the specifications on parts/equipment replacement.
- Work on the electrical components may only be performed by a qualified electrician according to the applicable rules of electrical engineering. Only use original spare parts.
- Unauthorized opening and improper interventions can lead to personal injury or material damage. Repairs on the solar inverter may only be carried out by the manufacturer or persons authorized by the manufacturer. Check protective equipment regularly.
- Before performing any maintenance work, the solar inverter must be disconnected from mains supply, PV-generator and its own power supply and secured against restarting. The five safety rules must be complied with.

1.17 Utilities and operating materials

- Comply with all applicable environmental protection regulations. Ensure that all utilities and operating materials are disposed of properly.

2 Transport

2.1 Special safety instructions



⚠ WARNING

High weight and unusual center of gravity!

Tilting the solar inverter may result in death or serious injuries. Due to the size and weight of the solar inverter, there is the risk of accidents during transport. Center of gravity is not the middle of the solar inverter.

- Take utmost care during transport in order to prevent damage and deformation. Transport, attachment and lifting of loads may only be carried out by specially instructed staff who are familiar with the work.
- Take care when putting down the solar inverter.
- Only use suitable transport and lifting equipment with sufficient carrying capacity. The lifting cables/chains used must be able to carry the weight of the solar inverter. Check the ropes or chains for damage.
- Wear appropriate safety clothing.
- When lifting the solar inverter up ensure that it does not fall over, is displaced, swings out or falls down. Always use appropriate securing devices.
- Before the solar inverter is lifted up, everybody must have left the work area.
- Before transport, make sure the transport path has sufficient carrying capacity.
- Tilting the solar inverter is prohibited. Transport may only be effected in upright position.
- Do not step under suspended loads.

2.2 Dimensions/weight

For information on the weight and dimensions of the solar inverter, refer to chapter 4 "Technical data".

2.3 Marking of centre of gravity

The centre of gravity is marked on the packaging of the solar inverter.

Figure 2-1: Marking of centre of gravity

2.4 Crane transport

2.4.1 Transport by means of load frame

NOTE

Damaging of solar inverter

- Always use a load frame for transport. The tensile loads must act vertically on the solar inverter. If the tensile forces don't act vertically on the eye bolts, this will result in mechanical damage and distortion.

- Lift the solar inverter up carefully. Avoid putting it down abruptly.

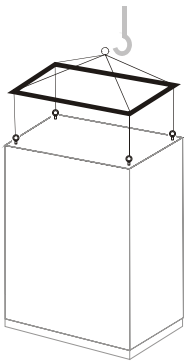
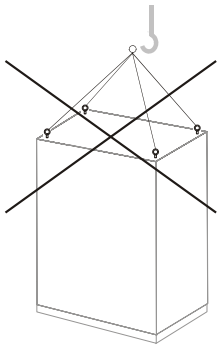


Figure 2-2: Transport by means of load frame



Not permissible.

2.4.2 Transport by means of crane fork

- Remove the base sheets on the front and rear side. See "Preparing the solar inverter for connection".
- Move the crane fork below the solar inverter.
- Lift the solar inverter up carefully. Avoid putting it down abruptly.
- After installation, mount the base sheets again.

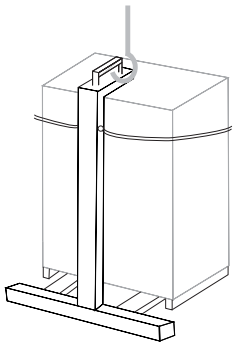


Figure 2-4: Transport by means of crane fork

2.4.3 Transport by means of (fork) lift truck

In exceptional cases, transport by means of a (fork) lift truck is permissible. Comply with the safety instructions in chapter 2 "Transport".

2.5 Storage

NOTE

Damaging of solar inverter

- Wrong or inappropriate storage may result in damage, e.g. due to moisture and dirt. Avoid major temperature variations and high air humidity.
- During storage, protect the solar inverter against moisture and dirt.

Ensure that all packaging materials are disposed of in an environmentally compatible manner.

3 Scope of supply

Immediately after delivery, check that the contents are undamaged (transport damage) and corresponds to the scope of the order.
Check if the specifications on the shipping not match the specification on the rating plate. Also check the type and completeness of any supplied accessories. Report any transport damage and missing articles to the forwarding agent immediately.

The following components are included in the scope of supply:
In the storage compartment on the inside of the solar inverter, you will find:

- Electrical cabinet key
- Circuit diagrams
- Foamed material seal for cable entry
- Instructions for grid monitoring device
- Option: data logger instructions

4 Technical data

Type						
RPS 450			-030	-060	-120	-170
DC side input						
Recommended maximum connected generator power[1]		kip	30	60	120	170
MPP area		V DC	425 ... 875			
Max. DC input voltage		V DC	900			
Max. DC input current		A	70	140	250	350
AC side output						
Mains voltage		V AC	400[2]			
Mains frequency		Hz	50[3]			
AC rated power		kW	27	54	108	150
Mains current (400 V grid)		A	39	78	156	217
Power factor			adjustable, > 0.99 at rated power			
Distortion factor		%	< 3			
Control voltage, external		-	230 V, 50 Hz, 16 A backup fuse			
Transformer						
Isolation level		-	according to EN 60726:2003			
Additional standards		-	EN 61558-2-4			
Efficiency						
Maximum efficiency		%	95,2	95,7	96,7	96,7
European efficiency		%	94,4	94,9	95,9	95,9
Consumption during night hours		W	20			
Mechanics						
Dimensions	W H[4] D	mm	600 1300 500	800 1500 600	1200 1700 800	1200 1700 800
Weight approx.		kg	400	650	950	1200
Degree of protection		-	IP 20[5]			
Environment						
Ambient temperature		°C	-10 ... 40[6]			
Rel. air humidity		%	15 ... 85, not condensing			
Rate of coolant air required		m^3/h	750	1500	3000	4500
Protection and monitoring						
Insulation monitoring			50kΩ, fixed tripping value			
Grid monitoring			adjustable voltage and frequency range			
Overvoltage protection			EN Type 2, IEC Class II on mains and generator side			

Due to tolerances, deviations from the data specified here are possible.

For higher power levels, BONFIGLIOLI VECTRON offers a modular system.

[1] other power classes on request
[2] other mains voltages on request
[3] other mains frequencies on request
[4] Solar inverters with a higher degree of protection will be higher
[5] Higher degrees of protection optional
[6] In a higher ambient temperature, the AC rated power will be lower (derating)

5 Product overview / Description of function

The devices of the RPS 450 series are grid-coupled solar inverters used for feeding the power generated by PV modules to the supply grid.
The solar inverter works fully automatically, i.e. no manual intervention is required for feed-in operation.
The solar inverter starts feeding to grid automatically as soon as the PV modules produce enough power after sunrise. Before that, the control and regulation unit starts to monitor the grid voltage and frequency as well as the isolation resistance.
The display of the control unit integrated in the solar inverter displays information on the plant.
The solar inverter works in a way that ensures that the maximum power is taken up from the PV modules.
As soon as the energy supplied by the PV modules is no longer enough to supply power to the grid (dawn), the solar inverter disconnects from the grid and shuts down. All settings and saved data are maintained. Manual shutdown is also possible. The startup and shutdown behaviour can be configured.

5.1 Product variants/overview of components

5.1.1 RPS 450-030

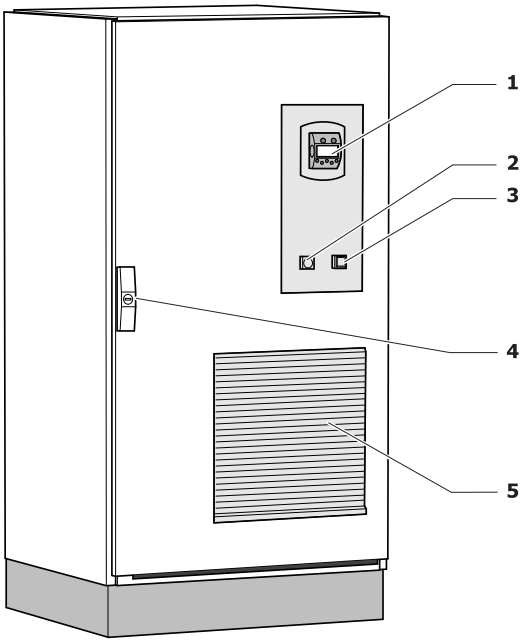


Figure 5-1: RPS 450-030 outside view

RPS 450-030			
1	Control unit KP500	4	Lock
2	Control switch Start/Stop	5	Air inlet filter
3	Illuminated reset button		

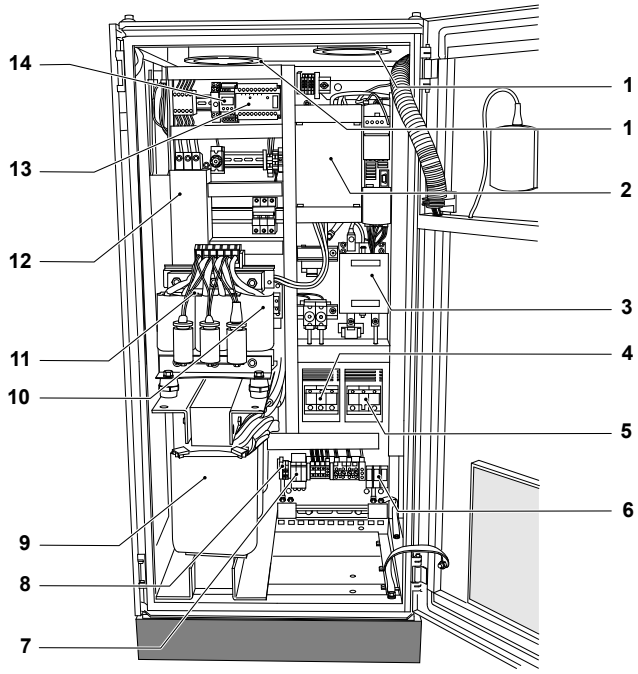


Figure 5-2: RPS 450-030 inside view

RPS 450-030			
1	Fan	8	Overvoltage protection - control voltage
2	Frequency inverter AEC	9	Isolating transformer
3	DC radio interference filter	10	Main contactor (behind sine filter)
4	AC Fuse disconnector	11	Sine filter
5	DC Fuse disconnector	12	AC radio interference filter
6	DC overvoltage protection	13	Insulation monitoring
7	Overvoltage protection - grid	14	Grid monitoring

Details of the layout may differ from the layout shown above.

5.1.2 RPS 450-060

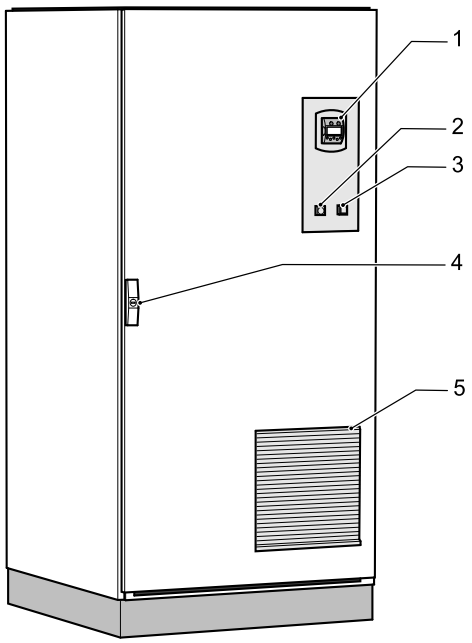


Figure 5-3: RPS 450-060 outside view

RPS 450-060			
1	Control unit KP500	4	Lock
2	Control switch Start/Stop	5	Air inlet filter
3	Illuminated reset button		

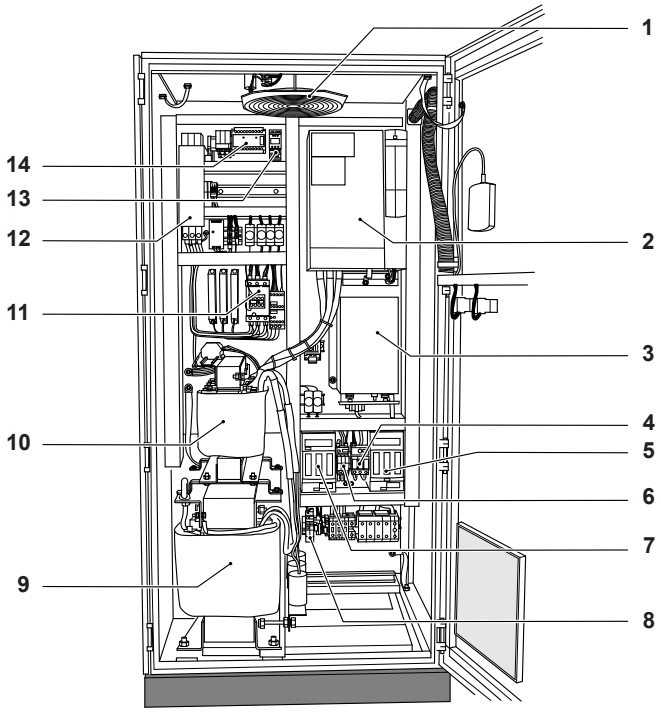


Figure 5-4: RPS 450-060 inside view

RPS 450-060			
1	Fan	8	Overvoltage protection - control voltage
2	Frequency inverter AEC	9	Isolating transformer
3	DC radio interference filter	10	Sine filter
4	DC overvoltage protection	11	Main contactor
5	DC Fuse disconnector	12	AC radio interference filter
6	Overvoltage protection - grid	13	Grid monitoring
7	AC Fuse disconnector	14	Insulation monitoring

Details of the layout may differ from the layout shown above.

5.1.3 RPS 450-120/170

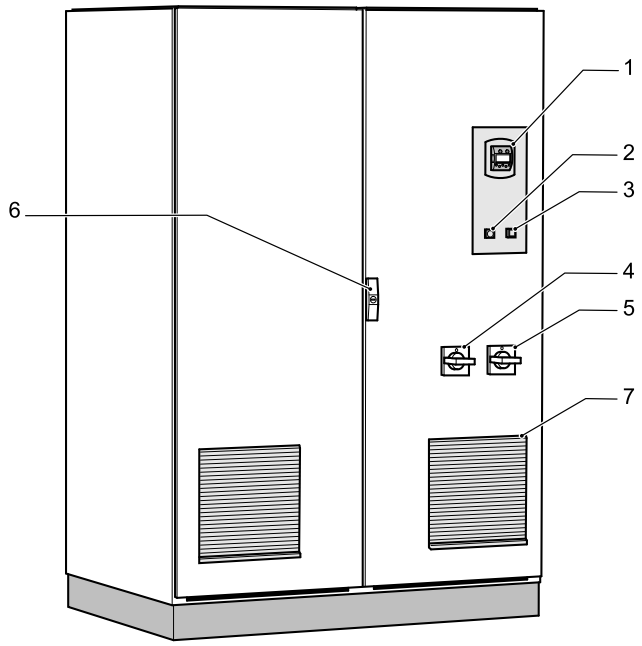


Figure 5-5: RPS 450-120/170 outside view

RPS 450-120/170			
1	Control unit KP500	5	DC main switch for cutting off the connection to PV field
2	Control switch Start/Stop	6	Lock
3	Illuminated reset button	7	Air inlet filter
4	AC main switch for cutting off the connection to the grid		

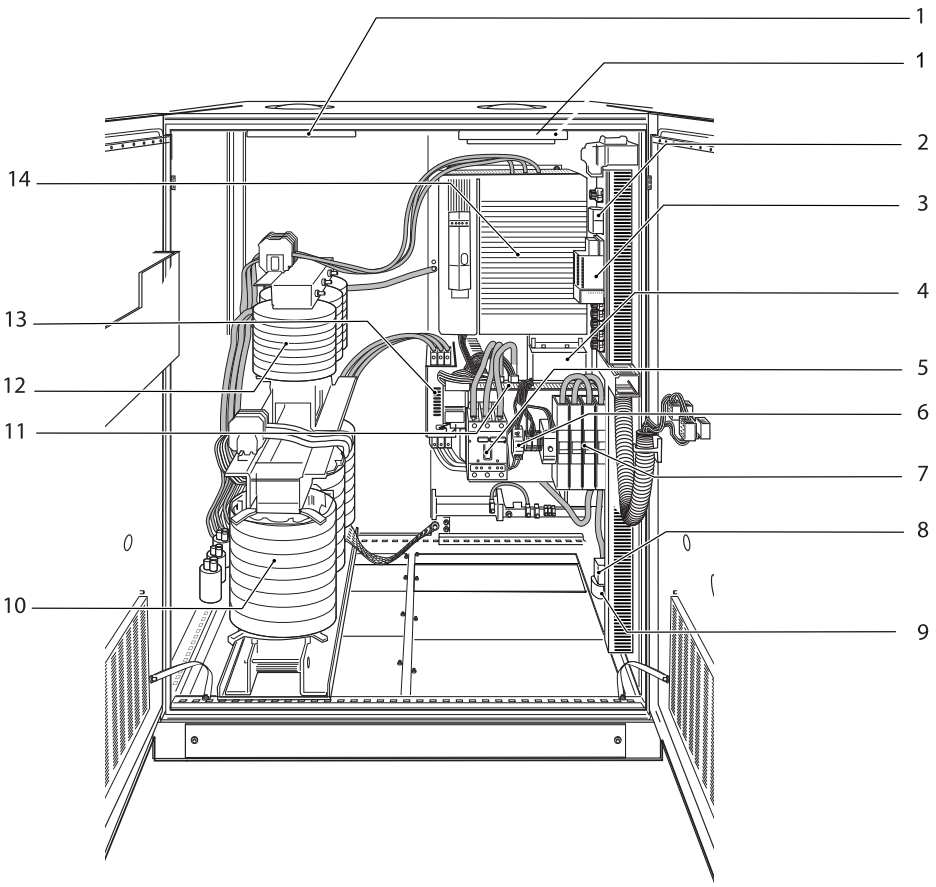


Figure 5-6: RPS 450-120/170 inside view

RPS 450-120/170			
1	Fan	8	DC overvoltage protection
2	Grid monitoring	9	Overvoltage protection - grid
3	Insulation monitoring	10	Isolating transformer
4	DC radio interference filter	11	Main contactor (behind of mounting plate)
5	AC main switch	12	Sine filter
6	Overvoltage protection - control voltage	13	AC radio interference filter
7	DC main switch	14	Frequency inverter AEC

Details of the layout may differ from the layout shown above.

