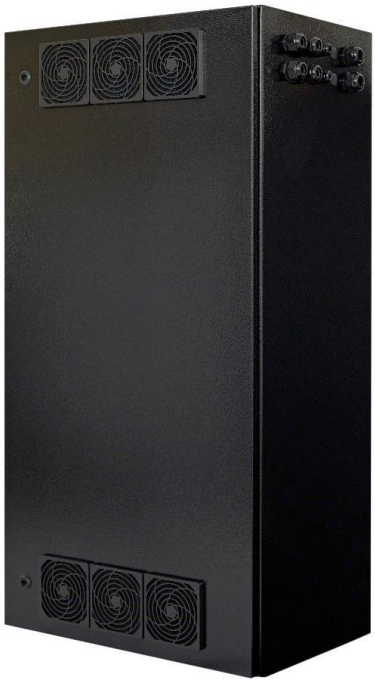
IOM MANUAL

Installation – Operation - Maintenance Manual

BOS Hybrid Storage Smart Systems

Business Versions



MADE IN GERMANY

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GENERAL INFORMATION

Thank you for purchasing a high quality, German made product from BOS Balance of Storage Systems 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.

Safety instructions

- Please read and understand the whole user manual before installation and usage of the Hybrid Storage Smart Battery System.
- This device contains sensitive electronics, so take care during installation and use.
- Lead acid batteries can generate explosive gases during operation. Never smoke, allow flames or sparks near the battery. Make sure to keep sufficient ventilation around the batteries and read the lead acid battery user manual.
- Protect the HS against heat (e.g. prolonged sun exposure), fire and from water. Do NOT store or operate the HS near hot or flammable objects.
- Install this device step by step as written in this manual for best results.
- After installation, the device needs to be fully charged.
- Do NOT charge the device over an extended period if the device is unused.
- After prolonged storage period, it may be necessary to charge and discharge the device numerous times to achieve the full performance capability.
- 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.
- Keep the HS away from paper clips, coins, keys, nails, screws, or other small metal objects, that can make a connection from one terminal to another. Shorting the battery-pack terminals together may cause burns or a fire. For short-circuiting damage caused in this manner, any and all warranty claims shall be invalid.
- Do not store or place any object or device on top of the system.
- Once the system has been installed, do not move, or change its location without consulting first with your supplier (see chapter “Repositioning”).
- Maintenance must be performed by the product supplier or trained personnel.
- Do not block the air outlets and inlets 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.
- Safety instructions might vary depending on the mode of transport and on local country regulations.
- Check Victron product manuals and safety instructions, when working on Victron products used in BOS systems.
- 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 during installation.
- 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.
- Incorrect operation can damage system components.
- The device must not be connected to a lead acid battery if it has a damaged casing.
- 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.

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- Check the recycling information 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 objects on the Lithium/Pb Battery.
- **In case of fire, you must use a CO_2, ABC or Foam Fire Extinguisher.** If fire extinguishers are not available, use water or sand to extinguish 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:
    - **Eyes**: Flush with water for at least 15 minutes and hold eyelids open to rinse thoroughly. Seek for medical assistance.
    - **Ingestion:** Rinse mouth with clean water immediately, induce vomit under the direction of expert, and seek medical assistance. Schadet das nicht der Lunge?
    - **Inhalation:** If inhaled, remove to fresh air immediately, seek medical assistance, and ventilate the contaminated area.
    - **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 by turning off all circuit breakers 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.
- Do NOT mix up the + (plus) and - (minus) poles of the battery.
- 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.
- Do NOT open the battery pack. Danger of short-circuiting.
- Do NOT use with nickel cadmium batteries, nickel metal hydride batteries or other battery types.
- Do NOT connect loads or power sources directly to the lithium batteries.

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Intended use of BOS Hybrid Systems

- The primary application of the HS systems is the stationary storage of renewable energy in the area of solar energy.
- The systems only power AC loads. Connecting loads directly to the batteries will cause inner damages.
- Basically, energy of your PV system will be used to charge the batteries and power your loads.
- The second Excess AC output is switched by BOS Master Board. Only in case of real excess energy or until a certain amount of battery SOC, it will be turned on.
- In case of grid input connection, the output voltage will just be modulated onto input voltage. That means, that voltage fluctuation will be looped to outputs as well, although the energy is taken out of the battery. Instable grids should be rather shut off.
- Several kinds of product configurations are available. For more information or upgrade possibilities, ask your HS supplier.
- This device is for residential, recreational & bigger commercial operations.
- Failure to follow this precaution can cause damage to this device and the energy source to which it is connected.
- Consult authorized supplier if device will not be connected in standard configuration.
- If sizing of the system is not done within the specification, warranty becomes void.
- Failure to comply with correct product usage or neglecting the user manual, the warranty and guarantee become void.

Site of operation

- The device is not permitted to be mounted in outdoors or exposed areas of interior spaces (e.g. outer wet chamber).
- Avoid dusty environments as well.
- Optimal operating ambient temperature is between 15 and 25 °C. Higher or lower temperatures shorten the lifespan of the batteries. Do NOT place device in direct sunlight!
- High air humidity recommends several special preparations. For this, ask your local supplier.

Disposal of batteries and electronical components

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. Tape or mask off the contact surfaces of the battery pack's terminals with adhesive tape before disposing of the device.
Only for EC countries:
According to the European Guideline 2012/19/EU, electrical devices/tools that are no longer usable, and according to the European Guideline 2006/66/EC, defective or used battery packs/batteries, must be collected separately, and disposed of in an environmentally correct manner.

Warranty

The HS Hybrid Storage systems come with a five-year warranty on the system enclosure workmanship and electronic components, and a three-year warranty on the batteries 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, a warranty claim or the need for spare parts please contact the local dealer or for support.

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LIST OF ABBREVIATIONS

Abbreviaton/unit	Explanation
µA	Microampere (unit)
A	Ampere (unit)
AC	Alternating Current
ADR	Accord européen relatif au transport international des marchandises Dangereuses par Route
AMMP	Asset Monitoring And Management Platform
AUX	Auxiliary (shunt trip) switch
BOS	Balance Of Storage Systems
CB1	(Miniature) Circuit Breaker (No.) 1
CE	Communauté Européenne
DC	Direct Current
DIP-switch	Dual In-line Package switch
EC	European Countries
E-Check	Electrical Check
ESS (Assistant)	Energy Storage System (Assistant of Victron Inverter Software)
EU	European Union
FAQ	Frequently Asked Questions
GND	Ground (negative level)
GRS	Gemeinsames Rücknahme System
GSM	Global System for Mobile Communications
HS	Hybrid Storage System
I	Current
IMEI	International Mobile Equipment Identity
K1	Relay (No.) 1
kW	Kilowatt (unit)
kWh	Kilowatt hour (unit)
LED	Light Emitting Diode
MB	Master Board
MCB	Miniature Circuit Breaker
mV	Millivolt (unit)
mm^2	Square millimetre (unit)
MPPT	Maximum Power Point Tracker
PE	Protective Earth
PV	Photovoltaic
PWM	Pulse Wide Modulation
RCD	Residual Current Device
RS485	Recommended Standard number 485
SOC	State Of Charge
SPD	Surge Protection Device
U	Voltage
UTC	Coordinated Universal Time (Zone)
V	Volt (unit)
VE.Bus	Victron Energy Binary Unit System
VE.Direct	Victron Energy Direct
W	Watt (unit)

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SERVICE PROCEDURES

Service contact

BOS Balance of Storage Systems AG
Böttgerstrasse 2/2
89231 Neu-Ulm
https://bosag.happyfox.com/home/
www.bos-ag.com

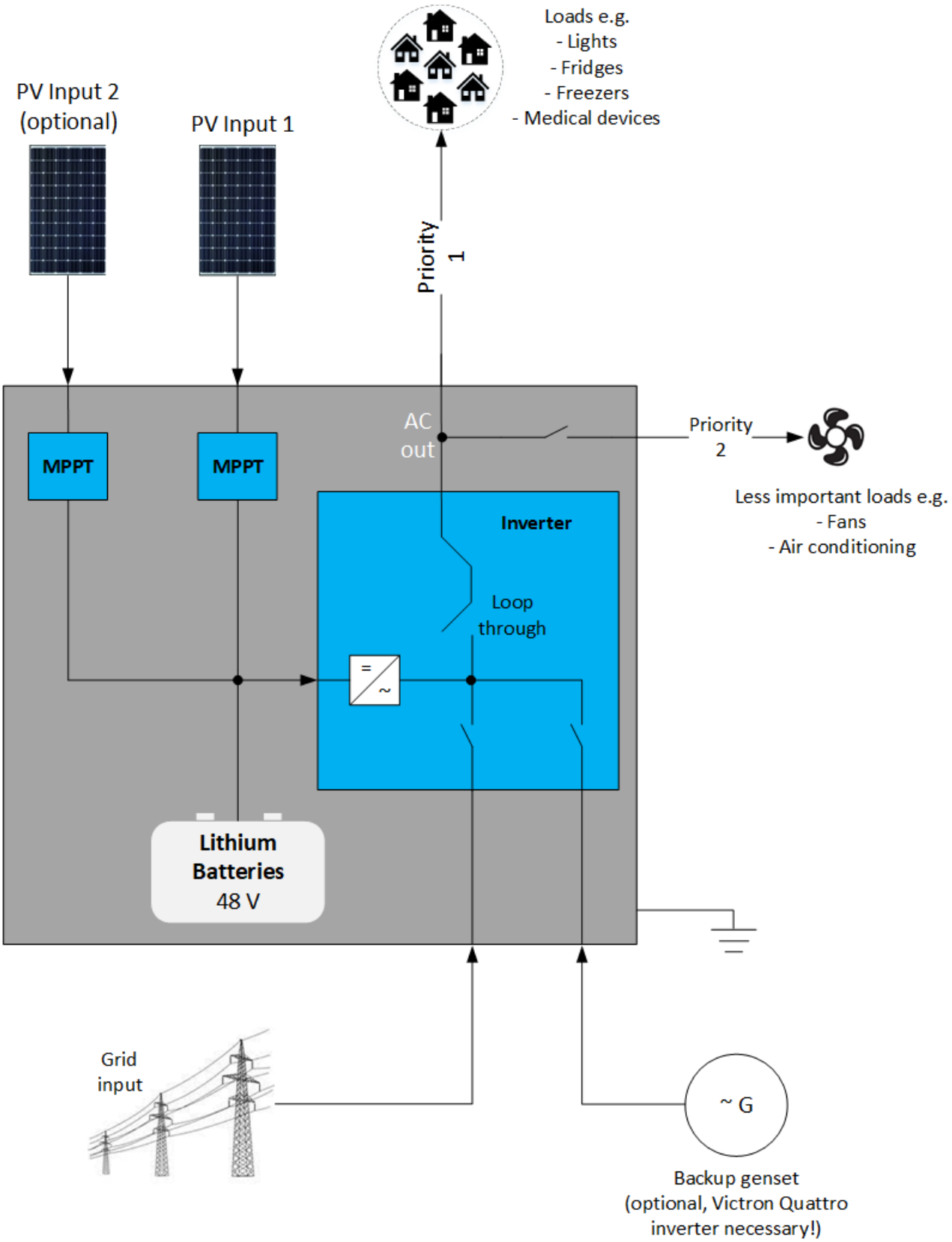
Remote firmware update

The remote firmware upgrade can only be done by BOS. Future systems will have automatic upgrade options.
For GSM upgrade, a functional SIM-card with data credit and sufficient reception is required. If you don't have a SIM-card, use the global BOS SIM-card provided. First, the SIM must be activated by your local supplier or BOS. Additionally, the system must be listed in the AMMP logging platform.

There are two ways of update installation: automatic update and manual update
Note: Both, the automatic and manual way, will last 2 to 5 minutes. During this time, the HS will not work!
For more information, see "GSM Monitoring".

