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AEG

Power supply systems

Uninterruptible Power Supply UPS Protect 5. 31/xxx-S05 10 kVA – 120 kVA

AEG Power Supply Systems GmbH
Department: PSS AE
Name: Schenuit/Schöpe
Revision: 03
Date: 03.04.2008

Operating Instructions
8000016206 BAL, en

Notes on these Operating Instructions

Duty to provide information

These operating instructions must be read carefully by all persons working with or on the UPS prior to installation and initial start-up.

These operating instructions are a composite part of the UPS.

The owner of this unit is obliged to communicate the full content of these operating instructions to all personnel transporting or starting the UPS or performing maintenance or any other work on this unit.

Validity

These operating instructions comply with the current technical specifications of the UPS at the time of publication. The contents do not constitute a subject matter of the contract, but serve for information purposes only.

AEG Power Supply Systems GmbH reserves the right to make modifications with regard to the content and technical data in these operating instructions without prior notice. AEG Power Supply Systems GmbH cannot be held liable for any inaccuracies or inapplicable information in these operating instructions, as no obligation to continuously update the data and maintain their validity has been entered into.

Warranty

Our goods and services are subject to the general conditions of supply for products of the electrical industry, and our general sales conditions. We reserve the right to alter any specifications given in these operating instructions, especially with regard to technical data, operation, dimensions and weights. Claims in connection with supplied goods must be submitted within one week of receipt, along with the packing slip. Subsequent claims cannot be considered.

AEG Power Supply Systems GmbH will rescind all obligations such as warranty agreements, service contracts, etc. entered into by AEG Power Supply Systems GmbH or its representatives without prior notice if maintenance and repair work is carried out using anything other than original AEG Power Supply Systems GmbH spare parts or spare parts purchased from AEG Power Supply Systems GmbH.

Handling

These operating instructions for the UPS are structured so that all work necessary for start-up, maintenance and repair of the unit can be performed by qualified 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, it is highlighted accordingly by pictograms explained in Chapter 1, Safety Regulations.

Abbreviations

The following abbreviations are used in these instructions:

DOU	=	Graphical Display and Operation Unit
SBS	=	Static Bypass Switch
REC	=	Rectifier
INV	=	Inverter

Hotline

Do you have any suggestions for improving these operating instructions?

Do you have any questions on any of the subjects dealt with in these operating instructions?

Our service department is available on the hotline number given below:

AEG Power Supply Systems GmbH
Emil-Siepmann-Straße 32
D-59581 Warstein
Germany

☎ +49 (2902) 763 100
FAX: +49 (2902) 763 645
E-mail: Service-Be.aegpss@powersupplysystems.com

http://www.aegpss.de

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Table of Contents

1 Safety Regulations

1.1 Important Instructions and Explanations

The instructions for operation and maintenance, as well as the following safety regulations must be complied with to ensure the safety of personnel as well as the continued availability of the unit. All personnel installing/dismantling, starting up, operating or servicing the units must be familiar with and observe these safety regulations. Only trained and qualified personnel may perform the work described, using tools, equipment, test equipment and materials intended for the purpose and in perfect working condition.

Important instructions are highlighted by **"CAUTION:"**, **"ATTENTION:"**, **"NOTE:"** and indented text.

CAUTION:
This symbol identifies all working and operational procedures requiring absolute compliance to avoid any danger to persons.

ATTENTION:
This symbol identifies all working and operational procedures requiring absolute compliance to prevent any damage, irreparable or otherwise, to the UPS or its components.

NOTE:
This symbol identifies technical requirements and additional information requiring the operator's attention.

This document includes brief instructions which describe the function and start-up of the UPS.

These instructions must be glued to the free area on the inside of the unit door.

1.2 Accident Prevention Regulations

Compliance with the accident prevention regulations valid in the respective country of use and the general safety regulations in accordance with IEC 364 is mandatory.

The following safety instructions must be observed prior to any work on the UPS:

- **Disconnect the unit from the power supply.**
- **Secure against reclosing.**
- **Verify that the unit is disconnected from the power supply.**
- **Earth and short circuit the unit.**
- **Provide protection by covers or barriers for any neighbouring live parts.**

1.3 Danger during Maintenance and Repair Work

CAUTION:
The voltage applied to the UPS can be fatal. Prior to start-up and/or maintenance work always **disconnect** the UPS **from the power supply** and secure the unit **against reclosing.** The capacitors must be discharged. Free-standing and movable components can protrude into the work area and cause injuries.

ATTENTION:
Considerable damage can be caused to equipment if **unsuitable spare parts** are used during repair work, if work is carried out by unauthorised personnel, or the safety regulations are not observed.

NOTE:
Only trained and qualified personnel (refer to Chapter 1.5) may work on or around the UPS while **strictly observing** the **safety regulations**.

1.4 Fire Protection

Structure of fireproof enclosures (EN 60950)

If uninterruptible power supply units are installed in rooms with inflammable floors (e.g. textile, wood, PVC) or in computer centres, the floor plate must always be installed. The assembler is responsible for proper installation.

CAUTION:
If smoke is detected or a fire breaks out, immediately disconnect the UPS from the power supply and inform the maintenance personnel.

1.5 Qualified Personnel

The UPS may only be transported, installed, connected, started, serviced and operated by qualified personnel who are familiar with the pertinent safety and installation regulations. All work performed must be inspected by responsible experts.

The qualified personnel must be authorised by the responsible safety officer of the installation to perform the work required.

Qualified personnel is defined as personnel

- having completed training and gained experience in the respective field,
- familiar with the pertinent standards, rules and regulations and accident prevention regulations,
- having received instruction on the mode of operation and operating conditions of the UPS,
- capable of recognising and preventing dangers.

Regulations and definitions for qualified personnel can be found in DIN 57105/VDE 0105, Part 1.

1.6 Safety Awareness

The personnel defined in chapter 1.5 are responsible for safety. They must also ensure that only suitably qualified persons are permitted access to the UPS or the safety area.

The following points must be observed:

All such working procedures are prohibited which are detrimental to the safety of persons and the operation of the UPS **in any way**.

The UPS may only be operated in perfect working condition.

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 unsuitable behaviour and reporting any faults detected to the respective authority or person.

1.7 Application

The UPS may only be used for uninterrupted power supply in the described installation position and operating mode while observing the maximum permissible connection values as specified in these operating instructions. The unit may only be used for this intended purpose. It is not permitted to make any unauthorised modifications to the UPS or to use any spare parts and replacement parts not approved by AEG Power Supply Systems GmbH or to use the UPS for any other purpose.

The person responsible for the installation 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 is informed without delay or that the UPS is shut down immediately in the event of abnormal voltages or noise, high temperatures, vibrations or any similar effects in order to detect the cause.

These operating instructions contain all information required by qualified personnel for operation of the UPS. Additional information and explanations for unqualified persons and for the use of the UPS in non-industrial applications are not included in these operating instructions.

The warranty obligations of the manufacturer are only applicable if these operating instructions are observed and complied with.

1.8 Liability

No liability is accepted if the UPS is used for applications not intended by the manufacturer. Any measures necessary for the prevention of injury or damage to equipment are the responsibility of the owner or user. In the event of any claims in connection with the UPS, please contact us immediately quoting:

- Type designation
- Works number
- Reason for claim
- Period of use
- Ambient conditions
- Operating mode

1.9 Directives

The Protect 5. 31/xxx units comply with the currently applicable DIN and VDE regulations. VBG4 is met on the basis of compliance with VDE 0106, Part 100.

The requirements of VDE 0100, Part 410, "Functional extra-low voltage with safe isolation", have been complied with where applicable.

The CE sign on the unit confirms compliance with the EC outline directives for 72/23 EEC – Low voltage and for 89/339 EEC – Electromagnetic compatibility if the installation and start-up instructions described in these operating instructions are observed.

2 Technical Data

Please refer to the enclosed technical data sheet for optional and unit-specific setting values.

Type kVA		10	20	30	40	60	80	100	120
Rated connection voltages Voltage range in V		3 x 400 V ± 15 %							
Frequency on rectifier input in Hz		45 - 66							
Current consumption at max. battery charge in A		23	43	65	87	133	176	217	259
Current consumption at trickle charge in A		16	35	56	68	100	134	167	200
Rectifier output current I_{AGR} in A		50	95	143	190	280	370	460	550
Intermediate circuit voltage in V (rated voltage)		216 bei 108 Pb-Zellen einsetzbar von 173 bis 260							
Output voltage in V, neutral conductor under full load		230 V optional einstellbar von 220 V - 240 V							
Output current in A		43	87	130	174	261	348	435	522
Output frequency in Hz		50 Hz ± 1 % optional 60 Hz ± 1 %							
THD factor in % at rated load		≤ 3 %							
Overload capacity		1,5 x I_{Nenn} für 1 Minute 1,25 x I_{Nenn} für 10 Minute $I_{Kurzschluß}$ (max) = 3 x I_{Nenn}							
50 % Load	Efficiency in % Power loss in W	82,9 825	84,6 1456	85,1 2101	86,7 2454	86,5 3746	86,9 4837	a/A*	a/A*
75 % Load	Efficiency in % Power loss in W	83,9 1160	83,8 2320	86,3 2857	86,1 3875	86,7 5522	86,9 7236	a/A*	a/A*
100 % Loadt	Efficiency in % Power loss in W	83,2 1615	82,9 3300	86,1 3875	85,0 5647	85,3 8282	85,3 11029	a/A*	a/A*
Dimensions in mm without transport eyelets (IP20) Height Width Depth		1810 600 850	1810 900 850	1810 1200 850	1810 1200 850	1810 1200 850	1810 2100 850	1810 2100 850	1810 2100 850
Weight in kg (ca.)		350	520	800	800	780	a/A*	a/A*	a/A*

Table 1 Technical data of the UPS

3 General Information

One application of Protect 5. 31/xxx systems is to ensure an uninterruptible power supply to computers, IT systems, process control systems and their periphery in production and administration systems.

The Protect 5. 31/xxx range covers a power range of 10 kVA to 80 kVA.

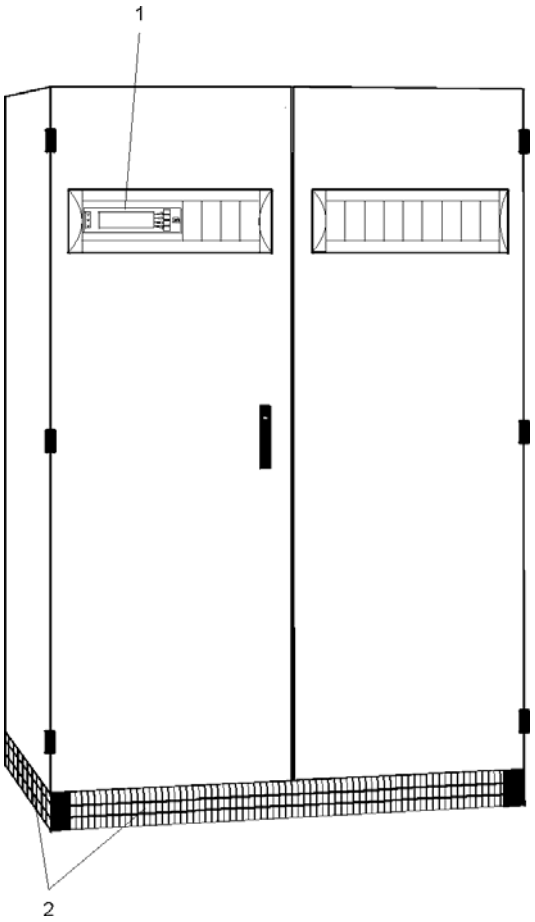


Figure 1 Example model 60 kVA (refer to Chapter 2, Table 1 for dimensions)

1 DOU – display and operation unit

2 Ventilation grids (4x) for each control cabinet

3.1 Technology

Due to the utilisation of electronic high-performance components, the Protect 5. 31/xxx series is suitable for universal applications and has a very high degree of operational reliability as well as optimum efficiency and communication capability with other systems due to integrated interfaces.

The entire control electronics of the UPS is based on the utilisation of state-of-the-art microcomputer assemblies. Logical integration and linking of the various assemblies in the overall system permits specification of the unit properties by unit-related software parameter settings.

The information exchange between the individual modules is carried out using the CAN bus (Controller Area Network). This CAN bus has high interference immunity and is frequently used for industrial applications.

