1 Features

- Supports 3 to 18 cells
- LTC6813 chipset
- Charge-only BMS
- Chemistry: LiIon, LiPo, LiFePo4
- SoC & SoH estimation
- Charge current measurement
- Charge cutoff on cell over temperature
- Charge cutoff on cell over charge
- Over temperature detection BMS
- Cell temperature monitoring (3x NTC)
- Self test routine
- CAN connectivity
- Communication with VESC motor controller
- Buzzer for acoustic warning signals
- VESC Tool desktop and mobile support for configuration and monitoring (mobile requires a wireless module)

2 Applications

- General purpose smart BMS for 3 to 18 cells in series
- For integration into VESC ecosystem

3 Description

The VESC 18S Light BMS is a charge only battery management system (BMS) for up to 18 cells in series featuring cell balancing, charge coupling and decoupling, temperature monitoring and system health checks. The device is designed to be integrated into the VESC ecosystem, allowing it to continuously share information about the battery sate with other CAN linked devices, so that the battery always will be operated within pre-defined and acceptable limits. The VESC motor controllers use the data on the CAN-bus from the BMS for soft power rampdown when the cells get warm or approach end of charge, which preserves the cells and avoids hard cutoffs. This dynamic interaction sets the device apart from less sophisticated solutions without a transparent communication structure.

The BMS is backed by VESC Tool, which runs on Linux, Windows, iOS, MacOS and Android. Features include a wide range of adjustments for the battery setup and operation as well as live monitoring and logging capabilities onto a computer or VESC device like the VESC-Express.

4 Typical installation

The typical installation is shown in the diagram below.
It is necessary to use appropriate fuses on all connections, matching the discharge current and charge current.
It is highly recommended to use 200mA fuses on all balance cables, close to each cell! Each battery has to be equipped with at least one temperature probe (NTC10K 3380K) in the centre of the battery and with sufficient thermal contact to the cells.

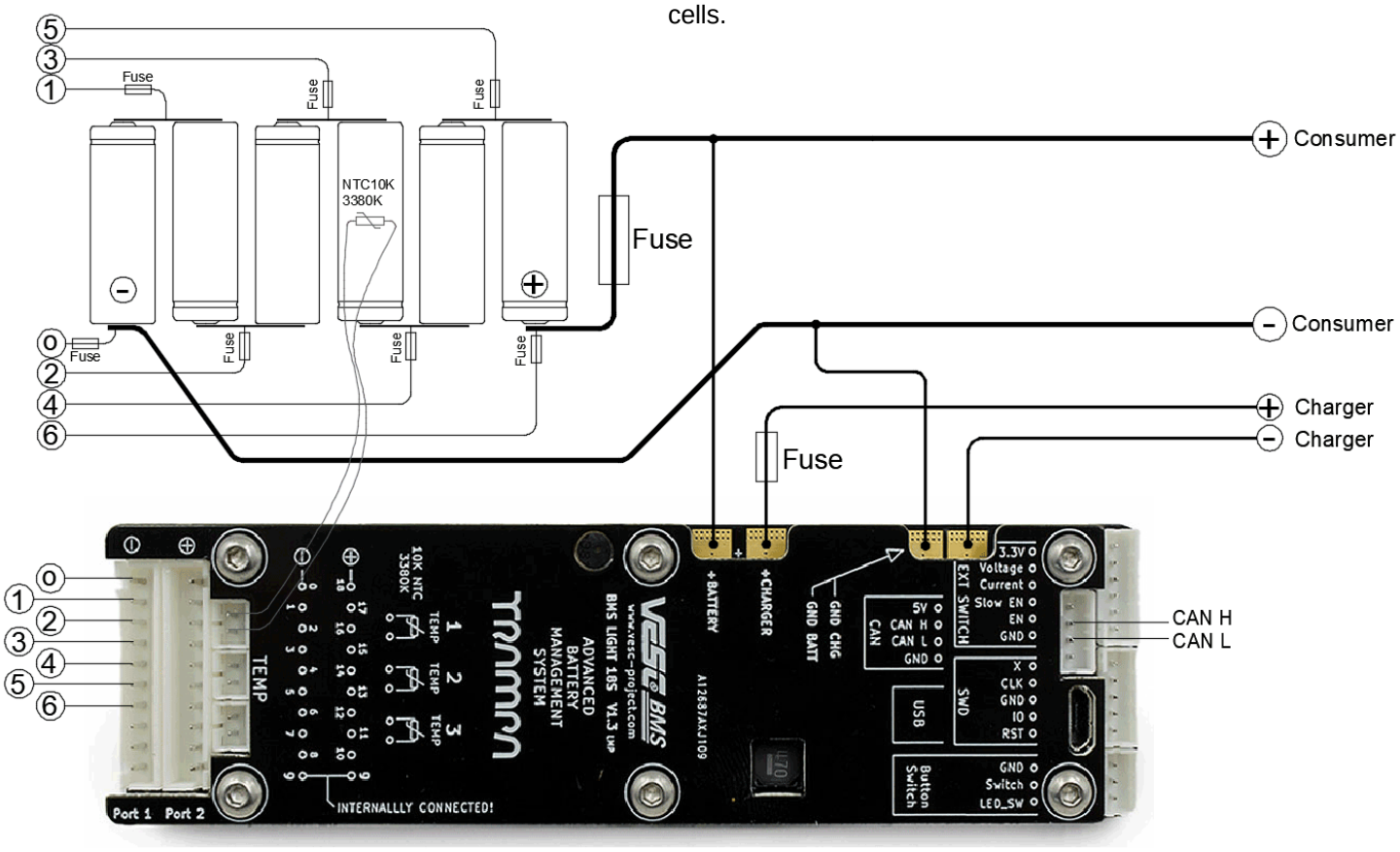


Table of Content

5 Warnings

WARNING: Read the ENTIRE instruction manual to become familiar with the device and its features before operating. Failure to operate the product correctly and safely may result in damage to the product, personal property and cause serious injury.

