

# SMART ENERGY STORAGE SOLUTIONS

User Manual



EN Version - Release date: August 2019

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## 1. GENERAL INFORMATION

Thank you for purchasing a high quality, German made product from BOS Balance of Storage System AG. We worked according to strict engineering standards in order to deliver valuable energy services for our customers. In case of technical problems or comments of any kind, please contact the local distributor for support.

Please read the whole content of this user manual before using the HS system. For installation and maintenance, please refer to IOM installation operation and maintenance manual.

### Application Scope

- This device is for residential, recreational & small commercial operations.
- The system must be installed indoors in a dry environment and in a well-ventilated area (not inside a cabinet or similar).
- Installation and maintenance must be only performed by qualified personnel. Warranty is void when the interior of the system has been modified by unauthorized personal.
- PV installation needs to fit to the overall system design. PV size recommendations are done in section 7 of this manual.
- If the sizing of the system is not done within the specification, warranty becomes void.
- Failure to follow this precaution can cause damage to this device and the energy source to which it is connected.
- Failure to comply with correct product usage may void warranty.

## 2. SAFETY INSTRUCTIONS

Use the device **only after reading & understanding this Manual**. Keep this document in a safe place for the entire service life of the device. Pass the document on to subsequent owners and operators of the device. If you have any question, please contact your supplier.

### General Safety Instructions

- This device contains sensitive electronics, so take care during installation and use.
- The product is used in combination with a permanent energy source (battery). Even if the equipment is switched off and circuit breakers opened (green), a dangerous electrical voltage can occur at certain system terminals.
- Never use the product at sites where gas or dust explosions could occur.
- Never operate the system in a wet or dusty environment.
- Best operating temperature is between 15 and 20 °C. Higher temperatures shorten the lifespan of the batteries and might cause inverter switch off due to elevated temperatures.
- Do NOT place the system in direct sunlight!
- Keep the device away from fire & other heat sources.
- Once the system has been installed, do not move or change its location without consulting first with your supplier.
- Maintenance must be performed by the product supplier.
- Do not store or place any object or device on top of the system.

- Do not block the air inlets located on the top corners of the system.
- If the system has been severely shocked or knocked, do not use it until it has been inspected by your supplier, since it could have produced an internal short-circuit or battery damage.
- Install this device step by step as written in this manual for best results.
- Use electrically insulated tools for connecting cables.
- The mounting and the electrical connection may only be carried out by trained specialists.
- Use only properly functioning test equipment with this device.
- Internal voltage of device may be higher than the rated level, take care to avoid being zapped during installation.
- Factory labels and markings must never be altered, removed or rendered unreadable.
- Consider all relevant official safety instructions during transportation of the device.
- Safety instructions might vary depending on the mode of transport and on local country regulations.
- Check the recycling information at the end of the user manual for disposal of device.

### Battery Safety Instructions

- All maintenance must be only performed by qualified personnel. Do not attempt to access the interior of the enclosure.
- Lithium and Pb batteries are volatile and can be very dangerous if mishandled, stored, charged or discharged improperly. Failure to read and follow these instructions may result in fire, personal injury, and damage to property.
- Explosion and fire hazard! Terminals of the Lithium/Pb Batteries are always alive; therefore, do not place any metallic object on the Lithium/Pb Battery.
- In case of fire, you must use a CO<sub>2</sub>, ABC or Foam Fire Extinguisher. If fire extinguishers are not available, use water or sand to put out the fire.
- When working with a battery, remove all personal metal items like watches, rings, necklaces and bracelets. Metal items in contact with the battery terminals might cause a short circuit with a very high electric current, which may heat up and melt nearby objects and cause severe burns.
- In case of contact with the batteries' electrolyte:
  - o Eyes: Flush with water for at least 15 minutes and hold eyelids open to rinse thoroughly seek medical assistance.
  - o Ingestion: Rinse mouth with clean water immediately, induce vomit under the direction of expert, and seek medical assistance.
  - o Inhalation: If inhaled, remove to fresh air immediately, seek medical assistance, and ventilate the contaminated area.
  - o Caution: In all cases if irritation persists, seek medical assistance at once.
- If battery emit peculiar smell, heating, distortion or appear any unconventionality during charging/discharging process, please disconnect it from the system and stop using. Please contact with your Product Provider.
- Do NOT connect anything to a damaged battery. It could heat up, catch fire or explode.
- Follow all safety precautions during installation of device & handling batteries.
- Improper handling of batteries may introduce a risk of battery explosion.
- Keep batteries away from children & animals.
- During handling of batteries no smoking or exposure to naked light & fire.
- Wear eye protection during installation process.

### 3. TECHNICAL INFORMATION

Our modular solar systems are available in different product sizes. This is a brief overview of the main technical attributes. For detailed information check the specific datasheet of your system.

Main Technical Data	Modular Solar Storage Systems
Nominal System Voltage	24 VDC / 48 VDC
Integrated Lithium Battery Capacity	2.5 5 or 10 kWh
Inverter Output	Pure sine wave
AC Output Voltage and Frequency	230V / 50Hz
AC Power Output	1600 - 5000 VA @25 °C
AC Power Output Peak	3 - 10 kW
AC Input Voltage and Frequency	187 - 265 V / 45 - 65 Hz
Max. Charge Current from Grid	35 - 70 A
AC Grid Bypass Current	16 - 100 A
Solar Charger Type	MPPT
Max. PV Open Circuit Voltage	100 or 150 V
Max. Charge Current from PV	50 A - 2x70 A
Nominal Total PV Power	Up to 10 kWp
Self-consumption	< 20 - 35 W
Style of Housing	Industrial enclosure
Max Wire Size	25 - 50 mm <sup>2</sup>
Weight	60 - 150 kg depending on system and battery size
Ambient Temperature	0 - 50 °C, maximum battery life at 15 - 25 °C
Features	Integrated display, remote 2G access, lithium balancing, priority selection AC/Solar, individually controlled AC outputs overload, overcurrent, short-circuit, deep-discharge, wrong-polarity protection

