Setup Motors FOC

1. Overview

The FOC (Field-Oriented Control) setup wizard is the recommended method to configure your motor. It automatically detects motor parameters and calibrates the encoder (if present) for optimal performance.
In this tutorial we will configure AESC motor controller in combination with a BLDC (Brushless Direct Current) motor.

2. Software Preparation

- **Download VESC Tool: https://vesc-project.com/vesc_tool**
- **You can find the download tutorial here:**

Figure 1: AESC configuration tutorial QR code

- **Run the VESC Tool software**

3. Hardware Preparation

3.1.Required Components

- AESC motor controller (e.g., AESC V4, AESC V6.7,AESC V4 Pro,AESC V6.7 Pro)
- BLDC motor (e.g.,5065,6374,63100)
- Li-ion battery pack/LiPo battery pack/DC power supply(e.g.,32V,36V,48V)
- PC
- USB Type-C
- Optional: Bluetooth module (e.g., Autoro BT Nano), PPM/ADC remote control, sensors.

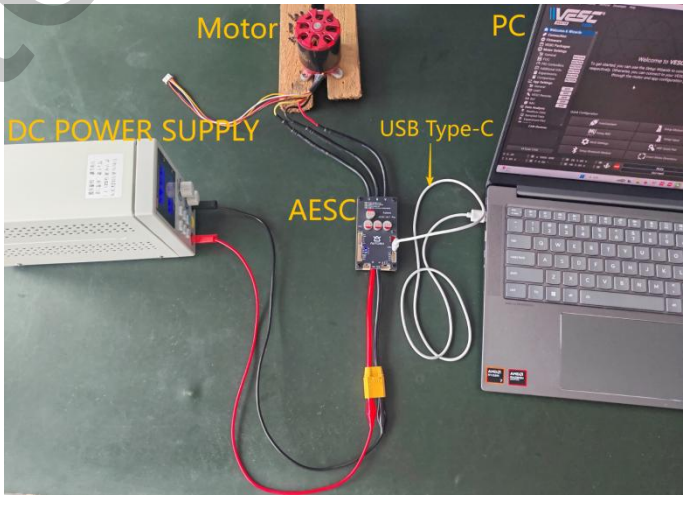

Figure 2: Overall hardware connection diagram

3.2.Hardware Connections

a. Power down everything

- Ensure all components are disconnected from power sources before making any connections. This is a critical safety precaution.

b. Connect motor to AESC

- Connect the three motor phase wires (A, B, C) to the AESC's phase outputs (A/B/C) . The order may be corrected later during software setup.

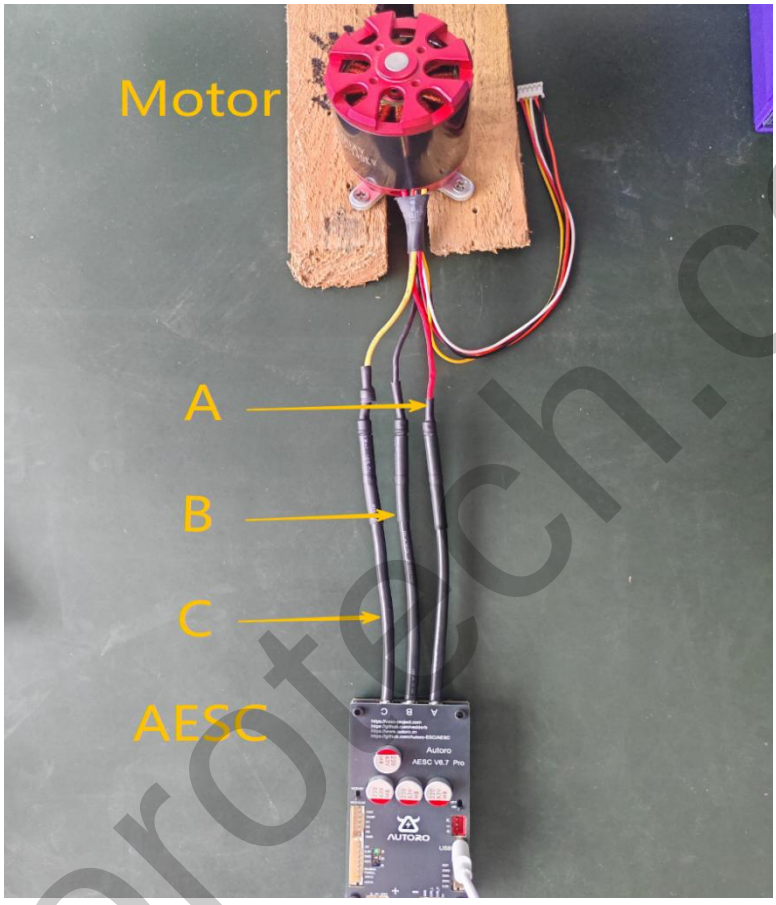

Figure 3: Motor phase wires connected to AESC terminals

c. Connect AESC to computer

- Use the USB Type-C cable to connect the AESC to your computer for configuration and firmware updates.
- You should see status LEDs light up on the controller.

d. Verify Power System Compatibility

- **Before connecting the battery,** it is **critica**l to ensure your power source (battery) is compatible with both your AESC and your motor.
- **Voltage Check:** Confirm that your battery's **nominal voltage** and **fully-charged voltage** are within the **input voltage range** specified in your AESC's user manual. Exceeding the maximum voltage will permanently destroy the controller.
- **Current Check:** Ensure your battery can supply enough **continuous current** to meet the demands of your motor and AESC setup. The battery's current output (in Amps) should be greater than the **maximum current** you plan to draw.
- **Motor Compatibility:** The power system must be able to drive your specific motor at its required voltage and current.

e. Connect battery to AESC

- **Warning: Observe Polarity**! Connect the battery's **positive (+)** wire to the AESC's **polarity**+ input and the **negative (-)** wire to the **polarity-** input. Reverse polarity will instantly destroy the controller.