This product must be operated with caution, common sense and in harmony with any regulations in place. Usage requires special mechanical and electrical ability and training. Failure to operate this product in a safe and responsible manner could result in injury or damage to the product or other property.
This product is not intended for use by children. Do not attempt disassembly, use with incompatible components or augment product in any way without given approval by the manufacturer. This manual contains instructions for safety, operation and maintenance. It is essential to read and follow all the instructions and warnings in the manual, prior to assembly, setup or use, in order to operate correctly and avoid damage or serious injury.
Age Recommendation: Not for children under 18 years. This is not a toy.

Throughout the literature the following terms will be used to indicate various levels of potential harm when operating this device.

NOTICE: Procedures which, if not properly followed, create a possibility of physical property damage AND little or no possibility of injury.

CAUTION: Procedures which, if not properly followed as described in this manual, create the probability of physical property damage AND a possibility of serious injury.

WARNING: Procedures which, if not properly followed, create the probability of property damage, collateral damage, and serious injury OR
create a high probability of superficial injury.

WARNING: This device may not be used for applications requiring fulfilment of special safety standards. Among others this includes: Vehicles, aircrafts, certain machines and operation in safety critical environments like medical, nuclear and military!

6 Type of batteries

This product may only be used for suitable batteries, such as LiIon, LiPo and LiFePo4. The settings in the software must the changed to match the cell chemistry and other call parameters. Please refer to the data sheet of your battery cell.

Depending on your country, safe handling for untrained persons is limited to a certain voltage range. If you don't have professional training, you may not operate this device above the specified voltage range. This voltage range is specified by the low voltage directive of your country of operation.

WARNING: Battery cells may not be overcharged or operated below their lowest specified discharge voltage. Batteries operated outside these parameters are a serious risk of fire and/or explosion! Even a single event of overcharge and over discharge should result in a safe disposal of the battery!

Typical values for different cell chemistries are:
(Lowest discharge voltage - Max charge voltage)

LiFePo4: 2.5V – 3.6V
LiIon: 2.8V - 4.21V
LiPo: 3.2V - 4.21V

For optimal battery life it is recommended to stop charging at 95% of the possible charge level and avoid discharging the cells to the lowest possible voltage. For example LiIon: 3.2V – 4.15V per cell.

WARNING: Battery cells may not be mixed! A battery must be made from cells of the same chemistry, same type, same age, and same wear level! Each cell must be fused with an appropriate fuse.

7 Charger

The charger must match the battery chemistry, battery voltage (cells in series) and maximum battery charge current. The maximum possible charge current this product can safely handle is 12A.

The charge port must be secured with an appropriate fuse.

The BMS is capable of decoupling the charger if the battery faces conditions outside of safe parameters. This includes overcharge of individual cell groups and over temperature of the battery pack.

8 Charge process

The charge process must be monitored at all times! Never attempt to charge a hot battery or battery that was just used. Let the battery cool down before charging it. Let the battery cool down before using it again. Monitor the battery temperature before and after the charge process.

Before charging the battery make sure to monitor the state of balance. A healthy battery should stay well balanced throughout the discharge and charge process. A battery with cell balance issues may have bad internal contacts or incorporates damaged cells!

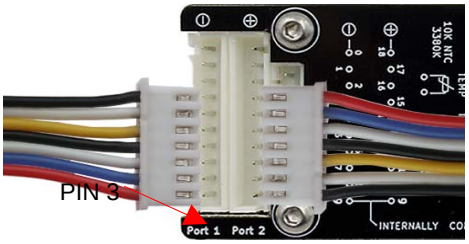
9 Setup in Software

The BMS must be configured before it can be used in conjunction with your battery. After installation to the battery a connection to VESC-Tool (latest version) must be established. The connection can either be done via USB, a VESC wireless module (VESC-Express) or via another CAN attached device. We advise to use USB for the initial setup.

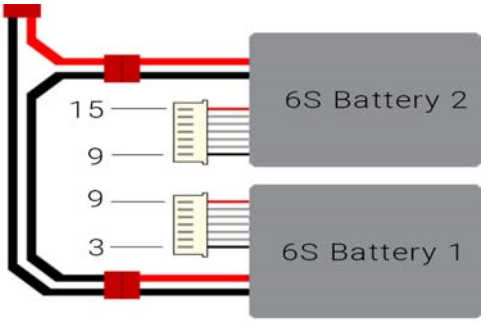
Procedure: Launch VESC-Tool, connect via USB, click on the Auto-Connect button on the front screen. The device should now connect and in the lower right corner of VESC-Tool you should see a statement **Connected (Serial) to COM X. Notice**: it can take 20 – 30 seconds for the BMS to show up after plugging in USB due to the sleep mode.

