Operating Instructions

Protect PV.500-UL

AEG Power Solutions GmbH, Warstein-Belecke
Department: PS AED
Revision: 01
Revision date: 07/27/2013 / Schenuit
Released: 07/27/2013 / Gleitsmann

Document no. 8000042437 BAL, en

AEG POWER SOLUTIONS

AEG Power Solutions GmbH
Emil-Siepmann-Strasse 32
59581 Warstein
Germany

☎ +49 2902 763 100
Fax: +49 2902 763 645
E-mail: service.aegpss@aegps.com
Internet: http://www.aegps.com

Table of Contents

1 Information on How to Use these Instructions

This chapter contains general information about these instructions and the people they are intended for.
In the following, the Protect PV.500-UL with two control cabinets (+DCD/ACD, +INV) is referred to as 'equipment.' The precise name (PV.500-UL) cannot be avoided in some situations. In such cases, the equipment is referred to as the PV.500-UL equipment or the individual control cabinets are mentioned.

1.1 General Information

Validity

These instructions correspond to the technical specifications of the equipment at the time of publication. The contents of these instructions do not constitute a subject matter of the contract, but are for information purposes only.

AEG Power Solutions GmbH reserves the right to make modifications regarding the content and technical data in these instructions without prior notice. AEG Power Solutions GmbH cannot be held liable for any inaccuracies or inapplicable information in these instructions, which came about as a result of changes to the content or technology applied after this equipment was supplied, as there is no obligation to continuously update the data and maintain its validity.

Warranty

Our goods and services are subject to the general conditions of supply for products in the electrical industry and our general sales conditions. We reserve the right to alter any specifications given in these instructions, especially with regard to technical data, operation, dimensions, and weights. AEG Power Solutions GmbH will rescind all obligations such as warranty agreements, service contracts, etc. entered into by AEG Power Solutions GmbH or its representatives without prior notice in the event of maintenance and repair work being carried out with anything other than original AEG Power Solutions GmbH spare parts or spare parts purchased from AEG Power Solutions GmbH.

Complaints

In the event of complaints, please contact us within eight days of receipt of goods and provide the following details:

Type designation	
Serial number	
Nature of complaint	
Period of use	
Ambient conditions	

Any claims submitted after this point cannot be considered.

Handling

These instructions are structured so that all work necessary for operation can be performed by appropriately qualified skilled personnel.

Illustrations are provided to clarify and facilitate certain steps.

If danger to personnel and equipment cannot be ruled out in the case of certain work, this is indicated accordingly by pictograms explained in Chapter 2, Safety Regulations.

1.2 Target Groups

This document explains which groups these instructions are intended for and the obligations of these groups. Definitions of staff requirements are also provided.

Every care has been taken in drafting these instructions. Should you notice any errors, please contact the manufacturer immediately.

To keep the instructions up to date, please remember to insert any supplements received from AEG Power Solutions GmbH.

1.3 Explanations regarding Target Groups

These instructions are intended for various target groups:

- The equipment operator or the person appointed by him (the party responsible for the equipment)
- The skilled personnel responsible for using the equipment

1.3.1 Obligations of the Equipment Operator

The equipment operator or the person appointed by him/her (the party responsible for the equipment) is responsible for the safety of personnel and for the safety, function and availability of the equipment. These factors depend on compliance with the safety instructions. Compliance with the safety instructions is required at all times.

To ensure the safety of personnel, the equipment operator must:

➔ Select skilled personnel on the basis of skills and training (→ Chapter 1.3.2)

➔ Make skilled personnel aware of the need for compliance with regulations (→ Chapter 1.3.2)

➔ Provide skilled personnel with personal protective equipment, user information and instructions

➔ Provide skilled personnel with regular briefings about all safety measures and keep a record of such briefings

➔ Inform skilled personnel of where fire extinguishers are located and how to use them

To ensure the safety of the equipment, the equipment operator must:

➔ Only operate the equipment in perfect working order and in accordance with good electrical engineering practice

➔ Arrange a fault detection check immediately if the equipment starts to behave abnormally

➔ Keep all safety signs and warning notices on the equipment in a complete and clearly legible condition

➔ Install fire extinguishers in the immediate vicinity of the equipment

1.3.2 Skilled Personnel Skills and Training

Only trained and qualified skilled personnel may perform the work described, using tools, equipment and test equipment intended for the purpose and in perfect working order.

All work is coordinated and monitored by the **person responsible for the work**. The person responsible for the work is directly responsible for the execution of the work. Before work commences, the person responsible for the work must inform the **person responsible for the equipment** and agree on a work schedule with him. The persons responsible for the work and equipment must be trained and qualified skilled personnel and may be one and the same person.

"Trained skilled personnel" means electricians who, as a result of their specialist training:

- Have knowledge and experience of the relevant standards, regulations, requirements and accident prevention regulations
- Have been instructed in the mode of operation and operating conditions of the equipment
- Have the ability to assess the effect of any intended work on the safe operation of this particular equipment
- Can assess the work and recognize and avoid potential risks

Compliance with the safety instructions described is mandatory for the protection of skilled personnel and the equipment. Skilled personnel must be aware of and follow these safety instructions.

Obligations of skilled personnel

Observe the following safety instructions.

➔ Work on and in electrical equipment is governed by strict rules in order to avoid electrical accidents. The rules are summarized in the five rules of safety. You must observe these rules:

1. **Disconnect safely.**
2. **Secure the unit against being switched back on.**
3. **Verify that all poles are de-energized.**
4. **Ground and short-circuit the equipment.**
5. **Provide protection in the form of covers or barriers for any neighboring live parts.**

➔ Once work is complete, reverse the five safety rules starting at number 5 and working back to number 1.

➔ Read these instructions. Memorize the safety instructions. (→ Chapter 2)

➔ Ensure compliance with the following regulations:

- Accident prevention regulations of the respective country of destination and the generally valid safety regulations according to IEC 364.
- BGV A1 (Prevention principles)
- BGV A3 (Electrical systems and equipment)
- BGV A8 (Safety and health protection warnings in the work-place)

➔ Report any damage to the equipment and electrical installations to the equipment operator.

➔ Only use spare parts approved by the manufacturer for maintenance
and repair work.

➔ Use personal protective equipment (PPE) as intended.

➔ Check that PPE is in perfect working order and report any defects you notice to the equipment operator.

➔ Wear a hair net if you have long hair. Do not wear loose clothing or jewelry.

➔ Reinstate protection devices upon completion
of all work on or with the equipment.

➔ Keep the instructions in the pull-out document pocket.

1.4 Storing Instructions

Store these instructions in an appropriate place. A pull-out document pocket is located on the inside of the door. These instructions must be stored together with the equipment.

Should the equipment change hands, include these instructions when handing it over to the new operator.

2 Explanation of Symbols and Safety Instructions

All of the symbols and abbreviations used in the text are described below.

2.1 Explanation of Symbols

This section describes the symbols used in these instructions.

Symbol	Meaning
	Hazard symbols are triangular and feature a yellow background, black border and corresponding symbol.
	Signs containing orders are round and have a blue background with a white symbol.
i	Information is indicated by the letter i. These sections contain important information about the phases of the equipment's service life.
	Environmental demands are identified by a waste container. Environmental demands make reference to mandatory requirements set out by regional or national authorities which must be observed especially when disposing of materials used during operation, for example.

Table 1 Instruction and warning symbols in these operating instructions

Other symbols and their meanings

Typographical element	Meaning
➔	This symbol is used for action instructions.
1. **2.** **3.**	Numbers are used for action instructions that need to be followed in a specific order.
●	This symbol is used for bulleted lists.
→	References to figures, chapters or tables are shown using the symbol on the left.

Table 2 – Other symbols

2.2 Safety Instructions

All safety instructions have the following structure:

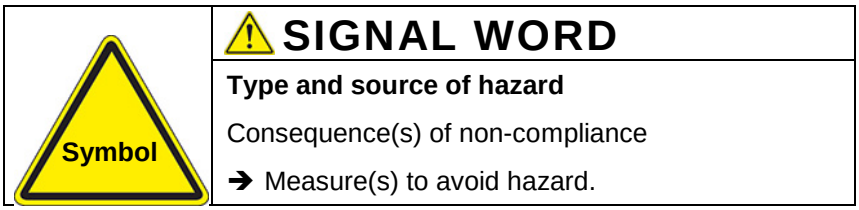


Figure 1 Warning associated with operator action

2.2.1 Signal Words Used

Signal words at the start of safety instructions indicate the type and severity of the consequences if the measures for avoiding the hazard are not taken.

Warning color	Consequences
DANGER	Warns of a situation posing an immediate hazard which will lead to death or serious injury.
WARNING	Warns of a situation posing a possible hazard which may lead to death or serious injury.
CAUTION	Warns of a situation posing a possible hazard which may lead to minor injury.
ATTENTION	Warns of possible damage to property and the environment which could interrupt operation.

2.2.2 Hazard Symbols Used

The following hazard symbols are used to illustrate hazards in the safety instructions.

Symbol	Meaning for skilled personnel
	General hazard source
	**Electrical hazard**
	Risk of falling loads
	Risk posed by flammable material

	Risk posed by corrosive vapors and liquids
	Risk posed by explosive material

Table 3 – Hazard symbols

2.2.3 Signs Containing Orders for Personal Protective Equipment

The following signs relate to the use of personal protective equipment. You are required to comply with them.

Symbol	Meaning for skilled personnel
	Wear a face shield.
	Wear an electrician's safety helmet.
	Wear insulating safety boots.
	Wear insulating overalls.
	Wear insulating gloves with long sleeves.
	Wear hearing protection when operating the equipment.

Table 4 Signs containing orders for PPE

Check that personal protective equipment is in perfect working order and report any defects you notice to the equipment operator.

2.2.4 Abbreviations

The following abbreviations are used in these operating instructions:

DOU	Display and operation unit
AC	Alternating current
BGV	Regulation set out by Employer's Liability Insurance Association (Germany)
CAN	Controller Area Network
CNF	Manufacturing order number
DC	Direct current
DCD/ACD	DC/AC control cabinet
DCS	Distributed control system
DIN	German Standards Institute
EPO	Emergency power off (system off)
GCB	Generator connection box
Grid	Power grid (power utility company's grid)
IEC	International Electrotechnical Commission
IGBT	Insulated-gate bipolar transistor
INV	Inverter cabinet
PE conductor	Equipment grounding conductor, grounding
PV	Photovoltaics
VDE	Verband der Elektrotechnik Elektronik Informationstechnik e. V. (German Association for Electrical, Electronic & Information Technologies)
INV	Inverter

2.3 Emergency Procedure (e.g. in the Event of a Fire)

➔ Never put your own life at risk. Your own safety is paramount.

➔ Call the fire department.

➔ Call the emergency doctor, if necessary.

➔ Shut down the equipment using the system stop switch (ensuring your own safety).

2.4 Safety Awareness

The qualified skilled personnel defined in Chapter 1.3.2 are responsible for safety. The member of personnel who is responsible for the equipment must ensure that only suitably qualified persons are allowed access to the equipment or permitted within its vicinity.

The following points must be observed:

- All working procedures which are detrimental to the safety of persons and the operation of the equipment in any way are prohibited.
- The equipment may only be operated when in perfect working order.
- Never remove or render inoperable any safety devices.

- All necessary operational measures must be initiated prior to deactivating any safety device in order to perform maintenance, repair or any other work on the unit.

Safety awareness also entails informing colleagues of any misbehavior and reporting any faults detected to the appropriate authority or person.

The member of personnel responsible for the work must ensure that:

- The safety instructions and operating instructions are readily available and are complied with
- The operating conditions and technical data are observed
- Safety devices are used
- The prescribed maintenance work is performed
- Maintenance personnel are informed without delay or the equipment is shut down immediately in the event of abnormal voltages or noise, increased temperatures, vibrations or any similar phenomena, so that the cause of this can be determined

2.5 Particular Dangers associated with Photovoltaic Systems

Here you will find information about the additional dangers associated with photovoltaic systems.

An active power source is connected. Depending on the operating status, the PV cells and the equipment may be live.

⚠ DANGER

Contact with voltage. Extremely high DC voltages of up to 1000 VDC are present.

Risk to life due to electric shock.

➔ Do not touch live parts.

➔ Wear personal protective equipment (→ Chapter 2.2.3).

Crystalline silicon cells

Crystalline PV cells (silicon cells) usually have an IT system configuration, i.e. a non-grounded system that will be inadvertently grounded in the event of a ground fault.

A generator with a complex branched structure can only be shut down with a great deal of difficulty (in the event of a short circuit, for example).

Thin-film cells

To prevent corrosion, **thin-film cells** must be grounded.

Lightning protection

The desired level of protection can only be achieved if a lightning protection zone concept in accordance with DIN VDE 0185-4 has been implemented for the building where the unit is installed.

System stop switch

The system stop switch is on the door of the equipment's DC/AC control cabinet.

The system stop switch is not intended for switching off the equipment. It may only be used in an emergency.

The DOU is used, among other things, to switch the equipment on and off.

The system stop switch causes the
- PV inputs
- power input and
- power 2 input

to be separated. This interrupts the energy supply.

It does not mean that the unit has been de-energized.

2.6 Safety Signs and Warning Notices on the Equipment

Safety signs and warning notices are located in the vicinity of danger spots. They provide information about electrical hazards and residual hazards associated with working on and with the equipment.

Safety signs and warning notices must always be in perfect condition and clearly legible. You must comply with safety signs and warning notices whenever you are working on or with the equipment.

2.7 Safety and Protection Devices for the Equipment

This section describes all safety and protection devices. Safety and protection devices protect personnel against hazards which cannot be countered by safe design.

Safety and protection devices must always be in perfect working order.

2.7.1 Protective Covers

The equipment is designed so that the live components in the operating area are secured with protective covers wherever possible. The protective covers provide protection against accidental contact with live parts.

Such protection may only be removed for start-up and for maintenance or repair work.

The covers must be re-installed immediately on completion of such work and checked to ensure that they are in perfect working order.

2.7.2 Lockable Equipment Doors

Some equipment doors are fitted with a control cabinet lock. This prevents unauthorized personnel from accessing the equipment. The equipment door must be kept closed at all times.

It may be opened for maintenance and repair work.

i	The space requirement for the opened equipment doors must be taken into account

The equipment door must be closed again once maintenance and repair work is complete.

2.7.3 Guard

The guard forms the equipment's housing. It protects against unintended contact with live parts and electromagnetic rays.

It may be removed for maintenance and repair work.

i	The area around the equipment must be made secure when the guard is removed.

The guard must be put back in place once maintenance and repair work is complete.

2.8 Residual Hazards

This section describes residual hazards. Despite the measures taken to ensure safety and protection, the equipment poses residual hazards which cannot be countered by design.

Observe warnings at all times while you are working.

2.8.1 Electrical Hazards

DANGER

Contact with voltage.
Risk to life due to electric shock.

➔ Use dry insulating material to remove the victim from the live parts.

➔ Seek medical assistance and inform the control room.

➔ Disconnect the equipment.

