TRAMPA

1 Feature overview

- Voltage: 24V – 92V (Safe for 6S to 22S LiPo). Optimal performance at 20S LiIon
- Voltage spikes may not exceed 100V
- Current: Continuous 500A, peak 680A. Values depend on the temperature, switching frequency and cooling of the device!
- 1x 5V 0,5A output for external electronics
- 1x switchable 5V 3A output for external electronics
- 5x switchable and variable 6-24V (15A combined)
- 1x static output, variable 6-24V
- 3.3V 0,5A output for external electronics
- 9 axis IMU
- Modes: DC, BLDC, FOC (sinusoidal)
- Supported sensors: ABI, HALL, AS5047, SIN/COS and other encoders

2 Applications

- Controller for light electric vehicles
- Non street legal if not homologated
- For integration into VESC ecosystem

3 Description

The VESC STR 500 is a versatile three-in-one vehicle controller designed primarily for use in light electric vehicles such as electric motorbikes, boats, karts, and similar applications. It incorporates a microprocessor-controlled DC-DC converter to generate auxiliary power for the vehicle's electronics.

Apart from the DC-DC converter, the STR 500 is equipped with IO functionality for controlling inputs and outputs. This feature enables direct control of various vehicle-mounted equipment, including lights, blinkers, a horn, and more. Additionally, the STR 500 includes a logging module for continuous recording onto a Micro SD-Card and supports GPS antenna connectivity.

For accessibility, the device offers wireless connections through BLE and WiFi. The STR 500 is supported by the VESC-Tool, compatible with Linux, Windows, iOS, MacOS, and Android. Its features encompass a broad range of adjustments for controller setup and operation, along with real-time monitoring and logging capabilities on a computer or directly onto the STR 500 itself.

4 Typical installation

The typical installation is shown in the diagram below. It is necessary to use appropriate fuses on the battery connection, matching the current flow in the system. The battery needs to be managed by a suitable battery management system (BMS). The BMS should control a contactor on the positive discharge wire.
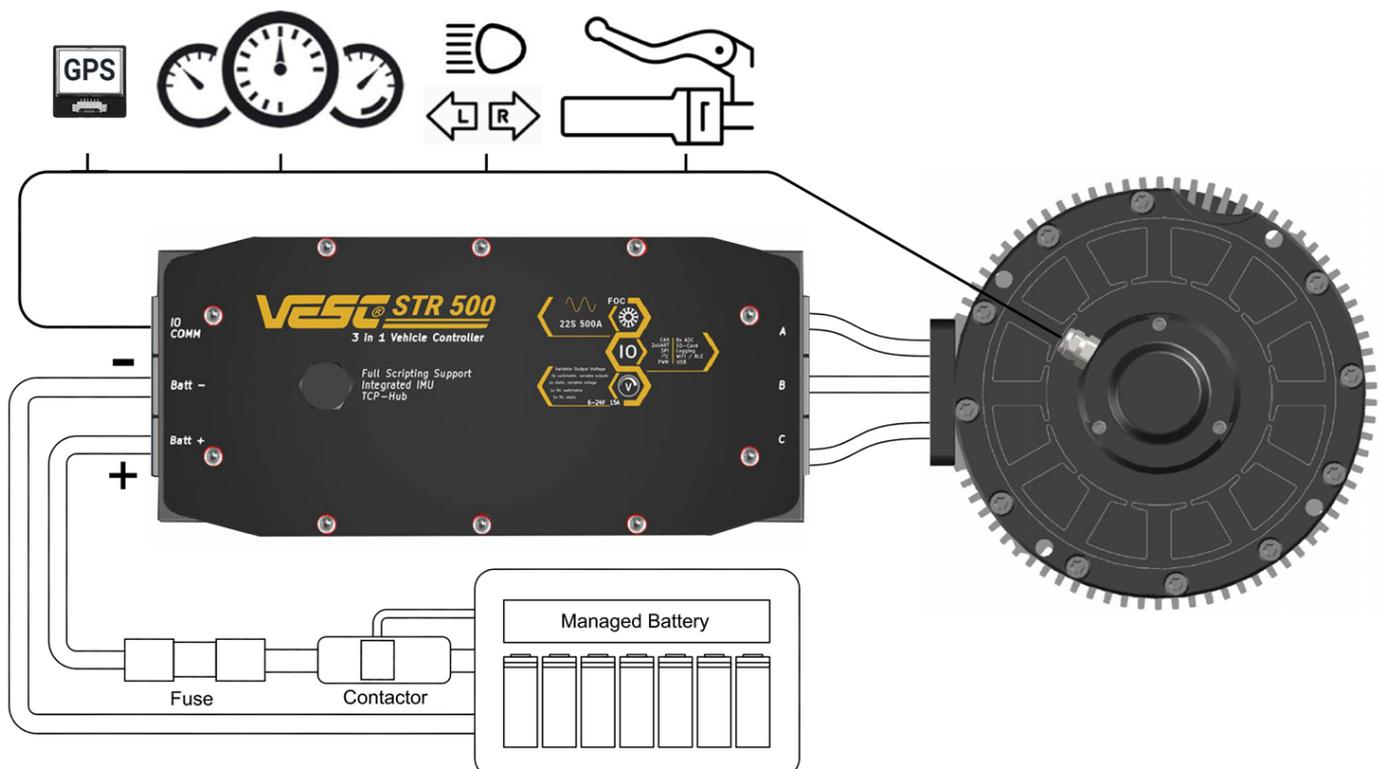
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5 Warnings

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 may include: 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 together with suitable batteries, such as Lead Acid, LiIon, LiPo and LiFePo4. The settings in the software must the changed to match the cell chemistry and other cell 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 or similar regulations.

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!

WARNING: Protection circuits must be installed in between the battery and the VESC STR 500 controller. This includes a current flow controlled contactor and fuse. Do not bypass a Battery Management System!

7 Pre-Charge
Connections to a battery must be established via a suitable pre charge switch. The initial current flow should be routed via a 10 Ohm power resistor until all built in capacitors are fully charged. The exact value of the resistance depends on the STR 500 and other devices attached to the same battery.
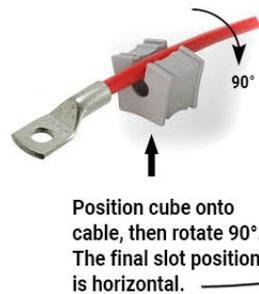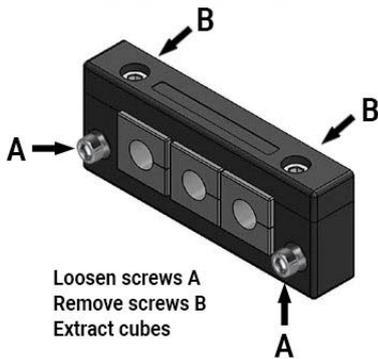
8 Vehicle storage / parking

A parked or stored vehicle should disconnect the STR 500 from the battery. This may be done by phsically unplugging the battery or electronically by releasing a contactor switch.

