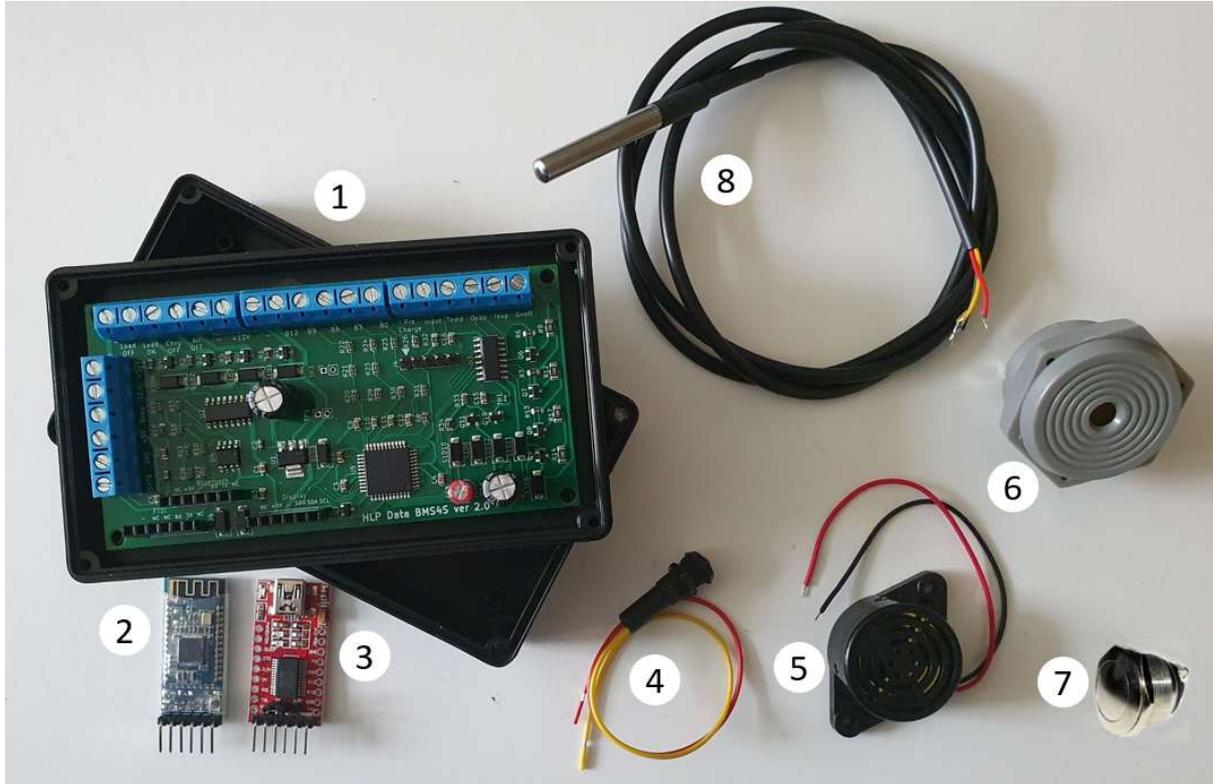*data*

BMS4S user manual version 3

Valid for software version 3.x.80 (and 2.0.80, but notice that some ports are different)

This manual is no longer updated, but the new functions added in new software versions that do not require another circuit board are always available also for this version of circuit board. The description of these functions can be read in the manual for the latest version of BMS4S.

BMS4S DIY kit:

The basic package contains: 1: a BMS4S circuit board and a box to mount it in.

In addition to this, you may also need

2: a Bluetooth radio for communication with BMS4S,

3: an adapter for USB to serial connection to BMS4S,

4: a 12 V LED for low SoC early warning,

5: a buzzer/alarm.

6: or a buzzer/alarm for panel mounting,

7: a pushbutton for temporary charge level setting,

8: one or more temperature sensors

Introduction

BMS4S is versatile battery management system that can be used in many different configurations. It is designed to supervise four LiFePO4 cells and automatically control that they are kept within specified boundaries. It can be used with default configuration straight out of the box, but can also easily be changed and used in a completely different setup. There are few limitations built into it.

You will find a description on how to install the BMS4S in chapter "Installation", with more details on exactly how to connect all wires in chapter "Equipment connection description". After installation you should test that it is working as expected. This is described in chapter "Testing".

During normal usage there is not much you need to do, but there are some things that can be of interest for most users. This is described in chapter "Normal usage".

How you use your cellular phone to connect to BMS4S is described in chapter "Normal usage".

Available commands are described in three places: "Basic configuration", "Additional commands" and "System commands". All commands are built from one or two small letters, so in the Basic configuration chapter the commands can be derived from the printout, the capitals in each line is the command to use to change that setting. To give any commands that changes any settings you must first unlock the device with command du=1234. Default PIN is 1234, but you should change this after installation to your own one, command dp=nnnn. All system commands are protected by another level of protection since you can make BMS4S completely useless by a single bad system command. To unlock system commands, use command: fu=1632. Do not use any system command if you have not read the user manual carefully first. But there is always a way to get back to the original settings from factory, see command: fr.

And you can always get a command summary when connected to BMS4S with command: h.

Important information

The first thing to be connected to BMS4S is ALWAYS - (minus) and B0. And if you are going to disconnect it, these are the ones to be disconnected last. That is, you must NEVER disconnect the negative terminal from the battery, because then you disconnect - (minus). It also means that the shunt is only connected to + 12V (via connected devices), and it does not withstand BMS4S. More about how to connect can be found in the chapters "Short step-by-step basic installation" and "Connection of additional equipment and a some more details"

Normal usage

BMS4S is switched on as long as it has power on terminal +12V. Normal usage is to take a look at the LED every now and then. If it is blinking twice, then there is less than 20% energy left in the batteries. If it is blinking once, it is less than 10%. You can change this to start the blinking at any level of charge. Command sl=nn.

Beside the LED you have the push-button. When you are on your way home and the boat will be unused for a while, then your batteries lifetime will increase if they are not left fully charged. Then press it until you see 3 long blinks on the LED. This will decrease the voltage when BMS4S will stop charging with 0.10 V, which equals approx. 80% SoC when using default settings. Or keep in pressed until 4 long blinks on the LED. This to achieve approx. 60% SoC (decreases the stop-voltage with 0.15 V).

When you press the push-button for a single long blink, three things will happen: the charging voltage will be reset to normal, if an alarm is beeping it will be rest and you will wake up (actually restart) the Bluetooth radio that you can connect your cellular phone to. BMS4S has two ways of communication: a socket to plug in a FTDI adapter and a socket to plug in a bluetooth module of type HM-10 or equivalent. You connect with e.g. "Serial Bluetooth" on an android phone and with
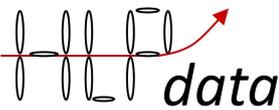
"BLE Terminal" on an I-phone. These are available for free on Google play and Apple appstore. When installed, scan, find and connect to the Bluetooth device.

It often happens that the USB adapter and the bluetooth adapter interfere with each other, so if possible have only one of them connected at a time.

If you give the **command p** (print) you will get a printout looking like this:

U=3.264 3.268 3.262 3.266 13.060 I=-1.335 SoC=35 (38)

This (U=…) means that all four cells have 3.26 V each (reported in order B3, B6, B9, B12), adding up to 13.06 V. Next, I=…, means that right now there are 1.335 A leaving the batteries (this only works if you have connected BMS4S to a current shunt, but that is not necessary for it to work). And SoC=… means that BMS4S estimates current state of charge to 35 % based on the last 15 minutes (can be changed with te=nnn). The value within parenthesis (38) indicates what the estimate is at this exact moment. Using voltage and load gives a very rough estimate on higher SoC levels, but to use it as an early warning system when SoC is getting low works well. And it does not require regular synchronizations like a coulomb-counter based meter does.

Another thing that is good to check every now and then is **command pe** (print extreme point log). See the description of it in chapter "Additional commands". It will give you information about hoe your batteries are performing.

And it may be useful to regularly press the button and see that the BMS4S responds with a blink to ensure that the BMS4S is operational. If you want automatic monitoring, install double BMS4S. Then they can monitor each other and alert if one of them stops responding.

Basic configuration

The starting point before changing anything is to take a look at current configuration. You do the with command ps (print setup):

WorkMode= 1
BatterySize= 100 Ah
BatteryUse= 30 Ah
BatteryCharging= 50 A
TimeEstimate= 900 s
TimeBeep= 200 ms
TimeRelay= 300 ms
TimeprecharGe= 0 s

VoltBalance= 3.500 V
VoltDifference= 0.000 V
BalanceInit= 0.000 Ah
BalanceAmount= 0 %

StartLedblinking= 20 %
VoltWarn= 3.100 V
VoltLow= 3.050 V
VoltVerylow= 3.000 V
TimeLow= 15 s
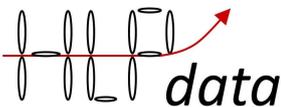
VoltswitchOnagain= 3.100 V
VoltlowExtrabat= 0,000 V
Voltlimitextrabat2= 0,000 V

VoltAbsorb= 3.500 V
TimeAbsorb= 1200 s
VoltHigh= 3.600 V
TimeHigh= 5 s
TimeChargeoff= 14400 s
VoltResumecharge= 3.250 V
TimeWarning= 120 s

Templow1= 5 C
Tempwarn2= 50 C
Temphi3= 60 C

Temptarget4= 95 C
Temphi5= 100 C
Tempres6= 90 C
Limit-step1= 40
Limit-step2= 100
Limit-step3= 100

TimePrintout= 0 s
TimeMemlog= 315/600 s
TimeioOpen= 600 s

**The first block of lines describes some basic setup of BMS4S:**

WorkMode= 1: this means that a current shunt is connected.

