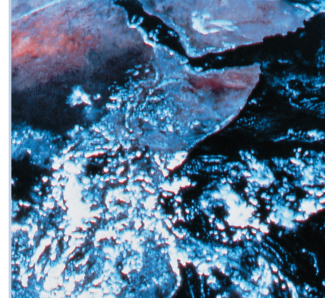
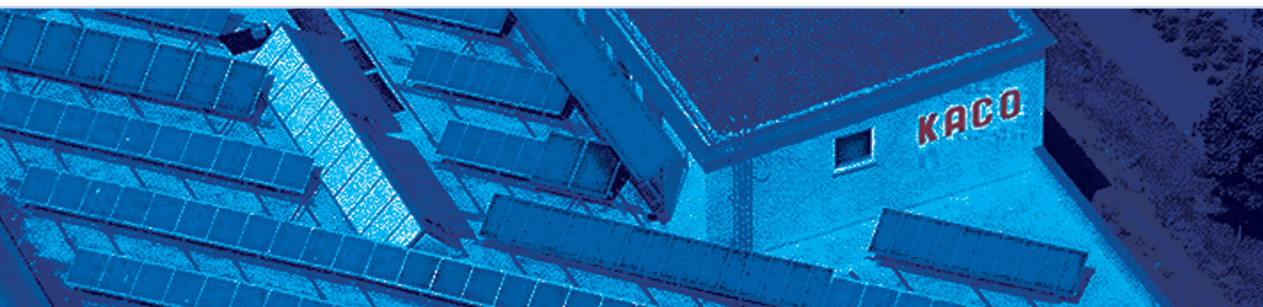


Manual.



Powador.

The new DC-isolated xi-series.



full of energy.



K A C O

GERÄTECHNIK

For the Operator

Operator's Instructions Powador 1501xi / 3501xi / 4501xi

1	About this document	2			
1.1	Attachment and Maintenance of documents	2	4.4	Set Mode	6
1.2	Symbols used in this document	2	4.5	Start key	6
1.3	CE Certification	2	4.6	The Serial RS232-Interface	7
1.4	Type Label	2	4.7	The RS485 Interface	9
			4.8	Display	9
2	Safety information and instructions	2	5	Accessories	12
3	Notes concerning installation and operation	3	6	Troubleshooting	13
3.1	Factory guarantee and liability	3	7	Recycling and disposal	14
3.2	Service	3			
3.3	Intended use (normal use)	3			
4	Operation	4			
4.1	Overview of operating elements and displays	4			
4.2	LED displays	4			
4.3	"Display" and "Set" buttons	5			

General Remarks

With the inverter manufactured by KACO Gerätetechnik GmbH you have purchased a device that excels by highly reliable and powerful technology. You will benefit from our long-standing experience in the field of current inverter technology and power electronics.

Powador 01xi inverters are electrically isolated, robust inverters, which are operated without any blowers and offer a high degree of efficiency. An illuminated display and intuitive menu guidance enables you to display the most important grid feeding data of the inverter. The inverter data can be transmitted to a PC for visualization.

Protection class IP 54 makes the inverters ready for use in any kind of environment – our inverters are even suitable for use in agricultural and industrial applications.

1 About this document

The following information will guide you through the entire operator’s manual. Further documents will be valid in conjunction with these operating and installation instructions.

We shall not be liable for any damage caused by non-adherence to the instructions given in this manual.

Pertaining documents

During the inverter installation please observe all assembly and installation instructions for components and other parts of the system. These instructions are shipped together with the respective installation components or supplementary equipment.

1.1 Attachment and Maintenance of documents

Please keep these operating and installation instructions in a safe place to ensure that they are available if needed.

1.2 Symbols used in this document

Please observe the safety information provided in this manual when operating your inverter!



Warning!
Lethal Hazard!



Danger!
Lethal Hazard by Electric Shock!



Caution!
Potential hazard for the product and environment!



Note!
Useful information and remarks!



Important!
Non-adherence to these instructions may adversely affect the operating convenience or functionality of the device.



This symbol designates a required action

1.3 CE Certification

CE labeling is used to document that the Powador inverter indicated on the type label meets the fundamental requirements according to the following directives:

- Directive concerning Electromagnetic Compatibility with Class B (Council Directive 89/336/EWG)
- Low Voltage Directive (Council Directive 73/23/EWG)

1.4 Type Label

The type label indicating the exact device description is located on the support plate at the underside of the enclosure.

2 Safety information and instructions



Danger!
Danger due to lethal voltages!
Hazardous live voltages are present inside the device/instrument and power lines. Therefore, the device/instrument must only be installed and opened by a skilled electrician.
Even when the device/instrument is switched off, dangerous live voltages may still be present inside the instrument.

Regulations concerning the prevention of accidents

The inverter must be installed by an approved skilled electrician who is responsible for the adherence to existing standards and regulations.

The proper and safe operation of the device/instrument requires proper transportation, storage, erection and assembly, as well as careful operation and maintenance.

Only personnel who have read and fully understood these operating instructions shall be authorized to operate the inverter.

Modifications/Manipulation

Manipulating the inverter is generally prohibited. Before performing any modifications on or in the environment of the inverter, a skilled electrician must be consulted by all means, as this electrician will assume responsibility.



Caution!
Hazard of damage due to unauthorized modifications/manipulation! By no means manipulate the inverter or modify or change the inverter or any other parts of the installation!

Transportation

The Powador inverter is subjected to extensive testing and inspection in our test field, so as to ensure the superb quality of our products. Our inverters leave our factory in a proper electrical and mechanical condition. Special packaging ensures that nothing can happen during the transport to our customers. Nevertheless, transport damage may not be ruled out completely. In this case, the forwarding agent/carrier will be responsible.

Please check the inverter carefully on arrival. Should you discover any visible signs of damage on the packaging, indicating that the inverter may be damaged, or should you find any visible signs of damage on the inverter please notify your responsible forwarding agent/carrier immediately?

If necessary, your solar installation provider or KACO Gerätetechnik GmbH will assist you. However, written damage reports must be received by the forwarding agent within six days after receipt of the goods at the latest.

Use exclusively the original packaging for returning the inverter – only this material will ensure safe transportation.

3 Notes concerning installation and operation

3.1 Factory guarantee and liability

KACO Gerätetechnik GmbH grants a guarantee of six years on Powador inverters, starting from the date of installation and max. 78 months after shipment by KACO.

During this time, KACO Gerätetechnik GmbH guarantees the proper function of the devices and free repair in the event that a defect should occur which we are accountable for.

Should your device show a defect or malfunction during the guarantee period, please contact your specialist dealer or, respectively, your installation expert.

Guarantee claims shall be excluded in the following cases:

- Use of the device for other than the intended use (normal use)
- Improper use and installation that does not comply with the required standards

- Improper operation
- Operation of the devices with defective protective equipment
- Manipulation of the device or makeshift repairs by the customer
- Influence of foreign objects or Act of God (lightning, overvoltage, tempest, fire)
- Inadequate ventilation of the device
- Non-adherence to the relevant safety instructions (VDE (Association of German Engineers), a.o.)
- Transport damage

All guarantee claims shall be handled at the premises of KACO Gerätetechnik GmbH. To this end, return transport shall be effected, as far as possible, in the original or equivalent packaging. The costs for these services cannot be borne by KACO Gerätetechnik GmbH.

Guarantee claims shall only be compensated by KACO if the damaged device is returned to KACO together with a copy of the invoice issued to the consumer by the specialist dealer. The type label on the device must be fully legible. In the event of noncompliance KACO reserves the right to deny guarantee services.

The warranty period for rework or replacement shipments shall be six months after shipment. However, it shall continue at least until expiration of the original warranty period granted for the shipped object.

3.2 Service

High quality and longevity of our inverters always have been of central importance for us - already at the time of product development. Our more than 60 years of experience in the field of current inverters are backing up this philosophy.

Despite all these quality-assuring measures, however, disturbances may occur in very rare cases. KACO GERÄTECHNIK GmbH will offer a maximum of assistance if one of these cases should arise. KACO GERÄTECHNIK GmbH will take every effort to remedy any defects fast and without unnecessary bureaucracy. Please contact our service department directly – and you will be aided and supported very quickly.

3.3 Intended use (normal use)

Powador inverters are built according to state-of-the-art and approved safety requirements. However, improper use may cause lethal hazards for operators or third parties and/or damage of instruments/devices or other property.

The device is intended to convert the direct voltage generated in the photovoltaic (PV) modules into alternating voltage (AC) and feed this voltage into the grid.

The inverter must only be operated in connection with a fixed/stationary connection to the public grid. Inverters are not intended for mobile use.

Any use other than the specified intended use shall not be deemed intended or normal use, and the manufacturer/supplier shall not be liable for any damage caused by such unintended use. Damage caused by unintended use is at the sole risk of the operator.

The term „intended use“ shall also include the adherence to the operating and installation instructions. Your skilled and authorized electrician will obtain the necessary applications and acceptance for your photovoltaic installation from your Utility Company. Some of the documents which are needed for these applications and acceptance are attached to these installation instructions.



Caution!
Using the device for any purposes other than intended/normal use is prohibited!

4 Operation

The grid-feeding process starts in the morning when there is enough daylight and, consequently, a certain minimum voltage is applied to the inverter. After a startup period of 3 minutes the inverter enables the grid feeding process. If this minimum voltage is fallen below at the end of day, the grid feeding process will be terminated and the inverter will be switched off.

4.1 Overview of operating elements and displays

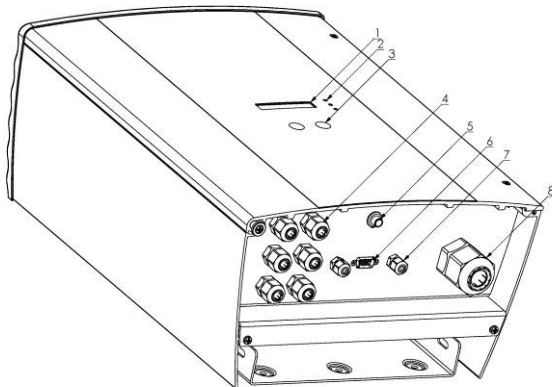


Figure 4.1: Overview of Powador

Captions

1 Display

Display of measured values and parameter settings

2 LED displays

Display of operating mode

3 Operating keys

Toggle function between measured values and parameter settings

4 Cable fitting for AC connection

5 Start key

This key is used to activate the display messages at the end of the day when it is getting dark.

6 RS232 interface

7 Cable duct for RS485 interface cable

8 Cable duct for DC connection

4.2 LED displays

Under normal operating conditions the photovoltaic modules will start to generate voltage as soon as enough daylight or sunlight is available. If a certain amount of voltage is applied to the inverter for a certain period of time, the inverter will start the grid-feeding process. The inverter is equipped with three LEDs, which provide information about the different modes of operation as follows:

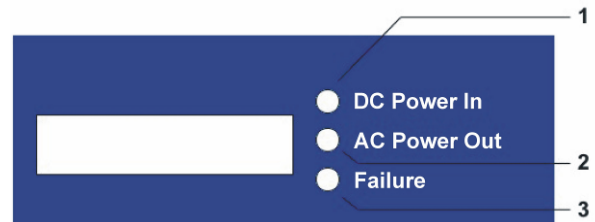


Figure 4.2: LED displays

LED DC Power In (1) (green):

This LED is illuminated from a generator voltage of approx. 100 V onward and extinguishes as soon as the generator voltage falls below 80 V. The DC Power In LED signals that the inverter is in its active state and the inverter controls are enabled. If this LED is not lit up the inverter will not be able to start grid feeding. Under normal operating conditions the LED is illuminated in the morning when there is enough daylight, and extinguishes again when it gets dark.