DANGER

Electric shock after activating "System stop."

Parts of the equipment remain live after "System stop" has been activated (e.g. external voltage present at remote signal terminals).

Risk to life due to electric shock.

➔ Disconnect the equipment.

DANGER

Electric shock caused by inverter.

Parts of the equipment remain live after the inverter has been shut down.

Risk to life due to electric shock.

➔ Disconnect the equipment.

DANGER

Electric shock caused by back-feeding.

The input terminals of the equipment may remain live after the incoming power supply has been interrupted.

Risk to life due to electric shock.

➔ Disconnect the equipment.

➔ Install back-feeding protection (a disconnector) in the load circuit.

DANGER

Electric shock caused by leakage currents.

The capacitors generate high leakage currents in the equipment. Conductive parts may be live in the event of connection errors.

Risk to life due to electric shock.

➔ Establish a PE conductor connection prior to start-up.

Using residual-current-operated protective devices (FI) alone is not permitted.

WARNING

Water in electrical equipment.

Risk to life due to electric shock.

➔ Do not use water to clean the cabinets.

➔ Do not place any vessels containing fluids on electrical equipment.

2.8.2 Risks due to Moving Parts

CAUTION

Risk of injury due to rotating fans.

The fans of the INV control cabinet are freely accessible**.**

➔ Never reach into rotating fans.

➔ When setting up any equipment, ensure that the fans cannot be touched.

2.8.3 Fire-Related Risks

Installation of fireproof enclosures (EN 60950-1)

A built-in floor plate ensures that, in the event of a fire, no molten or burning material can fall out of the equipment.

We recommend having a separate supply/exhaust air connection for the PV.500-UL in order to prevent smoke spreading in the event of a fire.

WARNING

Spread of smoke in electrical operating areas.

➔ If smoke or odor is detected or a fire breaks out, immediately disconnect the equipment from the power supply and inform the maintenance personnel.

2.8.4 Risks due to Loss of Control

ATTENTION

Failure of remote signaling.

If remote signaling fails or the signal lines are interrupted, the control room can no longer control the equipment.

In such an event, faults can only be identified locally at the unit itself.

Failure of external emergency switching device.

➔ Disconnect the equipment.

ATTENTION

Failure of the display and operation unit.

If the display and operation unit fails, the skilled personnel will no longer be able to control the equipment.

In such an event, faults will no longer be displayed.

➔ Inform the control room.

2.8.5 Risks from Maintenance and Repair Work

Only trained and qualified skilled personnel (as described above) may work on or around the equipment while strictly observing the safety regulations.

DANGER

Risk to life due to electric shock.

Potentially fatal voltages are present in the equipment.

➔ Disconnect safely.
➔ Secure the unit against being switched back on.
➔ Verify that all poles are de-energized.
➔ Ground and short-circuit the equipment.
➔ Provide protection in the form of covers or barriers for any neighboring live parts.

ATTENTION

Damage to property.

➔ Only use original spare parts.
➔ Do not make any unauthorized changes to the equipment.
➔ Observe the safety regulations.

3 Product Details

The equipment has been designed for solar power plants and provides professional solutions for the use of installations covering large roofs or in open spaces.

3.1 Product Description

The equipment is a solar inverter (INV) that feeds the electrical energy produced by the PV cells into a medium-voltage grid (e.g. 10 kV; 20 kV; 33 kV).

The required power transformer is **not** supplied with the unit and can be provided optionally if necessary. It is possible to combine two Protect PV.500-UL units to create a 1 MW system. A joint isolating transformer can be used, with an electrically isolated low-voltage connection for each Protect PV.500-UL.

The rating plate with all the relevant data is located on the inside of the door.

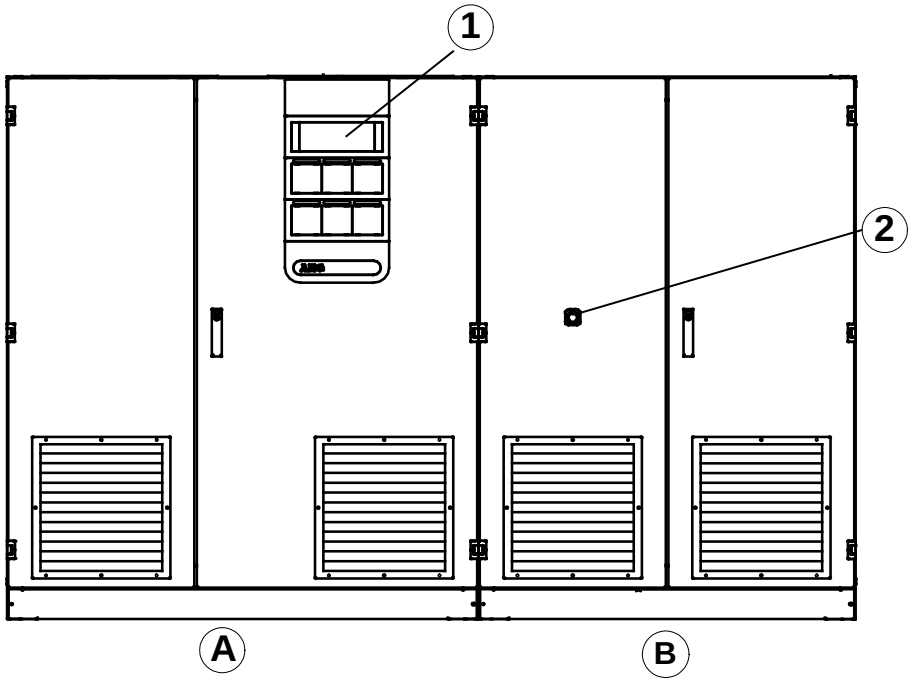


Figure 2 PV.500-UL equipment

Item	Designation
1	Display and operation unit (DOU)
2	System stop
A	INV control cabinet +INV
B	DC/AC control cabinet +DCD/ACD

i	**Important information about equipment documentation** Further descriptions and unit diagrams are included in the document folder.

3.2 Dimensions and Views

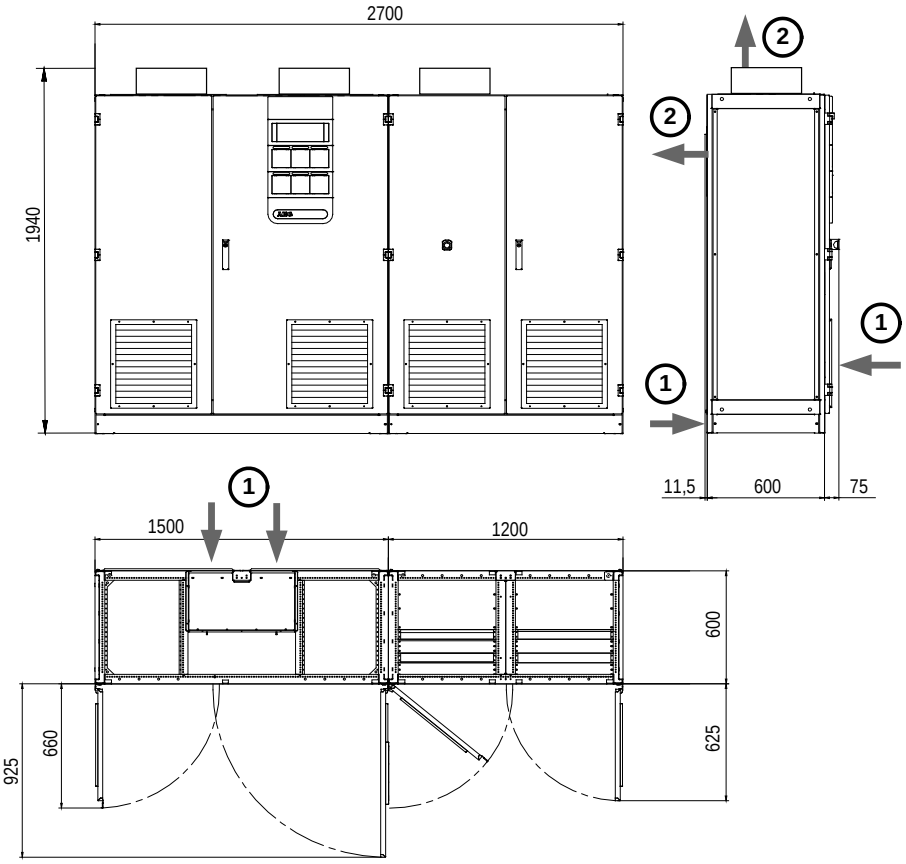


Figure 3 Dimensions and views

3.3 Appropriate Use

Only operate the equipment with the maximum permissible connection values stated in the technical data sheet. Any other use or modification constitutes inappropriate use.

Unauthorized modifications, manipulations or changes made to the equipment and its safety devices without the manufacturer's approval are not permitted. The manufacturer cannot be held liable for damage resulting from such modifications, manipulations or changes.

Safety

The equipment will operate reliably and safely subject to compliance with the instructions, the operating and equipment specifications and regulations set out by the Employer's Liability Insurance Association.

3.4 Inappropriate Use

No liability is accepted if the equipment is used for applications not intended by the manufacturer (inappropriate use). Inappropriate use can cause serious or fatal personal injury. The responsibility for any measures necessary for the prevention of personal injury or damage to property is borne by the equipment operator or user.

3.5 Standards, Directives and UL Mark

The equipment complies with the currently applicable UL1741. The requirements of BGVA3 are met on the basis of compliance with EN 50274/VDE 0660-51.

The requirements of VDE 0100, Part 410, IEC 60364-4-41, "Functional extra-low voltage with safe isolation" and IEC 62109, "Safety of power converters for use in photovoltaic power systems" have been complied with where applicable.

3.6 Nameplate

The following information appears on the nameplate:

Type	
Max. input voltage	Rated voltage
Min. MPP voltage	Rated frequency
Max. MPP voltage	Rated output power
Max. input current	Max. output current
Degree of protection	Ambient temperature
Year of construction	Protection class
CNF number	
Unit number	

Figure 4 Information on the nameplate

3.7 Technology

Due to the utilization of high-performance electronic components, the equipment boasts a very high degree of operational reliability, is extremely efficient and is characterized by its versatility in communicating with other systems by means of interfaces.

The entire control electronics system for the equipment is based on the use of microcomputer assemblies. The fact that the various assemblies are logically integrated and linked into the overall system means that unit properties can be defined by making unit-specific parameter settings in the software.

Information is exchanged between the individual modules using the CAN bus (Controller Area Network). This CAN bus features high interference immunity and is used in a wide variety of industrial applications.

The figure below illustrates the principle of the equipment.

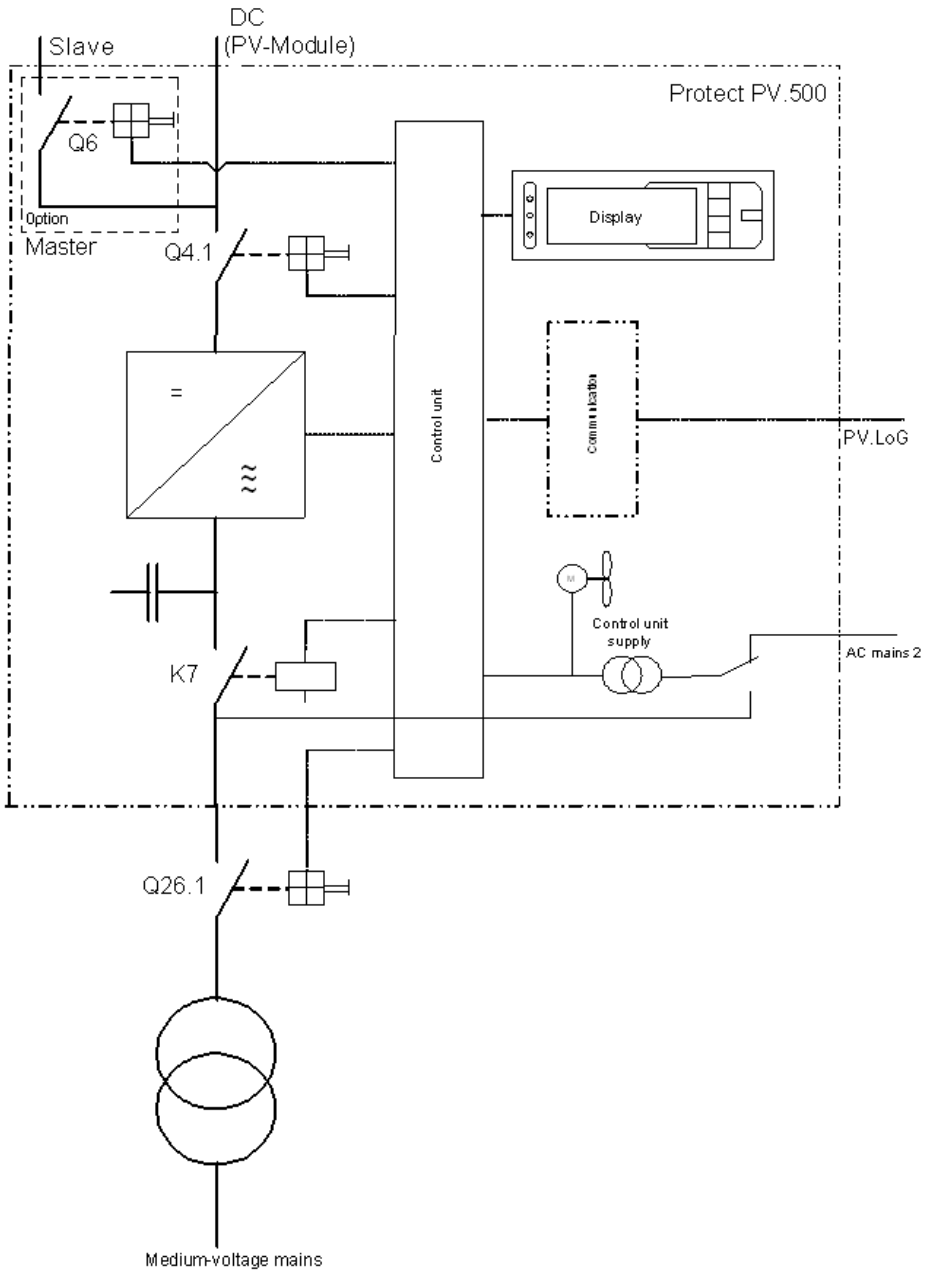


Figure 5 Functional principle of the equipment for connection to a low-voltage system

The main assemblies of the inverter are:

- DC load interrupter switch Q4
- Inverter stack, display and control unit with communication components
- AC filter
- Inverter output contactor K7
- Power transformer (external)
- Power disconnector Q26 (external)

	**ATTENTION** **The power transformer must be designed as an isolating transformer.** **The low-voltage connections and the neutral point of the low-voltage side must be potential-free; they must not be connected to the PE conductor.** Overvoltage protection devices must not be switched against ground. If multi-winding transformers are used, as is the case for the operation of 2 inverters, for example, both low-voltage windings and the neutral points must be potential-free.