    The value to set is calculated by adding the values for the following features:
    0 workmode normal
     +1 there is shunt connected
     +2 measures 12V only
     +4 supervised and supervising another BMS4S, master
     +8 supervised and supervising another BMS4S, slave
     +16 parasitic power for temp-sensors are activated
     +32 not used
     +64 Swedish CSV (comma separated values in printouts for import into Swedish excel)
     +128 not used
     +256 only p at tp= instead of both p and po, useful at certain test-cases
     +512 power off when high bat temp, normally only charging will be stopped
     +1024 all off port = charge on for bistable charging relay (no very low volt relay available)
     +8192 Charge OFF port is inverted

    So, if you e.g. have connected a current shunt and have two BMS4S supervising each other
    you shall give the command wm=5. You can also switch on and of functions individually by
    adding a sign in front of the figure. So if you want to switch on Swedish CSV and switch off
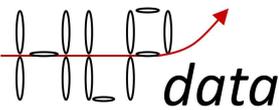
the shunt you do this: wm=+64, wm=-1. And after you have changed workmode, a restart can be required to get it into the new mode, command rb.

BatterySize= 100 Ah: size of installed LFP bank. Change with bs=nnn as implied by the capital letters. **But before you can start changing anything you must unlock the device by command (device unlock) du=**1234. You should change this to your own PIN by command (device pin) dp=nnnn. **If you have forgotten your PIN**, you can set a new one within 30 seconds after you have switched on the power to BMS4S. You can remove the PIN by command dp=0 (not recommended). (**note, all commands are given with small letters**)

BatteryUse= 30 Ah: You use 30 Ah every 24 hour which means that you get out of power after 3 days without charging (if you have a 100 Ah battery). Used to estimate SoC if no current shunt is connected. Change with command bu=nnn. The same applies to all commands below, the capital letters in the printout imply the command to use when changing the setting. If BatteryUse is set too high, SoC estimates will also be too high.

BatteryCharging= 50 A: the most common charging method will charge with 50 A. Used to estimate unbalance between cells if no current shunt is connected. If you are using automatic balancing using coulomb-counting, you should also install a shunt to ensure that the unbalance-estimates are as good as possible (see chapter "Equipment connection description" below).

TimeEstimate= 900 s: The Soc estimate is based on the last 900 seconds (15 minutes). If you have installed a shunt and calibrated BMS4S you can probably shorten this time. Then 300 s (5 min) might be good.

TimeBeep= 300 ms: each beep will be 300 ms long. If you have a really loud beeper you might want to shorten this to achieve a bearable sound level. Affects Beep output port.

TimeRelay= 300 ms: when the bi-stable relay is operated it is done with a 300 ms long pulse. Affects the Load OFF and Load ON outputs (and Charge On and All-OFF if WorkMode 1024 is enabled).

TimeprecharGe= 0 s: if you have equipment with high start-up current you might want to pre-charge them before operating the relay. If you set this timer between 1 and 10 s you will get a pulse to use for a small relay with a resistor parallel to the real relay that will soft-start the equipment. This pulse comes on the port "PreCharge".

The second block of lines describes how balancing will be handled.

VoltBalance= 3.500 V: There are two ways to use the built-in balancer. Both uses this value as the starting point when the balancing procedures are initiated. This value shall normally not be set below 3.4 V. If you do not activate the balancer, these settings will be used to calculate how big the unbalance is.

VoltDifference= 0.000 V: This is the first and simplest balancing alternative. If this value is set (recommended value: 0.050 V) then when the first cell has passed the BalanceVolt-value (during charging) and the voltage difference between two cells exceeds the VoltDifference-value the balancing will start and proceed as long as the BalanceVolt-value is exceeded and the unbalance remains. But since the balancing current is low (0.2 A) and that balancing is done only while charging, this method only works when the battery bank is reasonable well matched (all cells have close capacity values). Otherwise, the second method is recommended.

When you activate any kind of balancing BMS4S will check that balancing not will cause too much voltage drop due to too narrow wires. If you get the result "bad voltage sense cables!" it is recommended to increase the dimension or shorten the voltage sense cables.

BalanceInit= 0.000 Ah: This is the second balancing alternative. When the first cell passes BalanceVolt-value during charging (and VoltDifference is set to 0.000) coulomb counting starts and continues until the last cell passes it. If the difference between the best and the worse cell then exceeds the BalanceInit-value (recommended value: 0.5% of the total battery capacity, i.e. 0.500 Ah for a 100 Ah battery bank) the balancing will start and continue until the calculated balancing value is balanced away. It is recommended that you have installed a way to measure the current if you use this method. See chapter "Equipment connection description" how to do that. Note: VoltDifference must be set to 0 (vd=0) in order to activate this balancing alternative. It is also important that the charging current is similar when all cells passes the BalanceVolt-value since the measurement otherwise might be misleading. I.e. do not set the BalanceVolt-value close to where the charging device starts to decrease the charging-current.

You can see the coulomb counters with the sort Coulomb (As) with command po, and all calculated results presented in Ah with command pe. You can use this information to manually balance the cells with a 3.6 V charger.

When you activate any kind of balancing BMS4S will check that balancing not will cause too much voltage drop due to too narrow wires. If you get the result "bad voltage sense cables!" it is recommended to increase the dimension or shorten the voltage sense cables.

BalanceAmount= 0 %: when balancing starts, it will aim to reduce the difference with the percentage stated here. The recommended start value 25% is to ensure that it does not overshoot the target. This is especially important if no shunt is connected, since it then bases the coulomb counting on what value is set for BatteryCharging. If you find multiple similar entries in the "extreme point log" (command pe) before an unbalance is cured, you can increase this with e.g. 25% to speed up the process.

The third block of lines describes how and when a low voltage event shall be handled, i.e. when shall the loads be disconnected.

StartLedblinking= 20 %: when SoC gets below 20% the LED will start blinking as an early warning, 2 blink for 10-19 % and 1 blink for 0-9 %. Affects the LED output port.

VoltWarn= 3.100 V: this is the first level of protection. At 3.100 V the buzzer/alarm will start beeping "low voltage". It is now time to start the engine and start charging to prevent that any loads get disconnected. Affects the Beep output port.

VoltLow= 3.050 V: this is when the "not necessary" loads will be disconnected via the bi-stable relay. Affects the Load ON and Load OFF output ports.

VoltVerylow= 3.000 V: this is when all loads will be disconnected. You can use this e.g. if you have a second bi-stable relay isolating the batteries completely. If BMS4S is not disconnected when this happens, it will go into low power mode and only do the most important tasks in a slow paste, like switching on the system again once charging has brought the voltage up to VoltswitchOnagain. Affects the All OFF output port.
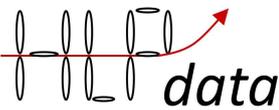
TimeLow= 15 s: the above voltages must be below the values for 15 seconds before the action is taken. If you use high power things like thrusters and starters for longer continues time than this you might want to extend this time, command tl=nn.

VoltswitchOnagain= 3.100 V: when the voltage har reached this level after a low-voltage event the system will go back to normal again. Affects the Load OFF and Load ON output ports.

VoltlowExtrabat= 0,000 V: If you have a backup battery you can supervise it so you do not forget to maintain it. A voltage around 12,6 can be reasonable for an LA battery (only available for PCB 3.0). Controlled by the Bat2 input and affects the Beep output port.

Voltlimitextrabat2= = 0,000 V: If you have a backup battery and connects it and disconnect LFP, then the voltage output from the alternator will be unregulated since the voltage is taken from the LFP bank. Here you can limit the alternator output in this case.

The fourth block of lines describes when charging shall be discontinued.

VoltAbsorb= 3.500 V: Normally LFP cells are fully charged at 3.6-3.65 V. Some chargers miss settings adopted for LFP, so they will not manage to get the voltage that high. Then you can set an "absorption" level that it can reach, and the let it stay there for a time. Here this time starts at 3.5 V. Affects Charge OFF and Gvolt output ports.

TimeAbsorb= 1200 s: and this timer will keep the charger on for 1200 s (20 min) before charging is stopped

VoltHigh= 3.600 V: All charging sources that can achieve 3.6 V will be stopped at that voltage. 3.6 V corresponds to approximately 90 % SoC when charging is done with 0.4 C, and is a good compromise between battery usage and battery life length. Affects Charge OFF and Gvolt output ports.

TimeHigh= 5 s: but the first cell must exceed the set voltage in more than 5 s before the action is taken.

TimeChargeoff= 280/14400 s: the total time it will be switched off is 14400 s (4 hours) and so far it has been switched off for 280 s. If it is set to 65500 it means it will never switch on charging, then it is only VoltResumecharg that will do that. Affects Charge OFF and Gvolt output ports (and All OFF if WorkMode 1024 is enabled).

VoltResumecharg= 3.250 V: if the voltage drops down to this level, charging will resume even if TimeChargeoff has not elapsed. Affects Charge OFF and Gvolt output ports (and All OFF if WorkMode 1024 is enabled).

TimeWarning= 120 s: if the voltage has not gone down below the set high voltage 120 s after charging has been switched off, BMS4S will start beeping "high voltage".

The fifth block of lines describes battery temperature limits.

Templow1= 5 C: if charging is started with battery temperature lower that this a "low temperature charging" will start beeping, and charging will be stopped for a preset time (see command tc). If you do not have any temperature sensors installed on the batteries, their temperature will be reported
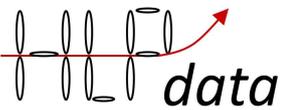
as 20 degrees. Affects Charge OFF and Gvolt output ports (and All OFF if WorkMode 1024 is enabled).

Tempwarn2= 50 C: if battery temperature exceeds 50 degrees Celsius a "high battery temperature" will start beeping.