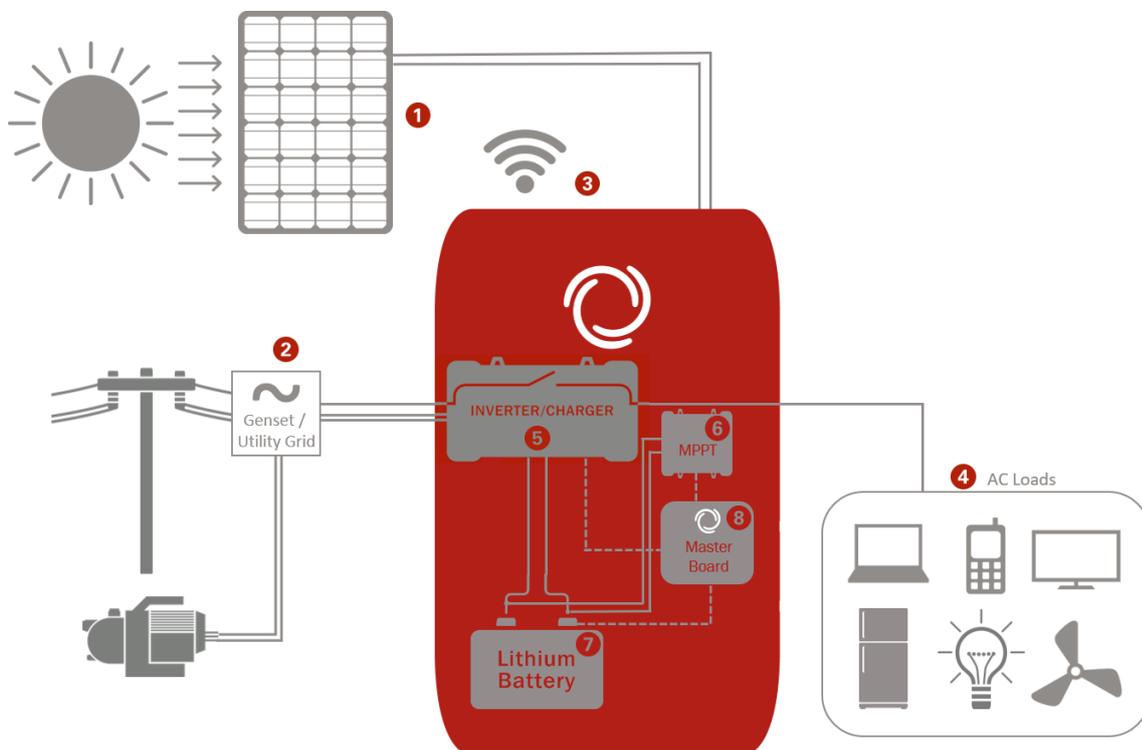
## List of Abbreviations

<b>Batteries</b>	
<b>SOC</b>	State of charge - describes how full a battery is charged.
<b>SOH</b>	State of health which is similar to the rest capacity of a battery.
<b>DOD</b>	Depth of discharge, which is $1 - \text{SOC}$ . 20% SOC equals 80% DOD.
<b>MPPT</b>	Maximum power point tracking, an algorithm to harvest most energy from PV modules at different weather conditions.
<b>BMS</b>	Battery management system, includes balancing functionality
<b>LiFePo4</b>	Lithium-Iron-Phosphate, which describes the lithium battery technology used in BOS systems.
<b>Electrics</b>	
<b>AC</b>	Alternating current, used in most loads and public grids.
<b>DC</b>	Direct current, used in PV modules, batteries or 12/48V application.
<b>ATS switch</b>	Automatic transfer switch, often used to choose genset or grid
<b>W</b>	Watt - describes the power. $1W = 1V * 1A$ .
<b>Wh</b>	Watt-hour. Describes energy like the size of a battery. 100Wh allows to power a 100W device for 1 hour or 10W for 10h.
<b>Photovoltaics</b>	
<b>Wp, kWp</b>	Watts or Kilowatts peak, which describes power of a PV module under STC.
<b>STC</b>	Standard test conditions, defined temperature and irradiation.
<b>OCV, Uoc</b>	Open circuit voltage, voltage at PV panel without load at STC.
<b>Isc</b>	Short circuit current, the maximum current a PV module provides
<b>Communication</b>	
<b>GSM</b>	Global System for Mobile Communications
<b>IMEI</b>	International Mobile Station Equipment Identity, an identifying number for a device in GSM network
<b>APN</b>	Access point name, needs to be selected for each GSM provider

## 4. OVERVIEW

BOS offers plug and play integrated PV battery solutions, which are integrated with lithium iron phosphate (LiFePo4) batteries together with charge controller and inverter. The graphic below gives a brief overview of the system and how it is connected.

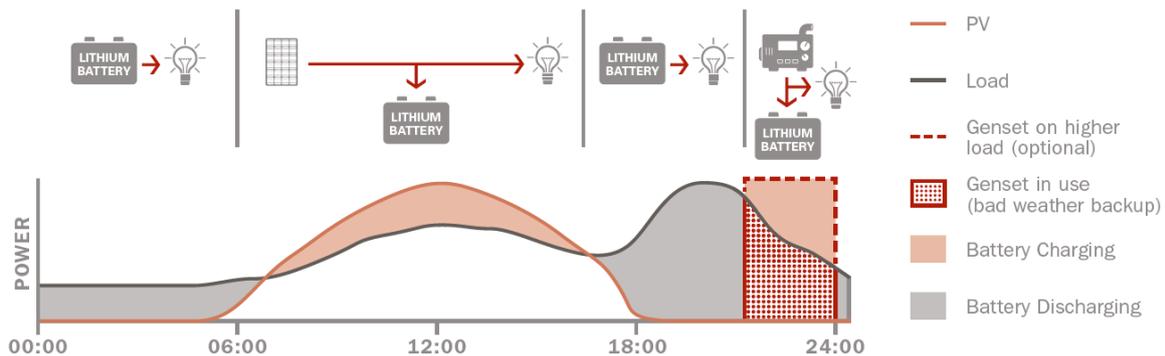
- This means, you can connect your AC loads directly to the HS system. It will automatically power your loads by photovoltaic energy, which can be stored in the lithium battery.
- For higher loads or in case of an empty battery, your HS system will connect automatically to public grid, diesel genset or any other backup power source.
- Also, you can select how much of your battery capacity should be used for backup purposes, to power your loads any time once public grid fails.



1. Solar Panels
2. Optional ATS Switch functionality, to switch Genset / Utility Grid
3. Optional GSM remote monitoring and PayGo functionality
4. AC Loads powered by HS system
5. Inverter/Charger
6. MPPT Solar Charger
7. Lithium Batteries LiFePO4
8. BOS Master Board controller

## 5. TYPICAL USE CASES

In most use cases any load needs to be powered, for example a household with typical load profile like shown in the graph below. This load profile is different to PV energy harvest, which will also vary depending of weather and season. Therefore, the lithium battery will buffer these differences. For additional energy consumption any backup power source like diesel genset or public grid can be used, too. Especially in case of unreliable grids and off-grid applications, BOS systems will provide clean and reliable energy to your loads.



### Residential Solar Systems – Power Every Day

BOS powers your entire home all day long. With BOS Smart Energy Storage Systems, all important residential AC appliances get enough energy whereby no utility power is required anymore. With all smart features and remote monitoring, living off-grid or zero net energy life can be achieved by BOS Smart Energy Storage Systems.

### Community Facilities – Long-Lasting Energy

BOS supports communities in becoming strong and independent by providing reliable and long-lasting energy for rural and semi-urban areas. Our energy solutions are capable of powering off-grid, rural community buildings like health facilities and schools with solar-based power systems and appliances.