•

The PV cells supply the inverter stack with DC voltage via DC load interrupter switch Q4. The inverter stack converts this DC voltage into a 3-phase AC voltage. A sinusoidal current is fed into the grid via the AC filter, inverter output contactor K7 and the power transformer.

	**ATTENTION** **By default, the negative pole of the INV input is grounded through a GFDI (**ground fault detection interruption**).** **If PV cells using thin-film technology are used that require positive grounding, the system can be switched to positive grounding.**

	**DANGER** **Risk to life due to electric shock.** Potentially fatal voltages are present at the terminals on the equipment. ➔ Do not touch live parts.

Power disconnector Q26 (external) and the isolator in the generator connection box (GCB) are there to isolate the inverter in the event of unit faults or when maintenance needs to be performed on the unit.

The control unit is supplied with power from the AC power grid or, optionally, from a second AC power grid.

3.8 Operating Elements

For details of how the internal operating elements are arranged, please refer to the documents included in the unit.

4 System Description

4.1 Individual Operation Operating Mode

In individual operation, the inverter works independently and is not connected to any other inverters. The DC infeed from the PV cells and the link to the AC power grid are only connected to this inverter. Switching operations, control commands and modifications to setting parameters are only performed by the unit concerned.

5 System Function

5.1 Description of Sequence Control

As soon as the equipment's control module is supplied with voltage, sequence control starts.

Initially, load interrupter switch Q4 remains open. Once the initialization phase is complete and if no deactivating faults are pending, load interrupter switch Q4 is closed. During subsequent operation, the switch is only opened by deactivating faults (→ Chapter 6).

Inverter output contactor K7 remains open initially. The contactor is switched by the sequence control.

The figure below provides a graphical illustration of the sequence control statuses.

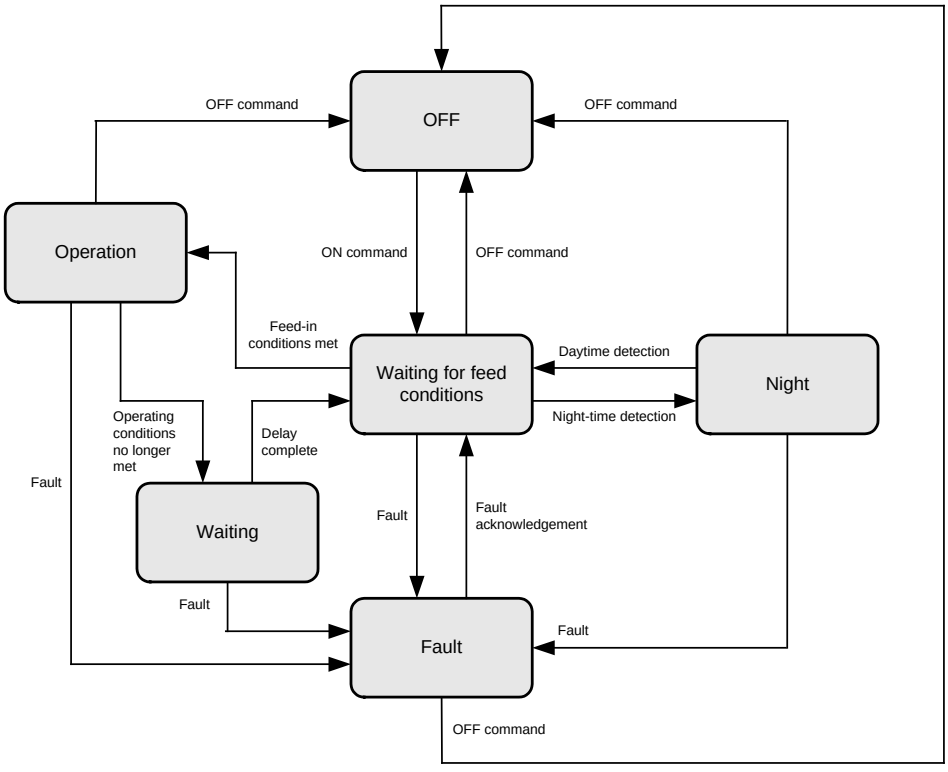


Figure 6 Sequence control

5.1.1 The "OFF" Status

The equipment has been switched off logically via the DOU or the master control unit.

The equipment is running without faults, the monitoring systems are not activated.

In this status, no power is fed into the grid.

Possible change of status:
The status can be switched from "OFF" to "Waiting for feed conditions" by switching the equipment on via the DOU and the master control unit.

5.1.2 The "Waiting for Feed Conditions" Status

The values of the DC voltage on the PV cells, the grid voltage and the grid frequency are monitored by the equipment.

The set monitoring values are regularly checked.

In this status, no power is fed into the grid.

Possible change of status:

If the DC voltage rises above a certain value for a certain time and the grid voltage and grid frequency are within a certain range, the unit switches to the "Operation" status. A start-up attempt is made, which involves switching on the inverter stack. If the DC voltage collapses too dramatically during this start-up attempt, the inverter stack is switched off again and there is a delay before attempting to start up again. The equipment will not switch to the "Operation" status until any dip in the DC voltage that occurs during a start-up attempt is within acceptable limits.

If the DC voltage falls below a certain value for a certain time, the equipment switches to the "Night" status.
If a deactivating or self-acknowledging fault is triggered, the equipment switches to the "Fault" status.
The status can be switched from "Waiting for feed conditions" to "OFF" using the "Off" control command.

5.1.3 The "Operation" Status

The equipment has met all conditions for operation and no deactivating or self-acknowledging faults are present.

The set monitoring values are regularly checked. In this status, power is fed into the grid and inverter output contactor K7 is closed.

Possible change of status:

If the generated power falls below a certain value for a certain time, the operating conditions are no longer met. The equipment then switches to the "Waiting" status. If a deactivating or self-acknowledging fault is triggered, the equipment switches to the "Fault" status.

The status can be switched from "Operation" to "OFF" using the "Off" control command.

5.1.4 The "Waiting" Status

If the power fed in falls below a certain value when the equipment is in "Operation", it switches to the "Waiting" status. Although the incoming power is low, the DC voltage of the PV cell could still be high enough and even stable enough to meet the feed conditions in the "Waiting for feed conditions" status. To prevent the inverter from switching back on again immediately, thereby subjecting inverter output contactor K7 to unnecessary strain due to frequent switching, the unit initially switches to the "Waiting" status after the "Operation" status. It remains in this status for a certain time, only switching to the "Waiting for feed conditions" status once this time has elapsed.

The set monitoring values are regularly checked.

Possible change of status:

Once the delay has elapsed, the unit switches to the "Waiting for feed conditions" status.

If a deactivating or self-acknowledging fault is triggered, the equipment switches to the "Fault" status.

The status can be switched from "Operation" to "OFF" using the "Off" control command.

5.1.5 The "Fault" Status

If a deactivating or self-acknowledging fault is triggered (→ Chapter 6), the equipment switches to the "Fault" status.

The set monitoring values are regularly checked.

In this status, no power is fed into the grid.

Possible change of status:

If a self-acknowledging fault has been triggered and this fault does acknowledge itself, the unit switches to the "Waiting for feed conditions" status.

If a deactivating fault has been triggered, the "Acknowledge fault" control command can be used to switch back to the "Waiting" status.
The status can be switched from "Fault" to "OFF" using the "Off" control command. In the "OFF" status, the unit is always free of faults.

5.1.6 The "Night" Status

If the DC voltage falls below a certain value for a certain time, the equipment switches to the "Night" status.

The set monitoring values are regularly checked.

In this status, no power is fed into the grid.

Possible change of status:

If the DC voltage rises above a certain value for a certain time in the morning, the equipment switches to the "Waiting for feed conditions" status.

If a deactivating or self-acknowledging fault is triggered, the equipment switches to the "Fault" status.

The status can be switched from "Operation" to "OFF" using the "Off" control command.

5.1.7 Sequence Control During the Course of the Day

Early morning:

The equipment is in the "Night" status. The sun's rays increase the DC voltage generated by the PV cells. If this voltage stays above a certain value for a certain time, the unit switches to the "Waiting for feed conditions" status.

The DC voltage continues to be monitored in this status. In order for a start-up attempt to be made, it must remain above a certain value for a certain time. The grid voltage and grid frequency are also checked. These values must be within certain limits.

If the DC voltage continues to increase due to the sun's rays getting stronger and the grid voltage and grid frequency are within acceptable limits, a start-up attempt is made. During a start-up attempt, the inverter stack is switched on, thereby drawing power from the DC voltage that is present. Inverter output contactor K7 is open during a start-up attempt. If the load on the DC voltage causes it to collapse too dramatically during this start-up attempt, the inverter stack is switched off again and there is a delay until the next start-up attempt is made. If the DC voltage does not dip too significantly, inverter output contactor K7 closes and power is fed into the grid. The inverter is now in the "Operation" status.

Day:

During the course of the day, the inverter will remain in the "Operation" status if the sun's rays are strong enough and no faults occur. Power is fed into the grid and inverter output contactor K7 is closed.

Evening:

As the sun goes down, the power fed into the grid decreases. If this power falls below a certain value for a certain time, the operating conditions are no longer met. The inverter stack is switched off, inverter output contactor K7 opens and the unit switches to the "Waiting" status.

Once the "Waiting" status delay has elapsed, the unit switches back to "Waiting for feed conditions". Although the sun's rays are not as strong, the DC voltage might still be high enough for a successful start-up attempt with the inverter stack and inverter output contactor K7 being switched on again. However, because the sun's rays are not as strong, it is unlikely that the operating conditions will still be met in the "Operation" status. As a result, the equipment will switch back to the "Waiting" status once a delay has elapsed.

When the unit switches back to this status, the delay is extended until the unit switches back to the "Waiting for feed conditions" status.

The cyclic changes of status "Operation" -> "Waiting" -> "Waiting for feed conditions" -> "Operation" can take place several times depending on insolation, the time of year, location and other conditions (e.g. snow on the PV cells). To prevent inverter output contactor K7 from being overloaded by this cycle of changes, the "Waiting" status delay is extended every time the unit switches to this status.

This has very little effect on the energy fed in, because the low levels of insolation mean that hardly any energy is being generated.

Later in the evening:

Levels of insolation continue to fall. As a result, the DC voltage drops again. If the DC voltage drops below a certain value for a certain time, no more start-up attempts are made. If the DC voltage continues to drop, the unit switches to the "Night" status.

Night:

The equipment shuts down all possible loads so that as little energy as possible is being consumed. The equipment remains in the "Night" status until the following morning.

5.1.8 Sequence Control Parameters

Switch-on conditions
Underfrequency, overfrequency, undervoltage, overvoltage:

The equipment will only switch from the "Waiting for feed conditions" status to the "Operation" status if the feed conditions are met. These conditions include the grid voltage and the grid frequency. These values must be within certain limits described by the switch-on conditions.

Voltage limit value for night detection,
delay time for night detection:

If the DC voltage falls below the voltage limit value for longer than the delay time, the unit switches to the "Night" status.

Voltage limit value for day detection,
delay time for day detection:

If the DC voltage rises above the voltage limit value for longer than the delay time, the equipment switches to the "Waiting for feed conditions" status.

Inverter stack switch-on time:

The time for which the inverter stack is switched on during a start-up attempt

Permissible voltage dip after switching on the stack:

Prior to the start-up attempt, a limit value is calculated from the present DC voltage and the permissible voltage dip.

If the start-up attempt causes the DC voltage to fall below this calculated limit value, this start-up attempt will fail.

Delay until the next start-up attempt following failure due to excess voltage dip:

After the failure of a start-up attempt, this delay must elapse before the next start-up attempt is made.

Power limit value for shutdown,
delay time for shutdown:

If the power fed into the grid remains below the limit value for longer than the delay time, the unit switches to the "Waiting" status.

Standard delay for a renewed start-up attempt following shut-down,
offset delay added to the standard delay after shutdown,
maximum number of times the offset delay can be added to the standard delay:
Variable delay in the "Waiting" status → Chapter 5.1.4.

Minimum DC voltage,
fill factor (PV system parameter):
If the DC voltage rises above a value resulting from the minimum DC voltage divided by the fill factor, a start-up attempt is made.

5.2 Description of Fan Control

5.2.1 General

The equipment features temperature-dependent fan control. The fans are either switched off, run on a fast or slow fan stage (cabinet fan only) or are gradually speeded up or slowed down (stack fan only).

Fan control:

- Extends the operating time of the fans
- Minimizes the noise generated by the fans
- Improves the efficiency of the equipment by reducing its power consumption

5.2.2 Fan Control, Cabinet Fan

As soon as the equipment's control module is supplied with voltage, fan control always starts with the fast fan stage. The control can be restarted to check whether the fans are working correctly. For example, after maintenance work, it is not necessary to wait for the fans to reach the temperature criterion to switch on the fast fan stage.

The fast fan stage is always active for at least a certain time. After this time, the unit exhaust air temperatures are checked. If the highest temperature from the two sensors is below a certain value, the fan control switches to the slow fan stage.

The unit exhaust air temperatures are also checked in the slow fan stage. If the highest temperature from the two sensors is below a certain value, the fans are switched off. If the highest temperature rises again during operation with the lower fan stage, fan control switches to the fast fan stage.

If, when the fans are switched off, the highest temperature from the two sensors rises above a certain value, fan control switches to the fast fan stage.

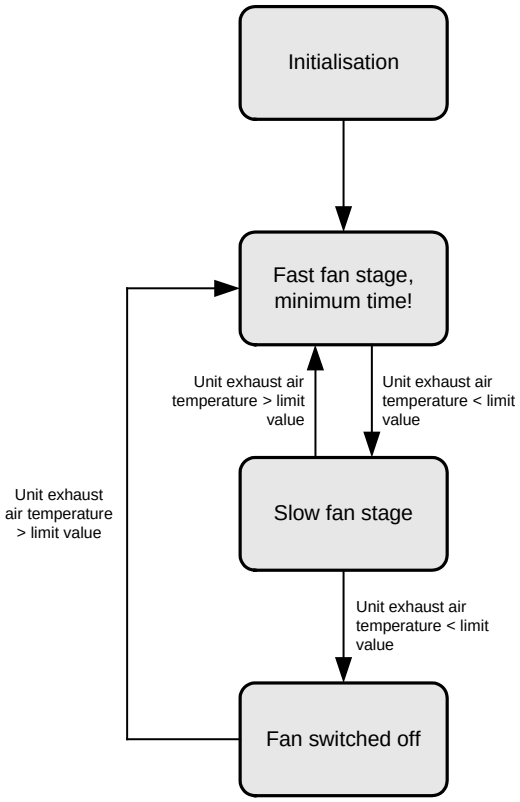


Figure 7 Fan control

5.2.3 Cabinet Fan Control Parameters

Unit exhaust air temperature limit value for switching on the fan:

If the highest exhaust air temperature rises above this limit value, the fans which were switched off are switched to the fast fan stage.

Unit exhaust air temperature limit value for switching off the fan:

If the highest exhaust air temperature falls below this limit value, the fans which were running in the slow fan stage are switched off.