5.1.4 Optional equipment

The following optional components can be integrated in the solar inverter:

- Control transformer for internal 230 V power supply (if no external 230 V supply available at place of installation),
- Interface converter from RS232/RS485 to Ethernet for plant monitoring,
- Data logger for data management, data storage and plant monitoring.

The standard variant features a RS485 communication module for plant monitoring and configuration via PC/notebook. This module can be replaced by an optional communication module for RS232, Profibus DP, CANopen or Ethernet.

5.1.5 Rating plate

Figure 5-7: Rating plate - example

The inverter type is identified by the rating plate. This is located on the inside of door and on the outside of the side panel of the solar inverter.

RPS 450-120

Recommended connected DC generator power (peak power) [kWp]

5.2 Function of RPS 450 and block diagram

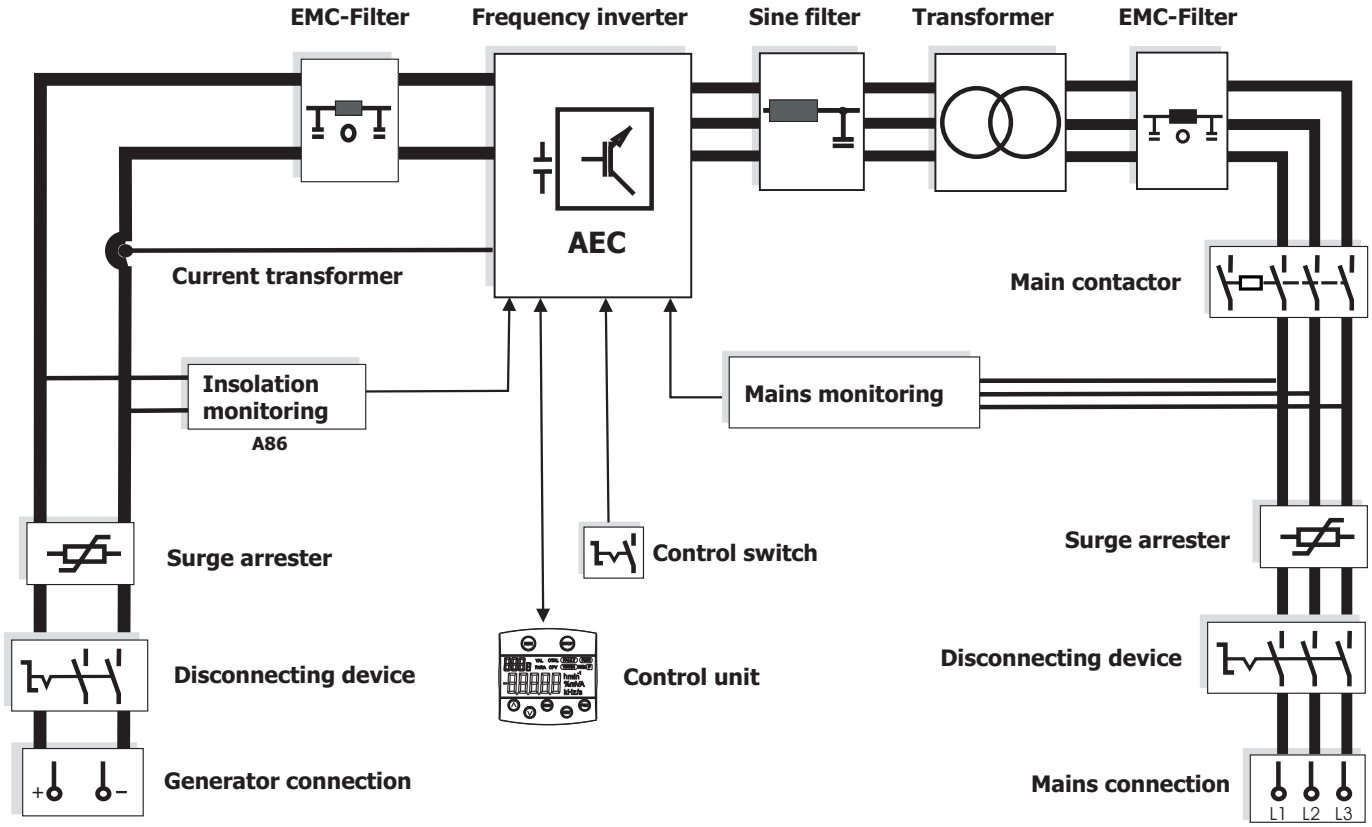


Figure 5-8: Block diagram RPS 450

If the DC disconnector is switched on, the energy coming from the PV field reaches the frequency inverter via the DC EMC filter. Surge arresters in the DC input protect the solar inverter against destructive overvoltage coupling from the PV field. In the case of an earth fault in the PV field or the components connected to the PV field, up to the isolating transformer, the insulation monitoring instrument responds. The response threshold is set permanently.

The frequency inverter controls the solar inverter. As from a DC voltage of 300 V, grid monitoring and insulation monitoring are activated.

If another voltage threshold is exceeded, the solar inverter will begin to determine the current power of the PV field if

- the solar inverter is enabled via the control switch and
- no error is signalled.

If the power assessment shows that the power currently produced by the PV field is greater than the power loss of the solar inverter, the main contactor is switched on. Now, the frequency inverter is connected to the grid via the filters and the transformer. One auxiliary contact of the main contactor activates feed-in mode and the MPP controller. The MPP controller adjusts the DC voltage such that a power optimum is obtained.

If the insolation becomes so weak that the power of the PV field is no longer enough for economical operation of the solar inverter, the AC EMC filter, isolating transformer, sine filter and frequency inverter are disconnected from the AC grid again.

If the DC voltage drops further in the evening, supply of the monitoring equipment is stopped, too.

5.3 Monitoring and protective functions

⚠ DANGER

Live components - risk of electric shock !

- Only qualified electrical staff may inspect the monitoring equipment.
- High mains voltage and high DC voltage from solar modules.
- Using suitable protective equipment, secure live components in the work area to prevent contact.

5.3.1 Grid monitoring

A mains monitoring device with combined voltage and frequency monitoring is installed in the solar inverter. Adjustment is not required. By default, this monitoring function is set to suitable values.

- The response values are adjustable,
- Error message F0405 "Grid failure" is triggered if the grid voltage or frequency is outside of the adjusted range

5.3.2 Insulation monitoring

Mostly, solar power systems are IT-Systems. The insulation monitoring is for the detecting of insulation faults in the positive or negative pole of the PV-Generator, which are caused by damage in the insulation. In the case of earthed solar power plants an earth fault control is used instead of an insulation monitoring. See also chapter 5.3.3 Earth fault control (EFC).

- Fixed response value
- Error message F0404 "Insulation" if value drops below 50 kΩ

5.3.3 Earth fault control (EFC)

5.3.3.1 General Information

The use of certain module types requires earthing of the PV generator at the negative or positive pole. The solar inverters designed for this application, are provided with high-performance circuit breakers with adjustable trip current. The insulation monitor required for IT systems is not required in this case. The high-performance circuit breaker signals earth faults at the non-grounded pole. In the case of an earth fault at the non-grounded pole, a current will flow between the defective area and the earth fault controller. This results in a tripping of the high-performance circuit breaker. Grounding of the grounded pole is stopped as soon as the earth fault control has tripped.

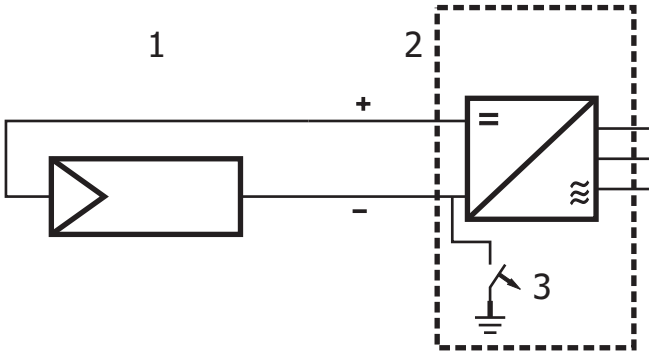


Figure 5-9: Earth fault control with grounding at the negative pole of the PV-Generator

1	PV-Generator	3	Earth fault control
2	RPS 450-		

Under certain circumstances, it may take a long time until an earth fault in the non-grounded pole results in the earth fault control being tripped. It might not even be tripped at all. Irradiation and the earth resistance influence the fault current. In the case of high earth resistance or low irradiation, particularly with low-power inverters, an earth fault in the non-grounded pole will not result in tripping of the earth fault control immediately.

NOTE

Requirements to be met by the plant

The following instructions must be followed:

- Ensure short-circuit and earth fault safe installation of the DC cables
- Ensure good reference to grounding of solar inverter
- The insulation monitor of the solar inverter does not exist in the case of grounded positive or negative pole. Both poles must be protected against direct contact.
- Grounding may only be effected in the solar inverter, additional earthing in the PV generator or the connection boxes is not permissible.

The tripping of the earth fault control results in error message F0404 "Insulation". Before the inverter can be commissioned again, the insulation fault must be repaired. Operation of the solar inverter with the earth fault control tripped is not permissible.

⚠ DANGER

Live components - Risk of electric shock!

- EFC protects the equipment only, it does not protect persons. Grounded PV plants may only be accessed by qualified and instructed electricians. If the plant is to be accessed by non-instructed staff, the grounding must be undone.

5.3.3.2 Operating behavior

An earth fault in the grounded pole has a negative impact on earth fault control and plant operation. For this reason, the insulation of the grounded pole must be checked at regular intervals to ensure that there is no earth fault at the grounded pole.

In the case of an earth fault at the grounded pole, part of the total current will flow through the earth fault controller during operation and can result in the EFC being tripped.
In the case of an earth fault at both poles, earth fault control will have no effect. The fault current will not flow through the earth fault controller and the circuit cannot be opened for this reason. This might damage the plant.

NOTE

Maintenance work

The following instructions must be followed:

- The generator grounding is undone when the DC disconnector in the solar inverter is opened. Insulation measurements may only be carried out on the PV generator when the solar inverter DC disconnector is open.

Setup values	
Setting range	Factory settings
3,8 A to 5,8 A	3,8 A

5.3.4 Temperature monitoring

The inside temperature and the heat sink temperature of the frequency inverter as well as the temperature of the sine filter and transformer are monitored.

- Temperature switches in coils of sine filter and line choke
  Fault message F0403 "Transformer overtemperature" if winding temperature is too high
- Power reduction if max. permissible temperature of frequency inverter is reached
  Fault message F0200 "Heat sink overtemperature" if maximum heat sink temperature is exceeded
  Fault message F0300 "Inside temperature" if maximum inside temperature is exceeded
  Fault message F0301 "Undertemperature" if minimum inside temperature is not reached
- Electrical cabinet temperature control, fan activation temperature can be parameterized

5.3.5 Surge arrester

- Overvoltage protection on AC and DC side
- Arrester class: EN type 2, IEC class 2, VDE class C
- Safe protection can be reached by external lightning protection provided by the customer, e.g. lightning arresters, arrester class EN type 1, IEC class 1, VDE class B.
- Error indication by visual signalling at surge arresters
- A warning or error message is displayed on the control unit if the surge arrester is not functional. Also refer to chapter 9.12.2 "Operation mode - Overvoltage protection".
  - Warning W8000 "Overvoltage protection" in setting "1 – Warning" (default setting) for *Operation mode - Overvoltage protection* **828**
  - Error F0406 "Overvoltage protection" in setting "2 – Error cut-off" for *Operation mode - Lightning protection* **828**. The solar inverter is switched off

6 Installation

6.1 Place of installation/environmental conditions

NOTE

Damaging of solar inverter

If not installed properly or if installed in inappropriate environments, the solar inverter may be damaged. The following instructions must be followed:

- Install the solar inverter in a closed, well-ventilated environment (technical equipment room), protected against rain, condensation, moisture and dust. Note the degree of protection.
- The temperature at the place of installation must be between 0 and 40 °C.
- Do not expose the solar inverter to direct sun impact at the place of installation.
- Relative air humidity must be in the range between 15% and 85%.
- The solar inverter must not be exposed to condensation water.
- The inlet and outlet filters must not be covered nor closed.
- The heat produced in the solar inverter is dissipated to the outside by means of roof fans. Keep a minimum distance of 500 mm to the ceiling.
- Do not place any objects on the solar inverter. Keep the top side of the solar inverter clear.
- The equipment room must not be heated up by the air discharged from the solar inverter.
- Install the solar inverter on level and non-slip floor. The floor and the environment must be non-flammable.
- The foundation must be designed to bear the weight of the solar inverter (sufficient carrying capacity).
- If necessary, install cable conduits in the foundation of the place of installation. The connecting cables can enter the solar inverter from below.
- Align the solar inverter on the floor such that it is straight.
- Ensure there is sufficient space for escape routes and for operating and maintenance work.
- BONFIGLIOLI VECTRON recommends installing a smoke detector in the equipment room.
- EMC and noise emission of the solar inverter are designed for operation an industrial environment.

6.2 Cooling

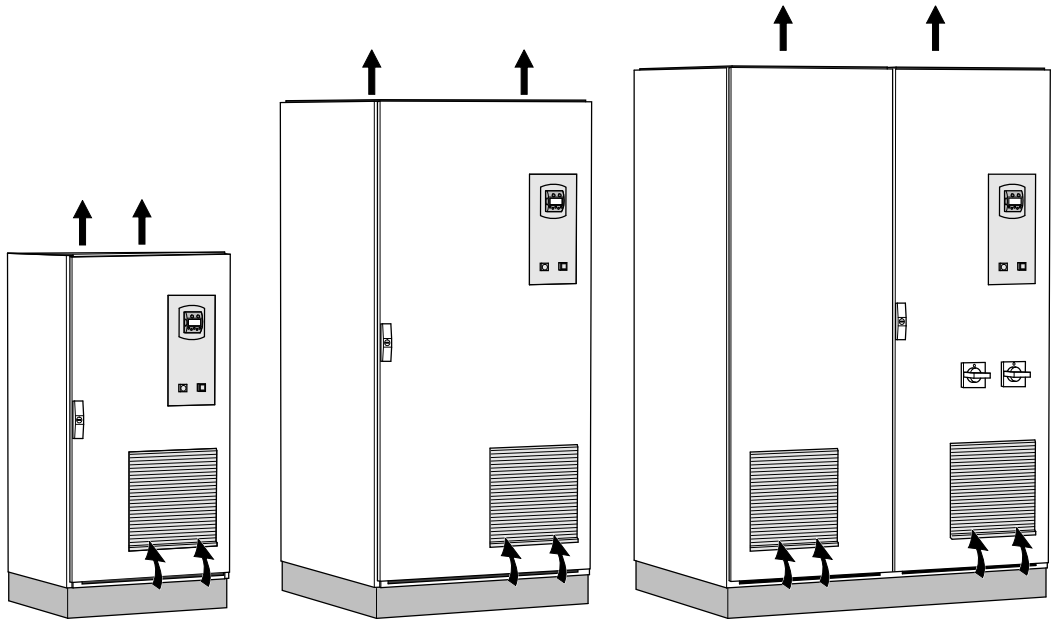


Figure 6-1: Air flow

For cooling the solar inverter, the cooling air is taken in through the ventilation openings in the doors and blown off via the fans in the upper area of the inverter. Air filters are provided in the ventilation openings. It is possible to install several solar inverters side by side.