SYSTEM OVERVIEW

System overview chart



Data sheet

Select your: BATTERY CAPACITY

Integrated battery capacity	5120 Wh	10240 Wh
Integrated battery type	Lithium-iron battery ($LiFePO_4$)	Lithium-iron battery ($LiFePO_4$)

Select your: AC OUTPUT VOLTAGE

AC output voltage	120 V	230 V
AC output frequency	50/60 Hz adjustable	50/60 Hz adjustable

Select your: INVERTER

Inverter type	3 kVA / Multiplus 1	3 kVA / Multiplus 2	5 kVA / Multiplus 1	5 kVA / Multiplus 2
Inverter output	Pure sine wave	Pure sine wave	Pure sine wave	Pure sine wave
AC power output	3000 VA @25°C 2400 W @25°C 2200 W @40°C 1700 W @60°C	3000 VA @25°C 2400 W @25°C 2200 W @40°C 1700 W @60°C	5000 VA @25°C 4000 W @40°C 3700 W @40°C 3000 W @60°C	5000 VA @25°C 4000 W @40°C 3700 W @40°C 3000 W @60°C
AC power output peak	6000 W	5500 W	10000 W	9000 W
Max. charge current from grid	35 A	32 A	70 A	50 A
AC grid bypass current	50 A	32 A	100 A	50 A

Select your: SOLAR CHARGER

Max. PV size	5 kWp	10 kWp
Solar charger quantity and type	1x MPPT 150/70	2x MPPT 150/70
Max. PV open circuit voltage	150 V	150 V
Max. charge current from PV	70 A	2x 70 A

General technical data

Nominal System voltage	48 VDC
Self-consumption	< 35 W
Max wire size	35 mm^2
Style of housing	Industrial enclosure
Housing dimensions	600 mm x 410 mm x 1230 mm (L x W x H)
Weight	190 kg (5 kWh) | 230 kg (10 kWh)
Ambient temperature	0 °C to 50 °C, maximum battery life at 15 °C to 25 °C
Protection	Overload, Overcurrent, Short circuit, Deep discharge, Wrong polarity
Features	Prewired, Preconfigured, Ventilation and temperature management, LCD-Display, USB charging port, Remote 2GSM access, PAYG remote control, Individual system monitoring and aggregated cluster monitoring, Lithium balancing, two individual controlled AC outputs, Priority selection AC in/Solar

DATASHEET IS SUBJECT TO CHANGE. REVISION MAY 2018

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UNPACKING THE PRODUCT

Condition of product

Cut package band and take off protection foam and cartons. Open cabinet with key provided.
Ensure:

- Interior must be dry
- Dirt or dust must not be inside
- Check parts if they are broken, cracket or mashed

If the outer package is intact, in most cases, the content will be intact as well.

HS Business 5 (3 kVA)

HS Business 5 (5 kVA)

HS Business 10 (5 kVA)

List of components provided

Components provided	Pcs. HS Business 5	Pcs. HS Business 10
Li-Battery blocks (four cells each)	4	8
Carton with battery assembling material	1	1
Cables battery connection	5	10
Master Board (and additional mounting material)	1	1
GSM Board for Master Board + antenna (optional)	1	1
Cable feedthrough M32	2	2
Cable feedthrough M25	4	4
Cable feedthrough M20	4	4
Key for cabinet	1	1
Inverter User Guide	1	1
MPPT User Guide	1	1
Bottom plate	2	2
Edge protection (for lower bottom plate)	2	2

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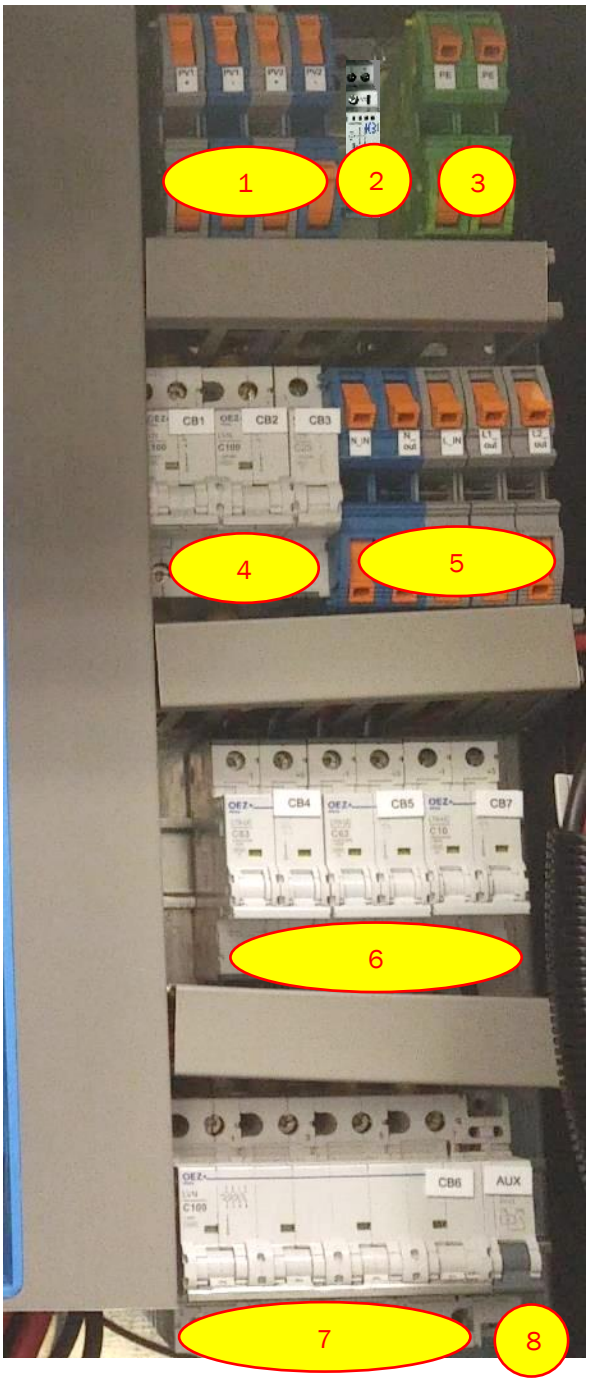
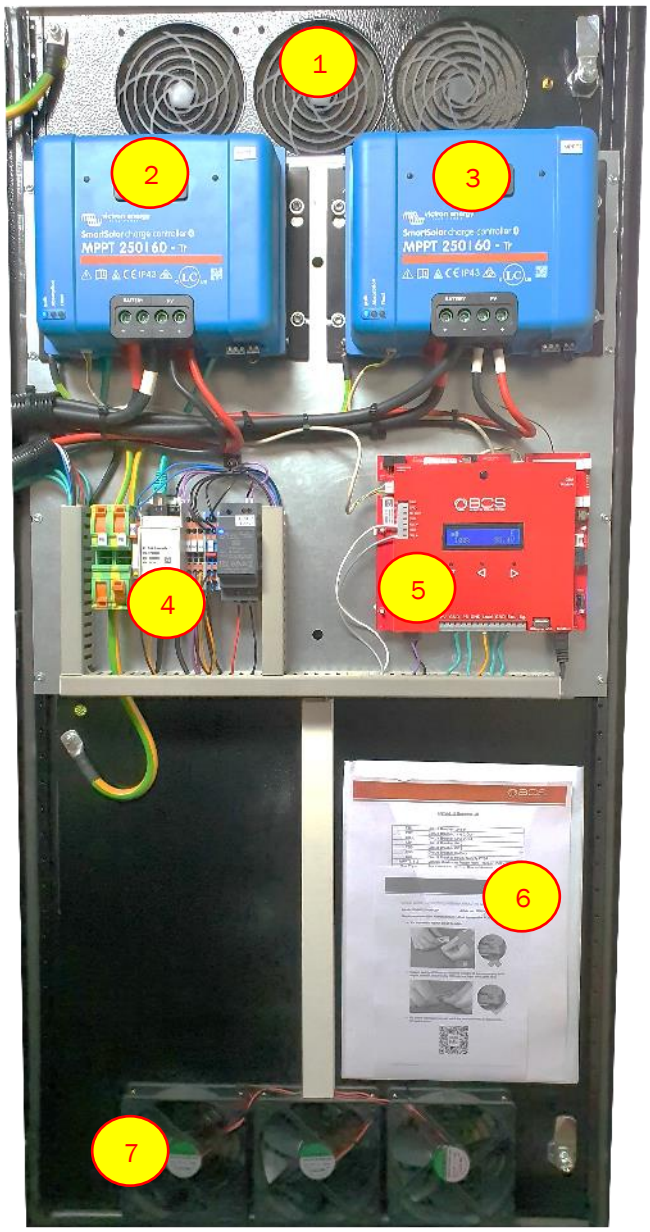
EXPLANATION OF COMPONENTS

Build-up of cabinet



No.	Description
1	PV input terminals (max. 35 mm²): - Grey: positive level (+) - Blue: negative level (GND) PV2 input is optional
2	K3: relay for second AC output (prioritized)
3	Earthing (PE) terminals (max. 35 mm²)
4	AC miniature circuit breakers: - CB1: AC input - CB2: AC output number 1 (high priority) - CB3: AC output number 2 (low priority)
5	AC input/output terminals (max. 35 mm²): - N_IN: neutral conductor input - N_out: neutral conductor output - L_IN: line conductor input - L1_out: line conductor output (high priority) - L2_out: line conductor output (low priority)
6	DC miniature circuit breaker: - CB4: PV input 1 - CB5: PV input 2 (optional) - CB7: Master Board
7	CB6: miniature circuit breaker batteries
8	AUX: shunt trip remote shut down for CB6



No.	Description
1	Ventilation outlet
2	Maximum Power Point Tracker PV input 1
3	Maximum Power Point Tracker PV input 2 (optional)
4	DC distribution and earthing - PE: earthing of door - K1: relay inverter remote control - VE.Bus Converter: communication translator - X1: 48 V input battery side - X2: 12 or 24 V distribution - X3: load output Master Board - X4: GND terminal - DC/DC Converter: voltage converter 48 V to 12 or 24 V
5	Master Board
6	System documentation - GSM board installation - Legend - Circuit diagram - Further installation information - Warranty plan
7	Fans (cabinet ventilation)

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PREPARATION BEFORE INSTALLATION

Required tools and software

Ensure all safety instructions are well-understood. To connect cables to the HS, VDE screwdrivers are necessary to avoid short circuits and electric shocks. A multimeter is recommended to measure inputs and outputs of both, AC and DC side. BOS provides all of these and many more tools in a BOS Tool-Kit:

Tools for electrical installation:

Tool No. 1

Tool No. 2

Tool No. 3

Tool No. 4

Tool No. 5

Tools for general mechanical and PV installation:

Tool No. 1

Tool No. 2

Tool No. 3

Tool No. 4

Tool No. 5

Tool No.	Description	Tool No.	Description
1. Clamp multimeter	Measures current up to 400 A cordless and diode, voltage, resistance, etc. tethered.	1. Drill set	Metal drills from 1 mm diameter up to 10 mm.
2. Cable plier	Cutting and stripping cables up to 50 mm² conductors.	2. Bit set	Slotted, Philipps, Torx, Allen key and hexagon socket bits in different sizes.
3. Cable stripper	Automatic stripping plier up to 6 mm² conductors.	3. Wrench (Allen key)	For tightening Allen screws (PV mounting).
4. VDE screwdriver set	Insulated screwdriver set (safe working up to 1000 V operation voltage).	4. Ratchet wrench 15 mm	Tightening hexagon socket screws (PV mounting)
5. Crimping tool	Crimps ferrules up to 10 mm² flexible conductors.	5. Ratchet wrench 13 mm	Tightening screws (surge protection mounting)

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Furthermore, the “BOS Starter-Kit” and a laptop with relevant software tools and firmware are required to update the system or change settings.
In case one wants to update the latest firmware on the Master Board or change settings/firmware op the inverter or MPPT, a BOS Starter-Kit is needed.