Unit exhaust air temperature limit value for switching to the fast fan stage:
If the highest exhaust air temperature rises above this limit value, the fans which were running in the slow fan stage are switched to the fast fan stage.

Unit exhaust air temperature limit value for switching to the slow fan stage,
minimum time in the fast fan stage:
If the highest exhaust air temperature falls below this limit value, the fans which were running in the fast fan stage are switched to the slow fan stage when the minimum time in the fast fan stage has elapsed.

5.2.4 Fan Control, Inverter Stack Fan

As soon as the equipment's control module is supplied with voltage, fan control always starts with the maximum fan speed. This means that the control can be restarted to check whether the fan is working correctly. For example, after maintenance work, it is not necessary to wait for the fan to reach the temperature criterion to switch on the maximum fan speed.

The maximum fan speed is always active for at least a certain time. After this time, the IGBT temperatures are checked. The fan speed is then determined using the highest of these temperatures. If the highest temperature from the two sensors is below a certain value, the fan is switched off completely.

If, when the fans are switched off, the highest temperature from the two sensors rises above a certain value, the fan is again operated at the maximum speed for a certain time.

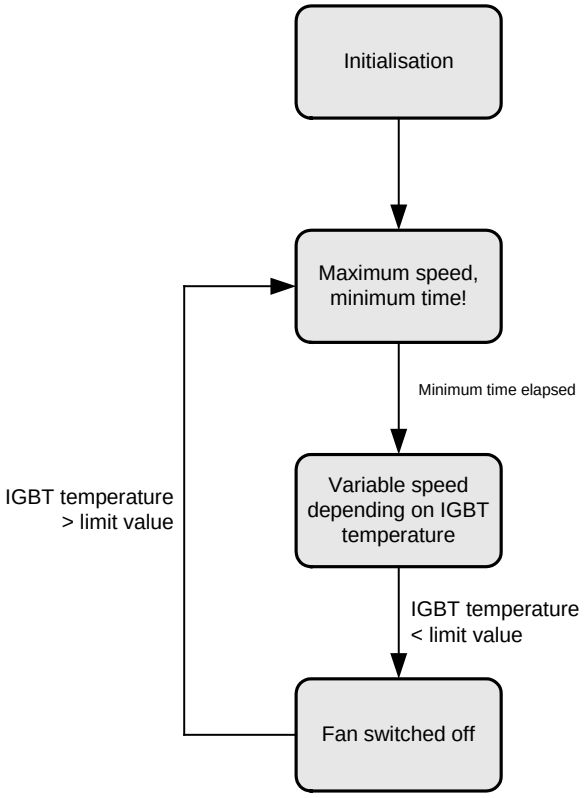


Figure 8 Fan control

5.2.5 Parameters of Inverter Stack Fan Control

IGBT temperature limit value for switching off the fan:
If the highest IGBT temperature falls below this limit value, the fan is switched off.

IGBT temperature limits and fan speeds, x-y coordinates for determining variable speed:
The variable fan speed is determined by a linear x-y characteristic on the basis of these values.

IGBT temperature limit:
If the IGBT temperature rises above the lower limit value, the fan that was previously switched off is run at maximum speed for the minimum time.

Minimum time, maximum speed:
If the minimum time has elapsed, the fan is controlled variably using the measured IGBT temperature.

5.3 Insulation Monitoring and Grounding of PV Cells

To enable the detection of ground faults in the PV generator, one pole is grounded through a fuse (GFDI - Ground Fault Detection Interruption). By default, the negative pole of the INV input is grounded.
If PV cells using thin-film technology are used that require positive grounding, the system can be switched to positive grounding.

ATTENTION

GFDI does not provide any protection to persons.

Additional grounding of the PV generators is not permitted. This would render the GFDI protection ineffective.

DANGER

Risk to life due to electric shock.

In the event of a fault, grounding can be interrupted by the GFDI. The pole grounded through the GFDI will then become live.

To enable the detection of ground faults in the DC circuit, one pole of the PV generator is grounded through a fuse. When a ground fault occurs on the non-grounded pole of the PV generator, the fuse trips and disconnects the ground connection. Tripping of the GFDI is detected by the control unit and indicated on the display.

The fault signal can be connected to one of three fault inputs provided for this purpose. These inputs influence the operating behavior of the inverter.
They are the following control inputs (see also Chapter 6):

- Signaling external fault
- Self-acknowledging fault
- Deactivating fault (default)

5.4 MPP Tracker

In the "Operation" status (see Chapter 5.1.3), the inverter detects the maximum power point (MPP) of the PV cells.

The MPP tracker detects the point at which the solar cells give off maximum power.

This enables the system to achieve optimum efficiency.

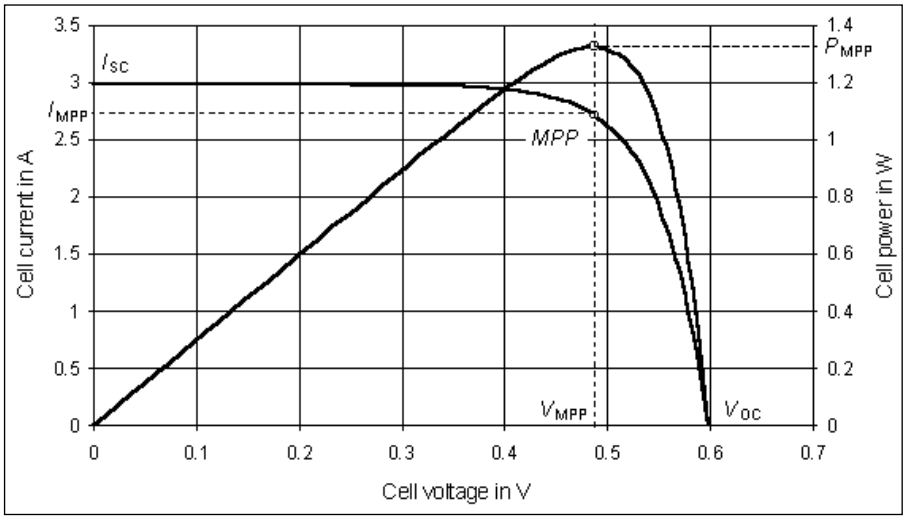


Figure 9 MPP performance curve

6 Monitoring Systems, Messages and Faults

6.1 General Information

All monitoring systems only generate fault messages when the inverter is switched on; when it is switched off, the inverter is always reported as being free of faults.

A distinction is made between **deactivating**, **self-acknowledging** and **signaling faults**.

Deactivating faults switch the equipment off permanently once they have occurred a number of times. K7 and Q4 are opened.

When a fault first occurs, it is acknowledged after a certain time has elapsed, and the inverter makes a start-up attempt. This start-up attempt is only made if the DC voltage did not drop too dramatically during the fault. If the cause of the fault is still present after the start-up attempt, the inverter is switched off again.

A maximum of 3 start-up attempts are made.

Each time the inverter is switched off, K7 and Q4 are opened.

After a successful start-up attempt and once a certain operating time has elapsed, the counter for start-up attempts is reset again.

If the third start-up attempt is also unsuccessful, the inverter is switched off permanently. The fault is then no longer self-acknowledging. It can be acknowledged by switching the equipment off and on or by manually acknowledging the fault. If the cause of the fault is still present following manual acknowledgement, a deactivating fault is generated again.
In addition to the software monitoring functions that are listed in the table below and that cause the unit to be switched off, a software-independent hardware monitoring function is implemented which also switches off the inverter in the event of an overload. When the unit is switched off, it is disconnected from the energy supply on the DC and AC side through Q4 and K7.

Self-acknowledging faults switch the equipment off. K7 is opened, Q4 remains closed.

The equipment starts up again when the cause of the fault is no longer present. The fault can also be acknowledged manually or by switching the equipment off and on. However, if the cause of the fault is still present following manual acknowledgement, another self-acknowledging fault will be generated.

Signaling faults do not have any effect on the equipment's sequence control. K7 and Q4 remain closed.

A signaling fault acknowledges itself automatically when the cause of the fault is no longer present. The fault can also be acknowledged manually or by switching the equipment off and on. However, if the cause of the fault is still present following manual acknowledgement, another signaling fault will be generated.

6.2 Table of Faults

The monitoring systems listed below will cause the inverter to switch off, are self-acknowledging or signaling and are shown on the DOU with corresponding plain text:

Temperature monitoring systems

Fault/Message	Deac-tivat-ing	Self-acknow-led ging	Signaling	DOU message
IGBT 1 stack temperature warning			X	!Equipment temperature fault!
IGBT 2 stack temperature warning			X	!Equipment temperature fault!
IGBT 1 stack temperature fault		X		#Equipment temperature fault#
IGBT 2 stack temperature fault		X		#Equipment temperature fault#
IGBT supply air undertemperature			X	!Ambient temperature fault!
IGBT supply air temperature warning			X	!Ambient temperature fault!
IGBT supply air temperature fault		X		#Ambient temperature fault#
Unit exhaust air 1 temperature warning			X	!Equipment temperature fault!
Unit exhaust air 2 temperature warning			X	!Equipment temperature fault!
Unit exhaust air 1 temperature fault		X		#Equipment temperature fault#
Unit exhaust air 2 temperature fault		X		#Equipment temperature fault#
Unit supply air undertemperature			X	!Ambient temperature fault!
Unit supply air temperature warn-ing			X	!Ambient temperature fault!
Unit supply air temperature fault		X		#Ambient temperature fault#
Temperature sensor fault IGBT 1 stack		X		#Temperature sensor fault#
Temperature sensor fault IGBT 2 stack		X		#Temperature sensor fault#
Temperature sensor fault IGBT supply air temperature		X		#Temperature sensor fault#
Temperature sensor fault unit exhaust air 1 temperature		X		#Temperature sensor fault#
Temperature sensor fault unit exhaust air 2 temperature		X		#Temperature sensor fault#
Temperature sensor fault unit supply air temperature			X	#Temperature sensor fault#
IGBT differential current deviation			X	!Difference current deviation!

CAN I/O monitoring systems

Fault/Message	Deac-tivat-ing	Self-acknow-led ging	Signaling	DOU message
Feedback signal DC load interrupter switch Q4.1			X	Q4.x: !Switch feedback fault!
Switch position Q4.1			X	Q4.x: Switch open
Feedback signal K21 grounding PV cells			X	K21: !Switch feedback fault!
Monitoring F21 grounding circuit breaker			X	!Miniature circuit breaker tripped!
Monitoring F81 surge voltage arrester DC input			X	!Overvoltage protection tripped!
Monitoring line voltage auxiliary power supply grid 2			X	!Auxiliary power supply – grid supply failed!
Monitoring F83/F84 surge voltage arrester AC – anti-condensation heater			X	F83/84: !Miniature circuit breaker tripped!
Monitoring F60 auxiliary line power supply 2			X	F60: !Miniature circuit breaker tripped!
Monitoring F61 independent line power supply 1			X	F61: !Miniature circuit breaker tripped!
Monitoring Q26 AC line disconnector			X	Q26: Switch open
Monitoring unit cabinet door			X	!Unit cabinet door open!
Monitoring communication CAN I/O AC cabinet			X	!Communication fault with I/O control!
Monitoring communication CAN I/O DC cabinet			X	!Communication fault with I/O control!
Monitoring CAN I/O parameters	X			#I/O parameter error#
External control input insulation			X	!Insulation monitor warning!
External control input insulation		X		!Insulation monitor alarm!
External control input insulation	X			#Insulation monitor alarm#

Unit Monitoring Systems

Fault/Message	Deac-tivat-ing	Self-acknow-led ging	Signaling	DOU message
Monitoring fan fault cabinet fan			X	!Fan failure!
Monitoring fan fault stack fans			X	!Fan failure!
Monitoring K91 feedback signal fan contactor			X	K91: !Switch feedback fault!
Monitoring K7 feedback signal INV output contactor	X			#Fault K7 feedback signal#
Monitoring parameter limits			X	!Parameter limit fault!
Monitoring PCB ID	X			#Self-test fault#
Monitoring EEPROM	X			#EEPROM fault#
Monitoring serial EEPROM			X	!System fault!
Monitoring Watchdog	X			#Watchdog#
Monitoring 15 V supply voltage	X			#15 V supply voltage fault#
Monitoring IGBT stack	X			#Stack fault#
Monitoring short-circuit/overload	X			#Short circuit#
Monitoring load current transformer	X			#Load current transformer fault#
Monitoring stack current transformer	X			#Stack current transformer – fault#
Monitoring inverter output voltage	X			#AC voltage deviation#
Monitoring stack overcurrent	X			#Stack overcurrent#
Monitoring mains synchronization		X		#Synchronization fault#
Monitoring parallel CAN communication			X	!Communication fault parallel CAN!
Monitoring remote monitoring communication			X	!Remote monitoring fault!

DC voltage monitoring systems

Fault/Message	Deac-tivat-ing	Self-acknow-led ging	Signaling	DOU message
Monitoring DC overvoltage		X		#DC voltage deviation#

Grid monitoring systems

Fault/Message	Deac-tivat-ing	Self-acknow-led ging	Signaling	DOU message
Field rotation or phase fault		X		#Field rotation fault#
Monitoring grid overfrequency		X		#Grid frequency deviation#
Monitoring grid underfrequency		X		#Grid frequency deviation#
Monitoring grid overvoltage		X		#Grid voltage deviation#
Monitoring grid undervoltage		X		#Grid voltage deviation#
Monitoring symmetric fault		X		#Grid symmetry fault#

7 Interfaces

PV power stations are usually monitored from a central location. Alongside the PV cells, the inverter is a key component of a power station, which is why various communication interfaces are available as standard.

These include relay contacts and optocouplers as well as various serial interfaces with protocols for integration into higher-level monitoring systems.

To facilitate PV power station monitoring, AEG also offers relevant additional components that are adapted for use with inverters and PV generators. This enables the client to monitor an entire PV power station from a central location easily and reliably.

7.1 Communication Interface

The photovoltaic inverter is equipped with a central communication unit, a "MultiCom CCC interface."

As well as performing various other functions, this unit facilitates communication between PV inverters and higher-level monitoring systems.

A special system of central monitoring via the Internet can be realized using AEG monitoring components such as "PV.LoG." The connection between the inverter and PV-LoG has been optimally adapted for monitoring and management purposes and is established via the Modbus protocol. If you have any further questions, please contact your supplier.

7.1.1 General

Two separate potential-free serial interfaces are provided as standard for the purpose of establishing communication connections. One interface – port X2 – is assigned the AEG-specific protocol CBSER and is used both locally and remotely for corresponding service tools. The other one – port X5 – supports the Modbus protocol and enables the PV inverter to be integrated into higher-level monitoring and control systems with ease. This port can be switched over from RS232 to RS485.

An external CAN bus provides a further connection option, which can be used for monitoring via a remote panel.

The MultiCom CCC interface can be found on the pivot inside the DC/AC cabinet (item A29.1; see the assembly diagram).