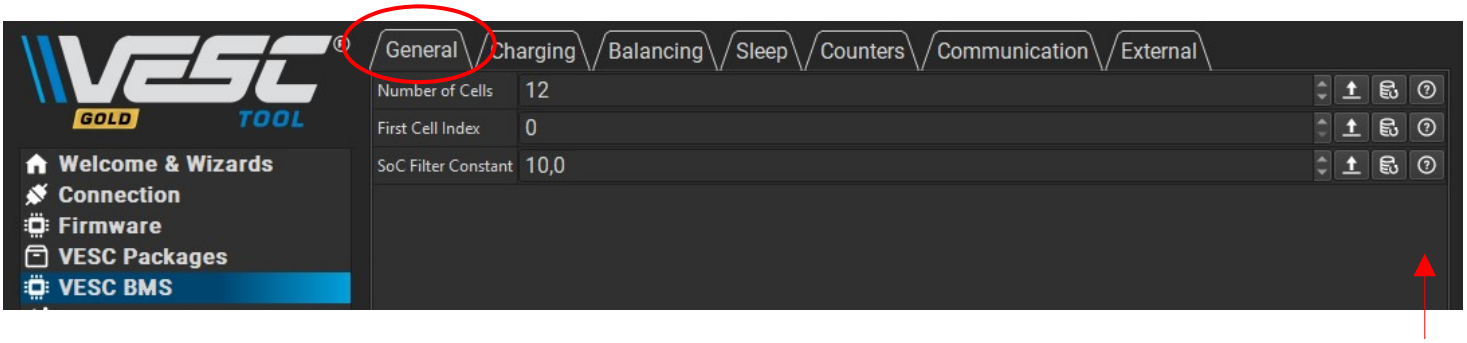
9.1 Starting the Setup: After the successful connection please navigate to the VESC BMS menu on the left hand side. In this window you will find different tabs with different settings. We will start with the *General* tab and enter the number of cells in series. In our example we have 12 cells in series and the *Number of Cells* is set to 12.
The *First Cell Index* is typically set to O. In some cases the balance cables are plugged into the BMS in a different way and this setting allows you to set the BMS accordingly.

EXAMPLE:



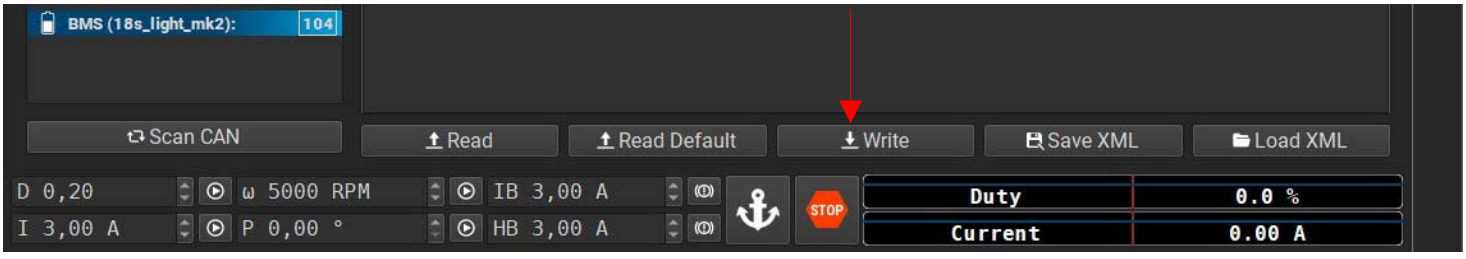
This example shows the balance connectors from two 6S batteries in series. The minus pole of the battery is connected to PIN 3. *First Cell Index* is set to 3
Balance cables must be plugged in a row with no empty pins in the middle, for example from PIN 3 to 15





The SoC filter constant typically stays untouched. Please note that clicking on the **?** Symbol will bring up some information about each setting.

After making the changes to the settings, the new settings must be written to the BMS! You can make all changes in all tabs first and then finally write all settings with one single click on the *Write* button. If you forget to write the settings, the BMS will not have the correct values for a safe operation!



9.2 The *Charging* tab: This tab is used to set up all relevant values for the charging process.

Charge End Voltage must be set to the maximum allowed single cell voltage or lower.
Please refer to the data sheet of the cell in use!

- For LiIon and LiPo batteries this value is typically 4.21V.
- For LiFePo4 this value is typically 3.65V
- For LiHv this value is typically 4.35V

Charge Start Voltage defines the single cell voltage below the charger will be engaged for charging.
In our example the charger will not be engaged if a single cell measures 4.17V.

Charge Minimum Voltage defines the minimum single cell voltage needed to allow charging. If a cell is over discharged, it should not be charged again! Please refer to the data sheet of your cell.