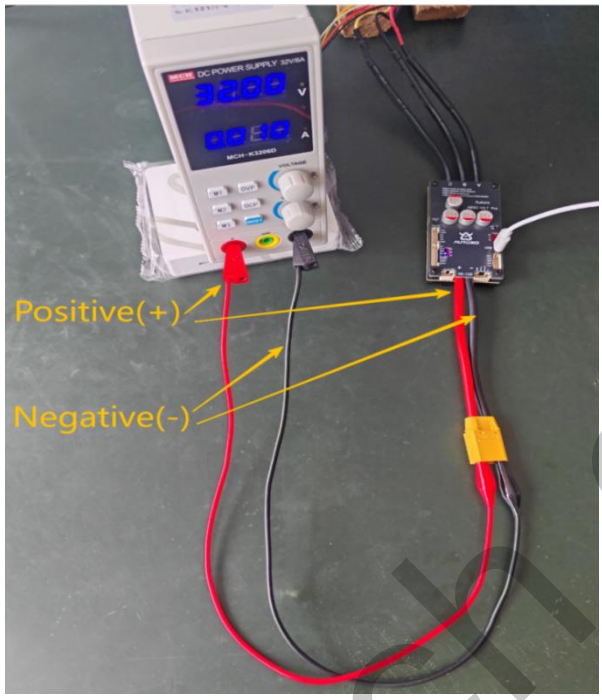

Figure 4: Correct power supply polarity connection

f. Connect optional peripherals (If applicable)

- **Bluetooth:**

Warning: ALWAYS verify the Bluetooth module's required input voltage (typically 3.3V or 5V) before connecting.

- Connect the module's **TX** pin to the AESC's **RX** pin.
- Connect the module's **RX** pin to the AESC's **TX** pin.
- Connect the module's **VCC** (or **3.3V**) pin to the AESC's **3.3V/5V** power output pin.
- Connect the module's **GND** pin to the AESC's **GND** pin.

- **PPM/ADC Remote:** Connect the signal wire to the designated **PPM** or **ADC** pin on the AESC.

3.3.Final connection check

- Visually double-check all connections for correctness and secureness, especially battery polarity.
- Ensure there are no loose wires or potential short circuits.

3.4.Apply power

- Once all connections are confirmed correct, connect the battery to power up the AESC.

4. Setup Motors FOC

⚠ Critical safety precautions before starting:

- **MUST DO: Ensure the motor is firmly mounted** and **can rotate freely** without any load. The motor will spin during detection. A secured motor prevents injury and damage.
- **Disconnect the motor from any load** (e.g., remove the belt from the pulley, or gear from the shaft).
- Have your motor's specification sheet handy, if available, to verify detected parameters.

4.1.Connection

a. Devices found.

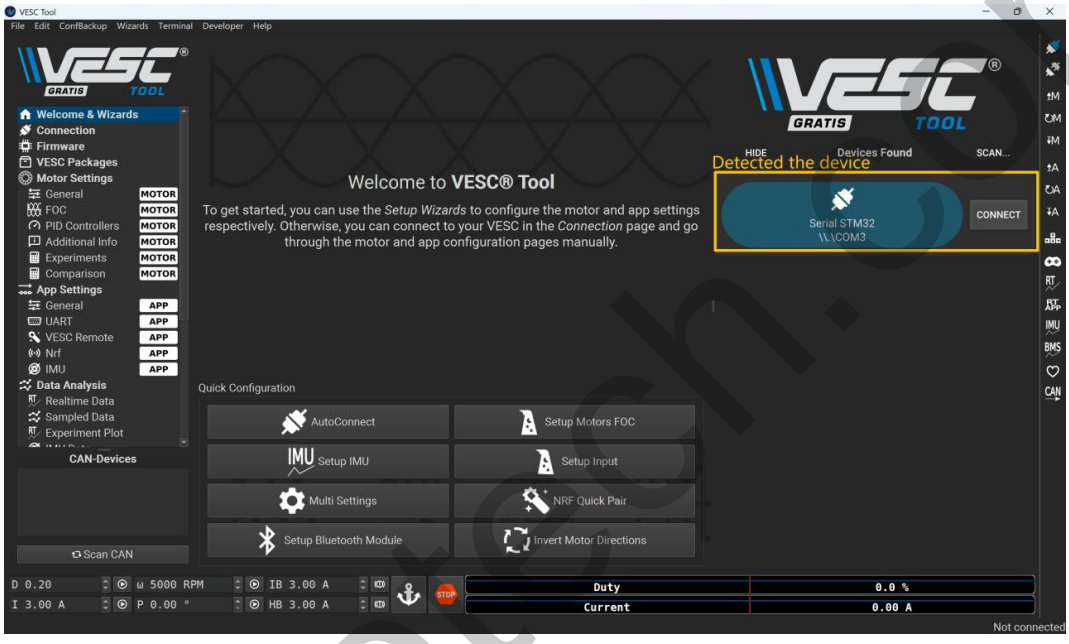

Figure 5: Detected the motor controller

b. Click "AutoConnect". A successful connection is indicated by the status "Connected (serial) to COM*" in the bottom-right corner.

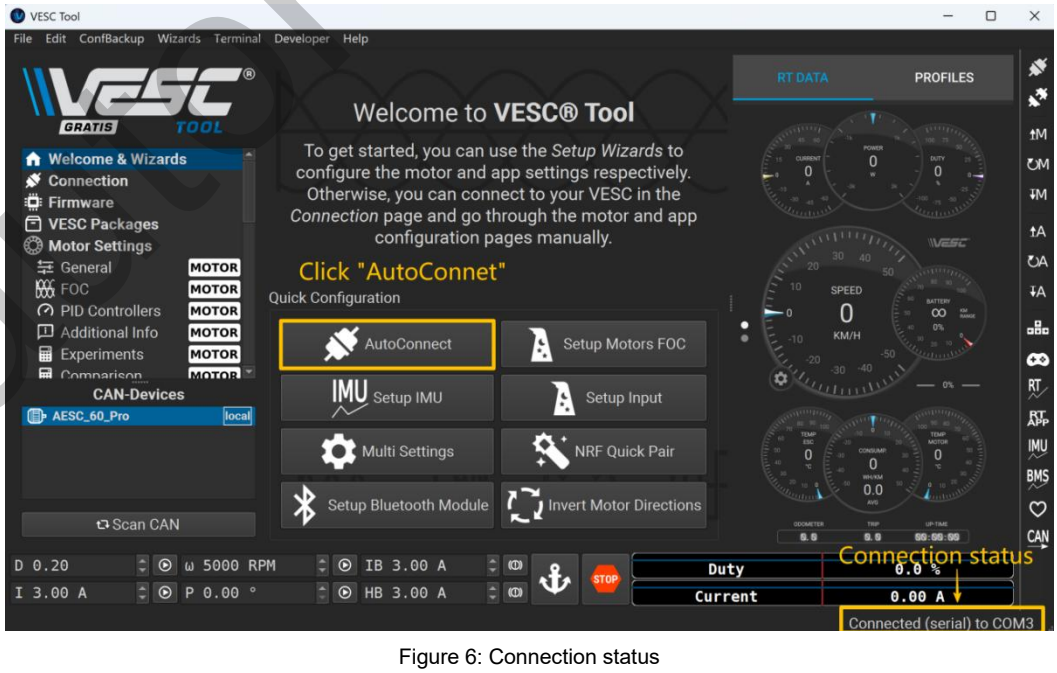

Figure 6: Connection status

4.2.Setup motors using FOC wizard

a. Click “Setup Motors FOC”.