LED AC Power Out (2) (green):

This LED is illuminated during the grid feeding process. To this effect, the generator voltage must first exceed a value of 125 V (factory setting) for 3 minutes, ensuring that the PV generator provides enough power. This means that the “AC Power Out” LED is not lit up unless the PV generator LED is illuminated.

Under normal operating conditions the inverter starts grid feeding in the morning and terminates this process as it becomes dark. On cloudy days or during the winter months the grid feeding process can be interrupted at certain times, depending on the PV generator and the actual grid feeding capacity, and can be resumed later on. This process might be repeated for several times, especially in the morning and evening. This is not a sign of faulty operation but is normal operating behavior.

Failure LED (3) (red):

This LED indicates that the grid-feeding process has been terminated as a result of a malfunction / failure.

The “failure” LED is activated in the following cases:

- Grid overvoltage or low voltage
- Grid frequency error
- Excessive generator voltage
- Excessive generator power
- High-temperature shutdown
- Defective device

Please wait for approx. 10 minutes to verify if the malfunction only occurs temporarily. If not, please contact your authorized electrician. On elimination of the disturbance the grid-feeding process is re-started after approx. 10 seconds.



Important!
During feeding power failure (power failure in the public grid) the “Failure” LED is not lit up. In this case all LEDs and the display are deactivated and the inverter is completely shut down. Only after the feeding power has returned can the inverter resume its normal operation.

Please check whether the cause of your disturbance is a general power failure or if the fuse between the power meter and inverter has blown. In the event of a fuse failure please contact your authorized electrician. In case of a general power failure please wait until the problem has been resolved. The installation will restart automatically.

4.3 “Display” and “Set” buttons

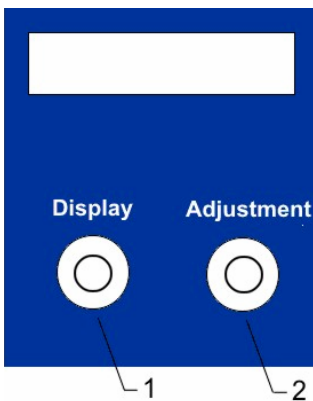


Figure 4.3: Operating keys of the Powador

The “Display” key (1) is used to toggle between the various read values and data. Using the “Adjustment” key (2) you may change the setting parameters, such as date and hour. The menu guidance is subdivided into two levels. Level 1 (display mode) is used to display the measured values, e.g. solar generator voltage. Only the “Display” key (1) is active at this level.



Keep this key pressed for approx. 1 second to select which measured value is to be displayed.

The menus are continuous, i.e. after reaching the last entry of the menu and pressing the “Display” key (1) the first entry is displayed again (s. Figure 4.4).

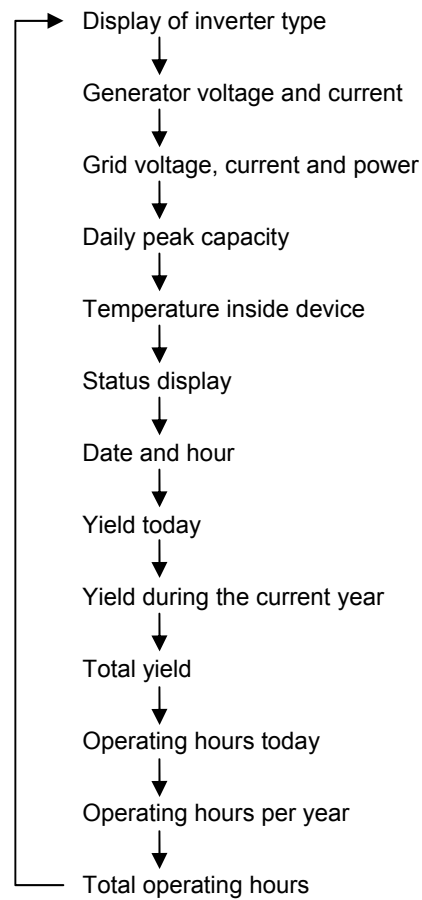


Figure 4.4: Display Mode Menu

If the “Display” key on the inverter is not operated for a longer period of time, the display will automatically show the currently fed-in power.

4.4 Set Mode



To go to level 2 (Set Mode), keep the “Display” key (1) pressed and simultaneously press the “Adjustment” (2) key for approx. 1 second. Using the “Adjustment” key (2) you may now change the selected parameter. Depending on the parameter the value will change after pressing the “Adjustment” key (2). The various setting parameters are shown in Figure 4.5.

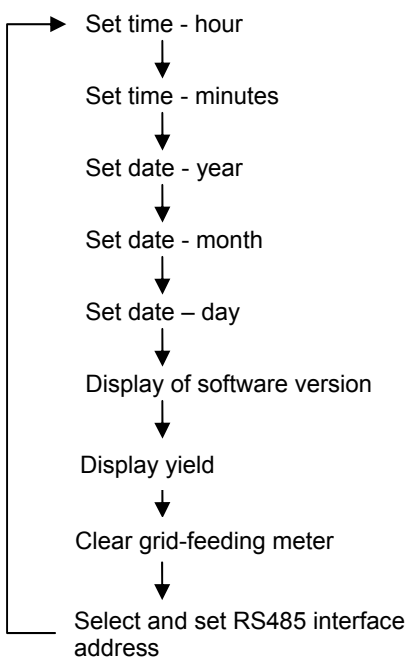


Figure 4.5: Set Mode Menu

Set hour and date

The set values are consecutive, i.e. as soon as you have reached the max. value the display will be reset to the min. value after pressing the „display (1) button once again. The display for setting the date covers a range up to 2050. After that, the value will be reset.

Clear grid-feeding meter

When clearing the grid-feeding meter, the values for “total yield” and “total operating hours” will be reset. The required parameter is “2” – please enter it by means of the “Adjustment” key (2).



The grid-feeding meter can only be cleared – it is not possible to make any other adjustments!

Selection of interface and address

Using the menu item “Select interface”, you may change between the RS232 and RS485 interface by means of the “Adjustment” key (2). If the RS485 interface is enabled, you can set the address by means of the “Display” key (1). Using the “Adjustment” key (2) you may set addresses consecutively from 1 to 32. Thereafter, the address will be reset to 1.

4.5 Start key

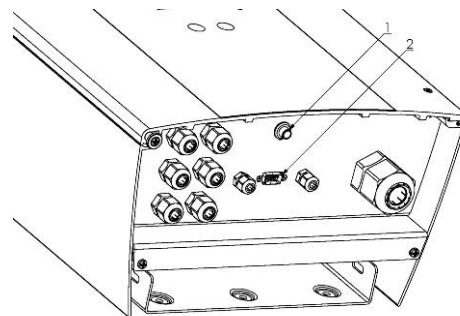


Figure 4.6: Underside of Powador

The device will be switched off in the evening with the break of dusk, and the display messages will be deactivated. If you wish to retrieve the values of the current day, press the start key (see Figure underside of inverter) to enable the device at nighttime.



Press the start key (1) at the underside of the device for approx. 5 seconds, until a message appears on the display and the LEDs “Grid feeding” and “Disturbance” are no longer lit up.

You may now scroll through the menu and retrieve the values of the current day. If no key is pressed for longer than one minute the device will be switched off again automatically.

The inverter will only store the latest values of a day. The values of “operating hours per year”, “Total operating hours”, “Annual fed-in power” and “Total grid feeding power” will be stored and added up. These values will not be lost even if the device is not operated for a longer period of time. The date and hour may have to be reset if the device has not been used for several days.

4.6 The Serial RS232-Interface

By means of an electrically isolated serial interface (2) the operating data can be transmitted to a computer (e.g. notebook) and processed individually with any commercial spreadsheet program. To connect the inverter to the PC you only need a commercially available interface cable. The cable length should not exceed 20 meters.



Using the optional accessories (see page 13) you can also establish a wireless data connection between the inverter and your PC over a long distance.

The inverter data is transmitted via the serial interface as text only; there is no error check.

Powador Sub-D male 9-pole	Meaning of message on PC	PC Sub-D female 9-pole
2	TXD	2
3	RXD	3
4	RTS	4
5	GND	5

Table 4-1: Pin allocation of the RS232 Interface

The RS232 interface has the following parameters:

- Baud rate: 9600 Baud
- Data bits: 8
- Parity: None
- Stop bits: 1
- Protocol: None

Figure 4.7 shows an example of a transmission via RS232 interface.

Data can be transmitted by means of any terminal emulation supplied together with all commercially available operating systems, or by means of the KACOViso visualization tool.



The KACOViso visualization software is available for download under <http://www.kaco-geraetetechnik.de>

In connection with the Powador inverter, KACOViso assumes the function of a data logger. It stores the inverter data and displays it in different diagram types, such as daily or monthly displays.

The PC has to remain switched on permanently in this case. Therefore, this type of monitoring should be limited to a certain period of time (e.g. troubleshooting) due to energy reasons. For continuous system monitoring we recommend the optional Powador-Display, Powador-easyLOG or Powador-proLOG accessories (see page 12).

Column 1	2	3	4	5	6	7	8	9	10
04.06.2005 16:55:30	4	363.8	0.37	134	226.1	0.53	103	23	
04.06.2005 16:55:40	4	366.0	0.39	142	226.1	0.53	112	23	
04.06.2005 16:55:50	4	359.5	0.41	147	226.1	0.53	116	23	
04.06.2005 16:56:00	4	369.8	0.42	155	226.1	0.58	118	23	
04.06.2005 16:56:10	4	377.0	0.43	162	226.1	0.63	131	23	
04.06.2005 16:56:20	4	373.6	0.45	168	226.1	0.63	133	23	
04.06.2005 16:56:30	4	364.0	0.48	174	226.1	0.68	146	23	
04.06.2005 16:56:40	4	364.3	0.49	178	226.1	0.68	146	23	

Figure 4.7: Extract from a communication protocol via RS 232 interface

Column	Explanation	Column	Explanation
1	Date	6	Generator power in W
2	Hour	7	Grid voltage in V_{AC}
3	Operating mode/status (see below)	8	Grid current, delivered current in A_{AC}
4	Generator voltage in V	9	Grid-feeding power in W
5	Generator current in A_{DC}	10	Device temperature in °C

Table 4-2: Explanation of the individual columns

Status	Explanation	Comment
0	Inverter has just switched on	Only after the first start-up in the morning.
1	Waiting for start	Grid parameters and generator voltage are checked.
2	Waiting for shut-down	Insufficient generator voltage and generator power. Condition that precedes the night shutdown.
5	Grid feeding operation	The inverter starts feeding into the grid.
15	Transition to night cut-off	Inverter "goes to sleep"
16	Inhibited operation	3 errors during self test – operation will be resumed after complete shutdown
24	DSP error	error <ul style="list-style-type: none"> - Communication error - Grid shutdown frequency - Offset (grid feeding is too high) - High-temperature cut-off - Transducer (Plausibility error – measuring technique) - Impedance cut off - Overload cut off
25	Self test of power electronics	The shutdown behavior of the power electronics is checked before the start of the grid-feeding process
26	Self test of grid isolation relay	The grid isolation relay is checked before the start of the grid-feeding process.
28	Hardware error	Self test was unsuccessful, a defect has occurred.

The interface of the connected PC or laptop must comply with the standard for RS232 interfaces. Some computer manufacturers are not 100 % compliant with this standard. In these cases there may be problems during the data transfer.



The read data for current and voltage are subject to the indicated tolerances and not suitable to measured degrees of efficiency or yield data.

These readings are merely used to check the installation for its general function and proper operation.