Temphi3= 60 C: if battery temperature exceeds 60 degrees Celsius a charging will be switched off for a preset time (see command tc). Affects Charge OFF and Gvolt output ports (and All OFF if WorkMode 1024 is enabled, and also Load ON and Load OFF if WorkMode 512 is enabled).

The sixth block of lines describes when and what to do when the alternators temperature is getting high.

Temptarget4= 95 C: when the alternator exceeds 95 degrees Celsius, BMS4S will regulate down charging current and keep the temperature around 95. However, the temperature is a slow feedback on how much power the alternator generates, so the temperature will fluctuate a bit around the set value. Therefore, it is important to set a max-value (**Temphi5**) where charging will pause completely if the regulation is too slow. This regulation will only work if your alternator has a voltage sense cable, and you have installed a temperature sensor on the alternator. Affects Gvolt output port.

Temphi5= 100 C: when the alternator temperature exceeds 100 degrees Celsius, all charging will pause. This will only work if you have installed a temperature sensor on the alternator. Affects the Gvolt and Charge OFF output ports.

Tempres6= 90 C: when the alternator temperature has come down to 90 degrees Celsius, charging will resume if it has been paused. Affects Charge OFF (and All OFF if WorkMode 1024 is enabled).

Limit-step1= 40: Regulation is performed by a PID-regulator (with the integration disabled since it is of no interest). This is the delay time between adjustment-calculations in seconds. It takes some time before an adjustment of current influences the temperature, so too short interval will always generate oscillations, and too long interval will make reaction slow. If you have mounted the sensor directly against the stator the delay is normally not that long, then l1=10 often works well.

Limit-step2= 100: This is the amplification of the P value (the temperature) feedback in percent when the temperature differs more than +- 2 degrees from set value. Below this the feedback is always 0 (the temperature is accepted)

Limit-step3= 100: This is the amplification of the D value (temperature difference) feedback in percent. This is how the regulator stabilizes the temperature when it is within accepted temperature range.

If the temperature oscillates too much, try increasing Limit-step1.

If the regulation is too slow so the temperature hits Temphi5 or Tempres6, try decreasing Limit-step1 or increasing Limit-step2

And the last block contains features useful to understand how your system is performing.

TimePrintout= 0 s: if e.g. command tp=5 is given, then the command p and po will automatically be given every 5 s. This can be useful when testing.

TimeMemlog= 315/600 s: this means that voltage and current will be logged every 600 s (10 min). The log is started by command tm and can be printed with command pm. 315 is the time since last log entry was saved.

TimeioOpen= 600 s: after a command is given the Bluetooth radio will remain on for 600 s (10 min). If you want the Bluetooth interface to stay on all the time, to=65500 can be given.

A command summary and description of blinks and beeps are always available with command h:

h	help	tr=	time relay (ms)
l	print settings	tw=	time before warning beep (s)
p	print voltage	v2=	volt limit bat2 (V)
ba=	balance amount (%)	va=	volt absorb (V)
bi=	balance initiate diff (Ah)	vb=	volt balance (V)
bp=	button press	ve=	volt low extra bat (V)
bs=	battery size (Ah)	vh=	volt high (V)
bu=	battery usage (Ah)	vo=	volt power on again (V)
bt=	bluetooth 0=off, 1=sleep, 2=on	vr=	volt resume charging (V)
ce	clear extreme points log	vw=	volt warning (V)
cm	clear memory log	vl=	volt low (V)
dl	device lock	vv=	volt very low (V)
dp=	set device pin	AT	AT command
du=	device unlock		
fr	factory reset	a1-4=	adjust battery volt
fu=	factory settings unlock	l1=	initial search step for charge limit
pd	print debug	l2=	second search step for charge limit
pe	print extreme-point log	l3=	third search step for charge limit
pm	print memory log	s1-4=	set battery volt
po	print other info	sc=	set current (A)
ps	print settings	sf=	save factory data
pv	print version	ss=	set float size
rb	reboot	sv=	set verbose
rp	reprogram		
sl=	set led blink-level (%)	wm=0	workmode normal
wm=	set work mode	+1	shunt connected
t1=	temp low charging (C)	+2	12V only
t2=	temp high battery warn (C)	+4	supervised master
t3=	temp high battery (C)	+8	supervised slave
t4=	temp target (C)	+16	not used
t5=	temp high pause charging (C)	+32	BT sleep
t6=	temp resume charging (C)	+64	Swedish CSV
ta=	time absorb (s)	+128	not used
tb=	time beep (ms)	+256	only p at tp=
tc=	time of charging pause (s)	+512	power off when high bat temp
te=	time for soc estimate (s)	+1024	all off port = charge on
th=	time high (s)	+2048	not used
tl=	time low (s)		
tm=	time memory log (s)	1 blink	SoC 0-9
tp=	time print volt (s)	2 blink	SoC 10-19

...
10 blink SoC 90-99

2 beep low temp charging
3 beep high battery temp

4 beep low voltage
5 beep high voltage
6 beep BMS device failure
7 beep temp device failure
8 beep failed to detect balancing values

Additional Commands

What you normally do is described chapter "normal usage" and chapter "basic configuration", so you have the explanation of the important commands there. Here you have a few more commands that can be of use.

AT AT-command
This is the exception to the statement "all commands are written with small letters". The Bluetooth radio this device was designed for entered AT-mode (mode where it accepts commands) when no device is connected over the radio. So, if you want to change something in the Bluetooth-radio you can give it e.g. a command like this: AT+NAMEMyBMS. As soon as this is sent you will be disconnected which will get the Bluetooth device into AT mode. Half a second after you have given the command, BMS4S will sent it to the radio. When this is done you will see a blink on the LED. After that you have 10 seconds to reconnect to get the response that the radio gave to your command. Unfortunately, not all bluetooth devices work exactly the same. If this does not work, check the manual for the bluetooth device you have and see if there are any other way to change its settings. But you do not have to change anything, it will work fine anyway.

bp Button Press
Instead of pressing the button to do something, with this command you can do it remotely. Example: bp=1

ce Clear Extremepointlog
will clear all entries from the log.

cm Clear Memorylog
will clear all entries from the log. You can add a text with 12 characters e.g. to state when the logging was started. Example:
cm=24/12-09:30

n1(-5) Name temperature sensor
If you give the command po you will get a list of temperature sensors. In order for BMS4S to know what these are used for, you must name them with two characters each. If the first character is an 'a', it is supervising an alternator. And if it is a 'b', it is supervising a battery. To name the first one in the list give command n1=xx, the second with n2=xx etc. To identify one sensor, warm it up with your hand and see which one it is with command po. Example:
n1=a1
n2=a2

n3=b1

p   **Print**

will produce a printout of cell-voltage, total voltage, current and estimated SoC. Example:
U=3.283 3.283 3.283 3.284 13.133 I=0.000 SoC=41

pe   **Print Extremepointlog**

Command pe will give a printout like this:

HVE , 3.599 , 3.600 , 3.598 , 3.599 , 14.396 , 77.130 ,
HVA , 3.517 , 3.520 , 3.518 , 3.520 , 14.074 , 14.970 ,
LVE , 2.997 , 2.996 , 2.996 , 2.997 , 11.986 , -1.663 ,
UBC , 3.563 , 3.564 , 3.563 , 3.555 , 14.264 , 75.622 , 0.720 , 0.720 , 0.810 , 0.010 ,
UBI , 3.563 , 3.564 , 3.563 , 3.565 , 14.254 , 75.622 , 0.720 , 0.720 , 0.810 , 0.010
UBE , 3.277 , 3.277 , 3.277 , 3.277 , 13.109 , -1.204 ,
VBI , 3.480 , 3.500 , 3.499 , 3.497 , 13.976 , 75.622,

This time the log contained six entries, can store around 50 entries. The log is cleared by **command ce**. The first four numbers in all lines are the voltage of each cell when the event happened. The fifth is the total voltage, and the sixth is the current at the event.

HVE means "high voltage event", HVA "high voltage absorption event" (timeout has happened in VoltAbsorbtion phase, see command va), LVE "low voltage event".

UBC means "unbalance calculation" and the four last numbers are the amount of energy that were charged into each cell at the latest cell balance measurement (done by coulomb counting), with the sort Ah. This counting starts when the voltage passes VoltBalance . So right now, there is an unbalance of 0.8 Ah (0.810-0.010) between cell 3 and cell 4, where cell 3 is the best charged one. UBI means "unbalance calculation and balancing initiated". UBE then means that the initiated balancing has ended. If an UBE is missing after an UBI then the system has been switched off before the balancing ended, which is nothing to worry about. If there are enough remining unbalance the process will restart at the next unbalance-calculation. If there are multiple UBI in sequence with the same order of unbalance this indicates that you can increase how much of the unbalance you try to remove each time. Then you can increase the BalanceAmount (ba=nn, see "Basic configuration") with steps around 25% each time.

VBI means that voltage based balancing has been initiated. It will stop when the voltage is back under VoltBalance.

