



1 Features

- Maximum input voltage of 135V (32s Li-Ion battery cells)
- Short circuit protection up to 600A with 10 μ s response time
- Charge current configurable up to 30A
- Built in power switch with precharge circuit
- Open-Source firmware/scripting supports coding of custom applications that can run on the onboard ESP32-C3
- Four configurable temperature sensor inputs compatible with NTC 10k Ohm 3380 B
- Broad range of communication interfaces including USB, Bluetooth, Isolated CAN-bus and Wi-Fi
- Included cross-platform configuration tool enabling easy setup of custom batteries and monitoring of cells.
- Fully configurable integrated sleep mode with ultra low sleep current to support under-voltage-lockout, and auto power-up and shutdown
- Integrated temperature sensors automatically protect the system during high power draw
- Extreme depth of customization with VESC Tool Desktop (Linux, Windows, Mac) and both Android and iPhone applications
- Integrated ESP32-C3 supports both station and access-point Wi-Fi connections alongside BLE 5
- Monitor the state of charge either by voltage or coulomb counting
- Balancing after charging allows using lower balancing currents over longer time to handle large unbalance without generating excess heat

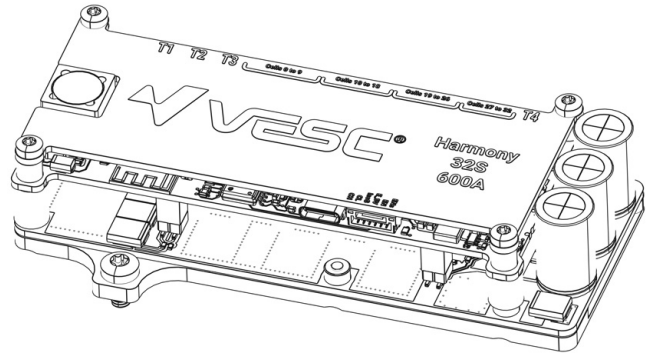


Figure 1: An isometric view of the Harmony 32

2 Description

The Harmony 32 is a high-power BMS which can manage up to 32 cells in series for batteries discharging up to 600A. An on-board ESP32 micro-controller running open-source VESC Software enables precise real-time and fully independent control of individual cell groups. VESC Tool enables complete flexibility to configure all the parameters of the BMS so that the battery can be operated safely. With a maximum charge current of up to 30A and real-time monitoring of cells, the battery can be wirelessly monitored while waiting for the battery to charge. This BMS also features short circuit protection up to 600A with a 10 μ s response time.

Isolated CAN-bus connectivity allows for seamless integration with other VESC devices for effective communication between all devices in the system. Other communication methods include USB-C, Wi-Fi and Bluetooth for convenient and flexible options to connect, configure and monitor the device via VESC Tool.

Suggested applications include small electric vehicles such as E-bikes, electric motorbikes, go-karts, trikes and buggies.

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3 Specifications

3.1 Absolute Maximum Ratings

Exceeding the Absolute Maximum Ratings may cause permanent damage to the device. Exposure to the absolute maximum rated conditions for extended periods of time may effect the device reliability.

Parameter	Min	Max	Unit
Input Voltage	15	135	V
Cells in Series	4	32	S
Cell Voltage*		5	V
Charge Current		30	A
Battery Current		600	A
Charge Voltage (per cell)		4.4	V
Balance Current		80	mA
Number of Temperature Sensors	0	4	-
Temperature Sensor Detection	-50	150	°C
Short Circuit Protection Current		600	A
Short Circuit Protection Delay	10	50	µs

*Incorrect cell connection order: If cells are connected in the wrong order, it will cause a large current to flow through the balance IC, which will cause immediate irreparable damage

3.2 Product Characteristics

Parameter	Value
Cell Chemistry	Lilon, LiPo, LiFePo4
Balance Method	Passive
Balance Mode	During and after charging

3.3 Recommended Operating Conditions

Parameter	Min	Max	Unit
Operating Temperature	-40	85	°C
Humidity		Non-condensing	-

3.4 Physical Properties

Parameter	Value	Unit
Length	123	mm
Width	71	mm
Height	28	mm
Mass	180	g

4 Wiring Diagram

4.1 Wiring Warnings

- **Installation and wiring must be performed by qualified personnel** experienced with high-voltage battery systems and VESC-based devices.
- **Read and fully understand all instructions, datasheets, and safety warnings** before attempting any wiring procedures.
- **Verify correct polarity for all connections.** Incorrect wiring can cause irreversible damage to the BMS, battery pack, or connected equipment. **Always double-check the wiring diagram before proceeding.**
- **Insulate all exposed terminals and wiring** to prevent accidental short circuits or electric shock.
- **Keep metal objects and tools away from the BMS and battery terminals during installation** to avoid accidental bridging of electrical contacts.
- **Only use manufacturer-specified connectors and cables** to ensure safe and reliable electrical connections.
- **Do not drill, cut, or modify the BMS enclosure or circuit board.** Unauthorized modifications may compromise safety or functionality.
- Before and while wiring or installing the device **ensure the device is completely free from any moisture, debris or conductive materials.**
- To ensure the integrity of creepage and clearances, **devices should be potted and totally watertight, and cabling sufficiently insulated.**