### AC Mini Grid – Simplified and Modular

BOS Smart Energy Systems are specially designed for simplified AC mini grids. With its modular and integrated solution, BOS systems are easily scalable to different mini grid sizes and allow adding capacity to existing mini grids. Smart system sizing prevents complete grid failures as the mini grid is divided into multiple energy hubs and a backup system which can be lead acid system, diesel genset or both.

### Businesses – Smart Energy Models

BOS Smart Energy Storage Systems enables commercial consumers and businesses to achieve energy security and savings. BOS technology facilitates the management of different generating sources and operates in the most economical way to minimize fossil fuel consumption. With smart business models like Power-As-A-Service and reduced electricity expenses, businesses get the maximum value for their energy investments and can focus more on growing their key business.

## 6. SYSTEM FUNCTIONS AND OPTIONS

### Modular System

BOS systems are modular systems, which are pre-wired and pre-configured, requiring only solar PV modules to be installed at the site. Lithium battery and charge controller are one unit, while the solar generator, additional AC sources like utility grid or diesel genset and different loads are simply connected to the BOS hybrid systems using standard wire connectors. Components can be exchanged to achieve different system solutions like 120 -or 230 Volt applications with 50 or 60 Hz, different inverter and battery sizes but anyway a standardized system with low installation efforts and simple, effective management of standardized components and spare part management.

### Single phase, split phase or three phase

A single HS system can only be used for single phase operation. Up to three HS systems can be configured in parallel and 3 phase configurations, which requires the additional “three phase kit” hardware and configuration procedure described in the separate three phase manual.

2x120 V / 240 V split phase operation can be achieved with two 120 V units in split phase configuration, or one 230 V unit with split phase transformer.

### ESS Mode

The HS System AC charger is quite powerful and can charge batteries with high currents. Even though, it is important to use the grid as minimally as possible, in order to optimize the PV generation. Therefore, when the battery bank is above backup SOC level (adjustable from 0 to 100% SOC), the system will recognize it automatically and stops charging the batteries from the AC charger by using the available solar energy. Depending on the configuration used in the system, the grid can still bypass power to the AC loads.

### Off-grid Mode

When the AC input fails (or there is none), the system switches automatically into inverter operation mode without interruption. Therefore, the system can be used as a backup power system.

Please note: The system is not configured for health or safety applications or sensitive equipment. Therefore, special certifications might be required. Please consult your provider to know whether the HS System meet these requirements/regulations.

### Automatic Energy Saving Mode

All HS Systems have an automatic energy saving mode. Thanks to this economy mode, the self-consumption power of the inverter/charger is decreased by approx. 70% in no-load operation. When the batteries are not being charged by the grid, the inverter is switched off in case of no load or very low load. It will switch back on automatically, when load is connected.

### Protection Features

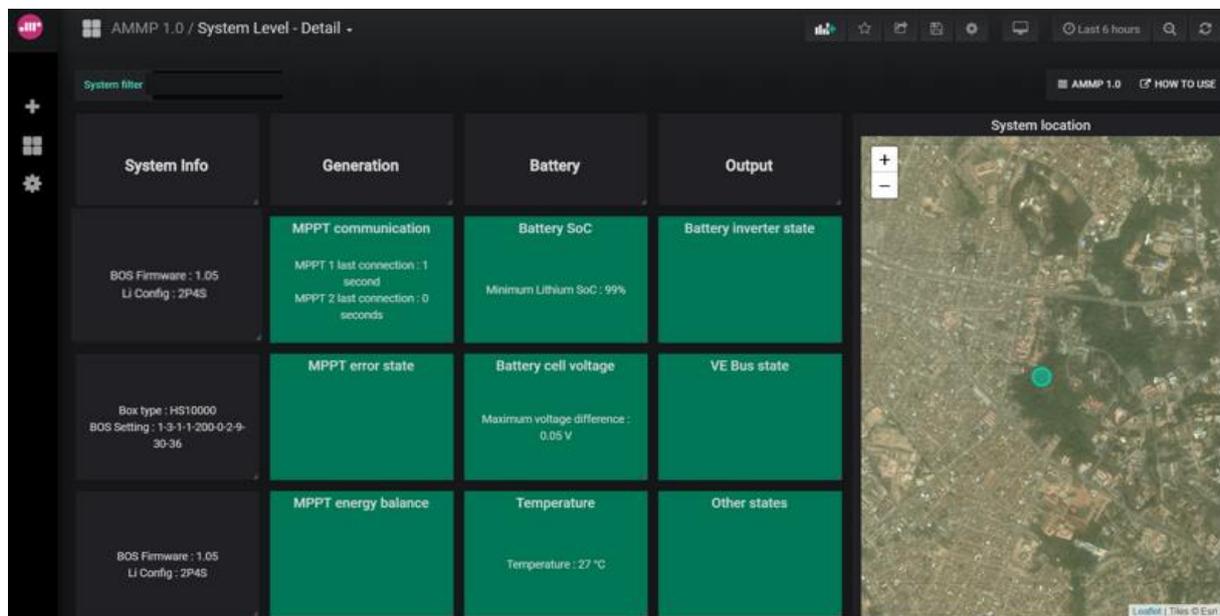
Due to the intelligent battery management, the systems are fully protected against overload and deep discharge, as well as overcurrent, short circuits, wrong polarity and temperature extremes. In cases of high temperature of the batteries, the Master Board switches on a cooling fan, to not exceed the temperature limit. Ultimately, this process prevents overcharging and over discharging.

In case of deep discharge or cell damage, the Master Board automatically triggers the battery breaker to protect the batteries from further damage. The Master Board and Balancers will go in sleep mode, consuming in total less than 5 mA. When the message: “Deep discharge” appears on the display, contact your supplier for support.