You can use this information to manually balance the cells with a 3.6 V LiFePO4 charger. Here you can charge cell 4 with a 5 A 3.6 V charger for 10 minutes to even out the unbalance

pm   **Print Memorylog**

will produce a printout of the memory-log started with command tm. The log can contain 288 entries. Example of log with two entries:

interval=600

3.249 , 3.247 , 3.253 , 3.248 , 12.997 , 0.000 ,
3.249 , 3.247 , 3.253 , 3.249 , 12.997 , -4.130 ,

Each line contains voltage on cell 1 to cell 4, system voltage, and current at that time. This log is cleared when BMS4S is switched off, or by command: cm (Clear Memory log).

po   **Print Other info**

will produce a printout of some other information that can be of interest:

volt high adjust=0.000	there is a push-button you can adjust down the end voltage with 0.05, 0,10. 0.15, 0,20 or 2 V. Press the push-button until 2 long blinks to set it to 0,05, 3 blinks for 0,1, 4 blinks for 0,15, 5blinks for 0,2 and 6 blinks for 2 V (which will always switch off charging). Keep it pressed until long blinking stops to reset it to normal. It will also be reset when BMS4S is switched off. This can be useful e.g. if you motor home and want to leave the boat with less than fully charged batteries.
charge is on	Charging is allowed (normal state)
load is on	Power consumption is not limited (normal state)
temp:	There are two temperature-sensors connected here
a1=71	This one is supervising an alternator (first letter is 'a')
b1=22	This one is supervising a battery
charge-limit-state=0	there are several reasons charging is limited. When this is 1 to 4 it is limited due to the temperature of the alternator, when 5 it is stopped for a preset time since the battery is either fully charged, or battery temperature is too low or too high for charging. 1 to 4 will of course only happen if you have installed and configured a temperature sensor. Only printed if verbose not is zero (command sv=1).
push-level=0	A value showing representation of voltage on terminal Gvolt. Lower value means higher voltage. Only printed if verbose not is zero (command sv=1).
coulomb counters=0 0 0 0	Result of latest coulomb counting, sort is coulomb (As). Only printed if verbose not is zero (command sv=1).
balancing: off	Will list all cells currently being balanced (or none, as here)
buzzer: 0	State of the buzzer, silent right now
led-blink: 0	State of the LED, SoC level ok right now
extra bat=12,678	Voltage of the extra battery (V) (Only on PCB 3.0)

pv   **Print Version**

will produce a printout of the model and version of the installed software.

pd   **Print Debug**

will produce a printout of the device internal memory. Used for debugging only.

rb   **ReBoot**

Will force the device into a fault situation that will make the system supervision reboot the device.

sc   **SetCurrent**

Used to adjust the values used to calculate actual current. Must be set if you are using a shunt different from the predefined one (50 mv = 500 A), and it doesn't hurt to do it anyway, it will improve the result. First start by stating that there is a shunt connected, command wm=nn, see command wm for what nn shall be). Then define the zero point: ensure no load or charging sources are connected, and give command sc=0. Then connect a load of known size and give command sc=-15.5 (if the load is 15.5 A). And lastly connect a known charging source and give command sc=20.0 (if the source delivers 20 A). The given values should normally not be below 10A.

ss   **SetfloatSize**

Set how many decimal digits you want presented. The resolution of voltage measurements is 0,004 V, so more than 3 digits make no sense, two is normally enough.

sv   **SetVerbose**

Set level of information at printouts. Used for debugging.

tm   **TimeMemorylog**

sets the time between each sample in the log. The log can contain more than 250 entries which is enough for logging every 5 min (300 s) for almost 24 hours.

System Commands

Here are some commands that you should not use unless you know exactly what you are doing. If you have done so anyway, look at command **fr** below to understand how to resolve the problem.

a1(-4)   **Adjust voltage for cell 1-4**

If you are sure that BMS4S reports a faulty voltage on a cell you can adjust the value-calculation with this command.
Example: a4=-0,005

fr   **Factory Reset**

When you have done too much changes and want to come back to a known status, this will reset the system to original settings as it was when it was shipped from the factory.
Example: fr

rp   **ReProgram**

If there are some new functions released or faults corrected, this is used to update the BMS4S. Exact usage is supplied together with the update package.

s1 (-4)   **Set voltage for cell 1-4**

If you are sure that BMS4S reports a faulty voltage on a cell you can by this command set the correct voltage of the actual cell.
Example s4=3.233
You can as an alternative set the accumulated value of that cell, the result will be the same
Example s4=13.3

sa **Set All voltage**
Can be used to set the voltage on all cells if they are perfectly aligned.
Example sa=3.233

sz **Set allowed max temp on the board**
Can be used to set the temperature limit on the board. Do not change this unless you are asked to do it from HLPdata.
Example sz=2000

Installation
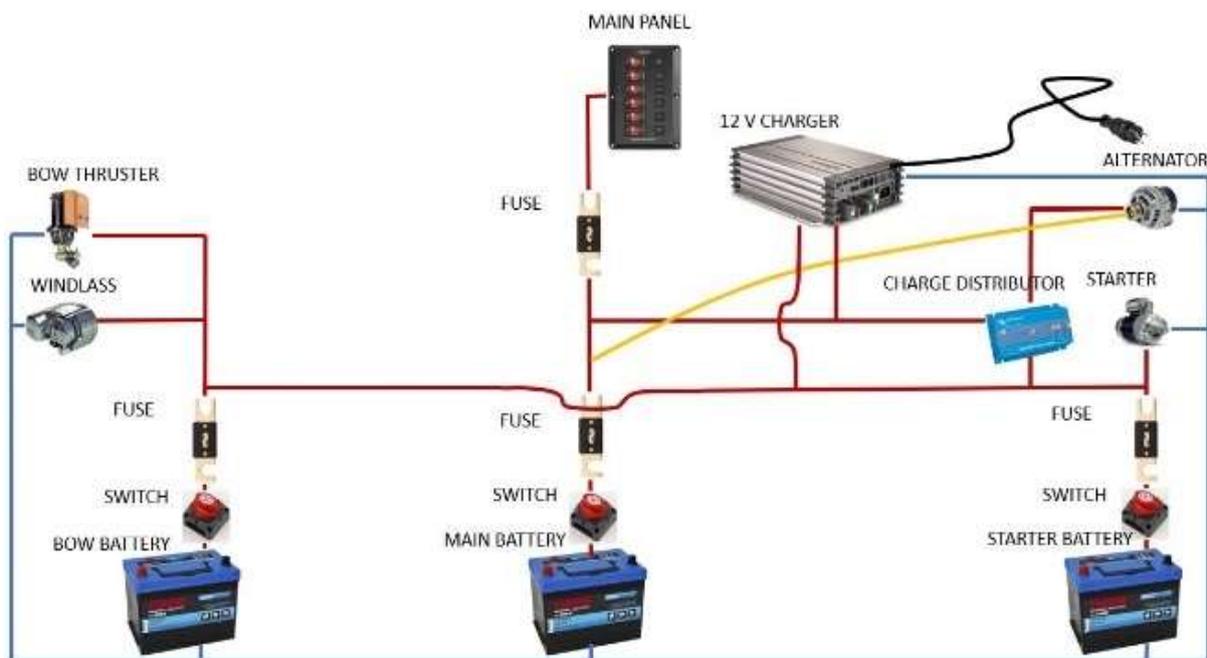
When you start the electrical system looks something like above. You often have a starter battery and a house battery. These are kept separate so that the starter battery is not used by the boat's consumers, and they are charged via a charging distributor or a relay that switches on when the engine is running. If you have bow thruster then you often also have a battery for it, placed in the bow of the boat. All batteries, of course, have switches and fuses installed.
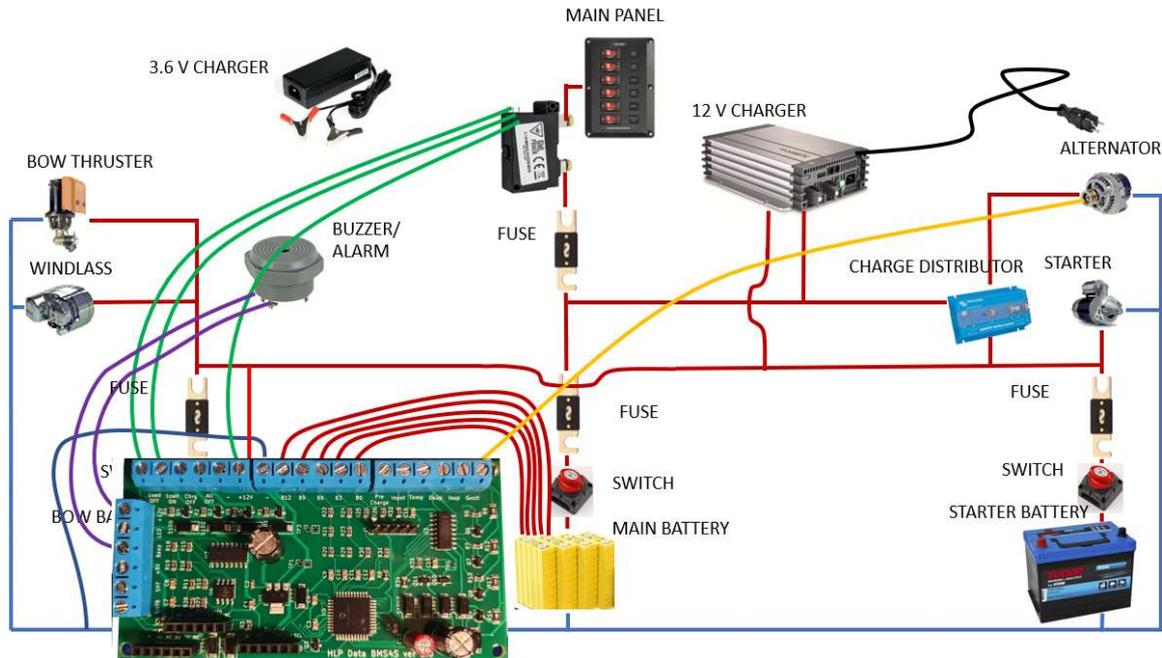
The simplest way is to just replace the main battery with LFP cells, and connect them to BMS4S. You also connect a buzzer/alarm to it. Then you move the voltage sense (often yellow) cable and connect it to BMS4S. You also have to connect a bi-stable relay between the new main-battery and   to BMS4S. Then at last you connect the power to supply BMS4S from after the main switch (but before the relay) so it is switched off when all other electricity is switched off.