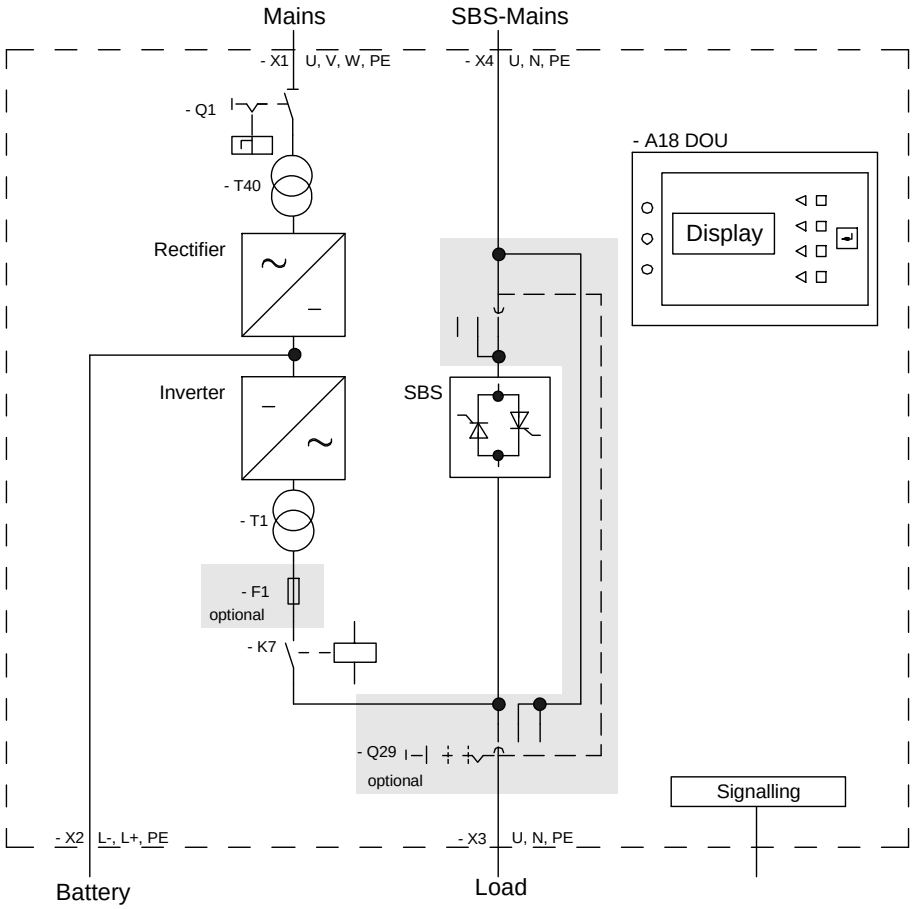


Figure 2 Functional principles of the Protect5.xxx/31

The main components of the UPS are (Figure 2):

Rectifier section with:

- Thyristor stack and control unit
- Transformer
- Smoothing device for the batteries
- Interference suppression devices

Inverter section with:

- Inverter stack and control unit
- Interference suppression devices

Static bypass switch (SBS) with:

- Thyristor stack and control unit
- Interference suppression devices

Figure 2 illustrates the functional principle of the uninterruptible power supply unit.

The rectifier (REC) supplies the inverter and the battery with DC voltage. The inverter (INV) converts this DC voltage into a 1-phase AC voltage.

In the event of a mains fault (such as a power failure), the power supply to the load is maintained from the battery without any interruption.

The supply reliability is further increased by the static bypass switch (SBS), which in the event of an INV fault switches the SBS circuit over to the load circuit without any interruption.

3.2 Operating Elements of the UPS

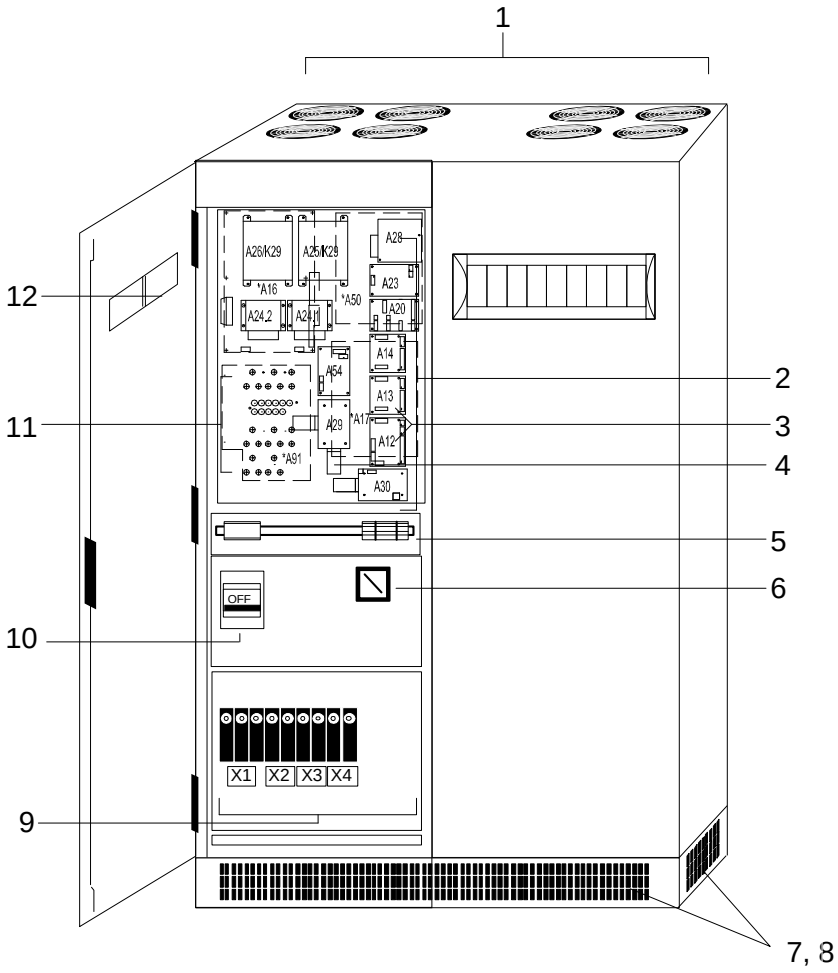


Figure 3 Arrangement of the operating elements, components and individual PCBs with open door

1	Fans
2	Optional PCBs on the control unit pivot plate
3	Remote signalling (master board and expansion board)
4	CAN-COM controller (CCC)
5	Terminal strip X12 (remote signals and options)
6	Q29, manual bypass switch (optional)
7, 8	Ventilation grids
9	Terminals for rectifier and SBS circuits, battery and loads
10	Q1, load interrupter switch for the rectifier circuit
11	Internal fuses for control unit and fan (A91)
12	DOU display and operation unit

4 Transport, Storage and Installation

4.1 Packing

The UPS units are packed at the works to withstand both rail and road transport. The housing is fixed to the transport pallet using four bolts. The unit is packed in plastic film to prevent any damage to the surface paint and protect the unit against moisture.

NOTE:
To prevent damage only remove the protective film from the UPS immediately prior to installation.

The four fixing bolts on the base frame can then be removed using a spanner.

4.2 Crane Transport

CAUTION:
Do not walk under suspended loads!
Always wear protective clothing such as a helmet, safety shoes and work gloves!
Transport the unit with due care and observe the safety regulations!

ATTENTION:
Only transport the UPS in an **upright position**!
Never **tilt** or **cant** it, avoid displacing the centre of gravity!

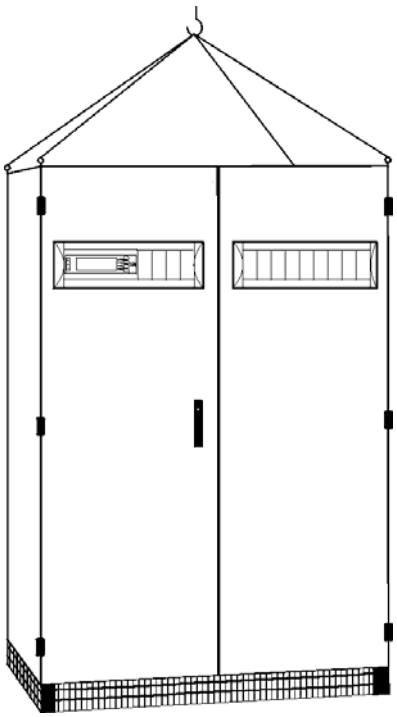


Figure 4 Transporting by crane

The length of the ropes is calculated so that an angle of 45° is given between the rope and the top edge of the cabinet (DIN 580). The minimum load capacity of each rope must be ≥ 0.5 times the weight of the cabinet (DIN 580). The weight of each UPS can be found in Table 1, Chapter 2. One rope must be used for each transport eyelet.

Proceed as follows to transport the unit by crane (Figure 4):

- Insert and tighten the four transport eyelets (not supplied) in the threaded bores provided on top of the cabinet.
- Hook in the four ropes.
- Carefully lift the UPS and transport it to its intended location.
- Lower the UPS carefully without jolting it.
- Remove the ropes and transport eyelets.

4.3 Transporting the Unit using a Forklift or Lowlift Truck

ATTENTION:
Prior to transport with a forklift or lowlift truck, always ensure that the transport devices used for the UPS are designed for the respective weight (refer to Table 1, Chapter 2).

NOTE:
Transport with a forklift or lowlift truck should be avoided whenever possible, especially on construction sites and/or uneven ground.

Always transport by crane when possible!

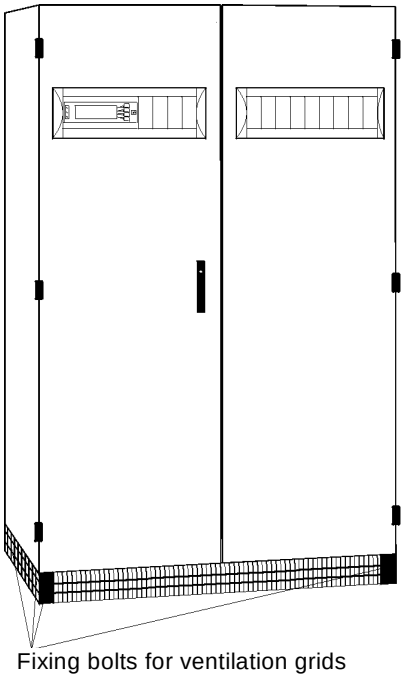
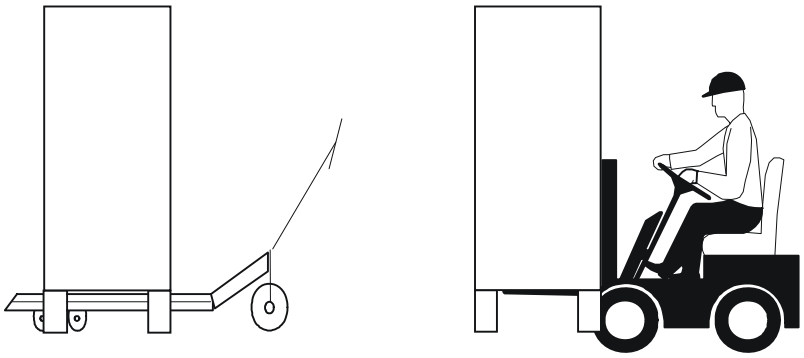


Figure 5 Ventilation grid

Preparation:

Leave the UPS on the transport pallet.



Transport with lowlift truck | Transport with forklift truck

Figure 6 Transport with lowlift and forklift truck

ATTENTION:
Observe the centre of gravity of the unit!

The lifting arms must be
- sufficiently long and
- sufficiently far apart.

Transport the unit as follows:

- Insert the lifting arms between the transport pallet and the UPS.
- Carefully lift the UPS and transport it to its intended location.
- Lower the UPS carefully without jolting it.
- Retract the forklift or lowlift truck.
- Refit the ventilation grids on the UPS using the corresponding fixing bolts.

4.4 Site Requirements

Suitable floor surfaces for installation of the UPS are:

- Double floors
- Above cable ducts or
- directly on a level surface.

Ensure that the weight of the UPS units does not exceed the maximum floor bearing capacity (refer to Table 1, Chapter 2).

The site must also meet the following requirements:

- be free of conductive dust,
- be free of corrosive or acid fumes,
- the intake air temperature of the unit must not exceed 35 °C, and
- the air vents of the UPS must not be obstructed by any constructional features or other measures.

UPS units are suitable for installation in confined spaces. Ensure that a min. space of 1000 mm is provided in front of the unit to ensure an escape route, and a space of 400 mm above the unit to guarantee unobstructed air venting.

ATTENTION:
The waste heat of the UPS must be dissipated!