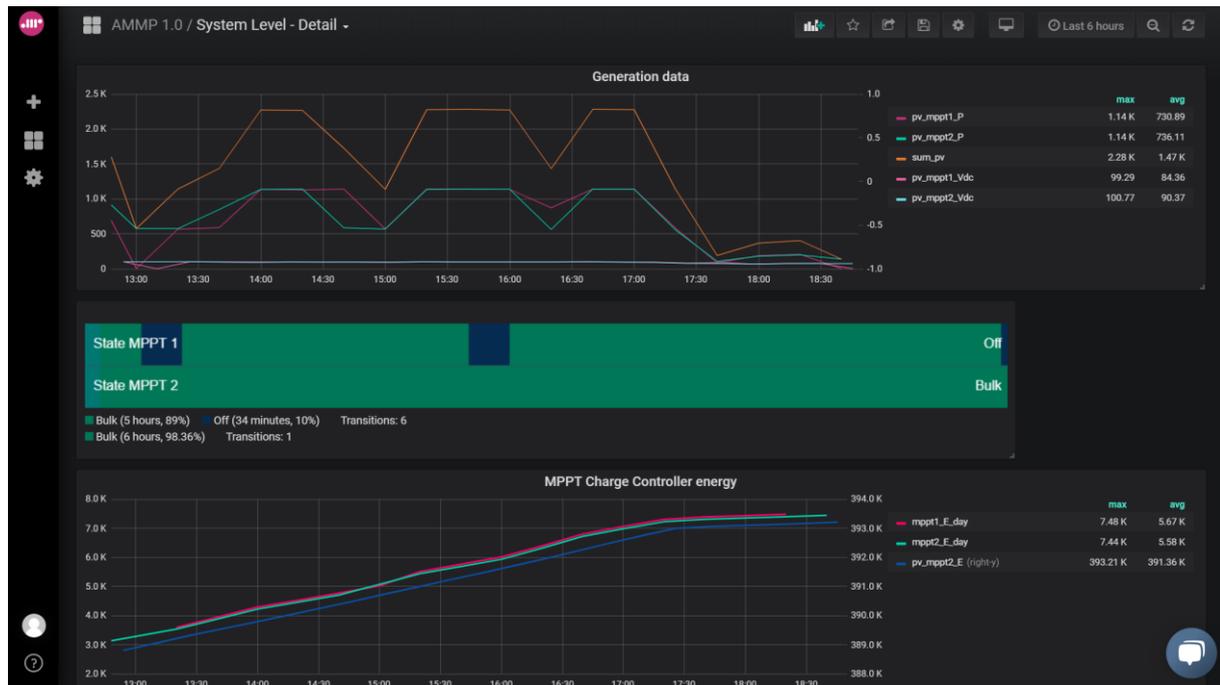
### Remote Monitoring

BOS battery systems can be monitored remotely, with the help of a GSM module embedded with the controller. The data can be sent from the system to the BOS monitoring system (developed by AMMP) or can be integrated with the customer’s monitoring platform. For customer’s using BOS monitoring system, BOS can monitor the systems’ service-related issues or regular preventive maintenance. Customer’s will also be given the access to the AMMP portal, if the BOS monitoring platform is used. For larger number of installations, customers can set up their own AMMP system, which can be customised for special needs and different language options.

System overview with tiles turning yellow and red for warnings



## System performance and monitoring graphs



## 7. SYSTEM COMPONENTS AND OPERATION

### System configuration

BOS products can be ordered with different configurations (see Chapter 3 - technical information). This chapter gives an overview how to set up and install a BOS system. Please be aware that because of modular systems approach, the number of batteries, inverter size or breaker rating can be different to the pictures shown in this chapter.

**WARNING: The installation and connection must only be done by the product provider. Especially make sure that:**

- System Installation must be performed by professionals that participated at a BOS installation training.
- This device contains sensitive electronics; therefore, electronics components must be handled with care and anti-static protection.
- The product must be installed in a heatproof environment. Ensure therefore that there are no chemicals, plastic parts, curtains or other textiles, etc. in the immediate vicinity of the equipment at any time that could cover the venting openings.

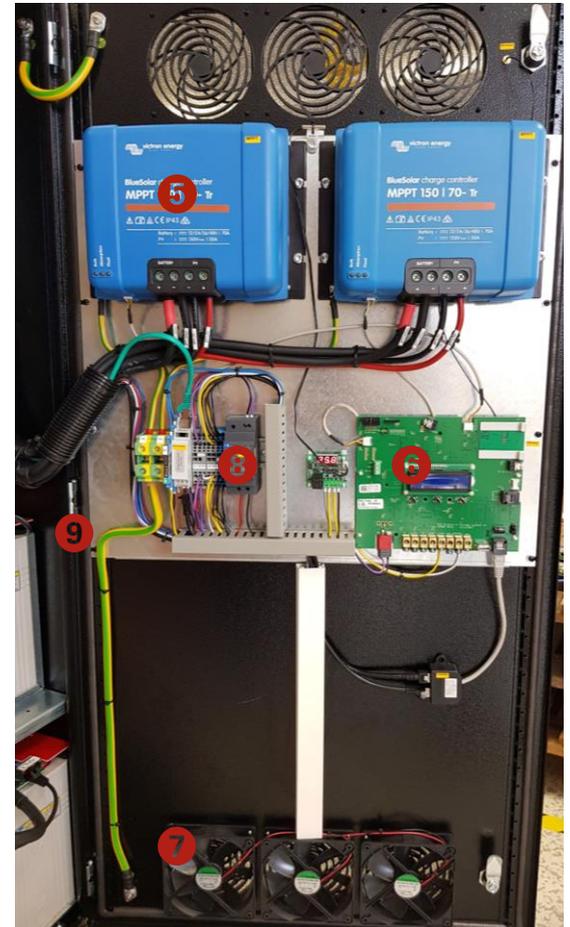
## System overview

The following pictures give an overview how the installed system looks like.

Overview insight Cabinet



Overview Door



1	Inverter (Picture shows 230V 5 kVA version)
2	Lithium batteries with integrated balancer boards
3	Cable channels
4	Connectors for AC input, AC output and Photovoltaics
5	MPPT chargers (Picture shows 2x MPPT 150/70)
6	BOS Master board (green PCB until V0.4 hardware, red PCB from V0.5)
7	Fans
8	DC / DC Converter
9	Earthing

## Lithium Batteries

The systems come with integrated lithium Iron Phosphate batteries and are pre-configured. Before installing the single battery blogs into the system, make sure the packs are pre-configured according to the Battery manual. The Battery- blogs should look like in the picture below:



NOTE: In some cases, the system and batteries must be shipped separately, or battery cells can be added to the shipment but must be assembled to battery packs locally. In this case please refer to latest battery assembly manual, which can be downloaded from [bosag.happyfox.com](http://bosag.happyfox.com).

Per system there is a minimum of two batteries in 24 V systems and a maximum of 8 batteries in 48 V systems installed.

## Battery Management System

The in house-built Battery Management System (BMS) protects the Lithium iron phosphate batteries from getting damaged and levels out the state of charge of each single battery cell. If voltage threshold is reached, the BMS switches on the balancer resistor. During the whole charging process, the BMS compares single cell voltages and balances the cells to the same state of charge, whenever it is necessary.

## Master Board

The Master Board is the main controller, communicating to all relevant devices in the HS system. Therefore, all relevant settings can be set in this device.

The table below shows, which connections are usually used for a standard system. For individual configuration there can be additional connections used,

Terminal	Cable to be connected
Li+	T-Plug Adaptor
GND LEFT	Double Black Cable with white Ferrule
GND RIGHT	Black Cable with Blue Ferrule
LOAD	Double Red Cable with white Ferrule
SIG	Blue Cable with White Ferrule
RS485#1	Patch Cable
VE.Direct 1	4 Pol Comm Cable from MPPT 1
VE.Direct 2	4 Pol Comm Cable from MPPT 2 (not used with 1 MPPT)
GSM Antenna	GSM Board

Once it is mounted and all cables are connected, the Master Board will look like this:



### Inverter

BOS Systems use a bi-directional Victron inverter, which can be ordered in different sizes from 3 to 5 kVA power, 120 or 230 V AC voltage.