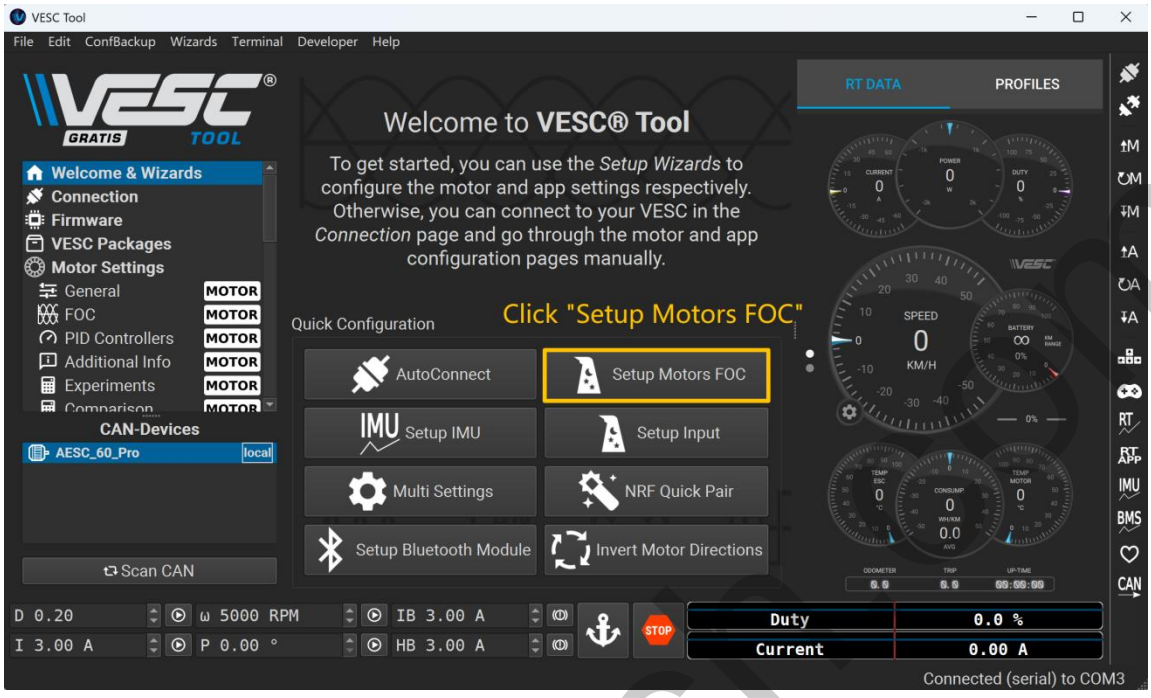

Figure 7: Accessing the “Setup Motors FOC” Wizard

b. Click “YES” to restore all parameters to factory defaults before FOC detection. Click “NO” to keep your existing settings and proceed.

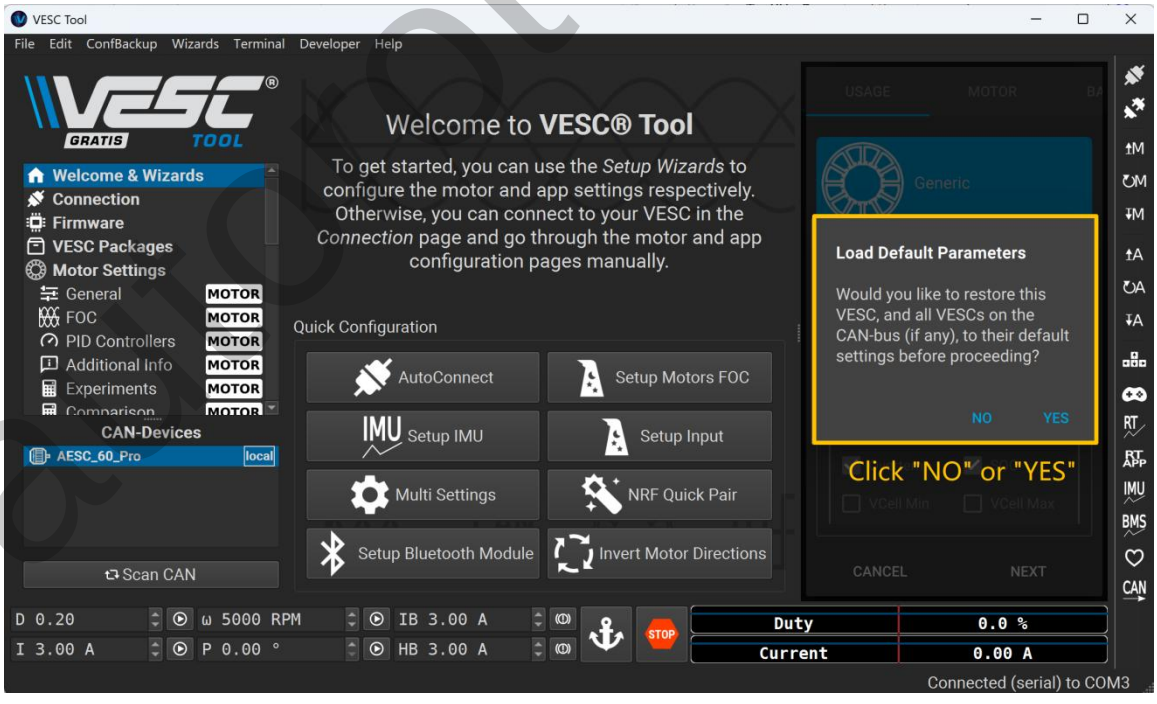

Figure 8: Load default parameters

c. Select the application scenario for the motor. Choose "Generic" if no specific requirements are needed.