4.2 Lithium Batteries Warnings

- **Always operate lithium batteries within the manufacturer's specified voltage and current limits.** Exceeding these limits can result in cell damage, fire, or explosion.
- **Never short-circuit, crush, puncture, or disassemble lithium battery cells or packs.** Physical damage can lead to dangerous chemical leaks or thermal runaway.
- **Do not expose lithium batteries to open flames, direct heat, or high temperatures.** Excessive heat can cause batteries to swell, leak, or catch fire.
- **Store batteries in a cool, dry place away from flammable materials.** Proper storage reduces the risk of fire and prolongs battery life.
- **Do not charge damaged, swollen, or visibly defective battery packs.** Charging compromised batteries may result in fire or explosion.
- **Always use a charger specifically designed for the type and configuration of your lithium battery pack.** Incompatible chargers can cause overcharging or improper balancing.
- **Never leave a charging battery unattended.** Continuous supervision allows for immediate action in case of malfunction.
- **Immediately disconnect the battery pack from the system if any abnormal behaviour, unusual smell, or smoke is detected.** Prompt action can prevent escalation of hazardous situations.
- **Dispose of used or damaged lithium batteries in accordance with local regulations and recycling guidelines.** Improper disposal can harm the environment and pose safety risks.
- **Keep lithium batteries out of reach of children and pets.** Accidental exposure or ingestion can cause serious injury or health hazards.

4.3 Wiring Guidelines

Please follow the guidelines below to correctly wire up the BMS to your battery:

- This BMS has two balancing ICs. Cells 1 - 16 go to IC1 and cells 17 - 32 go to IC2. A minimum of 4 cells must be connected to IC1 or IC2, with a maximum of 16 cells being connected to either IC1 or IC2. When using 16 cells or less all cells can be connected to IC1 and IC2 can be left unused.
- If all the inputs on IC1 are not being used, the last cell must also be connected to the last input of IC1 (cell 16). An example of this is shown in the 13s and 18s wiring diagrams.
- Wire up temperature sensors in the order of T1, T2, T3, T4. For example, do not use T2 without T1 being used.
- All temperature sensors / thermistors used must be NTC 10K 3380K.
- **No semiconductor device is sufficient to meet regulatory requirements for discharge, and therefore it is prerequisite that your system includes a certified and correctly rated fuse to protect cells and wiring from over-current conditions.**
- **Cells must be connected in the correct order.** Failure to do so will cause a large current to flow through the balance IC, which will cause immediate irreparable damage.

Please connect the battery to the BMS in the following order:

1. Cell Negative
2. Cell Positive (Be aware that this connection is the most likely for large current to flow, and therefore be prepared to unplug if necessary)
3. 0- Cells 9+
4. 10+ Cells 18+
5. 19+ Cells 26+
6. 27+ Cells 32+
7. T1, T2, T3, T4

Please refer to the example wiring diagrams which demonstrate various examples of how to wire the BMS depending on the number of cells used.

- If the number of cells is between 4 and 15, please refer to Figure 2.
- If the number of cells is equal to 16, please refer to Figure 3.
- If the number of cells is between 17 and 19, please refer to Figure 4.
- If the number of cells is between 20 and 21, please refer to Figure 5.
- If the number of cells is equal to 22, please refer to Figure 6.
- If the number of cells is greater than to 23, please refer to Figure 7.