Tools and spare parts:

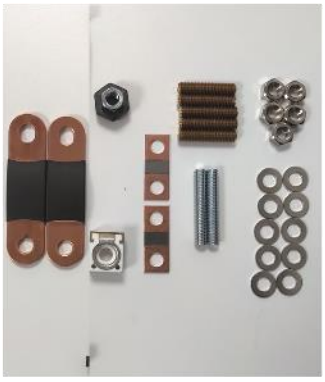
No. 1

No. 2


No. 3


No. 4


No. 5


No. 6


No. 7

Adapter and cables:

No. 1


No. 2

No. 3


No. 4

No. 5


No. 6

No.	Description	No.	Description
1. Bit set	For assembling batteries and further mechanical work	1. VE.BUS to USB adapter	To connect laptop with Victron inverter.
2. Screwdriver 0.8 x 4 x 24 mm	Connecting cables to big 35 mm² spring close device terminals	2. VE.Direct to USB adapter	To connect laptop with Victron MPPT.
3. Cabinet key and earthing material	Spare part.	3. J-link Adapter	For flashing Master Board.
4. Balancer Board	Spare part.	4. USB A to USB B cable	To connect J-link adapter with laptop.
5. Tools	Wrench insert for battery assembling and screwdriver for connecting cables to Master Board terminals.	5. Patch cable	Spare part (also usable as an extension cable).
6. Mechanical parts	Spare parts (batteries).	6. Ribbon cable	To connect J-link with Master Board.
7. Torque wrench	For assembling batteries.		

For assembling the battery blocks, following tools and equipment are needed:

- Slotted screwdriver 1,0 x 5,5
- Torque wrench
- Hexagon socket wrench insert SW 13
- Screwdriver cross recess PZ1
- Allen key 4mm

Optional and nice to have:

- Cordless screwdriver
- Machine tap M4
- Drilling and cutting oil
- Double open-end wrench SW 8

Pre-assembling battery blocks

Follow installation instructions of

- **BATTERY BLOCK WITH CUBE FUSE 97908500**
- **BATTERY BLOCK WITHOUT SHUNT 97908400**
- **BATTERY BLOCK WITH SHUNT 97908300**

The last two steps of each instruction are relevant now to follow up with the installation of the battery bank(s).

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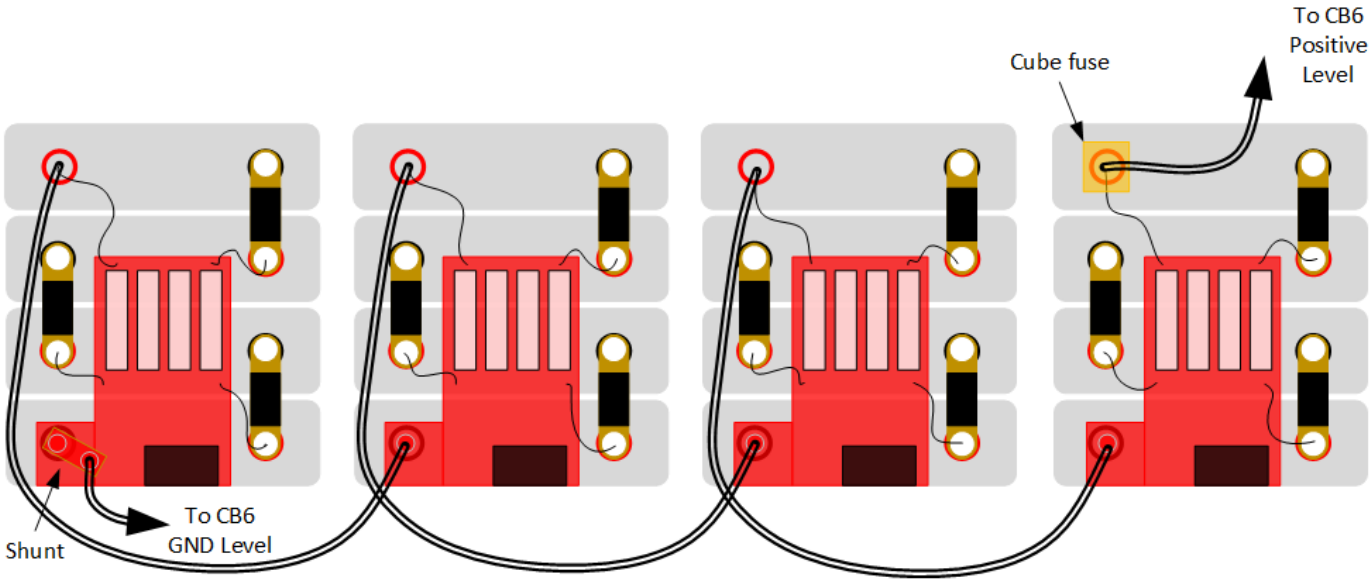
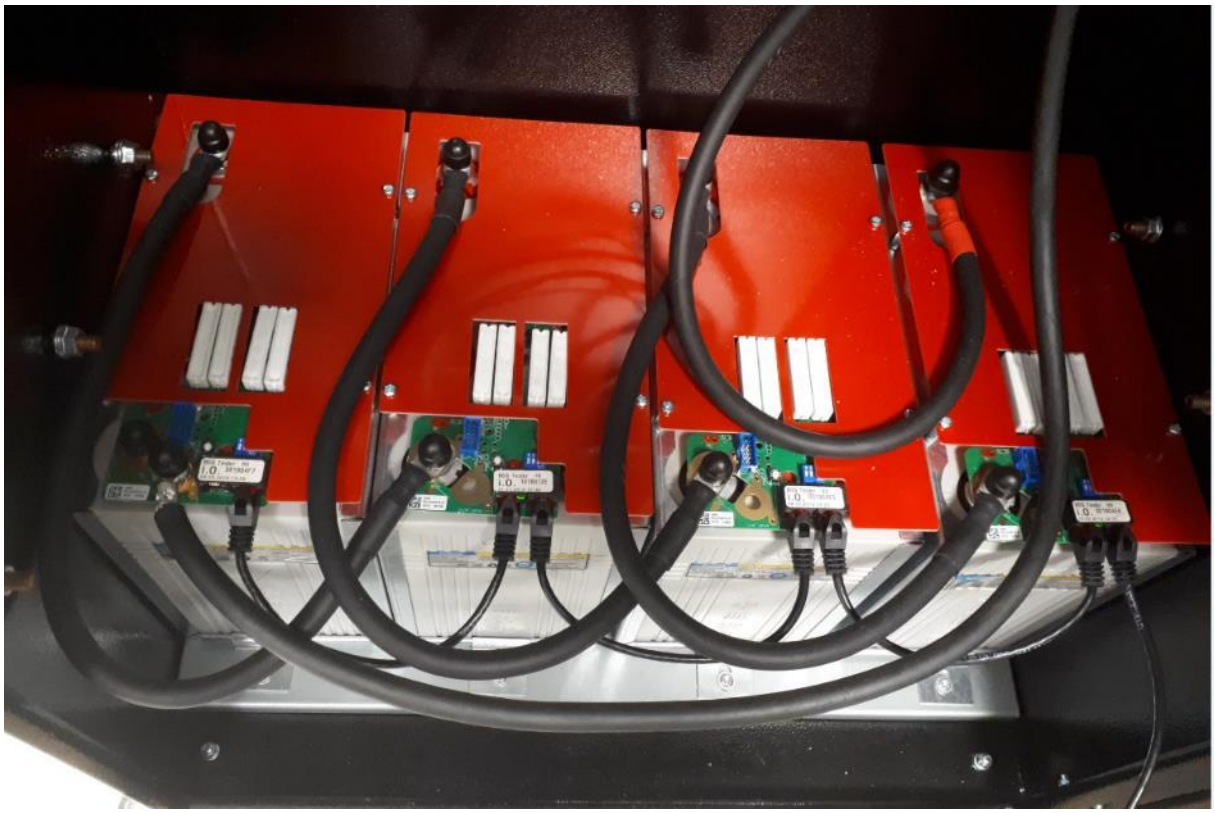
ASSEMBLING THE SYSTEM

Installing battery bank(s)

HS Business 5 systems receive one battery bank, HS Business 10 systems receive two.
All battery banks are similar constructed as shown in pictures below:





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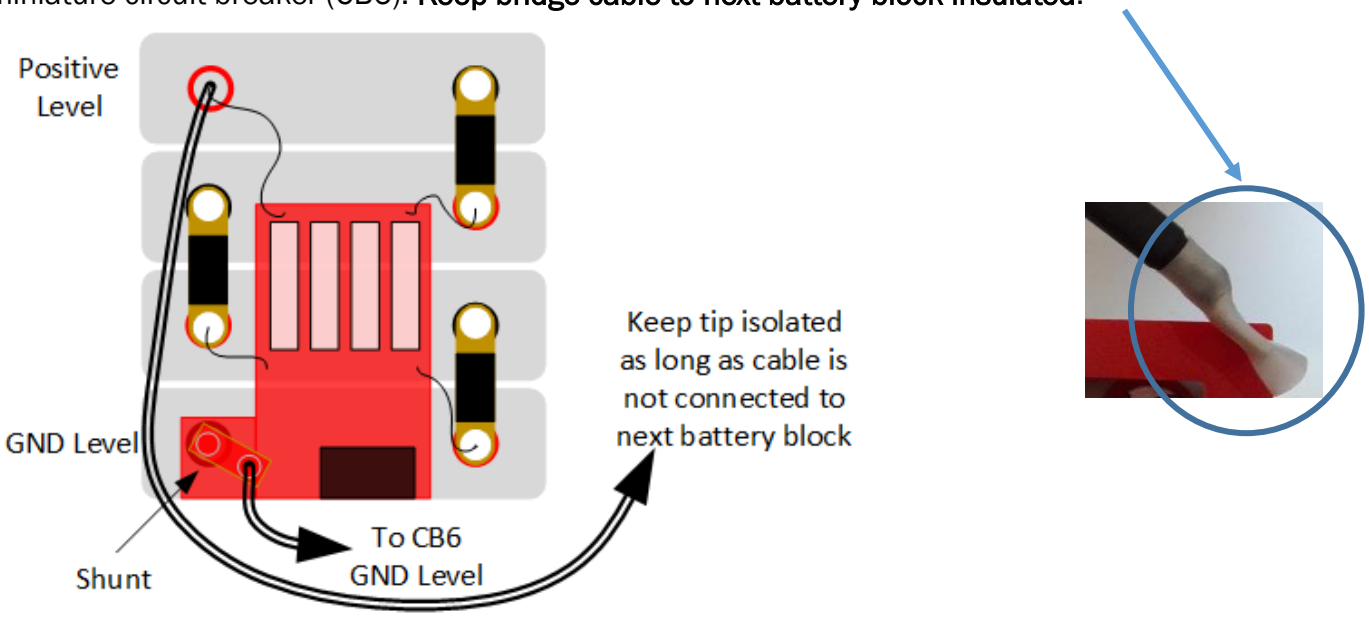
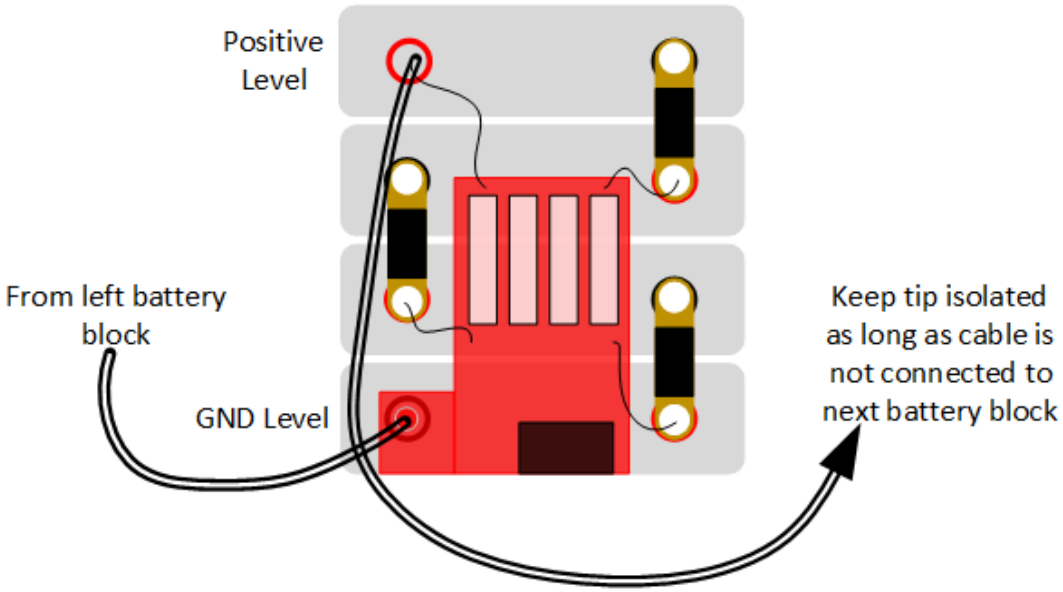
Step 1:
Put in lower bottom plate. Insert first battery block <u>with shunt</u> at the very left and connect GND cable to miniature circuit breaker (CB6). **Keep bridge cable to next battery block insulated.**



Step 2:
Insert second battery block and connect bridge cable from first battery block to GND level. Keep bridge cable to next battery block insulated.