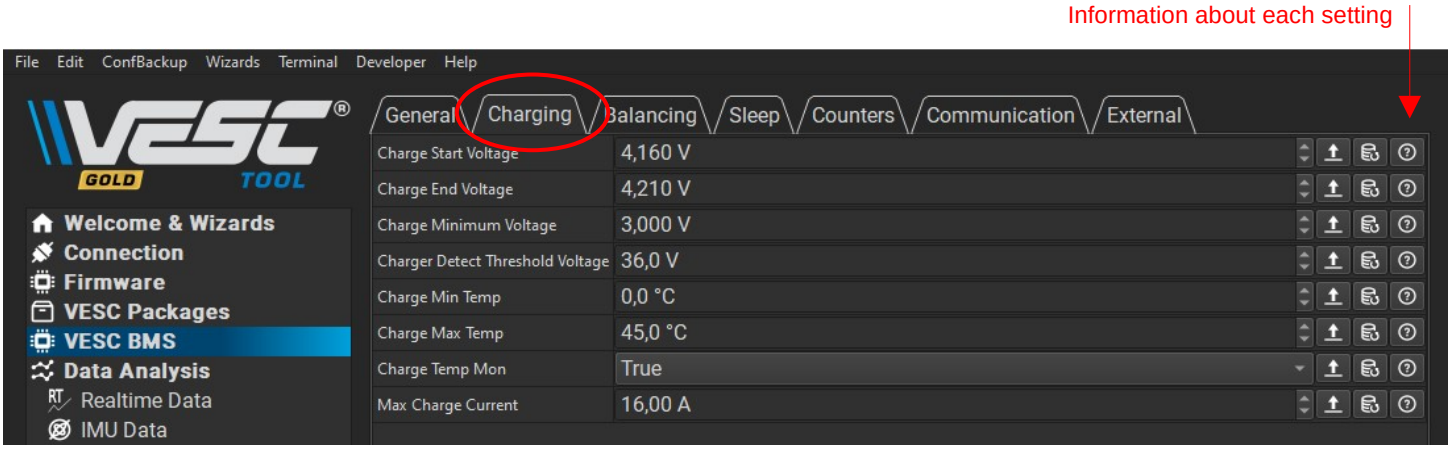
Charge Detect Threshold Voltage defines the minimum voltage measured at the charge port to allow charging.
This number should be slightly lower than the no-load voltage of the charger.

Charge Min Temp is the lowest temperature allowed during the charge process.

Charge Max Temp is the highest temperature allowed during the charge process.

Charge Temp Mon is used to disable temperature monitoring of the cells. This setting should only be used in a safe environment with other measures to monitor the battery temperature.

Max Charge Current is the highest charge current accepted by the BMS. If the charger is too powerful, the BMS will decouple the charger.



9.3 The Balancing tab: This tab is used to adjust all relevant values in reference to the balancing process.

The first thing to define is the *Balancing Mode*. Your options are:

BALANCE_MODE_DISABLED
Do not balance cells at all.

BALANCE_MODE_CHARGING_ONLY
Only balance while charging.

BALANCE_MODE_DURING_AND_AFTER_CHARGING
Balance cells during charging and after charging has finished. Balancing will stop as soon as the balance_max_current is exceeded.

BALANCE_MODE_ALWAYS
Always allow balancing.

The *Balance Starting Voltage* is the Voltage difference towards the lowest measured cell voltage. If a cell is this much higher in voltage, then this cell will be balanced (drained) to level out with the other cells in the pack.

The *Balance End Voltage* is the voltage tolerance that is accepted towards the other cells in the battery pack (seen as equal in voltage level). In the example below: A cell being 0.008V higher in voltage will not be balanced any longer.

The *Balance Minimum Voltage* is the voltage a cell needs to have before it can be balanced (drained) to meet the other cells voltages. Any cell with a voltage below this value will not be balanced.

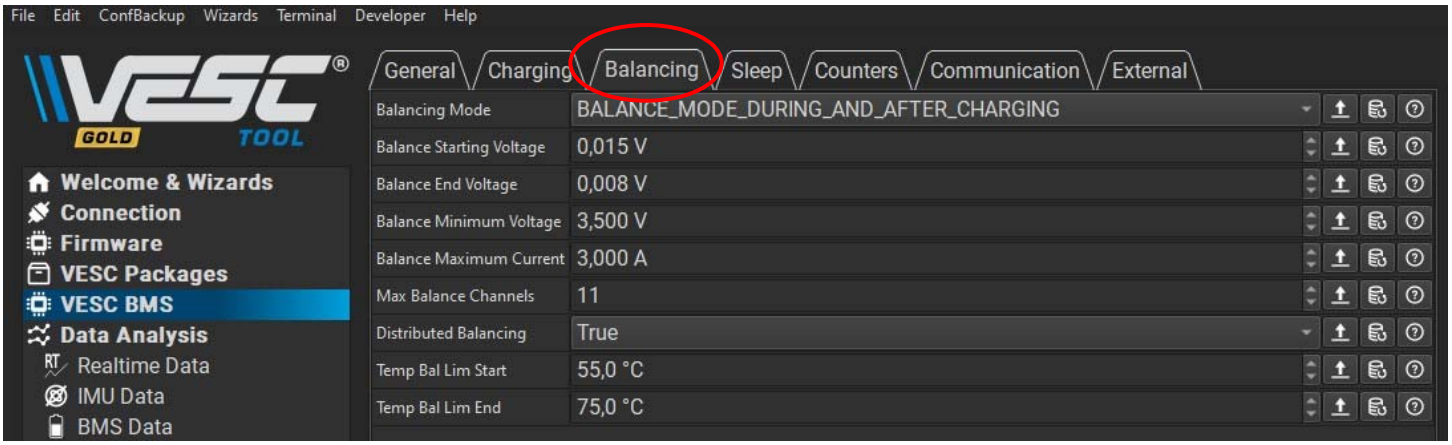
The *Balance Maximum Current* defines the charge or discharge current flow that is accepted while balancing. If the current flow is higher, then balancing is interrupted. **Notice:** The discharge-current is typically reported on the CAN-bus by the VESC motor controller.