4.7 The RS485 Interface

To enable remote monitoring of your photovoltaic installation, Powador inverters are additionally equipped with an RS 485 interface see Figure 4.1

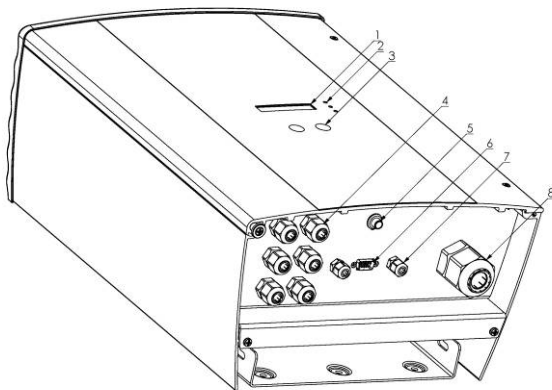


Figure 4.1

This interface enables monitoring several inverters at the same time. By means of the Powador-proLOG series you can receive your yield and operating data or error messages by SMS or e-mail. This monitoring option is especially recommended in cases where you are unable to check the functionality of your installation on-site at regular intervals, i.e. if your domicile is too far away from the installation site. In addition, you can use the Powador-link in your installation, so as to bridge long distances between several inverters or between an inverter and proLOG by means of a wireless RF connection. Please contact your installer if you wish to integrate remote monitoring in your system.

4.8 Display

The inverters of the Powador xi-series are equipped with an illuminated LCD display (see Fig. 4-1).

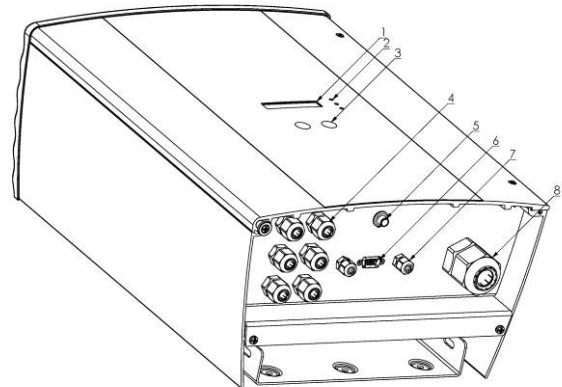


Figure 4.1 – (1). This display shows all measured values and data. In normal operation the background illumination is de-activated. As soon as you press one of the keys the background illumination will be activated. If 10 seconds elapse without a key being pressed, the background illumination will be switched off again.

During normal operation the current grid-feeding power is shown on the display, if no key is pressed for a longer period of time.



Important!

Due to measuring tolerances the measured values may not always correspond to the actual values. The measuring sensors of the inverter have been selected in a way to ensure maximum solar yields.

Due to the tolerances the daily yields displayed on the inverter may deviate from the values of your Utility Company's grid-feeding meter by up to 15% (admissible meter tolerance approved by your Utility Company: $\pm 2\%$).

Using the operating keys (see Section 4.3) the values and data listed in Table 4-3 can be shown.

No.	Display Message	Explanation
1	<div style="border: 1px solid black; border-radius: 10px; padding: 5px; width: fit-content;"> Start from 125 V Measurement xxx.x V </div>	Display shown during the starting-up period (in the morning), after a malfunction or prior to night shutdown. <u>No grid feeding</u> in this mode of operation. The inverter waits until the voltage has exceeded a value of 125 V. If this value is exceeded for longer than 4 minutes the grid feeding will be started. An audible sound is generated when the grid isolation relay is enabled
2	<div style="border: 1px solid black; border-radius: 10px; padding: 5px; width: fit-content;"> Solar generator xxx.x V xx.xx A </div>	Existing voltage and current of the solar generator connected to the inverter. Shown in volts and amps; voltage tolerance $\pm 3\%$; current tolerance $\pm 5\%$ at rated power. Greater tolerances are possible when smaller generator currents are displayed.
3	<div style="border: 1px solid black; border-radius: 10px; padding: 5px; width: fit-content;"> Grid xxxx W xxx.x V xx.xx A </div>	Actual grid voltage, grid current and power (measurement of the phase into which power is delivered); displayed in volts, amps and watts; voltage tolerance: $\pm 3\%$; current tolerance: $\pm 3\%$.
4	<div style="border: 1px solid black; border-radius: 10px; padding: 5px; width: fit-content;"> Daily peak Capacity xxxx W </div>	Short-term peak grid feeding capacity of the day, displayed in W. According to the regulations stipulated by the Power companies, this peak capacity must not exceed 10 % of the rated power of the inverter. However, the generator may be dimensioned for higher capacities.
5	<div style="border: 1px solid black; border-radius: 10px; padding: 5px; width: fit-content;"> Temperature inside the device xx ° </div>	Display of the actual heat sink temperature, in °C. The inverter will limit grid feeding if the temperature exceeds 65°C. If the device temperature exceeds 80°C it will switch off automatically.
6	<div style="border: 1px solid black; border-radius: 10px; padding: 5px; width: fit-content; margin-bottom: 10px;"> Status: Grid feeding operation </div> <div style="border: 1px solid black; border-radius: 10px; padding: 5px; width: fit-content; margin-bottom: 10px;"> Status: Waiting for startup </div> <div style="border: 1px solid black; border-radius: 10px; padding: 5px; width: fit-content; margin-bottom: 10px;"> Status: Waiting for shutdown </div> <div style="border: 1px solid black; border-radius: 10px; padding: 5px; width: fit-content;"> Status: Device switches off </div>	Display of the various operating statuses Normal grid-feeding operation. Power is fed into the grid. Waiting for sufficient solar generator power. The generator voltage is not sufficiently high for grid feeding, or the grid feeding process was stopped and the system is re-started after a failure. Waiting for night shutdown. The generator capacity is no longer sufficient for grid feeding, and the device waits for the night shutdown. The device changes over to night shutdown.

7	<div style="border: 1px solid black; border-radius: 5px; padding: 5px; margin-bottom: 5px;">Error Grid voltage</div> <div style="border: 1px solid black; border-radius: 5px; padding: 5px; margin-bottom: 5px;">Error Grid frequency</div> <div style="border: 1px solid black; border-radius: 5px; padding: 5px; margin-bottom: 5px;">Error Grid impedance</div> <div style="border: 1px solid black; border-radius: 5px; padding: 5px;">Safety shutdown</div>	<p>Error Message</p> <p>Grid voltage is not correct (overvoltage or undervoltage), thus inhibiting the grid-feeding process.</p> <p>The grid frequency is not correct (excessive or low frequency), making the grid-feeding process impossible.</p> <p>There is an impedance jump in the AC network. This can be caused by e.g. bridging high capacity.</p> <p>A grid voltage error, grid current problem, grid frequency or grid impedance problem has occurred. The inverter has switched off to protect against damage.</p>
8	<div style="border: 1px solid black; border-radius: 5px; padding: 5px;">Internal failure xxx xxx xxx xxx</div>	<p>An internal failure occurred. It will clear itself and the unit starts again.</p>
9	<div style="border: 1px solid black; border-radius: 5px; padding: 5px;">Date xx.xx.200x Hour xx:xx:xx</div>	<p>Indicates date and hour</p>
10	<div style="border: 1px solid black; border-radius: 5px; padding: 5px;">Yield today xxxxx kWh</div>	<p>Power delivered since sunrise. Display in watt hours (not kWh!)</p>
11	<div style="border: 1px solid black; border-radius: 5px; padding: 5px;">Total yield xxxxx kWh</div>	<p>Power delivered during the current calendar year (January 1 to-date)</p>
12	<div style="border: 1px solid black; border-radius: 5px; padding: 5px;">Operating hours Today xxxxx:xx</div>	<p>Power delivered since the time of inverter startup.</p>
13	<div style="border: 1px solid black; border-radius: 5px; padding: 5px;">Operating hours Year xxxxx:xx</div>	<p>Today's operating hours since sunrise. Displayed in hours and minutes.</p>
14	<div style="border: 1px solid black; border-radius: 5px; padding: 5px;">Operating hours Total xxxxx:xx</div>	<p>Operating hours during the past calendar year (January 1 to-date).</p>

Table 4-3: Possible display messages



Caution!
If the values for date and hour are set incorrectly, this will also affect the display of operating hours and yields!

5 Accessories

KACO Gerätetechnik GmbH offers its customers a wide range of useful accessories. The product range includes devices of superb quality for monitoring, display, data transfer and visualization.

Powador-Display

You wish to see what your installation is doing and whether everything is the way it should be? Then Powador-display is the right choice for you. Via an RF module, the inverter transmits its data to the display, where you can observe the daily curve or read the current output or daily yield. You will be able to recognize any problems in your installation very quickly. The attractive display is suitable for use in home or office surroundings.



Figure 5.1: Powador-Display

Powador-proLOG

You wish professional monitoring and data recording of your installation? Powador-proLOG is the high-end solution to provide error messages by SMS, fax or e-mail, remote access to installation data, display of your PV installation on the web or many other things – it's just no problem for Powador-proLOG. Up to 32 devices can be connected to Powador-proLOG by means of the RS485 interface.

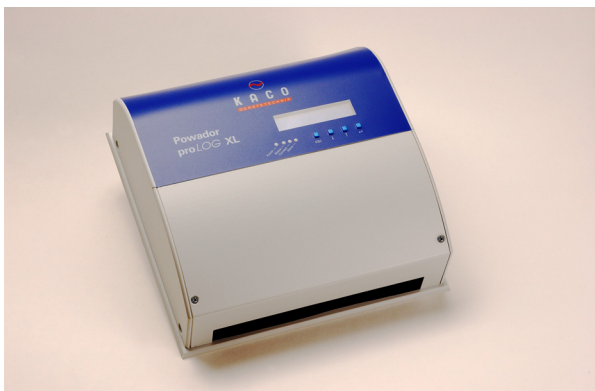


Figure 5.2: Powador-proLOG

Powador-easyLOG

Powador-easyLOG is used to transmit the operating data of your inverter via a wireless connection and display such data either on the Powador-Display or on a PC.



Figure 5.3: Powador-easyLOG

Powador-go

If you simply wish to know if your installation is working properly Powador-go is the right choice for you. If your PV installation or your modules stop producing current, Powador-go-Set will provide an acoustic warning signal after 24 hours. The entire processes are independent of the inverter, so just lean back and relax – your installation will tell you if there is a problem.



Figure 5.4: Powador-go

6 Troubleshooting

Within the scope of our continuously expanding Quality Assurance System, our goal is to rule out and eliminate any faults and defects. You have purchased a product that has left our factory in a proper condition. Each individual device has successfully passed extensive inspection tests for proper operation and functioning of protective devices, as well as a long-duration test at our factory.

Should your PV installation not work properly despite all these measures, we recommend the following procedure for remediation:

Check the solar generator and grid connections leading to the Powador, observing all the safety instructions given in this manual. Please observe the inverter carefully and take note of the display messages and LED displays.