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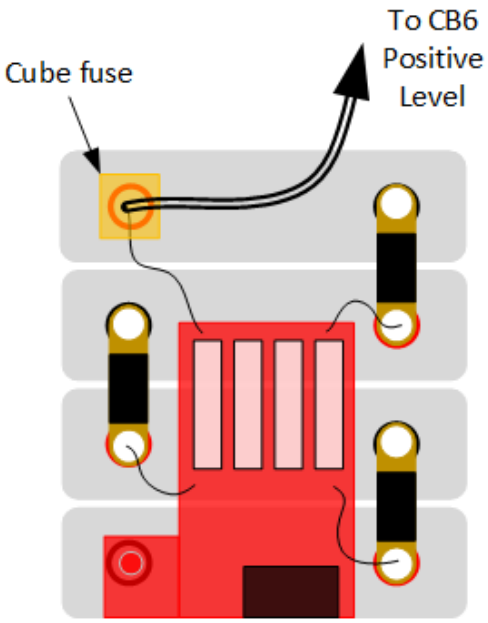
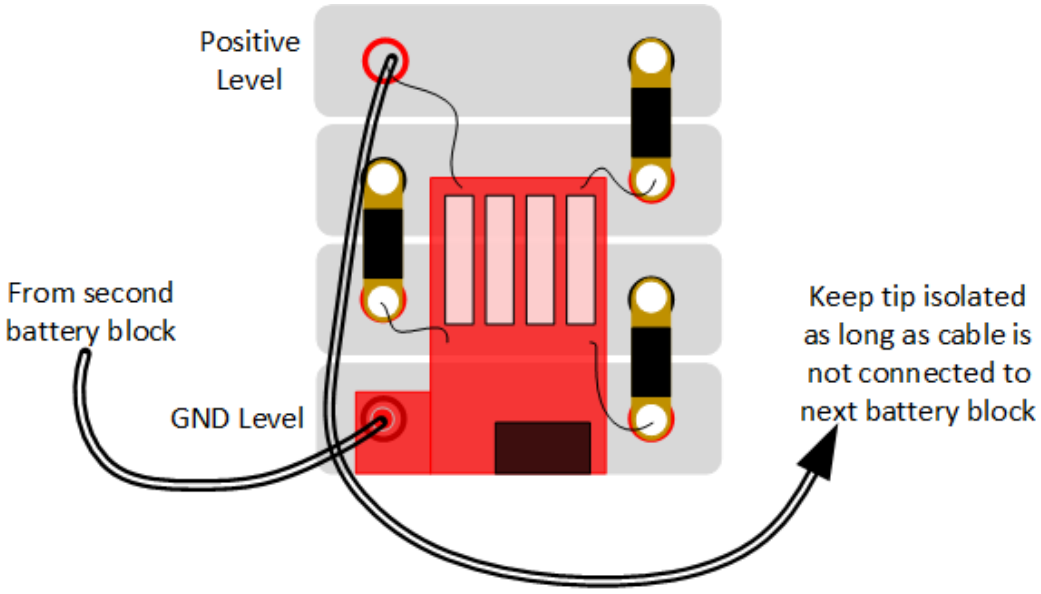
Step 3:
Insert fourth (very right) battery block with cube fuse and connect + level cable to miniature circuit breaker (CB6).



Step 4:
Insert third battery block. Connect the two remaining bridge cables to the battery poles.



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Step 5:
At the very end, fix the battery blocks with brackets and screws provided.

Step 6:
Each battery block must be addressed before communication is possible. Therefore, adjust DIP-switches on Balancer Boards. Each block must receive a **unique** address. Address “0000” is not allowed.
We recommend following addresses for HS Business 5: 0001, 0010, 0100, 1000
And for HS Business 10 systems furthermore: 0011, 0110, 1100, 1001

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Step 7:
In case you are installing a HS Business 10:
Put in upper bottom plate and go on with step number 1 … 6 again.

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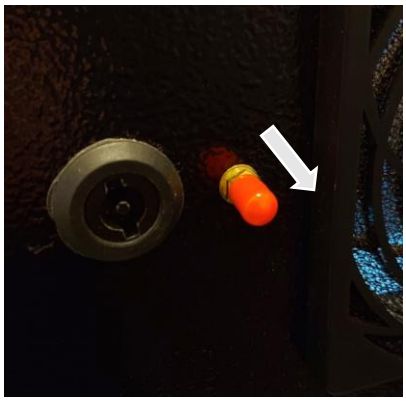
Installing Master Board (MB) and GSM Board

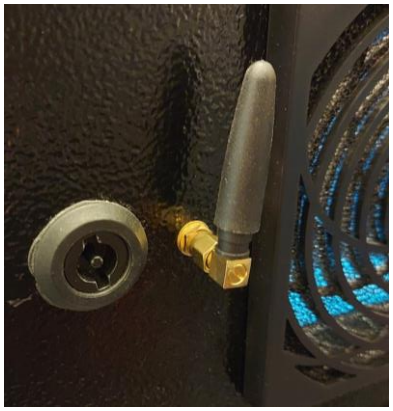
See Quick Start Manual – Master Board & GSM Module Installation

Ensure the SIM card is activated and has enough data credit. Check credit regularly, sending data without enough credit is not possible.

Prepare antenna installation by removing the red cover from the antenna threat (top left corner of the cabinets door):

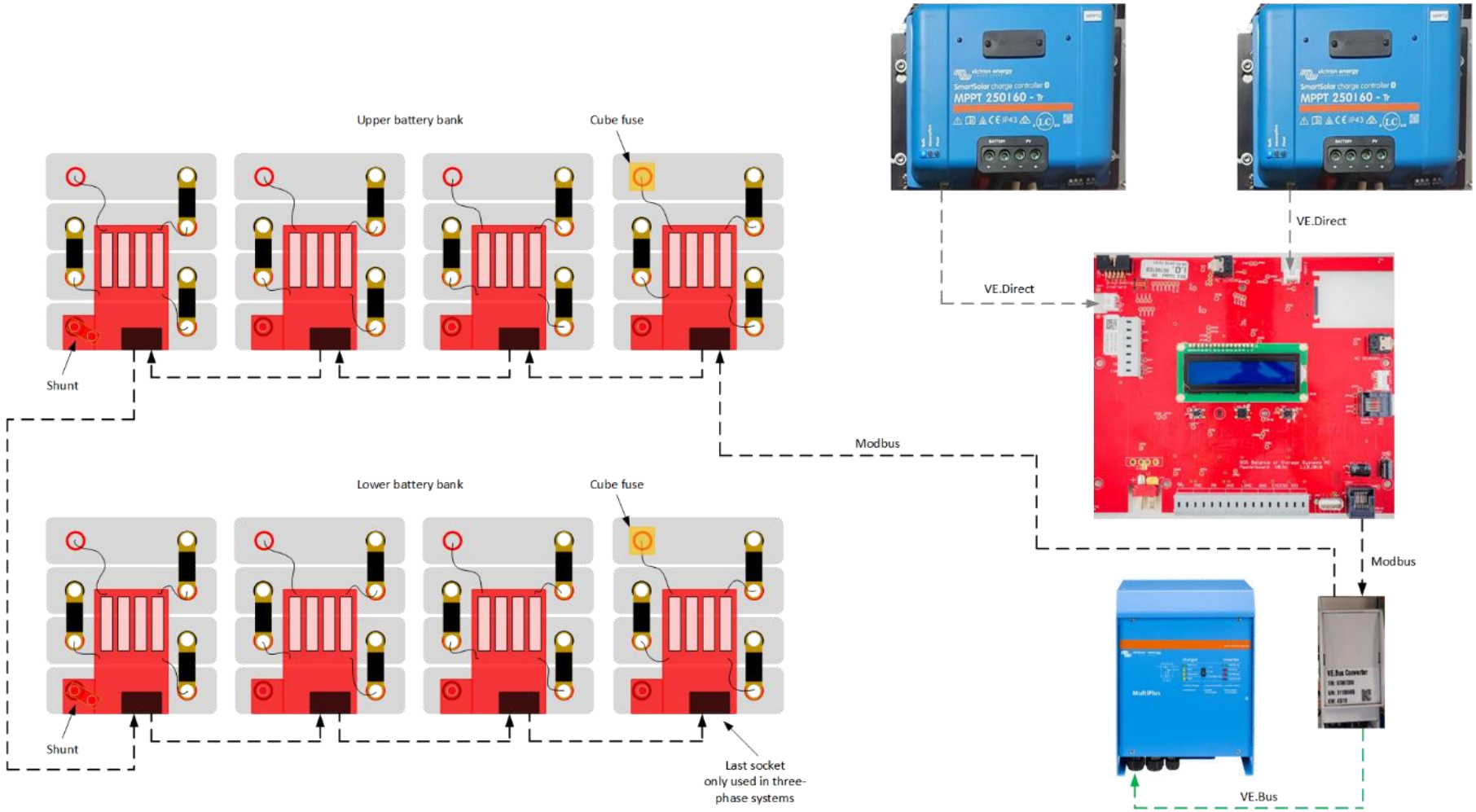


Mount antenna onto threat (tight nut carefully (clockwise) as far as it will go):



Internal system communication

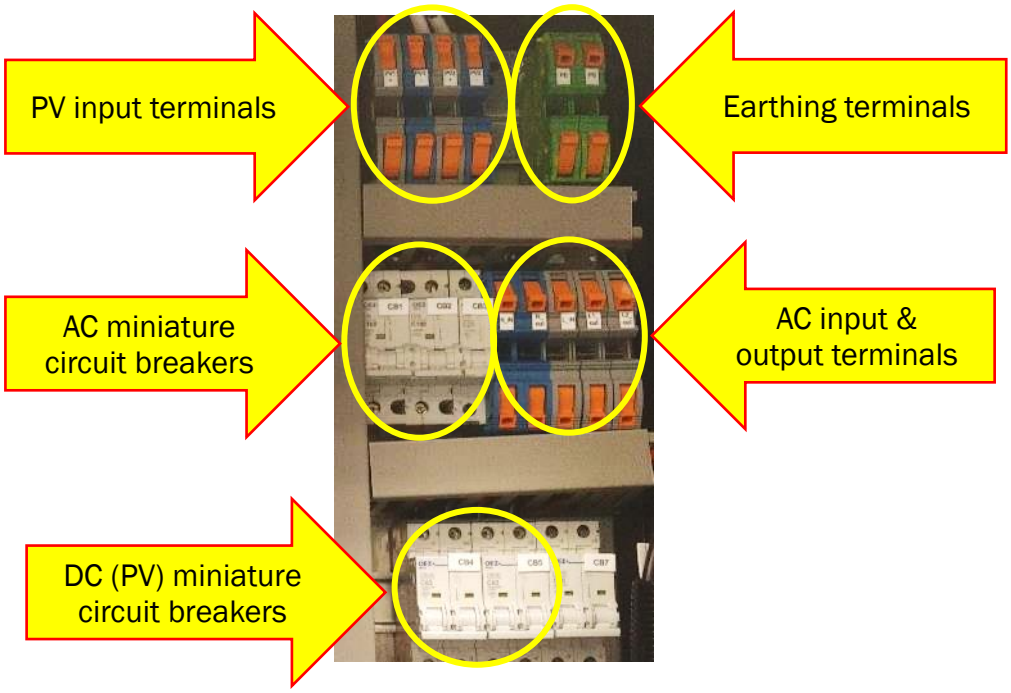
There are three kinds of communications within the HS system:
Modbus (black network cables), VE.Bus (green network cables) and VE.Direct (grey cables with small, white 4-pole plug).
Connect the system as shown in the picture below:



SORROUNDING INSTALLATION

Before starting the installation, make sure all components of the existing AC installation comply with local standards and are fully functional. We recommend writing installation protocol including detailed photos of site, PV installation, AC distribution and HS system from inside and outside.