4.4 Example Wiring Diagram - 13s

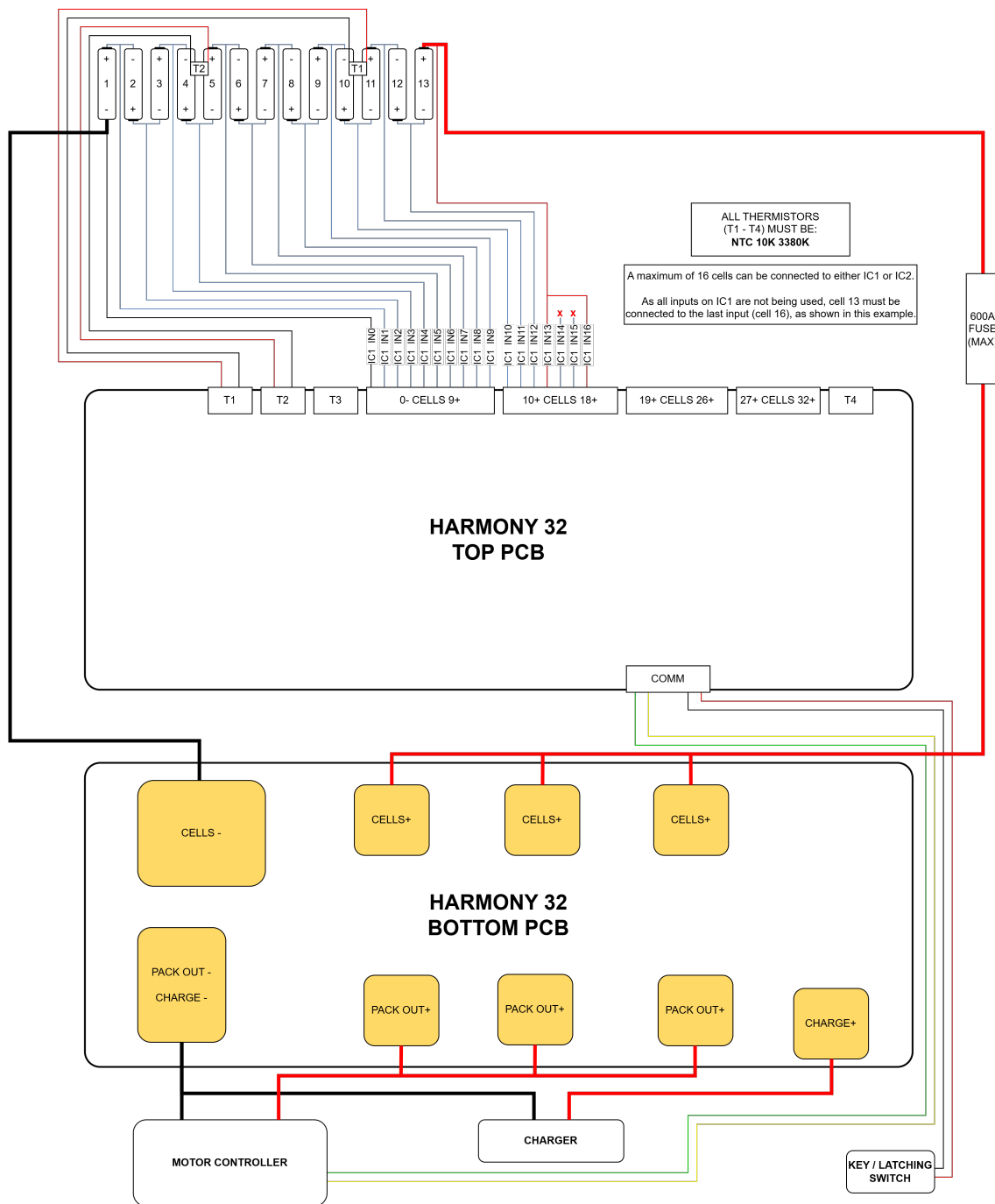


Figure 2: 13s Wiring Diagram

4.5 Example Wiring Diagram - 16s

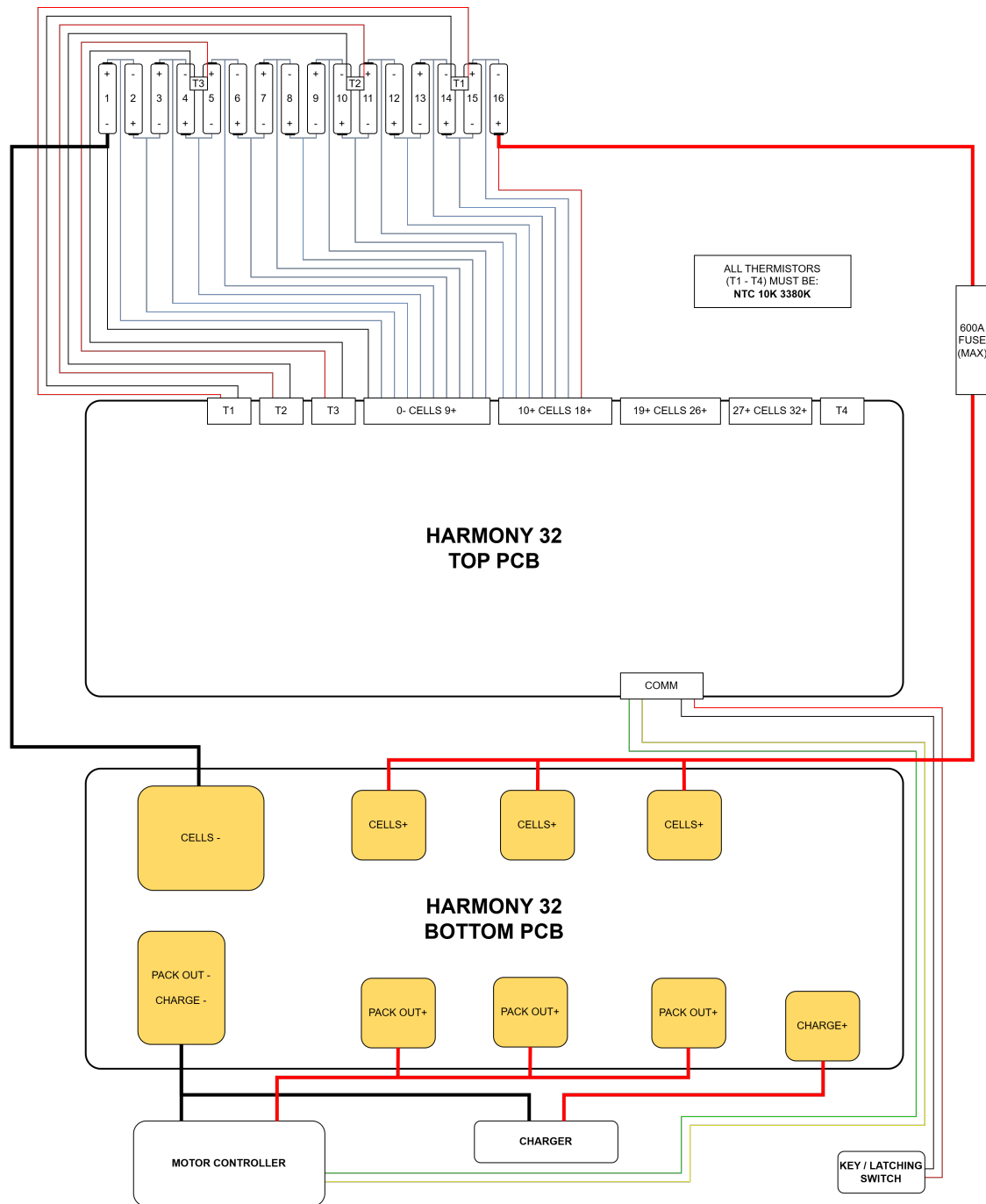


Figure 3: 16s Wiring Diagram

4.6 Example Wiring Diagram - 18s

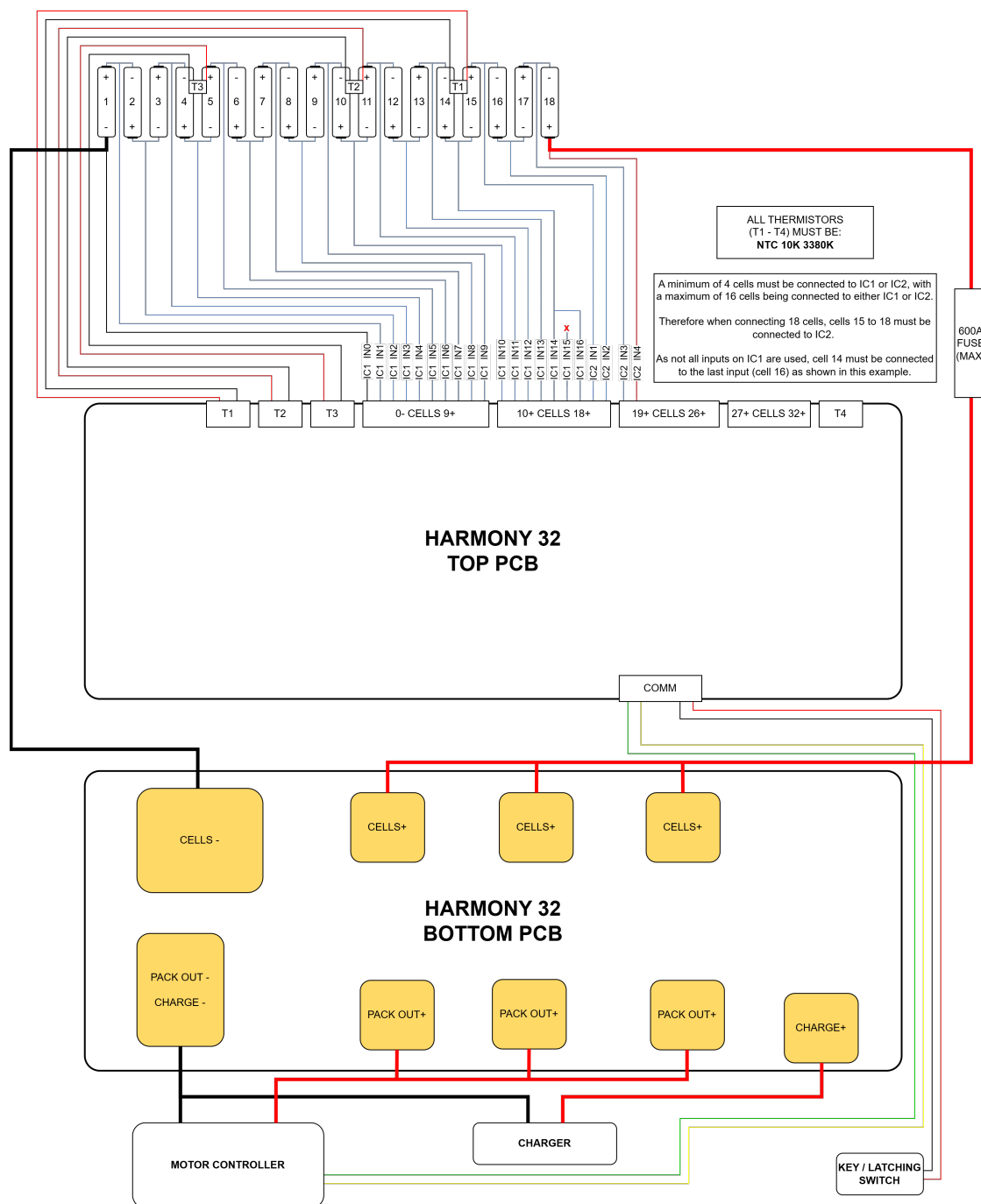


Figure 4: 18s Wiring Diagram

4.7 Example Wiring Diagram - 20s

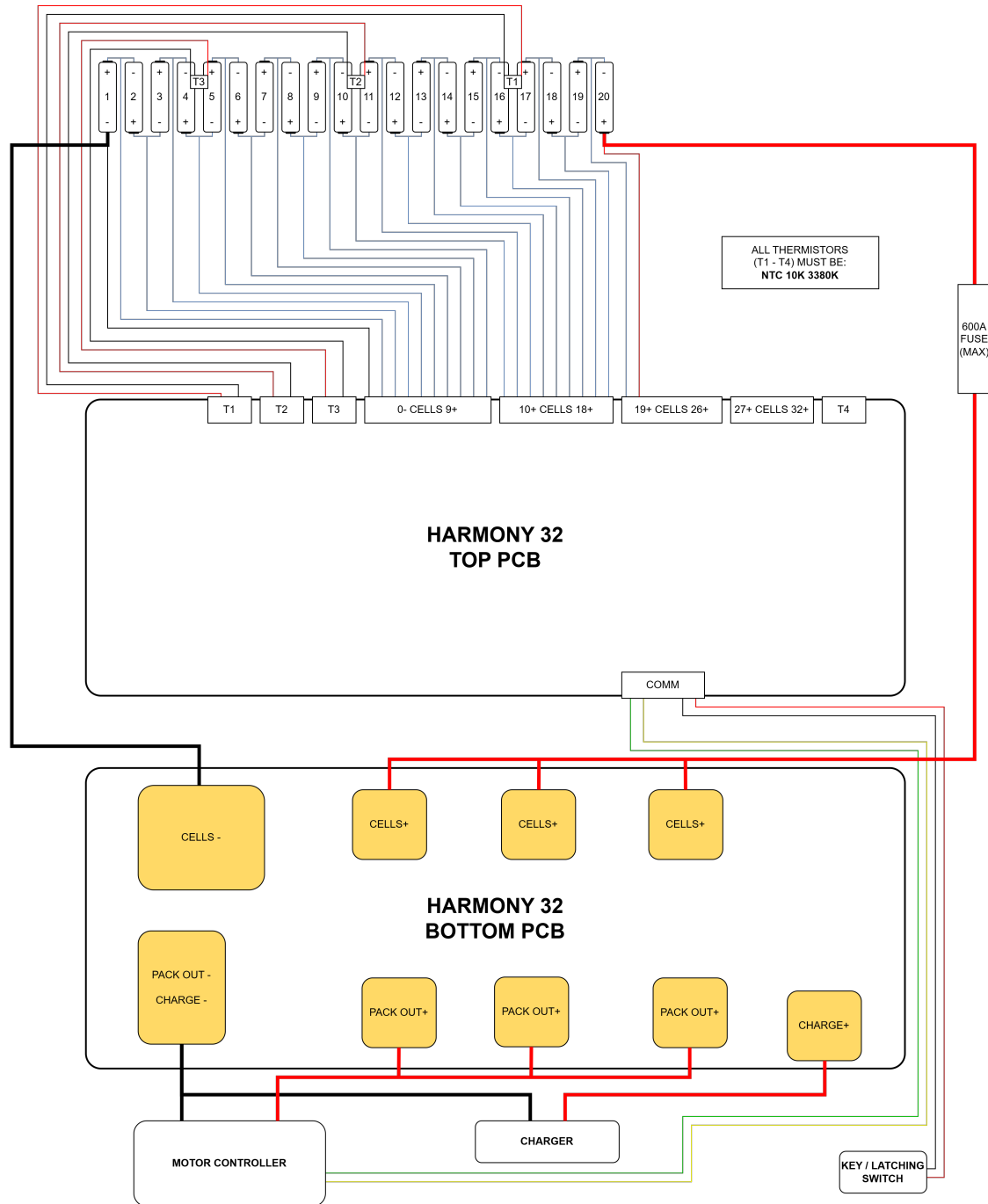


Figure 5: 20s Wiring Diagram

4.9 Example Wiring Diagram - 32s

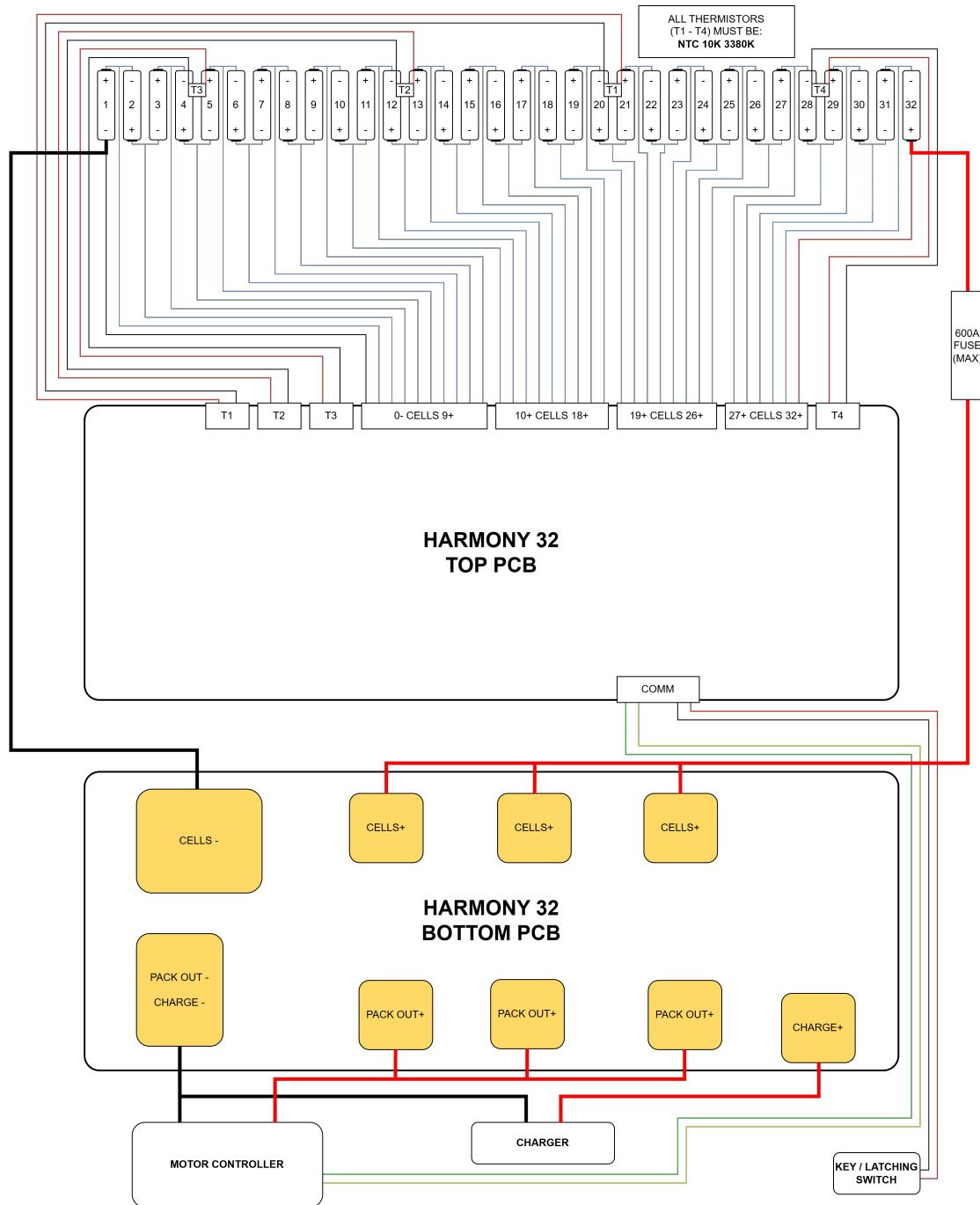


Figure 7: 32s Wiring Diagram

4.10 Pinout Table

Pin Name	Description
T1	
T1	Thermistor 1
GND	Ground Reference Pin
T2	
T2	Thermistor 2
GND	Ground Reference Pin
T3	
T3	Thermistor 3
GND	Ground Reference Pin
0- CELLS 9+	
GND	Cell Ground
C1	Cell 1
C2	Cell 2
C3	Cell 3
C4	Cell 4
C5	Cell 5
C6	Cell 6
C7	Cell 7
C8	Cell 8
C9	Cell 9
10+ CELLS 18+	
C10	Cell 10
C11	Cell 11
C12	Cell 12
C13	Cell 13
C14	Cell 14
C15	Cell 15
C16	Cell 16