There are two more items we think you should connect: a push-button and a led. Details on this and where the wires are connected is described in Equipment connection description below.

The disadvantage with this setup is that the led batteries only get charged when the engine is running, and during most of that time the LFP bank keep the voltage below 13.8 V, which is not enough to get lead batteries fully charged.

Therefore, we recommend one more change: remove the power distributor and connect the three cables together you get a setup looking like this:
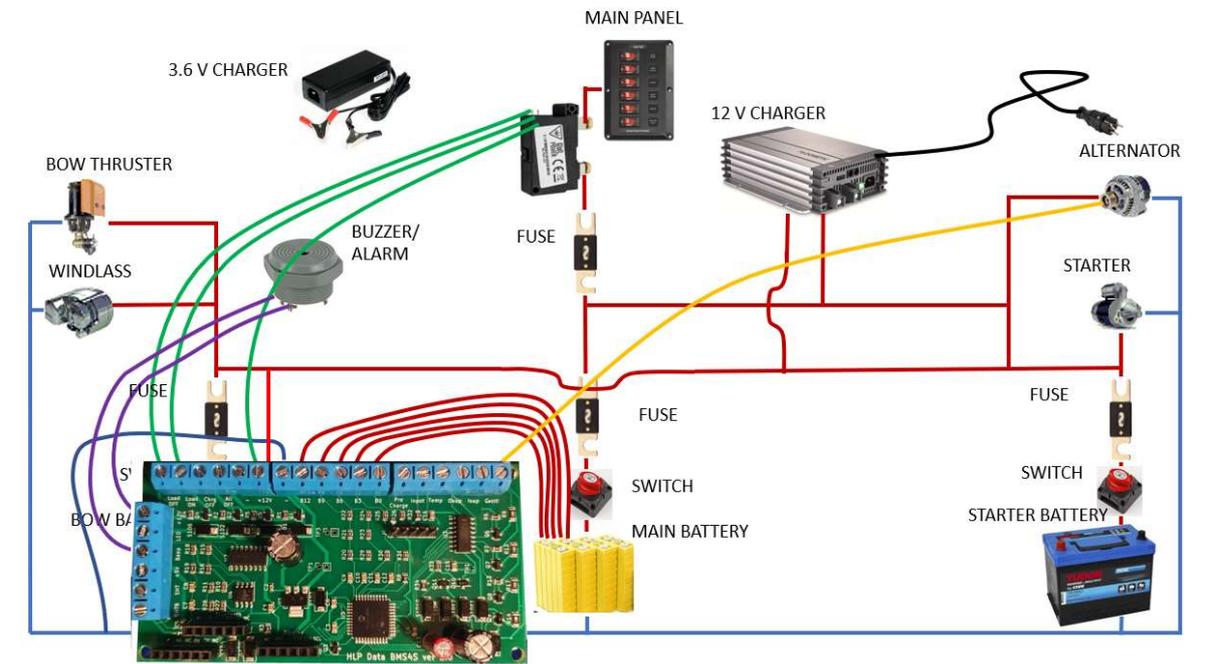
Now the lead batteries have become backup for security and is not used during normal operation. It is then enough to charge them every now and then, which can be done by simply switch them on. They will then get some small current from the LFP that normally are giving 13.2 V, and of course from the alternator when it is running. But since they are not used, they will always be available as backup and fully charge. But keep in mind that electric motors are a source of a lot of disturbances, so ideally they should have an own connection to the battery, or as in the picture, a very short common wire in comparison to the distance to the motors. This to allow the battery to absorb these disturbances. So how do you actually do this installation?

Short step-by-step basic installation

Here is a step-by-step instruction, but first a warning: NEVER CONNECT +12 V BEFORE – AND B0 ARE CONNECTED, AND ALWAYS START INSTALLATION BY CONNECTING – AND B0 FIRST. If you want to test the BMS4S before installation, connect – and B0 to battery minus first, and then +12 and B12 to battery plus (and then command wm=2 to tell BMS4S that only 12 V is connected). B0, B12 and – (minus/ground) must always be connected when BMS4S is connected to the LFP cells. More details on each connection can be found in the next chapter.

1. Plan where to put the BMS4S, the relay, the buzzer/alarm, the led for low SoC warning and the push-button for simple adjustment of charge level and to wake up the Bluetooth interface.
2. Drill holes slightly smaller than the cable in the cormorant at each position you will connect a cable. This way the box will be as dense as possible when you close it.
3. Start with connecting the relay on the cable between the man panel and the LFP cells.
4. Connect the relay to Load OFF and Load ON on the BMS4S, and to - (minus, ground).
5. Connect the buzzer/alarm to terminal Beep on BMS4S. On version 2.0 Beep is – (minus, ground). On 3.0 Beep delivers +12V.

6. Connect the LED to terminal LED on BMS4S. On version 2.0 LED is – (minus, ground). On 3.0 LED delivers +12V.
7. Connect the push-button between terminal Inpot and – (minus, ground)
8. Move the (often yellow) voltage sense cable from the generator to the Gvolt terminal on BMS4S.
9. Connect – (minus/ground) to the boat's ground/minus
10. Prepare five cables between the LFP cells and the BMS4S, and press on connectors on the battery side. If you intend to use automatic balancing, do not use too narrow cables. Use at least 0.75 mm2, and as short as possible. Mark the cables on the battery side with labels: B12, B9, B6, B3, B0.
11. Connect the cables on the BMS4S side first. Make sure the B0 cable is connected into the B0 terminal, the B3 cable to the B# terminal etc. Start with the B0 canle.
12. Connect the cables to the LFP cells. Make sure you place the cables on the right cell. Start with B0 on battery-minus, B3 on plus on first cell (same cell as B0 is connected), B6 on plus on the second cell, B9 on the third cell and B12 on battery plus (same terminal as the thick red power cable is connected to)
13. Now it is just to connect power to BMS4S via the terminals +12V
14. Now move the cables on the current distributor so they all are sitting on the same terminal (unless you intend to keep a separate starter-battery).
15. Test the installation as described in chapter Testing below.
16. Start the engine and run it for a while. Test with a wet finger that the alternator does not exceed 100 degrees. If it does it does probably not contain any protection against overheating. See bullet 6 in chapter "Equipment connection description" on how to mitigate that.
17. To maximize the capacity and life-length of your LFP cells you shall always charge them fully when they have been unused for a while. Do that now with the 3.6 V LFP charger, one cell at the time. (But do not leave them fully charged if they will be unused for a while. Discharge them then to below 80% SoC to maximize life-length.)
18. Now you are ready to go. Enjoy a life with less worries about lack of electricity.

Connection of more equipment and some more details
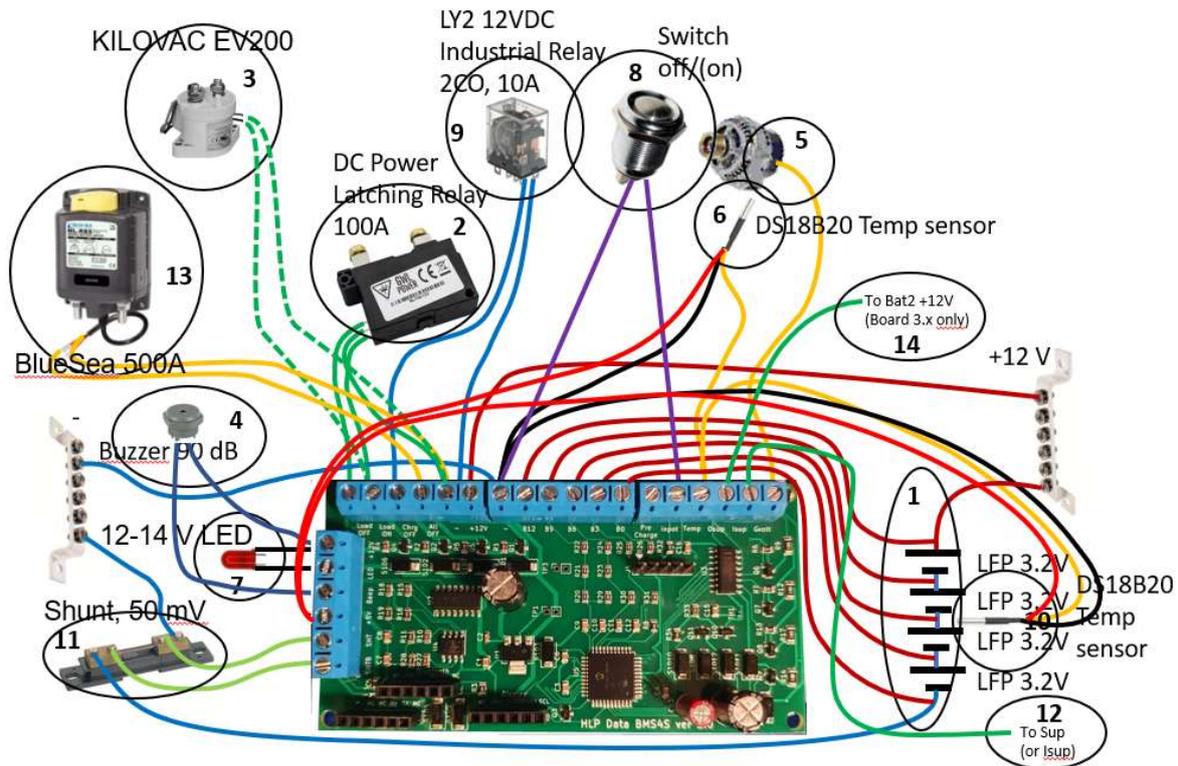
Here is a picture showing how equipment shall be connected to BMS4S. Please note that there are no switches or fuses shown in the picture. All wires leaving a battery should have a switch and must be properly fused close to the battery if there is a slightest risk that it can ever create a shortage or overload, but that is outside the scope of this manual and you will have to find descriptions on how to do this elsewhere. So, let us instead discuss how the equipment in the picture shall be connected to BMS4S. We'll take them one by one, but first a warning: NEVER CONNECT ANYTHING ON ANY PORTS BEFORE – AND B0 ARE CONNECTED. If you want to test the BMS4S before installation, connect – and B0 to battery minus, and then +12 and B12 to battery plus (and then command wm=2 to tell BMS4S that only 12 V is connected). B0, B12 and – (minus/ground) must always be connected when BMS4S is connected to the LFP cells.