9 Charge process of vehicles

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.

10 Attaching the motor and battery cables

Make sure to use appropriate wire gauge for the application and expected current flow. The cable entry grommets are available in different sizes to assure a perfect IP 67 rated sealing of the housing. Make sure to choose the correct size for your wire gauge. Follow the instructions below to assemble battery and motor cables.

Loosen screws A
Remove screws B
Extract cubes

Position cube onto cable, then rotate 90°. The final slot position is horizontal.

Re-tighten screws B
Re-tighten screws A

A / B / C = phase wires motor
Make sure to use appropriate Wire Gauge matched to current flow.

1 = battery positive pole
Make sure that cable shoe doesn't touch the housing! Re-shape shoe if necessary.

2 = battery negative pole
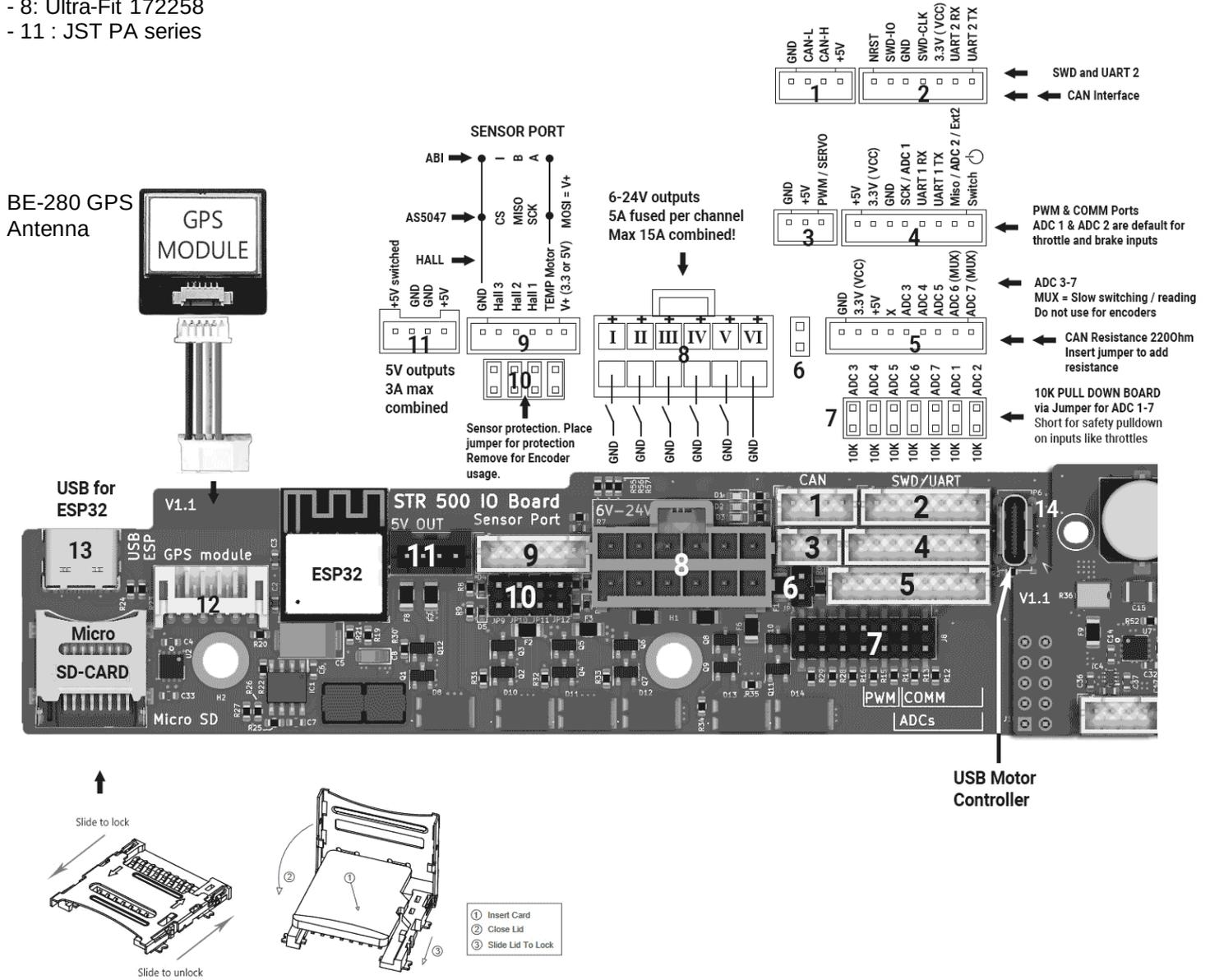
check for clearance

Use self locking washer pair on all 5 cable shoes. Tighten bolts according to torque specified.

11 IO-Board connections

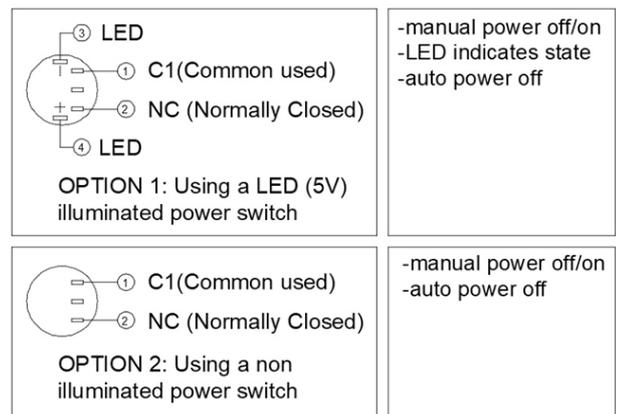The below diagram shows the connections on the IO-Board.

