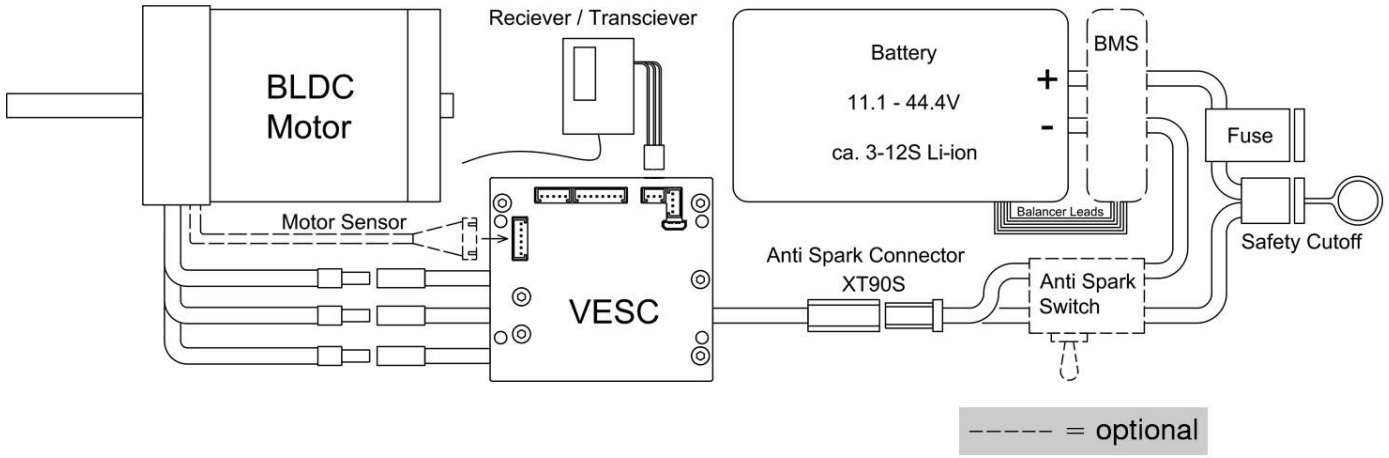
Configuration of your VESC® or VESC® based ESC using the VESC®-Tool Software.

In this tutorial we will configure a genuine VESC® motor controller in combination with a BLDC motor.
We will run the motor in FOC mode and we will make use of Hall sensors.

Make sure to use the latest VESC-Tool version!
Download from http://www.vesc-project.com/vesc_tool