1   You need five cables between BMS and the LFP cells. If you intend to use automatic balancing, do not use too narrow cables. Use at least 0.75 mm2, and as short as possible. Mark them in one end with labels: B12, B9, B6, B3 and B0. Start connecting the B0 wire in B0 on BMS4S and then connect it to the battery minus terminal. Continue with B3 which shall be connected to + side of the first cell (same cell as B0 is connected to). B6 to the second cells + terminal. B9 to the third, and B12 to the fourth cells + terminal (same terminal as the thick red power cable is connected to). Check each wire one extra time before connecting it to the battery. And if you have a multimeter, make a last check that the voltage between B0 and B3 is around 3.2 V, between B0 and B6 around 6.6 V, between B0 and B9 around 9.7 V, between B0 and B12 around 13 V.

2   Open up the wires between the battery and the main panel and connect the latching relay so that it can disconnect all user equipment when a low voltage situation occurs. Then connect the wires between the relay and BMS as in the picture, i.e. the wire that switches off the relay to the Load OFF terminal, and the one switching it on to the Load

On terminal. The common wire is connected to ground. The control terminals for driving the relays on BMS4S are of MOSFET type, and can drive max 1.2 A (version 3.x) or 3 A (version 2.0) continuously**.** You can of course use high power relays like Bluesea 500 A if you have equipment with a high demand for power, e.g. a 3 kW inverter.

3   If you want to use a monostable relay, like KILOWAC EV200, you connect it to the Load on terminal. For mono-stable relays you must also change the time the relay is pulled to 0, which means it is pulled all the time, command: tr=0. This also means that the Load off terminal will always be in the opposite position of the Load on terminal. Mono-stable relays will use current all the time it is connected, so bi-stable relays have a definite advantage.

4   4. Depending on which version you have, this connection is a little different. **Version 2.0:** You can use any 12 V buzzer / alarm to receive beeps when something needs to be done, as long as it uses less than 100 mA. You connect it to 12 V and connect the negative wire to the terminal marked Beep. If you want to use higher power equipment, simply connect a normal open relay to the port and let it supply power to the equipment. **Version 3.x:** You can use any 12 V buzzer / alarm to get beeps when something needs to be done, as long as it uses less than 1.2 A. You connect it to Beep and connect the negative lead to minus. If you want to use higher power equipment, simply connect a normal open relay to the port and let it supply power to the equipment.

5   Many modern alternators have a voltage sensing (often yellow) cable used to compensate for the voltage drop in the cables between the alternator and the batteries. If your alternator is missing such a cable it is probably a low power one, and it might be a good idea to replace it to get improved charging since LFP batteries can recharge much faster than lead-batteries does. The voltage sensing cable is simply moved from where it was connected before to the terminal on BMS4S marked Gvolt. But if you still want to use the existing alternator without a voltage sensing cable you have to open it up and identify the two wires that is feeding the rotor with power. They will always go to the two carbon brushes, sometimes built in to the regulator. You have to cut up one of these and extend the two resulting wires outside of the alternator, and connect them to a relay that is of type normally connected (NC). Then connect the relays control wires to terminal Charge OFF and – (ground) on the BMS4S. Now the relay will break up the power feeding of the rotor when BMS4S activates it, and the alternator will stop producing current. This way is also how you connect relays switching off charging from other sources like solarpanels, wind generators etc.

6   Many modern alternators are also protected against overheating. A simple test is to run it loaded for a while and then touch it with a wet finger. You hear directly if it is above 100 Celsius since the water then instantly boils. BMS4S can protect the alternator if it doesn't do it itselfPosition the temperature sensor so that it touches the generator and connect the one shown in the picture between the Temp terminal (yellow cable), ground/minus (black cable) and + 5V (red cable). It usually also works to also connect the red cable to ground. The sensor will then use what is called parasite feeding, but then the parasite feeding must be switched on (wm = + 16). But if one of the sensors is/becomes faulty, it can overload and destroy the temp port, so check all sensors carefully that they work before they are parasitically connected. Dependent on where on the alternator you place it you might have to adjust the temperature values:

command t4=nn, t5=nn and t6=nn. Do not forget to configure it as an alternator-sensor, command n1(-5)=an (first letter must be an "a" to make it supervise an alternator).

7   The LED must be of type 14 or 12 V if you connect it as in the picture. Otherwise you must insert a 1 kOhm resistor in series with the diode. Depending on which version you have, this connection differs a bit. **Version 2.0:** Note that the LED may be sensitive to polarity so that you connect the correct leg (+) to + 12V. **Version 3.x:** Note that the LED may be sensitive to polarity so that you connect the correct leg (+) to the LED terminal, and the other to minus.

8   The push-button is connected between the inpot terminal and – (minus/ground). It is used to temporarily change the settings for charging, and to wake up a bluetooth radio that is switched off.

9   If you want to automatically switch off the power to the fixed installed charger when the battery is fully charged you can use a standard industrial relay with sufficient power capability and connect it to terminal Charge OFF and ground (minus).

10 If you want to supervise the batteries temperature you connect one ore more temperature-sensors to the battery and connect it same as for the alternator above. a thermistor between ports – (minus/ground) and Btemp on BMS4S and place it at the LFP cells. Do not forget to configure these as battery-sensors, command n1(-5)=bn.

11 If you have a low-side 50 mV shunt for 500 A connected on the low (minus) side, you can connect BMS4S to it as in the picture. Connect the side closest to the battery and terminal SHTB, and the other at SHT. When it is connected you must inform BMS4S about it, command wm=1. You must always zeroize it (see text below). You can calibrate it to adjust for other shunt values. If you have no shunt, connect it to the two sides of the first cable on the battery's minus side if the expected voltage over it never will exceed 100 mV. Or push two needles into the wire with 0.3 m in between if it is a 50 mm2 wire, or 0.2 m if it is a 30 mm2 wire. Start with an idle system (no current) and zeroize it, command: sc=0. Then start charging with a known current, e.g 20 A, then give the command: sc=20. And lastly switch on a known load, e.g. 10 A and give command: sc=-10. The current measurement is not high resolution, and is mainly used to roughly estimate SoC and the amount of unbalance between the cells (by coulomb counting during charging).

12 If you want redundancy (if you have a very large / expensive LFP bank), you can install a second BMS4S, either exactly the same as the first, or simplify by reducing some of the duplicate equipment. The simplest working configuration is to only connect + 12V, - and a cable to the alarm / buzzer so that it can notify you if something is broken. Then connect the two with a wire that runs between Sup (Isup on board 2.0) on one BMS4S to Sup on the other. Then change the working mode on one to "supervised master", and the other to "supervised slave" Command wm = + 4 on one, and wm = + 8 on the other. Make sure that the two BMS4S do not share the same fuse to avoid a single fault knocking out the monitoring. They are now monitoring each other, and if one breaks down, the other will start beeping "device errors" while still monitoring the LFP bank.

13 If you intend to keep the batteries connected all the time, also when leaving the boat for long times, it can be wise to install a bi-stable relay that isolates the battery completely in case of a low voltage incident. It shall be connected to terminal All OFF, and BMS54S sends out a 1 s pulse when the voltage of the first cell goes below 2.8 V (can be changed with vv=n.nnn). It is recommended that this relay switches off ALL consumers. You might

have to connect a capacitor in parallel with the relay of 100-300 uF to ensure that it is finishes switching after the power is cut. This kind of high-current relay can of course also be used as relay in point 2 above if you have equipment like high current inverters. For thrusters and winches it is enough if the control buttons are powered from behind the low-voltage relay, they use very little power.

Testing

Switch on the power and connect to BMS4S with your phone or PC over Bluetooth (or FTDI cable). Start with checking that all voltages are reported correctly, command p. Then take a look at the settings to see if there are anything you want to change, command ps. And verify the all connected temperature-sensors are correctly configured. Now it is time to test the system. Firstly, we test that the low voltage protection works:

1. Temporarily change the limits for when power to consumers is turned off and on: command vo = 3.4 and vl = 3.4. To be able to change settings, the device must be unlocked, command du = 1234.
2. After 15 seconds the relay shall cut off the electricity to the main panel.
3. If you have a very-low-voltage shutoff relay, temporarily set the very low voltage to 3.4, command vv=3.4
4. After 15 seconds the relay shall cut off all power
5. Reset the voltage levels to the desired values (vl=3.05, vv=3.0 and vo=3.1). You might have to switch on the very-low voltage-relay manually to do this, dependent on how you have connected it.
6. The low-voltage relay shall immediately switch the power on again

If this works ok it is time to test the high voltage protection.

1. Start the engine
2. If the batteries are not fully charged, set the high voltage to 3.1 V, command vh=3.1
3. After 15 seconds the engine shall change sound and run more easily since the alternator now has stopped to charge the battery. If you have installed a power shunt you can verify that charging has stopped with command p, that will print voltage and current.
4. Prepare the command to reset the high voltage limit to 3.6 V, command vh=3.6, but do not send it yet.
5. Wait 2 minutes, and the buzzer/alarm for high voltage will start sounding
6. Now send the prepared command to make the alarm stop.
7. Restart charging by pressing the push-button until the LED blinking stops. Will take around 7 seconds.
8. You can also test that the charging stops also by temporarily changing the setting. Press the push-button until you have seen 6 long blinks on the LED. Now you have temporarily decreased the stop charging voltage with 2 volts, which definitely will stop charging within the set delay. Doing it this way will not generate any high voltage alarm.
9. Restart charging by pressing the push-button until the LED blinking stops.
10. Stop the engine.