Mating wire connectors:

- 1,2,3,4,5,9,12: JST PH series
- 8: Ultra-Fit 172258
- 11 : JST PA series

BE-280 GPS Antenna

12 Hibernation switch attachment

The STR500 can be used in combination with a **N**ormally **C**losed (NC) switch setting the device into a ultra low power sleep mode.
1 + 3 = GND, 2 = Switch pin, 4 = 5V supply
Use COMM port to wire up the switch.

|	
③ LED ① C1(Common used) ② NC (Normally Closed) ④ LED OPTION 1: Using a LED (5V) illuminated power switch	-manual power off/on -LED indicates state -auto power off
① C1(Common used) ② NC (Normally Closed) OPTION 2: Using a non illuminated power switch	-manual power off/on -auto power off

13 Avoiding ground loops

Ground loops will damage your devices. Follow the guidelines below to prevent loops.
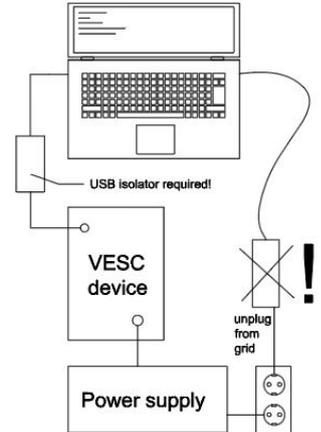
Multiple VESC controllers connected to one receiver or micro controller via PPM, UART, I²C or SPI. Receiver or micro controller is powered by one VESC device.
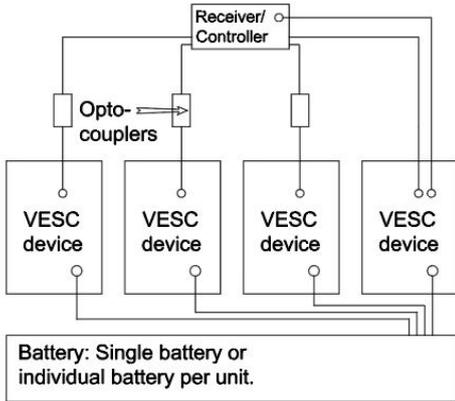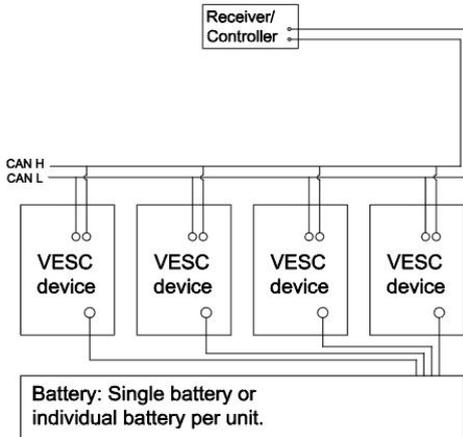
Multiple VESC controllers connected to one receiver or micro controller via PPM, UART, I²C or SPI. All devices are powered by the same battery.
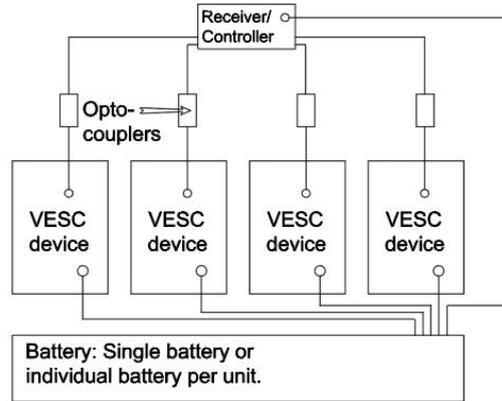
Ground loop via grid! Run computer form battery or use USB isolator.

Multiple VESC controllers connected to one receiver or micro controller via CAN. Receiver or controller can be powered from any source. Only connect CAN H and CAN L.

Never share any connections, other than CAN H and CAN L with other VESC devices. This will typically create a ground loop. Ground loops will damage your controllers. Only the battery ground may be shared. Use optocouplers instead.
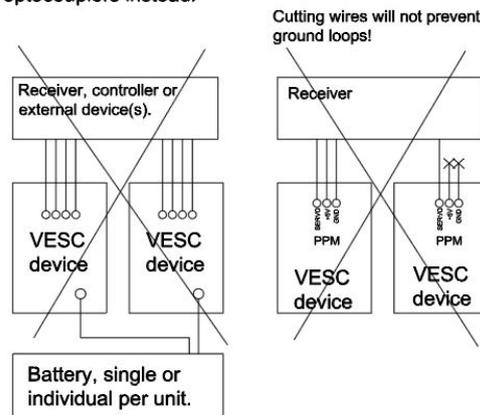
Typical ground loop free setup. Controller/Receiver powered by VESC device. Further devices linked via CAN.
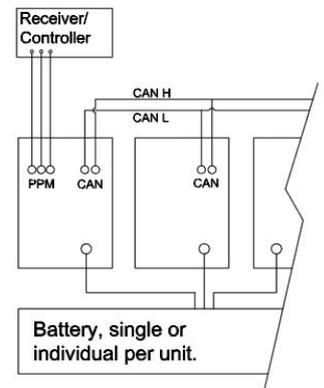
Multiple VESC controllers connected to one receiver or micro controller via PPM, UART, I²C or SPI. Receiver or micro controller has its own power supply.
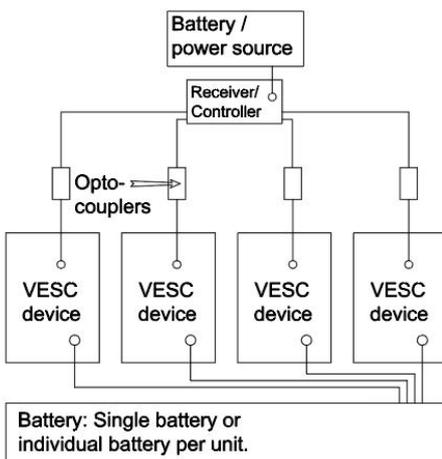
Multiple VESC controllers connected to one receiver or micro controller via PPM, UART, I²C or SPI. Receiver or micro controller is attached to other devices.
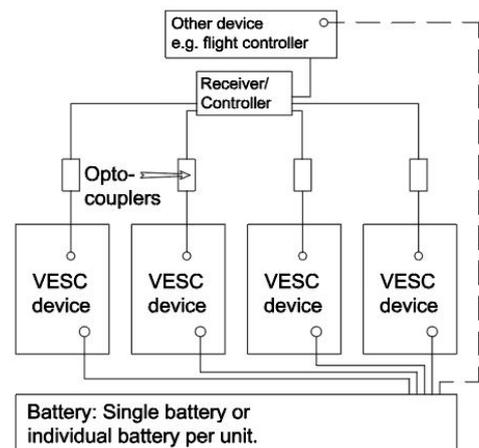
14 Connectors and Pins

The VESC STR 500 controller is equipped with USB, CAN-Bus, PWM, COMM, SWD, ADC and a Sensor port. The following List will give you an idea how to interconnect the VESC STR 500 controller to other devices.