Below is a summary of possible error and recommended remedies:

Error	Cause	Remedy/Explanation
Inverter shows an unrealistic daily peak value	Grid voltage failure	Even if an incorrect daily peak value is displayed the inverter continues to work properly and without any yield losses. Values are reset overnight. If you wish to reset the display immediately, disconnect the inverter and the DC grid voltage supply and switch on the inverter again.
Daily yield values do not correspond to the values shown on the power meter of the Utility company.	Tolerances of the inverter's internal measuring elements	Measuring errors are caused by tolerances of the measuring elements. The tolerances of the individual measuring values are shown in Table 4-3, Display Operation and Settings. The daily yield value may deviate from the value shown on the power meter by up to 15%.
No display shown	Device is in the night shutdown mode No grid voltage is present Solar generator voltage is less than 110V	The inverter shuts down over night. If the display should not be illuminated during a normal time of the day you should check on the power meter whether or not the device delivers power. If power is delivered the display module is defective, and the inverter has to be returned to KACO for repair. If no power is delivered you should check that grid voltage is present and that the solar generator voltage is higher than 125 V. If this is the case but the inverter still fails to deliver power the device has to be returned to KACO for repair.
Inverter does not start	Device is in its night shutdown mode No grid voltage is present The solar generator voltage is less than 125 V	The inverter shuts down over night. If the display should not be illuminated during a normal time of the day you should check on the power meter whether or not the device delivers power. If power is delivered the display module is defective and the inverter has to be returned to KACO for repair. If no power is delivered you should check that grid voltage is present and that the solar generator voltage is higher than 125 V. If this is the case but the inverter still fails to deliver power the device has to be returned to KACO for repair.
Inverter is active but does not deliver power – the display reads: Start from 125 V Measurement: xxx V	Insufficient generator voltage. Voltage measured < 125V	After sunrise, at sunset, and during times of low insolation due to bad weather conditions the generator voltage or, respectively, generator power fed from the roof may be insufficient for grid feeding
Inverter is active but does not deliver power – the display reads: Start from 125 V Measurement: xxx V (measured voltage is higher than 125V)	The inverter has interrupted grid feeding due to a malfunction/disturbance.	After an interruption of grid feeding due to a malfunction (grid power failure, overtemperature, overload, etc.) the inverter always waits for approx. 3 minutes before resuming its grid feeding operation. Grid failures may cause interruptions during the day. If more than 10 interruptions should occur over several weeks you should contact your solar installation provider.

Error	Cause	Remedy/Explanation
The inverter terminates grid feeding shortly after starting-up although there is enough insolation.	Defective grid isolation relay in the inverter.	Although there is enough insolation, the inverter delivers power for a few seconds only and switches off again. During this short time a grid feeding value between 0 – 5 W is displayed. If insufficient generator power can be ruled out in this case the grid isolation relay is presumably defective and prevents the inverter from being activated.
Grid fuse triggers	Insufficient grid fuse rating Inverter hardware is damaged	At times of high insolation the inverter may exceed its rated current for a short time, depending on the type of solar generator. Therefore, the grid fuse should have a higher rating than the max. grid feeding current. The grid fuse acts immediately if the inverter changes over to grid feeding (i.e. on termination of the start-up period). In this case, the inverter hardware is damaged and the device has to be returned to KACO for repair.
Inverter causes noise	Special environmental conditions	Under special environmental conditions the devices may cause audible noise. This may be due to the following causes: <ul style="list-style-type: none"> - Grid effects and/or grid disturbances caused by special consumers (motors, machines, etc.), which are connected to the same grid point or which may be installed in the vicinity of the inverter. - Dynamic weather conditions (frequent changes between sun and clouds) may cause a slight um due to high energy - Certain grid conditions may result in grid resonance between the input filter of the device and the grid, which may continue to be audible even after the inverter is switched off. - People with very sensitive ears (children, in particular) may perceive high-frequency hum of the inverter, caused by the operating frequency of 18 kHz. - This noise does not affect the operation of the inverter or inverter performance and will not result in failure, damage or shorter useful life of the devices.

If any defect found should not be able to be remedied by means of the measures described above please contact your solar installation provider or our Service Department.

Please have the following information ready to enable our Service Department to respond quickly and properly:

Inverter Data:

- Serial number of the device
- Inverter type
- Short description of error
- Is the fault or error reproducible? If so, please provide a short description.
- Does the fault or error occur sporadically?
- Describe the insolation conditions prevailing when the error occurred.
- Hour of the day

Solar generator data:

- Module type, manufacturer (please send data sheet, if available).
- Number of modules connected in series
- Number of strings
- Generator power

7 Recycling and disposal

Both the inverter and associated transport packaging mainly consist of recyclable raw materials.

Device

Defective inverters and accessories do not belong in your household garbage. Please ensure that the old device and any accessories are disposed of according to the applicable regulations.

Packaging

Please ensure that the transport packaging is disposed of properly.

For skilled and authorized electricians

Installation Instructions

Powador 1501xi / 3501xi / 4501xi

1. About this document	2		
1.1 Attachment and Maintenance of documents	2		
1.2 Symbols used in this document	2		
1.3 CE Certification/Labeling	2		
1.4 Type label	2		
2. Safety information and instructions	2		
3. Notes concerning installation and operation	3		
3.1 Factory guarantee and liability	3		
3.2 Service	4		
3.3 Intended use (normal use)	4		
4. Device description	4		
4.1 Dimensioning of the PV generator	4		
4.2 Protective concepts	5		
4.3 Mechanical dimensions	5		
5. Installation and startup	6		
5.1 Selecting the appropriate place of installation	6		
5.2 Installing the inverter	6		
5.3 Electrical connections	7		
5.4 Connecting the fault-signal relay	10		
5.5 Connection of the S0 output	10		
5.6 Connection of the RS485 interface	10		
		5.7 Startup of the inverter	10
		5.8 Programming the parameters	11
		6. Applications/Acceptance by Your Utility Company	13
		7. Switching off the inverter	14
		8. Troubleshooting	14
		9. Technical Data	17
		10. Appendix	18
		10.1 EU Declaration of Conformity	18
		10.2 Declaration of Conformity concerning the rated power and max. output of photovoltaic inverters	19
		10.3 Certificate of Conformity/Non-Objection	20

1. About this document

The following information will guide you through the entire documentation. Further documents will be valid in conjunction with these operating and installation instructions.

We shall not be liable for any damage caused by non-adherence to the instructions given in this manual.

Pertaining documents

During the inverter installation please observe all assembly and installation instructions for components and other parts of the system. These instructions are shipped together with the respective installation components or supplementary equipment.

1.1 Attachment and Maintenance of documents

Please keep these operating and installation instructions in a safe place to ensure that they are available if needed.

1.2 Symbols used in this document

Please observe the safety information provided in this manual when operating your inverter!



Warning!
Lethal Hazard!



Danger!
Lethal Hazard by Electric Shock!



Caution!
Potential hazard for the product and environment!



Note!
Useful information and remarks



Important!
Non-adherence to these instructions may adversely affect the operating convenience or functionality of the device.



This symbol indicates that a certain action is required.

1.3 CE Certification/Labeling

CE labeling is used to document that the Powador inverter indicated on the type label meets the fundamental requirements according to the following directives:

- Directive concerning Electromagnetic Compatibility with Class B (Council Directive 89/336/EWG)
- Low Voltage Directive (Council Directive 73/23/EWG)

1.4 Type label

The type label indicating the exact device description is located on the support panel at the underside of the enclosure.

2. Safety information and instructions



Danger!

Danger due to lethal voltages!

Hazardous live voltages are present inside the device/instrument and power lines. Therefore, the device/instrument must only be installed and opened by a skilled electrician.

Even when the device/instrument is switched off, dangerous live voltages may still be present inside the instrument.

Standards and Regulations

- VDEW conformity according to the regulations of the Association of German Utility companies
- "Independent power generating plants on low-voltage grids", Directive concerning the connection and parallel operation of independent power generating plants on the low-voltage grid, 4th Edition 2001
- IEC 60364-7-712 Electrical installations of buildings - Part 7-712
- DIN EN 60891 Process of converting measured current-voltage characteristic curves of photovoltaic components
- DIN EN 60904 Photovoltaic Installations – Part 1 to 8
- EMC Test Methods according to EN50081-1:1992, EN50082-1:1997
- Emitted interference: EN 55014-1: 1993
- Interference immunity: EN 55014-2: 1997
- Harmonic (upper) waves: EN61000-3-2: 1995
- Voltage fluctuations + Flicker: EN61000-3-3: 1995
- Semiconductor inverters: EN 60146-1-1: 1994, EN60146-1-3: 1994

Technical rules

The assembly must be in compliance with the local regulations and technical rules, in particular with regard to:

- Electrical connections
- VDE 0100 Setting-up of power installations with rated voltages of up to 1000 volts
- VDE 0105 Part 100 Operation of electrical plants/installations
- VDE 0185 General information concerning the setup of lightning protection installations

- VDE 0190 Main potential isolation of electrical plants/installations
- VDE 0298 Part 4 Rubber-insulated leads carrying rated voltages of up to 450/750 volts
- DIN 18382 electrical cable and routing installation in buildings

Regulations concerning the prevention of accidents

The inverter must be installed by an approved skilled electrician who is responsible for the adherence to existing standards and regulations.

The proper and safe operation of the device/instrument requires proper transportation, storage, erection and assembly, as well as careful operation and maintenance.

Only personnel who have read and fully understood all safety information contained in these operating and installation instructions, as well as the assembly, operating and maintenance instructions, shall be authorized to operate the inverter.

During the operation of this device, certain parts of the device inevitably carry hazardous live voltages, which may lead to severe personal injury or even death. The following precautions should be followed to minimize the risk of lethal hazards or personal injuries.

The installation of the device must be in compliance with the relevant safety regulations (e.g. DIN, VDE) or other applicable national or local provisions. Proper earthing, conductor dimensioning and an appropriate short-circuit protection must be provided to ensure operational safety.

All instrument covers must remain closed during operation.

Prior to performing any visual checks and maintenance work the device must be disconnected from all power sources and protected against inadvertent switching on. If measurements have to be conducted while the device is connected to power, NEVER touch live terminals. Remove all jewellery from your wrists and fingers. Ensure that the test equipment is in a good and safe operating condition.

When working on the switched-on device, make sure to stand on an insulated surface and ensure that there is no connection to ground.

Exactly follow the instructions given in these operating and installation instructions and especially observe all information concerning possible hazards, warnings and precautions.

This list does not constitute a complete list of all required measures. Should any specific problems occur, which are not covered sufficiently for the purposes of the buyer, please contact your specialist dealer.

Modifications/Changes

Performing any modifications or changes on the inverter is generally prohibited. Performing any changes or modifications in the environment of the inverter is only permitted if they comply with national standards. Transportation



Caution!
Hazard of damage due to unauthorized modifications/manipulation! By no means manipulate the inverter or modify or change the inverter or any other part of the installation!

The Powador inverter is subjected to extensive testing and inspection in our test field, so as to ensure the superb quality of our products. Our inverters leave our factory in a proper electrical and mechanical condition. Special packaging ensures that nothing can happen during the transport to our customers. Nevertheless, transport damage may not be ruled out completely. In this case, the forwarding agent/carrier will be responsible.

Please check the inverter carefully on arrival. Should you discover any visible signs of damage on the packaging, which imply that the inverter may be damaged, or should you find any visible signs of damage on the inverter please notify your responsible forwarding agent/carrier immediately.

If necessary, your solar installation provider or KACO Gerätetechnik GmbH will assist you. However, written damage reports must be received by the forwarding agent within six days after receipt of the goods at the latest.

Use exclusively the original packaging for returning the inverter – only this material will ensure safe transportation.

3. Notes concerning installation and operation

3.1 Factory guarantee and liability

KACO Gerätetechnik GmbH grants a guarantee of six years on Powador inverters, starting from the date of installation and max. 78 months after shipment by KACO.

During this time, KACO Gerätetechnik GmbH guarantees the proper function of the devices and free repair in the event that a defect should occur which we are accountable for.

Should your device show a defect or malfunction during the guarantee period, please contact your specialist dealer or, respectively, your installation expert.

Guarantee claims shall be excluded in the following cases:

- Use of the device for other than the intended use (normal use)
- Improper use and installation that does not comply with the required standards
- Improper operation

- Operation of the devices with defective protective equipment
- Manipulation of the device or makeshift repairs
- Influence of foreign objects or Act of God (lightning, overvoltage, tempest, fire)
- Inadequate ventilation of the device
- Non-adherence to the relevant safety instructions (VDE (Association of German Engineers), a.o.)
- Transport damage

All guarantee claims shall be handled at the premises of KACO Gerätetechnik GmbH. To this end, return transport shall be effected, as far as possible, in the original or equivalent packaging. The costs for these services cannot be borne by KACO Gerätetechnik GmbH.