I this works ok, then test the low voltage warning

1. Set the warning blink level to 100 %, command sl=100

2. The LED shall start blinking with one blink for each 10% of state of charge in the battery, i.e. if the SoC is 45 there will be 5 blinks, 2 seconds pause, 5 blink etc.
3. Reset the warning blink level to 20 % (or what you think it should be), command sl=20

And lastly, we test the charge level adjustment

1. Press the push-button until you see 3 long blinks on the LED.
2. Check that the system has noticed this, command po.
3. Check that in the printout contains: volt high adjust= -0.10 V
4. Do the same thing until you see 4 long blinks, po will give: volt high adjust = -0.15 V
5. Do the same thing until you see 6 long blinks, po will give: volt high adjust = 2.00 V, which means that all charging (that BMS4S controls) will be stopped all the time
6. Press the push-button until it stops blinking and check that the line says: volt high adjust = 0.00 V

If everything seems ok, print the extremer-point log, command pe. This will show the log of all tests you have done. Then reset it so that there will be plenty of space for real life entries, command ce.

Balancing

If you have a 3.6V charger it is normally enough if you use it to fully charge all cells one or two times a year with it. Since BMS4S always act on the first cell reaching a boundary, there will be no harm done even if there is an unbalance and the usage-settings are aggressive using as close to 100% of available capacity as possible. Even if you intend to use the built-in automatic balancer you must always start with manually top-balance your cells before you use them for the first time. Connect them all in parallel and charge them up to 3.65 V (or read what the manufacturer recommends).

The balancer can work in two modes: "voltage based" and "coulomb based". The first one is the simples and is recommended if you have well matched cells. If you notice that the unbalance is increasing when looking at the printout from command pe then this is not the case. Then you must use the latter (coulomb based balancing).

How you set it up is described in chapter "Basic configuration".

Alarm

All alarms consist of n number of sound shocks with set length (tb = 300 is default) with a 2 second pause. Many alarms stop automatically when the fault condition ceases, but otherwise you can silence an alarm by pressing the button until a longer flash appears on the LED. Below is a description of what the alarms are due to.

2 beep low temp charging

If BMS4S notices that charging is started and the battery temperature is lower than the set mini temperature (t1 = 5 is default), then the alarm will start and charging will be stopped. As soon as the charging stops, the alarm will also stop.

3 beep high battery temp

If the battery temperature exceeds the set value (t2 = 50 is the default), the alarm will start. As soon as the temperature has dropped, the alarm will stop.

4 beep low voltage

If the voltage is below the set value (vw = 3.1 is the default) then the alarm will start and not end until the voltage has risen, or gone below "very low volt" when BMS4S goes down in low power mode and shuts off everything except waiting that the voltage should rise.

5 beep high voltage

If the battery voltage has not dropped for a while after the BMS4S has stopped charging (tw = 120 is the default), the alarm will go off. Turns off when the voltage has dropped.

6 beep BMS device failure

If the voltage is below the set value (vl = 3.1 is the default) then the alarm will start and not end until the voltage has risen, or gone below "very low volt" when BMS4S goes down in low power mode and shuts off everything except waiting that the voltage should rise.

5 beep high voltage

If the battery voltage has not dropped for a while after the BMS4S has stopped charging (tw = 120 is the default), the alarm will go off. Turns off when the voltage has dropped.

6 beep BMS device failure

If you have two BMS4S monitoring each other, and one stops working, the other will sound the alarm. The alarm does not stop until the failure works again. If it has broken, then maybe you should turn off the monitoring (command wm = -4).

7 beep temp device failure

If the BMS4S does not get in touch with the number of temp sensors installed at start-up, or if there are too many incorrect readings from one or more sensors, it will raise this alarm.

If the alarm comes on start-up, list the sensors with the command po. If you have given the sensors different names (for example: a1, b1 and b2), you will immediately see which sensor is missing.

If the alarm comes on during operation, you can give the command sv = 5 and remain connected to BMS4S. Now, for example, the printout "temp sensor: 2 name: a1 delivered bad report" can come. It means that the sensor that is listed as number 2 in the printout you get from the command po has problems. The name, which here is a1, can sometimes be incorrect because it was taken from the incorrect report. But the number in the list is always correct.

8 beep

Not used in this version.

9 beep high board temperature

For some reason, the circuit board is warmer than it should be. If this happens, it may be because the balancing circuits have broken. If the alarm does not end within a few minutes, and you do not

find any other reason why the BMS4S has become too warm, you should disconnect the BMS4S and have it replaced.

10 beep low voltage bat2

Battery 2 has a voltage below the set monitoring voltage (ve = nn.n).

For some reason, the circuit board is warmer than it should be. If this happens, it may be because the balancing circuits have broken. If the alarm does not end within a few minutes, and you do not find any other reason why the BMS4S has become too warm, you should disconnect the BMS4S and have it replaced.

I/O description PCB version 2.0

In the lower left corner, you can connect the Bluetooth module and a FTDI card (or any serial TTL (5V) serial adapter: Baud rate: 9600, Data bits: 8, Stop bits: 1, Parity: None). Make sure you use the right socket and the right pins in the right holes. TX means that this is where the board is transmitting, shall be connected to the adapters RX.

BMS4S has 24 I/O screw-sockets. From lower left corner clockwise:

SHTB   connect to battery side of a low side current shunt, voltage must never exceed 1 V

SHT   connect to load side of a low side current shunt, voltage must never exceed 1 V

+5V   can be used to support LED and BEEP with current, max load 200 mA

Beep   open collector terminal, used for warning buzzer, max load 100 mA

LED   open collector terminal, used for LED indicating SoC, max load 300 mA

+12V   power supply, can be used to feed the LED and Beep with current

Load OFF   produces a 12 V pulse to switch off the relay for all loads, max 3A constant load

Load ON   produces a 12 V pulse to switch on the relay for all loads, max 3A constant load

Charge OFF   produces 12 V to disconnect all charging sources, max 3A constant load

All OFF   produces a 12 V pulse to disconnect loads when low voltage, max 3A constant load

-             minus, ground, can be used for relays for load and charge.

+12V   power supply, entry point for the power from the battery. BMS4S will use less than 10 mA during normal operations, but this terminal is also driving all equipment on terminals Load OFF, Load ON, Charge OFF, All OFF as well as all loads connected to +12V

-             minus, ground, entry point for the power from the battery

B12   voltage sense cable input, 12 V

B9   voltage sense cable input, 9 V

B6   voltage sense cable input, 6 V

B3   voltage sense cable input, 3 V

B0	voltage sense cable input, must ALWAYS be connected BEFORE B3 to B12 and +12V is connected
Pre Charge	open collector terminal, used to pre-charge for example an inverter before the bi-stable relay is switched on, max load 100 mA
Inpot	connection point for the push-button, must never exceed 5 V
Temp	connection for the yellow cable from the temperature sensors
Osup	open collector terminal, not used
Isup	terminal to connect two BMS4S together for supervision, must never exceed 5 V
Gvolt	connection point for the voltage sense cable from the alternator

Power usage:	less than 10 mA during normal operation (most often below 5 mA)

I/O description PCB version 3.0, 3.1 & 3.2

In the lower left corner, you can connect an FTDI card (or any serial TTL (5V) serial adapter: Baud rate: 9600, Data bits: 8, Stop bits: 1, Parity: None). Make sure you use the right socket and the right pins in the right holes. TX means that this is where the board is transmitting, shall be connected to the adapters RX.

The Bluetooth module is connected to the center of the card at the top. There are different variants of bluetooth modules, and some of them have pins in the opposite order. So also here you have to be careful so it ends up right: TX on the card should end up in RX on the adapter.

BMS4S has 24 I/O screw-sockets. From lower left corner clockwise:

SHTB	connect to battery side of a low side current shunt, voltage must never exceed 1 V
SHT	connect to load side of a low side current shunt, voltage must never exceed 1 V
+5V	used to power the temperature-sensors (normally not necessary), max 200 mA
Beep	produces a 12 V pulses, used for warning buzzer, max load 1.2 A
LED	produces a 12 V pulses, used for LED indicating SoC, max load 1.2 A
-	can e.g. be used for LED and Beep
Load OFF	produces a 12 V pulse to switch off the relay for all loads, max 1.2 A constant load
Load ON	produces a 12 V pulse to switch on the relay for all loads, max 1.2 A constant load
Charge OFF	produces 12 V to disconnect all charging sources, max 1.2 A constant load
All OFF	produces a 12 V pulse to disconnect loads at low voltage, max 1.2 A constant load
-	minus, ground, can be used for relays for load and charge.
+12V	power supply, entry point for the power from the battery. BMS4S will use less than 10 mA during normal operations, but this terminal is also driving all equipment on

terminals Load OFF, Load ON, Charge OFF, All OFF as well as all loads connected to +12V

- minus, ground, entry point for the power from the battery

B12 voltage sense cable input, 12 V

B9 voltage sense cable input, 9 V

B6 voltage sense cable input, 6 V

B3 voltage sense cable input, 3 V

B0 voltage sense cable input, must ALWAYS be connected BEFORE +12V is connected

Pre Charge produces a 12 V pulse, used to control pre-charge of for example an inverter before the bi-stable relay is switched on, max load 1.2 A.