The build in Inverter from Victron Energy features sophisticated full-bridge and toroidal transformer topology - which is suitable for powering sensitive electronics. It is overload, temperature, and short-circuit protected.

Whenever a high power is drawn on start-up, which can trigger false alarms and shutdowns, multiples inverters take care of this situation in a different way and only shut down in cases of persistent overload. Intelligent shutdowns will be followed by a series of restarts to eliminate 'false alarms'.

With its Power Assist feature the Inverter can add up to 5 kVA ( $\pm 22$  A) to the output during periods of peak power requirement. Together with a maximum input current of 100 A this means that the output can supply up to  $100 + 22 = 122$  A. An earth leakage circuit breaker and a fuse or circuit breaker, rated to support the expected load must be included in series

with the output, and cable cross-section must be sized accordingly. The maximum rating of the fuse or circuit breaker is 122 A.

### Photovoltaics

BOS HS Systems have an integrated Maximum Power Point Tracker (MPPT) solar charger. MPPT solar chargers are usually up to 30% more efficient than most of the PWM solar chargers and offer the potential ability to have an array with higher input voltage than general battery banks.

With an MPPT it is possible to use a wide variety of PV modules and layout. Following conditions need to be given:

- Short Circuit Current of PV Array is lower than maximum input current of 50A each MPPT.
- Open Circuit Voltage (OCV) of PV Array is lower than maximum input voltage of 150V. It is Important not to have an OCV too close to the MPPT max. voltage, since cold winter days will lead to higher OCV voltage which could damage the MPPT charger.
- PV Array voltage under MPP conditions must be at least 5V higher than system battery voltage.

Quantity MPPT	1	2
Battery Voltage	48 V	48 V
Rated MPPT Charge Current	70 A*1	2x 70 A
Nominal MPPT Power	48V * 70 A = 3360 W	2*48V * 70 A = 6720 W
Max. MPPT PV OCV	150 V	150 V
Max PV Short Circuit Current (per MPPT)	50 A	2 * 50 A
Number of PV Modules with 60 cells	15	30
PV Total Power	9 kWp*2	9 kWp*2
Configuration (S=Serie, P=Parallel)	3S5P	2x 3S5P

To use 72 cell modules, please get in contact with BOS AG. In this case the open circuit voltage under STC conditions might be below 150V, but in cold weather the voltage will be higher than under STC conditions. Therefore, if 72 cell modules should be used, carefully check PV module datasheet and coldest weather conditions for your location.

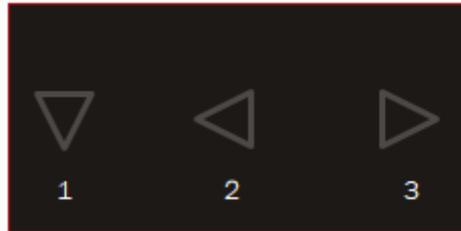
#### IMPORTANT:

The MPPT could get damaged if PV Array does not meet all MPPT requirements, especially overvoltage at PV input. Warranty will be void in such case.

Always switch on battery breaker first, then switch on PV breaker. Never switch on the PV breaker first, while battery breaker is switched off. This can damage the MPPT charger device.

## 8. MASTER BOARD SETTINGS

The system integrates a User interface in which the system information is displayed. The display is located on top of the system and includes three buttons to navigate through the menu.



1. Use this button to go through the different options in the menu. If you hold it, you will return to the previous option within the same menu.
2. Use this button to go back to the previous menu
3. Use this button to go forward to the selected option. Also used to increase/decrease values by pressing the button short or longer time.

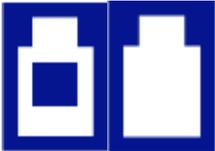
Following are the different parameters and options that can be seen/set on the display. Note that if the system is upgraded to a newer firmware, the number of options or parameters could have increased. **Options needed for HS10.000 in bold letters below:**

Field	Information in each field	Definition
<b>System Info</b>		
<b>1.1 Measurements</b>	Pb Volts (V)	Voltage of the Pb Battery Bank (Only HS500)
	Li Volts (V)	Voltage of the Li Battery Bank
	Li Amps (A)	Charge or Discharge Battery Current
	PWM PV OC (V)	When used the PWM Master Board Charger, this is the Solar Panels Open Circuit Voltage. (Only HS250)
	Signal (V)	Voltage of the Master Board Signal Output
	AC IN	AC Grid Charge Current.
	AC OUT	AC Load Output Current
	Grid Avail	Grid availability. It shows "yes" when there is voltage in the Inverter AC Input
	Hy Bat	Charge or Discharge current in Hybrid batteries. Measured by DC sensor. (Only HS500)
<b>1.2 Li Info</b>	Cell Voltage	Individual Voltage of each Li cell voltage
	Pack Voltage	Voltage of each pack (each pack has 4 cells)
	Highest cell	Voltage of the cell with higher voltage in the system
	Lowest cell	Voltage of the cell with higher voltage in the system
<b>1.3 MPPT Info</b>	Bat Volts (V)	Battery Voltage
	VPV	Photovoltaic Panels Voltage
	PPV	Photovoltaic Panels Power
	Ch. Bat I	Battery Charge current @ Bat Voltage
	Today (kwh)	Energy produced today
	Day Max	Max Power today
	Error Code	No error=0. For any other value, contact with BOS for support
	State	Charger State: Off=0, Fault=2, Bulk=3, Absorption=4, Float=5
	Last Conn	Time since last communication with Master Board
	Buf problem	N/A
<b>1.4 PayGO Info</b>	Code	GSM Board Imei Number
	Time left	Time before the system shuts down due to lack of credit.
	GSM comm	Time since last connection with server