The *Max Balance Channels* is the number of cells being balanced simultaneously. This number also defines the heat being generated while balancing a battery pack. The more cells you balance in parallel, the more energy is being transformed into heat via the balance resistors. The more channels you allow, the faster the battery pack will balance.

The *Distributed Balancing* setting allow the use of multiple VESC 18S Light BMS systems on one larger battery system. One example is two batteries in parallel, each having a VESC 18S Light BMS attached to it. The BMS devices have to sit on one CAN bus, being able to communicate with each other. If one BMS detects an issue and decouples the charger, the other BMS is informed to follow this instruction to prevent further charging of the battery.

The *Temp Balance Start defines* the temperature of the BMS circuit board and balance chipset resulting in a a decrease in balance performance to decrease the heat. This is done via reducing the maximum number of balance channels being operated at the same time (Max Balance Channels).

The *Temp Balance End defines* the temperature of the BMS circuit board and balance chipset resulting in a total stop of any balance activity. The balance process will start once the temperature dropped back to an acceptable level.

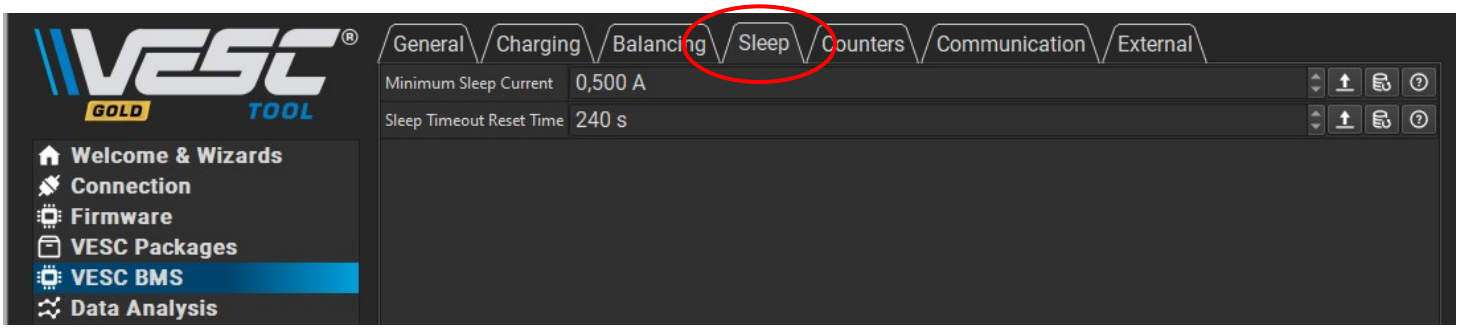


9.4 The Sleep tab: There are two settings you can change. The pre defined setting are acceptable for most systems. Please refer to the screenshot displayed on page 7

The *Minimum Sleep Current* defines the current that allows the BMS to go into sleep mode.

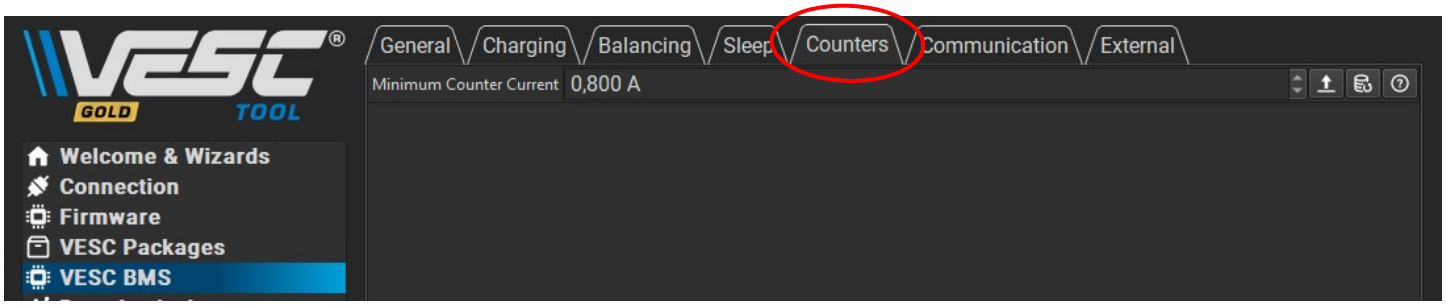
The *Sleet Timeout Reset Time* allows the BMS to go into sleep mode if no keep-awake event has occurred for longer time than this. Examples of keep-awake events are:

Balancing is active
Values are polled over CAN or USB
USB cable plugged in
Charging is active
Other BMSes on the CAN-bus are charging or balancing
VESC status messages are received
Current over min_current_sleep is drawn