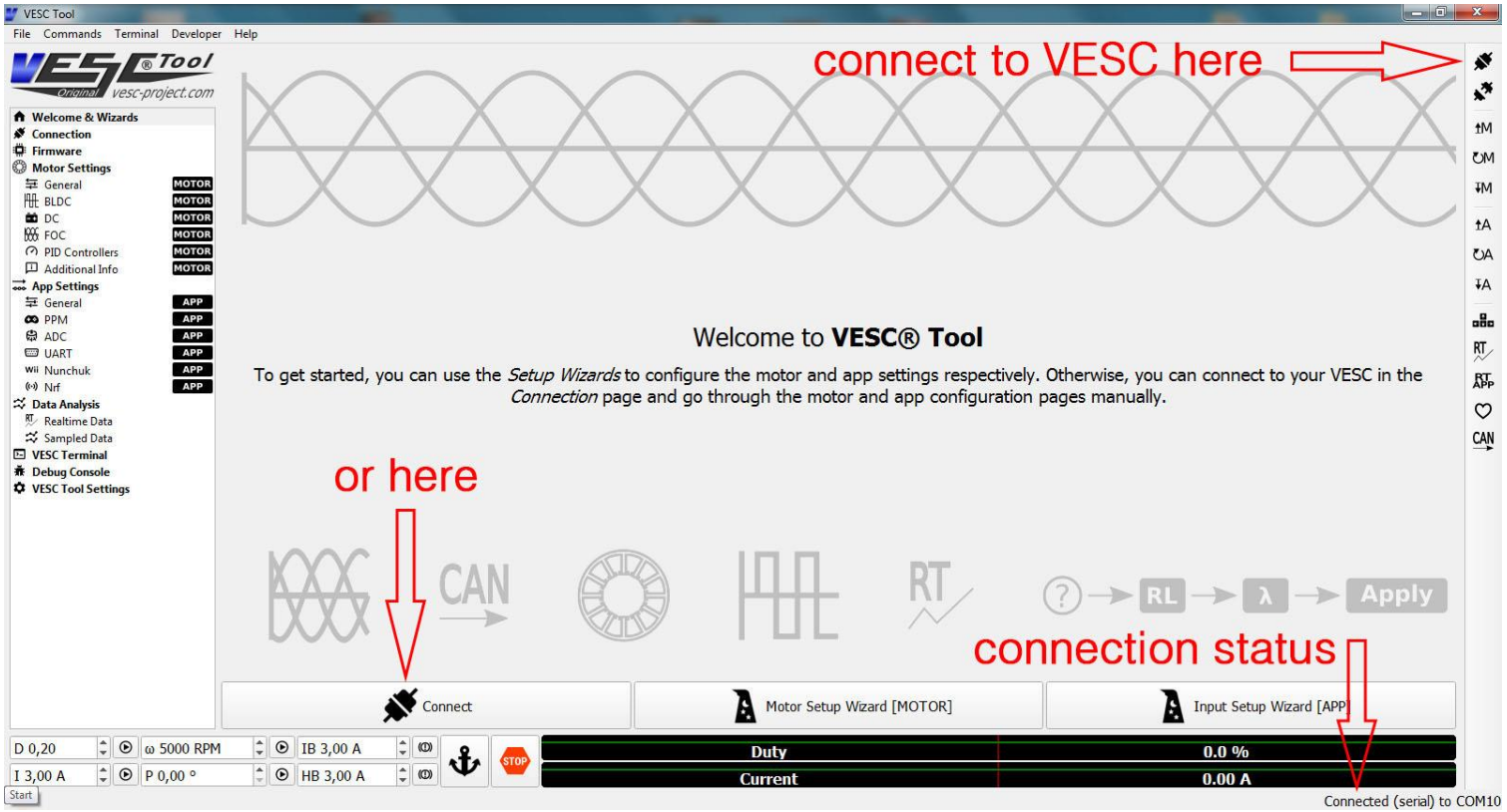
Connect your VESC® according to the wiring digram shown in the manual.