C17	Cell 17
C18	Cell 18

19+ CELLS 26+	
C19	Cell 19
C20	Cell 20
C21	Cell 21
C22	Cell 22
C23	Cell 23
C24	Cell 24
C25	Cell 25
C26	Cell 26
27+ CELLS 32+	
C27	Cell 27
C28	Cell 28
C29	Cell 29
C30	Cell 30
C31	Cell 31
C32	Cell 32
T4	
T4	Thermistor 4
GND	Ground Reference Pin
COMMUNICATION	
CANH	Isolated CAN High
CANL	Isolated CAN Low
IsoG	Isolated Ground
E_5V	Isolated 5V Output 0.25A Max
EN	Power switch (bridge ENs)
ENs	Power switch (bridge EN)

5 Device Installation

5.1 Installation Warnings

- **Installation must be performed by qualified personnel** with experience in high-voltage battery systems and VESC-based devices.
- **Read and fully understand all instructions, datasheets, and safety warnings** before beginning installation.
- **Gather all necessary tools and materials** including the BMS unit, wiring harnesses, connectors, insulation materials, and personal protective equipment.
- **Ensure the battery pack is prepared and properly arranged** with correct cell spacing and secure mounting.
- **Securely mount the BMS using threadlock** in a location protected from vibration, moisture, dust, and direct heat sources.
- **Do not install the BMS in locations exposed to water, condensation, or flammable materials.**
- To ensure the integrity of creepage and clearances, **devices should be potted and totally watertight, and cabling sufficiently insulated.**
- **Install temperature sensors as required**, positioning them according to manufacturer guidelines for accurate monitoring.
- **Only use manufacturer-specified connectors and cables** to ensure safe and reliable connections.
- **Verify correct polarity for all connections.** Incorrect wiring can cause irreversible damage to the BMS, battery pack, or connected equipment. **Double-check the wiring diagram before proceeding.**
- **Insulate all exposed terminals and wiring** to prevent accidental short circuits or electric shock.