- Sensors: Sensor Port for **ABI, HALL , AS5047P motor encoder and other encoder listed in VESC-Tool**. Motor sensors allow precise and powerful rotation of the motors rotor from a random (standstill) position or from a defined position A to a defined position B. The sensor voltage will switch according to the detected sensor type. 3.3V or 5V is possible.
NOTE: SIN / COS encoders need to be attached to ADC pins on the COMM port or to ADC 3,4 and 6.

- SWD: Serial **W**ire **D**ebug allows to access the STM32 Chip while running your VESC controller: Diagnostics, debugging and real time data + second UART RX/TX

- COMM : I2C, SPI, UART and ADC Interface to allow communication with other devices, such as Microcontrollers (e.g. Arduino, Raspberry Pi) or using analogue input devices such as analogue throttles and switches.

- ON/OFF SWITCH PIN: Use momentary (**N**ormally **C**losed) momentary switch to wake up device from hibernation. The switch needs to connect this pin to the GND PIN on the Connectors 1-5.

- PWM: Connect input devices using **P**ulse-**P**osition **M**odulation e.g. a 2.4GHz transceiver for controlling the motors output power and speed (Radio control). Never connect one receiver to separate VESC devices (Y-PPM). Use opto decouplers!

- CAN: CAN BUS for interconnection of VESC devices in an array. CAN-bus is also a universal bus to link the VESC controller to other devices also featuring CAN-Bus. Only connect CAN L and CAN H! If connected to the same battery, all devices must be connected to the same battery GND **at all times**! **Never** interrupt this connection while the CAN cable is attached! The GND pin and 5V pin of the CAN link should never be connected in an array of controllers!

- Motor A,B,C Connectors for a single three phase wired BLDC Motor (Coil A, B, C). If you know your motor phases, plug in the phases accordingly (Yellow = A, Blue=B, Red=C) to be displayed correctly in the VESC-Tool real time data analysis. DC-Motors use only connections **A** and **C**, B will be left unplugged!

- USB USB-Ports to connect to a computer for the purpose of configuration, firmware updates and real time data analysis.

15 Switchable Outputs

Your STR 500 features 6 outputs for the auxilary power. Each output is fused with a 5A SMD Fuse. Five of the 6 outputs are switchable in software. The functionality can be defined via a Script. See VESC-Tool DEV Tools for examples.
VESC DEV Tools >> LispBM Scripting >>Examples

- 6-24V auxiliary power outputs
The auxiliary voltage can be defined via scripting. The default output voltage is set to 12V
● Outputs I-V are switchable as defined in software.
● Output VI is permanently on.

- 5V auxiliary outputs
The IO-Board features two 5V outputs, combined 3A capable. Each channel is coupled with a 2A Fuse.
● Output A is switchable in software
● Output B is permanently live

16 Fault Codes

The following LED light codes will be displayed by your VESC controller:

- BLUE: VESC controller is powerd up
- GREEN DIM: SW Running >> Software (Firmware) installed and running
- Green Bright: VESC controller is driving the motor.
- Red: Fault code. Something is wrong! Read out the fault code in VESC-Tool.

Please visit *www.vesc-project.com/documentation* for more Information.

17 Software – Beta tool

The VESC STR 500 is very new and needs to use BETA FIRMWARE until VESC-Tool 6.05 is released.
The VESC STR 500 will already have the correct firmware installed but can only be configured using the beta version of the VESC tool.
This is a quick walk through of how to download the beta version of VESC-Tool.
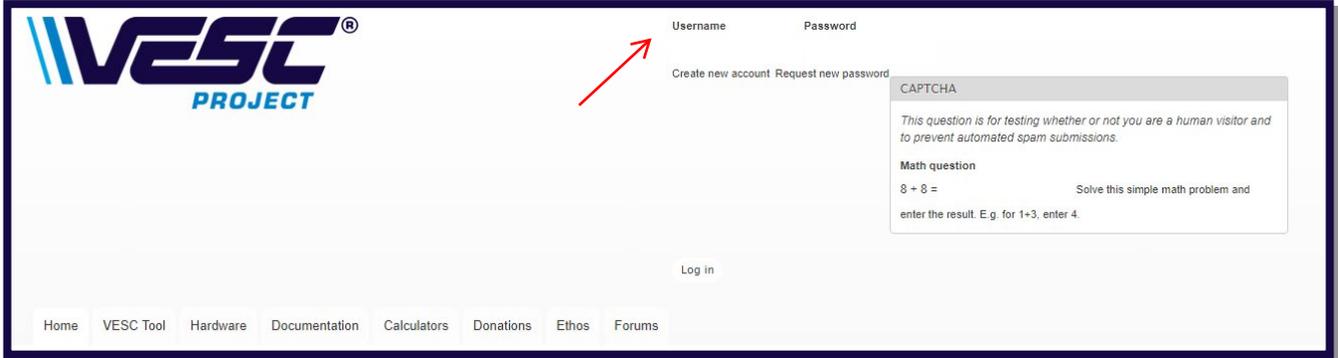
Once logged in, menu options will appear in the top right corner. Click on PURCHASED FILES to access the beta download link. NOTE if you have not downloaded the VESC-Tool, the beta link will not be shown. Download the released version and then check back in PURCHASED FILES.
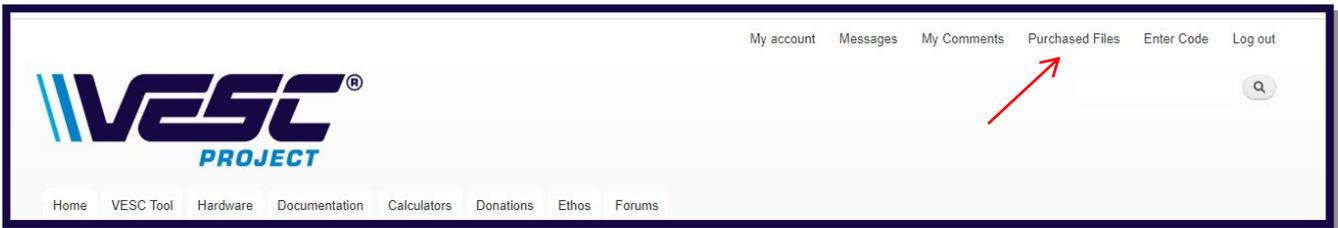

The Beta link will have all device versions in a .rar file. Please make sure you have software installed to read and unpack the files. E.g. Winrar, Winzip, etc