System overview

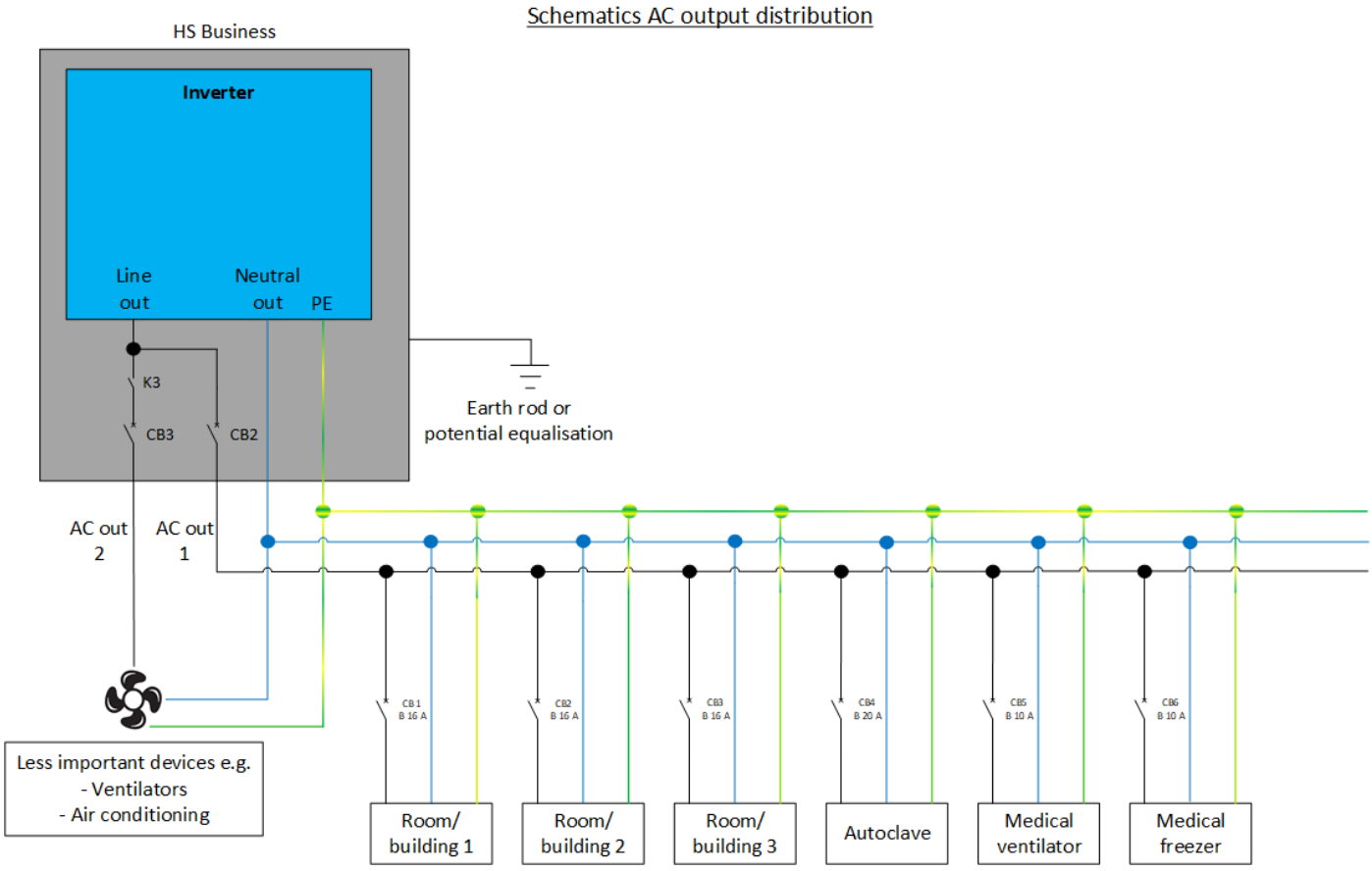


General installation information

To ensure selectivity of protection, each miniature circuit breaker (MCB) is rated with a C characteristic. At its best, the MCBs in the HS system trigger in the very end. First, customers' MCBs should trigger to avoid damages within the HS system.
Especially for circuits which are powered by the HS, use B characteristic breakers!

Miniature circuit breaker	Rating 3 kVA inverter	Rating 5 kVA inverter
CB1 – AC line input	C characteristic, 1-pole, 50 A	C characteristic, 1-pole, 100 A
CB2 – AC line output 1 (high priority)	C characteristic, 1-pole, 50 A	C characteristic, 1-pole 100 A
CB3 – AC line output 2 (low priority)	C characteristic, 1-pole, 16 A	C characteristic, 1-pole, 16 A
CB4 – DC input PV 1	C characteristic, 2-pole, 63 A	C characteristic, 2-pole, 63 A
CB5 – DC input PV 2 (optional)	C characteristic, 2-pole, 63 A	C characteristic, 2-pole, 63 A

Connection schematics:



Earthing & potential equalisation

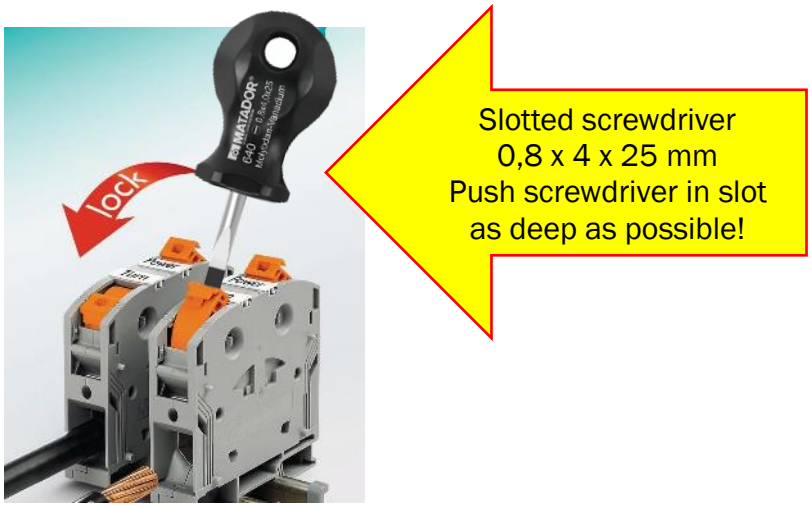
The entire enclosure including all metal parts of the internal devices have the same earth potential. The PE terminals are all connected directly to the DIN rail they are mounted on. Connect the earth rod or the potential equalisation panel (if available) to one of the PE terminals. The cable cross-section must be at least 16 mm².

Surge protection

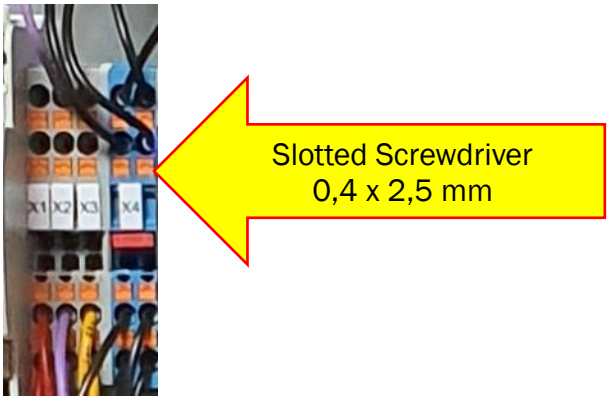
A surge protection can be realized by a Type 2 SPD (Surge Protection Device). Both, the line, and the neutral conductor must be connected in parallel to the SPD. Additionally, the earth access of the SPD must be connected to the overall PE/earth rod/potential equalisation.

Connecting input/output cables

Terminals for ingoing and outgoing cables are rated to be connected from 2.5 … 35 mm². Through the spring closing device, all kinds of cables can be connected, **no ferrules are needed**. Lock the terminal until “click” is hearable. If you have bought the BOS Starter-Kit, use the short black screwdriver provided:



The DC distribution has smaller terminals with a push-in device. Rating: 0,14 – 2,5 mm²
Solid conductors or conductors with ferrules can be connected toolless by just pushing in. Flexible conductors without ferrules can be linked by pressing the orange button (opening the spring closing device). After letting loose, the conductor will be fixed.



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COMMISSIONING & CONFIGURING

Overall check

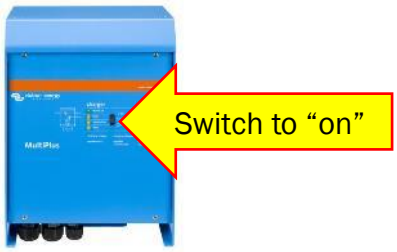
First, retighten all terminal screws of the miniature circuit breakers (MCBs) built in the HS system! Vibrations during shipment can sometimes untighten the terminal screws!

Visual control:

1. All cables must be connected and tightened well
2. No cords of flexibles cables overcome or touch other cords or cables
3. Earthing/potential equalisation is done and connected well
4. Surrounding electrical installation is finished completely
5. All covers of cabinets, sockets, switches etc. are mounted/closed
6. DIP-switches on battery blocks are adjusted and have unique numbers (except “0000”)

Commissioning the system

Turn on inverter:



Measure:
Measure DC voltages at the screws of the MCBs with a multimeter. Ensure you did not interchange + (red conductors) and GND (black conductors) level. For an easy double check, just control the colours of the connected cables at the MCBs. Colours of upper and lower side of the circuit breaker must match.

Voltages at battery side CB6 and CB7: **46 ... 56 V DC**
Voltages at PV input(s) CB4 (and optionally CB5): **max. 245 V DC**

Turn on CB6 and CB7. Now, the display of the Master Board must turn on.

To go on: see HS Business QUICK START MANUAL
The adjustments from QUICK START MANUAL are indispensable. Otherwise, system will not work!
To unlock the “3.0 Protected Settings” in QUICK START MANUAL, the BOS password is necessary!
For more information and settings available, please read the chapter after next “Configuring HS” in IOM.

Upon that, turn on PV MCBs CB4 (and CB5 optionally). In case you have solar radiation currently, the MPPTs start to charge the batteries and a sun symbol occurs at the display (left upper corner).

The system is ready now to go on with the AC side:
Check out the inverter front: The green LED “Inverter on” must be turned on.
Turn on CB1, CB2 and CB3 in the HS system. Now, input from grid (or genset optionally) works and both outputs are powered. Measure the AC side:

- Line to N (neutral) conductor **230 V AC**
- Line to PE (earthing) conductor **230 V AC**
- PE to N (neutral) conductor **0 V AC**

Consider: If no loads are connected to the HS, inverter probably turns off the output to decrease the energy self-consumption.

Updating Master Board firmware

See QUICK START MANUAL – MASTER BOARD UPDATE

The BOS Starter-Kit is required. During the update, the system will shut down automatically.
The Master Board restarts after the update.
After you did the update successfully, check menu point “1.8 Versions – SW-Version” at the display to see the current version.

Change Inverter Settings

See QUICK START MANUAL – CHANGE INVERTER SETTINGS

Do not connect the power supply to the laptop! The BOS Starter-Kit is required.

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Configuring HS

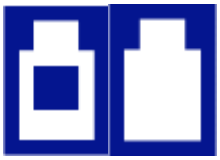
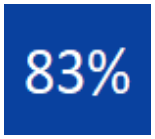
There are lots of adjustments available at the Master Board to configure your HS individually as well as many system information. **To unlock the "3.0 Protected Settings", the BOS password is necessary! Running the system without getting into "Protected Settings" is not possible!**

Display user interface:

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.

Display symbols:

Symbol	Definition
	Excess Mode (AC output priority 2 will be turned on): If the overall SOC is above the threshold, you have adjusted at the Master Baord ("3.12 Excess on above SoC"), the relay K3 turns on, and with this, AC output number 2 works.
	Communication issue. This could be related to: - **Cell Voltages out-of-threshold:** Please check at Master Board "1.2 Li-info" menu that all cells are in between 2.85V-3.65V. If one is out of range, please contact your product provider. - **Faulty Balancer Board communication:** Please check all patch cables are properly connected in Master Board and Balancers **Wrong protected settings**. Please check that the right protected settings have been selected (ensure "3.3 Storage Type" is set to "Lithium only" at the Master Board.
	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 Hybrid Battery, it is the average SOC of Lithium and Lead Acid batteries.
	Lithium battery voltage.