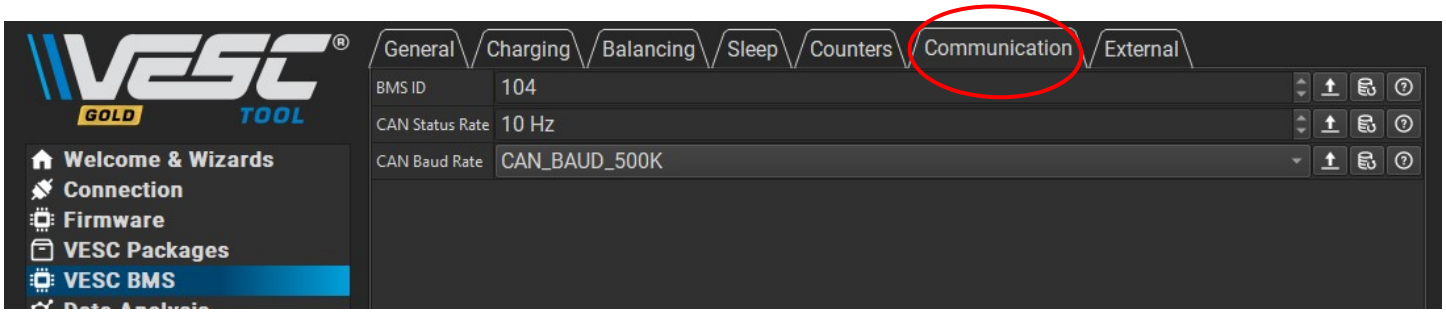
9.5 The *Counters* tab: The counters tab allows you to change setting in reference to the counters for Wh and Ah data. The per-defined setting can be used as standard.

The *Minimum Counter Current* defines the current magnitude needed for the Ah and Wh counters to run.

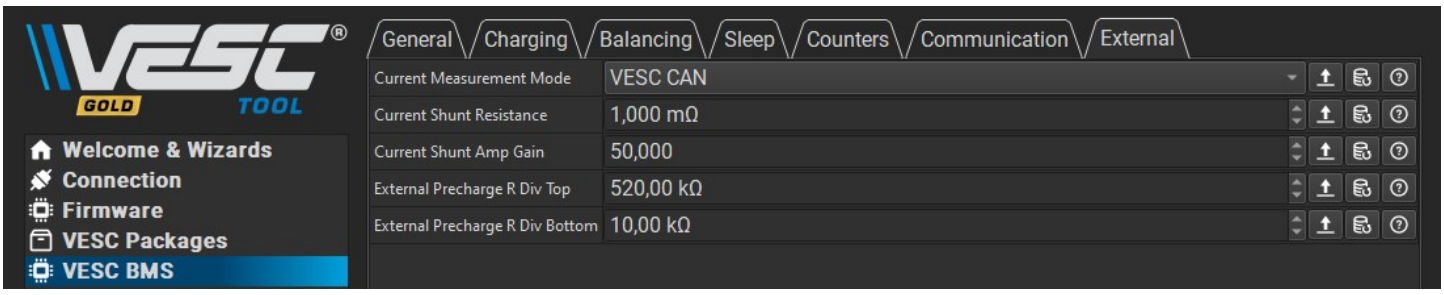


9.6 The *Communication* tab: This tab allows you to change setting for CAN communication with other devices.

- *BMS ID*: You can manually change the BMS ID. Make sure that no other device on the CAN-bus has the same ID.
- CAN Status Rate: Send status messages on the CAN-bus at this rate. High values might clog up the bus!
- CAN Baud Rate: The CAN-bus baud rate needs to match the baud rate of the other devices on the same bus.



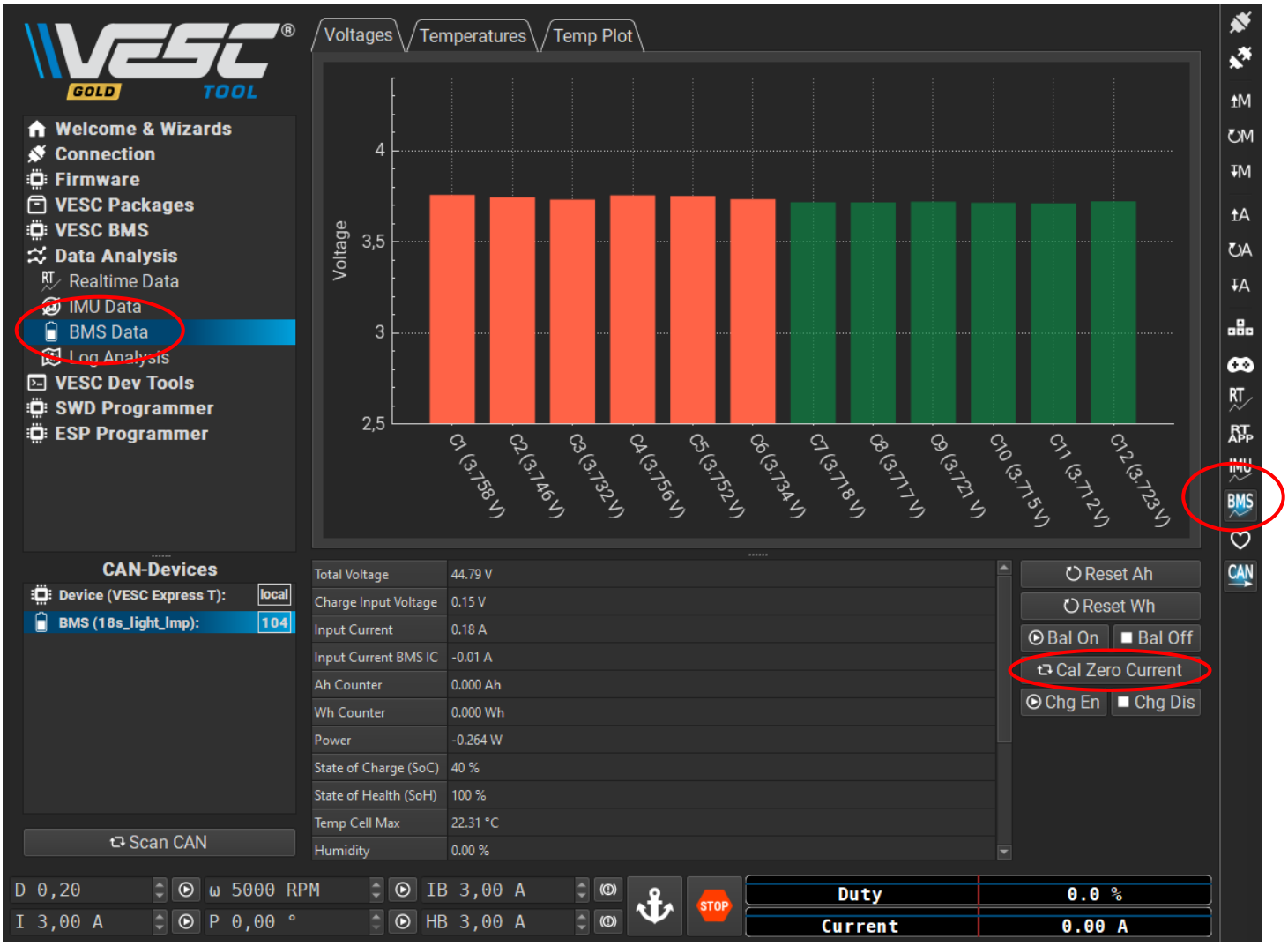
9.7 The External tab: This tab allows you to define settings for an external power switch and/or current measurement unit attached to the VESC BMS 18S Light. It should generally be left with the default values.