Pick your desired version, click extract, and choose a folder. There is always a file with the build date, use this for reference as the beta usually updates once a week. Make sure to keep up to date until there is an update for the released VESC-Tool to Version 6.05.
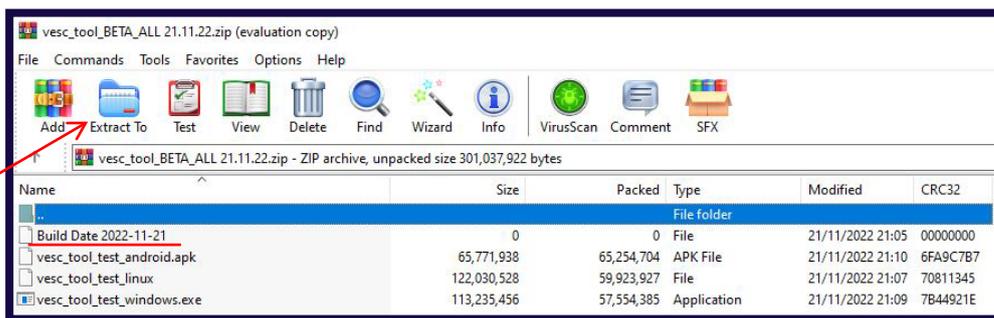
17.1 Software

The STR 500 is fully supported by the official VESC-Tool software package, either in App format or desktop version.
Use the **AutoConnect** button or **Scan** button to find your device and establish a connection.
Download VESC Tool from https://vesc-project.com/vesc_tool or the Apple App Store or Google Play Store.

➥For motor detection it is advisable to use the ***Setup Motor FOC*** Wizard
➥For the input calibartion please use the ***Setup Input*** Wizard
➥For the IMU calibration please use the **Setup IMU** Wizard
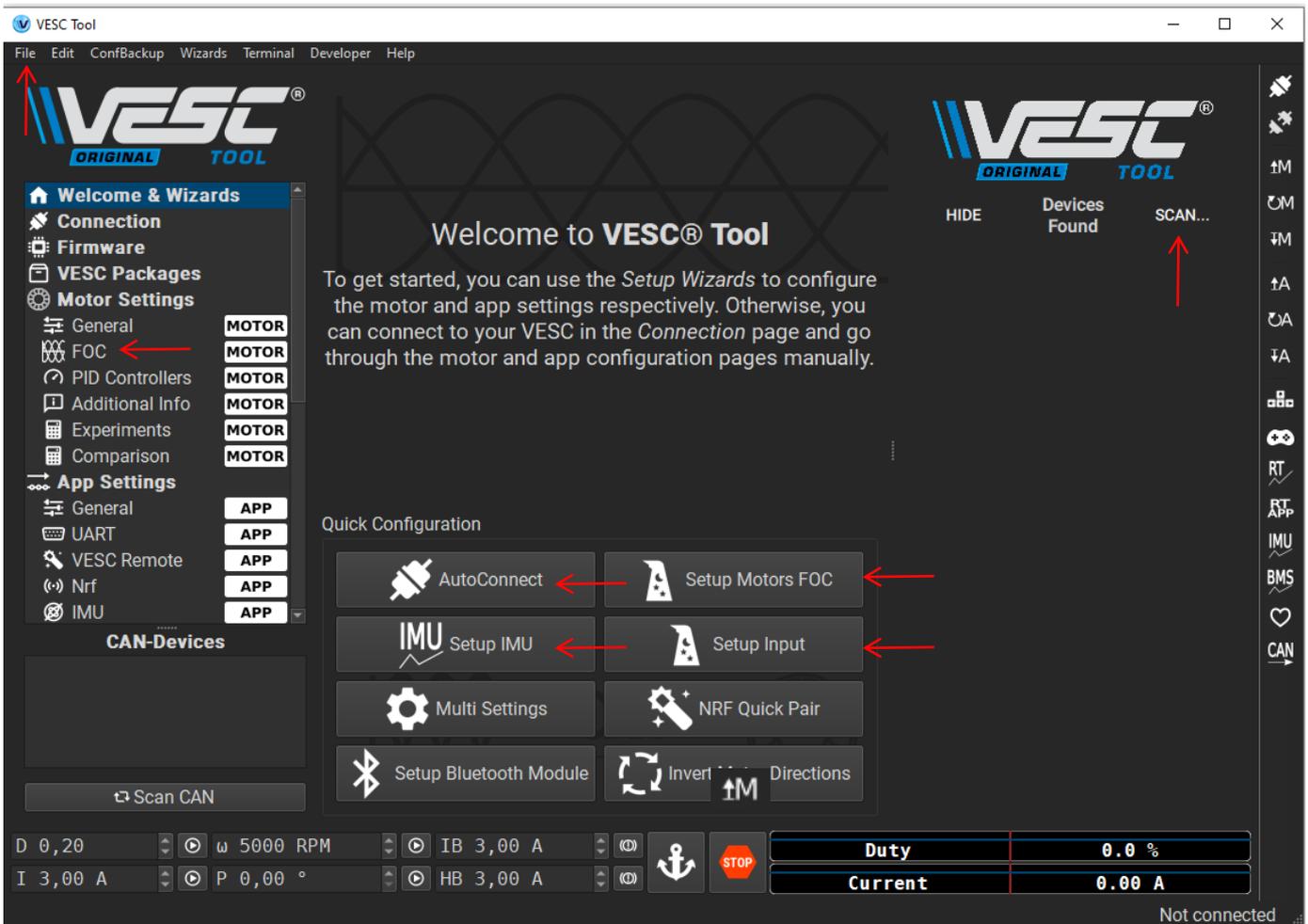
## 17.2 Motor parameters for saturating motors

Many motors are pushed into saturation during their operation and require modified motor parameters in order to operate at the specified performance levels! Manual adjutments are possible in the **Motor Setting >> FOC.**
For known motors it is possible to load a known, working setup via File >> **Load Motor Configuration XML**
In many cases multiplying the inductance by a factor of roughly 0.70 - 0.75 and adjusting the time constant to 350-500µS is a good starting point. After changing the values hit **Calc Apply Old** and then write the settings to the controller
Using the ⬇M button. Carefully test the behaviour after each change made.

The following page will show an example and guide you step by step.

It is also possible to save configurations and share them with friends and the VESC community.
Click on File and then save Motor Configuration XML or Load Motor Configuration XML.