7.1.2 Technical Data

MultiCom CCC hardware data (assembly A29.1)

Connector	:	**Port 1** RS232 for configuration and COM server connection
		X2: 9-pin D-sub (socket; insulated)
		Port 2 RS232/RS485 for Modbus
		X5: 9-pin D-sub (socket; insulated)
RS485 connection:		Twisted pair with Data+, Data-, shielded, shield attached on one side
Distance:		1200 m max. at 9600 baud
Bus stations:		Max. 32
Data line:		Shielded 1:1 data line (2 x 0.22; twisted pair), e.g. Lapp "UNITRONIC-BUS LD"
		Port 3 CAN bus for remote panel X4: 3-pin Combicon connector

Communication data port 1 (X2)

Protocol:	CBSER
Transmission rate:	1200 - 57,600 baud (adjustable)
Transmission parameters:	**9600 baud, 8, E, 1** (**default**)
Configuration mode:	9600 baud, 8, N, 1

Communication data port 2 (X5)

Protocol:	Modbus
Transmission mode:	Half-duplex
Transmission code:	RTU
Transmission rate:	1200 - 57,600 baud (variable)
	19,200 baud (**default**)
Start bits:	**1**
Data bits:	**8**
Parity:	none, **even**, odd (variable)
Stop bits:	2 with no parity, 1 with parity
Function code:	03 (read register) 06 (write register) 16 (write multiple registers)
Min. response time of slave:	0-99 ms variable (**0 ms default**)
Modbus slave address:	01-99 (adjustable) (**01 default**)

Communication data port 3 (X4)

Protocol:	Proprietary CAN bus
Transmission rate:	50 kbaud

7.1.3 Structure of the MultiCom CCC Interface

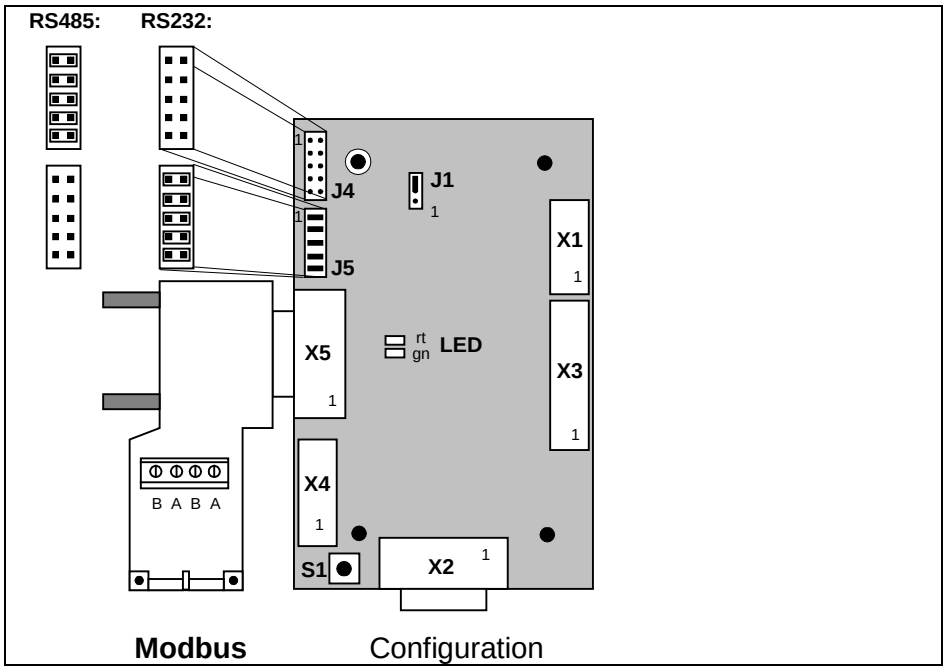


Figure 13 MultiCom CCC interface as a Modbus interface (top view)

Connections:

X1: Internal inverter bus and power supply

X2: Potential-free RS232 serial interface

X3: Triggering of "remote signaling"

X4: A remote panel can be connected to this potential-free CAN interface.

X5: Potential-free RS485/RS232 serial interface

Configuration jumpers:

J1: 1-2: Firmware update; 2-3: (**default**)

J4: All closed: RS485 (**default**)

J5: All closed: RS232

The transmission topology of the Modbus interface (connector X5) is set by means of the two configuration jumper blocks (J4/J5). The factory setting is RS485.

In order to be able to use the Modbus interface as a point-to-point connection via RS232, you must remove all jumpers from block J4 and plug them in on block J5.

Button:

S1: Button for initiating the configuration via connector X2

LED signals:

Green/red flashes:	Configuration can be selected via the terminal (up to 30 seconds after restarting)
Green on:	Operating status; no external communication via X2 and X5
Green flashes:	Data transmission on the serial interfaces (X2 or X5)
Red on:	Fault

Description of serial interfaces:

Port 1: Serial interface X2

The potential-free RS232 serial interface at connector X2 supports the AEG-specific CBSER protocol for parameter setting and monitoring purposes. Special service tools can be used to monitor and manage the equipment locally and (with the aid of the COM server) remotely via a network. This is also the port used for configuring the assembly's interfaces.

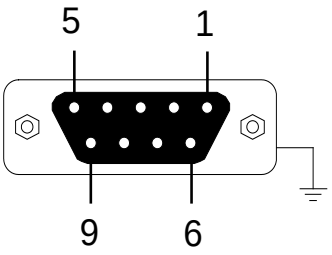


Figure 14 Serial D-sub connector X2

Port 1 (X2): RS232 pin assignment

Pin number	Signal	Description
2	RxD	PC receiving data from the MCC
3	TxD	PC sending data to the MCC
5	GND	Interface reference potential
Housing		INV housing potential

Please use a 1:1 data cable for configuration purposes.

Port 2: Serial interface X5

The potential-free RS485 interface at connector X5 supports the Modbus protocol for integration into higher-level monitoring systems.

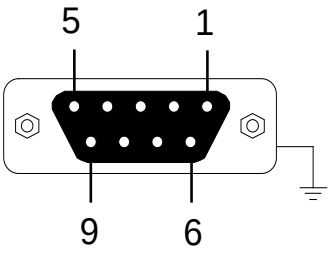


Figure 15 Serial D-sub connector X5

Port 2 (X5): RS485 pin assignment (default)

Pin number	Signal	Description
3	B	High data
8	A	Low data
Housing		INV housing potential

Please use a shielded fieldbus cable as the line,
e.g. 2 x 0.22 twisted pair Lapp "UNITRONIC-BUS LD."

Please connect the RS485 bus line via the bus interface connector supplied. In an RS485 network, the ends of the bus must always be terminated. If necessary, insert the 120 ohm resistor supplied between connections A and B.

Shield connection of the RS485 bus line:

Shielding is a means of weakening (attenuating) magnetic, electrical or electromagnetic interference fields.
Interference currents on line shields are dissipated to ground by means of the shield busbar that has a conductive connection to the housing. A low-impedance connection to the PE conductor is especially important to prevent these interference currents from themselves becoming a source of interference.

If possible, only use lines with a braided shield. The shield coverage should be at least 80%. Avoid using lines with a foil shield because tensile and compressive stresses applied when fastening the line can easily damage the foil, resulting in a reduction in the shielding effect.

Please bear the following points in mind when handling the shield:

- Use cable clips or shield terminal blocks made of metal to secure the braided shield. The clips must surround the shield and make good contact with it over a large area.
- Attach the shield to a shield busbar right after the line enters the cabinet. Run the shield right up to the assembly; however, ensure that it does not make contact there.

When used in PV applications, the shield of the RS485 bus line should only be grounded on one side so that no equalizing or interference currents can flow through the shielding. However, if several bus stations are present, you must make sure that the shield is never interrupted.

Always attach the shield of the RS485 bus line to ground on the quiescent side, i.e. only one side of the shield is attached to the ground potential on the master or data logger side.

In the PV inverter, the shield must not be connected to the housing in any way.

Insert the RS485 bus cable into the equipment until it reaches the MultiCom interface, shorten it accordingly and attach both wires to terminals A and B.

The X5 interface can be switched from RS485 to RS232 using jumpers J4 and J5. The factory setting is RS485, i.e. all jumpers are inserted at J4. You have the option of switching the interface to RS232 by reconnecting all jumpers to J5.

Port 2 (X5): RS232 pin assignment

Pin number	Signal	Description
2	RxD	PC receiving data
3	TxD	PC sending data
5	GND	Interface reference potential
7	RTS	Handshake
8	CTS	Handshake
Housing		INV housing potential

If the RS232 version is used for this port, please use a 1:1 data line.

Controller Area Network (CAN) at X4

Up to four remote panels can also be connected to the potential-free CAN interface for central signaling and display.

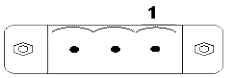


Figure 16 Connector X4

Port 3 (X4): CAN pin assignment

Pin number	Designation	Cable color coding
1	GND	White + brown
2	Data_L	Yellow
3	Data_H	Green

Please use a shielded CAN bus cable as the line,
e.g. 2 x 0.22 twisted pair Lapp "UNITRONIC-BUS LD."

Route the CAN bus line from the PV inverter to the remote panel. In a CAN bus network, the ends of the bus must always be terminated. A 120 ohm terminating resistor is pre-installed at connector X4 of the CAN bus connection as standard.

Connect the line shield to the housing potential of the INV unit via shield terminal blocks. Openings are provided in the plate of the PV inverter for installing the shield in the connection room area. Remove approx. 20 mm of the sheath at this point.

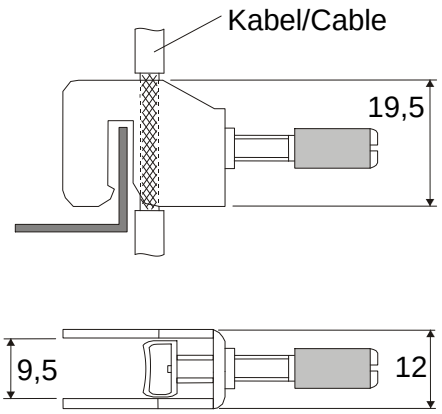


Figure 17 Shield connection

7.1.4 Configuration

The communication interface does not have to be configured in order to connect the PV inverter to the data logger system of the AEG "PV.LoG." Once the bus cable has been installed and the system has been powered up, the configuration settings are made fully automatically.

If you are using a different/in-house monitoring system, you can adjust the transmission parameters and the slave address of the Modbus interface to suit your requirements via port 1 (X2). We would be happy to provide you with the Modbus unit profile on request.

7.1.4.1 Configuration Preparations

You will need a 1:1 data line and a PC.

For this configuration, you must connect the PC to the MultiCom interface (X2) via the data line and start a terminal program, e.g. Hyperterminal, on the PC.

Setting the terminal program:

Data transmission:	COMx, 9600 baud/8 data bits/1 stop bit
	No parity/no protocol
Terminal emulation:	VT100

You can then start the configuration by pressing the “S1” button on the MultiCom interface. Ensure that no communication has taken place via interfaces X2/X5 for at least 10 seconds before doing so.

Initiation of the configuration is displayed by the two LEDs flashing on the MultiCom interface and the following display on the terminal:

“PRESS <CR> FOR CONFIGURATION WHILE LED IS FLASHING”

The configuration starts provided you press the <ENTER> key (<CR>) within 30 seconds. The configuration main menu opens:

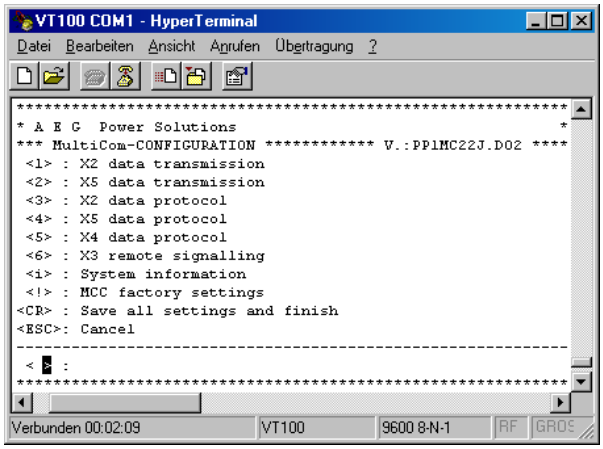


Figure 18 Main menu

If the configuration does not start, you must wait for 10 seconds and then repeat the procedure. Make sure that no data is received via the X2/X5 interfaces during this time.

Press the following key in the main menu:

<CR> to save the set values, exit the configuration and activate the MultiCom interface.

<ESC> to cancel the configuration.

<2> to access the X5 data transmission configuration.

<4> to access the X5 data protocol configuration.

The possible keyboard actions are shown in the menu in angle brackets (< >).

The following special keys can be used in the menus:

<CR>:	Carriage return (↵) or ENTER key
<ESC>:	Escape key
<TAB>:	Tabulator (→) key
<BS>:	Backspace (←) or rubout key
< >:	Space bar

7.1.4.2 Configuring the Modbus Protocol

To access the X5 data protocol configuration, press <4> in the main menu:

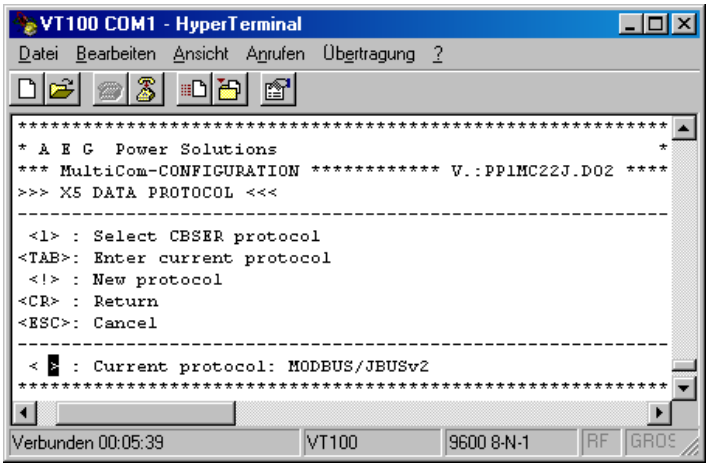


Figure 19 Data protocol configuration

Press one of the following keys in the “X5 Data Protocol” menu:

<TAB> to configure the Modbus protocol

<CR> to accept the set values. The configuration is finished and the main menu is opened again.

<ESC> to cancel the configuration. This opens the main menu.