Guarantee claims shall only be compensated by KACO if the damaged device is returned to KACO together with a copy of the invoice issued to the consumer by the specialist dealer. The type label on the device must be fully legible. In the event of noncompliance KACO reserves the right to deny guarantee services.

The warranty period for rework or replacement shipments shall be six months after shipment. However, it shall continue at least until expiration of the original warranty period granted for the shipped object.

3.2 Service

High quality and longevity of our inverters always have been of central importance for us - already at the time of product development. Our more than 60 years of experience in the field of current inverters are backing up this philosophy.

Despite all these quality-assuring measures, however, failures may occur in very rare cases. KACO GERÄTETECHNIK GmbH will offer a maximum of assistance if one of these cases should arise. KACO GERÄTETECHNIK GmbH will take every effort to remedy any defects fast and without any unnecessary bureaucracy. Please contact our service department directly – and you will be aided and supported very quickly.

3.3 Intended use (normal use)

Powador inverters are built according to state-of-the-art and approved safety requirements. However, improper use may cause lethal hazards for operators or third parties and/or damage of instruments/devices or other property. The device is intended to convert the direct voltage generated in the photovoltaic (PV) modules into alternating voltage (AC) and feed this voltage into the grid.

The inverter must only be operated in connection with a fixed/stationary connection to the public grid. Inverters are not intended for mobile use.

Any use other than the specified intended use is not deemed intended or normal use, and the manufacturer/supplier shall not be liable for any damage caused by such unintended use. Damage caused by unintended use is at the sole risk of the operator.

The term "intended use" shall also include the adherence to the operating and installation instructions.

Some of the documents which are needed for these applications and acceptance are attached to these installation instructions.



Caution!

Using the device for any purpose other than intended/normal use is prohibited!

4. Device description

The electrically isolated Powador xi-series devices are currently available for three different power classes. The appropriate inverter type is selected in accordance with the selected and mounted photovoltaic modules. The max. power values are indicated in the data sheet (Section 9).

The inverter designation is shown on the front side above the display and on the type label.

4.1 Dimensioning of the PV generator

The selection of the PV generator is of crucial importance when dimensioning a PV installation. It must be observed by all means that the solar generator is the right match for the inverter. Please observe the data given in the Technical Data Sheet (Section 9) for dimensioning the solar generator.



The design and dimensioning Kacocalc pro is available for easy selection of PV modules – please obtain your free download at

<http://www.kaco-geraetetechnik.de>

Dimensioning of the PV generator:

The number of PV modules connected in series must be selected in such a way that the output voltage of the PV generator is maintained within the admissible input voltage range of the inverter – even in the event of extreme external temperatures. In Central Europe, module temperatures between -10°C and $+70^{\circ}\text{C}$ should be assumed. Depending on the type of module assembly and geographical conditions, $+60^{\circ}\text{C}$ or $+70^{\circ}\text{C}$ should be used for calculating the voltage. The temperature coefficient of the solar modules should be observed. The following criteria must be met for calculating the voltage of the PV generator:

$U_0 (-10^{\circ}\text{C}) < \text{max. input voltage (500VDC)}$

Even at very low external temperatures (-10°C), the no-load voltage of the connected string must remain within the admissible input voltage range. For example, if the temperature falls from 25°C to -10°C , the no-load voltage of 12-V modules will increase by approx. 2.8 V per module (5.6 V for 24V modules). The no-load voltage of the entire string must be less than 500 volts.

$U_{MPP} (+60^{\circ}\text{C}) > \text{min. input voltage (125VDC)}$

Even at very high external temperatures ($+60^{\circ}\text{C}$) the MPP voltage of the connected string should remain within the admissible input voltage range. If the temperature rises from 25°C to 60°C , the MPP voltage of 12V modules will decrease by approx. 3.6 V per module (7.2 V for 24V modules). The MPP voltage of the entire string should be $> 125\text{ V}$.

Even if the MPP voltage is beyond the admissible input range, the installation nevertheless will continue to work properly. However, the delivered power is slightly less than the maximum yield.

Provided that the input voltage is within the admissible input voltage range, the inverter will **not be damaged** if a connected PV generator should supply current above the max. usable input current.

If the PV generator should supply more than the max. PV generator power of the inverter for a short time, particularly due to clouds and relatively low module temperatures, it is possible that the inverter switches off for safety reasons and automatically switches on again after approx. 10 seconds. The overload status is shown on the display in plain text. Under normal circumstances, however, the dynamic control of the inverter ensures that this condition is recognized and the inverter operation is continued without any interruption.

The solar generator still represents the most substantial cost factor of a solar installation. Therefore, it is very important to obtain maximum energy yields. To achieve this goal, solar generators located in Central Europe should be orientated towards the South at an angle of inclination of 30° , and shading of whatever kind should be prevented under all circumstances.

In many cases, the recommended angle of inclination cannot be implemented for technical reasons. To achieve the high energy yield of a solar generator with optimal orientation (South, inclination angle of 30°), the efficiency of the solar generator can be increased.

For roofs that are orientated towards the East/West we recommend two-string PV installations. To ensure optimum yield of the installation, the first string should be installed on the East side of the roof, whereas the second string should be installed on the West side of the roof.

In exposed mountain areas or in Southern regions it is recommended to reduce the efficiency ranges. Please consult your specialist dealer or notify us if you should require any further assistance.

4.2 Protective concepts

The following monitoring and protective functions are integrated in Powador inverters:

- BISI grid monitoring to protect against personal injuries and avoid islanding effects according to VDE0126.
- Overvoltage varistors to protect the power semiconductors against high-energy transients on the grid side.
- Temperature monitoring of the heat sink
- EMC filters to protect the inverter against high-frequency grid interference
- Grid-side varistors to earth/ground, to protect the inverter against burst and surge pulses.

4.3 Mechanical dimensions

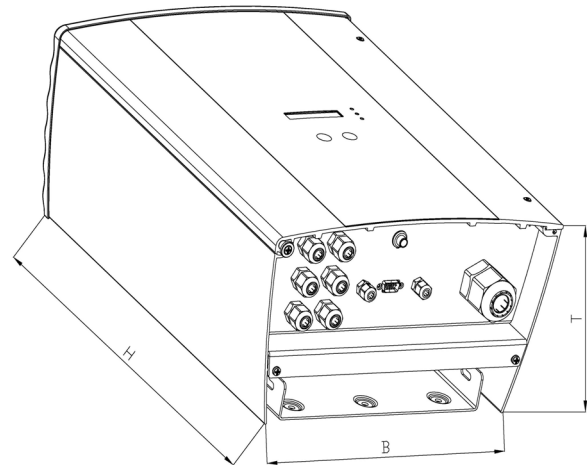


Figure 4.1: Dimensions of Powador

Type	Height	Width	Depth
1501xi	450mm	340mm	200mm
3501xi	500mm	340mm	200mm
4501xi	650mm	340mm	220mm

5. Installation and startup

5.1 Selecting the appropriate place of installation



Powador inverters will meet the requirements of protection class IP54, if all cable connections are allocated or closed accordingly.

Nevertheless the place of installation should be as dry as possible in order to ensure long lifetimes. In addition, the installation environment should be well air-conditioned so as to protect against overheating and prolongate the useful life.

The following rules should be observed when selecting the place of installation of your inverter:

Ensure good access for assembly or service work.

Maintain a minimum clearance of 500 mm around the device and between the device and other objects, such as cabinets, ceiling, or similar

The device has been designed for vertical wall installation.

Please ensure free air circulation around the device and through the heat sink at the rear side.

If the inverter is installed in a switch cabinet or similar, please provide forced ventilation to ensure that heat is dissipated adequately.

The heat sink may reach a temperature of max. 90°C. Therefore, only mount the inverter on walls that are made from a heat-resistant material.

Ensure that the wall has an adequate load-bearing capacity and only use the appropriate installation material.

In areas with a special risk of flooding, always make sure to install the inverter in a sufficiently elevated place.

Installation at eye level makes it easier to read the display.



Important!

Due to the high system voltage, less current may flow on the DC voltage side than on the AC voltage side. Given the same cable cross-sections, losses are therefore higher on the AC voltage side than on the DC voltage side. For this reason and for thermal reasons, the inverter should therefore be placed in the vicinity of a metering station.

5.2 Installing the inverter

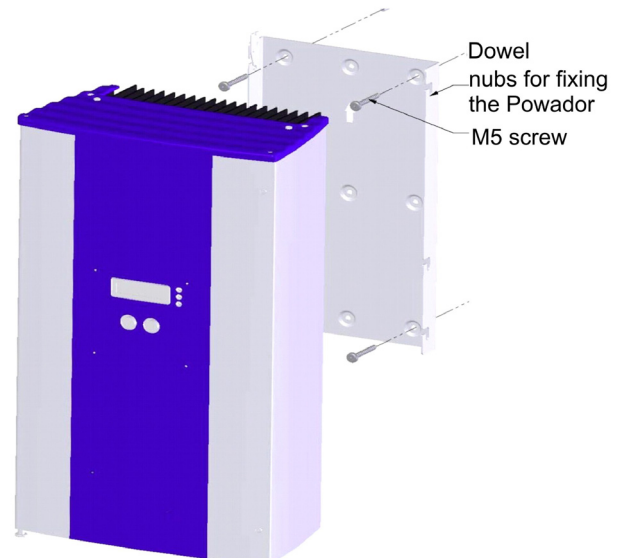


Figure 5.1: Wall installation of Powador

The inverter is shipped together with an installation kit consisting of four dowel pins and four 70 mm Philips-type screws. Prior to installation the condition of the mounting wall has to be checked. If necessary, use a kit other than the one shipped with your inverter.



- Drill the holes for the dowel pins according to the positions indicated on the mounting plate.
- Place the dowel pins into the holes.
- Using the Philips-type screws, fasten the mounting plate to the wall. Make sure that the arrow shown on the mounting plate is directed upwards.
- Suspend the inverter in the suspension fixture. Ensure that the bars rest on the appropriate lugs/noses in the heat sink.
- **Lock the safety catch. To do this, slide the upper end of the catch towards the wall until the groove is parallel to the wall (see Figure 5.2)**



Figure 5.2: Safety catch is open (left) and closed (right)

5.3 Electrical connections

General Information

The electrical connections can be established after the inverter has been installed in its fixed location.



Caution!
The electrical installation of Powador must only be performed by skilled personnel and by an electrician who has been approved by the responsible Electrical Utility Company.

All applicable safety instructions, technical connections stipulated by the responsible Electrical Supply Company, and the relevant VDE regulations must be adhered to.

To connect the inverter the AC and DC side must be disconnected from all voltage sources and protected against inadvertent switching-on. The connection of the PV generator and the grid connection are established via PCB terminals in the connection box of the inverter (see Figure 5.3).



Open the door of the housing/enclosure. The door is secured against opening by means of two recessed-head screws on the right upper side.



The max. cross section of the AC and DC terminals is 10 mm².

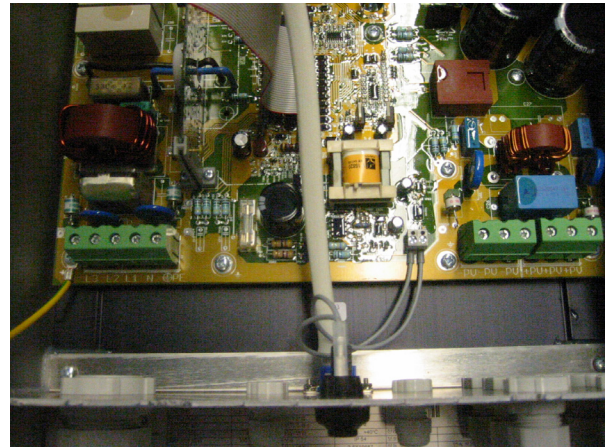


Figure 5.3: Connection box of Powador

Grid connections

3-lead connections are used (L1, N, PE). To insert the wires use watertight conduits at the underside of the housing.