NOTE

Damaging of solar inverter

For the minimum and maximum ambient temperature and relative moisture, refer to the table in chapter 4 "Technical data".

For the cooling air requirements, refer to the table in chapter 4 "Technical data".

If the specified cooling air values cannot be reached, the operator must install additional ventilation equipment at the place of installation.

If the cooling air is very dirt-loaded, the operator must install additional filters (e.g. in building).

When the unit leaves the factory, the overtemperature cut-off and the parameters for control of the electrical cabinet fans are set to suitable values.

6.3 Distance to ceiling

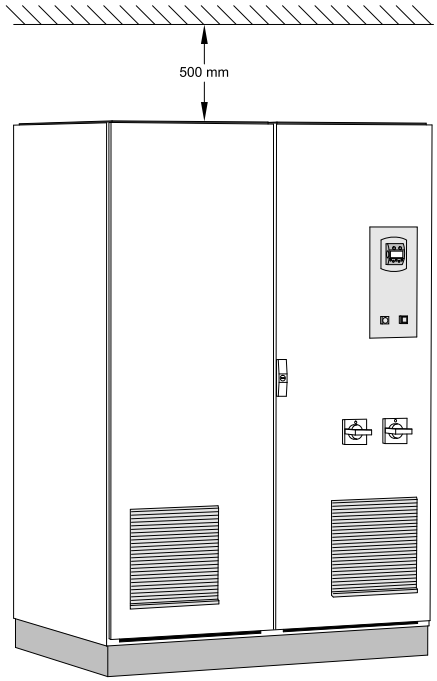


Figure 6-2: Distance to ceiling

NOTE

Damaging of solar inverter

All solar inverters must keep a distance to the ceiling of at least 500 mm.

7 Electrical connections

7.1 Special safety instructions

⚠ DANGER

Live components - Risk of electric shock!

In the case of improper installation, accidents or material damage may result from non-compliance with the safety instructions. Note:

- High mains voltage and high DC voltage from solar modules.
- The unit may only be connected with the power supply to the solar inverter switched off.
- The solar inverter must be isolated safely from the PV generator and the grid.
- Switch off external isolation provisions. Secure to prevent restarting.
- Verify safe isolation from power supply.
- Earth and short-circuit.
- Even with the AC and DC disconnectors turned off, dangerous voltage levels may be present in the solar inverter. This is the case if:
  - No external isolation facility is installed and turned off.
  - The DC link capacitors are still charged. Wait for some minutes until the DC link capacitors have discharged before starting to work at the solar inverter.
- Using suitable protective equipment, secure live components in the work area to prevent contact.

Depending on the power class, details of the electrical connection may differ from the layout shown above.

Lightning protection
The DC and AC side of the solar inverters are protected by type 2 surge arresters against overvoltage. In order to achieve lightning protection as per DIN VDE 0185-4, additional lightning arresters must be installed on the building or in the plant.

Tools
For electrical connection provide the following tools:
Stripping tool
Crosshead screw driver
Slotted screwdriver
Torx screw driver
Allen wrench
Torque wrench

Cable installation
The cables must be prepared properly by the operator before connection, i.e. sufficient length and cross-section.

7.2 Preparing the solar inverter for connection

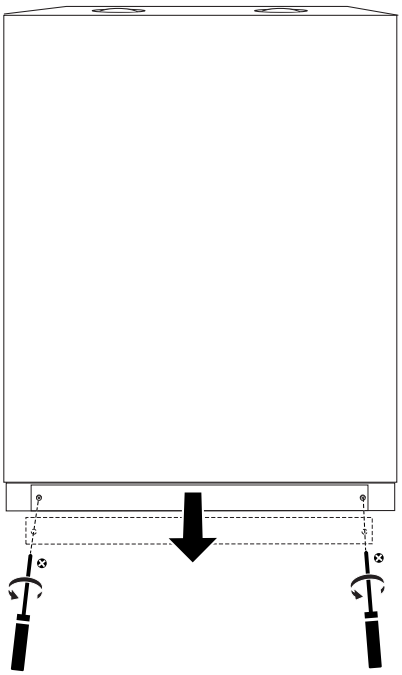


Figure 7-1: Disassembly of base sheets

1. For cable entry, any base sheet can be removed. This is only required if no cable conduit is provided in the foundation for guiding the cables into the solar inverter from below. Remove the base sheet in the rear part of the solar inverter. If cables are to enter from the side, the side base sheet must be removed.
2. If the cables enter from the side/rear, cut suitable holes in the base sheet for the cable glands.

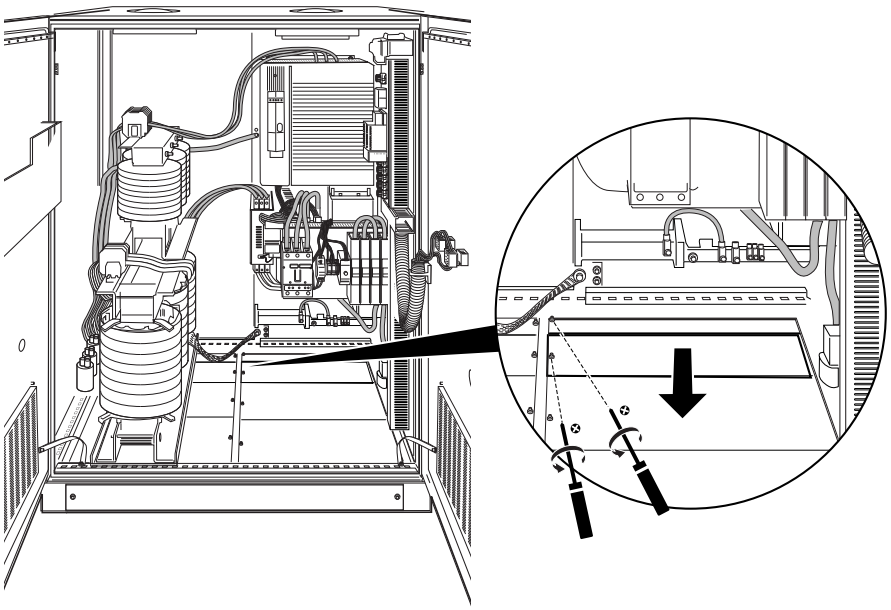


Figure 7-2: Disassembly of bottom sheet (only required in the case of RPS 450-120/170)

3. Remove the bottom sheets in the rear part of the solar inverter.
4. Pull the connecting cables into the solar inverter.

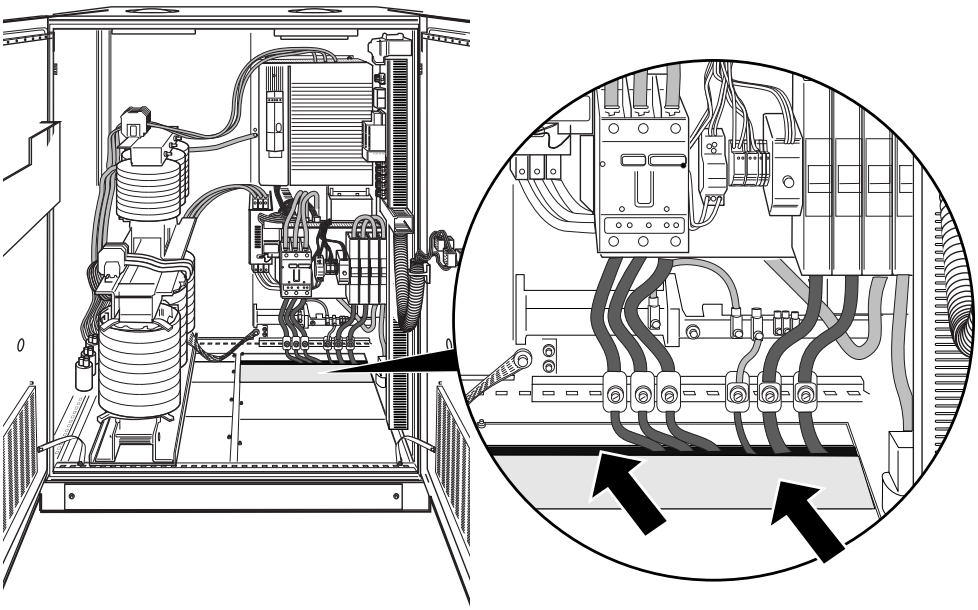


Figure 7-3: Assembly of bottom plate

5. For strain relief, fix the feeder cables to the cable clamp rails using suitable cable clamps made of aluminium.
6. Using the supplied foamed material seal, seal the open area in the solar inverter. All cable entries must be sealed tightly in order to prevent intake of unfiltered air.
7. Fix the base sheets again.

7.3 Execution of electrical connection

7.3.1 Notes

NOTE

Damaging of solar inverter

- The values specified in "Technical data" for maximum DC input voltage and maximum DC input current must not be exceeded. Otherwise the solar inverter may be damaged.
- When connecting the DC cables ensure that the polarity of the solar modules matches the polarity of the DC connections. Prevent short circuits between DC+ and DC-.

7.3.2 Circuit diagrams

You will find the relevant circuit diagrams on the inside of the solar inverter door.

7.3.3 RPS 450-030

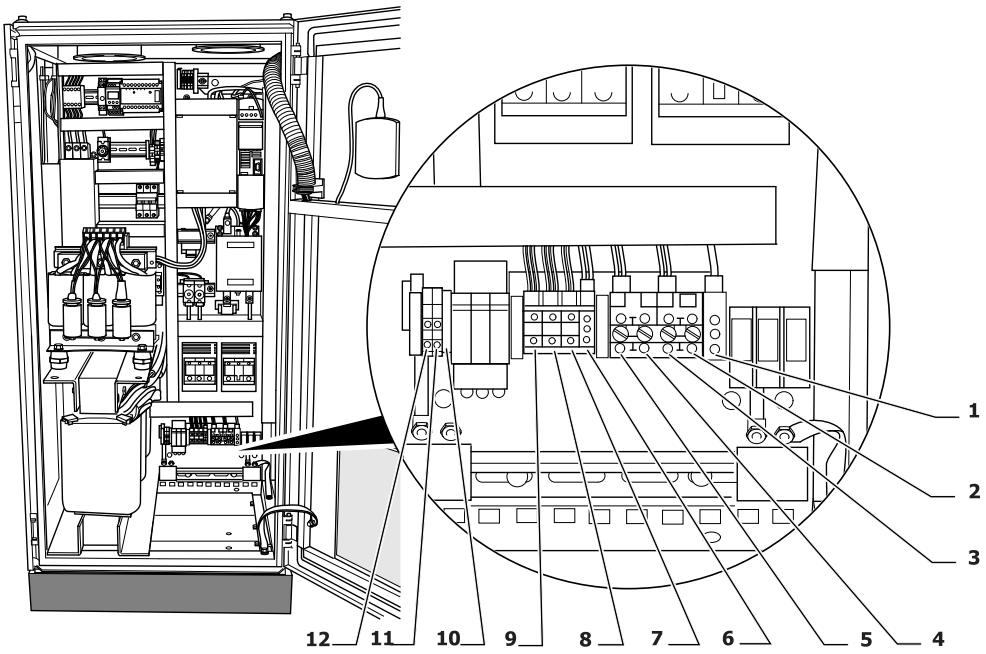


Figure 7-4: Connection RPS 450-030

1	PE connection	7	AC connection L3
2	DC connection -	8	AC connection L2
3	DC connection -	9	AC connection L1
4	DC connection +	10	PE connection
5	DC connection +	11	Control voltage L0
6	PE connection	12	Control voltage L10

Before connecting the solar modules, verify if the voltage value of the solar modules as specified by the manufacturer match the actual values. When measuring the voltage, note that solar modules supply a higher DC voltage if the insolation remains the same while temperatures drop.

7.3.3.1 DC connection

- The PV generator is connected to terminals DC- and DC+.
- Use wire-end ferrules for connection.
- Ensure that the cross-section and voltage resistance of the cables is sufficient.
- Note the maximum cable cross-section.
- Do not exceed the specified tightening torques.
- Conform to the norm VDE 0100-712 an external load break switch must be installed on the DC voltage side between photovoltaic generator and solar inverter.

DC connection		
Max. cable cross section	mm^2	35
Tightening torque	Nm	3,2 … 3,7

7.3.3.2 AC connection

- The PV generator is connected to terminals L1, L2, L3, PE.
- Make sure to connect the AC cables considering the correct phase sequence to obtain a clockwise field of rotation at the terminals.
- Use wire-end ferrules for connection.
- Ensure that the cross-section and voltage resistance of the cables is sufficient.
- Note the maximum cable cross-section.
- Note that the cross-section of PEN or PE is sufficient.
- Do not exceed the specified tightening torques.

AC connection		
Max. cable cross section	mm^2	16
Tightening torque	Nm	1,5 … 1,8
Recommended back-up fuse	A	63

7.3.4 RPS 450-060

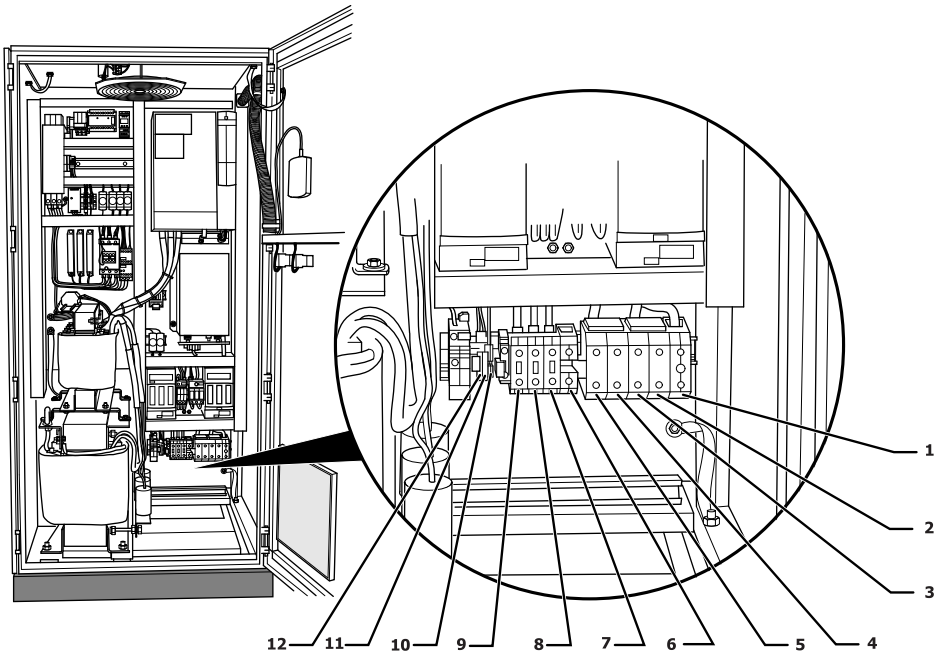


Figure 7-5: Connection RPS 450-060

1	PE connection	7	AC connection L3
2	DC connection -	8	AC connection L2
3	DC connection -	9	AC connection L1
4	DC connection +	10	PE connection
5	DC connection +	11	Control voltage L0
6	PE connection	12	Control voltage L10

Before connecting the solar modules, verify if the voltage value of the solar modules as specified by the manufacturer match the actual values. When measuring the voltage, note that solar modules supply a higher DC voltage if the insolation remains the same while temperatures drop.

7.3.4.1 DC connection

- The PV generator is connected to terminals DC- and DC+.
- Use wire-end ferrules for connection.
- Ensure that the cross-section and voltage resistance of the cables is sufficient.
- Note the maximum cable cross-section.
- Do not exceed the specified tightening torques.
- Conform to the norm VDE 0100-712 an external load break switch must be installed on the DC voltage side between photovoltaic generator and solar inverter.