The ventilation of the battery compartments must be carried out in accordance with DIN/VDE 0510, Part 2. The following general rule is applicable for ventilation requirements (for lead-acid batteries):

$Q = 0.05 \times n \times I / 2$

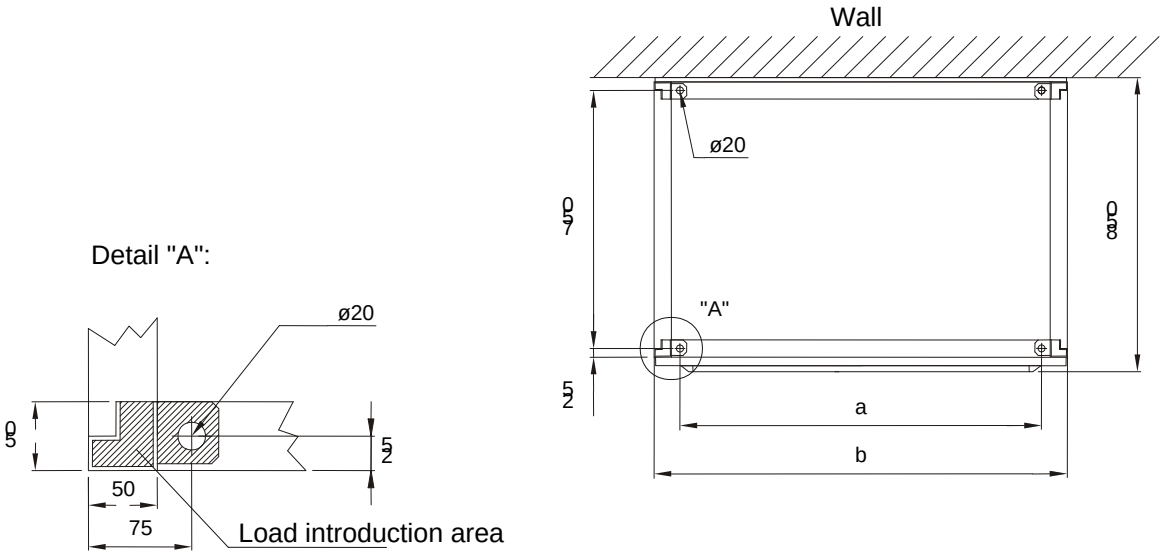
with: Q = air volume in m^3/h
n = number of lead-acid cells
I = amperage

The ambient temperature in the battery compartment should not exceed 20 °C, as the service life of the batteries is otherwise considerably reduced.

4.5 Floor Mounting

Four holes are provided in the base frame of the UPS for the fixing bolts. The spacing and diameter of the bores can be found in the table below.

Before securing the UPS to the floor, ensure that it is vertically aligned, and compensate for any unevenness (e.g. using metal wedges).



Type rating in kVA	10	20	30/40	60	80/100/120 Cubicle 1	80/100/120 Cubicle 2
a in mm	450	750	1050	1050	750	1050
b in mm	600	900	1200	1200	900	1200

Figure 7 Dimensions for floor mounting

4.6 Storage

UPS units may only be stored for a maximum period of six months in the original packaging in dry, ventilated rooms with a permanent roof. The permissible ambient temperature range is between -35 °C and +70 °C with a relative humidity of ≤ 85%.

If the unit is stored for longer than six months, conventional desiccants must be added and the UPS units must be sealed in airtight plastic film.

Please refer to the respective manufacturer's instructions for storage instructions for the batteries.

5 Function

5.1 Operating Modes

Four different operating modes are possible:

- Operation with mains power supply
- Operation with faulty mains supply
- Operation with defective inverter, and
- operation with manual bypass.

5.1.1 Operation with Mains Power Supply

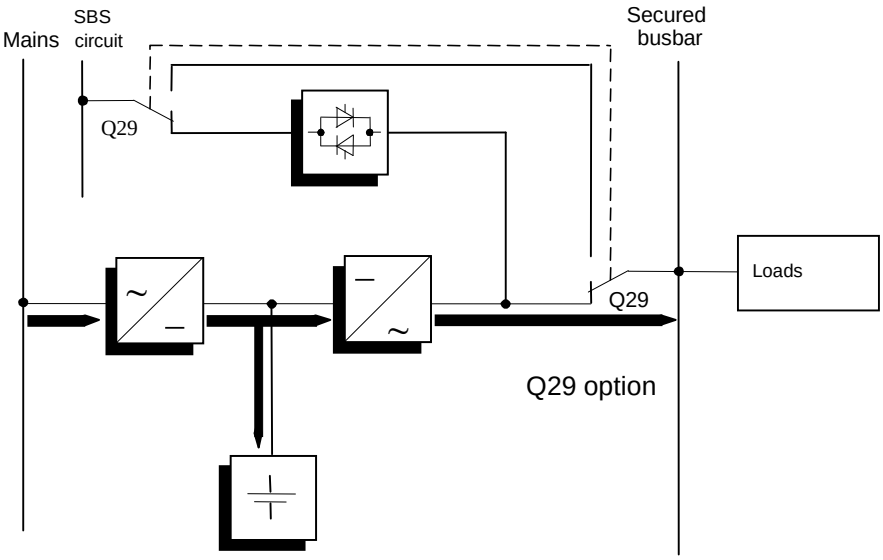


Figure 8 Power circuit with mains supply

The rectifier is powered from the mains and converts the AC voltage statically into a stabilised DC voltage. This DC voltage serves for charging and automatic trickle charging of the connected battery, which is always charged as a result.

The inverter converts this secured DC voltage into a stabilised sinusoidal AC voltage and powers the connected loads.

5.1.2 Operation with Faulty Mains Supply

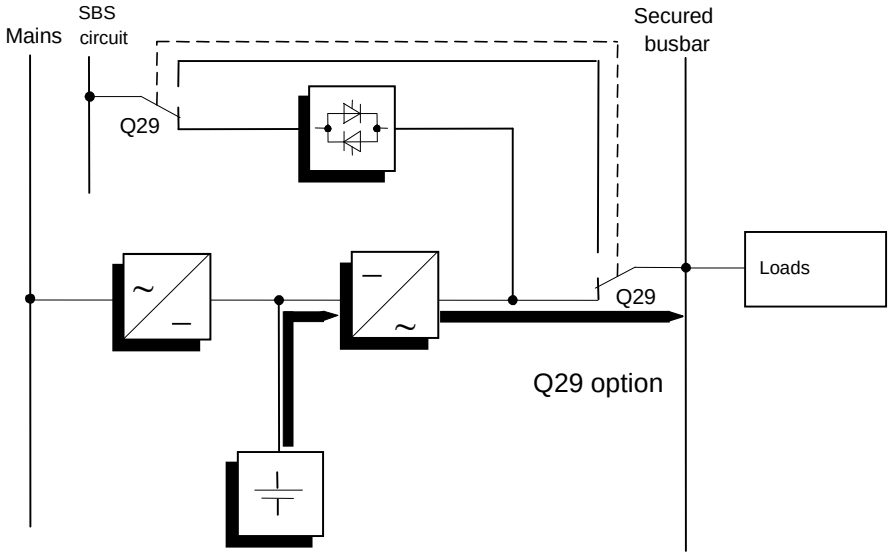


Figure 9 Power circuit with a faulty mains supply

The mains does not sufficiently maintain the supply of the rectifier of the UPS system. In this case, power is supplied to the inverter from the charged battery without interruption. The power supply to the loads is therefore also ensured in the event of a mains failure.
The standby time is limited by the extent to which the batteries are discharged and is primarily determined by the battery capacity.

The inverter only switches off when the battery voltage drops below the permissible value.

When the voltage and frequency are within the tolerance range once more after the mains supply has been restored, the rectifier switches back on automatically. It then resumes the voltage supply to the inverter and the charging of the battery.

5.1.3 Operation with a Faulty Inverter

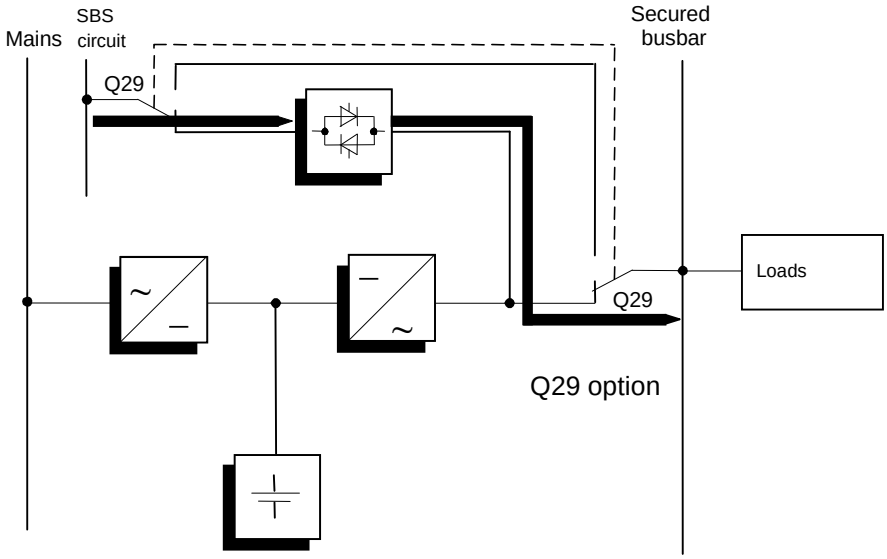


Figure 10 Power circuit with a faulty inverter

If an inverter is defective, power is supplied to the loads by the SBS circuit.

The SBS is an electronic switching device between the load and the mains. The synchronisation unit in the SBS ensures that the frequency and phases of the inverter voltage are synchronised with the mains.

5.1.4 Operation with Manual Bypass

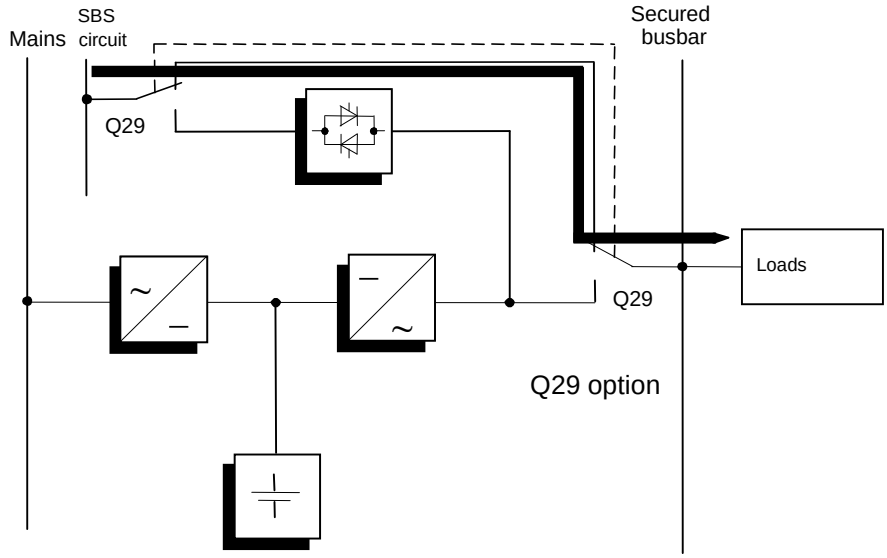


Figure 11 Power circuit with manual bypass

The manual bypass enables maintenance and service personnel to perform work on the UPS without having to switch off the load circuit.

ATTENTION:
The manual bypass switch **Q29** may only be actuated when the inverter is switched off.
In the event of a mains supply failure in manual bypass mode, the load supply fails.

5.2 Function of the Circuit Breakers

Load interrupter switch Q1:

The rectifier is switched over to the REC circuit using load interrupter switch Q1 (Figure 2). The open-circuit shunt release of Q1 reacts in the event of a fault (e.g. short circuit) so that the rectifier is isolated from the REC circuit.

In the event of maintenance and/or service work, the rectifier can be disconnected from the power supply with Q1 and by opening the battery isolator (external).

Manual bypass switch Q29 (option)

Switch Q29 (Figure 2) is located externally to fully disconnect the UPS. It can, however, also be installed in the unit as an alternative. It permits switchover of the loads to the mains input of the SBS without interruption. This switchover is only permitted if the inverter has been switched off and the SBS activated
(see also Chapter 5.1.4 Operation with Manual Bypass).

NOTE:
The Protect 5. 31/xxx works setting of Q29 (option) is **"1"**, i.e. not activated. This setting is for normal UPS operation.

Inverter output contactor K7:

Inverter output contactor K7 (Figure 2) switches the output voltage of the inverter to the load output.