17.3 Example for motor tuning for ebike Talaria®, SUR-RON® or similar.

The below image shows you the standard detection parameters from a Talaria® Sting bike with stock motor
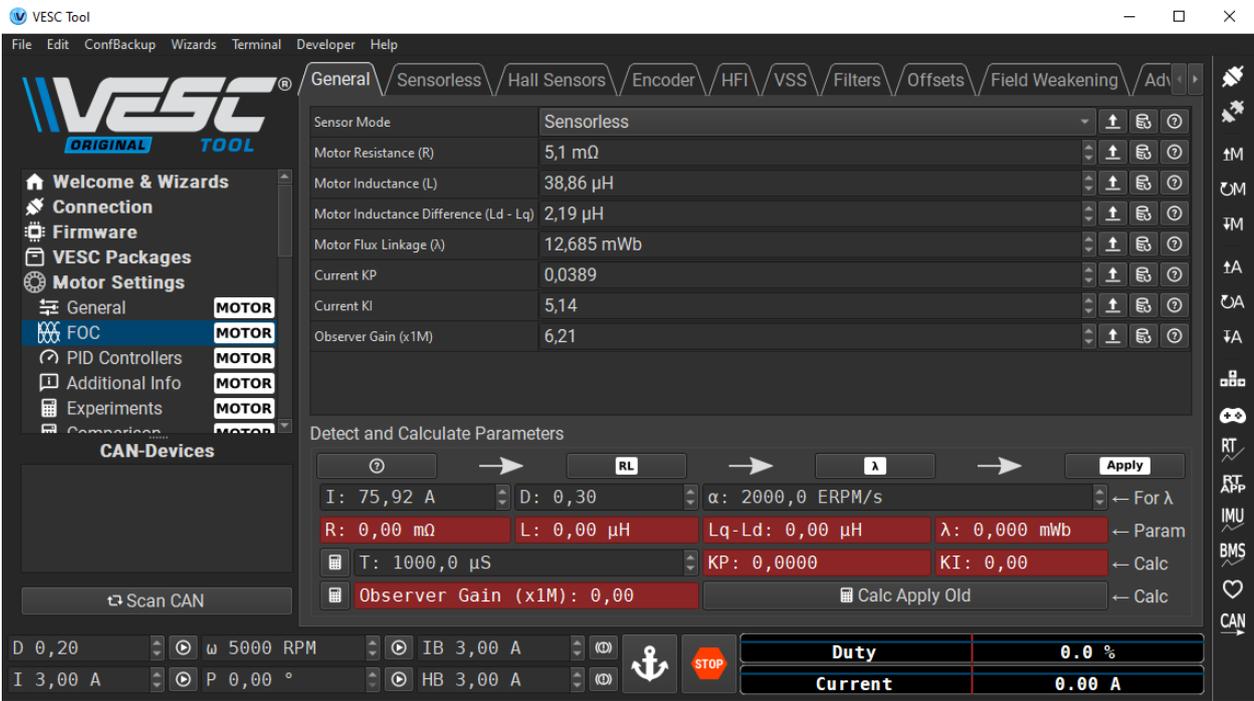
The below image shows you the tweaked parameters for a Talaria Sting bike with stock motor.

The Resistance value was upped by roughly 5%: 5,1mΩ x1,05 ≈ 5,4mΩ (1) + - 5% is the range to try.
Original Inductance was lowered using this Formula: 38,86µH *0,72 ≈ 28µH (2)
The Time constant T was set to 400µS instead of the original 1000µS (3)
After making these changes press Calc Apply Old (4)
The settings were written to the controller by pressing ↓M (5)
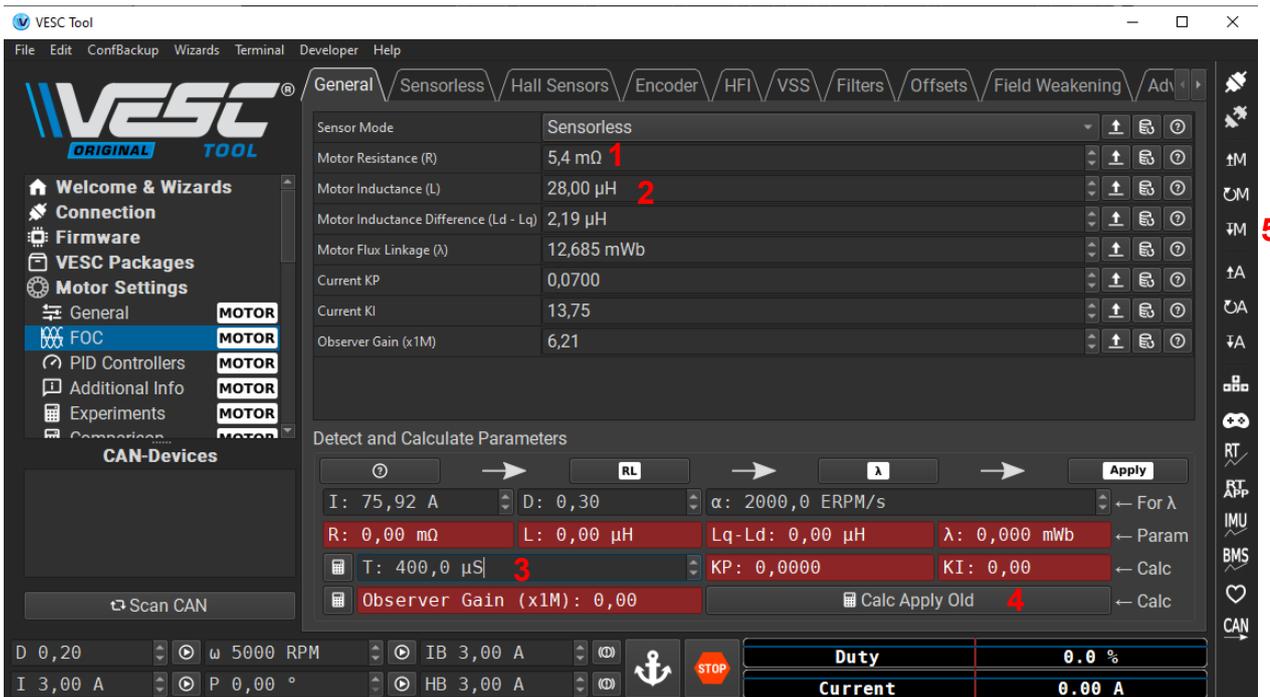
17.4 Increased current settings for example setup

The below image shows you the standard detection parameters from a Talaria® Sting bike with stock motor.