DC connection		
Max. cable cross section	mm^2	95
Tightening torque	Nm	15 … 20

7.3.4.2 AC connection

- The PV generator is connected to terminals L1, L2, L3, PE.
- Make sure to connect the AC cables considering the correct phase sequence to obtain a clockwise field of rotation at the terminals.
- Use wire-end ferrules for connection.
- Ensure that the cross-section and voltage resistance of the cables is sufficient.
- Note the maximum cable cross-section.
- Note that the cross-section of PEN or PE is sufficient.
- Do not exceed the specified tightening torques.

AC connection		
Max. cable cross section	mm^2	50
Tightening torque	Nm	6 … 8
Recommended back-up fuse	A	100

7.3.5 RPS 450-120/170

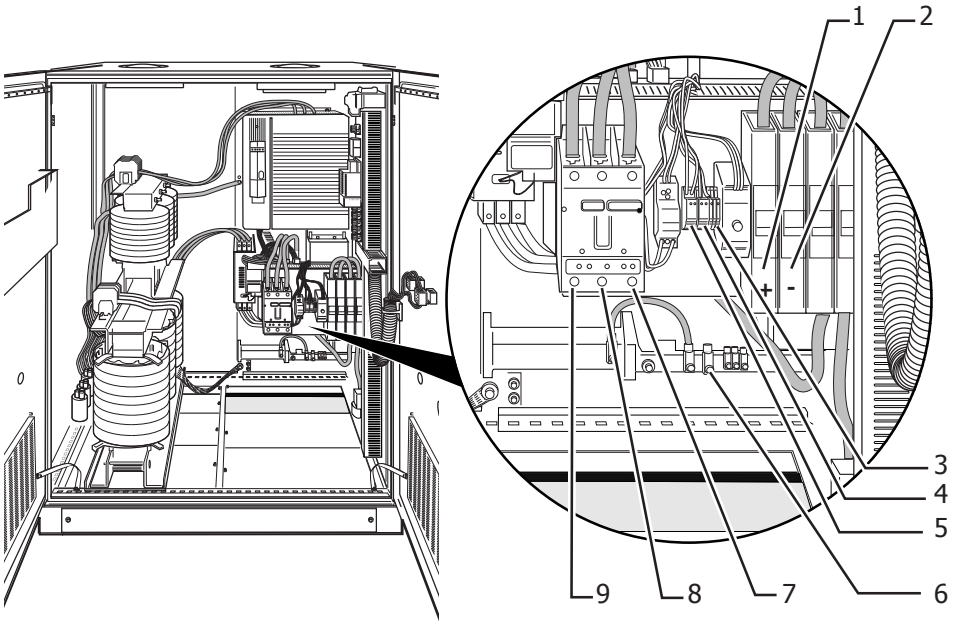


Figure 7-6: Connection RPS 450-120/170

1	DC connection +	6	PE connection
2	DC connection -	7	AC connection L3
3	PE connection	8	AC connection L2
4	Control voltage L0	9	AC connection L1
5	Control voltage L10		

Before connecting the solar modules, verify if the voltage value of the solar modules as specified by the manufacturer match the actual values. When measuring the voltage, note that solar modules supply a higher DC voltage if the insolation remains the same while temperatures drop.

7.3.5.1 DC connection

1. Pull off the two left covers of the DC main switch.
2. Connect the positive pole and the negative pole of the PV field to the terminals of the DC main switch. After connection of a pole, fix its cover before connecting the other pole.

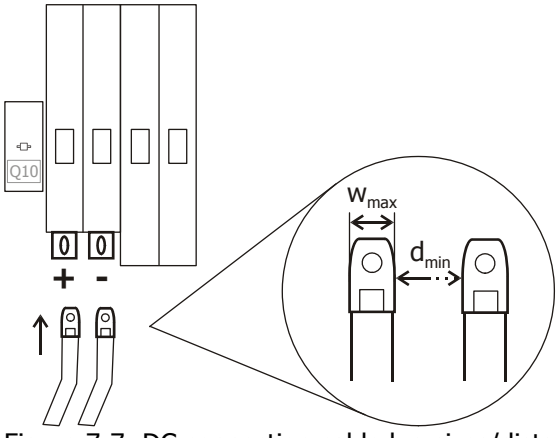


Figure 7-7: DC connection cable lug sizes/distances

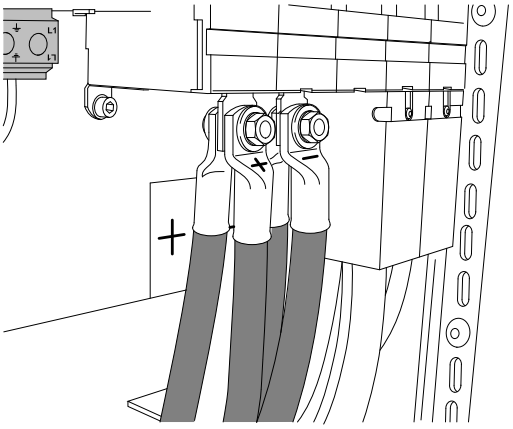


Figure 7-8: DC connection RPS 450-120/170 with two cables per pole

3. After installation, the covers of the DC main switch must be fixed again.
4. Between the fixed cable lugs at the positive and negative pole, the specified minimum distance d_{min} must be kept.
5. Do not exceed the maximum width w_{max} of the cable lugs.

- Use cable lugs for connection.
- Ensure that the cross-section and voltage resistance of the cables is sufficient.
- Note the maximum cable cross-section.
- Do not exceed the specified tightening torques.

DC connection			
RPS 450		**-120**	**-170**
Fixture		Bolt M8 x 25	Bolt M10 x 30
Minimum distance between cable lugs d_{min}	mm	10	10
Max. width of cable lugs w_{max}	mm	26	34
Tightening torque	Nm	15 … 22	30 … 44

7.3.5.2 AC connection

- Mains connection is performed directly at the main switch.
- Make sure to connect the AC cables considering the correct phase sequence to obtain a clockwise field of rotation at the terminals of the AC main switch.
- Use wire-end ferrules for connection.
- Ensure that the cross-section and voltage resistance of the cables is sufficient.
- Note the maximum cable cross-section.
- Note that the cross-section of PEN or PE is sufficient.
- Do not exceed the specified tightening torques.

AC connection			
RPS 450		**-120**	**-170**
Max. cable cross section	mm^2	95	120
Max. tightening torque	Nm	14	14
Recommended back-up fuse	A	200	250

7.3.6 Control voltage

Depending on the design of the solar inverter, the 230 V power supply for the solar inverter controller can be generated internally or supplied via a connected external power source.
If an internal 230 V power supply is available, no external power supply may be connected.
An external 230 V power supply must be connected to the terminal provided for this purpose. Power must be supplied from a source designed for this purpose. The operator must ensure that the 230 V power supply is protected by means of a 16 backup fuse.

Internal power supply for controller
A control transformer is installed. Power supply for the controller of the solar inverter is tapped internally from the AC mains supply. No power supply may be connected to the control voltage terminals.

External power supply for controller
A control transformer is not installed.

- Connect an external 230 V/50 Hz power supply (P_{min} = 400 W) to the terminals designated for that purpose (L10, L0, PE).

Connection		
Max. cable cross section	mm^2	2.5
Max. tightening torque	Nm	0.6
Recommended back-up fuse	A	16

Use wire-end ferrules.
Protect the external 230 V power supply by means of a 16 A back-up fuse.
The following components are connected to the 230 V power supply:

- Contactors
- Insulation monitoring
- Grid monitoring
- Electrical cabinet fan
- Options, extensions

7.3.7 Communication

Solar inverters can be connected to form a bus system. The bus structure is linear. Via a bus Master, up to 30 frequency inverters can be addressed. This enables communication connection to a data logger RPSlog. Additionally, solar inverter data can be polled and set during operation via the bus system by means of a PC or a PLC.

- A twisted and shielded cable is to be used for the RS485 bus line.
- The shield must be a braided shield (no foil shield).
- The shield is to be connected to PE properly on both sides (large contact surface).
- The so-called semi-duplex/2-wire method is the transmission method used.

7.3.8 RS485 assembly CM-485T

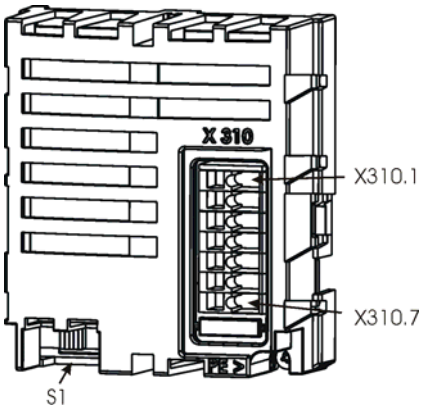


Figure 7-9: RS485 assembly

The RS485 assembly can be found on the frequency inverter AEC.
For details on the pin assignment, refer to the following table

Bus connector X310 CM-485T (7-pin terminal strip)		
Terminal	**Name**	**Function**
1	A	Short-circuit proof and functionally insulated; max. current 60 mA
2	A'	Bridge from pin 1 for cable loops
3	B	Short-circuit proof and functionally insulated; max. current 60 mA
4	B'	Bridge from pin 3 for cable loops
5	+5 V	Supply voltage interface converter +5 V
6	0 V	Earth / GND
7	PE	Shield

The connection of the RS485-Interface is done via terminal **X4.2** which can be found in the bottom area of the cabinet. The shield should be connected via the shield terminal to the designated shield busbar. More details of wiring can be found in the circuit diagram which is enclosed to the cabinet.

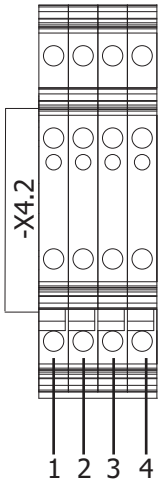


Figure **7-10:** RS-485 connection terminal block

Details of the assignment of terminal block X4.2 are listed in the following table.

Terminal block X4.2		
Terminal	**Name**	**Function**
1	A	Short-circuit proof and functionally insulated; max. current 60 mA
2	A’	Bridge from pin 1 for cable loops
3	B	Short-circuit proof and functionally insulated; max. current 60 mA
4	B’	Bridge from pin 3 for cable loops

7.3.9 Bus termination

The physically first and last client must be terminated, i.e. provided with a bus termination resistor. In the case of the CM-232 and CM-485, you can use DIP switch S1 to that end, see Figure 7-9: RS485 assembly”. This is a passive termination.
By default, the bus termination is OFF

NOTE

- Ensure proper bus termination. Otherwise, communication via the RS485 interface is not possible.
- Active termination is permissible only once per network. Termination via an external circuit and the DIP switch at the same time is not permissible.
- Ensure that the GND is not interrupted. In practice, this result in a better fault behaviour.
- The terminals for signals A and B are parallel. This enables wiring of several inverters.

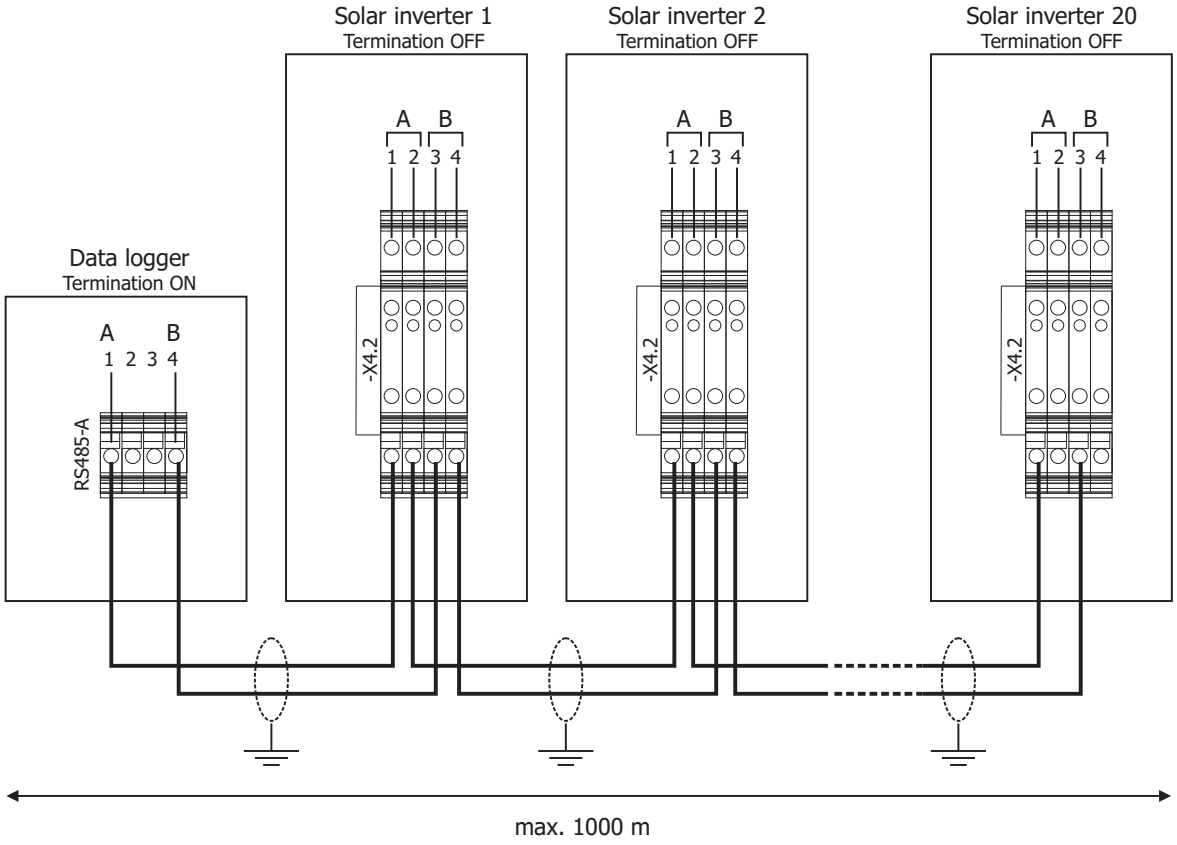


Figure 7-11: Wiring example

NOTE

- With a data logger RPS log it is possible to record data from up to twenty solar inverters. For details on the data logger, refer to the separate RPSlog1000 user manual.

8 Operation

8.1 Special safety instructions

⚠ DANGER

Live components - Risk of electric shock!

- When shutting down the plant, note that an active power source is connected. Depending on the operating status, voltage from the PV generator or the solar inverter may be present.
- The control switch is no isolating device. By turning the solar inverter off via the control switch, the solar inverter is not disconnected from power supply of the PV field. For full disconnection, all main switches and external isolating devices must be opened.
- High DC voltages (without zero transition) can cause light arcs and damage components in case of malfunctions, improper installation or improper handling of plug contacts and fuses.
- The short-circuit current of the PV field depends on the insolation and only slightly higher than the maximum operating current. Short circuits in the plant will not always result in disconnection by fuses.
- The non-grounded IT grid of the PV field may be grounded unintentionally in case of a defect. Occurrence of another defect can cause a short circuit.
- For easy disconnection of PV field in case of a defect, e.g. short circuit, install additional external DC isolating devices for each input close to the solar inverter.
- Before connection, check the cables for any damage. Replace any defective cables.
- Note the warning signs.