1.5 Versions	SN	Serial Number
	TN	Part Number
	HW Version	Hardware Version
	SW Version	Software Version
<b>Display Settings</b>		
2.1 Display Settings	Change Contrast	
	Backlight within menu	
	Backlight outside menu	
<b>Protected Settings</b>		
3.1 Pb type	AGM	Select this option if Pb battery is AGM type (Only HS500)
	Flooded type	Select this option if Pb battery is Flooded type (Only HS500)
3.2 Signal Out	Li. Aux Switch	Used to trigger the Battery switch. <b>Select this option for HS10000</b>
	LE300 SOC Input	Used to read SOC from LE300. (Only HS500)
	PT function	N/A
	GND Connection	N/A
3.3 Storage Type	Li-Only	<b>Use this option for HS10000</b>
	Lead Acid Only	(Only for HS500 without LE300)
	Lead Acid & Ext. Li	(Only for HS500 with LE300)
	Hybrid	N/A
3.4 GSM APN		Select the right Sim Card APN from the menu. If the APN is not included in the menu, contact with BOS.
3.5 MPPT Enable		To enable/disable MPPT chargers
3.6 DC Sensor Calibration		Used to calibrate the External DC Sensor in the HS500. Do the calibration when the system is turned on for the first time. Important: Do the calibration with all the AC and DC outputs disconnected. (Only HS500)
3.7 Aux switch test		When pressing ok, the Aux switch will be triggered, which confirms safety feature is installed correctly.
3.8 GSM Settings		Select GSM and PAYG settings. Attention: Once PAYG is selected, it remains forever and can only be unlocked/changed by BOS.
3.9 Pb Capacity	25...200Ah	Select the total capacity @24V of the Pb batteries to achieve the most accurate SOC. (Only HS500)
3.10 Li Capacity	25...400Ah	Select the total capacity of the Li batteries to achieve the most accurate SOC. <b>Select 200Ah for the HS10000</b>
3.11 AC charge until SOC	0...95% SOC	Defines, up to which SOC level the battery gets recharged from AC grid
3.12 AC feed in		Allowed (feed into grid) / Not allowed (don't feed into public grid)
3.13 Grid AC-in limit	0...100A	Defines maximum current taken from AC input
3.14 AC in of PV	0...200%	Allows to loop through PV energy that is created from a second PV source connected to AC input, like lead acid backup mini grid. Standard setting is 0%.
3.15 Inverter Limit	0...10kW	Allows to limit maximum power of the inverter
3.16 Group setup	Solo or master/slave	Solo or master for single systems, and slave configuration if connected to other systems like 3 phase configurations
3.17 Enable fan	15...45 °C	Temperature setting to start the fan. 36 °C standard setting
3.18 Firmware Update		Displays that firmware updates are available, and allows to manually trigger remote firmware update procedure

## Display Symbols

The following table displays all symbols used on the Master Board display:

Symbol	Definition
	This means Excess Mode: On this mode, the Excess DC Load Output (which normally would be connected to not priority loads) will turn on and the AC Charging cut off (in order to use more optimally Solar Energy). When the lowest cell voltage is lower than 3.25V, then the Excess Mode is turned off.
	Communication issue. This could be related to: <ul style="list-style-type: none"> <li>- <b>Cell Voltages out-of-threshold:</b> Please check in Master Board “Li-info” menu that all cells are in between 2.85V-3.65V. If one is out of range, please contact your product provider.</li> <li>- <b>Faulty Balancer communication:</b> Please check all patch cables are properly connected in Master Board and Balancers</li> </ul> <b>Wrong protected settings.</b> Please check that the right protected settings have been selected.
	Night: There is no PV Charging at the moment.
	Daytime: There is PV Charging at the moment.
	Battery is not getting charged from PV.
	Battery is getting charged from PV.
	AC Grid input available
	State of Charge (SOC) of the Battery Bank. In case of

<div style="background-color: #0056b3; color: white; padding: 10px; font-weight: bold; font-size: 24px;">83%</div>	Hybrid Battery, it is the average SOC of Lithium and Lead Acid batteries.
<div style="background-color: #0056b3; color: white; padding: 10px; font-weight: bold; font-size: 24px;">26.4V</div>	In the case of HS500 this is the voltage measured at the Pb Battery Terminals. In HS10000, this is the Lithium Battery Voltage.

## 9. MAINTENANCE

This chapter only describes basic maintenance procedures that can also be executed by end users with basic technical knowledges.

Depending on national rules and regulations, it is recommended or required to do an annual electrical check-up, to confirm the condition of electrical devices and distribution lines is fully operational and there is no safety risk recognizable.

Beside this, the device itself is basically maintenance free. It is only recommended to keep the surfaces clean with a wet cloth. Do never get the wet cloth in contact with electrical devices or cables.

Also, especially in dusty environments, it can be necessary to clean the filters frequently. The filters can either be cleaned with vacuum cleaner, or the plastic frames can be opened with a screwdriver from the outside to remove and clean the filter mat separately.

## 10. TROUBLE SHOOTING AND FAQ

For service, support and maintenance please get in contact with your system distributor.

System distributors, please use our service platform [bosag.happyfox.com](https://bosag.happyfox.com) to download the IOM manual for questions regarding installation and maintenance. The platform can be used to download manuals, latest firmware, FAQ's and to get in contact with our service team.

The following procedures can be executed by end user, too:

### Error Messages

For error messages, please check Annex C. This will also describe what actions can be done in case an error message occurs.

### Restart of the System

To restart the BOS Master Board, please press all three buttons below the display at once. This action will reboot the system. Loads will turn off and turn back on after 10-30 seconds.

The restart of the system is also required in case the inverter experienced a continuous overcurrent or short circuit situation. This will be indicated by red blinking LED at the inverter. To restart the inverter, a restart of the BOS Master Board will be sufficient.

After the restart, the Master Board will display the firmware version and the configuration of lithium batteries connected. 1P4S for example means that there are four battery packs in series and 1 in parallel, which is a 5 kWh system. 2P4S indicates a 10 kWh system.

### AC and DC Breakers

In case of overcurrent, a breaker will turn off to protect cables and devices from overcurrent. The breakers can be manually switched back on. In case the breaker trips off again, please check if the loads connected fit to inverter size or if it is an overload condition.

The main DC breaker (battery breaker) also has an auxiliary switch. To turn this breaker on again, please press the small blue button at AUX switch if there is one. Systems with OEZ breakers do not have this button and can be switched on like each standard breaker.

## 11. STORAGE AND TRANSPORTATION

The battery system must never be transported with batteries built in. For transport, always disconnect and remove the batteries, and transport them separately in a way which is defined by UN 38.3 for lithium batteries.

- Consider all relevant official safety instructions during transportation of the device. Safety instructions might vary depending on the mode of transport and on local country regulations.
- Store the product in a dry environment; the storage temperature should range from 0 to 25 °C.
- In general, even if the system is unused, leave the PV input always connected to maintain the batteries always charged.
- If the system is going to be stored/unused without PV or AC input connected for more than 3 days, please disconnect the inner battery breaker to avoid their self-discharge.

## 12. DISPOSAL OF BATTERIES



DO NOT throw the battery in municipal waste. The symbol of the crossed out wheeled bin indicates that the battery should not be placed in municipal waste.

The recycling of the integrated lithium battery is handled in Germany by GRS Service GmbH.

Do not dispose in waste bin, but recycle electronics, batteries and packaging materials according to local regulations.

## 13. WARRANTY & LEGAL NOTES

### Warranty

The HS Systems come with a two-year warranty on the product including the integrated lithium battery starting from the date of purchase. There is no warranty granted on other system components from other manufacturers that are used together with the HS Systems. In case of problems, comments or a warranty claim or the need for spare parts, please contact your local dealer or BOS AG headquarters for support. No warranty applies to prototypes.