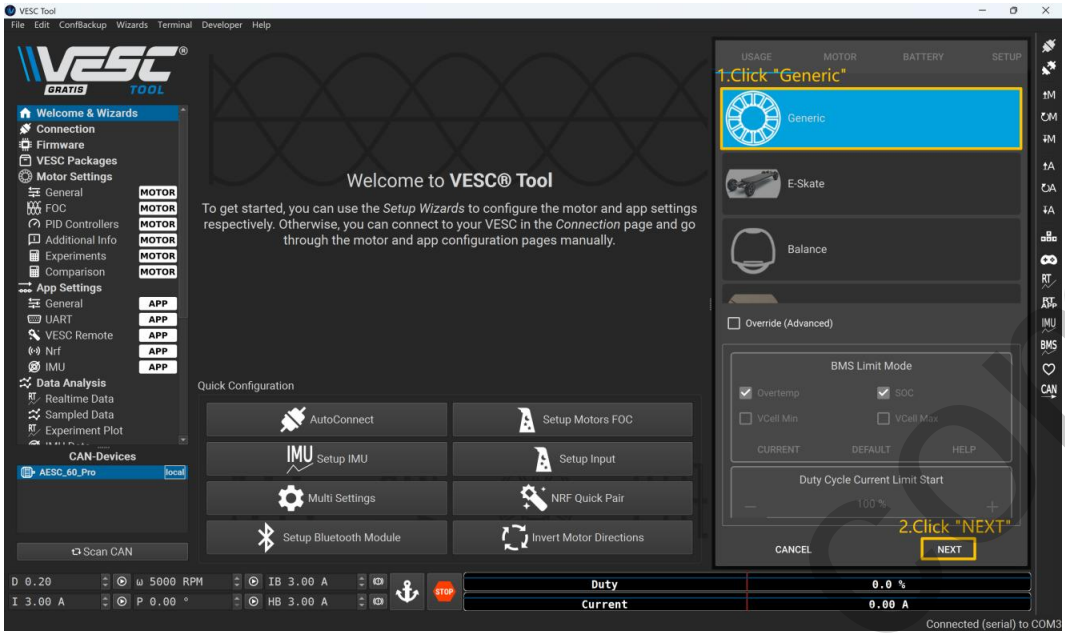

Figure 9: Usage

d. Select the corresponding or similar motor based on the motor parameters.

- Inrunner or Outrunner
- Weight

Note:

If you want to use the AESC as a controller for your electric skateboard or scooter, the 750g Medium Outrunner is 99% chance your motor to choose.

No matter if your motor is 6064 or 80100, the size category is still the Medium Outrunner. For other motor types and sizes, please choose accordingly.

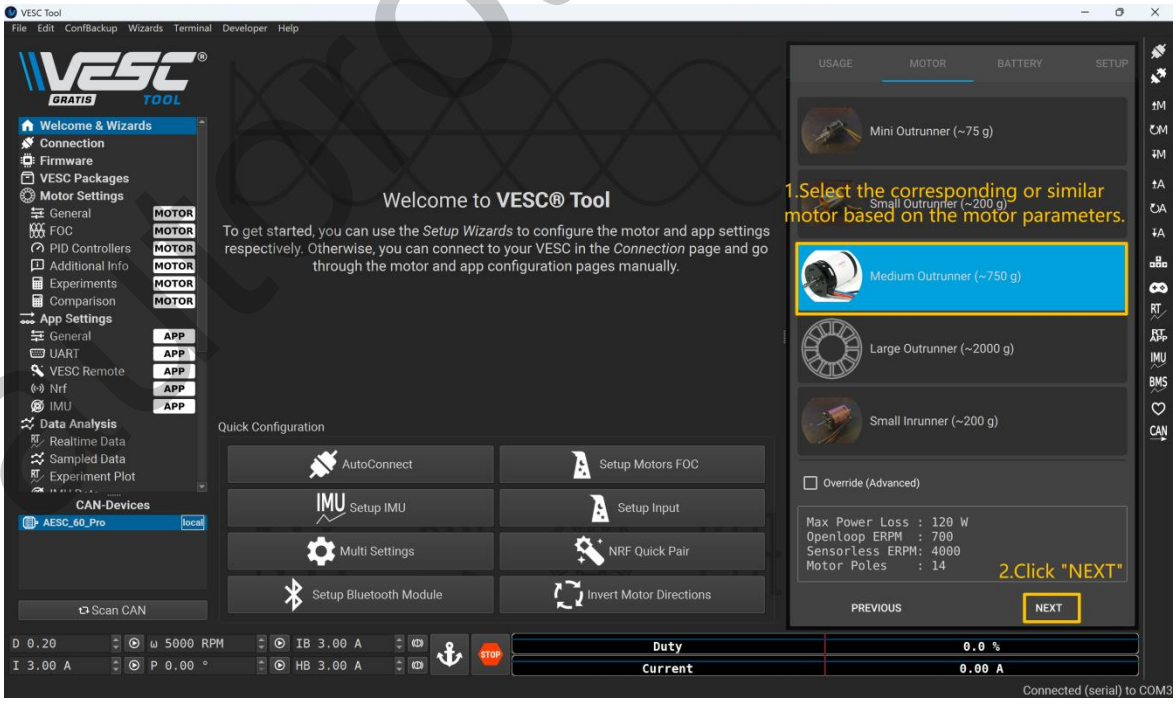

Figure 10: Motor parameters

e. Please review the warning message. If everything is correct, click “YES” to proceed.

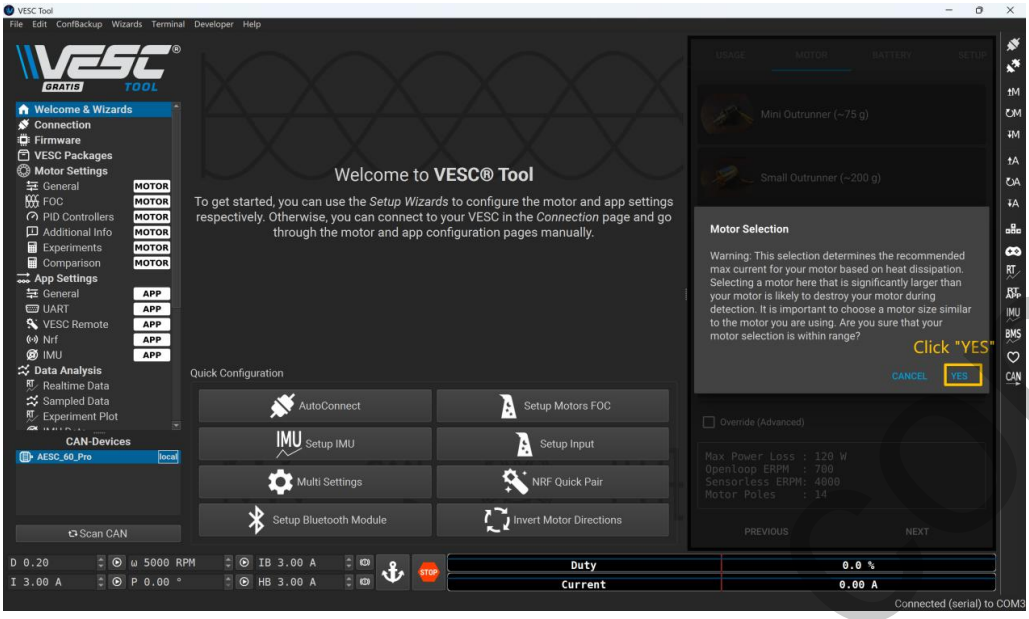

Figure 11: Motor selection warning massage

f. Configure battery parameters.