See following Master Board menu structure:

Master Board firmware 1.16		
System Info		
1.1 Measurements	Pb Volts (V)	Voltage of the Pb Battery Bank (Only HS500)
	Li Volts (V)	Voltage of Li Battery Bank
	Li Amps (A)	Charge or Discharge Li 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 (A)	AC Grid Charge Current measured by external AC sensor
	AC out (A)	AC Load Output Current measured by external AC sensor
	Grid Avail.	Grid availability. Depends on the external GPIO pin, not used in HS systems
	Hy. Bat	Charge or Discharge current in Hybrid batteries. Measured by external DC sensor. (Only HS500)
	Temp (°C)	Temperature of Master Board controller
1.2 Li Info	Li state	Connection status to the Li batteries
	config	Configuration of number of Li batteries connected in series and parallel
	lowest (V)	Lowest Li cell voltage
	highest (V)	Highest Li cell voltage
	current (A)	Charge/Discharge current
	good con (s)	When was the last successful connection between Master Board and Li batteries (how many seconds ago)
	Module	Select to get the details of each cell voltage in each battery modules
1.3 AC system	Bus state	Status of the VE.Bus
	Inv state	Status of the inverters
	found x devices	Number of AC devices connected with the Master Board
	Power In L1:	Input power from line 1
	Power In L2:	Input power from line 2
	Power In L3:	Input power from line 3
	Power Out L1:	Output power from line 1
	Power Out	Output power from line 2

	L2:	
	Power Out L3:	Output power from line 3
	target ACin L1:	Value sent from Master Board towards inverters: how much power should be drawn /feed into the grid at ACin Line1
	target ACin L2:	Value sent from Master Board towards inverters: how much power should be drawn /feed into the grid at ACin Line2
	target ACin L3:	Value sent from Master Board towards inverters: how much power should be drawn /feed into the grid at ACin Line3
	ESS stat: L1: L2: L3:	Status of ESS on each device (each Inverter needs ESS assistant installed)
1.4 MPPT 1 Info	Bat Volt (V)	Battery Voltage measured by MPPT
	VPV (mV)	Photovoltaic Panels Voltage
	PPV (kW)	Photovoltaic Panels Power
	Ch. Bat I (A)	Battery Charge Current @ Bat Voltage
	today (kWh)	Energy produced today
	day max (W)	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
	I limit (A)	Current limit
	last con (s)	Time since last successful communication with Master Board
	Firmware	Firmware version of MPPT
1.5 MPPT 2 Info	See MPPT1	See MPPT1
1.6 GSM info	IMEI number	IMEI number of the connected GSM board
	time limit	Time limit for GSM connection (paygo)
	GSM con	Last successful connection time
	UTC time	Time from GSM (UTC time zone)
1.7 Group info (three phase systems)	Group Stat Connection	Status of Group connection
	number of slaves	Number of slaves connected
	total HCV	Highest cell Voltage in whole group
	total LCV	Lowest cell Voltage in whole group
	total MPPT count	Number of MPPT connected in whole group
	total MPPT	Total current and voltage of the MPPT
1.8 Versions	SN	Serial number of Master Board
	TN	Part number of Master Board
	HW-Version	Hardware version of Master Board

	SW-Version	Software version of Master Board
Display Settings		
2.1 Display Settings	Change contrast	
	Backlight Within Menu	
	Backlight Outside Menu	How strong is the display backlight when menu is not active
Protected Settings – password necessary		
3.1 Pb Type	GEL/AGM	Select this option if Pb battery is GEL/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 safety switch on the Signal output
	LE300 SOC Input	Used to read SOC from LE300. (Only HS500)
	PT function	Used with external BOS Power Meters
	GND Connector	Signal not used
	GENSET START	Signal output starts generator
3.3 Storage Type	Lithium Only	Use this option for HS10000/HS5000 Don't forget to adjust Lithium Only!!!
	Lead Acid Only	Only for pure Lead acid systems
	Lead Acid & Ext. Li	Only for HS500 with LE300
	Hybrid	Only for HS500 without LE300 (LI directly connected to Master Board)
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 charger
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 when all the AC and DC outputs are disconnected. (Only used for HS500)
3.7 Test Aux Switch		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 without "log" option is selected, it remains forever and can only be unlocked/changed by BOS
3.9 Pb Capacity	0...975 Ah	Select the total capacity of the Pb batteries to achieve the most accurate SOC. (Only HS500)
3.10 Li Capacity	0...975 Ah	Select the total capacity of the Li batteries to achieve the most accurate SOC. Select 200Ah for the HS10000
3.11 AC Charge until	0...95 %	Defines up to which SOC level the battery gets

Soc		recharged from AC grid
3.12 Excess on above SoC	5…100 %	Defines at which SOC level excess power gets switched on (AC output 2 with lower priority)
3.13 Grid FeedIn		Allowed (feed into grid)/Not allowed (**do not feed into public grid**)
3.14 Grid AC-in Limit	0…250 A	Defines maximum current taken from AC input
3.15 ACin of PV	0…195 %	Allows to loop through PV energy that is created from a second PV source connected to AC input, like lead acid back up mini grid. Standard setting is 0%, which is good for most installations
3.16 Inverter limit	500…9500 W	Allows to limit maximum power of the inverter
3.17 Group setup	Solo or master/slave	Solo or master for single systems, and slave configuration if connected to other systems like 3 phase configurations
3.18 AC system	Victron VE.Bus, Victron Phoenix or Siemens	Select the AC system type connected with the system
3.19 Enable Fan over	20…60 °C	Temperature setting to start the fan
3.20 Firmware update		Displays the firmware updates are available, and allows to manually trigger remote firmware update procedure

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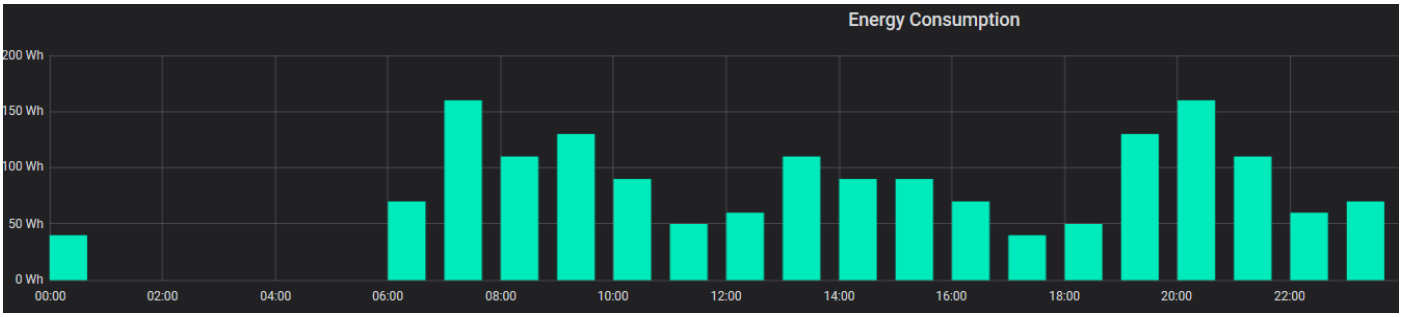
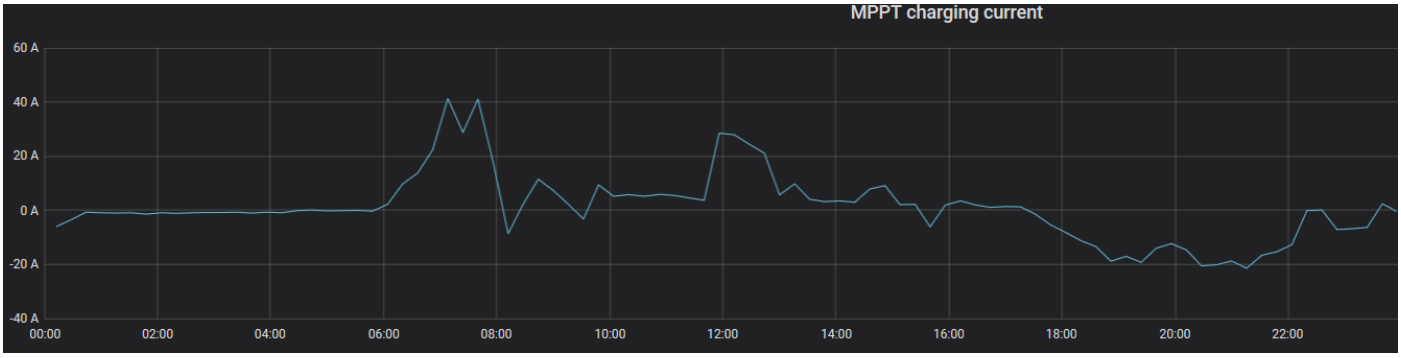
GSM MONITORING

AMMP platform

A functional SIM-card with data credit and sufficient reception are required for establishing the monitoring. Once these preparations are done, the IMEI number must be send to BOS or your local supplier. Only with the appropriate IMEI number, it is possible to integrate your system(s) into the AMMP platform. If you don't have a SIM-card, use the BOS global SIM-card provided. Ask your local supplier or BOS to activate the SIM.

The platform shows energy input and output as well as battery voltage, inverter frequency, SOC of Li-battery, temperatures, errors, and many more in different resolutions (such as monthly, weekly, daily, hourly). Following pictures show some examples of a HS system in Africa:





MAINTENANCE

Filter

Remove the black covers of the six fans built in the door. Take out the filter insertions and use compressed air (if available) to clean these filters insertions.

Do not clean the filters in rooms, where battery systems are placed! Clean them outside!

Depending on the environment, repeat this action at least monthly. Very dry and dusty regions are recommended to do this daily.

Screw retightening

Retighten screws of miniature circuit breaker after 6 months of commissioning once. Repeat this in case you have repositioned the system or you have replaced a miniature circuit breaker.

E-Check

Depending on local regulations, fulfil the electronical check (e.g. E-Check in Germany) with appropriate measurement equipment in inherent time intervals.

RCD test:

In case you have installed RCDs (Residual Current Device) within your electrical installation, press test button once a month to trip the RCD. Replace RCD or check earthing/potential equalisations if tripping is not possible by pressing button.

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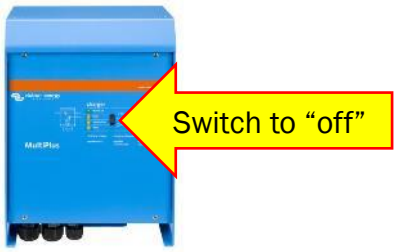
SHUTTING DOWN THE SYSTEM

Power off HS system

1. Turn off all MCBs of surrounding electrical installation
2. Switch off inverter



Now, the AC side of the HS is turned off completely. Yet, the MPPTs on DC side are still on and charge the batteries. As long as the inverter stays off, the batteries will stay fully charged most of the time. Only the Master and Balancer Boards have a small amount of self-consumption which discharges the batteries nearly negligible.

Permanent/long term shut down

1. Power off HS system as described before
2. Switch off PV miniature circuit breaker(s) CB1 (and optionally CB2)
3. Switch off Master Board (CB7) and battery (CB6) MCBs

In this constellation, there are just the Balancer Boards still discharging the batteries. With a current consumption of less than 20 µA each, the batteries will keep their SOC in a stable range for several years.

Note: best condition for a long term shut down will be a scheduled shut down at 70% battery SOC

Shutdown threshold values

The main switch-off criteria depend on the lowest or highest cell voltage of the entire battery system. All cell voltages are sent to the Master Board regularly by each Balancer Board.

For the system shutdown, there are three redundant possibilities to be executed. Two of them switch off the inverter and provide the batteries from being deep discharged/overcharged, but the batteries still stay connected to the system. The third one switches off the miniature circuit breaker of the batteries and provides the batteries from both, being deep discharged, and overcharged. The inverter shutdowns can be withdrawn automatically by the Master Board when the voltage has regenerated. The circuit breaker switch-off must be withdrawn manually by turning on the circuit breaker (CB6) again.

Inverter switch-off:
The Master Board is connected to the inverter in two ways, by Modbus-Communication (green network cable) and by relay contact (2x blue cable).