5.3 Static Bypass Switch (SBS)

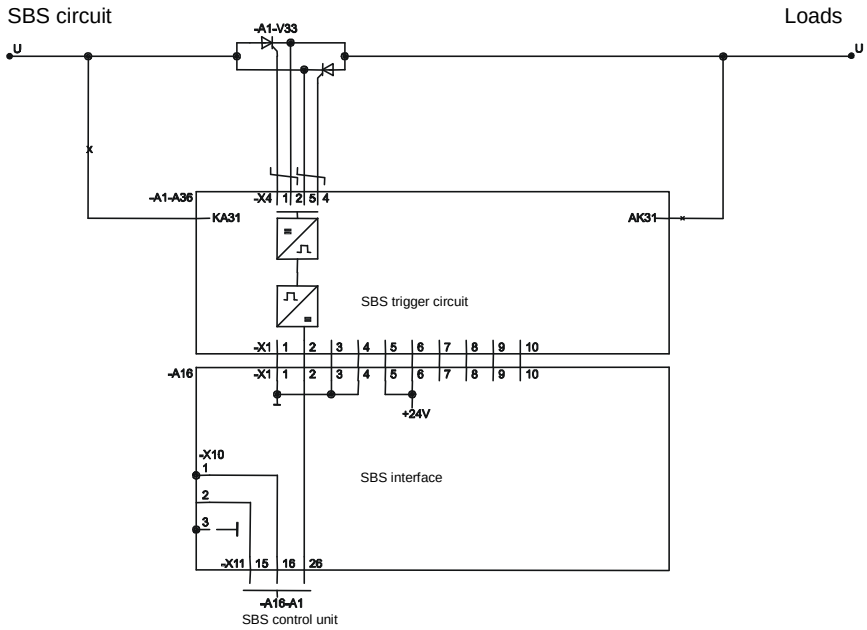


Figure 12 Functional principle of the SBS control unit

The SBS control unit monitors the voltages of the load circuit and the SBS incoming mains and, in the event of an overload or inverter fault, initiates switchover of the load to the SBS circuit without interruption (providing the SBS circuit is in the permitted tolerance range). The load circuit is then supplied via the thyristor contactor. As soon as the output voltage of the inverter returns to the permitted tolerance range, the load circuit is automatically switched back to the inverter (INV), also without any interruption.

Switchover from the INV to the SBS circuit and back can also be carried out by the UPS operator by manually switching the INV OFF or ON.

The SBS control unit initiates and monitors synchronisation of the INV voltage with the SBS circuit. If these two circuits are not synchronised, the DOU displays "phase deviation".

NOTE:
If during "phase deviation" it is necessary to switch the loads over from the INV to the SBS circuit or if the INV is switched off, switchover to the SBS circuit takes place with a voltage gap.

Depending upon customer requirements, the switchover can be blocked if there is a "phase deviation". This operating mode becomes necessary if the connected loads could not withstand such a voltage gap without suffering damage.

The SBS circuit voltage at terminal X4 is monitored by the SBS control unit. If the SBS circuit voltage is not within the permitted tolerance range, the SBS is blocked!

ATTENTION:
If the SBS is blocked, there is no switchover to the SBS circuit! This means that if the INV fails or is switched off by the operator, the load circuit is no longer connected to the power supply. The loads must then be manually reconnected by switching the INV back on or activating the SBS (switch Q28 off and back on).

5.4 Charging the Battery

The battery is charged according to DIN 41772 in accordance with a CVCC curve. This ensures that the battery is charged in the shortest possible time and also prevents overcharging.

Battery charging is electronically controlled and monitored. Operating faults are registered, causing the charging process to be interrupted.

Charging:

After a mains failure, for example, the battery is charged with a constant current (e.g. 10 A/100 Ah). When the charging voltage is reached (e.g. 2.35 V/cell for lead-acid cells), the control electronics maintains this voltage constant at ±1% with decreasing current. When the calculated charging time has elapsed, the battery is switched over to trickle charging.

Trickle charging:

When the electronically controlled charging has been carried out, the control unit switches over to trickle charge voltage (e.g. 2.27 V/cell).

5.5 Manual Characteristic Curve Switchover

Additional operating modes are available for special treatment of the battery. These can be manually activated via the DOU using the "SERVICE / REC OP. MODE" menu.

The works setting of the characteristic values can be changed via the DOU in the menu "SERVICE / BATTERY VALUES". This allows ideal adaptation to the existing battery.

Equalising charging:

Equalising charging is carried out in accordance with a CVCC curve, including automatic switchover back to trickle charging after 8 hours. As standard, the characteristic curve values correspond to the charging values. The charging voltage can be adjusted separately.

Start-up charging:

Start-up charging is carried out in accordance with a CVCC curve, including automatic switchover back to trickle charging after 8 hours. The charging current and charging voltage can be adjusted separately from the other characteristic curves.

5.6 Battery Tests

The implemented battery tests can be started via the DOU in the menu "SERVICE / BATTERY TEST", if they are enabled. The yellow LED on the DOU signals an ongoing test. Status messages and measured values of the battery tests are shown on the display.

Test of the battery charging circuit:

This brief test checks the connected battery by lowering the voltage and carrying out a current analysis. Line interruptions or defective fuses in the battery circuit are also detected. With a battery present, the test takes approx. 1 second. It is carried out automatically each week by the rectifier control unit.

5.6.1 Capacity Check

This operating mode allows a check of the battery status by **drawing constant current** from the battery. In this process, the regulator lowers the DC voltage until the desired discharge current flows from the battery. The inverter load must be larger than the discharge current.

The following characteristic curve values can be preselected using the DOU:

- Discharge current
- Discharge time
- Final discharge voltage

The test can be started under the following conditions:

- Operating mode: charging or trickle charging
- Battery voltage > 2.2 V/cell (for lead-acid cells)
- Rectifier current < 90% of I_{nom}
- Rectifier current > Battery discharge current setpoint + 5%
- At least 1 min must have elapsed since the last test

Values displayed on the DOU:

Before the test:

- Date and time of the last test

During the test:

- Battery voltage, battery current, test duration, capacity drawn from the battery

After the test:

- Battery voltage, battery current, test duration, capacity drawn from the battery at end of test

The capacity check is finished when the final discharge voltage or the max. discharge time is reached. It is interrupted if the inverter load becomes too low. The test can also be interrupted manually using the DOU. After the test, the system automatically switches back to battery charging.

ATTENTION:
As the battery is partly or completely discharged, the full standby time of the UPS is not available in the event of a mains failure.

NOTE:
In the event of a battery fault, the system must be switched over to the SBS (capacity check / capacity test).

5.6.2 Capacity Test

The capacity test allows the availability of the battery to be tested using the **currently available inverter load**. In this process, the regulator lowers the DC voltage setpoint to approx. 1.9 V/cell. Generally, the battery backs up the DC voltage and supplies the entire current to the inverter. This simulates a rectifier circuit failure. In the event of a battery fault, the inverter continues to be supplied by the rectifier.

The following parameters can be set using the DOU:

- Discharge time
- Final discharge voltage

The test can be started under the following conditions:

- Operating mode: Trickle charging
- At least 1 min must have elapsed since the last test

Values displayed on the DOU:

Before the test:

- Date and time of the last test

During the test:

- Battery voltage, battery current, test duration, capacity drawn from the battery

After the test:

- Battery voltage, battery current, test duration, capacity drawn from the battery at end of test

The capacity test is finished when the final discharge voltage or the max. discharge time is reached. It can be interrupted using the DOU. After the test, the system automatically switches back to battery charging.

ATTENTION:
As the battery is partly or completely discharged, the full standby time of the UPS is not available in the event of a mains failure.

NOTE:
In the event of a battery fault, the system must be switched over to the SBS (capacity check / capacity test).

6 Connection

CAUTION:
Prior to commencing work, ensure that the connection cables are disconnected from the power supply and that it is not possible to activate the power supply.

NOTE:
In order to avoid deformation of the supporting rail and to protect the base of the connection terminal against torsional forces, it is advisable to hold the cable in position when tightening the clamping screw (refer to Figure 14/15).

The protective measure of earth connection serves to prevent excessive touch voltages on freely accessible metal parts. The UPS is earthed using the earthing bolts (PE) provided on the housing (refer to Table 2, Chapter 6.4).

Prior to start-up it is necessary to ensure that the UPS is earthed in accordance with valid regulations (VDE 0100).

6.1 Inputs and Outputs

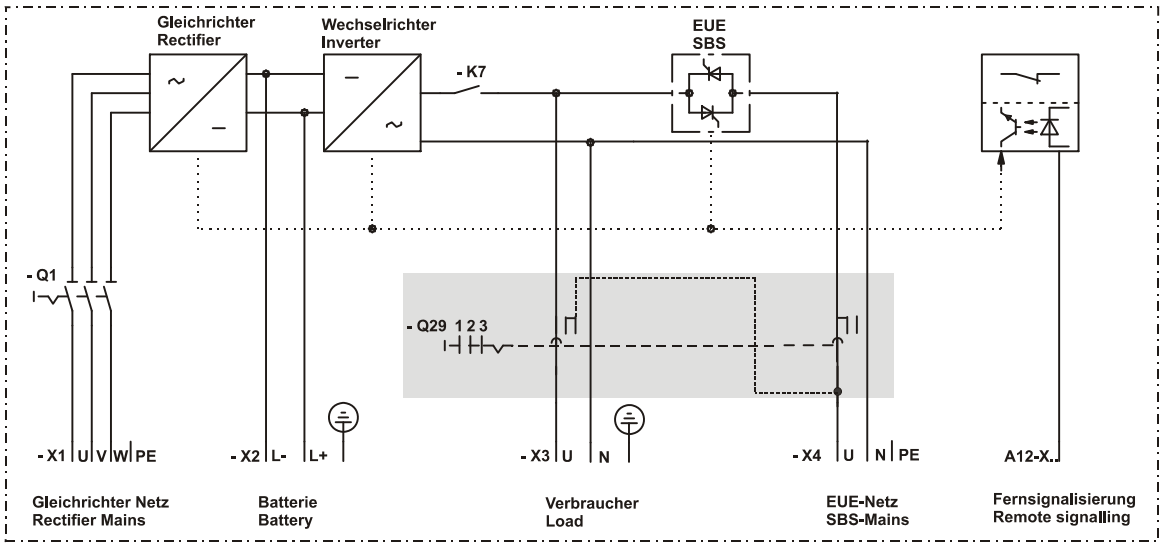


Figure 13 Connection elements of the UPS

Terminal strips X1 and X4 serve as supply inputs. Connection of two independent circuits, a main circuit and an SBS circuit, or one common supply circuit is possible.

The battery is connected via X2, and the loads via X3.

6.2 Connection of the Mains, Load and Battery Cables

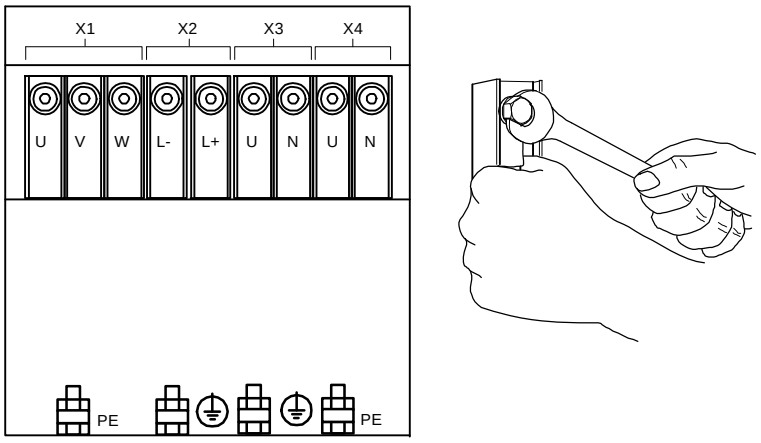


Figure 14 Connection panel of the Protect 5. 31/10-60 kVA

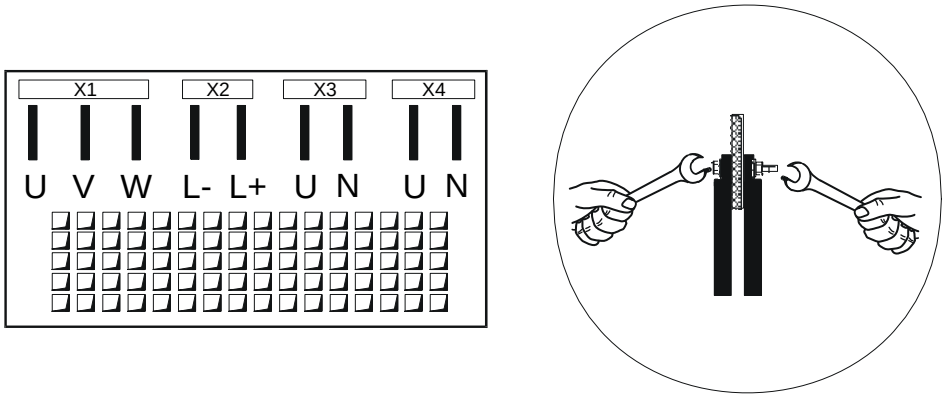


Figure 15 Connection panel of the Protect 5. 31/80-120 kVA

ATTENTION:
Ensure correct polarity when connecting the cables!
The following general rules apply:
Terminal X1 = connection of the rectifier circuit
Terminal X2 = connection of battery
Terminal X3 = connection of the load circuit
Terminal X4 = connection of the SBS circuit

The cables are connected as follows:

- Open the control cabinet door.
- Remove the connection cover from the terminals.
- Insert the cables to be connected into the UPS from below or from the rear. Cables coming from above are routed down next to the UPS.
- Secure the cables to the respective copper rails by securing the cable lugs (refer to Figure 14 and 15) using a spanner.
- **Secure the protective earth conductors (PE)** to the designated unit frames.
- A shielded battery line may have a favourable effect on the EMC. For this purpose, connect the shield of the battery line to the PE connection next to terminal strip X2 using the shortest possible route.
- Secure the cables for strain relief on the cable clamp rail.
- Check to ensure that the cables are secured correctly and tighten the fixing bolts if necessary.
- Check the cables for correct polarity and correct phase sequence.
- Remove any cable debris, tools, bolts, etc. from the connection panel.
- Replace the connection cover.