The *Motor Current Max* value was adjusted to 400A. This value might be carefully increased to 450A.
The *Motor Current Max Brake* was set to -60A
The *Absolute MAX (ABS)* was set to 600A
The *Battery Current Max* was set to 120A
The *Battery Current Max Regen* was set to -60A, matching the Motor Current Max Brake value

After all adjustments were made, press ⬇M
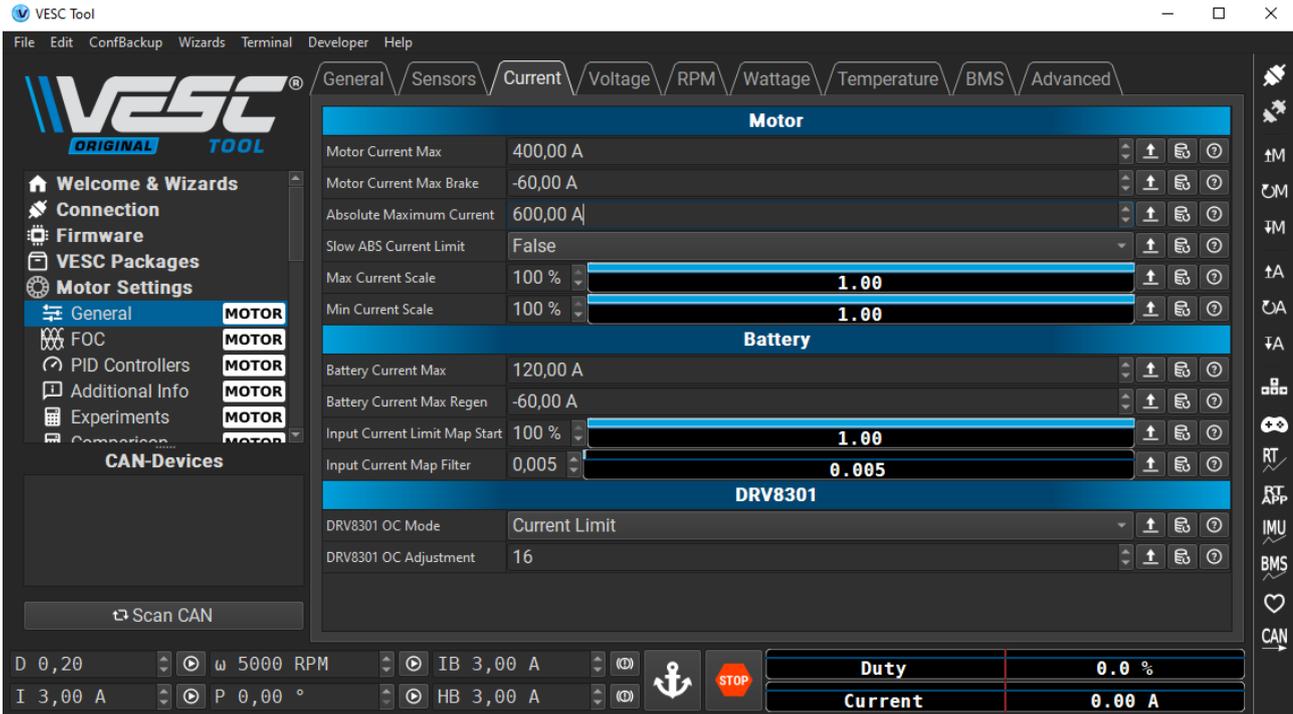
The maximum possible current depends on many factors. One limiting factor is the physical motor size and ability to cope with higher currents. Oversaturated motors create current spikes beyond the *Absolute Max Current* setting and will eventually cause motor hick-ups and consequently the fault code *ABS overcurrent* is generated. In this case the *Motor Current Max* value needs to be lowered or additional tuning to the detection parameters is needed. Fault codes can be printed by typing *faults* into the Terminal. Fault codes are erased after de-powering the VESC controller! The example below shows an ABS Overcurrent Fault after 608A were registered.

Type *faults* here
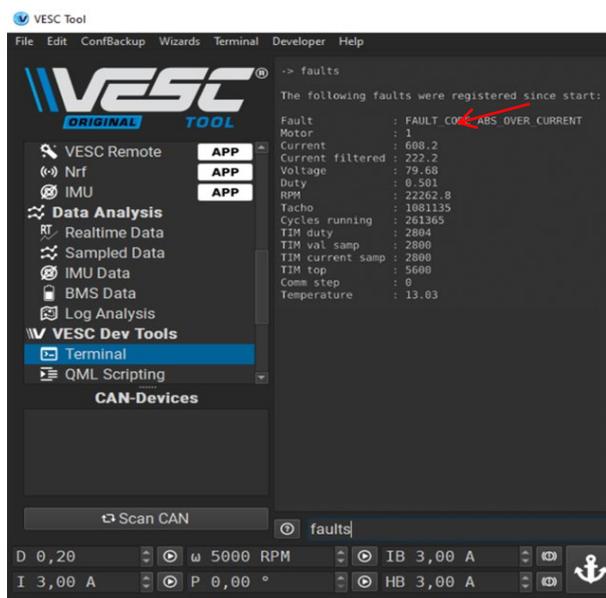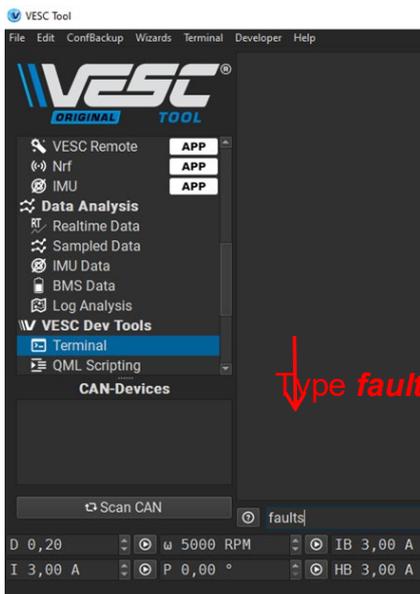
17.5 Software – DC-DC programming

There is a 15a DC-DC converter built inside the STR 500. This device is connected via CANBUS and has it's own micro processor which can be configured using the VESC tool.
Please follow the guide below to adjust and set the output voltage of the DC-DC converter.