Modbus shutdown: at **3.0 V** (and turns on again at **3.2 V**)
Relay contact shutdown: at **2.83 V** (and turns on again at **3.1V**)

Difference of both is, that the relay contact shuts off the inverter completely (hardware side), while the Modbus-Shutdown just displaces the inverter into a standby mode. So, in the standby mode, it’s possible to wake it up again by PV input and if AC input (from grid or genset) turns on. Then, depending on the amount of the loads and of what you have adjusted on the Master Board (“3.11 AC Charge until SoC”),

the batteries will be charged. In case of the relay shutdown, only PV input can charge the batteries until the voltage has regenerated enough (without the standby mode, it is not possible to communicate with the inverter anymore, so the AC input can't be recognized).

AUX switch-off:
To avoid the batteries from being damaged irreparably, there is a shunt trip (abbreviation in all documents is "AUX") build in the system beside the 4-pole miniature circuit breaker (CB6). If any battery cell reaches a minimum of **2.7 V** or a maximum of **3.7 V** for more than **two minutes**, the Master Board will send a signal to trip the circuit breaker through the shunt trip. Then, all batteries are not connected to the rest of the system anymore. To withdraw the issue, turn off all the loads (ideally CB2 and CB3), wait for solar radiation and turn on the batteries' circuit breaker again to charge via PV system. Through the two minutes time delay, the Master Board will recognize the PV power, and also that no loads are connected after what the circuit breaker won't be tripped. Then wait for several hours, until the batteries have regenerated. In case of huge voltage differences between the cells, this could last for some days, until all cells are balanced similarly.

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REPOSITIONING

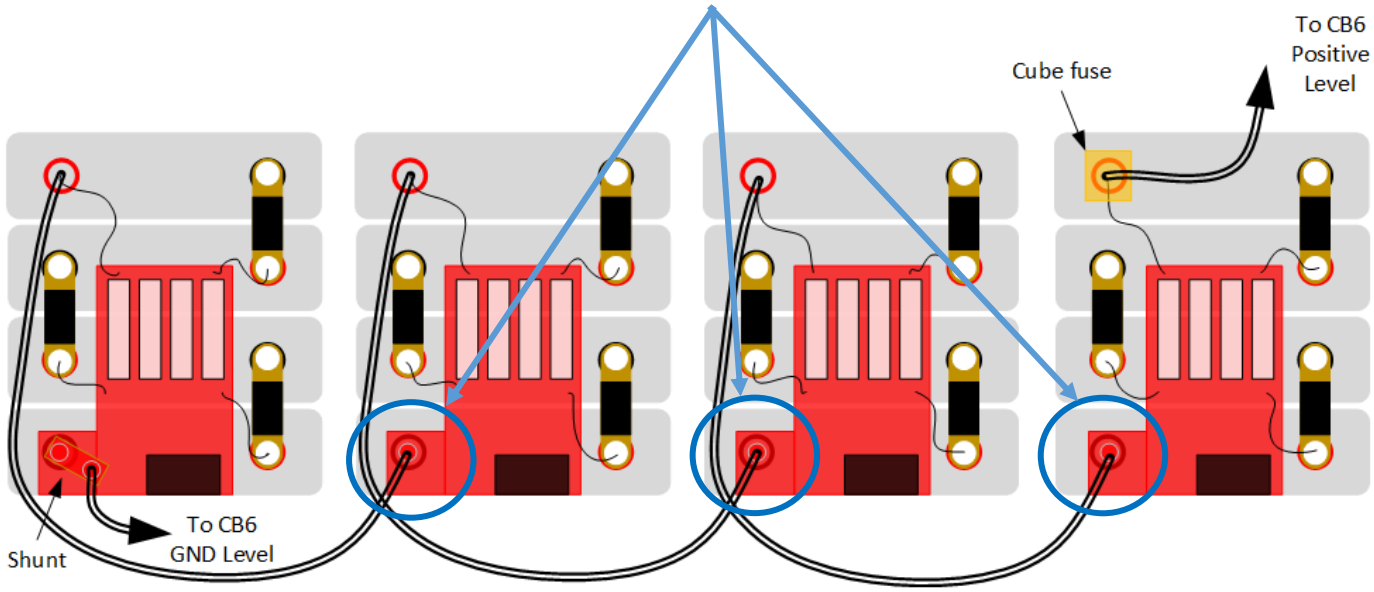
Disconnecting inputs and outputs

Ensure, all MCBs and inverter are switched off.
Disconnect all cables at input and output terminals. Therefore, unlock the orange spring device terminals with a slotted screwdriver 1,0 x 5,5 mm. **Ensure the screwdriver is pushed in the orange slot as deep as possible:**

1. Open the terminal halfway with less force
2. Open second half strongly until “click” is hearable
3. Pull out cable completely

Disconnecting battery bank(s)

1. Disconnect battery cables on lower edge of CB6 one by one**. Insulate ferrules after disconnecting to avoid short circuits!!!**
2. Remove bridge cables**.** Therefore, unbolt three screws at front edge with insulated (torch) wrench as shown in picture below and **insulate open ends**:



3. Take out battery blocks carefully. Start with the two middle ones.

Transportation

Cover battery block terminals and cable tips very well to avoid short circuits. Try to carry the blocks in plastic boxes or other non-conductive boxes. **Do not move the HS cabinet with batteries built in!**
Reintegrate the batterie blocks even after the HS system is well positioned. For more information, see “GENERAL INFORMATION” in IOM. When being transported, special requirements and labelling must be observed according to local regulations.

Insulation of tips

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DECLARATION OF CONFORMITY

Declaration of conformity

The HS systems comply with all applicable provisions of relevant directives and regulations and are in conformity with the relevant standards. The full declaration of conformity is found for download at www.bos-ag.com.

When being transported by commercial users or third parties (e.g. air transport or forwarding agency), special requirements on packaging and labelling must be observed (e.g. ADR regulations). If necessary, an expert for hazardous materials can be consulted when preparing the item for shipping

Inform your parcel service that the package contains dangerous goods. Please also observe the possibility of more detailed national regulations.

In case of questions concerning transport of the HS systems, please refer to an authorized BOS dealer. The BOS dealers can also provide suitable transport packaging.

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.

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TROUBLESHOOTING & FAQS

Watch Master Board display to see the error code and read the tables below:

Problem	Description	Solution
#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
#26	Balancer Board has old firmware installed	Update Balancer Board

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Error at Master Board display	Description
OVERCURRENT PTC	There was an overcurrent event on the internal PTC detected.
OVERCURRENT LI	There was an overcurrent event on the internal Lithium load output detected.
OVERCURRENT PB	There was an overcurrent event on the internal Lead acid load output detected.
OVERCURRENT LOAD	There was an overcurrent event on the internal load output or excess output detected.
SHORTCIRCUIT LI	There was a short circuit event on the internal Lithium load output detected.
SHORTCIRCUIT PB	There was a short circuit event on the internal Lead acid load output detected.
L.VOLTAGEDROP PB	There was high voltage drop over the internal Lead acid load switch detected.
L.VOLTAGEDROP LI	There was high voltage drop over the internal Lithium load switch detected.
DEVICE RESTARTED	The device has been restarted.

Question	Answer
How can I unlock protected settings?	Get password from your local supplier or BOS.
After starting, display shows a "!". What is wrong?	Unlock protected settings at Master Board display and set "3.3 Storage Type" to "Li only".
What kind of solutions are available for different applications?	BOS offers 3 range of products, Home, Business and customized solutions. As the names indicate, Home is typically for smaller requirements up to 1.6 kVA. This will help you power regular appliances like fans, TV, phone charging etc. Business powers the commercial applications like mini-grids, community projects, schools, hospitals, resorts, etc. For individual projects which need customized solutions, we have bigger capacity systems.
I want to buy a new system, what information do I need to provide?	Customers need to visit one of our approved partners and provide details such as available roof space for the PV panels, type of roof, available loads and planned upgrade/new purchase of appliances, grid quality and diesel genset availability. Based on these factors, our partners will propose a suitable energy solution that fits your needs
Who can install a BOS system?	To install a BOS system, you must be certified electrician or similar qualification, which allows to do electrical installations in your country. Additionally, you need to visit a BOS installer training to understand how to set up and maintain BOS systems.
What is the warranty on the systems? What are the conditions for claiming the warranty?	BOS provides a 5-year warranty on the system enclosure workmanship and electronic components. The warranty applies only on production and/or development faults. The lithium batteries are provided with a 3-year warranty. Please refer to warranty conditions document from BOS for the terms to claim the warranty.
Are Lithium batteries a safety hazard? What precautions do I need to take to keep the batteries safe?	BOS systems employ Lithium Iron Phosphate cells ($LiFePO_4$) which are one of the safest Lithium chemistries, hence BOS systems are safe to operate. However, enough care needs to be taken that system is used as per the conditions mentioned in the manuals. Loads should never be connected directly to the battery terminals or batteries should never be charged directly from PV panel.
What type of maintenance is required?	Lithium batteries are maintenance free hence no active maintenance is required however, enough care needs to be taken to maintain the right temperature and keep the environment dust free for better performance.
Where can I order BOS systems?	Please see our authorized dealers and partners to order the products or reach out to the concerned regional sales manager for support regarding buying the BOS products.

Can the system capacity be expanded in future?	Yes, the system can be increased in steps of 2.5, 5 and 10 kWh at any point of time product specific
In my region we do not have 230V 50Hz. Can I use BOS products anyway?	Yes. You can choose between 50 and 60 Hz in the inverter settings. Also, you can optionally buy 120V systems instead of 230V or use a split phase transformer, to transform 230V into 2x120V split phase output.
Can we use our present hybrid inverter/MPPT charger? Can I integrate BOS system with PV AC inverter?	If the hybrid inverter and MPPT charger is from Victron Energy, the existing components can be used. However, this needs to be double checked with the BOS team in Germany.
How deep can we discharge the Lithium batteries?	Li batteries can be discharged 100% without any harm to the batteries, however BOS systems have a default setting of 80% to get best out of the Lithium batteries.
What is the usable capacity of BOS systems?	80% of the nominal Lithium capacity.
How many cycles do BOS systems offer and what is the shelf life of the batteries? What needs to be done after the system is unused for prolonged period?	3000 full cycles. After a long term shut down, first charge the batteries fully. Then turn on loads and do some cycles. The batteries need several cycles to be balanced completely and to use them at best efficiency again.
What is the best temperature range to store the batteries?	The average ambient temperature for best performance is between 15 ^{0}C ... 30 ^{0}C and for warranty claims, the temperature should never fall below -10 ^{0}C or exceed 45 ^{0}C.
What variables can I see with the AMMP monitoring system?	• PV generation • Battery status, SoC with cell level monitoring • Grid and diesel input • Power consumption • Faults and errors
Why do the batteries not charge fully, although the MPPTs have full current?	Charge current limitation could be linked to the lithium battery size that was set in protected settings, the Master Board limits the maximum current to 1C (as default the setting is 25 Ah Lithium which would result in a maximum charge current of 25 A).
Troubles with AC charging from grid or genset?	https://www.victronenergy.com/live/multiplus_faq
Which PV panels and configuration can I use for HS Business 5000/10000?	Attention: 72 cell modules don´t fit well with input voltage of 100 or 150V at cold temperatures. 60cell modules fit much better. When using 72 cell modules better use MPPT 250/60 with 4S configuration.
Display shows IMEI but GSM module does not send data anyway. How can I troubleshoot this?	Try if mobile data works in a mobile phone. APN provider settings correct?
What can I do when Inverter trips off frequently (stops for some seconds and turns on again)?	Use latest firmware. Or: energy safe mode is adjusted, and no loads are connected to the system -> Inverter trips off and turns on again periodically to save energy.
Can I do remote firmware update? For which components?	Only Master Board can be updated remotely. Updates of Victron components must be done on site (via laptop).
Can I use Victron colour control or Venus GX in BOS systems?	No.
Can I connect AC inverters to BOS systems?	Only in HS systems output with 1:1 sizing rule.
Can I stack two HS boxes upon each other?	No, the box is not designed to carry the weight of another HS system.
Is there an inbuilt lightning protection or overvoltage protection?	No, but you can add them during the installation process if required. Integrate an SPD into the surrounding installation.
Is there an inbuilt RCD (FI)?	No, but it makes sense to include it to the surrounding AC distribution on site.
Is there a larger battery or battery	Not yet please get in contact with BOS or your local supplier for

extension available?	further information.
Genset (remotely controlled by Master Board) does not turn off or on.	Check “3.2 Signal out” at Master Board display. “GENSET START” must be set.
Got electric shocked by touching the HS enclosure!	Phase (or neutral conductor) is connected anywhere to earth (PE) before RCD. Search this connection immediately and separate it!
RCD didn’t trip off.	The output cables to the loads are not connected to the output of the RCD correctly. PE and N conductor must be separated!