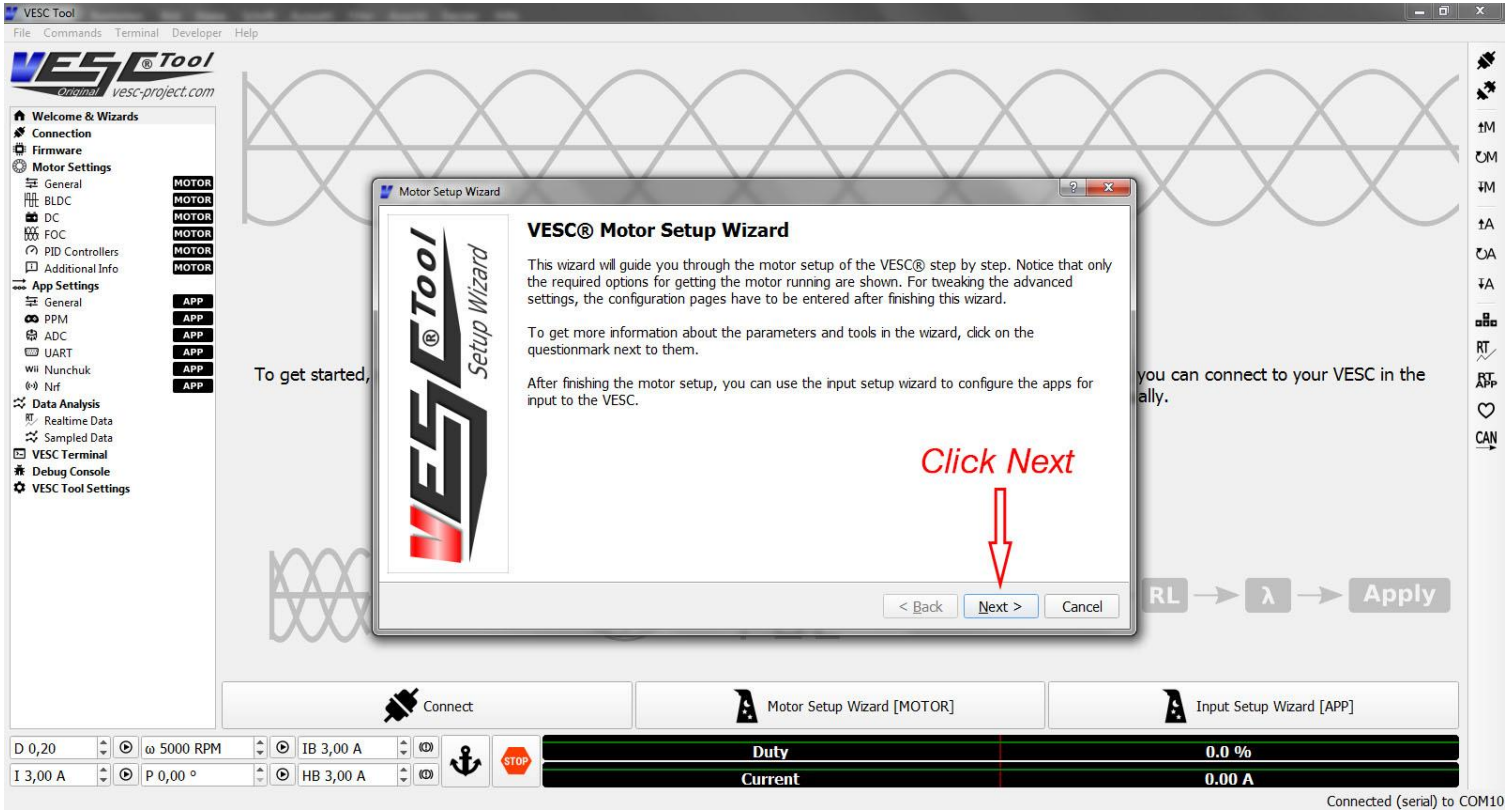


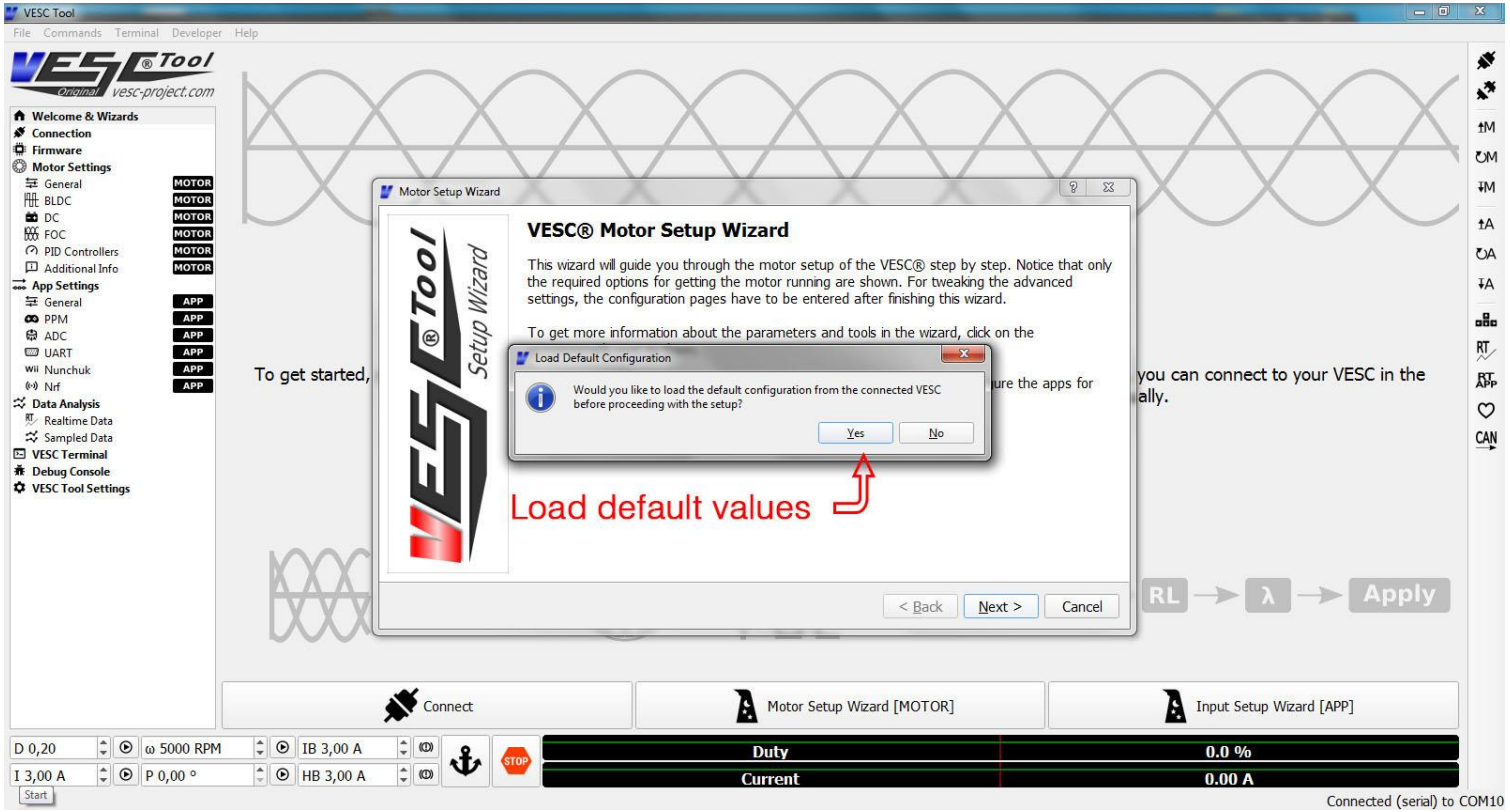
Connect your VESC® to your computer using a mini/micro USB cable.