8.2 Control elements

8.2.1 RPS 450-030/060

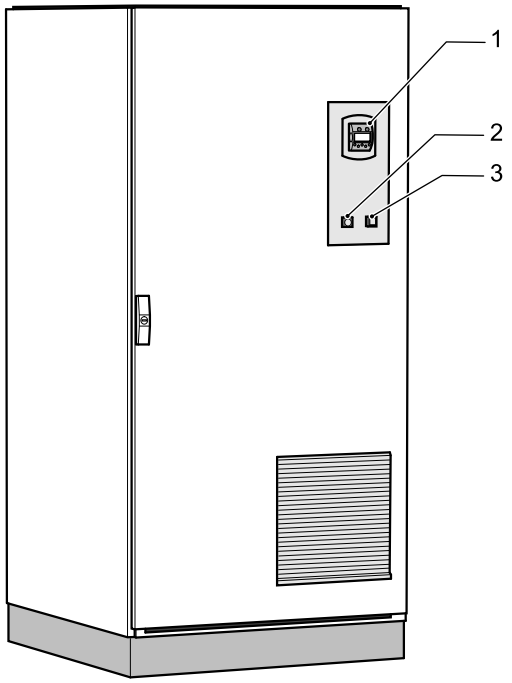


Figure 8-1: Control elements RPS 450-030/060

Control elements RPS 450-030/060	
1	Control unit "KP500", parameterization and display device for: - Setting of parameters for operating behavior - Display of measured and operating values - Error diagnosis
2	Control switch "Start/Stop"
3	Illuminated "Reset" button

8.2.2 RPS 450-120/170

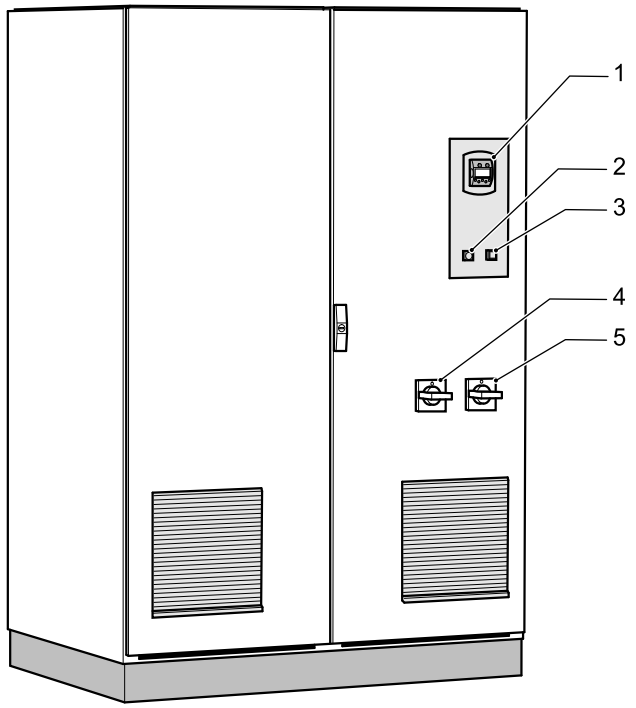


Figure 8-2: Control elements RPS 450-120/170

Control elements RPS 450-120/170kwp	
1	Control unit KP500, parameterization and display device for: - Setting of parameters for operating behaviour - Display of measured and operating values - Error diagnosis
2	Control switch Start/Stop
3	Illuminated reset button
4	AC main switch for cutting off the connection to the grid
5	DC main switch for cutting off the connection to PV field

8.3 Control unit "KP500"

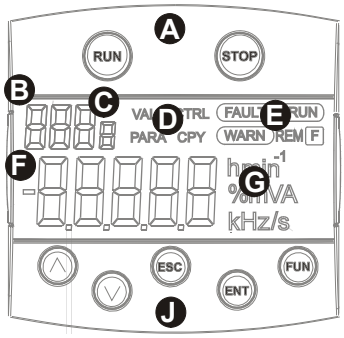
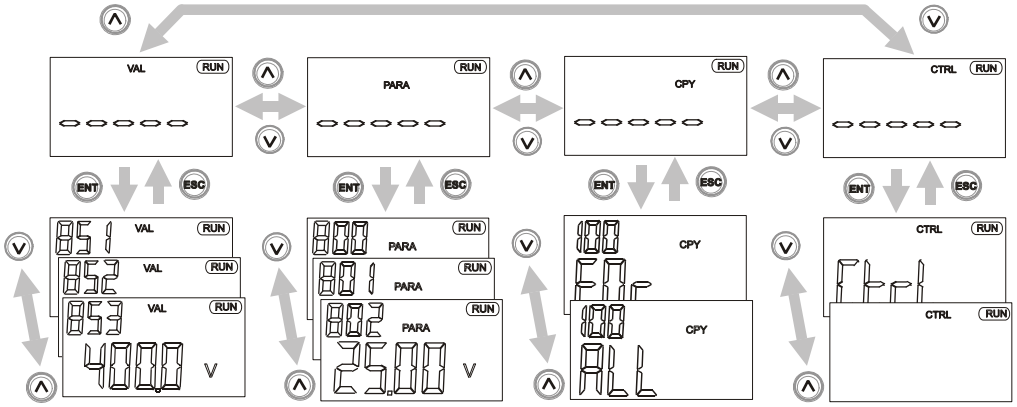
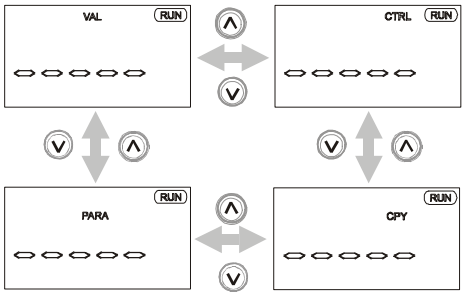


Figure 8-3: Control unit

Keys		
A	RUN	No function.
	STOP	No function.
J	▲ ▼	Used for navigating in the menu structure and selecting parameters. Increasing/decreasing of parameter values.
	ENT	Used for opening parameters or switching to another menu within the menu structure. Confirmation of the selected function or the set parameter.
	ESC	Used for aborting parameters or switching back to the previous menu within the menu structure. Canceling the function or resetting the parameter value.
	FUN	FUN , ▲ (pressed one after the other): Display of last parameter (highest number), FUN , ▼ (pressed one after the other): Display of first parameter (lowest number).
Display		
B	Three-digit 7-segment display to show the parameter number.	
C	One-digit 7-segment display, e.g. display of the active data set.	
D	Display of the selected menu branch:	
	VAL	Display actual values.
	PARA	Selection of parameters and adjustment of parameter values.
	CTRL	No function.
	CPY	Copy parameters via the control unit: ALL All the parameter values are copied. Act Active parameter values are copied only. FOr Control unit memory is formatted and deleted.
E	Status and operating messages:	
	WARN	Warning about a critical operating behavior.
	FAULT	Message indicating that the unit was switched off due to a fault.
	RUN	Flashing: signals readiness for operation. Lights up: signals that the unit is operating and the output stage is enabled.
	REM	Active remote control via interface connection.
	F	Function switch-over with the FUN key.
F	Five-digit 7-segment display for display of parameter value and sign.	
G	Physical unit of the parameter value displayed.	

8.3.1 Menu Structure





Menu branch – VAL
Display of actual values.

Menu branch – PARA
Display and edit parameters.

Menu branch – CPY
Copy parameters.

Menu branch – CTRL
No function.

Figure 8-4: Menu structure control unit

8.4 First commissioning after connection

8.4.1 RPS 450-030/060

Before first commissioning after connection of the solar inverter, the following must be checked/carried out.

- Electrical installation was carried out according to chapter 7 "Electrical connections" and the supplied circuit diagrams.
- The control switch in the door is in "Stop" position".
- All fuses and circuit breakers are switched on.
- Rated values for mains voltage and mains frequency are complied with at AC mains connection. See chapter 4 "Technical data". The phase sequence is correct. Clockwise phase sequence is present.
- The maximum values for DC input voltage and DC input current are kept. See chapter 4 "Technical data".
- The poles of the PV field are connected to the correct poles of the DC main switch. Positive and negative pole are not exchanged.
- In an insulation test, it was verified that the PV field does not have an earth fault. The measurements of the insulation resistance between the positive pole of the PV generator and PE as well as between the negative pole of the PV generator and PE must result in a value > 50 kΩ.
- For devices with earth fault control make sure that the high performance circuit breaker is switched on.
- The solar inverter is connected to the equipotential bonding system at the place of installation or in the equipment room.
- All cables are connected to the terminals. The screws of the terminals must be checked for tight fit.
- After transport from a cold environment to an equipment room, condensation water can form. Before commissioning, the solar inverter must be dry.
- In the case of an external power supply for the controller: The external power supply for the controller is connected.
- There may be no objects on the solar inverter, e.g. tools.
- Close the doors of the solar inverter.

- Close external disconnecting devices.
- In the case of using a data logger with several solar inverters, it is necessary to adjust the NodeID of the communication interface of each solar inverter. See chapter 9.9 “Communication interface for system monitoring”.

8.4.2 RPS 450-120/170

Before first commissioning after connection of the solar inverter, the following must be checked/carried out.

- Electrical installation was carried out according to chapter 7 "Electrical connections" and the supplied circuit diagrams.
- AC main switch and DC main switch at door are switched off.
- The control switch in the door is in "Stop" position".
- All fuses and circuit breakers are switched on.
- Rated values for mains voltage and mains frequency are complied with at AC mains connection. See chapter 4 "Technical data". The phase sequence is correct. Clockwise phase sequence is present.
- The maximum values for DC input voltage and DC input current are kept. See chapter 4 "Technical data".
- The poles of the PV field are connected to the correct poles of the DC main switch. Positive and negative pole are not exchanged.
- In an insulation test, it was verified that the PV field does not have an earth fault. The measurements of the insulation resistance between the positive pole of the PV generator and PE as well as between the negative pole of the PV generator and PE must result in a value > 50 kΩ.
- For devices with earth fault control make sure that the high performance circuit breaker is switched on.
- The solar inverter is connected to the equipotential bonding system at the place of installation or in the equipment room.
- All cables are connected to the terminals. The screws of the terminals must be checked for tight fit.
- After transport from a cold environment to an equipment room, condensation water can form. Before commissioning, the solar inverter must be dry.
- In the case of an external power supply for the controller: The external power supply for the controller is connected.
- There may be no objects on the solar inverter, e.g. tools.
- Close the doors of the solar inverter.
- Close external disconnecting devices.
- In the case of using a data logger with several solar inverters, it is necessary to adjust the NodeID of the communication interface of each solar inverter. See chapter 9.9 “Communication interface for system monitoring”.

8.5 Commissioning

8.5.1 RPS 450-030/060

NOTE

Damaging of solar inverter

- The DC voltage must not exceed the maximum input voltage of 900 V. The solar inverter may be damaged.
- In any case, follow the right order when switching the solar inverter on.

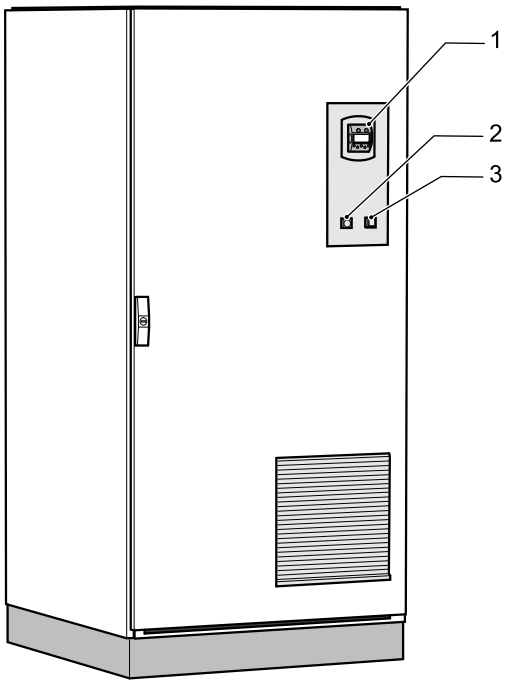


Figure 8-5: Control elements RPS 450-030/060

1. Adjust the Start up behaviour and Shut down behaviour according to the technical data of the PV generator (see chapter 9.4 "Start up behaviour" and 9.5 "Shut down behaviour").
2. Turn the solar inverter on via the control switch (2) ("Start" position).

If an error is displayed on the control unit after start of the inverter, correct the error following the instructions in chapter 11 "Error diagnosis".

If the DC mains switch is switched on before the AC main switch, the error F0405 "Grid failure" is displayed.

It can take up to one minute after enabling the solar inverter till proper work will be signalled.

If the inverter works properly, the green signal lamp in the door will be on and the control unit, (in default settings) will display the parameter *Active power* **213**.

Additional actual values can be displayed on the control unit. The actual value parameters are described in chapters 9.15 "Actual values of solar inverter", 9.16 "Actual values of frequency inverter" and 9.17 "Actual mains values".

8.5.2 RPS 450-120/170

NOTE

Damaging of solar inverter

- The DC voltage must not exceed the maximum input voltage of 900 V. The solar inverter may be damaged.
- In any case, follow the right order when switching the solar inverter on.

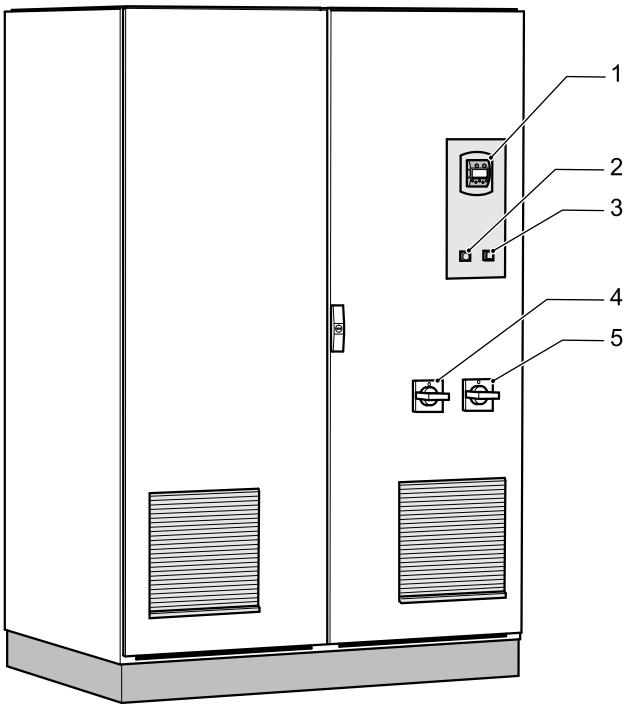


Figure 8-6: Control elements RPS 450-120/170

1. Switch AC main switch (4) on.
2. Switch DC main switch (5) on.
3. Adjust the Start up behaviour and Shut down behaviour according to the technical data of the PV generator (see chapter 9.4 "Start up behaviour" and 9.5 "Shut down behaviour").
4. Turn the solar inverter on via the control switch (2) ("Start" position).

If an error is displayed on the control unit after start of the inverter, correct the error following the instructions in chapter 11 "Error diagnosis".

If the DC mains switch is switched on before the AC main switch, the error F0405 "Grid failure" is displayed.

It can take up to one minute after enabling the solar inverter till proper work will be signalled.

If the inverter works properly, the green signal lamp in the door will be on and the control unit, (in default settings) will display the parameter *Active power* **213**.

Additional actual values can be displayed on the control unit. The actual value parameters are described in chapters 9.15 "Actual values of solar inverter", 9.16 "Actual values of frequency inverter" and 9.17 "Actual mains values".

8.6 Decommissioning

⚠ WARNING

Live components - Risk of electric shock!

Even with isolating devices switched off, dangerous voltage is present in the solar inverter.

- When shutting down the solar inverter, note that an active power source is connected. Depending on the operating status, voltage from the PV generator or the solar inverter may be present.
- The control switch is no isolating device. By turning the solar inverter off via the control switch, the solar inverter is not disconnected from power supply of the PV field. For full disconnection, all main switches and external isolating devices must be opened.

⚠ CAUTION

Danger of burns due to hot surfaces!

Even some time after shutdown of the solar inverter, certain components, e.g. heat sink, transformer, fuse, sine filter may have a high temperature.

- Don't touch the surfaces directly after shutdown. Wear safety gloves where necessary.

8.6.1 RPS 450-030/060

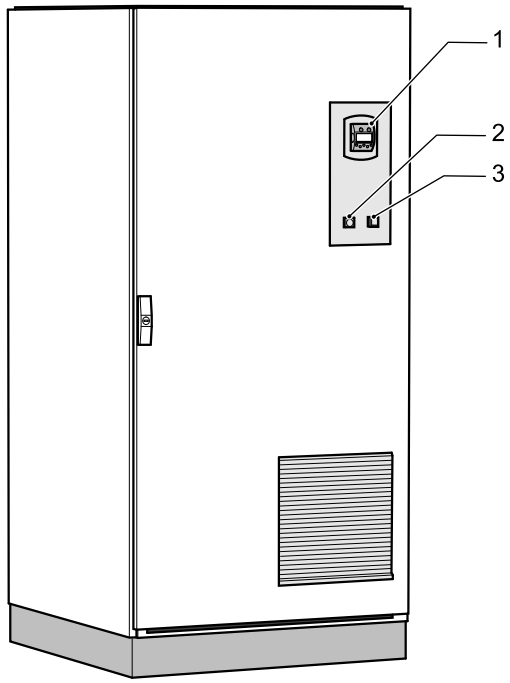


Figure 8-7: Control elements RPS 450-030/060

1. Turn the solar inverter off via the control switch (2) ("Stop" position).

8.6.2 RPS 450-120/170

NOTE

Damaging of solar inverter

If you must shut the solar inverter down, follow the following instructions:

- Only actuate the main switches without load. Always turn the control switch off before.
- In any case, follow the right order when switching the solar inverter off.