- Select the correct battery type from the Type dropdown menu.

BATTERY_TYPE_LIION_3_0__4_2:Lithium ion, voltage range 3.0 to 4.2V

BATTERY_TYPE_LIIRON_2.6__3_6:Lithium iron phosphate, voltage range 2.6 to 3.6V

BATTERY_TYPE_LEAD_ACID:Lead Acid, voltage range 2.1 to 2.36V

For standard Lithium-Ion batteries, the default preset BATTERY_TYPE_LIION_3_0__4_2 is typically used.

- The currently auto-detected number of battery cells in series can be manually adjusted if it is incorrect.
- Configure battery capacity.
- Click “NEXT”.

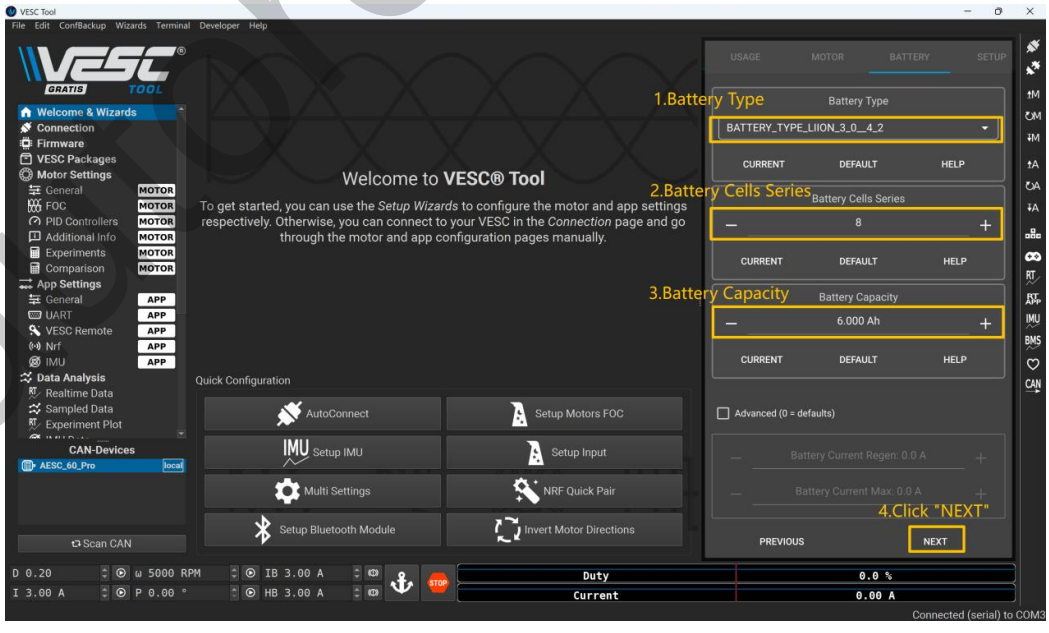

Figure 12: Battery parameters

g. Please review the warning message. If everything is correct, click “OK” to proceed.

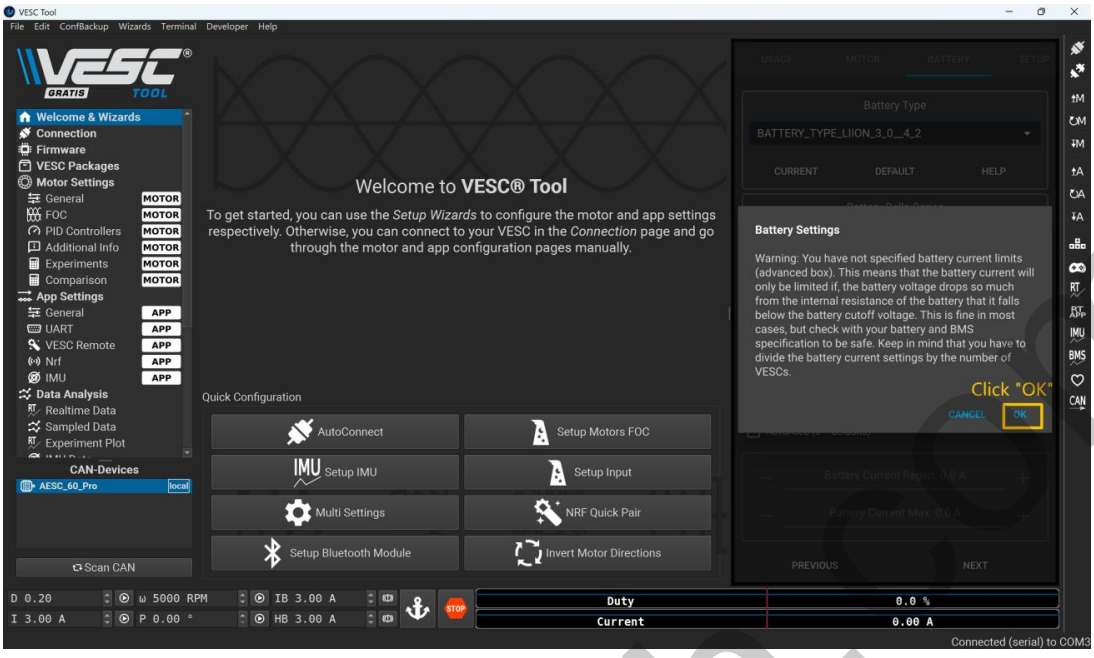

Figure 13: Battery settings warning message

h. Enter accurate gearing and wheel diameter in VESC Tool for precise real-time data: speed, range, energy use, and more. Measure your wheel carefully for best results.

•Gear Ratio: If the belt is not installed, select "Direct Drive".