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APPENDIX

Wires, colours, functions

Colour of conductors:

- red: 48 V+ and PV+
- black: GND
- brown: phase
- blue/white: AC out 2
- light blue: neutral conductor
- yellow-green: protective earth conductor (PE)
- dark blue: remote inverter
- yellow: load output of master board
- orange: excess 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

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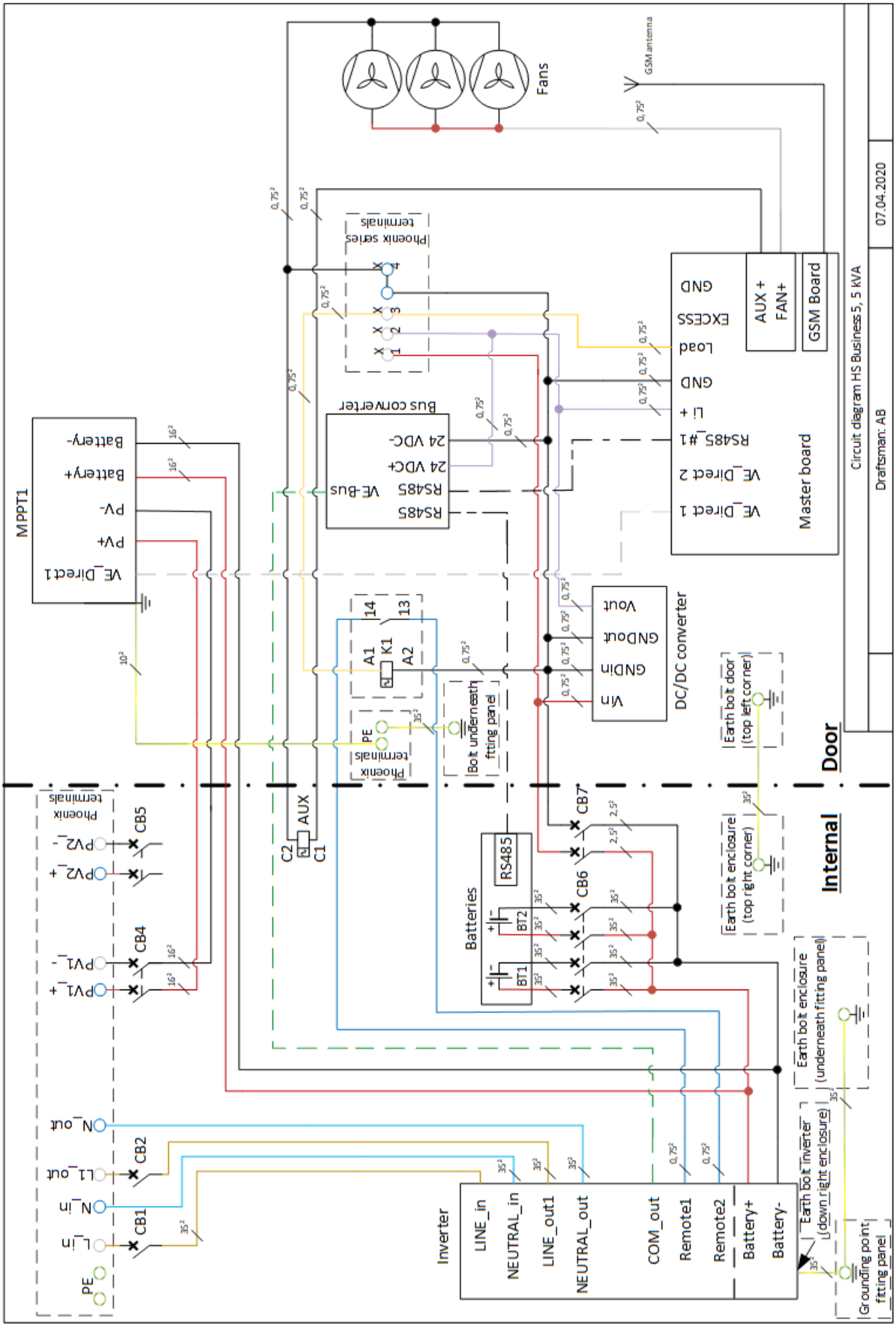
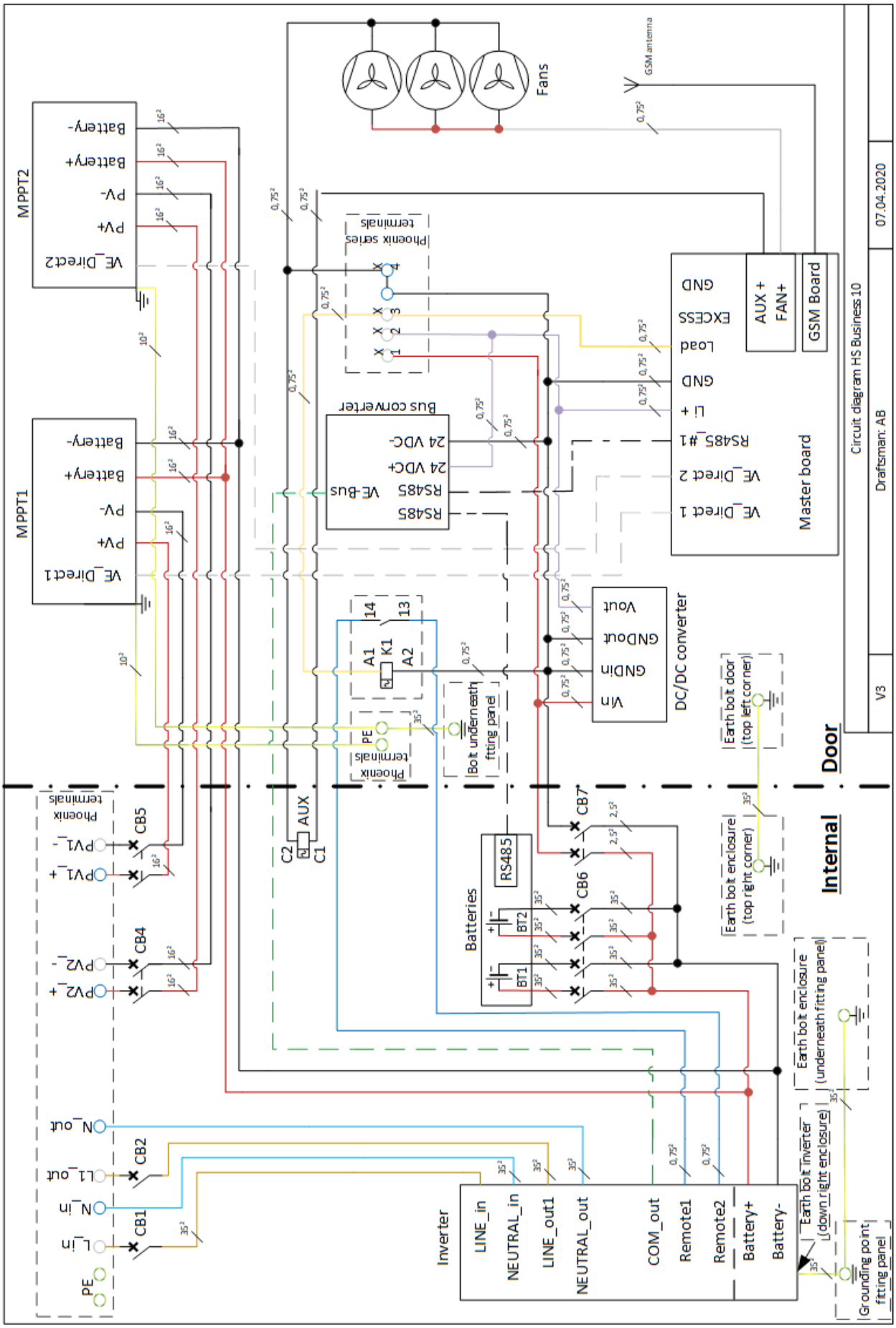
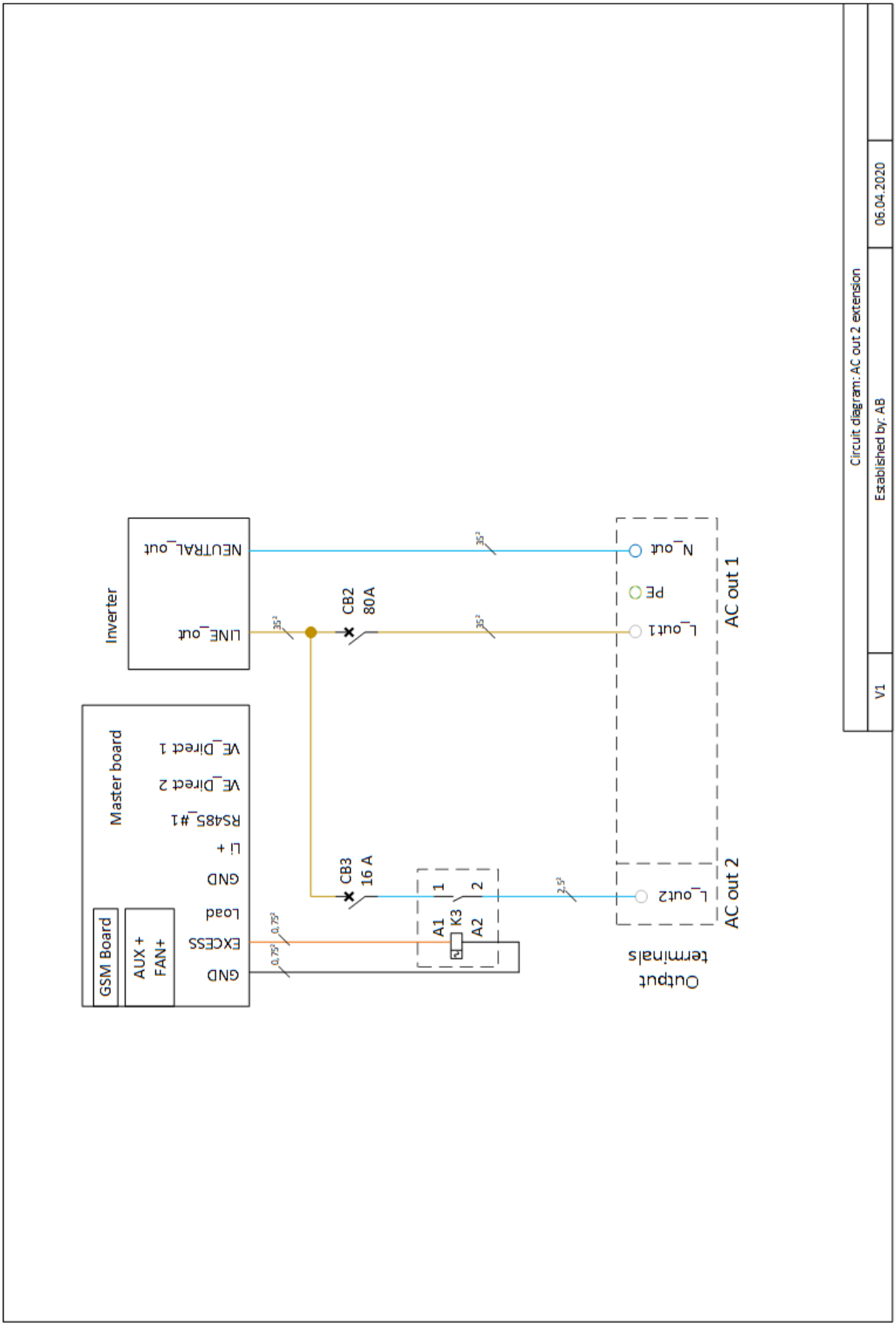
Circuit diagram HS Business 5



Circuit diagram HS Business 10



Circuit diagram AC output priority 2



Circuit diagram Victron Inverter