Make sure the STR 500 is powered and connected to the VESC tool.
1. Select the DC-DC device in CAN-Devices
2. Select VESC DCDC in the menu
3. Set your desired output voltage
4. Click write to save your settings to your device
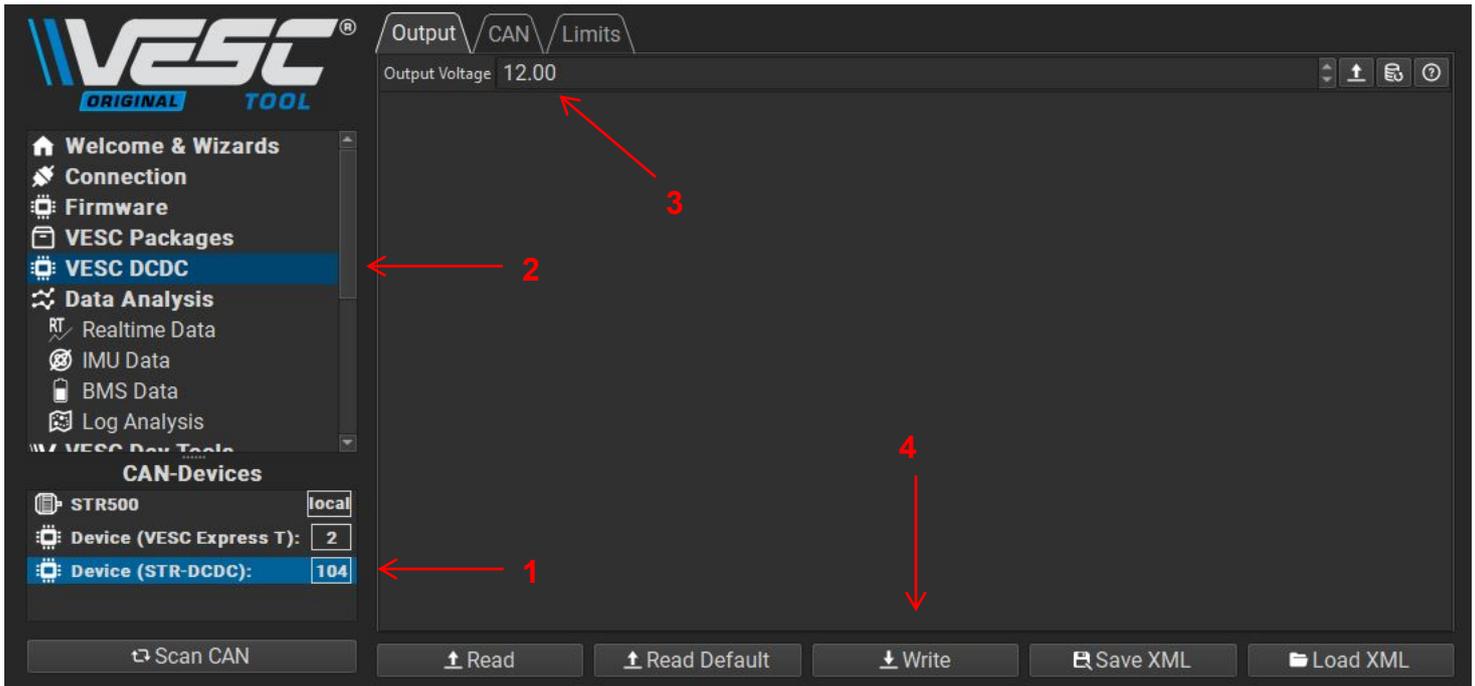
Please not that ONLY output channel 6 is currently working. The other 5 switched channels will be available soon with the next firmware update.

18 VESC community

To connect with other VESC equipment users please reach out to the VESC-Forum: https://vesc-project.com/forum

Stay tuned and get the latest updates on recent developments! Visit Mr. Vedders YouTube channel

 https://www.youtube.com/@BenjaminsRobotics

19 Technical Data Sheet

- Voltage: 24V – 92V (Safe for 6S to 22S LiPo). Recommended usage at 20S LiIon
- Voltage spikes may not exceed 100V
- Current: Continuous 500A, peak 680A.
  Values depend on the temperature, switching frequency and cooling of the device!
- 1x 5V 0,5A output for external electronics
- 1x switchable 5V 3A output for external electronics
- 5x switchable and variable 6-24V (15A combined)
- 1x static output, variable 6-24V
- 3.3V 0,5A output for external electronics
- 9 axis IMU
- Modes: DC, BLDC, FOC (sinusoidal)
- Supported sensors: ABI, HALL, AS5047, SIN/COS and many other encoders (Full list see VESC-Tool)

Box Outer DIMENSIONS without HEAT SINK
STR-500 Box Length 236mm
STR-500 Box Width 108mm
STR-500 Box Height 62mm
STR-500 Weight: 1500g

Box Outer DIMENSIONS with HEAT SINK
STR-500 Box Length 267mm
STR-500 Box Width 122mm
STR-500 Box Height 73mm
Weight: 2190g
Weight: 1,641g

20 Features

- Accurate current and voltage measurement on all phases
- Adjustable Current and voltage sensors
- Works reliably with nearly any DC and BLDC, PMSM motor and low inductance motors
- Regenerative braking
- Sensored or sensorless operation + hybrid mode
- Configurable RPM-, current-, voltage- and power limits
- Input source: PPM, Analogue, NRF (BLE 4.1)
- Communication ports: USB, CAN, UART, I2C, SPI
- Throttle curve and ramping for all input sources
- Seamless 4-quadrant operation
- Motor revolution, amp hour, watt hour counting (ERPM,RPM, Ah, Wh)
- Transmission and wheel diameter configurable
- Therefore accurate calculation of speed and consumption
- BLE wireless connection (if activated)
- Real time data analysis and read out via communication ports
- Scripting interface for added functionality
- Data storage on SD-Card
- GPS antenna connectivity
- Modes
  ➔ Current Control
  ➔ PID Speed Control
  ➔ Position Control
  ➔ Cruise Control
  ➔ Self balancing (Monowheel, Onewheeled, Gimbals)

- BLE and WiFi wireless connection (if activated)
- Real time data analysis and read out via communication ports and wireless connections
- Scripting interface for added functionality
- Data storage on SD-Card
- GPS antenna connectivity
- Adjustable protection against:
  ➔ Low input voltage
  ➔ High input voltage
  ➔ High motor current
  ➔ High input current
  ➔ High regenerative braking current (separate limits for
  ➔ the motor and the power input)
  ➔ High RPM (separate limits for each direction).
  ➔ Over tempertaure (MOSFET and motor)
  ➔ Over temperature for the Battery (dependant on
  ➔ BMS used)
  ➔ Over current and short circuit on the auxiliary output
  ➔ (6-24V)

21 Integration in your vehicle

Warning: The VESC STR 500 should be carefully integrated into the vehicle. Wrong assembly and placement may cause issues resulting in an unsafe operation with the probability of property damage, collateral damage, and serious injury or death!

- 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 STR 500 needs to be able to dissipate the heat it generates
- The STR 500 should be placed limiting direct water spray

22 General safety information about Iilon 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

23 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 STR 500
Item Number: #VESC STR 500 V1.0

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, 10.01.2024

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.