### Exclusion of Liability

The manufacturer can neither monitor the compliance with this manual nor the conditions and methods during the installation, operation, usage and maintenance of the device. Improper installation of the device may result in damage to property and, as a result, to bodily injury.

Therefore, the manufacturer assumes no responsibility and liability for loss, damage or costs which result from or are in any way related to incorrect installation, improper operation, incorrect execution of installation work and incorrect usage and maintenance.

Similarly, we assume no responsibility for patent right or other right infringements of third parties caused by usage of this device.

The manufacturer reserves the right to make changes to the product, technical data or installation and operating instructions without prior notice.

### Declaration of Conformity

The full declaration of conformity is found for download at [www.bos-ag.com/de/produkte/hybrid-backup-solutions/](http://www.bos-ag.com/de/produkte/hybrid-backup-solutions/)

### CONTACT HEADQUARTER

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BÖTTGERSTRASSE 2/2  
89231 NEU-ULM  
Germany

FON: +49 (0) 731 72 54 41 07  
SERVICE@BOS-AG.COM  
WWW.BOS-AG.COM

## APPENDIX A: SYSTEM OVERVIEW

### Colour of conductors:

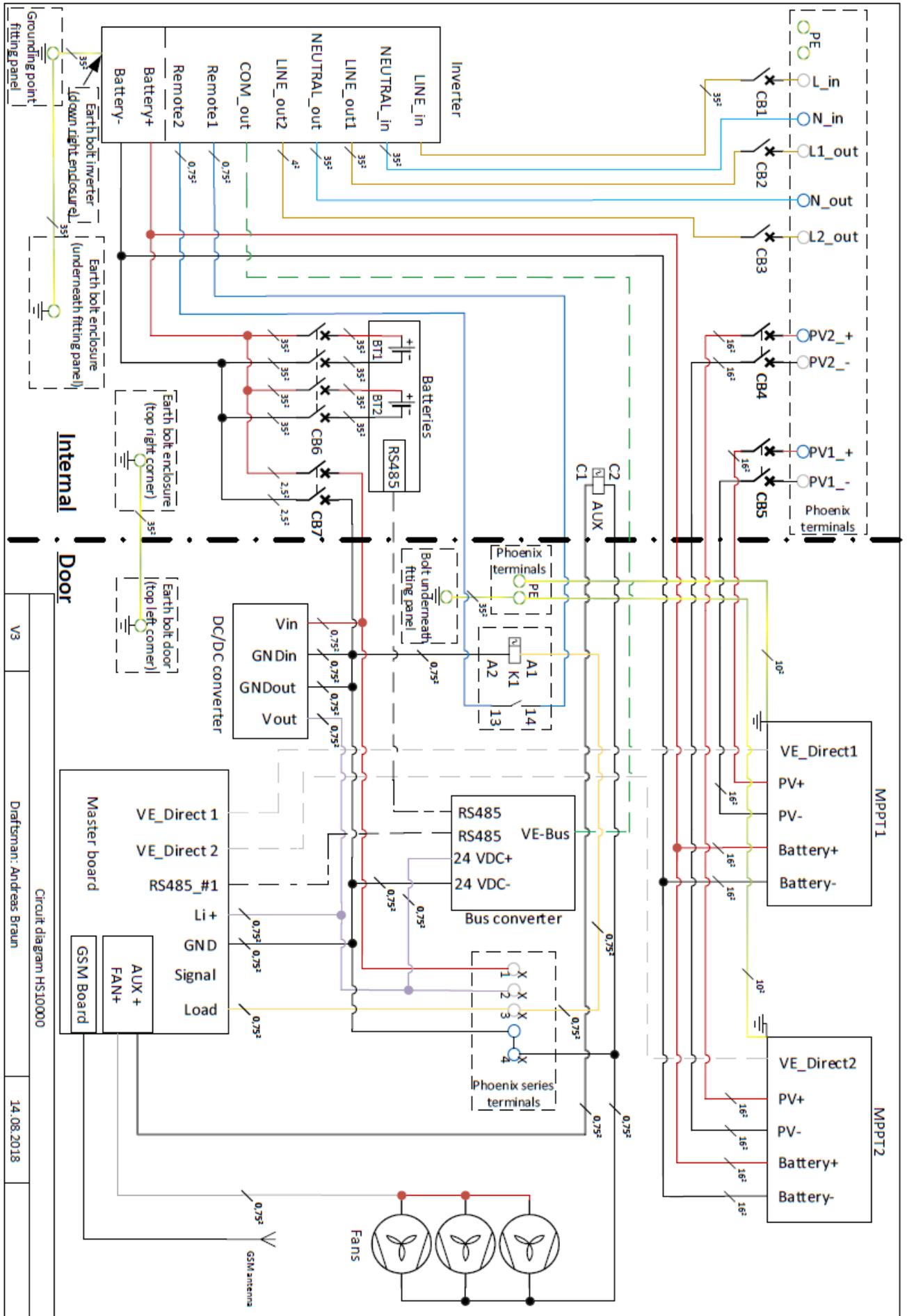
- red: 48 V+ and PV+ 
- black: GND 
- brown: phase 
- light blue: neutral conductor 
- yellow-green: protective earth conductor  (PE)
- dark blue: remote inverter 
- yellow: load output of master board 
- purple: 12 V+ 
- white: AUX+ output of master board (triggers AUX-switch) 
- grey: fan activation FAN+ master board 
- network cable green: VE Bus 
- network cable black: RS485/Modbus 
- communication cable grey: LiYY wire with four-terminal JST plug 

### Lines:

-  Current-carrying cables/hookup wires
-  Communication wires
-  Enclosure borderline: internal – door