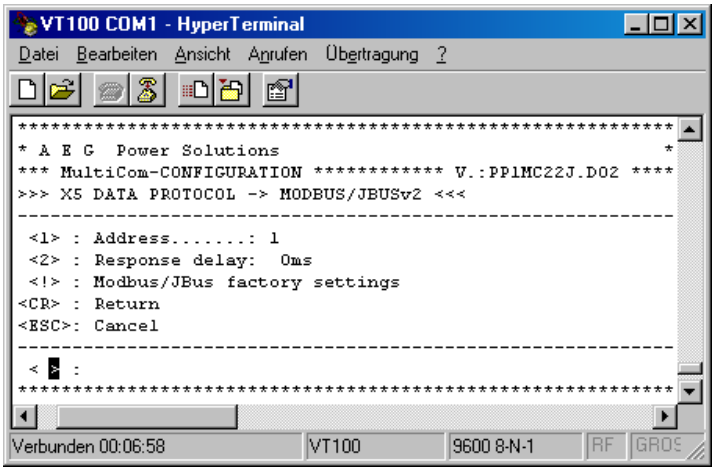


Figure 20 Modbus protocol configuration

Press one of the following keys in the “X5 Data Protocol – Modbus/JBusV2” menu:

- <!> to load the factory setting.
- <1> to configure the Modbus slave address.
- <2> to configure the delay time between a request from the master and the response from the slave.
- <CR> to accept the set values. The configuration is finished and the main menu is opened again.
- <ESC> to cancel the configuration. This opens the main menu.

7.1.4.3 Configuring Modbus Data Transmission

To access the X5 data transmission configuration, press <2> in the main menu:

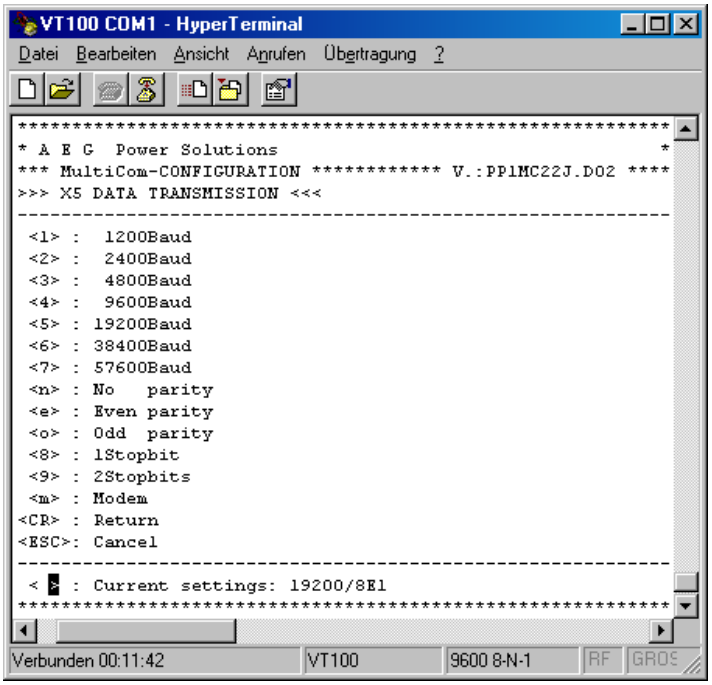


Figure 21 Modbus/JBus data transmission configuration

Press one of the following keys in the “X5 Data Transmission” menu:

- <1-7> to set the baud rate.
- <n,e,o> to set the parity.
- <8,9> to set the number of stop bits.
- <CR> to accept the set values. The configuration is finished and the main menu is opened again.
- <ESC> to cancel the configuration. This opens the main menu.

The Modbus factory setting is: 19200 8 E 1.

7.2 COM Server

7.2.1 General

The COM server makes the PV inverter data available via an Ethernet network. A software application can communicate with the PV inverter via the network using a virtual COM port (this needs to be installed on a workstation). The COM server is installed as standard and is used by the AEG service department for remote maintenance purposes. This calls for an appropriate Ethernet network with an Internet connection plus a fixed IP address assignment.

The COM server is located at position A27.

7.2.2 Network Connection

This COM server has an IEEE 802.3-compatible network connection on a shielded RJ45 plug connector. Its assignment corresponds to that of an MDI interface, which means the connection to the hub or switch is made using a 1:1 wired patch cable.

Ex-works, the COM server operates in an autonegotiation mode on the network side. This means the data transmission speed and the duplex process are automatically negotiated with the connected switch or hub and are set accordingly.

7.2.3 Structure of the COM Server

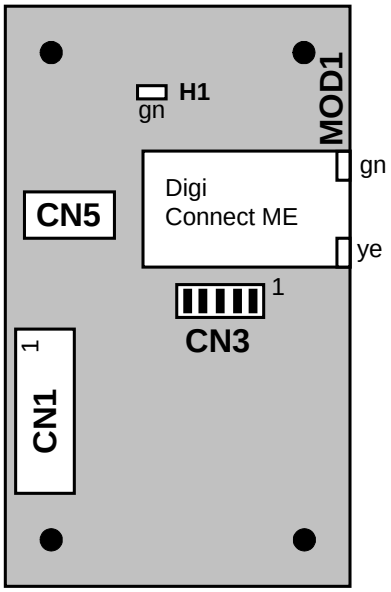


Figure 22 COM server interface (top view)

Connections:

CN1: Internal inverter bus and power supply

MOD1: Ethernet connection

CN5: Interface for firmware update

Configuration jumpers:

CN3: All closed (default)

LED signals:

Green LED (H1):

The green LED on the assembly indicates the global status of the assembly. The following signals are possible:

LED	Jumper	Meaning
Flashing	CN3	Start-up/error
On	CN3	Ready
Flickering	CN3	Ethernet ⇔ CAN communication

Green network LED (MOD1):

The green LED indicates communication on the network.

Yellow network LED (MOD1):

The yellow LED remains on permanently if an Ethernet network is connected.

7.2.4 Installation of the COM Server

The COM server uses a communication module from Digi ("Digi Connect ME"). In order to communicate via the COM server, it must be integrated into the network and a virtual COM port must be set up on a computer. The "Digi Device Discovery" tool and a Digi RealPort driver are required for this purpose. You can find these tools at www.digi.com/support or at www.aegps.com.

Network factory settings for the COM server:

IP address: 10.10.10.0

Subnet mask: 255.255.0.0

Default gateway: 0.0.0.0

7.2.5 Network Integration Configuration

For network integration, you will need a free IP address for the COM server, the subnet mask plus the IP address for the gateway. This information can be obtained from your administrator if necessary.

- Start the "Digi Device Discovery" tool.
- The tool searches the network for Digi modules. The modules found are displayed. If several units are found, please select the unit to be configured using the MAC address. You can find the MAC address on the Digi module sticker on the COM server. If no modules are detected, check your network and your firewall settings, then run the search again using "Refresh view."
- Select the required unit. You can enter the necessary network parameters using the right mouse button + "Configure network settings."
- Use "Save" and "Reboot" to apply the settings and complete the installation.
- Exit the "Digi Device Discovery" tool.
- You can use the "ping" command to test whether the COM server can be reached on the network.

7.2.6 Configuration of the Virtual COM Port

Communication with the COM server takes place via a virtual COM port, which is implemented by means of a RealPort driver. In order to do this, the RealPort driver needs to be installed and configured.

- Start the RealPort driver installation process. For this purpose, the COM server must be connected to the network and the network parameters must be set.
- The installation program searches the network for Digi modules. The modules found are displayed along with the configured IP address and MAC address. If several units are found, please select the unit to be configured using the MAC address and select "Next." The MAC address can be found on the Digi module sticker on the COM server. If no modules are detected, check your network and your firewall settings, then run the search again using "Refresh view."
- In the "Describe the Device" window, you can make RealPort settings. This is where you need to select the COM port through which the application is to communicate later. All other settings can be left as per the factory settings.
- Select "Finish" to complete the installation.

The application can communicate via the set COMx port with a baud rate of 115.2 kB as standard; 9600 kB is also possible as an alternative. Between these two transmission rates, the COM server has an autobaud detection function.

7.3 Remote Signaling

The remote signaling board is a contact interface for signaling PV messages and controlling PV units. It is supplied as an option for the AEG PV system and is intended for installation in the PV unit. The remote signaling master board consists of 5 potential-free signaling contacts and one control input.

There is an independent 24 VDC power supply for the control input. The control signal is activated by bridging the relevant input. There is no need for an additional auxiliary power supply.

The signals are assigned as standard or can be configured on a customer-specific basis. An integrated service switch enables maintenance work on the unit to be signaled.

Technical data:

The maximum load for the signaling contacts (X3/X4) is 500 V/8 A AC or 50 V/2 A DC.

I	If the specified power has been applied to the relay contacts once, those contacts can no longer reliably switch an extra-low voltage (evaporation of the gold alloy).

The control input (X5) has an independent 24 VDC power supply. The input is activated via a bridge.

Structure:

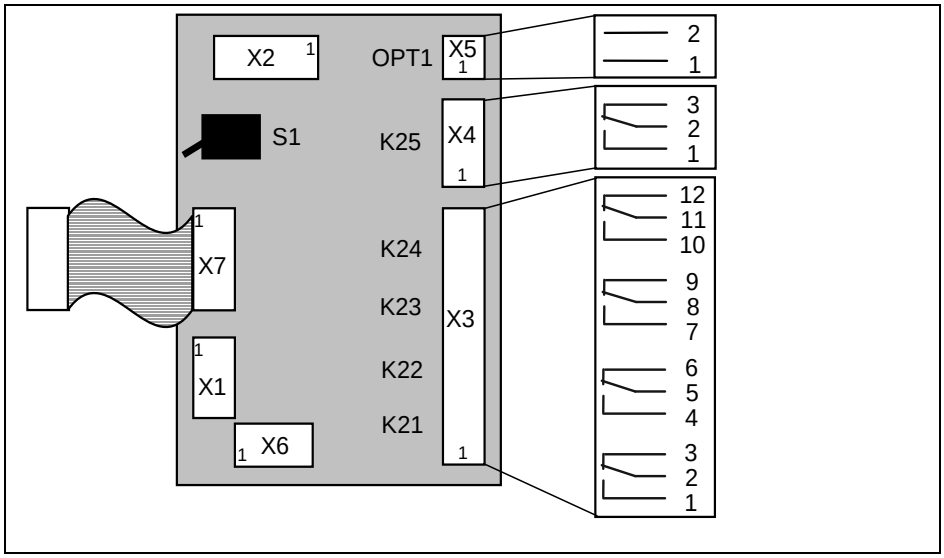


Figure 23 Remote signaling master module A12 (top view)

X1: Power supply connection

X2: Connection for remote signaling expansion boards

X3/X4: Remote signaling outputs with relay changeover switches

X5: Remote signaling input via optocoupler with independent power supply

X6: Service plug

X7: Connection to MultiCom interface

S1: Service switch

X3: When a signal is received, the contact between the two contact points with the lower numbers is closed (normally open or "NO").

X4: When a signal is received, the contact between the two contact points with the lower numbers is open (normally closed or "NC").

X5: The control signal is active when the input is bridged (normally open). The inverter is switched off.

The following default signals are used for remote signaling:

X3.1-2 3	Inverter feed operation	(NO)
X3.4-5 6	DC distribution signal*	(NO)
X3.7-8 9	AC distribution signal*	(NO)
X3.10-11 12	Incoming power supply fault	(NO)
X4.1 2-3	Inverter fault*	(NC)
X5.1-2	Inverter remote switch-off	(NO)

*): Collective signals that contain all messages and faults

Figure 23 shows the normally closed contact in the state that applies when the signal is not active (normally open) or the voltage is zero.

The service switch enables maintenance work on the unit to be signaled to the MultiCom interface using various protocols.

8 Graphical Display and Operation Unit

8.1 General Information

The graphical **D**isplay and **O**peration **U**nit (DOU) is integrated into the front of the solar inverter. It is used to signal and visualize unit data and to control the inverter system. The DOU consists of a display unit with 3 LEDs, a graphical LCD and an operating panel with 5 keys.

The global unit status can be read from the LEDs (1). An acoustic signal generator stresses the urgency of critical system statuses.

The graphical LCD shows equipment statuses and measured values using symbols and plain text. You can control and parameterize the unit using menus which are protected by a password.

The DOU is operated using 4 display keys, to which alternating functions are assigned, and one ENTER key. The key functions that are currently active are shown on the LCD in the form of symbols.

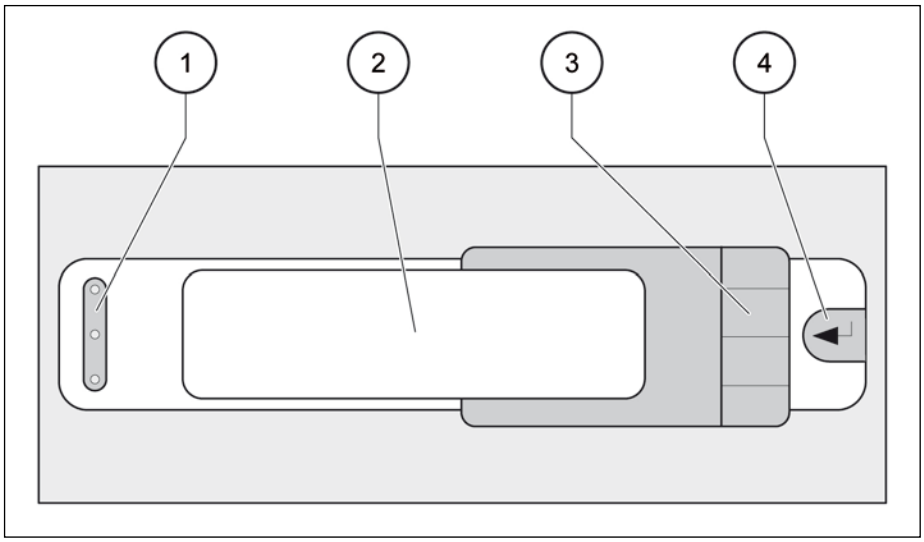


Figure 24 DOU

1 LEDs: Red, yellow, green (from top to bottom)
2 Graphical display (LCD)
3 4 general function keys
4 ENTER key

8.1.1 Signaling

LEDs:

Red, ON:	Deactivating fault (must be acknowledged via the menu)
Red, flashing:	Self-acknowledging deactivating fault
Yellow, flashing:	Self-acknowledging message
Green, OFF:	INV in sleep mode
Green, flashing (1Hz):	INV waiting for feed conditions
Green, flashing (0.5 Hz):	INV feeding into grid with derating
Green, ON:	INV feeding into grid

Acoustic signal generator:

Signal generator ON: Urgent message and equipment fault

8.1.2 Keyboard Operation

You can use the ENTER key to open and close submenus and to acknowledge control functions and parameters.

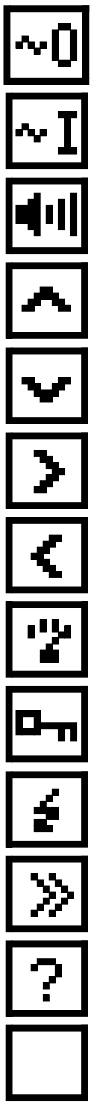
The 4 display keys are assigned to different functions. The key functions that are currently active are represented as symbols which can be found in a small framed area on the right-hand side of the LCD.

In the "Operating display" and "Inverter" menus, you can switch the inverter on and off using the general keys. The keyboard symbols in the menu indicate the control function which is currently available. If a switch-off procedure has been initiated, you must confirm it by means of a security prompt in order to avoid inadvertent switching off. The general control system of the inverter can be blocked and protected with a password.