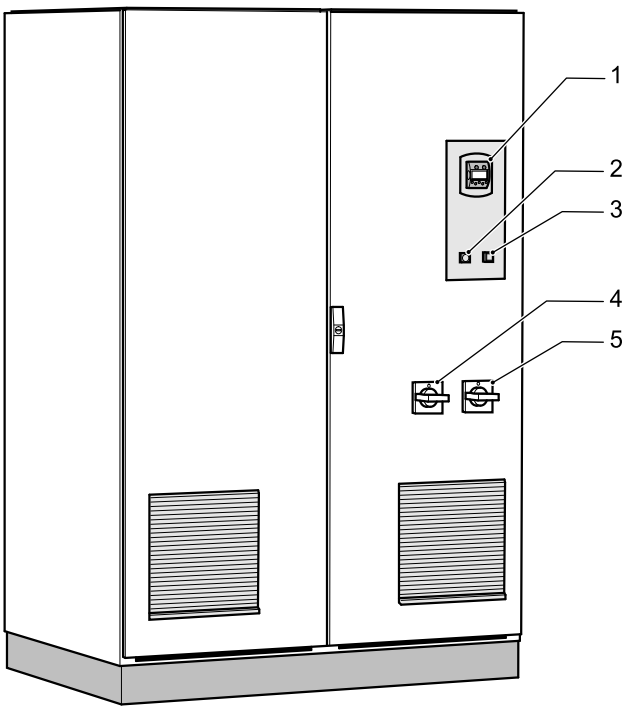


Figure 8-8: Control elements RPS 450-120/170

1. Turn the solar inverter off via the control switch (2) ("Stop" position).
2. Switch AC main switch (4) off.
3. Switch DC main switch (5) off.

Doors can only be opened with the main switches turned off.

8.7 Emergency shutdown

8.7.1 RPS 450-030/060

1. Turn the solar inverter off via the control switch ("Stop" position).
2. Disconnect the solar inverter from the PV generator and the grid.
3. Switch off external isolation provisions. Secure to prevent restarting.

8.7.2 RPS 450-120/170

1. Turn the solar inverter off via the control switch ("Stop" position).
2. Switch AC main switch off.
3. Switch DC main switch off.
4. Disconnect the solar inverter from the PV generator and the grid.
5. Switch off external isolation provisions. Secure to prevent restarting.

8.8 Final decommissioning/disassembly/disposal/recycling

When it comes to final decommissioning/disposal of the solar inverter, individual components and/or auxiliary and operating materials, ensure that all parts/materials are disposed of in an environmentally compatible manner.

Ensure that all metal and plastic parts are recycled.

9 Parameterization

As an alternative to the control unit, you can also use the optional PC user software VPlus for parameterization, monitoring and maintenance of the solar inverter.
The parameters are divided in 3 control levels.
The parameter *Control level* **28** defines the relevant control level.

- Control level 1 provides inverter information, actual values, an error list and contains parameters with which the operating behavior can be influenced.
- Control level 2 contains additional parameters, actual values and functions.
- Control level 3 contains additional error information, functions and actual values. Additionally, it enables fundamental changes of the operating behavior. Setting of parameters in this control level is not required and will not be fully covered by this user manual.

Parameter		Setting			
No.	**Description**	**Min.**	**Max.**	**Factory. setting**	**Control level**
28	Control level	1	3	1	1

9.1 Selecting the language

With parameter *Language* **33**, you can set the language in control level 1. The error messages and the loaded parameters (if PC user software is used) are displayed in the selected language.

Parameter		Setting		
No.	**Description**	**Setting**	**Factory setting**	**Control level**
33	Language	0 - German 1 - English 2 - Italian 3 - Spanish	1	1

9.2 Set password

As a protection against unauthorized access, the parameter *Set password* **27** can be set such that anyone who wants to change parameters must enter this password. A change of parameter is only possible if the password in entered correctly.
To deactivate password protection, enter "0" in parameter 27.

Parameter		Setting			
No.	**Description**	**Min.**	**Max.**	**Factory setting**	**Control level**
27	Set password	0	999	0	1

9.3 Display parameters

In menu **PARA** of the control unit, several actual values and statuses are available in addition to various parameters.
The available display parameters can be read via the control unit or the PC user software. Write access is only possible via parameter *User name* **29**.

9.3.1 Inverter data

The serial number can be set via parameter *Serial number* **0**.

9.3.2 Installed optional modules

Via parameter *Optional modules* **1**, you can find out which optional modules are installed in the frequency inverter, e.g. Extension Module EM or Communication Module CM.

9.3.3 Software version

Via parameter *FI software version* **12**, you can check the version number of the frequency inverter software.

9.4 Start up behaviour

Before the solar inverter is connected to the grid at sunrise, the inverter determines the power currently produced by the PV field. To that end, the solar inverter must be enabled by means of the control switch and no error may be present.
Power measurement is activated as soon as the DC input voltage exceeds the value *V DC Start* **830**. The value must be set such that the solar inverter can be switched on even in high module temperatures.
The main contactor is switched on if the power produced by the PV field is higher than the power loss of the solar inverter in no-load mode. In the case of low insolation, the DC voltage can normally not withstand high loads. If the DC input voltage drops below a certain threshold, the power measurement is stopped. The start procedure starts again.

Parameter		Setting			
No.	**Description**	**Min.**	**Max.**	**Factory setting**	**Control level**
830	V DC Start	450.0 V	750.0 V	500.0 V	1

9.5 Shut down behaviour

When insolation gets weaker in the evening, the power produced by the PV field drops. In order to prevent tapping power from the 3-phase grid, the main contactor is to drop out as soon as the power produced by the PV field is no longer sufficient to cover the losses. To that end, the AC power, DC power and DC input voltage are monitored during operation.
If the DC input voltage is lower than the reference value set with *U DC shutdown limit* **837**, feed-in operation is stopped.
Feed-in operation is also stopped if the power drops below the following adjustable reference values:

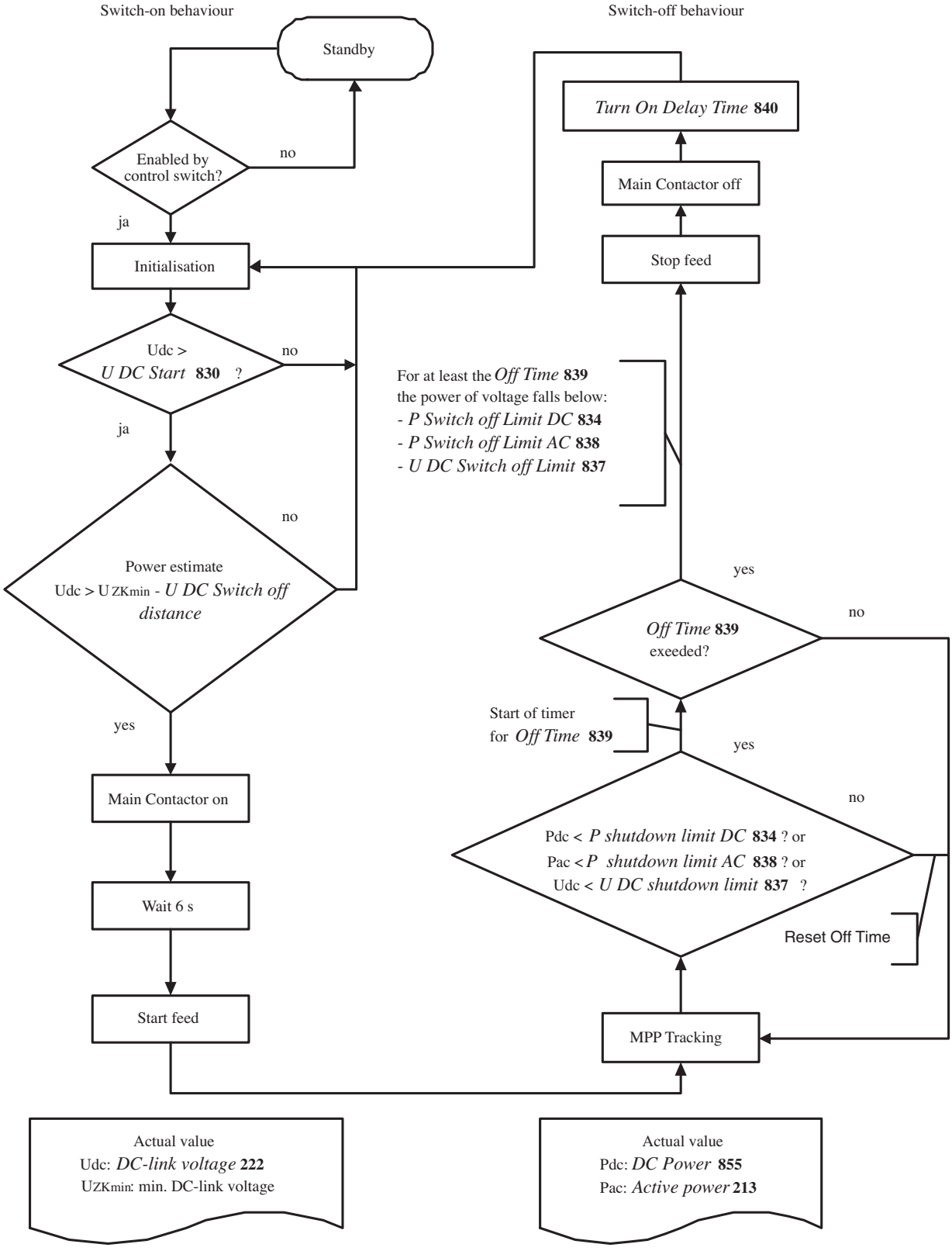
- *P switch off limit AC* **838** for AC power and
- *P switch off limit DC* **834** for DC power.

The power shutdown limits can be deactivated by entering 0.0.
The optimum shutdown point can be determined more precisely via the DC power.
In the case of solar inverters with DC current measurement, the AC shutdown threshold should be deactivated, *P switch-off limit AC* **838** = 0.0.
In order to prevent actuation of the main contactor during short power drops, you can set up a shut down delay via parameter *Off time* **839**. The power must drop the limits set via parameters **837**, **838** or **834** for this time before operation is stopped. Restarting can be delayed by an adjustable time via the *Turn on delay time* **840**.

Parameter		Setting			
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**	**Control level**
834	P Switch Off Limit DC	0.00 kW	20.00 kW	See below.	2
837	V DC Switch Off Limit	405,0 V	650,0 V	450,0 V	1
838	P Switch Off Limit AC	0,00 kW	20.00 kW	See below.	2
839	Off Time	1 min	20 min	5 min	2
840	Turn on Delay Time	1 min	30 min	10 min	2

Factory settings of shutdown limits				
RPS 450	**-030**	**-060**	**-120**	**-170**
P Switch Off Limit DC **834**	1,00 kW	1,00 kW	1,00 kW	1,00 kW
P Switch Off Limit AC **838**	1,00 kW	1,00 kW	1,00 kW	1,00 kW

9.6 Operating statuses



In the case of an error, feed-in is stopped and the error is displayed on the control unit.

9.7 Voltage controller

NOTE

Damaging of solar inverter

- The voltage controller may only be set up by qualified staff. Wrong setup can result in damage.

The following characteristics of a PV module show the DC output current (module current) as a function of the DC voltage (module voltage). Since the current remains fairly constant at first and drops in the area of the graph with higher voltage, there is a maximum power operating point. The operating point at which the modules produce maximum power is also referred to as MPP (**M**aximum **P**ower **P**oint).
By proper setting of the DC voltage it is tried to operate the PV modules at MPP. The DC voltage is adjusted by means of the solar inverter.
If insolation changes or the temperature of the PV modules changes, the DC voltage at which power output is at its maximum will also change.

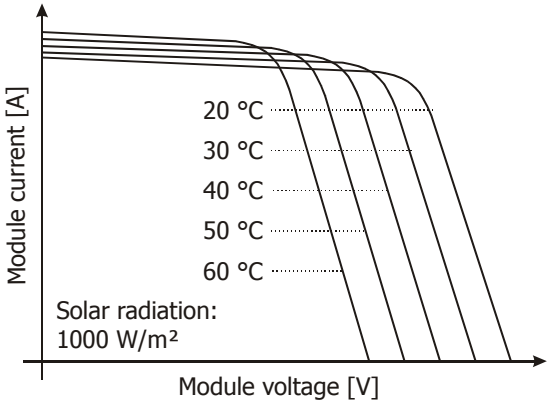


Figure 9-1: I=f(U), insolation const.

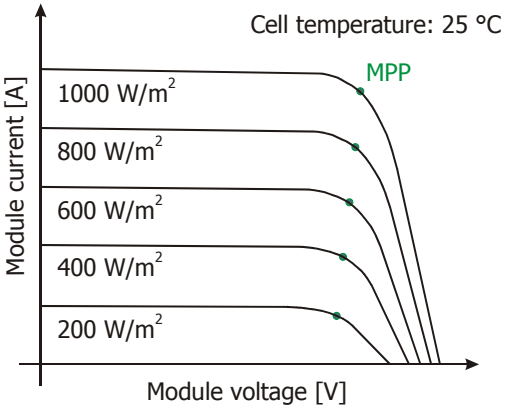


Figure 9-2: I=f(U), cell temp. const.

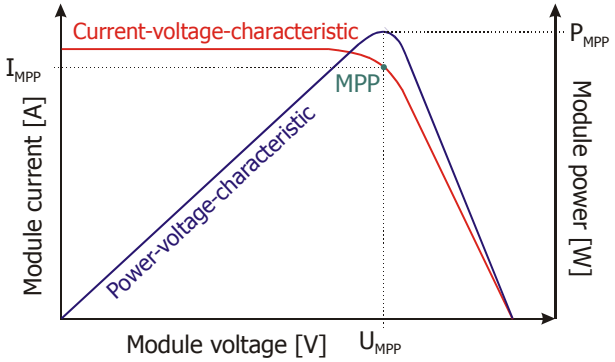


Figure 9-3: I=f(U), P=f(U)

The solar inverter contains a voltage controller which sets the DC voltage automatically such that the modules are operated at MPP.

9.8 Power limitation

Parameters *Max. output current* **803** and *Max. active power* **812** are used for power limitation. The smaller of the two values is used. The max. current (frequency inverter side) or power which may be fed to the grid are entered. If the output value or current reach the adjusted value in strong insolation, MPP control is deactivated. The operating point is changed such the limits set with parameters *Max. output current* **803** and *Max. active power* **812** are not exceeded. MPP is activated again if the values drop below the configured limits.

Parameter		Setting			
No.	**Description**	**Min.**	**Max.**	**Factory settings**	**Control level**
803	Max. Output Current	depending on type			2
812	Max. Active Power	depending on type			2

9.9 Communication interface for system monitoring

By default, interfaces CM-232 and CM-485 are set as follows:

Parameter		Setting
No.	**Description**	**Factory setting**
10	Baud rate	4 - 19200 Baud
394	RS232/RS485 NodeID	1
395	Protocol type	0 - VABus

If other settings are required, the communication modules are to be configured via the corresponding software parameters.
The baud rate must be the same in all clients. The NodeID must be different! Identical NodeIDs result in a communication fault!

9.9.1 Setting the Baud Rate

The transmission speed of the CM-485 is set via parameter *Baud rate* **10**.
The transmission speed of the CM-485 depends on various application-specific parameters. For example, the cable length limits the transmission speed due to signal propagation delays. With the additional "repeater" assemblies, the max. cable length can be increased.

Baud rate **10**		Function	max. line length
1	2400 Baud	Transmission rate 2400 Baud	2400 m
2	4800 Baud	Transmission rate 4800 Baud	2400 m
3	9600 Baud	Transmission rate 9600 Baud	1200 m
4	19200 Baud	Transmission rate 19200 Baud	1200 m
5	57600 Baud	Transmission rate 57600 Baud	600 m
6	115200 Baud	Transmission rate 115200 Baud	300 m

All bus clients must be set to the same baud rate.

Baud rate changes are only active after a reset of the frequency inverter via the software or Mains Off/On.

In the case of the software reset, proceed as follows:

- Via the control unit KP500, open parameter Program(ming) 34.
- Set parameter value "123".
- Confirm by pressing "ENT".

After the reset, the frequency inverter is initialized and is ready for operation after a few seconds.