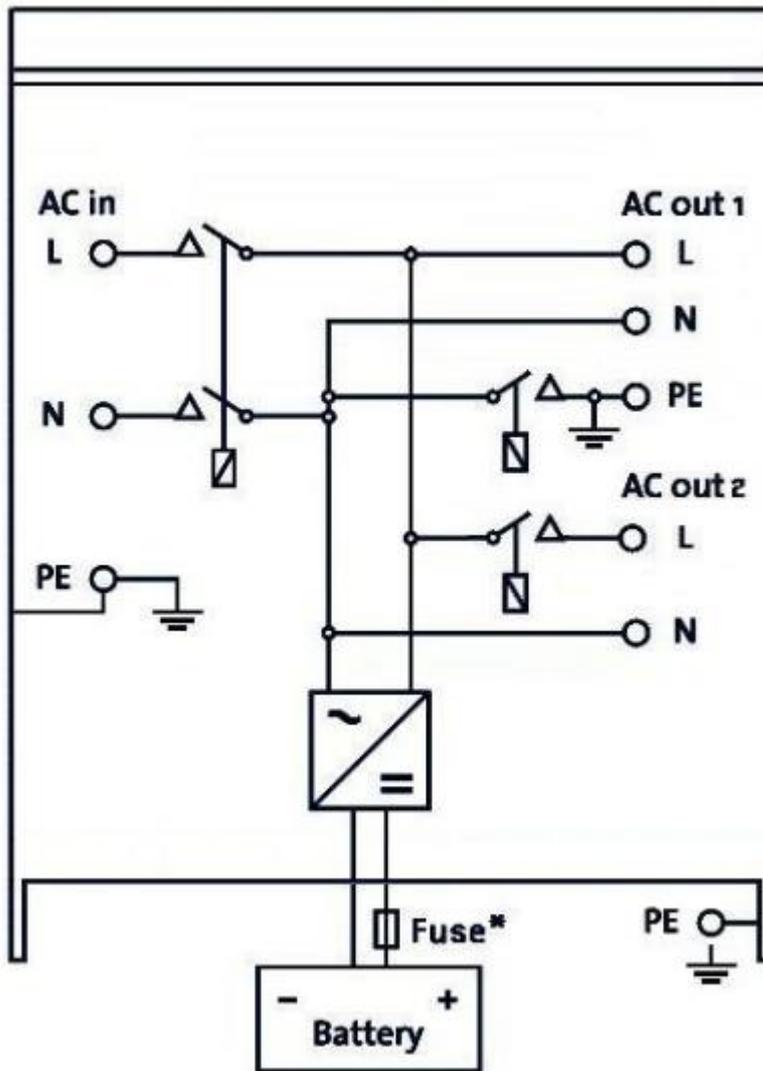
**Part description:**

Abbreviations	Whole descriptions	Data
CB1	Circuit breaker 1	C100 A, single terminal AC-breaker
CB2	Circuit breaker 2	C100 A, two-terminal AC-breaker
CB3	Circuit breaker 3	C25 A, single terminal AC-breaker
CB4	Circuit breaker 4	C63 A, two-terminal DC-breaker
CB5	Circuit breaker 5	C63 A, two-terminal DC-breaker
CB6	Circuit breaker 6	C100 A, four-terminal DC-breaker
CB7	Circuit breaker 7	C10 A, two-terminal DC-breaker
AUX	Auxiliary Switch, triggers four-terminal DC-breaker	MX+OF, 24 V - 48 V AC/DC
BT1	Battery 1	48 V DC, series connection of 4 single cells
BT2	Battery 2	48 V DC, series connection of 4 single cells
Phoenix terminals	Terminals for 4, 16 and 35 mm <sup>2</sup> wires (AC_in, AC_out, PV and PE)	PTI 16/S, PTI16/S BU, PTPOWER 35-PE, PTPOWER 35, PTPOWER 35 BU
Phoenix series terminals	Central allocation of all hookup wires, placed on DIN rail	PT 2,5.-QUATTRO, PT 2,5.-QUATTRO BU, FBS 2-5
K1	Relay 1 mounted on DIN rail (door)	RIF-0-RPT-12DC/ 1
GSM Board	Additional PCBA on master board	On top right of the master board
GSM antenna	Gilded antenna mounted on the outside (door)	Plugged in the GSM board
DC/DC converter	Voltage converter	Converts 48 VDC into 12 VDC
Fans	3x fan on bottom edge (door)	Connected in parallel with 2x Wago 221-412 in cable channel
MPPT	Maximum-Power-Point-Tracker	Adjusts the most efficient power point of the solar panels (depends on solar radiation)
Bus converter	Communication compiler	From VE Bus-terminal a green RJ45-wire to the inverter. Other RJ45-terminals with black wire to master board and balancer board.
Earth bolt	Gate hook with metric thread. Strength-welded to enclosure.	Mount earthing cable shoe, contact disc, washer and washer spring with nut on bolt
Grounding point fitting panel	Insert metric screw through fitting panel from behind	Mount earthing cable shoe, contact disc, washer and washer spring with nut on screw



Circuit diagram HS10000  
 Draftsman: Andreas Braun  
 14.08.2018

## APPENDIX B: INVERTER ELECTRIC DIAGRAM



## APPENDIX C: MASTER BOARD ERROR CODES

### Non-Confirmable Errors:

Error Code	Description	Action
#01	Internal Error: HAL error callback	Reset the device and notify BOS
#02	Internal Error: ADC default called	Reset the device and notify BOS
#03	Internal Error: I2C init	Reset the device and notify BOS
#04	Internal Error: ADC error 1	Reset the device and notify BOS
#05	Internal Error: ADC error 2	Reset the device and notify BOS
#06	Internal Error: Bal enable	Reset the device and notify BOS
#07	Internal Error: Modbus init	Reset the device and notify BOS
#08	Internal Error: I2C Semaphore	Reset the device and notify BOS
#09	Internal Error: I2C Read	Reset the device and notify BOS
#10	Internal Error: I2C Write	Reset the device and notify BOS
#11	Internal Error: LPUART1 RX DMA abort	Reset the device
#12	Internal Error: UART2 RX DMA abort	Reset the device
#13	Hardware Error: Tick timed out	Reset the device and notify BOS
#14	User Error: 3 times wrong password	Reset the device
#15	Internal Error: GSM Post String too long	Reset the device and notify BOS
#16	Internal Error: Global buffer returned by unauthorized task	Reset the device and notify BOS
#17	Internal Error: EEPROM unaligned	Reset the device and notify BOS
#18	Deep discharge Aux switch fired	call nearest Service
#19	Internal Error: UART Ringbuffer init	Reset the device and notify BOS
#20	Tamper detection: device erased	return the Master Board to BOS for ICT retesting
#21	MPPT firmware update needed	update all MPPTs
#22	Modbus internal error	Reset the device and notify BOS
#23	Wrong inverter ESS configuration	check inverter config file
#24	Updated VE.bus converter needed	Ask BOS for updated VE.bus converter
#25	SDcard timeout	Reset the device, backup SD card data and notify BOS

### Confirmable Errors:

Message on Display	Description
<b>OVERCURRENT PTC</b>	There was an overcurrent event on the internal PTC detected.
<b>OVERCURRENT LI</b>	There was an overcurrent event on the internal Lithium load output detected.
<b>OVERCURRENT PB</b>	There was an overcurrent event on the internal Lead acid load output detected.
<b>OVERCURRENT LOAD</b>	There was an overcurrent event on the internal load output or excess output detected.
<b>SHORTCIRCUIT LI</b>	There was a short circuit event on the internal Lithium load output detected.
<b>SHORTCIRCUIT PB</b>	There was a short circuit event on the internal Lead acid load output detected.
<b>L.VOLTAGEDROP PB</b>	There was high voltage drop over the internal Lead acid load switch detected
<b>L.VOLTAGEDROP LI</b>	There was high voltage drop over the internal Lithium load switch detected
<b>DEVICE RESTARTED</b>	The device has been restarted