If a unit fault occurs, refer to the "Inverter" menu, where the cause is specified. After eliminating the cause, acknowledge the fault in the menu. You can then switch the individual converters back on again.

You can acknowledge the acoustic signal generator using the keyboard. On the LCD operating display, you will find a special acknowledgement key for this purpose, which is represented by a loudspeaker symbol. In all other menus, you can press any key (even a key to which no functions have been assigned) to acknowledge the generator. If the number of messages or faults increases, the acknowledgement is cancelled. You can impose a general block that inhibits the acoustic signal generator in the event of a fault and inhibits the clicking sound when you press a key.

Possible keyboard symbols and their function:



Switch off inverter

Switch on inverter

Acknowledge acoustic signal generator

Cursor up/Increase value/Scroll upwards

Cursor down/Decrease value/Scroll downwards

Cursor to the right

Cursor to the left

Status/Measured values menu

System is blocked

Acknowledge fault

Select day/month/year curve

Help menu

No function

Figure 24a Keyboard symbols

8.2 Start-up

Following the **power-up reset**, the DOU performs a self-test. Data is read from the inverter once the test has been completed successfully. The LEDs light up in sequence during this phase. A start screen appears on the LCD and a status bar indicates the duration of the start-up process.

When you **start up the DOU for the first time** (commissioning), select the menu language using the general keys "<" and ">". The languages are indicated using their respective country-specific abbreviation (the same as those found on car number plates). The language that is currently selected is displayed on a black background. Once you have confirmed the selected language by pressing the ENTER key, the next menu opens. In order to comply with international requirements, all of the displays up to the one for language selection are displayed in English.

8.3 Menu Structure

8.3.1 Menu Tree

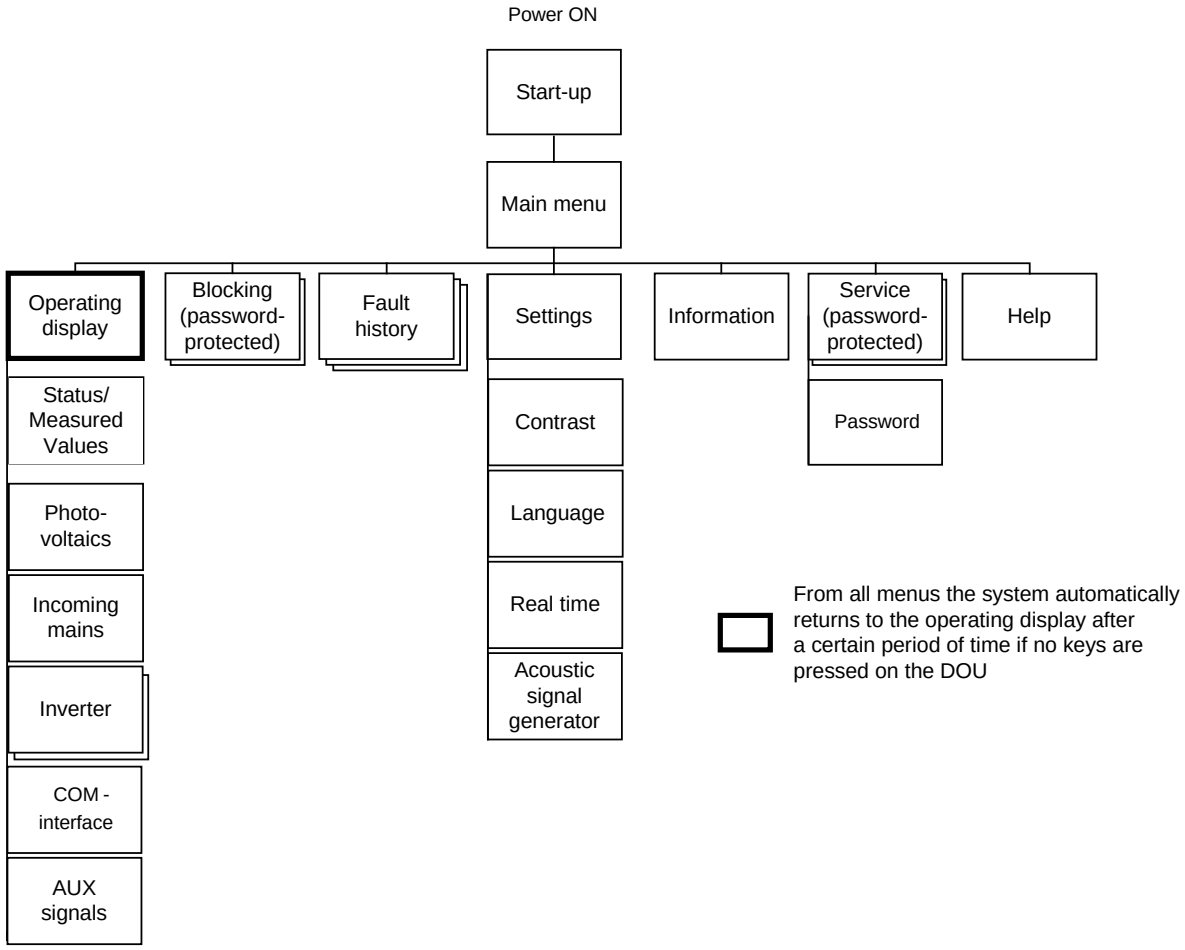


Figure 25 Menu tree

8.3.2 Main Menu

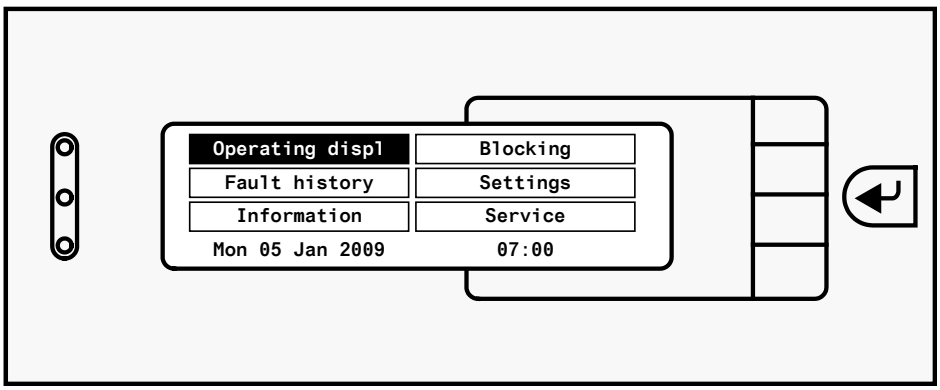


Figure 26 Main menu

After start-up, the "Main menu" represents the highest menu level, which means that you can open further submenus from here, and you can always return to this level.

The "Main menu" has the typical menu structure.

Additional submenus are displayed on the left-hand side. All selectable submenus are displayed in a frame. A black background indicates the current cursor position. The bottom line displays the current real time, which can be adjusted using the "Settings" menu.

On the right-hand side, the current key function is represented as a symbol which is displayed in a small framed area. You can move the cursor using the "<" and ">" keys to select the corresponding submenu. Use the ENTER key to activate a selected submenu. Using the "?" key, you can call up the "Help" menu, which describes all the various keyboard symbols.

8.3.3 Operating Display

You can call up the "Operating display" from the main menu. If the DOU has not been used for some time, the system automatically switches back to the operating display, no matter which menu it is in.

The LCD background illumination is switched off if no further operations are carried out and the system is not in an abnormal status. In the event of a unit fault, the background illumination remains switched on until the fault is acknowledged. If the inverter is in night mode, the content of the LCD is cleared and "Sleep mode" is displayed instead. The background illumination is also switched off.

You can reactivate the DOU by pressing any key.

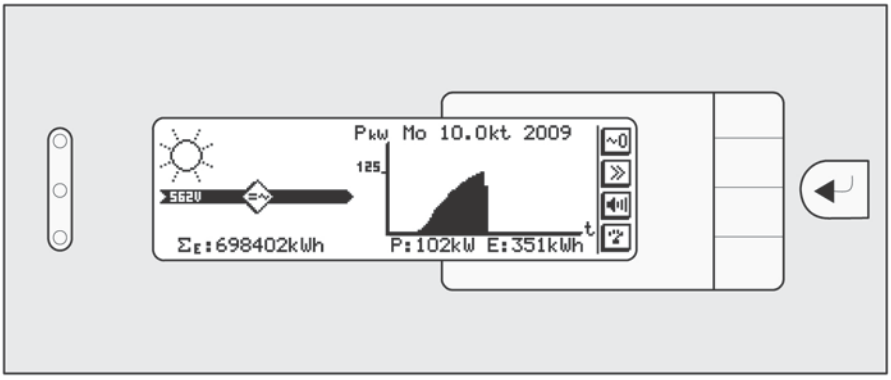


Figure 27 Operating display – Normal operation

The "Operating display" consists of 3 parts:

The left-hand side shows the current global unit status:

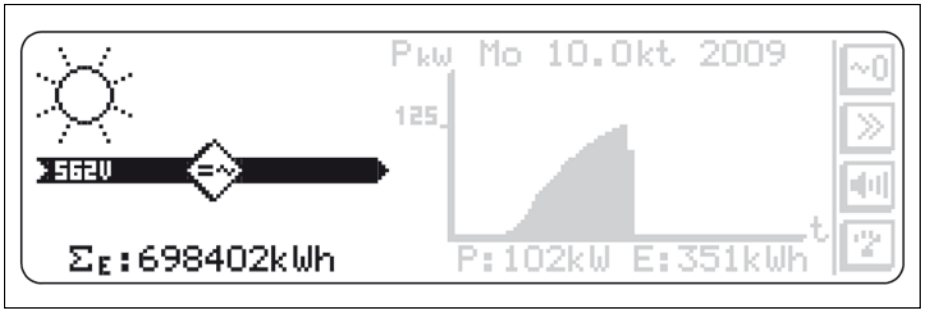


Figure 28 Operating display – Left-hand side

At the top, a sun symbol indicates the current solar radiation trend. If the sun is black or a moon symbol is displayed, the PV voltage is so low that the inverter is in its idle state. An empty sun with no rays also indicates that the PV voltage is still too low, with the inverter in standby mode.

The inverter is represented in the middle of the left-hand section. If a fault occurs or a message is present, the corresponding symbols flash on the inverter. The bar on the left shows the PV voltage as a symbol and a digital value. If the bar is completely filled in, this indicates that sufficient PV voltage is present. The bar on the right shows the inverter status. If the inverter is feeding power into the grid, the bar is filled in.

The total energy fed in is shown at the bottom of the display.

Examples of possible displays:

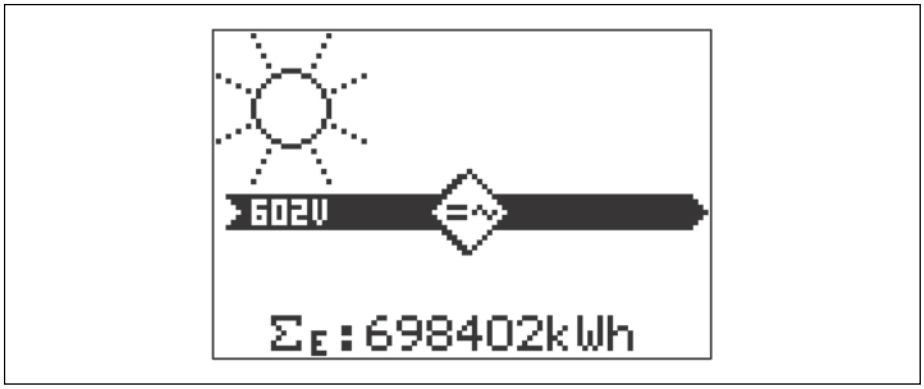


Figure 29 Example of operating display

The equipment is in its normal state, the inverter is feeding power into the grid.

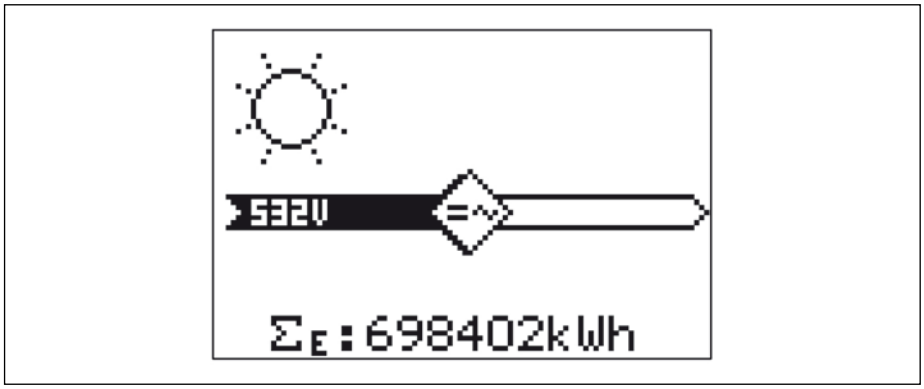


Figure 30 Example of operating display

Solar radiation is sufficient, the inverter is switched off. If the sine symbol on the inverter is flashing, the inverter has been switched off due to a fault or it is currently in the synchronization phase.

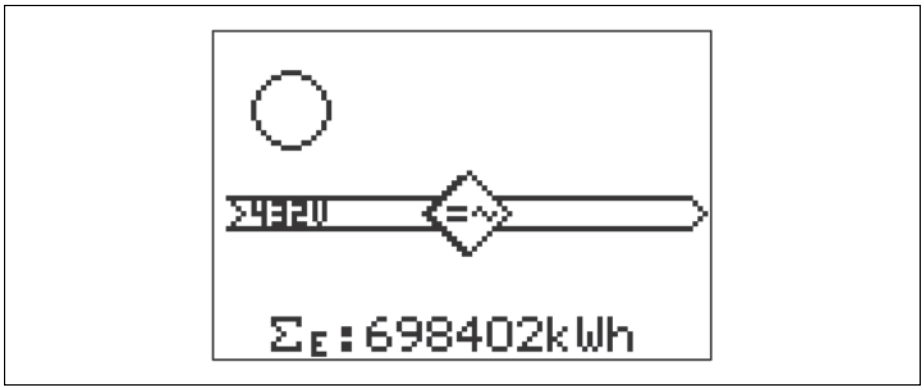


Figure 31 Example of operating display

Solar radiation is too low, the inverter is in standby mode.

Figure 32 Example of operating display

Solar radiation is too low, the inverter is in its idle state.

The middle section displays the unit's most important infeed values in the form of digital values and a graph covering a certain period of time. The current daily data is shown as standard. This display appears automatically if no keys have been pressed for 1 minute.