10 Calibration and final checks

After finishing the setup configuration, you need to calibrate the *Zero Current* and perform some tests to assure that everything is functional and safe. Go to the *BMS Data* page on the left hand side menu and activate *BMS Data* on the right hand side toolbar.

- Make sure that the battery is not charging and there is no consumer drawing current. **Press *Cal Zero Current.***



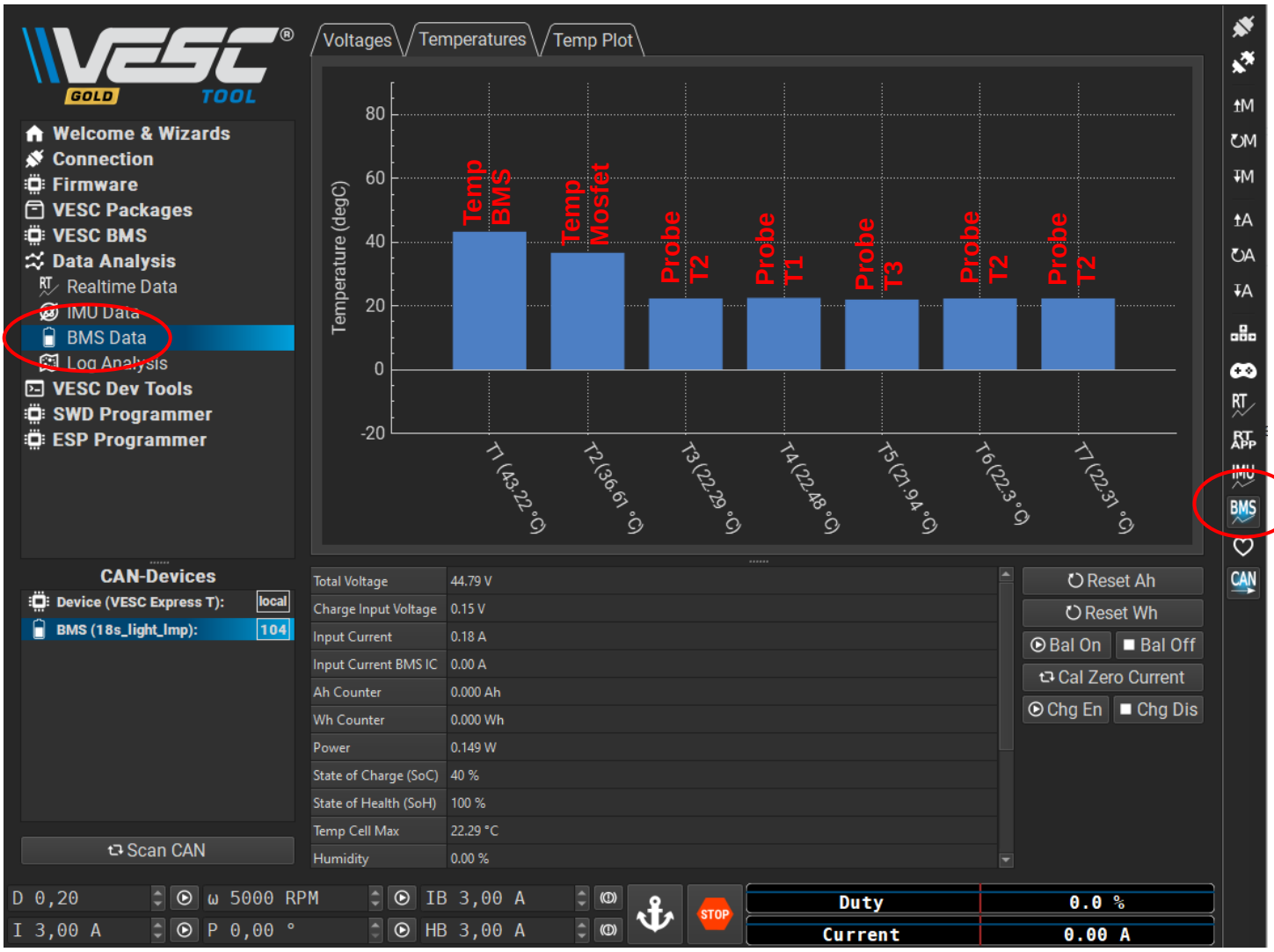
The next check is the temperature measurements. This window shows 7 temperatures. The temperature T1 and T2 are located on the BMS itself and show the temperture of the LTC chip and the Mosfet switch of the charge input. Temperature probe T1 on the BMS shows a T4 in this menu. T2 on the BMS shows as T3,T6,T7 and T3 shows as T5. Now plug your temperture probe(s) to T1, T2 or T3 on the BMS. These probes need to be an NTC10K with a beta value of 3380k.