•Wheel Diameter

The following parameters should be modified only when necessary:

•Motor Poles: Number of motor poles

•Motor Temperature Sensor Type

•Beta Value for Motor Thermistor

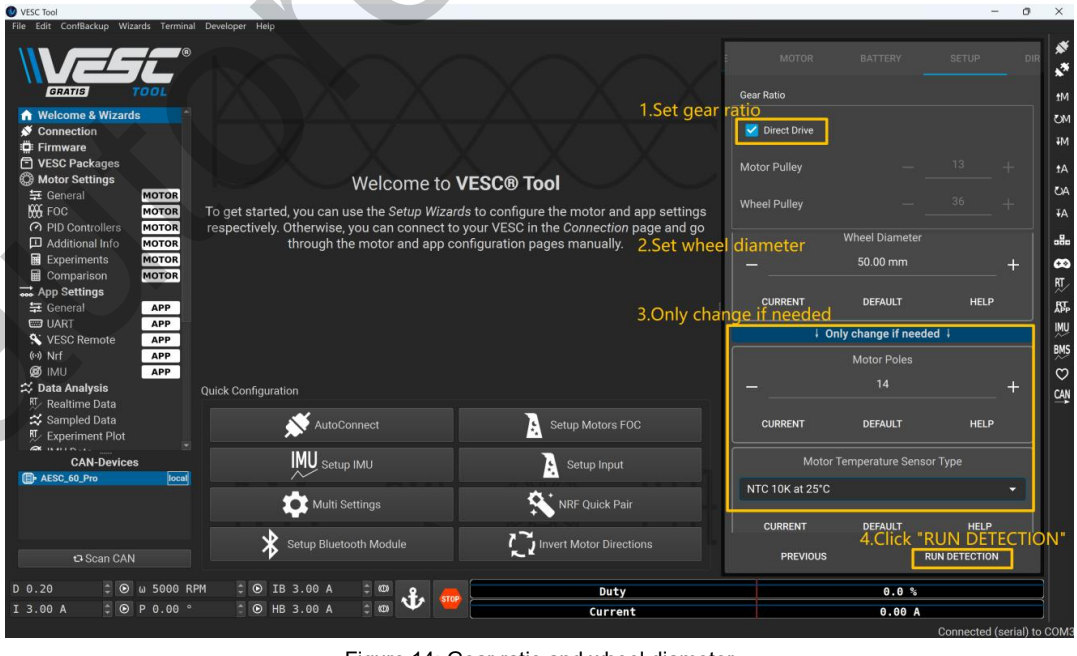

Figure 14: Gear ratio and wheel diameter

i. Please review the warning message. If everything is correct, click “OK” to proceed.

Warning: Ensure the motor is securely mounted and can rotate freely before clicking "OK".

- The motor will emit audible beeps and begin slow rotation.
- Detection typically completes within 30--60 seconds.

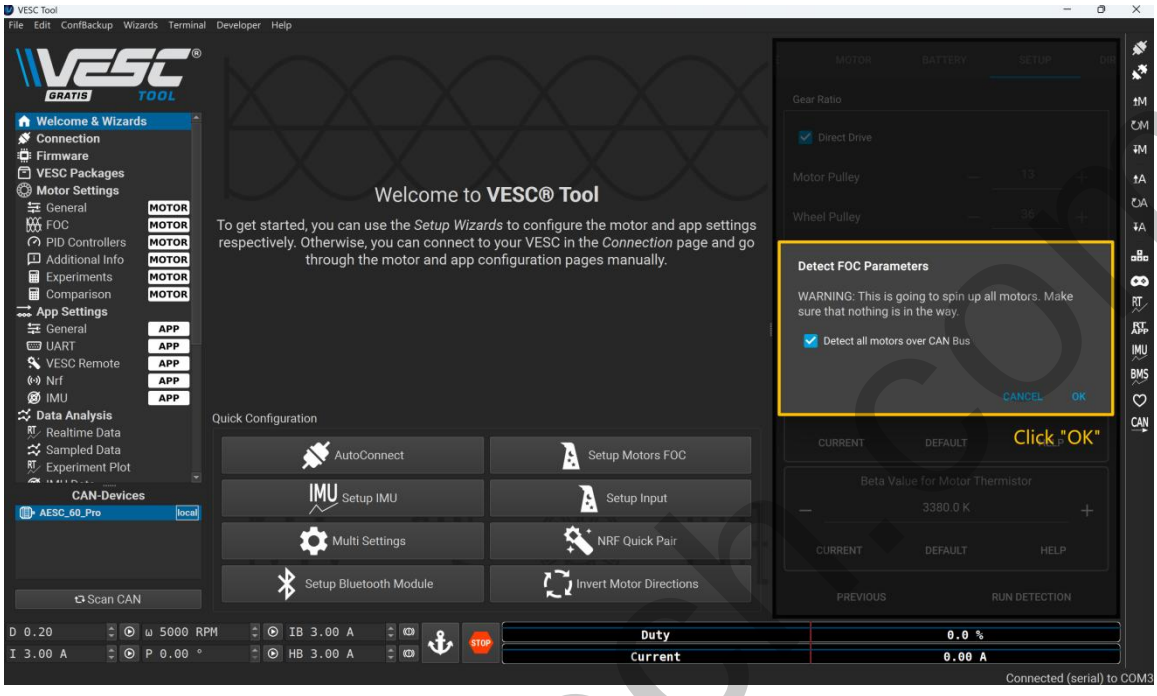

Figure 15: Detect FOC Parameters

j. Upon successful detection, the following parameters will be displayed:

- Resistance (R) • Inductance (L) • Flux linkage (λ) • Sensor Status

Then Click “OK”.