Inpot connection point for the push-button, must never exceed 5 V

Temp connection for the yellow cable from the temperature sensors

Bat2 terminal to supervise an extra battery, never to exceed 16 V

Sup terminal to connect two BMS4S together for supervision, must never exceed 5 V

Gvolt connection point for the voltage sense cable from the alternator

Power usage: less than 10 mA during normal operation (most often below 5 mA)

Appendix A, connect with an Android device

There are different manufacturers of blutooth adapters, and their variants may have the pins in different order, which means that they will point in different directions when connected to the BMS4S. Therefore, make sure that the pins RXD, TXD, GND (-) and VCC (+ 5V) end up correctly and in the correct socket on the BMS4S. On the BMS4S version 2.0, the bluetooth socket is in the lower left corner, and then it is only possible to connect adapters with the pin order as on the left picture below.

Then it is time to download "Serial Bluetooth" from Google play. The app should look like the one circled in picture 1.

| Bild 1 | Bild 2 | Bild 3 | Bild 4 | Bild 5 |
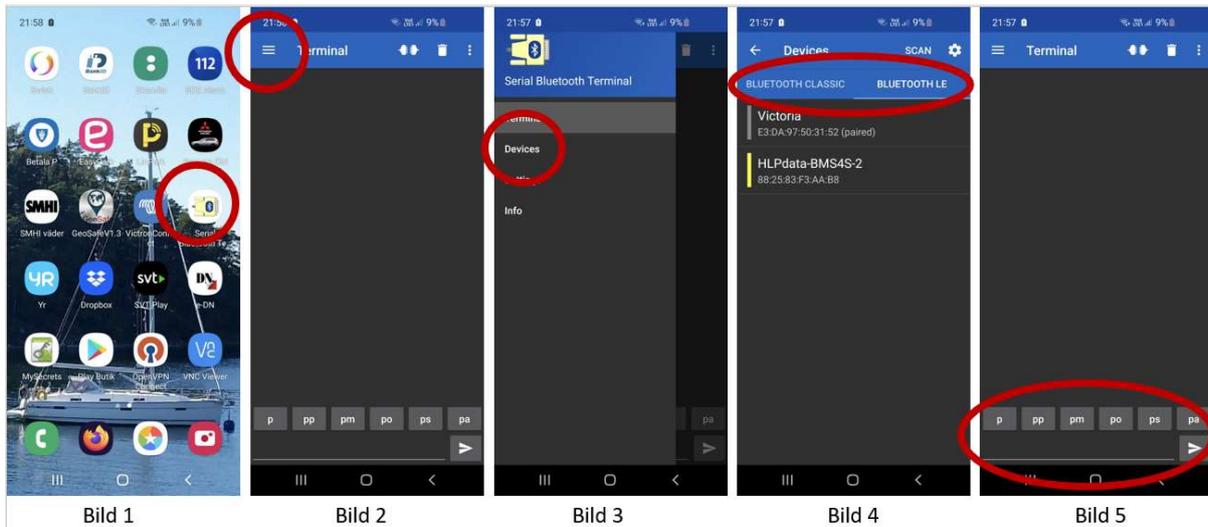
When you start the app, it looks like picture 2. Then pull down the menu, and then the options will appear according to picture 3. Select devices and you will come to picture 4. Depending on the type of bluetooth adapter you have, choose Classic or LE. A Classic must normally be paired before it appears in the list. PIN is normally 1234 for those. For LE, all shows up normally. When you have selected the right device, you will come to picture 5 and be connected (in the picture it is not connected, the symbol at the top right shall be closed if connected). Now you can give commands on the bottom line. It is also convenient to load common commands, such as p and po, under the

keyboard shortcuts. Then just start the app, click on and you will be connected, and press the shortkey p and you will see the status immediately.

Appendix B, connect with an Iphone or Ipad

There are different manufacturers of bluetooth adapters, and their variants may have the pins in different order, which means that they will point in different directions when connected to the BMS4S. Therefore, make sure that the pins RXD, TXD, GND (-) and VCC (+ 5V) end up correctly and in the correct socket on the BMS4S. On the BMS4S version 2.0, the bluetooth socket is in the lower left corner, and then it is only possible to connect adapters with the pin order as on the left picture below.

Then it is time to download the BLE Terminal from the Apple appstore. It looks like the circled app in picture 1.
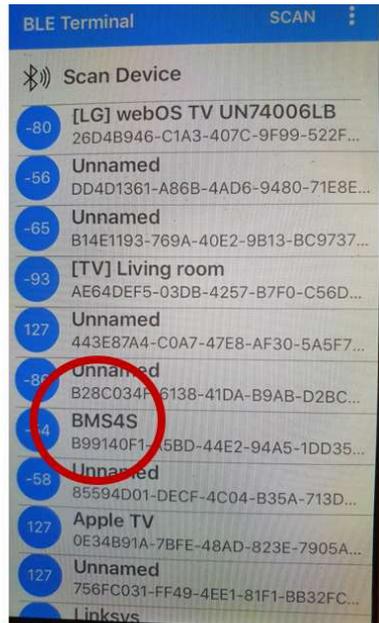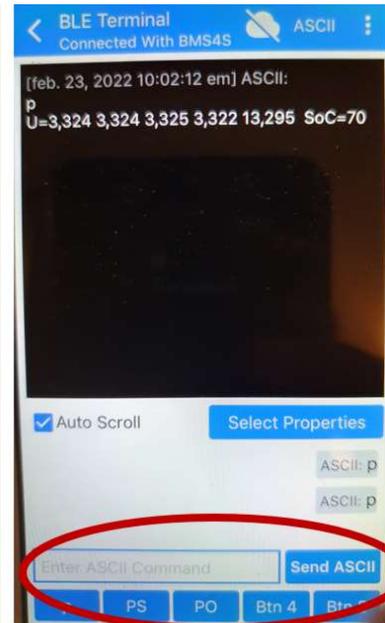
Bild 1

Bild 2

Bild 3

When you then open it, all bluetooth LE devices are listed immediately (the app does not support bluetooth classic). When you have selected from the list in picture 2, you will come to picture 3. There you can give commands on the bottom line. It is also convenient to load common commands, such as p and po, under the keyboard shortcuts. These are the only ones you normally use after the installation is completed.

Appendix C, connect with a Windows PC

Start by plugging the USB adapter into the PC. Windows will then install the correct driver automatically, and assign it a location among the available ports.

The program for serial communication can be found on hlpdata's website under downloads (Figure 1). Choose the version that suits your BMS4S. A folder of files will now be downloaded to your PC (Figure 2).
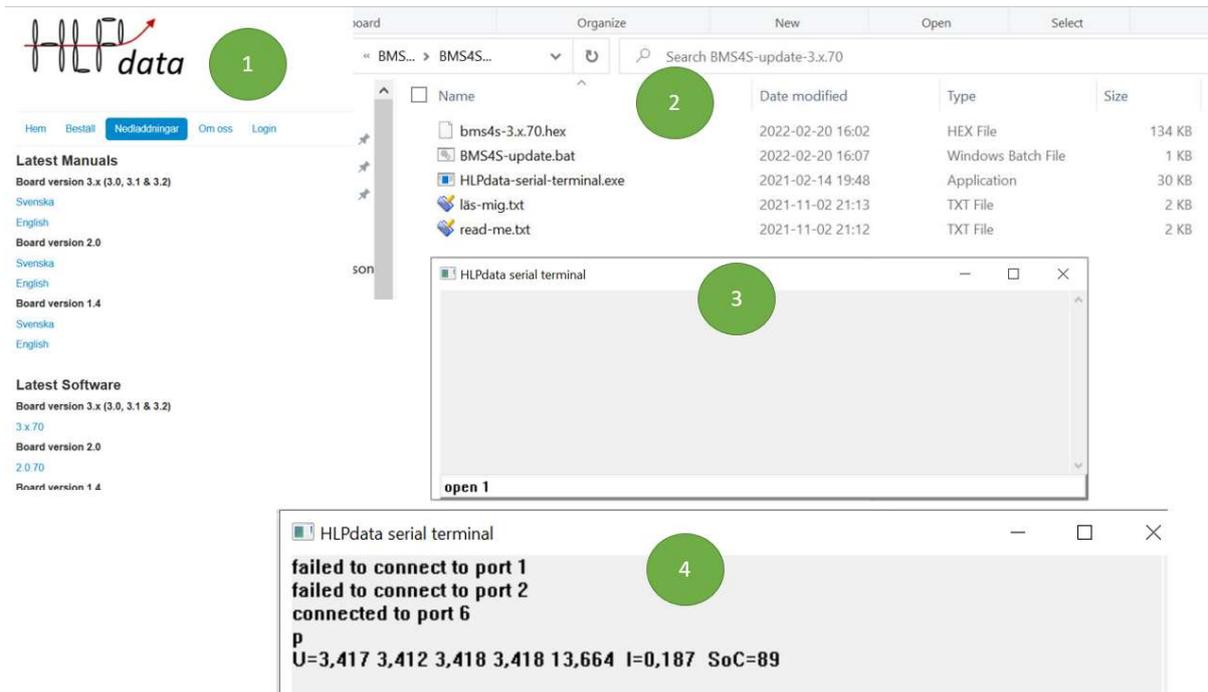
If you click on BMS4S-update.bat, the terminal window opens (Fig. 3). If you know which port Windows has assigned to your USB adapter (for example as com6) then you can open it directly with the command open 6. Otherwise you have to try it out. Start with open 1. If it does not work, continue with open 2, etc. (picture 4). When a port opens, try pressing enter repeatedly. Each press should then appear as a flashing LED on the adapter. If it does not flash, continue with the next port number. When you have found the right one, just connect the adapter in the right place on the BMS4S:

To the right you can see how the pins shall be located on a suitable FTDI-adapter

Now you can start giving commands, for example p as in picture 4. Sometimes the PC loose it's contact with the USB adapter is plugged into the BMS4S. Then just open it again. Now you know which com port it ended up at.