- **Keep metal objects and tools away from the BMS and battery terminals during installation** to avoid accidental bridging of electrical contacts.
- **Tidy up and secure all cables** with cable ties to prevent movement and wear.
- **Do not drill, cut, or modify the BMS enclosure or circuit board.** Unauthorized modifications may void the warranty and compromise safety or functionality.
- **Double-check all connections and wiring against the provided diagrams** before applying power to the system.
- **When powering up the system for the first time, do so in a controlled environment with appropriate protective equipment.** Be prepared to disconnect power immediately if any abnormal behaviour is observed.

5.2 Mechanical Dimensions

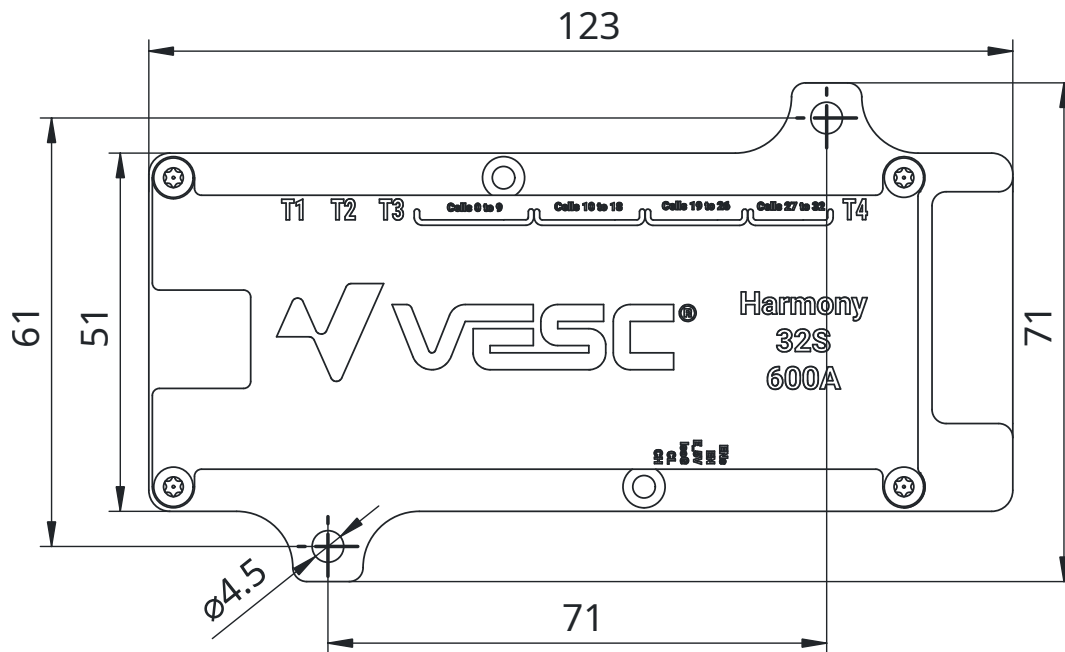


Figure 8: Mechanical Dimensions. The height of the BMS, which is not shown in this drawing, is 28mm.