- Enable *BMS real time data* in the left hand side menu and navigate to the *BMS Data* in the right hand side menu.
- Do the temperature probes bring up correct results in this screen? Compare the real temperature to the shown temperature.

Now prepare a temp probe and do not attach it to the battery. Heat up the probe and see if the temperature changes in the software. Now engage your charger and perform the following test:

- Heat up the temp probe above 60°C and see if the charger is decoupled by the BMS.

The test above has to end with a positive result, showing that the charge process is interrupted when the battery gets too warm. After a successful test, attach this temp probe to the middle of a battery cell within the middle of the battery pack. Make sure there is good thermal contact to the cell.



11 Integration in your battery housing

Warning: The VESC 18S Light BMS should be carefully integrated into the battery housing. Wrong assembly and placement may cause issues resulting in an unsafe battery with the probability of property damage, collateral damage, and serious injury or death!

- The battery itself needs to be safe and made to standards in place. Never integrate a VESC BMS into a damaged or unsafe battery!
- Cable routing and insulation needs to be safe and possible short circuiting needs to be ruled out
- Do not use flammable materials in your assembly, such as glues or flammable tape and insulation material.
- The Battery cells need to be thermally isolated from the BMS.
- The BMS needs to be able to dissipate the heat it generates while balancing.
- The enclosure has to protect the assembly and BMS against moisture, water and dust.

12 General safety information about IiIon and LiPo batteries

Warning: LiIon, LiPo and LiFoPo4 Batteries and also other types of batteries can be dangerous.
Wrong handling, assembly or operation may cause issues resulting in property damage, collateral damage, and serious injury or death.

Read the following manuals with care:

- Li-ion Battery Care & Safety information: https://trampaboards.com/resources/manuals/245.pdf
- LiPo Battery Care: https://trampaboards.com/resources/manuals/244.pdf

13 Support

If you have questions or doubts, please feel free to contact Trampaboards Ltd to clarify issues before proceeding with the assembly or operation of the product. Trampaboards Ltd is available during its business hours and via email. For further information visit: www.trampaboards.com

Declaration of conformity (in accordance with ISO/IEC 17050-1)

Product: VESC BMS Light
Item Number: #VESC BMS Light V1.3 Imp

The object of declaration described above is in conformity with the requirements of the specifications listed below, following the provisions of the EMC Directive 2004/108/EC:

LVD 72-23 / 93/68 EWG

Nottingham, 12.0.2023

Trampaboards Ltd.

TRAMPA BOARDS LTD 2002 - 2016
Company Registration UK 4653504
Registered Business Address
Unit 16, Centre Court,
33 Little Tennis Street,
Colwick, Nottingham,
NG2 4EL, United Kingdom

This device is manufactured to meet the **RoHS2** (2011/65/EU) regulations.

Instructions for disposal of WEEE by users in the European Union
This product must not be disposed of with other waste. Instead, it is the user's responsibility to dispose of their waste equipment by handing it over to a designated collections point for the recycling of waste electrical and electronic equipment. The separate collection and recycling of your waste equipment at the time of disposal will help to conserve natural resources and ensure that it is recycled in a manner that protects human health and the environment. For more information about where you can drop off your waste equipment for recycling, please contact your local city office, your household waste disposal service or where you purchased the product.

FCC COMPLIANCE
This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.
NOTE
This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment o and on, the user is encouraged to try to correct the interference by one or more of the following measures:
→ Reorient or relocate the receiving antenna;
→ Increase the separation between the equipment and receiver;
→ Connect the equipment into an outlet on a circuit different from that to which the receiver is connected;
→ Consult the dealer or an experienced radio/ TV technician for help.
The following parties are responsible for the compliance of radio frequency equipment with the applicable standards: in the case of equipment subject to authorization under the verification procedure, the manufacturer or, in the case of imported equipment, the importer. If subsequent to manufacture and importation, the radio frequency equipment is modified by any party not working under the authority of the responsible party, the party performing the modification becomes the new responsible party.