We recommend the following wire cross sections for cable lengths up to 20 m:

Powador 1501xi:	1.5 mm ²
Powador 3501xi:	2.5 mm ²
Powador 4501xi:	6 mm ²

Larger cross sections should be used for longer cable lengths. According to VDE 0100 Part 430 "Protection of cables and lines in the event of overcurrent", NYM leads should be protected as follows (fixed wiring, ambient temperature 25 °C and installation type B2 (multi-wire lead in a tube or channel on or inside walls or buried):

1.5 mm ²	16A
2.5 mm ²	20A
4 mm ²	25A
6 mm ²	35A

NEOZED cutout fuses of the type gL should be used as fuses.



Please make sure to use sufficiently wide wire cross-sections to avoid excessive line impedance (internal resistance of the electrical grid) between the domestic distribution and the respective Powador inverter.

At a high line impedance, i.e. long AC-side leads, the voltage at the grid terminals will increase during power delivery. This voltage is measured by the inverter. If the voltage across the grid terminals exceeds a defined limit, the inverter will switch off due to grid overvoltage. This condition must by all means be taken into consideration for dimensioning the AC lead.



Danger!
Hazard due to electric shock due to contact with terminals carrying high voltages! Check that the power cord is disconnected before inserting and routing it inside the device!



Route the shielded and stripped lead through the cable fitting. Connect the shielded and stripped lead according to the mark shown on the left side of the PCB terminal.



Caution!
Please check all leads for proper connection.



Once again check if all connected leads are securely fastened. Fasten the wire connection of the cable fitting.

5.3.1 PV Generator connections

The PV generator connections are established on the right side of the connection box.



Caution!
Risk of damage!
By all means ensure the correct polarity!



Danger!
To ensure maximum protection against hazardous live voltages during the assembly of the photovoltaic installation, both the plus and minus leads must be strictly isolated from earth potential (PE).



Please check that the PV generator is ground-free before connecting it to the Powador inverter.

Determine the DC voltage between protective earth (PE) and the positive lead or, respectively, between the protective earth (PE) and the negative lead of the PV generator. If stabilized voltages can be measured, this indicates a ground fault in the PV generator or generator wiring. The ratio between the measured voltages indicates the location of this fault. Make sure to remedy this fault prior to performing any further measurements!

Determine the electrical resistance between the protective earth (PE) and the positive (plus) lead or, respectively, between the protective earth (PE) and the negative (minus) lead of the PV generator.

A low resistance value (< 2 MΩ) indicates a high-resistance ground fault of the PV generator, which must by all means be remedied prior to further installation!



Caution!
Prior to connecting the DC leads to the inverter terminals the voltage of the solar generator must be measured.
The DC voltage must not exceed max. 500VDC. Connecting to higher voltages will result in the destruction of the device.

The PV generator can be connected in different ways:

- Via screwed cable gland fittings
- Via Tyco connectors
- Via MC plug-type connectors

Screwed cable gland fittings are provided as a standard. Tyco and MC plug-type connectors may be provided as options.

PV generator connection by means of screwed cable gland fittings



Open the screwed cable gland fittings until you can insert the cables. Fasten the cable ends in the terminals marked "PV+" and "PV-". Observe the correct polarity. Fasten the cap of the screwed cable gland fittings.

Connecting three or four strings to the inverter requires double allocation of one or, respectively two terminals (see Figure 5.4).

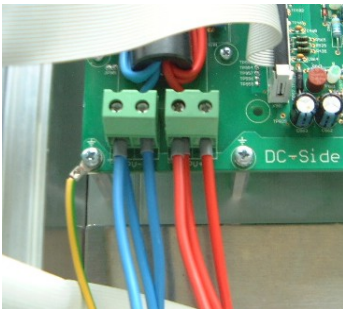


Figure 5.4: Connection of three PV strings

PV generator connection by means of multi-contact or Tyco plug-type connectors

MC or Tyco plug-type connectors may be enclosed to the inverter as options. These connectors may be used instead of the screwed cable gland fittings-type fittings mounted on the device (shipping condition). In this case, please remove the screwed cable gland fittings-type fittings and assemble the appropriate connectors instead.



Remove the screwed cable gland -type connectors from the provided apertures in the baseplate of the inverter. Insert the Tyco- or MC connector from outside into the apertures and fasten them inside by means of the black plastic nuts (see Figure 5.5).

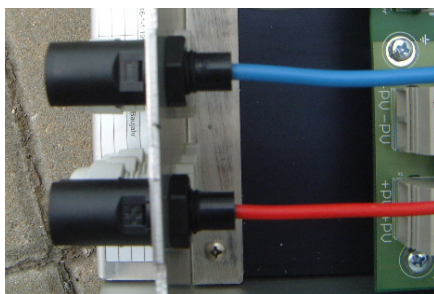


Figure 5.5: Assembly of Tyco connectors.

The assembly of the Tyco and MC-type connectors is depicted in Figure 5.6 and. Figure 5.7.

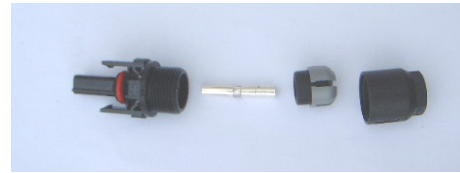


Figure 5.6: Assembly of Tyco connectors

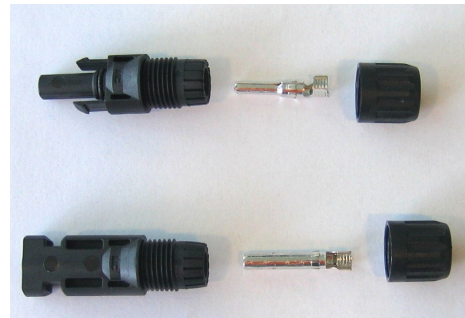


Figure 5.7: Assembly of MC connectors



Caution!
The PV generator should not be disconnected from the Powador inverter (i.e. by pulling the connector) under load except in absolute emergency cases. It should by all means be avoided during the normal grid feeding operation. Prior to disconnecting, always disconnect grid voltage by deactivating the grid fuses.

If this is not observed, arcing may occur and damage the connectors – both parts of the connector will have to be replaced.

5.4 Connecting the fault-signal relay

The inverter is equipped with a potential-isolated relay contact to signal faults. If a fault occurs, this contact will be closed.
Max. contact load: 30V / 1A.



Important!
In the event of a power failure in the public grid the relay will not trigger. In this case, all LEDs and the display will be extinguished and the inverter will be shut down completely. A fault signal will not be possible in this case!

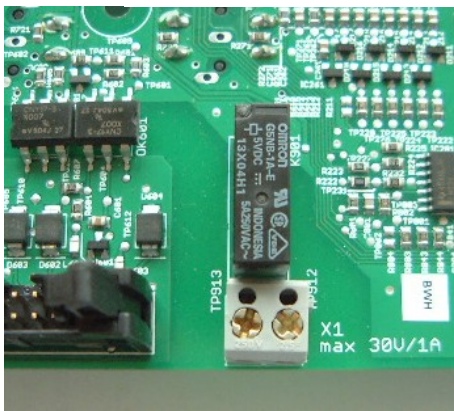


Figure 5.8 Fault-signal relay

5.5 Connection of the S0 output

The inverter is equipped with an S0 pulse output for connection of, e.g. a large display. The pulse rate is adjustable (see page 11, Section 5.8)

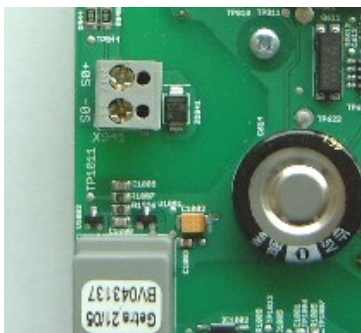


Figure 5.9 S0-Connection

5.6 Connection of the RS485 interface

On the control board (at the rear side of the door of the Powador inverter), there are four terminals marked RS485 A and B (see Figure 5.10). To connect several Powador inverters, terminal A of the first Powador must be connected to terminal A of the second Powador; terminals B are connected in the same way. You need a twisted and shielded data cable for connection, such as an ISDN cable. The connection to proLOG is established analogously. The wiring plan is shown in Figure 5.11. The total length of the RS485 wiring should not exceed 250 m.

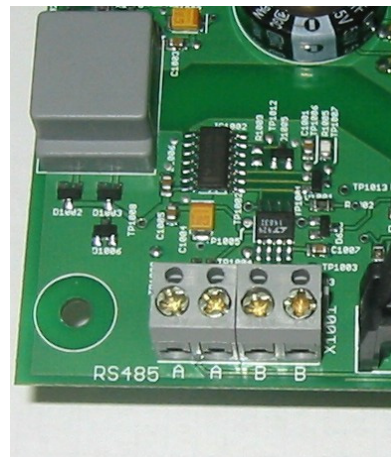


Figure 5.10: Connection terminals for RS485-Interface

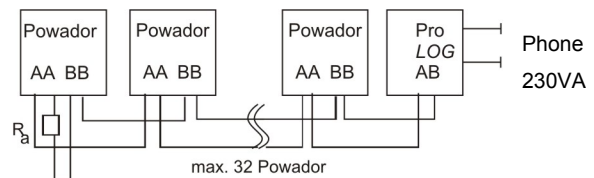


Figure 5.11: Wiring plan for RS485 Interface

The figure above shows a terminator which is connected to the left inverter ($R_a, 330\Omega$). This terminator resistor is needed on the last device in the chain to ensure correct signal transfer. The terminator is supplied together with the Powador inverters. Within a bus system, such as the RS485, each device taking part in this system must have a unique address (regardless of whether this is an inverter or current sensor). For inverters, the address range can be selected between 0 and 31. The address of each inverter can be determined via the Set menu, (see Operator's Manual).



Important!
Please ensure correct connection of the A and B wires. If these wires are confused, no correct communication will be possible!

5.7 Startup of the inverter

After completing the mechanical and electrical installation you may now put the inverter into operation as follows:

**NOTE!**

The inverter can only be put into operation under daylight conditions (i.e. at a solar generator voltage of > 100 V). If no daylight or solar generator voltage is present, the inverter can be activated by pressing the Start key (see Section 4.4 of the Operating Instructions), but normal operation will not be possible in this condition. (Only the values can be read off the display).



- Switch on the grid voltage (via the external automatic safety breakers).
- Switch on the solar generator via the DC circuit breaker (or DC plug-type connector).

The green LED "PV generator" will now be illuminated (if the generator voltage is greater than 125V). The display now shows the current generator voltage: "Start from 125V; measurement xxx V" If the measured voltage is greater than 125V, the device will start power delivery after approx. 3 minutes. This starting-up period of 3 minutes is necessary to ensure that the generator voltage is permanently above the power delivery limit of 125V.

A quick-start routine is provided for test purposes – this routine circumvents the start-up period. This quick-start is menu-controlled and obtained from the set-up mode (see Operator's Manual).

During the normal startup procedure the line power relay is switched on after approx. 3 minutes (audible acoustic noise), and power delivery is started. This is also signaled by the green "Grid-feeding" LED. The display now shows the delivered power. The "Display" key can be used to indicate the various measurement values (see Operator's Manual).