6.3 Connection of the Control and Signal Lines

The control and signal lines for the remote signalling PCB are connected to the terminals using a 3 mm screwdriver. Refer to Figure 21 for the connection.

Shielded control and signal lines may have a favourable effect on the EMC. For this purpose, connect the shield of the lines to the terminal unit. Additionally, the screen can also be connected to the PE connection provided on the control unit pivot plate.

6.4 Connection Cross Sections and Fuse Protection

	Layout of cross sections in acc. with DIN 0298, Part 4, Table 3		**Type rating in kVA**							
	Laying type B1/B2		**10**	**20**	**30**	**40**	**60**	**80**	**100**	**120**
1	**Rectifiers, input** **X1** Rectifier fusing in A		20	40	63	80	125	160	200	250
2	Cross section in mm²/pole *1	min. max	10 2x95	10 2x95	16 2x95	25 2x95	50 2x95	70 2x185	2x35 2x185	2x50 2x185
3	**SBS circuit input** **X4** SBS fusing in A		50	100	160	200	315	400	500	630
4	Cross section in mm²/pole *1	min. max	10 2x95	35 2x95	70 2x95	95 2x95	2x70 2x95	2x95 2x185	2x120 2x185	2x185 2x185
5	**Load output** **X3** Load output fusing in A	max.	16	25	35	50	80	100	160	160
6	Cross section in mm²/pole	min. max.	10 2x95	35 2x95	70 2x95	95 2x95	2x70 2x95	2x95 2x185	2x120 2x185	2x185 2x185
7	**Remote signalling** **X12** Cross section of the signal line in mm²/pole	max..	0,2 - 2,5							
	Battery									
8	**Battery connection** **X2** Battery fusing in A		50	100	160	200	315	400	500	630
9	Cross section in mm²/pole	min. max.	10 2x95	25 2x95	50 2x95	95 2x95	2x50 2x95	2x95 2x185	2x120 2x185	2x150 2x185

Table 2 Connection cross sections and fuse protection

*1 Laying of the PE conductor in accordance with VDE 0100 T540, Table 6

NOTE:
The cable clamp rail is located 185 mm above the ground.
Observe the bending radius!
(With one bend: radius = 10 x diameter)

7 Start-Up

The start-up procedure is the same for the various UPS versions from 10 kVA to 80 kVA. Prior to start-up, ensure that the preset unit specifications match the battery specifications.

For parallel systems, see description of "Parallel Operation"!

NOTE:
The start-up instructions of the battery manufacturer must be complied with. Any necessary parameter modifications must be made by our service personnel or via the DOU.

A phase-rotation indicator and a voltmeter are required for the work that follows.

CAUTION:
When the mains is connected, potentially fatal voltages are applied to the terminals.

Always observe the safety regulations!

Starting the UPS (see also Figure 3)

7.1 Preparing Start-up of the UPS (Individual Unit)

Step	Action
1	Q1 and battery isolator (external) to the **"OFF"** position.
2*	Q29 internal option set to position **"2"** manual bypass.
3	Remove connection cover.
4	Connect the mains voltage for the rectifier circuit and SBS circuit.
5	Measure the mains voltage at terminal X1 (outer conductor/outer conductor). The voltage should be 400 V. Measure the mains voltage at terminal X4 (outer conductor/neutral conductor). The voltage should be 230 V.
6	Check the rotating field on terminal X1. L1, L2 and L3 clockwise rotation.
7	Switch off the mains voltage for the rectifier circuit and SBS circuit.
8	Eliminate any errors if necessary and repeat the steps.
9	Replace the connection cover.

* Step only required when Q29 is installed

Table 3 Preparing start-up of the Protect

7.2 Starting up the UPS (Individual Unit)

Step	Action	DOU	
		LED	Display
1	Q1 and battery isolator (external) to the **"OFF"** position.		
2*	Q29 (internal option) to position **"2"** service mode.		
3	Switch on mains voltage for rectifier and SBS circuits. Wait until the self-test finishes.	Red/yellow/green continuously	Self-test
4*	Q29 (internal option) to position **"1"** inverter operation.		
5	The loads are supplied by the SBS.	Green and yellow flash	
6	When starting up the unit for the first time, select the dialog language of the DOU.		Main menu - operating display
7	Q1 to the **"ON"** position. The rectifier starts automatically. The DC voltage increases.		
8	The DC voltage reaches its final value and the inverter is supplied with power.	Yellow OFF	DC symbols OK
9	Check voltage values and polarity at the battery isolator.		
10	Battery isolator (external) set to **"ON"**. The batteries are charged.		
11	Switch on the inverter using the **"~I"** key on the DOU.		INV symbol flashes
12	The AC voltage reaches its final value.		
13	Following synchronisation with the SBS circuit, the system is switched over from SBS operation to inverter operation and the loads are supplied with power.	Green ON	Power flow display via the INV
14	Connect the loads.		

* Step only required when Q29 is installed

Table 4 Starting up the Protect

8 Operation

8.1 Disconnecting the UPS (Individual Unit)

ATTENTION:
Only switch off the UPS in an **absolute emergency** by switching off the **rectifier circuit and SBS circuit** in their distribution! In addition, the inverter must be switched off using the remote OFF contact. The external battery isolator must be opened to completely disconnect the unit from the power supply.

To restart the system, proceed as described in Chapter 7.

Proceed as described below to disconnect the UPS from the power supply (see also Figure 3).

Step	Action	DOU	
		LED	Display
1	Switch off the INV using the **"~0"** button on the DOU and confirm. The SBS circuit is automatically activated.	Green flashes	
2	Switch off the REC using the **"=0"** button on the DOU and confirm.	Green and yellow flash	
3*	Q29 (internal option) to position **"2"** service mode. Manual bypass is activated. The SBS is still connected to mains voltage.		Manual bypass symbol
4	Battery isolator (external) set to **"OFF"**.	Red, green and yellow flash	
5	Q1 to the **"OFF"** position. The REC circuit is switched off.		
6	Q29 (internal option) to position **"3"** manual bypass. SBS mains is switched off.		

* Step only required when Q29 is installed

Table 5 Disconnecting the Protect

CAUTION:
Even if disconnected, the UPS can still be **live** due to **charged capacitors** and connected remote signals.

Observe the safety instructions!

8.1.1 Restarting after Disconnection (Individual Unit)

Proceed as described in the following table to restart the UPS after it has been disconnected from the power supply.

Step	Action	DOU	
		LED	Display
1	Q1 and battery isolator (external) set to **"OFF"** position.		
2*	Q29 (internal option) set to **"3"** manual bypass (load supply via manual bypass).		
3	Connect the mains voltage for the rectifier circuit and SBS circuit.		
4*	Q29 (internal option) set to position **"2"**.	Red/yellow/ green continuously	Self-test
5	The SBS is starting up.	Green and yellow flash	Main menu - operating display
6*	Only if green LED flashes and SBS symbol is OK, Q29 (internal option) in position **"1"** inverter operation. The loads are supplied by the SBS.		
7	Q1 to the **"ON"** position. The rectifier starts automatically. The DC voltage increases.		
8	The DC voltage reaches its final value and the inverter is supplied with power.	Yellow ON	DC symbol OK
9	Battery isolator (external) set to **"ON"**. The batteries are charged.		
10	Switch on the inverter using the **"~I"** key on the DOU.		INV symbol flashes
11	The AC voltage reaches its final value.		
12	Following synchronisation with the SBS circuit, the system is switched over from SBS operation to inverter operation.	Green ON	Power circuit display via INV
13	The loads are supplied by the INV.		

* Step only required when Q29 is installed

Table 6 Restarting after disconnection

8.2 Shutting Down the UPS

If it is necessary to shut down the UPS, the system must be disconnected from the power supply as described in Chapter 8.1.

In addition, the mains supply must be disconnected from the REC circuit and the SBS circuit.

CAUTION:
Even when shut down, the UPS can still be **live due to charged capacitors**. Discharge the capacitors.

Observe the safety instructions!

To restart the UPS after shutdown, proceed as described in Chapter 7.

8.3 Emergency Shutdown

Emergency shutdown is available as an option and mainly serves to disconnect the loads from the power supply via an external contact. The exact design of the emergency shutdown depends on customer requirements.

NOTE:
For more information, please refer to the relevant operating instructions.

8.4 UPS Fuses

The fuses, fuse ratings and protected components can be found in the following table (see also Figure 3, Position 11).

Item	10-40 kVA (value)	Protected components
F1 to F10	2 A (slow-blow)	Fans M1 to M10, depending on type
F13	1 x 5 A (fast)	L1 Actual SBS mains voltage
F14 F15 F16	3 x 5 A (fast)	L1 L1 Actual load voltage L1
F17 F18	2 x 5 A (fast)	L1 Actual INV voltage L1
F20 F21 F22	3 x 5 A (fast)	L1 L2 Actual REC mains voltage L3
F24 F25	2 x 4 A (fast)	(+) DC intermediate circuit (–) REC control unit supply
F26 F27	2 x4 A (fast)	(–) DC intermediate circuit (+) INV control unit supply
F28	2 A (fast)	Supply to options
F31 F32 F33	3 x 5 A (fast)	L1 Supply L2 Rectifier interface L3

Table 7 Fuses in the Protect 5. 31/xxx

9 Graphical Display and Operation Unit

9.1 General Information

The graphical **d**isplay and **o**peration **u**nit (DOU) is integrated in the front of the UPS housing. It serves to signal and display UPS unit data and to control and parameterise the UPS 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 3 LEDs. An acoustic signal generator stresses the urgency of critical system statuses.

The graphical LCD shows system statuses and measured values using symbols and plain language. The unit can be controlled and parameterised using menus which are protected by a password.

The DOU is operated using 4 display keys, to which several functions are assigned, and one ENTER key. The currently active key functions are shown on the LCD as symbols.

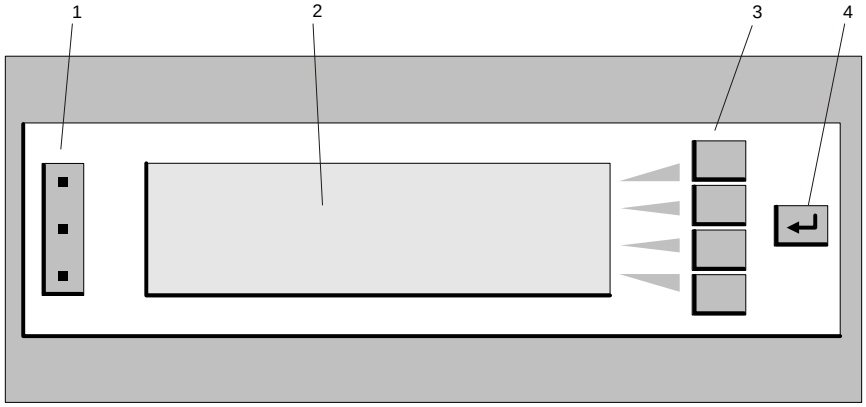


Figure 16 DOU

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

9.1.1 Signalling

LEDs:

Red, flashing:	System fault => Service required
Yellow, flashing:	Self-acknowledging faults/messages, extraordinary system statuses
Green, flashing:	The load is supplied by the bypass circuit
Green, permanently ON:	The load is supplied by the inverter

Acoustic signal generator:

Signal generator ON:	Urgent messages and system faults

9.1.2 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 current key functions 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 in the **"system",** you can **switch the converters on and off** using the general keys. The key symbols in the menu indicate the control functions which are currently available. You can only switch off the rectifier in the **"operating display"** when the inverter is switched off and while a general control is enabled in the **"system"**. If a switch-off procedure has been initiated, you must confirm it in the safety routine, so that the unit cannot be inadvertently switched off. The general control of the power converters can be blocked and protected with a password.

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

You can **acknowledge** the **acoustic signal generator using the keyboard.** On the LCD operating display you will find a special acknowledgement key represented by the symbol of a loudspeaker. In all other menus, press any key (even a key without function) to acknowledge. If the number of messages or faults increases, the acknowledgement is cancelled. You can generally block both the acoustic signal generator from notifying you of faults and the clicking sound when you press a key.