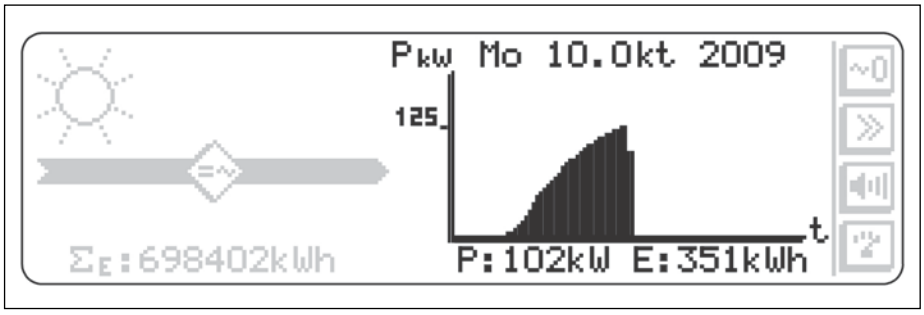


Figure 33 Operating display – Middle section

You can use the double arrow key to select the infeed periods below.

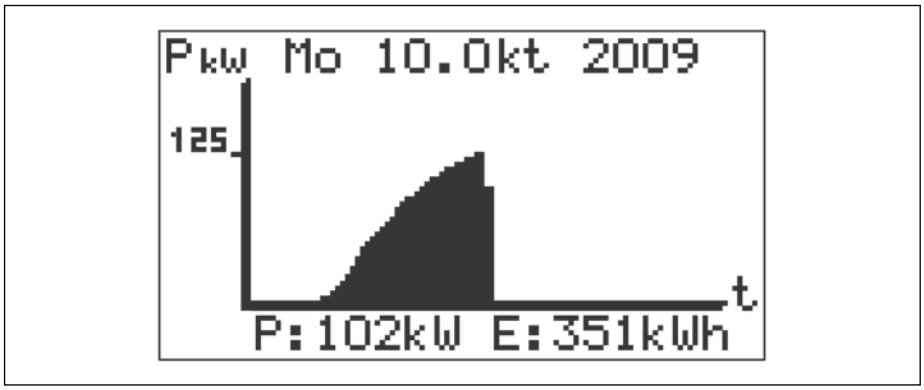


Figure 34 Example of daily data

Daily data for the current day, previous day
(t = 00:00 – 04:00, 15 minute intervals)

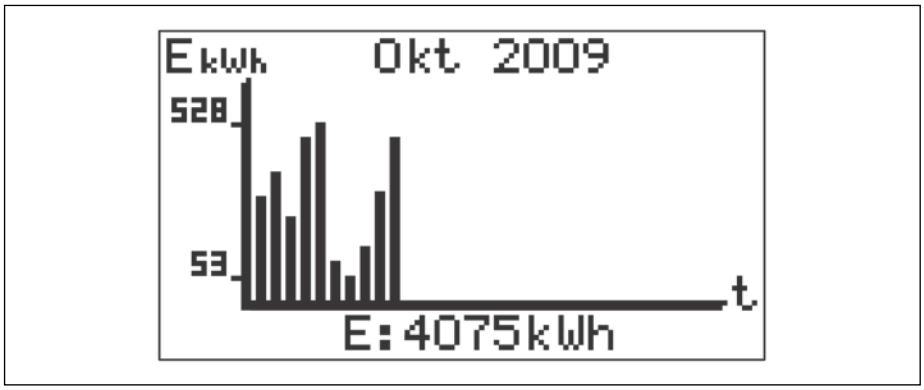


Figure 35 Example of monthly data

Monthly data (t = day 1 – 31) for the last 12 months

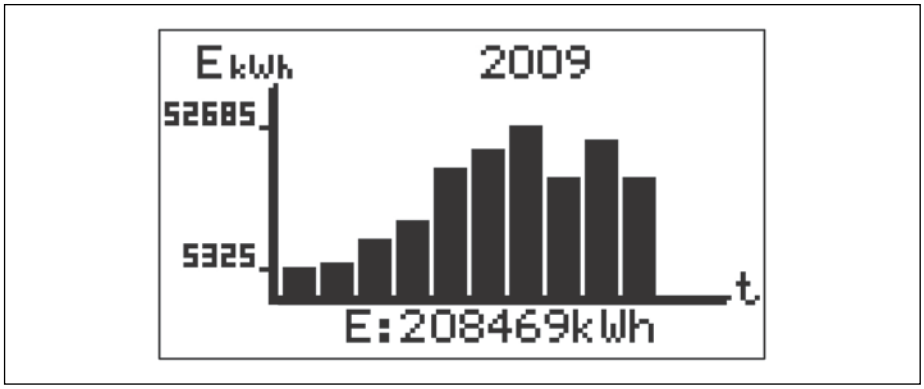


Figure 36 Example of yearly data

Current yearly data (t = month 1 – 12)

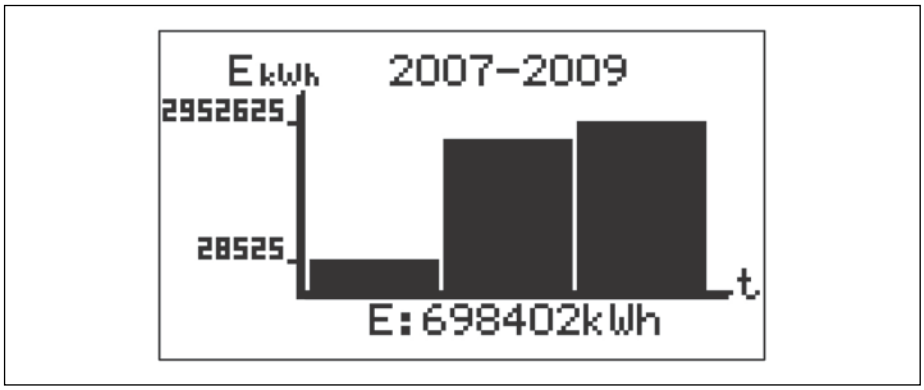


Figure 37 Example of yearly overview

Yearly overview
(t = year of start-up to current year)

The right-hand side shows how the key is currently assigned.

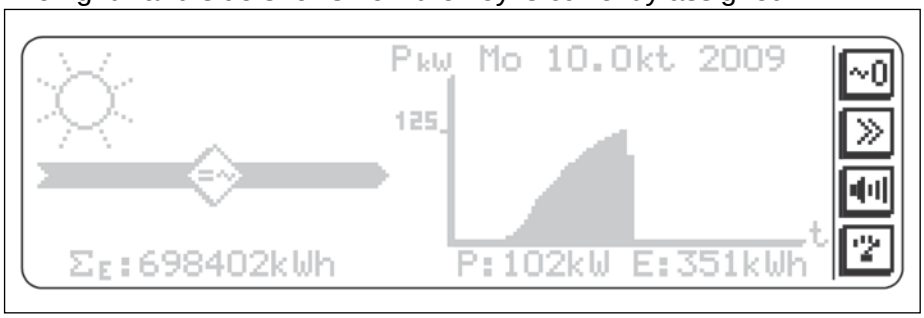


Figure 38 Operating display – Right-hand side

Here you can switch the inverter on or off, depending on the unit status. If the operation has been blocked, this is indicated here via a key symbol. If a blank button is shown here, a fault is present. The flashing measured values menu then takes you to the inverter menu, where detailed information can be found on the fault and where you have to acknowledge it.

You can use the double arrow key to select the different display types for the energy data logger.
Current day (default) -> Previous day -> Monthly overview -> Current yearly overview -> Yearly overview

If messages have been output or faults have occurred, you can acknowledge the acoustic signal generator here; otherwise, this key is not assigned.

Use the bottom key with the measuring instrument symbol to call up menus with detailed information on the status and the measured values. This key flashes in the event of a fault in the unit, enabling you to access menus containing additional fault information directly.

8.3.4 Status/Measured Values

You can call up the "Status/data" menu from the operating display using the bottom key with the measuring instrument symbol.
Here you can use the "<", ">", "^" and ENTER keys to open the submenus containing the statuses and measured values for the individual unit components.
Press the ENTER key to return to the Status/data menu.

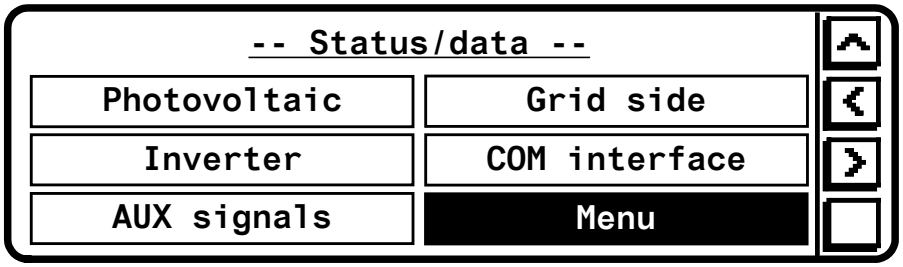


Figure 39 Menu: Status/data

You can use the "Photovoltaic" menu item to display the measured values for the panels. Any faults in the DC distribution are shown here too.

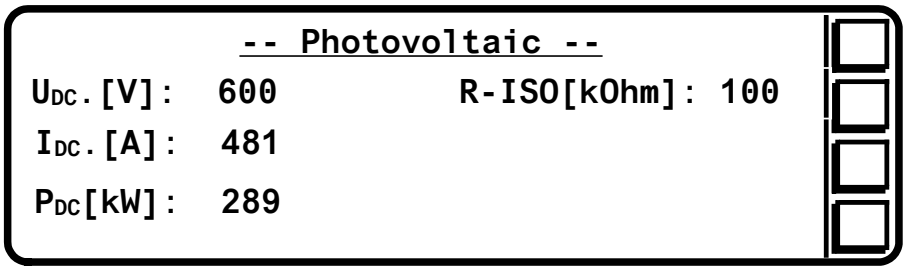


Figure 40 Photovoltaic menu

You can use the "Grid side" menu item to display the measured values for the incoming power supply. Any lir[kohm] faults in the AC distribution are shown here too.

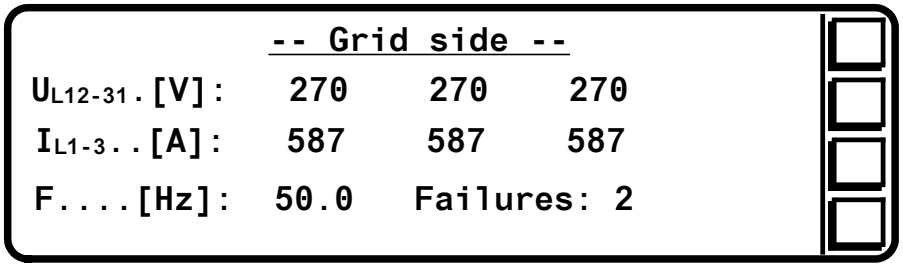


Figure 41 Menu: Grid side

You can use the "Inverter" menu item to display the statuses and measured values for the inverter. You can toggle between the two menus using the ">" and "<" keys.
In normal operation, the inverter can be switched on and off here, using the top key. In the event of a deactivating fault, you can call up a detailed description of the fault here. Once the fault has been rectified, you will need to acknowledge it using the top key. A high-voltage symbol "ϟ" will then appear on the top key.

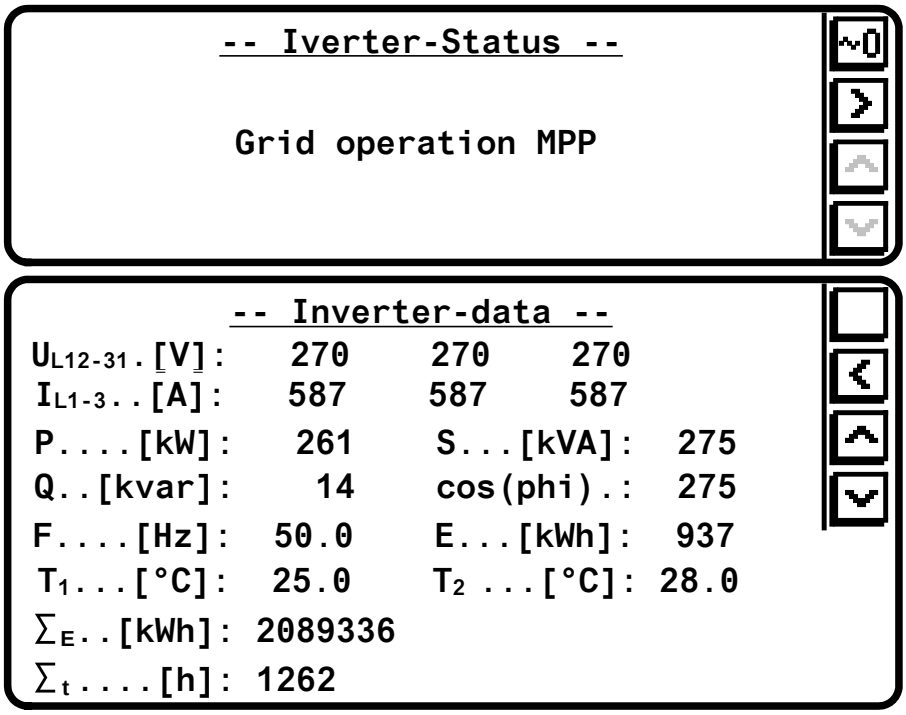


Figure 42 Menu: Inverter

The voltage and current of the three phases are displayed as measured values. The power values P, S, Q and cos-phi appear underneath these voltages and currents.

These are then followed by the frequency F and the daily energy E.

The ambient temperature of cabinet T1 and the supply air temperature of inverter stack T2 are shown as the temperatures.

Next come the total energy counter ∑E and the inverter operating hours counter ∑t.

You can scroll through the measured values using the "v" and "^" keys.

You can use the "COM interface" menu item to look up the statuses of the communication PCBs.

You can use the "AUX signals" menu item to look up the status of optional general signals on the remote signaling board.

8.3.5 Blocking

You can call up the "Blocking" menu from the "Main menu". After you have entered the current password, you can block operation of the inverter (switching ON/OFF and fault acknowledgement). The password must be entered digit by digit and then confirmed by pressing the ENTER key.

The default password set by the factory is: 1201.

In menus where switching operations are normally possible, blocking is indicated by a key.

8.3.6 Fault History

You can call up the "Fault history" menu from the "Main menu". A data logger that records the inverter's fault history is integrated in the inverter unit. You can display the 20 most recent faults as of the current date or as of a specific date.

8.3.7 Settings

You can call up the "Settings" menu from the "Main menu". Here you can set the following parameters in the submenus:
LCD contrast, Language, Real time and Acoustic signal generator for indicating faults and keyboard operation.

8.3.8 Information

You can call up the "Information" menu from the "Main menu". Using this menu, you can call up information about the unit type, the firmware versions and the available communication options.

8.3.9 Service

You can call up the password-protected "Service" menu from the "Main menu". The password must be entered digit by digit and then confirmed by pressing the ENTER key.

The default password set by the factory is: 1201.

Once the current password has been entered, you can select a submenu where you can change the DOU password.

- In the "**Password**" menu, you can set the password for blocking operation and for setting parameters. A range of 0000 to 9999 is possible.

I	Keep the password secure. If you have forgotten the password, the DOU will need to be reset at the customer's expense.

8.3.10 Help

You can call up the "Help" menu from the "Main menu" using the "?" key. This enables you to look up the meaning of the keyboard symbols.