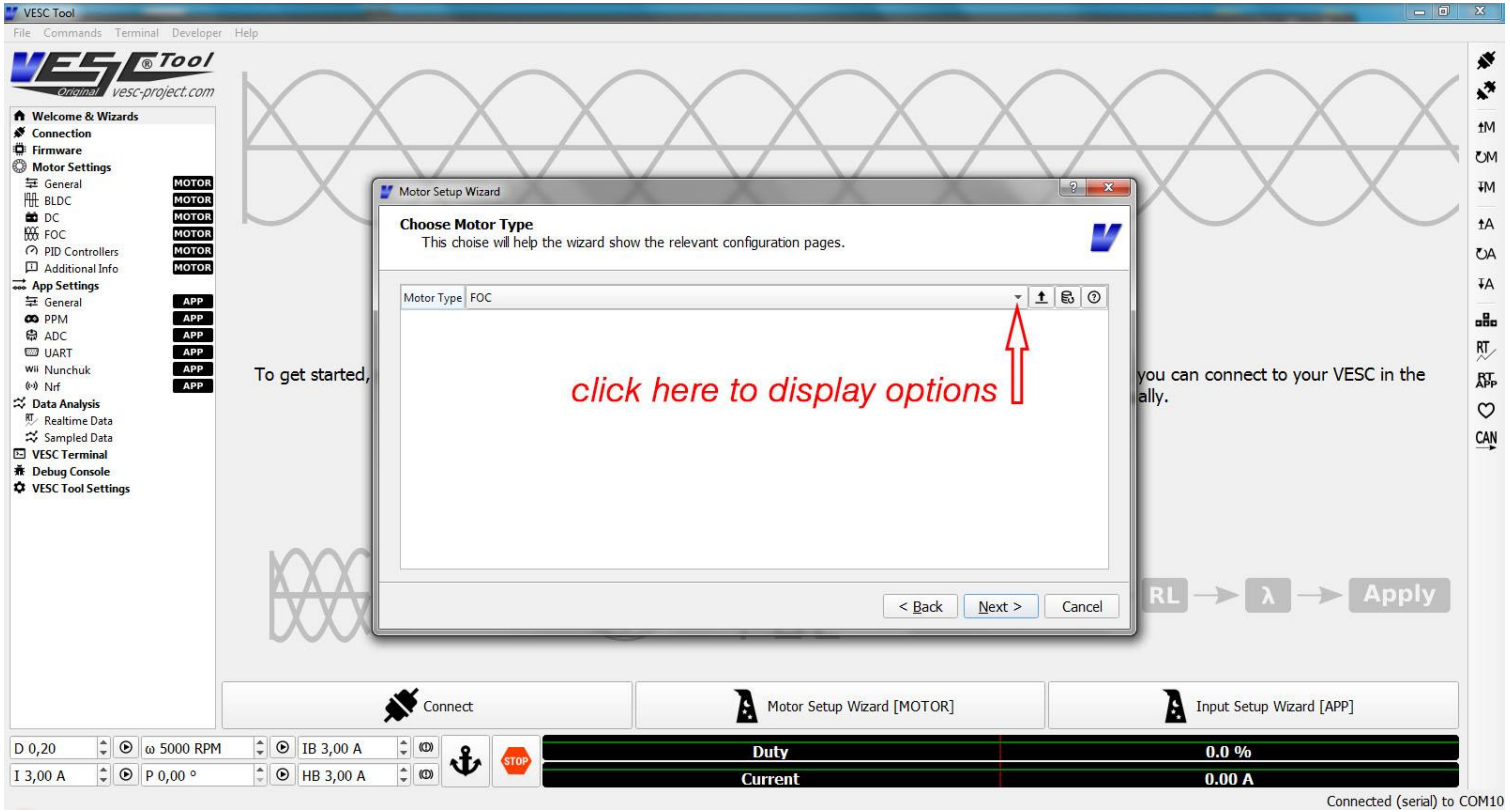
Mini USB is used for HW 4.xx only. Some cheap micro USB cables are designed for charging your phone and will not work properly! Try another cable if you experience any issues.