9.9.2 Setting the Node Address

The node address of the CM-485 is set via parameter *RS232/RS485 NodeID* **394**. Up to 30 frequency inverters can be used at the RS485 bus. The frequency inverters are assigned unambiguous addresses in the range from 1 to 30.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Factory settings**
394	RS232/RS485 NodeID	1	30	1

For operation with the RS485 module CM-485, each client must be assigned an address.

Bus addresses may only be assigned once, i.e. no double assignments.

An address change is effective immediately, i.e. without a restart of the frequency inverter.

9.9.3 Protocol

The VABus protocol is the standard protocol of BONFIGLIOLI VECTRON. It defines and describes the communication via the serial interfaces RS232/RS485. When they leave the factory, the frequency inverters are set to VABus protocol. Communication with the data logger RPSlog is only possible via the VABus protocol. If data capturing and monitoring is to be realized by means of an external product, other protocol types can be used for this. The protocol types are described in detail in the communication module user manual.
Via parameter *Protocol type* **395** you can view and set the protocol type:

Protocol type **395**	Function
0 - VABus	BONFIGLIOLI VECTRON Standard protocol (default setting)
1 - P-Bus	User-specific bus protocol
2 - Modbus- RTU	Please refer to the Modbus user manual.
3 - Modbus-ASCII	

Changes of the parameter *Protocol type* **395** take effect immediately, i.e. without a restart of the frequency inverter.

If the wrong protocol is selected, communication via CM-232/CM-485 is not possible.

In this case correct the protocol type using the control unit KP500.

9.10 Feed-in management

According to the law on renewable energy (EEG), operators of PV plants are obliged to equip plants with a power output of 100 kW with technical and operational provision for remote-controlled reduction of the feed-in power in the case of grid overload and for retrieving the current actual feed-in power.
As regards the active power output, a distinction is made between power limitation by an external setpoint and power limitation by mains overfrequency.

9.10.1 Power limitation by setpoint

In *Power reduction mode* **1025**, you can specify an external source for power reduction. The power reduction through *Max. active power* **812** is maintained in all operating modes. This also applies in the case of indirect power reduction through *Max. output current* **803** and *Max. feedback current* **805**.

Parameter		Setting		
No.	**Description**	**Setting**	**Factory setting**	**Control level**
1025	Power reduction mode	0 – OFF 1 – Reduction via RS232/485 2 – Reduction via system bus	1	3

If you select 0="Off", there will not be any additional power reduction.
If you select 1="Setpoint via RS232/485", there will be additional power reduction. The setpoint for reduction is specified in % via *Power reduction reference value* **1020** and refers to the *AC Nominal power* **1096.** The data logger RPSlog 1000 PM is connected directly with the ripple control transmitter of the utility company and transmits the current power reduction to the solar inverter while reading the solar inverter data. For more information, refer to the RPSlog1000 PM user manual.
If you select 2="Setpoint via system bus", there will be additional power reduction. The setpoint for reduction is specified in % via *S. power reduction system bus* **1027** and refers to the *AC Nominal power* **1096**.
Via *Power reduction timeout* **1026**, you can configure the time which may pass between two write accesses to parameter *Power reduction reference value* **1020** before the solar inverter resets the internal setpoint to 100 % automatically.

Parameter		Setting			
No.	**Description**	**Min.**	**Max.**	**Factory setting**	**Control level**
1020	Power reduction reference value	0 %	100%	100 %	3
1026	Power reduction timeout	0 min	1000 min	0 min	3
1027	S. power reduction setpoint	Selection		66-Reference percentage	3

In case of a power reduction ordered by the feed-in management system, the Feed-in power management power reduction warning is set.
For setting of the warning, the following conditions must be met.

- the required power defined by the feed-in management is lower than the *Max. active power* **812**
- the solar inverter could feed more power into the grid than the set power of the feed-in management.

9.10.2 Power limitation in case of overfrequency

Since there may be different requirements by utility companies, particularly in different European countries and the US, the frequency limits and the power gradient can be parameterized.

Via *Power reduction at upper frequency limit* **1030**, the operation mode for power limitation in the case of overfrequency is set.

Parameter		Setting		
No.	**Description**	**Setting**	**Factory setting**	**Control level**
1030	Power reduction at upper frequency limit	0 – OFF 1 – ON	1	3

In operation mode 0="Off", power limitation in case of overfrequency is deactivated.
In operation mode 1="ON", power will be reduced if the current frequency exceeds the parameter for *Frequency start power reduction* **1034**. Power reduction is effected based on the *Gradient for power reduction* **1036** in %/Hz. The current power is frozen as the rated value for further power reduction. If the mains frequency drops below the power increase frequency **1035**, power reduction will be stopped.

Parameter		Setting			
No.	**Description**	**Min.**	**Max.**	**Factory setting**	**Control level**
1034	Frequency start power reduction	35,00 Hz	70,00 Hz	50,20 Hz	3
1035	Frequency stop power reduction	35,00 Hz	70,00 Hz	50,05 Hz.	3
1036	Gradient for power reduction	5,00	50,00	20,00	3

9.10.3 Mains frequency monitoring

Via *Mode lower-/upper frequency monitoring* **1029**, you can set the operation mode for internal overfrequency and underfrequency monitoring. In operation mode 0="Off", mains frequency monitoring is deactivated. In operation mode 1="On" the mains frequency is monitored for under/overfrequency (Parameters **1032** and **1033**).

Parameter		Setting		
No.	**Description**	**Setting**	**Factory setting**	**Control level**
1029	Mode lower-/upper frequency monitoring	0 - OFF 1 - ON	1	3

If the current mains frequency drops below the set frequency threshold for *Lower frequency limit* **1032**, the solar inverter is disconnected from the grid, and error message F0421=Mains underfrequency is displayed.
If the current mains frequency exceeds the set frequency threshold for *Upper frequency limit* **1033**, the solar inverter is disconnected from the grid, and error message F0421=Mains overfrequency is displayed.

Parameter		Setting			
No.	**Description**	**Min.**	**Max.**	**Factory setting**	**Control level**
1031	Rated mains frequency	35,00 Hz	65,00 Hz	50,00 Hz	3
1032	Lower frequency limit	30,00 Hz	70,00 Hz	47,50 Hz.	3
1033	Upper frequency limit	30,00 Hz	70,00 Hz	51,50 Hz	3

9.11 Electrical cabinet fan

The electrical cabinet fans are controlled via an relay output. By default, the relay output with parameter *Operation mode- Digital output 3* **532** is linked to function "44-Electrical cabinet fan". However, it can also be linked to various other functions.
If function "44-Electrical cabinet fan" is selected for *Operation mode digital output 3* **532**, the fans are controlled depending on the heat sink temperature and the inside temperature of the frequency inverter.
The start temperature of the electrical cabinet fan can be controlled via parameters *Switching Limit Heat Sink Temp.* **825** and *Switching Limit Inside Temp.* **826**.
The temperature value at which the electrical cabinet fans are started is calculated from the type-dependent temperature limit minus the adjusted warning limit.
If one of the two switching temperature values is reached, the electrical cabinet fan will be switched on even if the other switching temperature has not been reached.
By default, the parameter is set to suitable values, i.e. no change of settings required.

Parameter		Setting	
No.	**Description**	**Factory setting**	**Control level**
532	Op. Mode - Digital Output 3	44-Electrical cabinet fan	2

If function "100-On" is selected for *Operation mode - Digital output 3* **532**, the fans will be on permanently independent of the temperature.

Parameter		Setting			
No.	**Description**	**Min.**	**Max.**	**Factory setting**	**Control level**
825	Switching Limit Heat Sink Temp.	-35	0	-15 °C	2
826	Switching Limit Inside Temp.	-30	0	-15 °C	2

Tk: Heat sink temperature of frequency inverter *Tk* **255**
Ti: Inside temperature of frequency inverter *Ti* **256**

Setting of these parameters does not affect the frequency inverter fans.

9.12 Error/warning behavior

9.12.1 Automatic error acknowledgement

If an error has occurred, it will be acknowledged automatically after the time set with parameter *Delay Time Auto Acknowl* **836**. After this, the solar inverter will restart automatically.

Parameter		Setting			
No.	**Description**	**Min.**	**Max.**	**Factory setting**	**Control level**
836	Delay Time Auto-Acknowl.	1 min	20 min	5 min	2

The maximum number of errors which can be acknowledged automatically per day is set with parameter *Allowed No. of Auto-Acknowl.* **835**. If a setting is made for this parameter, the set number of error acknowledgements will be available again on this day, even if one or more errors have already been acknowledged automatically.

Parameter		Setting			
No.	**Description**	**Min.**	**Max.**	**Factory setting**	**Control level**
835	Allowed No. Of Auto-Acknowl.	0	20	15	2

9.12.2 Operation mode - Overvoltage protection

Via parameter *Op. Mode overvoltage protection* **828**, you can set up the behaviour to be triggered after a defect of a surge arrester.
If a defect is recognized,

- Warning W8000 "Overvoltage protection" is displayed in setting "1 – Warning" (default setting)
- error F0406 "Overvoltage protection" will be displayed and the solar inverter will be shut down in setting "2 – Error cut-off".

Parameter		Setting		
No.	**Description**	**Selection**	**Factory setting**	**Control level**
828	Op. Mode overvoltage protection	0 – Off 1 – Warning 2 – error cut-off	1 – Warning	2

Thanks to the visual signaling at the surge arresters, you can identify the component which is defective and must be replaced.

9.12.3 Operation mode - Insulation monitoring

Via parameter *Op. Mode Isolation monitoring* **829**, you can set how often the insulation of the PV generator is to be checked. In setting "1 – Daily", the insulation will be checked once in the morning; if the insulation resistance is in the permissible range, no insulation defects will be reported on this day. In setting "2 – Permanent", the insulation is monitored continuously.
In these settings, error F0404 "Isolation" will be displayed if an earth fault is identified in the PV generator.

Parameter		Setting		
No.	**Description**	**Selection**	**Factory setting**	**Control level**
829	Op. Mode Isolation monitoring	0 – Off 1 – Daily 2 – Permanent	2 – Permanent	2

Note

- With integrated earth fault control the monitoring is done similarly.

9.13 Intelligent current limits

The current limits to be set avoid inadmissible loading of the connected solar inverter and prevent an error cut-off. The overload reserve of the frequency inverter can be used optimally by means of the intelligent current limits, in particular in applications with dynamic load fluctuations. The criterion to be selected via the parameter *Operation Mode* **573** defines the threshold to the activation of the intelligent current limit. The parameterized rated current of the frequency inverter is synchronized as the limit value of the intelligent current limits.

Operation mode 573	Function
0 - Off	The function is switched off.
1 - Ixt	Limitation to the overload of the frequency inverter (Ixt).
10 - Tc	Limitation to the maximum heat sink temperature (T_C).
11 - Ixt + Tc	Operation mode 1 and 10 (Ixt + T_C).

The threshold value selected via the parameter *Operation Mode* **573** is monitored by the intelligent current limits. In the operation mode Heat sink temperature monitoring, the reduction of power selected with parameter *Power Limit* **574** is done when the limit value has been reached. The total time of the power reduction as a result of an increased motor or heat sink temperature contains not only the cooling time, but also the additionally defined *Limitation Time* **575**.
The definition of the power limit should be selected as small as possible in order to give the frequency inverter sufficient time to cool down. The rated power of the frequency inverter should be used as the reference.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
574	Power Limit	40,00%	95,00%	80,00%
575	Limitation Time	5 min	300 min	15 min

In the operation modes with overload reserve (Ixt) there is a reduction of the output current when the threshold value is exceeded, with a distinction being made between long and short-term overload reserve. After the short-term overload (1s) has been used up, the output current is reduced to the long-term overload current matching the present switching frequency. After the long-term overload current has been used up (60s), the output current is reduced to the rated current which also depends on the switching frequency.
If the output current has already been reduced due to the fact that the long-term overload has used up, the short-term overload is no longer available even if it has not been used up beforehand. The defined overload reserve (Ixt) of the frequency inverter is available again after a power reduction lasting 10 minutes.

9.14 Status

Operation of the frequency inverter is monitored continuously. The parameter *Solar-Status* **1089** enables diagnosis of the inverter during operation.

The following table shows the values for *Solar-Status* **1089**.

No.	1089	Status
1	Init	Solar inverter is initialized
2	Wait for Init	Solar inverter is waiting for release of initialization, e.g. delay after MPP minimum shutdown.
3	Wait for grid management	Solar inverter is waiting for release by grid management.
4	Ready	DC voltage OK but no release.
5	Ready+warning	DC voltage OK but no release, a warning is output.
6	Undervoltage	DC voltage too low.
8	Mains synchronization	Magnetizing of transformer.
9	MPP tracking	Tracking of optimum MPP point.
10	MPP Tracking+Warning	Tracking of optimum MPP point, a warning is output.
11	MPP maximum	Power limitation, MPP point outside of maximum inverter power.
12	MPP minimum	MPP point below shutdown threshold.
13	MPP+FastSearch	Quick MPP tracking, e.g. after grid failure
14	Fault	A fault has occurred
15	Fault+Warning	A fault has occurred, a warning is output.
16	AutoQuit	There was a fault, but the fault is no longer present and is acknowledged automatically.

9.15 Actual values of solar inverter

Actual values of solar inverter		
No.	**Description**	**Contents**
222	DC link voltage	Current voltage in DC link
223	Modulation	Output voltage referred to input voltage, 100% = grid input voltage
244	Working Hours Counter	Current working hours in which the output stage of the inverter is active
245	Operation Hours Counter	Current operating hours in which U_{dc} > 250 V.
255	Heat Sink Temperature	Current heat sink temperature of frequency inverter
256	Inside Temperature	Current inside temperature of frequency inverter
259	Current Error	Error code
269	Warnings	Warning code
1089	Solar-Status	Status of solar inverter, see chapter 9.14.

9.16 Actual values of frequency inverter

Actual values of frequency inverters		
No.	**Description**	**Contents**
211	R.m.s Current	Effective current of frequency inverter
212	Output Voltage	Output voltage of frequency inverter
855	DC Power	DC power
860	DC Current	Current captured via analog input 1
861	Active Current	Active current of frequency inverter
862	Reactive Current	Reactive current of frequency inverter

The actual values of the frequency inverter are measured values on the primary side of the transformer (on frequency inverter side)

9.17 Actual mains values

Actual mains values		
No.	**Description**	**Contents**
213	Active Power	Current calculated active power
850	Frequency	Current mains frequency
852	Power Supply Current	Mains current
853	Power Supply Voltage	Mains voltage
863	Current a	Mains current in phase A
864	Current b	Mains current in phase B
865	Current c	Mains current in phase C
866	Power Supply Voltage a	Mains voltage in phase A
867	Power Supply Voltage b	Mains voltage in phase B
868	Power Supply Voltage c	Mains voltage in phase C
869	Active Power a	Active power in phase A
870	Active Power b	Active power in phase B
871	Active Power c	Active power in phase C
875	Apparent Power a	Reactive power in phase A
876	Apparent Power b	Reactive power in phase B
877	Apparent Power c	Reactive power in phase C
879	Apparent Power	Mains reactive power

The actual value display considers the transformation ratio of the transformer.
Due to the error tolerances, it is possible that, in the case of low power values, the shown actual values are not plausible.

9.18 Actual value memory

The actual value memory enables monitoring of maximum and average values determined over a certain period of time.

Actual value memory		
No.	**Designation**	**Description**
289	Peak Value Heat Sink Temp.	Maximum heat sink temperature of frequency inverter reached during working hours.
290	Average Value Heat Sink Temp.	The calculated average heat sink temperature of the frequency inverter. The temperature measurements for calculation of the average value are performed every 5 minutes.
291	Inside temp. peak value	Maximum inside temperature of frequency inverter reached during working hours.
292	Peak Value Inside Temperature	The calculated average inside temperature of the frequency inverter. The temperature measurements for calculation of the average value are performed every 5 minutes.
301	Energy, positive	The energy fed into the grid during working hours.
302	Energy, negative	The energy tapped from the grid during working hours.

The working hours can be read via parameter *Working hours counter* **244**.