Possible symbol keys and their function:

	Switch off inverter
	Switch on inverter
	Switch off rectifier
	Switch on rectifier
	Switch off booster
	Switch on booster
	Switch off charger
	Switch on charger
	Acknowledge acoustic signal generator
	Cursor / Value / Scroll upwards
	Cursor / Value / Scroll downwards
	Cursor to the right
	Cursor to the left
	Status / Measured values menu
	System is blocked
	Acknowledge fault
	Module selection
	Help menu
	No function

9.2 Start-Up

Following the **power-up reset,** the DOU performs a self-test. Data is loaded from the power converters after the test has been completed successfully. The LEDs light up sequentially 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),** you must select the menu language using the general keys "<" and ">". The available languages are indicated using their respective country-specific abbreviation (car number plate). The language currently selected is displayed on a black background. You activate the selected language by pressing the ENTER key, and the next menu opens. In order to comply with international requirements, all menus up to the language selection are displayed in English.

When you **start up the UPS for the first time (commissioning),** depending on the UPS type, the language selection menu is followed by several other menus where you have to set parameters for the UPS circuit and the installed battery. Step-by-step, you are prompted to parameterise the unit and carry out switching operations until the system is in normal operation.

During **subsequent UPS start-ups,** you can initiate the procedure used for the first start-up (commissioning) manually to modify the set parameters. Otherwise, the start-up process is shortened.

9.3 Menu Structure

9.3.1 Menu Tree

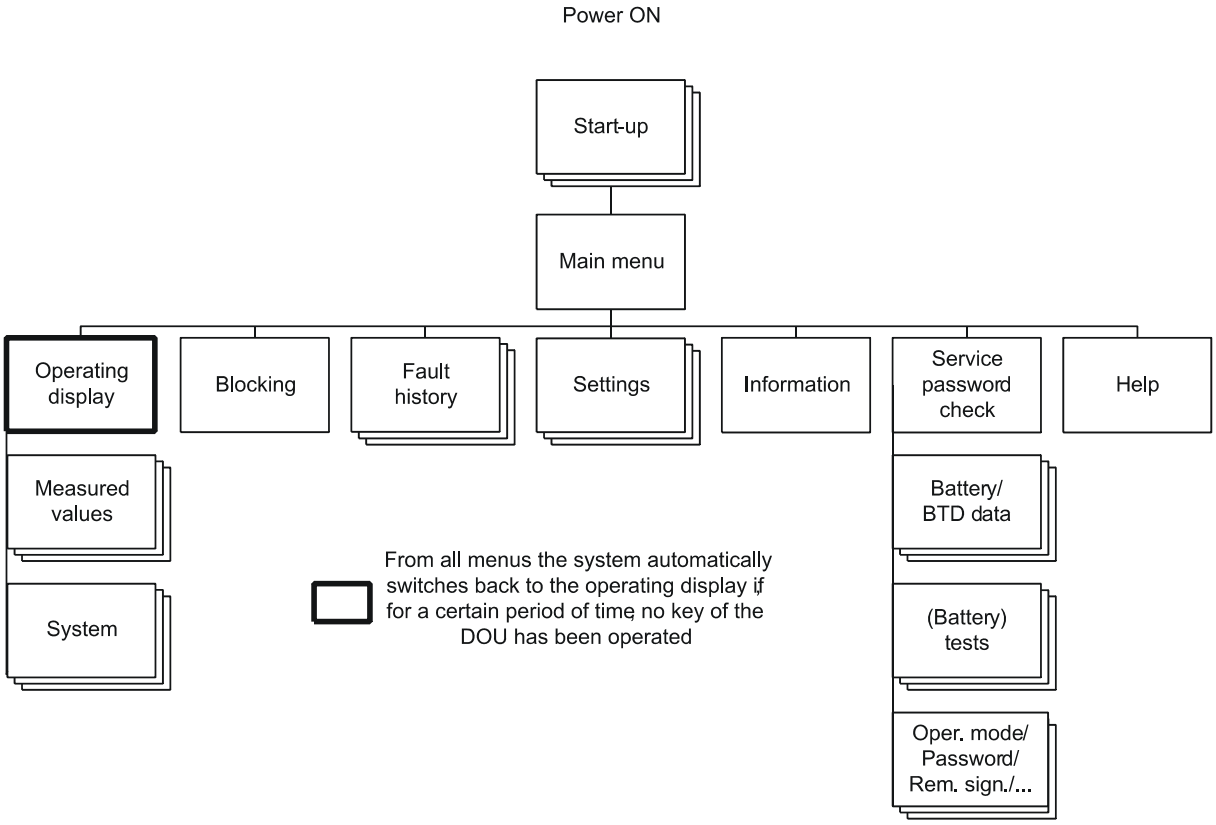


Figure 17 Menu tree

9.3.2 Main Menu

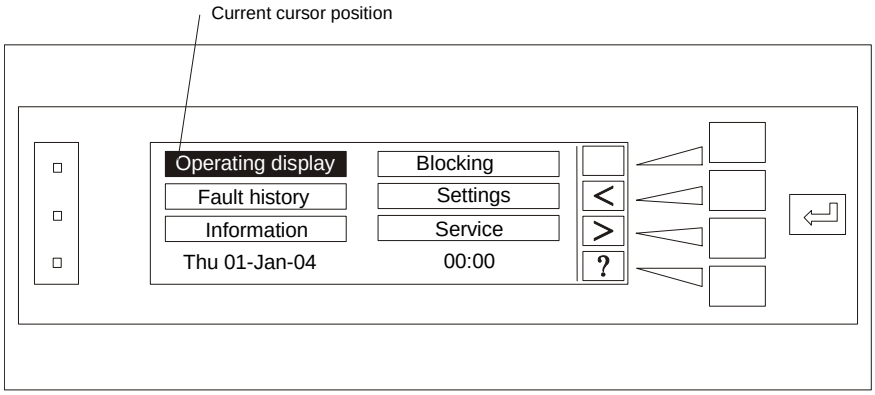


Fig. 18 Main menu

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 the various keyboard symbols.

9.3.3 Operating Display

You can **call up the operating display** from the **“main menu”**. If the DOU is **not used** for a **certain period of time,** the system **automatically switches back** to the operating display and the LCD background illumination is switched off. If you have started specific processes, such as a battery test, in a menu, this menu remains active until the process has been completed.

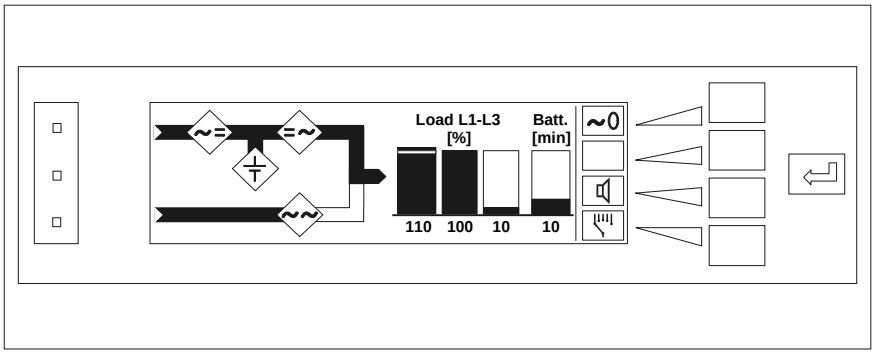


Figure 19 UPS operating display (normal operation)

The **operating display** consists of 3 parts:

On the left-hand side, the **unit status** is shown **in a pictogram**. The individual components of the unit are represented here as symbols. The respective symbol flashes in the event of messages or faults in a component. In addition, the current power circuit is indicated via a bar diagram.

The centre part displays the **most important measured values** of the unit in a digital as well as an analogue format. These values differ, depending on the unit type. In this example, the capacity utilisation of the individual phases (in this case, 3 phases) in percent and the standby time are displayed as the most important measured values of the unit.

The **current display key assignment** is displayed **on the right-hand side.** Here you can switch the power converters on or off depending on the unit status, as long as the operation has not been blocked. You can also acknowledge the acoustic signal generator in this area in the event of messages or faults. Use the bottom key with the measuring device icon to call up menus with detailed information on status and measured values.

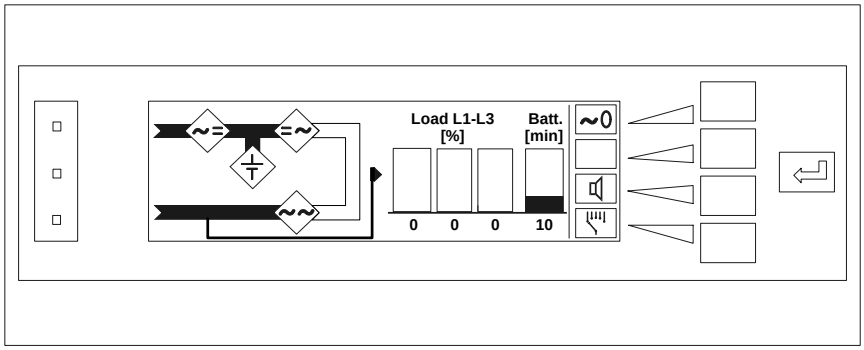


Figure 20 Operating display of the UPS with activated manual bypass

Using the **manual bypass switch** (option), you can disconnect the unit from the load. The load is then supplied directly by the mains. This state is shown on the display.

9.3.4 Status/Measured Values

You can **access** the **Status/Measured values menu from the operating display** using the **bottom key** with the measuring device icon. In this menu, you can select the statuses and measured values of the circuits, battery, loads or communication options. The **"System" submenu** displays the **status of the UPS** and the individual components. If a **fault** occurs in **a UPS component,** you can call up a **detailed fault description** in a submenu. **After the fault has been rectified,** you must **acknowledge** the fault in this menu.

If **optional communication PCBs** are installed in the unit, the "COM interface" or "Remote signals" submenu displays the status of the individual interfaces. Press the **ENTER key** in the respective submenu to **return** to the **“selection”** menu.

9.3.5 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 control systems (**switching on/off** and **fault acknowledgement**). The password must be entered digit by digit and then acknowledged using the ENTER key.

The **password** set ex works is: **1201**.

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

9.3.6 Fault History

You can **call up the “Fault history”** menu **from** the **“main menu”**. The UPS has an integrated **data logger** that records the fault history of **the circuits**, **the battery** and **the UPS system**. You can **display** the 20 most recent faults as of the current date or as of a specific date.

9.3.7 Settings

You can **call up** the **“Settings”** menu from the **“main menu”**. Here you can set the **parameters**

- **LCD contrast**
- **Language**
- **Real time**
- **Acoustic signal generator** for fault signalling and keyboard operation

in the respective submenus.

9.3.8 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.

9.3.9 Service

You can **call up** the **“Service”** menu **from** the **“main menu”**. After you have entered the current password, you can select submenus where you can set parameters for the UPS and for the battery as well as manipulate the system's operating statuses. The **password** must be **entered digit by digit and** then **acknowledged** using the ENTER key.

The **password** set ex works is: **1201**.

The following **abbreviations** are used in the menus:

Tri	=	Trickle charging
Equ	=	Equalising charging
Cha	=	Charging
DGS	=	Diesel Generator Set charging
Sta	=	Start-up charging

Menus for changing the operating statuses:

- In the **“Rectifier operating mode”** menu, you can change the charge status of the rectifier (charger). The current charge status is displayed.
- In the **“Battery test”** menu, you can initiate different battery tests, depending on the test implemented. The status and measured values of the battery are displayed during the test.

  See Appendix, Battery Tests.
- In the **“Maintenance” (with parallel systems)** menu, you can disconnect units from the complete interconnection of a parallel system for repair or maintenance purposes without causing the remaining units to shut down due to fault.

  See separate operating instructions for parallel operation.

Menus for setting parameters:

- In the **“Battery values”** menu, you can set the parameters of your battery for the charging procedure and for tests.

  See Appendix, Battery Data.
- In the **“BTD values”** menu, you can set the **B**attery - **T**ime of **D**ischarge parameters of your battery.

  See Appendix, Battery Data.
- In the **“Password”** menu, you can set the password for blocking operation and for setting parameters. A range of 0000 to 9999 is possible.

ATTENTION:
Keep the password in a safe place! If you have forgotten the password, the DOU must be reset at the customer's expense!

- In the **“Remote signals”** menu (option), you can program up to 3 general signals (IN1-3) for the max. 4 optocoupler inputs of the remote signalling expansion boards, if included. The signal name (IN1-3) cannot be changed. The DOU displays the signal status below the Status/Measured values menu. An active signal is also indicated via the yellow LED, the acoustic signal generator, and communicated to the connected IT system.

9.3.10 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**.

10 Annex

10.1 Battery Handling using the Graphical DOU

10.1.1 Charging the Battery

The battery is charged according to DIN 41772 in accordance with a CVCC curve. This ensures that the battery is charged in the shortest possible time and also prevents overcharging.

Battery charging is electronically controlled and monitored. Operating faults are registered, causing the charging process to be interrupted.

Charging:

After a mains failure, for example, the battery is charged with a constant current (e.g. 20 A/100 Ah). When the charging voltage is reached (e.g. 2.35 V/cell for lead-acid cells), the control electronics maintains this voltage constant at ± 1% with decreasing current. When the calculated charging time has elapsed, the battery is switched over to trickle charging.