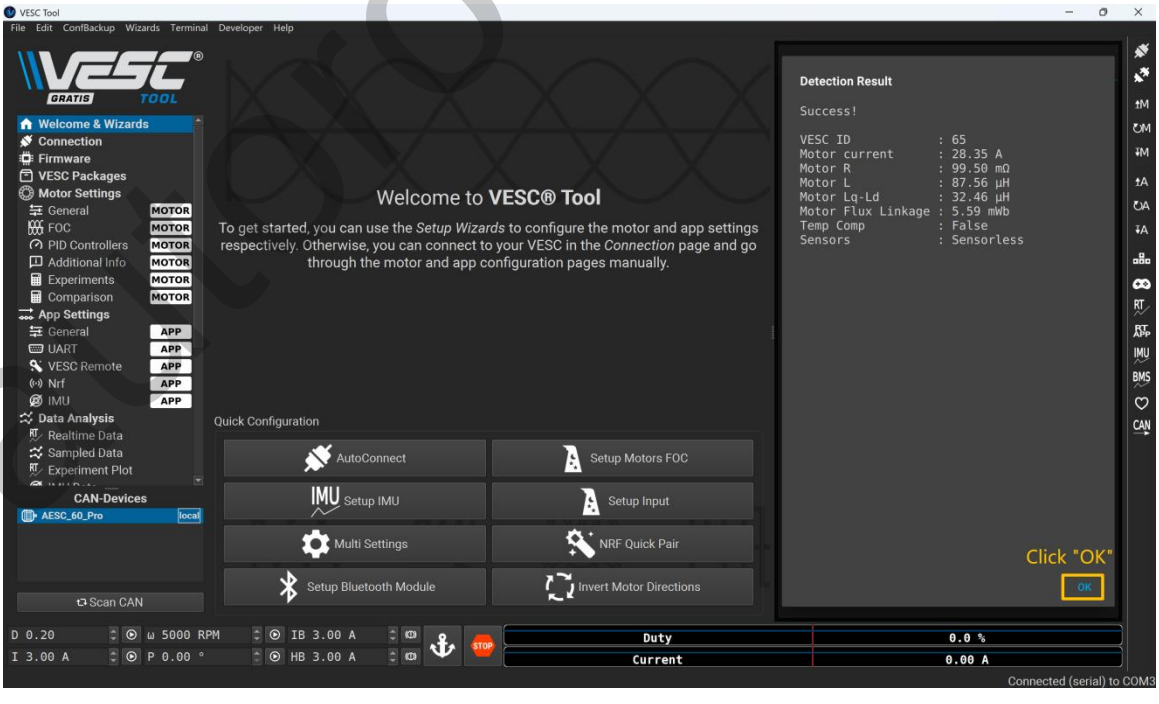

Figure 16: Detection result

k. Rotation Direction Test:

- Motor Direction OK: Click **"FWD"** and **"REV"** to check motor direction → Click **"FINISH"** to complete setting if the direction is OK.
- Motor Rotation Reversed: Click the "**Inverted**" on to change motor direction → click "**FWD**" and "**REV**" to confirm motor direction → Click "**FINISH**" to complete setting.

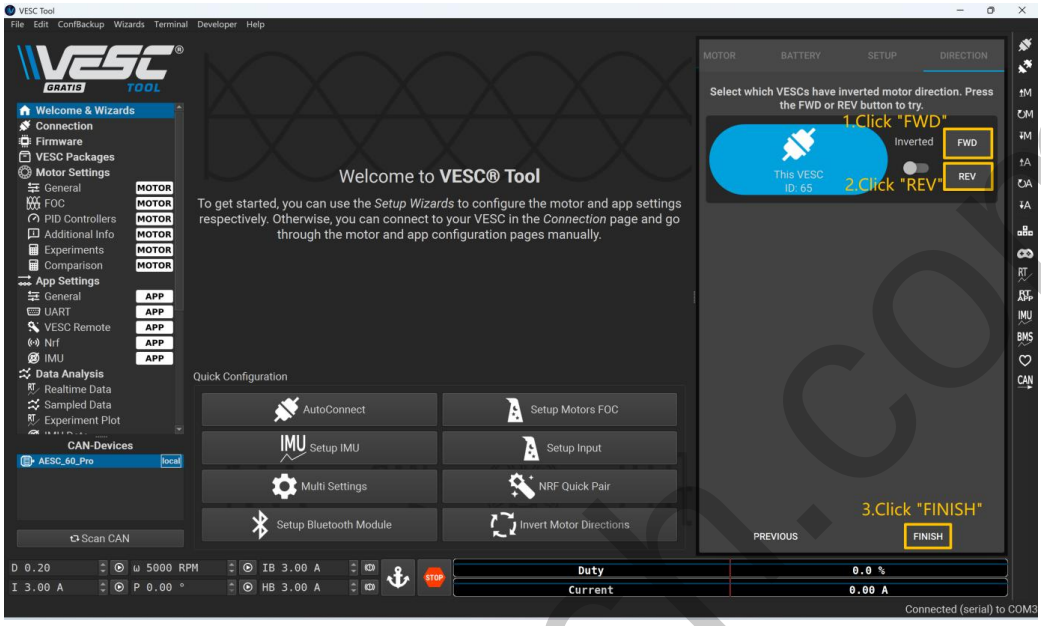

Figure 17: Click “FINISH”

4.3.Important Configuration

a. Current Configuration

Warning: After each completion of motor parameter calibration, the appropriate parameter values must be set; otherwise, it may cause damage to the electronic speed controller!

VESC Tool: “Motor Settings” → “General” → “Current” .

• **Motor Current Max:** This value must be lower than both the maximum current allowed by the motor itself and the ESC (AESC). For safety, please refer to your motor and ESC specifications and set it to the lower of the two rated currents.

• **Motor Current Max Brake:** Maximum braking current. This parameter sets the maximum reverse current during motor braking, usually represented as a negative value.

- When the system uses a switching power supply or lacks a regenerative braking (braking energy absorption) device, this value should be set to 0.

- When using batteries, its absolute value must not exceed the tolerance of the ESC and battery, otherwise it may cause damage.It is recommended to use a smaller value here, such as -10A.

• **Absolute Maximum Current:** Overcurrent protection threshold. This parameter sets the current limit for hardware protection.

- Once the detected current exceeds this threshold, the system will immediately shut down the output and generate a fault code to prevent hardware damage.

- Although the current control loop manages daily operating currents, short transient peaks may still occur. Therefore, this threshold should be set higher than other limits like **"Motor Current Max"** to avoid unnecessary protective shutdowns.A relatively high value can be set here, with a maximum of 150A for the Basic version and 200A for the Pro version.

• **Battery Current Max:** Maximum battery output current. This parameter limits the maximum current drawn from the battery.

- This value should generally be set less than or equal to the "**Motor Current Max**" you have configured and the maximum continuous current of the ESC itself.

• **Battery Current Max Regen:** Maximum battery absorption current. This parameter sets the maximum current that can be fed back into the battery during braking, usually represented as a negative value.

- When the system uses a switching power supply or does not support regenerative braking, this value should be set to 0.
- Its absolute value must not exceed the maximum motor current to ensure that the regenerative energy remains within the system's controllable range.It is recommended to use a smaller value here, such as -10A.