It may be necessary to reset the date and hour (please refer to the Operator's Manual).

5.8 Programming the parameters

The programming mode offers several options to change or program the parameters of your Powador inverter.



Caution!
Incorrect parameter settings may lead to a loss of functions!

The following parameters can be adjusted:

- Break threshold of undervoltage protection
- Break threshold of overvoltage protection
- Adjust grid voltage
- Adjust grid current



Danger!
 Always disconnect the inverter from all voltage sources before opening the inverter housing!



To change to the programming mode please change the jumper position as shown in Figure 5.11).

Change the jumper position as shown in Figure 5.13, so as to get to the Display and Programming Mode.

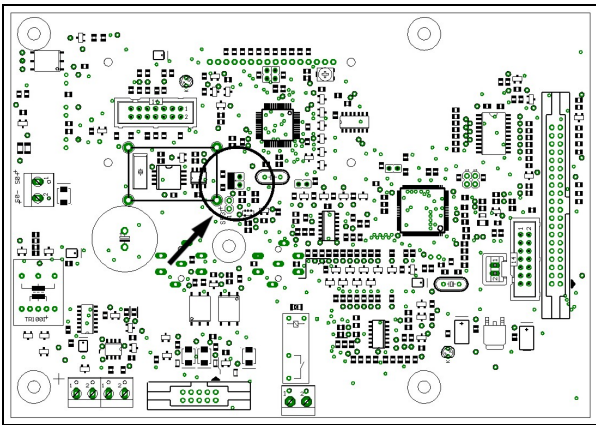


Figure 5.11: Jumper position to change between programming mode and power delivery (feed-in operation)

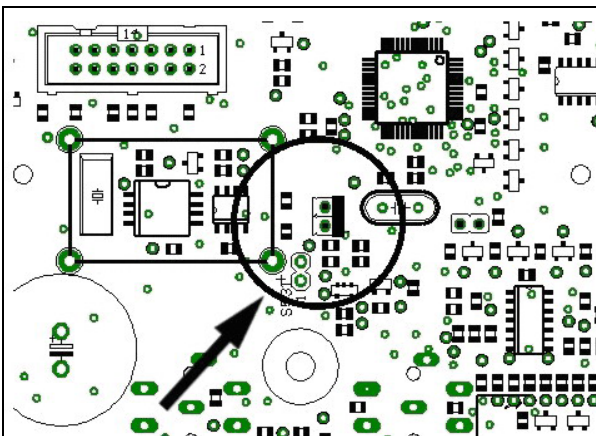


Figure 5.12: Jumper Position in normal feed-in operation (power delivery) – (shipping status)

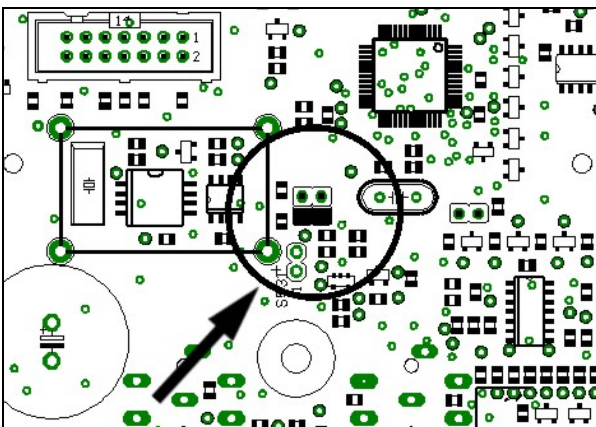


Figure 5.13: Jumper position in the programming mode



Close the device again.
To change to the programming mode, keep the “Display” key pressed and simultaneously press the “Set” button. After approx. 2 seconds, the first setting parameter will appear on the display. Use the “Display” key to scroll through the menu. This menu is continuous, i.e. if you have reached the end it will automatically return to the first menu item.

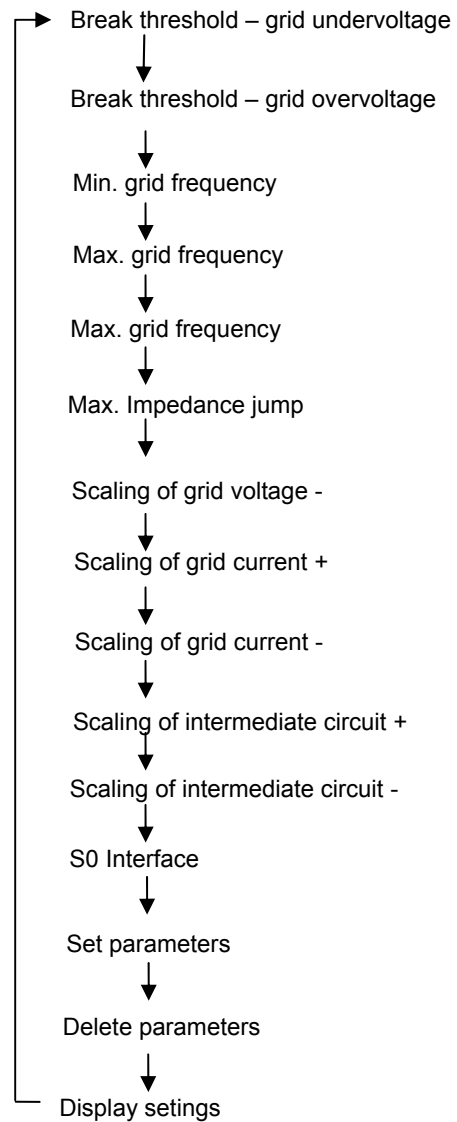


Figure 5.14: Set Parameters Menu



The "Set" key is used to change the respective parameter. Depending on the parameter, the value increases or decreases. The values are continuous, i.e. if you have reached the max. value, they will be reset to the min. value.

Explanation of individual parameters:

- Undervoltage break threshold:

If the grid voltage falls below a defined value the inverter must terminate its power delivery operation and disconnect from the grid. According to the applicable Directive the defined value can be 1.0 to 0.8 of the grid voltage value (184V ...230V). Under standard operating conditions the inverter shuts down at 190V and is thus within the permissible range. Under special circumstances your Electrical Supply Company can request that the inverter shuts down at a different voltage - in this case you can use the menu item "Minimum grid voltage" to set the new break threshold. The min. grid voltage can be adjusted in the range between 190 V and 230 V in increments of 2 volts. By all means ensure that the standard VDE 0126-1 is observed.

- Overvoltage break threshold

If the grid voltage should exceed a defined value the inverter must terminate its input operation and disconnect from the mains. According to the directive, this value can be 1.0 to 1.15 of the rated voltage (230V 264V). Under standard operating conditions the inverter shuts down at 264V and is thus within the permissible range. Under special circumstances your Utility Company may request that the inverter shuts down at a different voltage - in this case you can use the menu item "Maximum grid voltage" to set the new break threshold.

- Grid frequency:

The grid frequency is also monitored. If it should fall below a defined value the inverter must terminate its power delivery operation and disconnect from the grid. Both thresholds can be adjusted in increments of 0.1 Hz. The min. grid frequency range is between 49,8, – 60,0Hz, the max. frequency range is between 60,0 Hz and 50,2,0 Hz (factory setting if 49,8, –50,2, Hz).

- Scaling Grid Voltages and Grid current:

Prior to shipment all the displayed values are checked and adjusted in our factory. If the grid voltage shown on the display should not correspond to the grid voltage actually measured the value can be adjusted. If the grid voltage shown on the display is too low you can use the menu item "SCALING xxx +" to increase the value. If the grid voltage shown on the display should be too high you can use "SCALING xxx -" to reduce this value. This scaling is available for adjusting the solar voltage, generator current, grid voltage and grid current.

- Scaling of intermediate circuit voltage:

This parameter must only be changed by a service technician!

- SO interface:

The SO interface is used to control a large display. Use this parameter to adjust how many pulses per kWh are to be transmitted. The possible settings are 500, 2000 and 1500 pulses per kWh.

After changing these parameters the inverter must be reset to its original condition.



To do this, disconnect the inverter from all voltage sources and reset the jumper to its original position.

The inverter can now assume "normal" operation and be left unattended. Application/Acceptance of Utility Company

6. Applications/Acceptance by Your Utility Company

The practices of the responsible Utility Company must be observed for all applications and acceptances of your PV installation. Some of the documents you will need for application and acceptance are enclosed to these installation instructions.

The usual setting-up procedure is as follows:

- Submittal of documents to the Utility Company (responsibility of your solar installer)
- Installation
- Installation of power meter by the Utility Company
- Acceptance of your installation by the Utility Company

You will require the following documents:

- Application / Completion notice by the registered installation company
- Location plan showing the estate borders and place of installation
- Complete circuit diagram of installation and utilities (unipolar view);
- Data sheet for independent power generating plants (VDEW form) (responsibility of your solar installation company);
- Description of the protection devices indicating the type, circuit, make and function (responsibility of your solar installation company);
- Description of the inverter / declaration of conformity of the manufacturer;
- Information on the short-circuit resistance of circuit components

7. Switching off the inverter

The inverter must be switched off for adjusting, maintenance and repair work. Please proceed as follows:



The sequence of work, especially when using DC connectors as DC circuit breakers, must be observed by all means.

Otherwise, arcing might occur when disconnecting the DC connector under load. This will destroy the connectors.



- Disconnect the grid voltage (deactivate the external safety breakers). Disconnect the photovoltaic module via the generator box or DC plug-type connector.
- Check that the grid terminals of the inverter are disconnected from all voltage sources.



Danger!

Lethal hazard by electric shock!

Hazardous live voltages can be present in the inverter even if the electrical connections have been switched off or disconnected.

Please wait for five minutes before accessing the inverter. If you have to carry out any work on the solar generator you must additionally disconnect all connections of the DC main switch on the generator connection box (or DC connector). It is not sufficient to switch off the grid voltage in this case!

8. Troubleshooting

Within the scope of our continuously expanding Quality Assurance System, our goal is to rule out and eliminate any faults and defects. You have purchased a product that has left our factory in a proper condition. Each individual device has successfully passed extensive inspection tests for proper operation and functioning of protective devices, as well as a long-duration test at our factory.

Should your PV installation not work properly despite all these measures, we recommend the following procedure for remediation:

Check the solar generator and grid connections leading to the PVI, observing all the safety instructions given in this manual. Please observe the inverter carefully and take note of the display messages and LED displays.