9.19 Parameters

Parameters of solar inverter					
No.	**Description**	**Unit**	**Setting range**	**Factory setting**	**Chapter**
10	Baud rate RS232/RS485	-	Selection	5 – 57600 Baud	9.9.1
27	Set password	-	0 … 999	0	9.2
28	Control level		1 … 3	1	9
33	Language	-	Selection	1 - English	9.1
394	RS232/RS485 NodeID	-	1 … 30	1	9.9.2
395	Protocol RS232/RS485	-	Selection	0 - VABus	9.9.3
532	Op. mode digital output 3	-	Selection	44- Electrical cabinet fan	9.11
573	Operation mode - Intelligent current limits	-	Selection	11 – Ixt + Tc	0
574	Power limit	-	40,00 … 95,00	80	0
575	Limitation time	min	5 … 300	15	0
803	Max. output current	A	depending on type	depending on type	9.8
812	Max. active power	kW	depending on type	depending on type	9.8
825	Switching Limit Heat Sink Temp.	°C	-35 … 0	-15	9.11
826	Switching Limit Inside Temp.	°C	-35 … 0	-15	9.11
828	Op. Mode overvoltage protection	-	Selection	1 - Warning	9.12.2
829	Op. Mode isolation monitoring	-	Selection	2 - Permanent	9.12.3
830	V DC Start	V	450,0 … 750,0	500	9.4
834	P Switch Off Limit DC	kW	0,00 … 20,00	depending on type	9.5
835	Allowed No. of Auto-Acknowl.	-	0 … 20	15	9.12.1
836	Delay Time Auto-Acknowl.	min	1 … 20	5	9.12.1
837	V DC Switch Off limit	V	405,0 … 650,0	450	9.5
838	P Switch Off limit AC	kW	0,00 … 20,00	depending on type	9.5
839	Off time	min	1 … 20	5	9.5
840	Turn On Delay Time	min	1 … 30	10	9.5
1020	Power reduction reference value	%	0 … 100	100	9.10.1
1025	Power reduction mode	-	Selection	1 - Setpoint via RS232/485	9.10.1
1026	Power reduction timeout	min	0 … 1000	0	9.10.1
1027	S. power reduction system bus				9.10.1
1029	Mode lower-/upper frequency monitoring		Selection	1 - ON	9.10.3
1030	Power reduction at upper frequency limit	-	Selection	1 - ON	9.10.2
1031	Rated mains frequency	Hz	35,00 … 65,00	50	9.10.3
1032	Lower frequency limit	Hz	30,00 … 70,00	47,5	9.10.3
1033	Upper frequency limit	Hz	35,00 … 70,00	51,5	9.10.3
1034	Frequency start power reduction	Hz	35,00 … 70,00	50,2	9.10.2
1035	Frequency stop power reduction	Hz	35,00 … 70,00	50,05	9.10.2
1036	Gradient for power reduction	-	5,00 … 50,00	20	9.10.2
1096	AC nominal power	kW	depending on type	depending on type	9.10.1

10 Maintenance and service

10.1 Special safety instructions

⚠ DANGER

Live components - Risk of electric shock!

In the case of improper maintenance and service, accidents or material damage may result from non-compliance with the safety instructions. Note:

- High mains voltage and high DC voltage from solar modules.
- Maintenance work may only be performed with the power supply to the solar inverter switched off.
- The solar inverter must be isolated safely from the PV generator and the grid.
- Switch off external isolation provisions. Secure to prevent restarting.
- Disconnect the solar inverter from power supply. For more information, see chapter 8.6 "Decommissioning". Verify safe isolation from power supply.
- Earth and short-circuit (not DC side).
- Even with the AC and DC main switches turned off, dangerous voltage levels may be present in the solar inverter. This is the case if:
  - No external isolation facility is installed and turned off.
  - The DC link capacitors are still charged. Wait for some minutes until the DC link capacitors have discharged before starting to work at the solar inverter.
- Using suitable protective equipment, secure live components in the work area to prevent contact.
- For a functional test of the electrical equipment, the solar inverter must be connected to power supply. Take particular care when doing this. Do not touch any live parts or cable ends.

⚠ CAUTION

Danger of burns due to hot surfaces!

Even some time after shutdown of the solar inverter, certain components, e.g. heat sink, transformer, fuse, sine filter may have a high temperature.

- Don't touch the surfaces directly after shutdown. Wear safety gloves where necessary.

⚠ CAUTION

Danger of crushing due to rotating fan!

Fans are installed in the upper area of the inverter. These fans might start suddenly without warning.

- Always ensure that the unit is isolated from power supply.
- In the case of the solar inverters RPS 450 -30/60 kWp, the external control voltage supply must be disconnected.

10.2 Service intervals/preventive maintenance

Carry out the following maintenance work at the specified intervals. Shorter intervals may be required, depending on ambient conditions.

Service		
Monthly		
Subject	**Maintenance work**	**Reason**
Air inlet filter, Filter mats	Clean, replace if necessary	Filter mats can get clogged by pollen, dust, etc. and prevent proper cooling as a result. Dirty filter mats can result in overtemperature and consequently failures. The filter mat covers can be removed from the outside of the door.
Error protocol	Check	Frequent errors or errors which are present over extended periods may be a sign of hardware defects. In order to prevent unplanned outages, the relevant component(s) should be replaced in due time.
Yield	Check	Ageing and frequent failures reduce the yield. Compare the expected yield with the actual yield.
Yearly		
Subject	**Maintenance work**	**Reason**
Exterior	Visual inspection	The exterior components of the solar inverter (handles, contacts, filter grilles, etc.) may be damaged by improper handling.
Interior	Visual inspection, clean if necessary	Moisture, insects, dirt or dust may enter the solar inverter. In the case of significant moisture, insect, dirt/dust load, eliminate the cause.
Cabling and terminal connections	Visual check, replace if necessary	Insulation of the cable, particularly power cables, may change its colour due to temperature or ageing, change its structure or be damaged by animals. Replace damaged cables. Terminal connections may loosen in the course of time and must be checked for tight fit.
Warning information, signs	Check, replace if necessary	Warning labels and signs may loosen in the course of time due to environmental impact. Replace damaged or missing warnings and signs.
Fan	Functional test	Unusual operating noise is a possible sign of a fan failing soon. Defective filters can result in overtemperature and consequently failures. Visual inspection and check for unusual noise during operation.
Insulation, voltage, earth fault, frequency monitoring	Functional test	Possibly, the signal contacts or the electronics of the monitoring equipment don't work properly and defects will not be recognized. Check signalling. Check changeover contacts.
PV-Generator	Insulation test	If the RPS solar inverter features earth fault control an insulation check for earth faults in the grounded and the not grounded pole has to be done.
Overvoltage protection	Visual inspection or reading of warning messages	If the RPS solar inverter features overvoltage protection without signal relay, the visual indicator should be checked, particularly after a thunderstorm. After a defect, the solar inverter remains ready for operation, but the overvoltage protection must be replaced as soon as possible. Note the corresponding warning message of the solar inverter.
Switches, contactors	Visual inspection / functional test	The switches are hardly ever actuated. Nevertheless, there may be defects. Sparks may form in switching operations under load. These may change the colour of the switching device. Replace the switches, contactors in case of significant discoloration.

10.3 Test/inspections

If the solar inverter is subject to regular inspections by an inspection/testing organization, the relevant inspection intervals must be kept by the operator.

11 Error diagnosis

The following error messages, including a code and moving text, are displayed on the control unit after a fault. Press the start/enter button to stop error display.

11.1 List of errors

The last 16 error messages are saved in chronological order and the *No. of Errors* **362** shows the number of errors which have occurred since initial commissioning of the frequency inverter. The error code FXXXX is displayed in menu branch VAL of the control unit. For the meaning of the error code, refer to the following chapter 11.2 "Error messages". The error message can be acknowledged via the illuminated "Reset" button.

List of errors		
No.	**Description**	**Function**
310	last error	hhhhh:mm ; FXXXX error message.
311	second to last error	hhhhh:mm ; FXXXX error message.
312 to 325		Error 3 to error 16.
362	No. Of Errors	Number of errors occurred after the initial commissioning of the frequency inverter.

The error and warning behavior of the frequency inverter can be set in various ways. Automatic error acknowledgment enables acknowledgement without intervention by an overriding controller or the user. *No. Of self acknowledged Errors* **363** shows the total number of automatic error acknowledgments.

List of errors		
No.	**Description**	**Function**
363	Total of autom. acknowledged errors	Total number of automatic error acknowledgments with synchronization.

11.2 Error messages

The error code saved after a fault consists of the error group FXX and the code number XX.

Current error (P259)	Description
0000 No Fault	No error present.
F0100 IxT	Overloaded for more than 60 s.
F0102 Long-Term Ixt	Frequency inverter overloaded (60 s).
F0103 Short-Term Ixt	Short-term overload (1 s).
F0200 Heat Sink Overtemperature	Heat sink temperature of frequency inverter too high, check cooling and fan. Overtemperature faults are only resettable when the temperature has decreased for 5°C.
F0201 Heat Sink Sensor	Temperature sensor of frequency inverter defective or ambient temperature too low.
F0300 Overtemperature	Inside temperature of frequency inverter too high, check cooling and fan. Overtemperature faults are only resettable when the temperature has decreased for 5°C.
F0301 Undertemperature	Inside temperature of frequency inverter too low, check ambient temperature.
F0403 Transformer Overtemperature	Temperature of transformer or sine filter too high.

Current error (P259)	Description
F0404 Isolation	Earth fault in PV generator, check DC cabling.
F0405 Mains supervision	Mains parameters outside of nominal range, check mains connection for voltage/frequency deviations. Check fuses. Check main switch current settings.
F0406 Lighting protection	Defective surge arrester identified.
F0407 Mains Contactor	Main contactor does not pick up although the PV power is sufficient for feeding power to grid. Check main contactor, signal contact and main contactor control circuit. Motor circuit-breaker in the transformer pre-charge circuit has tripped.
F0409 Transformer magnetization	No transformer pre-charge feedback. Check control circuit. Pre-charge contactor or signal contact are broken.
F0412 Mains monitoring device	Digital inputs S5IND and EM-S3IND logically not identical. Check mains monitoring devices and their settings.
F0420 Mains upper frequency limit	Mains frequency exceeds the limit set in parameter P1033.
F0421 Mains lower frequency limit	Mains frequency falls below the limit set in parameter P1032.
F0500 Overcurrent	Overcurrent. Solar inverter overloaded, check filter, transformer and mains connection.
F0501 Uce-Control	Short circuit or earth fault at output. Check cabling.
F0502 Dyn. Phase-Current limitation	String current limit exceeded.
F0505 Earth fault	Total of currents is not correct. Check cabling.
F0506 Overcurrent	Overcurrent, quick triggering by hardware.
F0507 Overcurrent	Overcurrent, slow triggering by software.
F0700 Overvoltage	DC link voltage too high. Check generator configuration.
F0702 Power failure	Mains failure detected. Mains defect detected. Quick protection.
F0801 24 V Supply Voltage too low	Electronic voltage too low. Check control terminals.
F0804 24 V-Supply Overvoltage	Electronic voltage too high. Check control terminals.
F0900 Preload contactor	Pre-charge contactor in mains unit AEC does not pick up.
F0A11 EEPROM Read error	The control unit is not able to display the data of the solar inverter properly. The socket of the control unit should be changed.
F1201 Diagnostic-Error STO	At least one of the release paths is defective. Check cabling and EMC.
F1205 STO 5s-Supervision	The two release paths were not actuated at the same time. Check release switches.
F1300 Earth fault	Earth fault on inverter output.

11.3 Warning Messages

The current warning is displayed by a message in the warning status and can be used for early reporting of a critical operational condition. If a warning is present, this is indicated by the display field WARN of the control unit. Via the actual value parameter *Warnings* **269**, the current warning can be displayed.

Parameter	Warning message text	Meaning
0x0001	"Warning Ixt"	The warning limit for the available overload was reached.
0x0002	"Warning short-term Ixt"	
0x0004	"Warning long-term Ixt"	
0x0008	"Warning heat sink temperature Tk"	The heat sink temperature at which a warning is output was reached. Check ambient temperature.
0x0010	"Warning inside temperature Ti"	The inside temperature of the frequency inverter at which a warning is output was reached. Check ambient temperature.
0x0020	"Warning I-limit"	The output current of the solar inverter is limited.
0x0040	"Warning Init"	The solar inverter is released and in start state. The warning message is displayed if the solar inverter has been released via the control switch but is not in feed-in mode yet.
0x8000	"Warning 0x8000"	Defective surge arrester identified. The behavior set in parameter *Op. Mode overvoltage protection* **828** was triggered. A defect is indicated at the surge arrester (visual signal). Replace defective surge arrester.

12 Plant monitoring

In the standard variant, a control unit is installed in the door. This unit is used for parameter configuration and display of actual values and error messages. Optional components enable monitoring of the plant via various interfaces and data networks.

12.1 Plant monitoring by means of data logger

An optional data logger enables saving and transmission of data.
Monitoring is possible both on site and via remote maintenance.

Data transmission

The data logger can upload its yield data on a FTP server cyclically.

- As homepage data to supply an existing website with up-to-date values.
- As CSV files which can be opened and edited in MS Excel, for example.

For data transmission, the data logger requires a connection to the Internet.

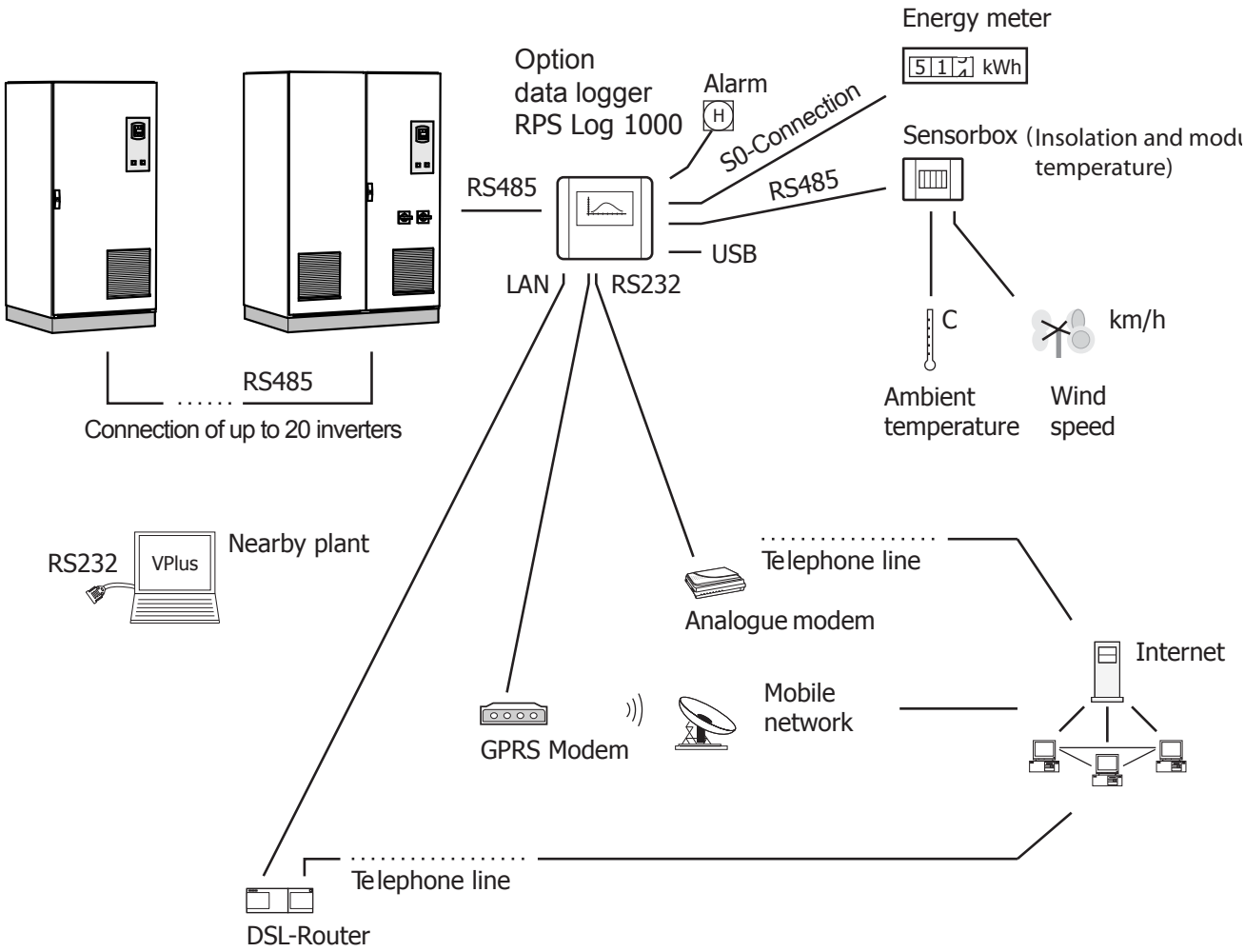


Figure 12-1: Plant monitoring by means of data logger

For details on the data logger, refer to the separate RPSlog1000 user manual.

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