6 Configuring the BMS

6.1 Configuration Warnings

- **Double-check all wiring connections** before powering on the BMS. Incorrect wiring can cause damage to the BMS, battery cells, or pose a fire risk.
- **Always disconnect the battery pack from any load or charger before configuring the BMS.** This helps prevent accidental short circuits or electrical hazards.
- **Always install the latest version of VESC Tool from the official website** to ensure compatibility with your hardware and access to the newest features, bug fixes, and safety updates. Download the installer from vesc-project.com/vesc_tool and follow the on-screen instructions. After installation, update your device firmware if prompted to ensure optimal performance.
- **Do not exceed the recommended cell voltage limits** for your specific battery chemistry. Setting incorrect voltage thresholds can result in overcharging or deep discharging, which may lead to battery damage or dangerous situations.
- **Do not exceed the recommended current limits** for your specific battery chemistry. Setting incorrect current thresholds can result in overheating or excessive stress on the cells, which may lead to battery damage or dangerous situations.
- **Ensure the number of cells and temperature sensors configured matches your physical setup.** Incorrect configuration can cause inaccurate monitoring and may compromise the safety functions of the BMS.
- **Avoid configuring the BMS in wet or humid environments.** Moisture can cause short circuits and damage sensitive electronic components.
- **If you are unsure about any configuration step, consult the datasheet or seek professional assistance.** Improper configuration can void warranties and lead to hazardous conditions.
- **Wear appropriate personal protective equipment (PPE),** such as safety glasses and gloves, when working with battery systems.

6.2 Connecting the BMS to VESC Tool

The BMS can be connected to VESC Tool via USB, Wi-Fi, Bluetooth, or CAN. For instructions on how to connect with and navigate VESC Tool please visit <https://www.vesclabs.com/category/getting-started/>.

1. Connect the BMS to VESC Tool using one of the mentioned methods.
2. Ensure the “VBMS32” has been selected from the list of CAN devices.

6.3 Configuring the Cell Voltages

1. Navigate to the “VESC BMS” section from the menu on the left of the screen (on desktop), or by swiping across the screen on a mobile device.
2. Select the “General” tab at the top of the screen.
3. The default values for “Cell Voltage Empty” and “Cell Voltage Full” are set correctly for Lilon or LiPo cells. If you are using another cell chemistry such as LiFePo4, please set the values according to the cell manufacturer’s datasheet.
4. Press the “Write” button to write the new configuration to the BMS.

6.4 Configuring the Number of Cells

The number of cells wired to IC1 and IC2 should be set according to how many cells have been wired to the BMS. If you are unsure how many cells have been wired to IC1 and IC2, please check your wiring and refer to the example wiring diagrams.

1. Set the value of “Cells IC1” to how many cells are wired to IC1 (Cell inputs 1–16).
2. Set the value of “Cells IC2” to how many cells are wired to IC2 (Cell inputs 17–32).
3. Press the “Write” button to write the new configuration to the BMS.

6.5 Configuring the Number of Temperature Sensors

1. Set the value of “Temperature Sensors” to how many temperature sensors have been wired to the BMS.
2. Press the “Write” button to write the new configuration to the BMS.

6.6 Applying the Settings

For the settings to be fully applied to the BMS it must be restarted. Go to the terminal-menu at the top of VESC Tool and select “Reboot”. That will disconnect you from the BMS, so you have to reconnect again. Once you are connected all new settings should be in use.

6.7 Check the Settings have been Written

1. Check that the “Stream BMS realtime data” button is activated on the right side of the window (highlighted blue indicates that it is activated).
2. Navigate to the “BMS Data” section from the menu on the left of the screen (on desktop), or by swiping across the screen on a mobile device.
3. Under the “Voltages” tab, check that the correct number of cells are being shown.
4. Check that the voltages shown correspond to the chemistry of cells used.
5. Under the “Temperatures” tab, check that the correct number of temperature sensors are shown.
6. Check that the temperatures of the sensors (T1–T4) are reading correctly.

6.8 Configuring the Charging Settings

The default values for “Charge Start Voltage” and “Charge End Voltage” are suitable for most LiPo and Lilon cells. For LiFePo4 or other cell chemistries please consult the battery cell datasheet.

The value of “Charger Detection Voltage” should be set appropriately for your battery and charger. In most cases you can set it to 80% of the total battery voltage when the battery is completely empty. So for a 22s battery it can be set to $22 * 2.5 * 0.8 = 44V$ assuming it is completely empty at 2.5 V per cell. Note that the charge port always outputs close to 12V with a weak pull-resistor to help certain chargers detect that there is a battery. Therefore “Charger Detection Voltage” should not be set too low as that can cause wakeups from the BMS thinking a charger is plugged in.

The “Max Charge Current” should also be set appropriately for your battery and charger.

1. Navigate to the “VESC BMS” section from the menu on the left of the screen (on desktop), or by swiping across the screen on a mobile device.
2. Select the “Charging” tab at the top of the screen.
3. Change “Charger Detection Voltage” to an appropriate value for your battery system and charger.
4. Change the “Max Charge Current” to an appropriate value for your battery system and charger.
5. Press the “Write” button to write the new configuration to the BMS.

6.9 Configuring the Balancing Settings

The default value for “Max Balance Channels” is set to 5. Depending on how well heat can get away from your BMS compartment, you may want to increase this value to speed up the cell balancing process. However, raising the number of balance channels will generate more heat during balancing. It is important to select an appropriate value to prevent the BMS from overheating, as reaching thermal limits can slow down or interrupt the balancing process.