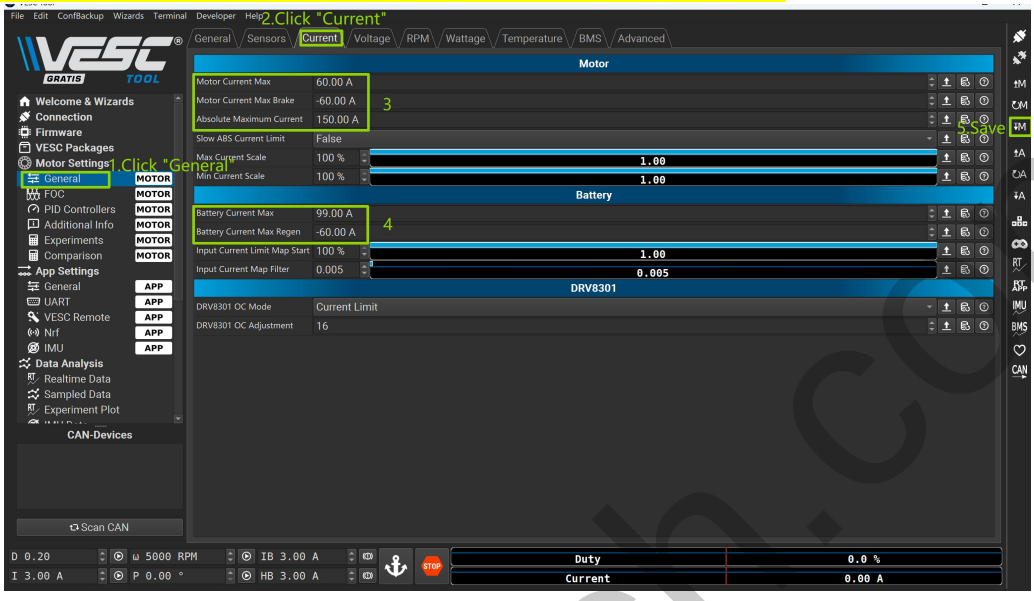

Figure 18: Current Configuration

b. Speed Configuration

The speed can be configured based on the ESC and motor specifications.

VESC Tool: "Motor Settings" → "General" → "RPM"

• **Max ERPM:** Maximum electrical RPM for forward motor rotation.Max value:150000.

• **Max ERPM Reverse:** Maximum electrical RPM for reverse motor rotation.Max value:-150000.

Formulas:

Motor Electrical RPM = Motor Physical RPM × Number of Pole Pairs

Motor Physical RPM = Voltage × KV

Number of Pole Pairs = Number of Magnetic Poles ÷ 2

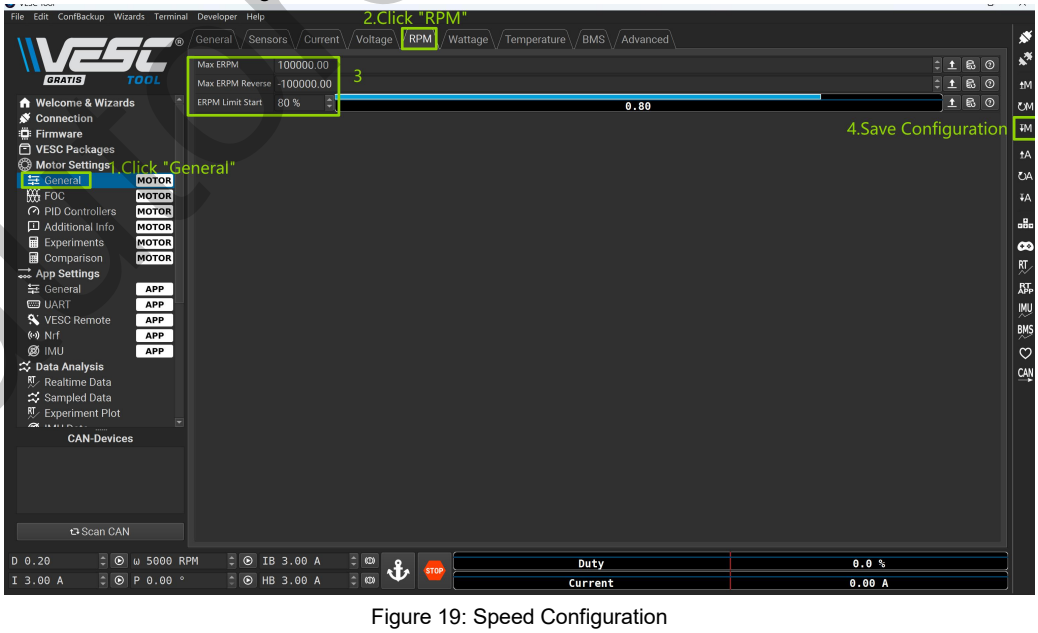

Figure 19: Speed Configuration

5. Troubleshooting

5.1.FOC Detection Failed

The FOC detection process can sometimes fail. If this happens, do not proceed, as running the motor with incorrect parameters can damage it or the AESC. Below are the most common causes and their solutions.

a. Motor wiring issues (most common)

- **Problem:** The three motor phase wires (A, B, C) are not connected securely, or the hall sensor/encoder cable is loose or incorrectly wired.
- **Solution:**
  - **Power off** the AESC completely.
  - Check that all motor phase wires are **securely screwed** into the AESC terminals.
  - If using sensors, triple-check the hall/encoder cable is fully seated and the pinout matches your AESC's layout. A single loose wire can cause failure.

b. Motor not free to move

- **Problem:** The motor is coupled to a load (gears, belt, wheel) or is jammed. The detection algorithm requires the rotor to spin freely.
- **Solution:**
  - Absolutely ensure the motor is completely disconnected from any load and can rotate 100% freely. This is a non-negotiable requirement.

c. Insufficient power supply

- **Problem:** Your battery or power supply cannot deliver the current required for the detection process, causing the voltage to sag too much.
- **Solution:**
  - Use a healthy, fully charged battery that can deliver high current. Ensure all power connections are tight. Avoid using weak bench power supplies.

d. Detection current too low

- **Problem:** For very large motors with high inductance, the default detection current might be too weak to get a clean signal.
- **Solution:**
  - In the settings of the FOC wizard, try **gradually increasing** the Detection Current parameter (e.g., from 5A to 10A). **Do not set this to an excessively high value.**

5.2.Negative/Zero Motor Flux Linkage

- **Problem:** The phase voltage filtering function (Enable Phase Filters) is enabled in the firmware, while the hardware platform (e.g., VESC4) does not actually support hardware-based phase voltage filtering.
- **Solution:**
  - Before running FOC calibration, you must disable the phase filtering option. "**Motor Settings**" → "**FOC**" → "**Filters**" → "**Phase Enable Filters**" to **False**, and save the configuration by clicking "**Write Motor Configuration**". Then restart the FOC calibration process.

6. Contact & Support

For technical support,contact : Autoro.service@hotmail.com

Website : https://www.autorotech.com