Trickle charging:

When the electronically controlled charging has been carried out, the control unit switches over to trickle charge voltage (e.g. 2.27 V/cell).

Further operating modes are available for special treatment of the battery, providing they are implemented in the UPS. These can be manually activated via the graphical DOU in the "SERVICE / REC OPERATING MODE" menu.

The works setting of the characteristic values can be changed via the DOU in the menu "SERVICE / BATTERY VALUES". This allows ideal adaptation to the existing battery.

Equalising charging:

Equalising charging is carried out in accordance with a CVCC curve and is automatically switched back to trickle charging after 8 hours, for example. As a standard, the characteristic curve values correspond to the charge values. The charging voltage can be adjusted separately.

Start-up charging:

Start-up charging is carried out in accordance with a CVCC curve and is automatically switched back to trickle charging after 8 hours, for example. Charging current and charging voltage can be adjusted separately from the other characteristic curves.

10.1.2 Battery Data

Depending on the system configuration, different battery parameters can be set in the "SERVICE / BATTERY VALUES" menu. The parameters for the individual battery tests are also set in this menu. Please refer to the data sheets of the battery manufacturer for the individual values to be set.

The following abbreviations are used in the menus:

Tri = Trickle charging

Equ = Equalising charging

Cha = Charging

EPS = Charging with emergency power supply operation

Sta = Start-up charging

The parameters can be set within restricted ranges. This range depends on the unit type. The unit type can be displayed on the DOU in the "Information" menu.
The max. values for the number of cells and the voltages can differ from the values mentioned above because a max. total battery voltage must not be exceeded. Parameters "Final disch. voltage/cell", "Max. disch. time" and "Disch. current" refer to the battery tests. The "Disch. time" depends on the battery test.

List of all possible parameters and their setting ranges:

Protect-5:

Type	Pb	NiCd
(Number of) cells	90 – 120	155 – 190
Cap(acity)	0 – 9999 Ah	
U Tri/cell	2.13 – 2.32 V/cell	1.33 – 1.50 V/cell
U Cha/cell	2.23 – 2.43 V/cell	1.37 – 1.70 V/cell
U Equ/cell	2.23 – 2.58 V/cell	1.37 – 1.75 V/cell
U EPS/cell	1.90 – 2.32 V/cell	1.10 – 1.50 V/cell
U Sta/cell	1.00 – 2.86 V/cell	0.50 – 1.95 V/cell
I(bat) limit(ation) Tri/Cha/Equ of Inom	1 – 110% of I_{nom}	
I(bat) limit(ation) Sta of Inom	1 – 110% of I_{nom}	
(Charging) time Equ	1 – 1999 min	
(Charging) time Sta	1 – 1999 min	
Final disch. voltage/cell	1.6 – 2.0 V/cell	0.65 – 1.20 V/cell
(max. bat. test) time	1 – 1200 min	
Disch. current [%] of xA	5 – 90% of I_{nom}	

The **B**attery **T**ime of **D**ischarge parameters can be set using the "SERVICE / BTD VALUES" menu.

Please refer to the data sheets of the battery manufacturer for the individual values to be set.
Using the battery table, the discharge powers or discharge currents of two different standby times are determined for a final discharge voltage of approx. 80% of the nominal battery voltage (1.6 V/cell for lead-acid batteries) depending on the unit type. To do this, it is best to select the following values:

One pair of values lies in the range of the nominal standby time of the system, and another at a standby time which is three times the nominal standby time.

Protect-5:

The standby time is determined by calculating the balance of the battery currents.

Parameters to be set and their setting ranges:

Discharge currents	Corresponding discharge times
I1: 1 – 9999 A	t1: 1 – 999 min
I2: 1 – 9999 A	t2: 1 – 999 min

Moreover, the set values must fulfil the following conditions:

t2 / I1 > t1 / I2

t2 > t1

I1 > I2

ATTENTION:
If a communication error with the respective control system occurs during the saving process, the setting procedure **must** be repeated.

10.1.3 Battery Tests

The implemented battery tests depend on the unit type and can be started and cancelled via the "SERVICE / BATTERY TEST" menu of the DOU. Status messages and measured values of the battery branches are shown in the display. The yellow LED signals an ongoing test. The tests are either completed successfully, completed with an error or cancelled manually.

The test parameters are set using the "SERVICE / BATTERY VALUES" menu. This menu allows the operator to set the discharge current, the maximum discharge time and the minimum battery voltage for each type of test.

Prerequisites for initiating the tests:

The UPS is in normal operation (no fault is present)

- The rectifier is switched on.
  - Note/Connection is possible using the DOU
- The battery charger is running in trickle charge mode.
  - Note/Switchover is possible using the DOU
- The INV is running.
  - Note/Connection is possible using the DOU
- The battery is installed.
- The last test was conducted at least 1 minute previously

10.1.4 Possible Battery Tests

Test of the battery charging circuit:

This brief test checks the connected battery by lowering the voltage and carrying out a current analysis. Line interruptions or defective fuses in the battery circuit are also detected. With a battery present, the test takes approx. 1 second. It is carried out automatically each week by the rectifier control unit.

Capacity check

This operating mode allows a check of the battery status by drawing constant current from the battery. For this, it is necessary to have an inverter load that is larger than the discharge current.
Before the test, the data of the last test is displayed together with the date and time. The values at the end of the test are retained after a current test.

ATTENTION:
As the battery is partly or completely discharged, the full standby time of the UPS is not available in the event of a mains failure.

Capacity test

The capacity test allows the availability of the battery to be tested using the currently available inverter load. This involves reducing the DC voltage of the rectifier, so the voltage should be supported by the battery voltage. The battery supplies the full current into the inverter. This simulates a rectifier circuit failure. In the event of a battery fault, the inverter continues to be supplied by the rectifier.

Before the test, the data of the last test is displayed together with the date and time. The values at the end of the test are retained after a current test.

ATTENTION:
As the battery is partly discharged, the full standby time of the UPS is not available in the event of a mains failure.

11 Interfaces

11.1 Remote Signalling

The remote signalling PCB consists of a remote signalling master board A12 and an expansion board A13, the contacts of which are connected to terminal block X12.

The remote signalling boards have the following inputs and outputs:

Inputs (via optocoupler):

- INV remote shutdown

Outputs (via relay contacts):

- Inverter operation
- Mains operation
- Rectifier fault (REC or REC circuit fault)
- Battery undervoltage
- Collective fault (REC, INV, SBS or battery fault)
- SBS blocked
- Fan fault
- REC circuit fault

NOTE:
The **maximum** load for the relay contacts is **250 V / 8°A AC**.

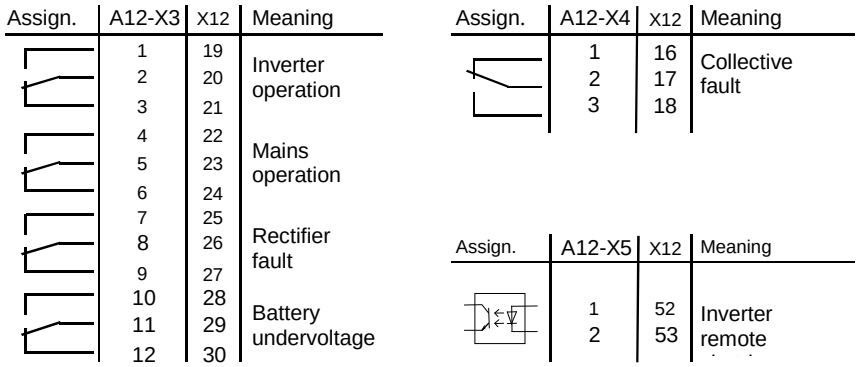


Figure 21 Terminal assignment of the remote signalling master board A12

NOTE:
The A13 and A14 expansion board can be programmed. See the technical data sheet for terminal assignment.

The maximum input voltage for terminal X5 is 24 V AC/DC.

When a signal is received, the contacts on X3 close on the two contact points with the lower numbers on the connection terminal.

The contacts on X4 close on the two connection terminals with the higher numbers (fail-safe principle).

The control and message lines are routed to the bottom using the cable duct in the centre of the unit.

Terminal strip X12	from	Designation	Remark
1		L1 load	A37 -> option
2		L2 load	A37 -> option
3		L3 load	A37 -> option
4		DC voltage (+)	A38 -> option
5		DC voltage (-)	A38 -> option
6		Neutral conductor	A37 -> option
7, 8, 9	A16-X10:2,3	PE conductor (9) feedback	A37 -> option
10, 11, 12	A50-X8:1,3	PE conductor (12) feedback	A38 -> option
13, 14, 15	Q29	Manual bypass activated (13,14)	Standard A12
16, 17, 18	A12-X4:1,2,3	UPS fault	Standard A12
19, 20, 21	A12-X3:1,2,3	INV operation	Standard A12
22, 23, 24	A12-X3:4,5,6	Mains operation	Standard A12
25, 26, 27	A12-X3:7,8,9	REC fault	Standard A12
28, 29, 30	A12-X3:10,11,12	Battery undervoltage	Standard A12
31, 32, 33	A13-X3:1,2,3	Signal – K26	A13 -> option
34, 35, 36	A13-X3:4,5,6	Signal – K27	A13 -> option
37, 38, 39	A13-X3:7,8,9	Signal – K28	A13 -> option
40, 41, 42	A14-X3:1,2,3	Signal – K29	A14 -> option
43, 44, 45	A14-X3:4,5,6	Signal – K30	A14 -> option
46, 47, 48	A14-X3:7,8,9	Signal – K31	A14 -> option
49, 50, 51	A23-X1:1; X1:2	24 V AC (49,51)	A23 -> OPTION
52, 53, 54	A12-X5:1,2; A13-X4:1	INV remote shutdown (52,53); OPT2 (54)	Standard A12, A13
55, 56, 57	A13-X4:2; A13-X4:3,4	Signal – OPT2 (55); OPT3 (56,57)	A13
58, 59, 60	A14-X4:1,2; A14-X4:3	Signal – OPT4 (58,59); OPT5 (60)	A14 -> option
61, 62, 63	A14-X4:4	Signal – OPT5 (61); NC (62,63)	A14 -> option

Table 8 Assignment of terminal strip X12

11.2 Serial Interface

Two separate potential-free serial interfaces are provided to establish IT connections.

These are occupied with the AEG protocol CBSER. Optionally, various protocols can be selected for the second interface. These are enabled upon purchase of a licence. A selection of the available protocols can be obtained from your UPS supplier.

The interface is a separate PCB and is located on the outside of the pivot plate next to the remote signalling unit.

For the implementation of special customer software as well as for integration into special bus systems for visualisation using protocol converters, a detailed protocol description is available from AEG Power Supply Systems GmbH.

12 Maintenance and Repairs

12.1 Diagnostic Functions

The comprehensive diagnostic functions implemented in the UPS not only increase its operational reliability considerably, but also reduce the time required for maintenance work and troubleshooting to a minimum.

The UPS is equipped with the following diagnostic functions, some of which are optional:

Self-diagnosis:

This is activated when the system is switched on. Internal auxiliary programs monitor and signal faults, including those from the bus system, the control PCBs or the sensors.

Data logger:

Specified measuring data and parameters from the REC, INV and SBS are stored in the event of a fault. This data is read out and evaluated as required.

12.2 Repairs

CAUTION:
Some repair work, e.g. replacing a fan fuse, can also be performed when the system is in operation and **live**.

Always observe the safety regulations!

ATTENTION:
Do not switch the battery under load!

12.2.1 Fault Table

Faults that occur are displayed on the DOU in plain text. Some faults can be located and eliminated quickly using the following table.

Fault	Possible cause	Remedy
Q1 triggered.	Earth fault or short circuit on the battery side.	Repair the system (renew defective fuse) and restart it as described in Chapter 7. If Q1 triggers again, contact the AEG service department.
REC does not work.	Q1 not in "ON" position. F20 to F22 defective F31 to F33 defective.	Switch on Q1. Replace the faulty fuses. Replace the faulty fuses.
SBS does not work.	Fault in the SBS circuit. F13 to F16 faulty.	Check the SBS circuit. Replace the faulty fuses.
INV does not work.	INV is not switched on. F26 and F27 faulty and/or F17 to F18 faulty. No supply to INV Battery voltage is outside the tolerance range.	Switch on the INV with S1 on DOU. Replace the faulty fuses. Check whether Q1 is in the "ON" position. Check voltage at X2.
No load voltage.	Load fuse faulty.	Measure output voltage at X3. Check external load fuses.
Faulty connection to battery.	Battery isolator (external) in the "OFF" position. F24 to F25 faulty.	Switch on battery isolator (external) (refer to start-up), renew defective fuses.
Fan does not work.	Fan fuse faulty. Loose contact in the plug connection. Fan faulty.	Renew the respective fuse in acc. with Chapter 8. Unlock and relock the respective fan connector on top of the cabinet several times. Renew the fan in accordance with chapter 12.
UPS overload.	Load consumption too high. System automatically switches over to the SBS circuit after one minute.	Reduce the load.