1. Select the “Balancing” tab at the top of the screen.
2. Change “Max Balance Channels” to a value suitable for your BMS enclosure conditions.
3. Press the “Write” button to write the new configuration to the BMS.

6.10 Configuring the Power Switch Settings

The power switch works by first pre-charging the output with a constant current of around 800 mA until it reaches 10V below the cell voltage, then it switches on the main switch. How long this takes depends on the input capacitance of your load (such as a motor controller). The setting “Precharge Time Max” sets the maximum allowed time for this process and is set to 3 seconds by default. If the precharge takes longer time than this setting a fault code is generated and the switching sequence is aborted until the switch input is cycled. Make sure that “Precharge Time Max” is set to a long enough time to not generate a fault, while not setting it to an excessively large time. The default value of 3 seconds is good for most loads.

1. Select the “PSW” tab at the top of the screen.
2. Change “Precharge Time Max” to a value suitable for your system.
3. Press the “Write” button to write the new configuration to the BMS.
4. Navigate to the “BMS Data” section from the menu on the left of the screen (on desktop), or by swiping across the screen on a mobile device.
5. Find “Status” at the bottom of the table (scroll to the bottom) which should show “PSW_OFF”
6. Power on the BMS using the power switch or key.
7. The “Status” should then change to show “PSW_PCHG” indicating the circuit is being precharged, before changing to “PSW_ON”.
8. If the “Status” shows “FLT_PCHG”, this indicates that there is a fault and possibly that “Precharge Time Max” should be increased to resolve this.

NOTE If your load draws more than 800 mA at boot the precharge sequence will fail. This can happen when e.g. powering a DCDC converter that drives lamps that are constantly powered on. To solve this make sure that you keep any load switched off until the BMS is done with the precharge sequence.

6.11 Configuring the Over-current Protection Settings

Table 1 shows the short-circuit current protection settings and the corresponding current they trigger at. As the shunt resistor is 0.1 mOhm, 10 mV of voltage correspond to 100 A of current. Note that it is possible to set the threshold higher than 60 mV in VESC Tool, but doing so is likely to permanently damage the BMS during a short circuit.

Threshold	Current
10 mV	100 A
20 mV	200 A
40 mV	400 A
60 mV	600 A

Table 1: Short-circuit Current Protection Values

1. Navigate to the “VESC BMS” section from the menu on the left of the screen (on desktop), or by swiping across the screen on a mobile device.
2. Select the “PSW” tab at the top of the screen.
3. Change “Shortcircuit Protection Threshold” to a value suitable for your system.
4. Press the “Write” button to write the new configuration to the BMS.

6.12 Verify the BMS Configuration is Correct by Charging

To verify that the BMS settings have been configured correctly, it is important to plug in the charger and check that everything operates correctly. Please follow these steps in order to ensure safe charging.

Do not plug the charger in if you suspect something has not been configured correctly!

To avoid damage to the device or batteries, as well as the risk of fire or injury, be prepared to unplug the charger immediately if the displayed values are incorrect.

If you notice any unusual signs such as unexpected smells, noises, or excessive heat, disconnect the charger immediately and investigate the cause.

1. Navigate to the “BMS Data” section from the menu on the left of the screen (on desktop), or by swiping across the screen on a mobile device.
2. Switch on the the charger and wait for it to be powered on and ready to charge.
3. Check the polarity of the charger output matches the charger input of the BMS.
4. Plug the charger output into the charge input of your battery.
5. In the VESC Tool's table of values, verify that the “Charge Input Voltage” rises to a level slightly above the “Total Voltage” (typically within 1V).
Please note the voltage may initially drop as the charger draws some power before then increasing.
6. Verify that “Input Current BMS IC” displays a negative value, indicating that current is flowing into the battery and charging is in progress.
7. Disconnect the charger from the battery pack.

6.13 Configuring the Sleep Mode Settings

By default, “Block Sleep Mode” is set to “True”, which prevents the BMS from going to sleep while it is being configured. The final step to configuring the BMS is to change this value to “False”. This enables the BMS to sleep when the power switch is not turned on.

1. Select the “Sleep” tab at the top of the screen.
2. Change “Block Sleep Mode” to “False”.
3. Press the “Write” button to write the new configuration to the BMS.

7 Product Warranty

7.1 Warranty Coverage

Please find the warranty information regarding VESC Labs products using the following link:
<https://www.vesclabs.com/warranty-and-returns-policy/>

8 Compliance & Regulatory Information

8.1 CE Marking

This product meets the requirements of all applicable EU directives and regulations and complies with the essential health, safety, and environmental protection requirements as set out in relevant legislation. It is CE marked in accordance with:

- **Directive 2014/30/EU** – Electromagnetic Compatibility (EMC)
- **Directive 2014/35/EU** – Low Voltage Directive (LVD)
- **Directive 2011/65/EU** – Restriction of Hazardous Substances (RoHS)

8.2 UKCA Marking

This product is compliant with UK regulations and bears the UKCA marking, confirming its conformity with the applicable statutory requirements in Great Britain. It meets the relevant provisions of:

- Electrical Equipment (Safety) Regulations 2016
- Electromagnetic Compatibility Regulations 2016
- The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012

8.3 WEEE Directive (2012/19/EU)

This product is compliant with the Waste Electrical and Electronic Equipment (WEEE) Directive. It should not be disposed of with unsorted municipal waste and must be collected separately for proper treatment and recycling. Please contact your local distributor or relevant waste authority for information on recycling options and collection facilities.