Below is a summary of possible error and recommended remedies:

Error	Cause	Remedy/Explanation
Inverter shows an unrealistic daily peak value	Grid voltage failure	Even if an incorrect daily peak value is displayed the inverter continues to work properly and without any yield losses. Values are reset overnight. If you wish to reset the display immediately, disconnect the inverter and the DC grid voltage supply and switch on the inverter again.
Daily yield values do not correspond to the values shown on the power meter of the Utility company.	Tolerances of the inverter's internal measuring elements/sensors	Measuring errors are caused by tolerances of the measuring elements/sensors. The tolerances of the individual measuring values are given in the Operator's Instructions. The daily yield value may deviate from the value shown on the power meter by up to 15%.
Grid fuse triggers	<ul style="list-style-type: none"> - Insufficient grid fuse rating - Inverter hardware is damaged 	At times of high insolation the inverter may exceed its rated current for a short time, depending on the type of solar generator. Therefore, the grid fuse should have a higher rating than the max. grid feeding current. The grid fuse acts immediately if the inverter changes over to grid feeding (i.e. on termination of the start-up period). In this case, the inverter hardware is damaged and the device has to be returned to KACO for repair.
No display shown	<ul style="list-style-type: none"> - Device is in the night shut-down mode - No grid voltage is present - Solar generator voltage is less than 100 	<p>The inverter shuts down over night.</p> <p>If the display should not be illuminated during a normal time of the day you should check on the power meter whether or not the device delivers power. If power is delivered the display module is defective, and the inverter has to be returned to KACO for repair.</p> <p>If no power is delivered you should check that grid voltage is present and that the solar generator voltage is higher than 125 V.</p> <p>If this is the case but the inverter still fails to deliver power the device will have to be returned to KACO for repair.</p>
Inverter does not start	<ul style="list-style-type: none"> - Device is in its night shut-down mode - No grid voltage is present - The solar generator voltage is less than 100 V 	<p>The inverter shuts down over night.</p> <p>If the display should not be illuminated during a normal time of the day you should check on the power meter whether or not the device delivers power. If power is delivered the display module is defective and the inverter has to be returned to KACO for repair.</p> <p>If no power is delivered you should check that grid voltage is present and that the solar generator voltage is higher than 125 V.</p> <p>If this is the case but the inverter still fails to deliver power the device has to be returned to KACO for repair.</p>
Inverter is active but does not deliver power – the display reads: Start from 125 V Measurement: xxx V	Insufficient generator voltage. Voltage measured < 125V	After sunrise, at sunset, and during times of low insolation due to bad weather conditions the generator voltage or, respectively, generator power fed from the roof may be insufficient for grid feeding
Inverter is active but does not deliver power – the display reads: Start from 125 V Measurement: xxx V (measured voltage is higher than 125V)	The inverter has interrupted grid feeding due to a malfunction/failure.	After an interruption of the grid feeding process due to a failure (grid power failure, overtemperature, overload, etc.) the inverter always waits for approx. 3-4 minutes before resuming its grid feeding operation. Grid failures may cause interruptions during the day. If more than 10 interruptions per day should occur over several weeks you should contact your solar installation provider.
The inverter terminates grid feeding shortly after starting-up although there is enough insolation.	Defective grid isolation relay in the inverter.	Although there is enough insolation, the inverter delivers power for a few seconds only and switches off again. During this short time a grid feeding value between 0 – 5 W is displayed. If insufficient generator power can be ruled out in this case the grid isolation relay is presumably defective and prevents the inverter from being activated.

Error	Cause of error	Remedy / Explanation
Inverter causes noise	Special environmental conditions	<ul style="list-style-type: none"> - Under special environmental conditions the devices may cause audible noise. This may be due to the following causes: - Grid effects and/or grid failures caused by special consumers (motors, machines, etc.), which are connected to the same grid point or which may be installed in the vicinity of the inverter. - Dynamic weather conditions (frequent changes between sun and clouds) may cause slight line hum due to high energy. - Certain grid conditions may result in grid resonance between the input filter of the device and the grid, which may continue to be audible even after the inverter is switched off. - Persons with very sensitive ears (children, in particular) may perceive high-frequency hum of the inverter, caused by the operating frequency of 18 kHz. - This noise does not affect the operation of the inverter or inverter performance and will not result in any failure, damage or shorter useful life of the devices.

If the defects found should not be able to be remedied by means of the measures described above, please contact your solar installation provider or our Service Department.

Please have the following information ready to enable our Service Department to respond quickly and properly:

Inverter Data:

- Serial number of the device
- Inverter type
- Short description of errors the fault or error reproducible? (If so, please provide a short description).
- Does the fault or error occur sporadically?
- Describe the insolation conditions prevailing when the error occurred.
- Hour of the day

Photovoltaic module data:

- Module type, manufacturer (if available, send data sheet)
- Number of modules connected in series
- Number of strings
- Generator power

9. Technical Data

Input – Electrical data

Type	1501xi	3501xi	4501xi
DC rated power	1580 W	3490 W	4880 W
Max. PV generator power	2000 W	4000 W	6000 W
MPP range	125 – 400 V _{DC}		
No-load voltage	Up to 500 V _{DC}		
Monitoring - input voltage	Stand-by from U _e >125V _{DC} Night shutdown from U _e <100V _{DC}		
Max. DC input current	14 A	30.5 A	43 A
Polarity safeguard	Short-circuit diode		
Overvoltage protection	Varistors		

Output – Electrical data

Rated power	1500 W	3300 W	4600 W
Max. power	1650 W	3600 W	5060 W
Grid voltage	190– 264V		
Rated current	6.5 A	14.5 A	20.0 A
Max. current	7.2 A	15.7 A	22.0 A
Frequency	49,8 – 50,2 Hz		
Distortion factor according to VDE 0838 part 2 (EN61000-3-2)	<3% at rated power <5% over the entire range		
Fault-signal relay	Potential-free NO contact (make contact), max. 30V / 1A		
S0-output	Open-Collector – output max. 30V / 50mA		

Inverter – Electrical data

Max. degree of efficiency	95.0 %	94.5 %	94.4 %
European efficiency	94.2 %	93.3 %	93.2 %
Internal consumption	Night shutdown: 0W Operation: < 5 W		
Min. grid-feeding power	10W		
Circuit design	Grid-tied, electrically isolated, RF transformer		
Clock frequency	18 kHz		
Principle	1.) galvanically isolated DC/DC converter 2.) IGBT full bridge as part of the inverter		
Grid monitoring	BIS1 according to E DIN VDE 0126, compliant with VDEW		

Inverter – Mechanical and technical data

Optical displays	DC Power in (green) AC Power out (green) Failure (red) LC display (2 x 16 characters)		
Operating elements	2 keys for display operation		
Connections	PCB terminals inside the device Cable routing via screwed cable gland fittings		
Ambient temperature	-20 ... +40°C		
Temperature monitoring	>70°C temperature-dependent power adjustment >80°C disconnection from the grid	>75°C temperature-dependent power adjustment >85°C disconnection from the grid	>75°C temperature-dependent power adjustment >85°C disconnection from the grid
Cooling	Free convection (no fan or blower)		
Protection Class	IP54 according to EN 60529		
Noise emission	< 35dB (noiseless)		
Housing/enclosure	Aluminum wall-mounted enclosure		
Dimensions W x D x H	340 x 200 x 450 mm	340 x 220 x 500 mm	340 x 220 x 650 mm
Weight	10 kg	19 kg	28 kg

10. Appendix

10.1 EU Declaration of Conformity

Name and address of manufacturer:	KACO GERÄTECHNIK GmbH Gottfried-Leibniz-Str. 1 D- 74172 Neckarsulm
Product description:	Photovoltaic grid-tied inverter Powador
Type descriptions:	Powador 1501xi Powador 3501xi Powador 4501xi

This is to confirm that the devices stated above are compliant with the protection requirements set forth in The EU Council Directive as of May 3 1998 for the Harmonization of Legal Stipulations of the Member States concerning Electromagnetic Compatibility (89/336/EWG) and the Low Voltage Regulations (72/23 EWG).

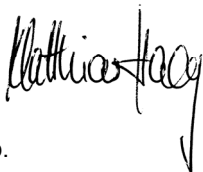
The devices are compliant with the following standards:

73/23/EWG "Directive concerning electrical equipment for use within defined voltage thresholds"	DIN EN 60950-1 DIN EN 50178
89/336/EWG "Directive concerning electromagnetic compatibility"	DIN EN 61000-6-3 DIN EN 61000-6-1 DIN EN 61000-3-2 DIN EN 61000-3-3

Therefore, the types stated above are designated with the CE label.

Any manipulation or modifications on the supplied devices and/or any use for other than for the intended purposes shall render this Certificate of Conformity null and void.

Neckarsulm, 21st June 2005
KACO GERÄTECHNIK GmbH



p.p.

Matthias Haag
Head of the Photovoltaics Division

10.2 Declaration of Conformity concerning the rated power and max. output of photovoltaic inverters

Inverter type	AC rated power (AC_{NENN}) in W	AC peak power * (AC_{PEAK}) in W	Ratio AC_{PEAK} / AC_{NENN}
Powador 1501xi	1500 W	1650 W	1.10
Powador 3501xi	3300 W	3600 W	1.09
Powador 4501xi	4600 W	5060 W	1.10

The AC peak power has been indicated as a mean value measured over a period of 10 minutes.

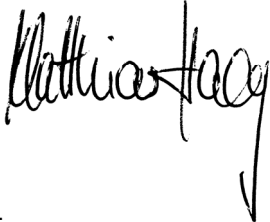
The $\cos\phi$ of the inverters is 0.999 at rated load. Therefore, the AC power in W is equivalent to the apparent power in VA. This declaration of conformity has been given by

KACO GERÄTECHNIK GmbH
Gottfried-Leibniz-Str. 1
D-74172 Neckarsulm

and authorized by its responsible representative,




Matthias Haag
Head of the Photovoltaics division

Neckarsulm, 8th July 2005
KACO GERÄTECHNIK GmbH



p.p.
Matthias Haag

10.3 Certificate of Conformity/Non-Objection

	innova Product Service GmbH	Gewerbestr. 28 87600 Kaufbeuren Germany
<h3>Certificate of conformity</h3>		
Manufacturer:	KACO GERÄTECHNIK GmbH Gottfried-Leibniz-Str.1 74172 Neckarsulm	
Product Type:	Inverter for photovoltaic	
Model:	POWADOR 1501xi and POWADOR 3501xi	
Certification Mark:		
<i>A representative test sample of above stated model passed the tests after</i>		
Applied rules and standards: IEC 60950-1:2001 (1 st Edition), EN 60950-1:2001, DIN/EN 60950-1:2003, VDE 0126:1999, E DIN VDE 0126:1999-04 and guideline "Eigenerzeugungsanlagen am Niederspannungsnetz" Ausgabe 2001. In addition, spacing passed to the requirements of EN 50178:1998 and IEC 62103:2003.		
Objectives: The above mentioned unit complies with the requirements for connection to the electrical network. The unit includes an automatic disconnection device, which prevents the hazard of over- and underfrequency, over- and undervoltage, direct current injection and Anti-Islanding.		
Issued:	29. September 2005	
This certificate of conformity is valid for 3 years from date of issue.		
Managing Director: Horst Haug		
		

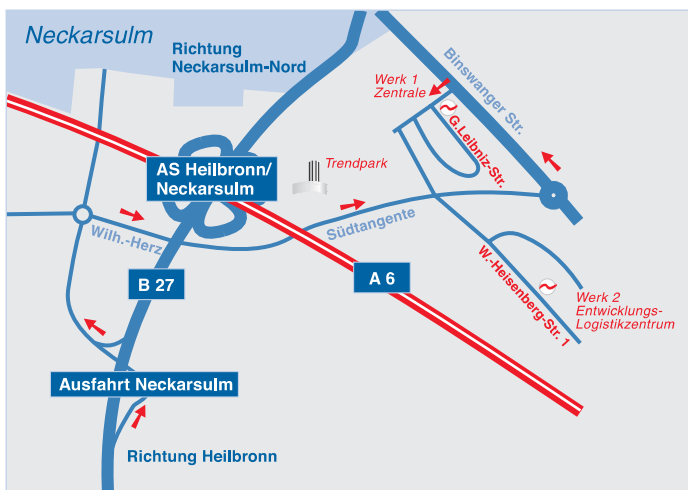
Your solar installation provider.

Our product portfolio.

INVERTERS
FREQUENCY CONVERTERS
DC / DC - CONVERTERS
CHARGING RECTIFIERS
POWER SUPPLIES
FUSED DC VOLTAGE SUPPLIES
EMERGENCY POWER SUPPLIES

Diese Seite bitte wie die deutschen Handbücher gestalten.

Ohne product portfolio
und
Adresse nicht fett.



KACO GERÄTETECHNIK GmbH
Gottfried-Leibniz-Straße 1
D-74172 Neckarsulm

KACO GERÄTETECHNIK GmbH
Entwicklungs- und Logistik-Zentrum
Werner-Heisenberg-Straße 1
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