Table 9 Fault table

NOTE:
If the rectifier is faulty and the inverter is switched off, the battery continues to be discharged by the internal power supply for the REC and INV section which is connected to DC voltage (approx. 50 W). The battery must be disconnected by opening the battery isolator to prevent it from becoming fully discharged (exhaustive discharge).

12.2.2 Removing and Installing the Fan

CAUTION:
The fan can only be removed and installed by trained and qualified personnel when the UPS is switched on.

Always observe the safety regulations!

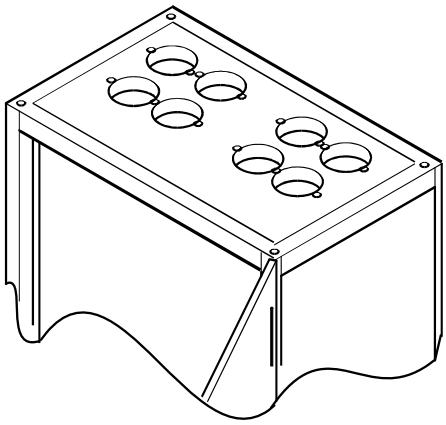


Figure 22 Installing and removing the fan (sample model 60 kVA)

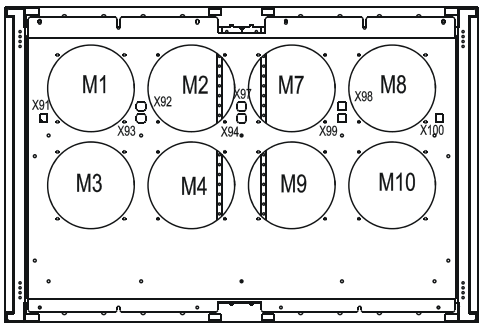


Figure 23 Fan distribution (example model 60 kVA) – (top view from front)

The defective fan is removed as follows (see Figure 23):

- Remove the corresponding fuse in acc. with Table 7.
- Unscrew the two fixing bolts on the fan cover grid and remove the grid. Lift the fan until the fan connector is accessible.
- Unlock and disconnect the fan connector.
- Remove the fan.

Installing the fan:

- Fit the fan connector onto the appropriate connector section on the UPS so that both connectors engage in place.
- Insert the fan, refit the fan cover grid and tighten the fixing bolts using a torque spanner, **1.3 Nm**.
- Reinsert the respective fuse.
- Check the correct functioning of the fan.
- The fault message disappears.

12.3 Maintenance

The Protect 5. 31/xxx is made up of state-of-the-art components which are almost non-wearing. We do, however, recommend regular

visual checks and functional tests of the unit to maintain its high availability and operational reliability and also to check the battery charge.
It is only possible for the UPS to reach its high degree of availability of approx. 99.99% if any unit fault is eliminated within 24 hours. This must be ensured by providing the necessary service work (e.g. through maintenance contracts).

CAUTION:
Maintenance work must sometimes be performed when the UPS is **connected to the power supply.** Ensure that the work area is cordoned off and **always observe the safety instructions!**

The following maintenance work must be performed if no other instructions are given by the battery manufacturer:

Task	Interval	Described in
Visual check	6 months	Chapter 12.3.1
Functional test	6 months	Chapter 12.3.2
Electrolyte level of the batteries	3 months	Chapter 12.3.3
Battery compartment	Annually	Chapter 12.3.3
Fan replacement*	40,000 hours	Chapter 12.2.2

Table 10 Checklist for maintenance work

* Depends on the ambient conditions (observe the instructions of the fan manufacturer).

12.3.1 Visual Checks

When visually inspecting the unit, check whether:

- there is any mechanical damage or whether foreign bodies can be found in the system,
- any conductive dirt or dust has accumulated in the unit,
- accumulation of dust affects heat dissipation.

CAUTION:
The UPS must be disconnected from the power supply in accordance with Chapter 8 and charged capacitors must be discharged prior to carrying out the following work.

Always observe the safety regulations!

If large quantities of dust have accumulated, the unit should, as a precaution, be cleaned using dry compressed air, in order to ensure better heat dissipation.

The intervals at which visual checks should be performed are largely determined by the site conditions.

12.3.2 Functional Test

The functional test of the UPS should be performed every six months and include the following tasks:

- Activate the manual bypass via Q29 in accordance with Chapter 8

Disconnect the UPS in accordance with Chapter 8 and check the following functions when restarting the system:

- LEDs of the DOU
- Correct start-up of the rectifier and the inverter
- Functioning of the SBS control
- Check the output voltages of the rectifier and the inverter as well as of the SBS and the battery charging voltage.

12.3.3 Checking the Battery

The battery charge is checked automatically **once a week**.

If the UPS is out of operation for a prolonged period, maintenance-free batteries, for example, must be recharged at **three-monthly** intervals. **Observe the instructions of the battery manufacturer!**

Check the batteries in the battery compartment

CAUTION:
Acid fumes leaking from batteries in the battery compartment are **corrosive** and can cause **injury** upon contact with the skin and when inhaled.
The applicable protective measures must be observed in accordance with the safety regulations of VDE 0510, Part 2.

If the electrolyte level of open batteries has dropped to the minimum mark, the level must be topped up with distilled water in accordance with DIN 43530, Part 4.

The battery must be kept clean and dry in order to prevent creepage currents.

Only use pure water without additives for cleaning the plastic battery components, especially the cell compartments.

The following values should be measured and recorded at three-monthly intervals:

- battery voltage,
- voltage of block batteries, and
- electrolyte temperature with open batteries.

The electrolyte density (only with open batteries) and voltage of all block batteries must be measured and recorded **annually**. Screw connections must be examined annually for tightness.

Checks must be carried out in accordance with DIN 43539 Part 1.

Special checks, e.g. in accordance with DIN VDE 0108, must also be observed. Additional checks using automatic test equipment are not permitted. These require the written approval of the battery manufacturer.

NOTE:
If the battery voltage does not comply with the specifications and the battery cannot be recharged satisfactorily, please contact the AEG service department.

13 Spare Parts and Customer Service

Despite using non-wearing components, we recommend stocking the spare parts listed in Table 10. This will help to ensure permanent operational availability of your UPS.

Item	Component
F1 to F10	Fuse, 2 A, slow-blow
F13 to F22	Fuse, 5 A, fast
F24 to F27	Fuse, 4 A, fast
F28	Fuse, 2 A, fast
F31 to F33	Fuse, 5 A, fast
M1 to M10	Fans
K7	Contactor
Q1	Load interrupter switch
Q29	Uninterruptible changeover switch (option)

Table 11 Spare part stocks

NOTE:
When ordering spare parts, please always state the designation (item / component) and the unit number.

If the battery for the UPS system has been supplied by AEG Power Supply Systems GmbH, the battery has been specially designed for the Protect 5.31/xxx model. Use a comparable battery type when replacing the battery!

We would like to draw your attention to the fact that spare parts not supplied by us have neither been tested nor approved. Installation of such spare parts can therefore have a detrimental effect on the functional capability and passive safety of the system. We do not accept any liability for any resulting damage.
Our customer service department will be pleased to send you a complete spare parts list for your UPS.

Please contact the following address for help in this matter or if you have any further questions or suggestions:

AEG Power Supply Systems GmbH
Emil-Siepmann-Straße 32
D-59581 Warstein
Germany

☎ +49 (2902) 763 100
FAX: +49 (2902) 763 645
E-mail: Service-Be.aegpss@powersupplysystems.com

14 Annex

Optional equipment is available for the Protect 5. 31/xxx:

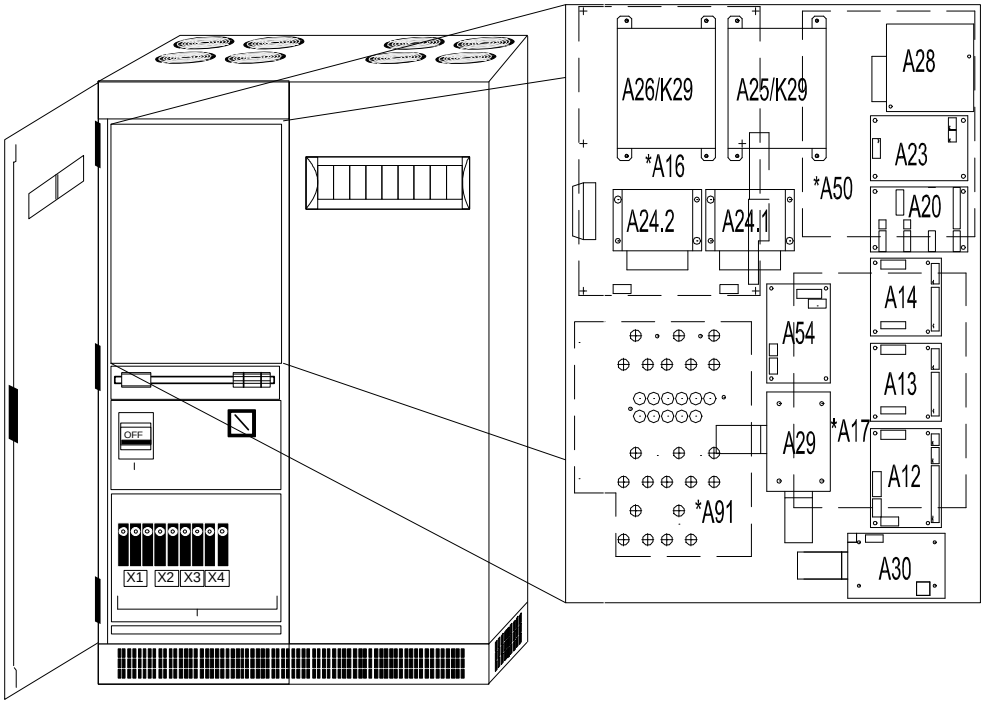


Figure 24 PCBs on the control unit pivot plate (sample model 40 kVA)

Options:

Slot	Designation
A13	Remote signalling expansion board 1
A14	Remote signalling expansion board 2
A20	Parallel operation adapter
A23	Power supply unit 24 V AC
A25	SNMP adapter (RFC1628)
A30	Modem UPS
A28	Power supply unit 12 V DC
A54	Measuring amplifier for temperature-dependent charging

Standard scope of supply:

Slot	Designation
A12	Remote signalling master board
A29	CAN COM controller (CCC)

Table 12 Legend for Figure 24

Please see the enclosed technical data sheet for the optional printed circuit boards and activated options installed in your unit.

Figure 25 shows all the PCBs included in the scope of supply. These are mounted on the control unit pivot plate behind a cover which can be opened by loosening the fixing bolts.

When **closing** this pivot plate, ensure that no cables are **pinched**.

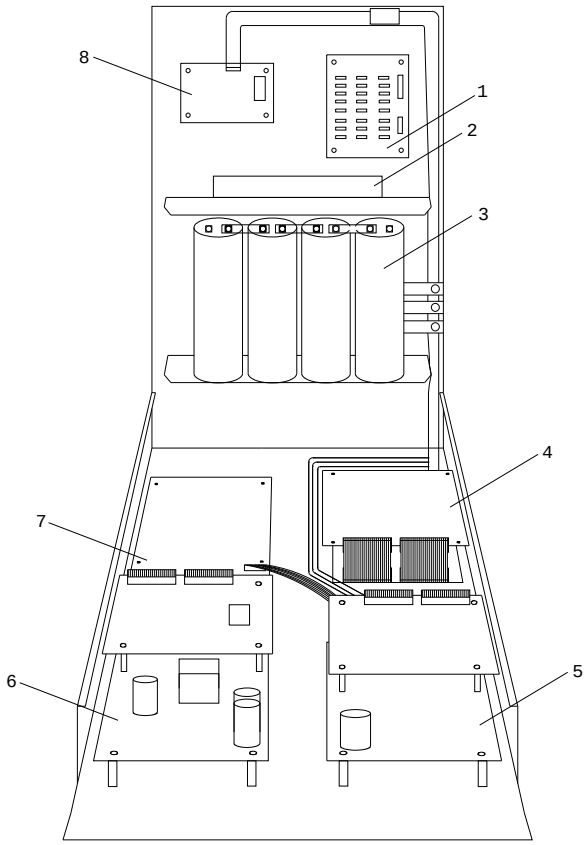


Figure 25 PCBs in the control unit pivot plate (sample model 40 kVA)

Item	Slot	Designation
1	A1-A80	Rectifier triggering
2	A1-A1	Inverter triggering
3	C42	Capacitor (number depending on capacity)
4	A17 A17-A1	Inverter interface Inverter control
5	A50 A50-A1	Rectifier interface Rectifier control
6	A16 A16-A1	SBS interface SBS control
7	A91	Fuse protection and fan monitoring (front)
8	A1-A36	SBS triggering

Table 13 Legend for Figure 25