Run the VESC®-Tool software.




VESC Tool
File Commands Terminal Developer Help
vesc-project.com
Welcome & Wizards
Connection
Firmware
Motor Settings
General
BLDC
DC
FOC
PID Controllers
Additional Info
App Settings
General
PPM
ADC
UART
Nunchuk
Nrf
Data Analysis
Realtime Data
Sampled Data
VESC Terminal
Debug Console
VESC Tool Settings
Motor Setup Wizard
VESC® Motor Setup Wizard
This wizard will guide you through the motor setup of the VESC® step by step. Notice that only the required options for getting the motor running are shown. For tweaking the advanced settings, the configuration pages have to be entered after finishing this wizard.
To get more information about the parameters and tools in the wizard, click on the questionmark next to them.
After finishing the motor setup, you can use the input setup wizard to configure the apps for input to the VESC.
Click Next
< Back
Next >
Cancel
To get started,
you can connect to your VESC in the
ally.
RL
λ
Apply
Connect
Motor Setup Wizard [MOTOR]
Input Setup Wizard [APP]
D 0,20
ω 5000 RPM
IB 3,00 A
I 3,00 A
P 0,00 °
HB 3,00 A
Duty
0.0 %
Current
0.00 A
Connected (serial) to COM10


VESC Tool
File Commands Terminal Developer Help
vesc-project.com
Welcome & Wizards
Connection
Firmware
Motor Settings
General
BLDC
DC
FOC
PID Controllers
Additional Info
App Settings
General
PPM
ADC
UART
Nunchuk
Nrf
Data Analysis
Realtime Data
Sampled Data
VESC Terminal
Debug Console
VESC Tool Settings
Motor Setup Wizard
VESC® Motor Setup Wizard
This wizard will guide you through the motor setup of the VESC® step by step. Notice that only the required options for getting the motor running are shown. For tweaking the advanced settings, the configuration pages have to be entered after finishing this wizard.
To get more information about the parameters and tools in the wizard, click on the
Load Default Configuration
Would you like to load the default configuration from the connected VESC before proceeding with the setup?
Yes
No
Load default values
< Back
Next >
Cancel
To get started,
you can connect to your VESC in the
RL
λ
Apply
Connect
Motor Setup Wizard [MOTOR]
Input Setup Wizard [APP]
Duty
0.0 %
Current
0.00 A
Connected (serial) to COM10

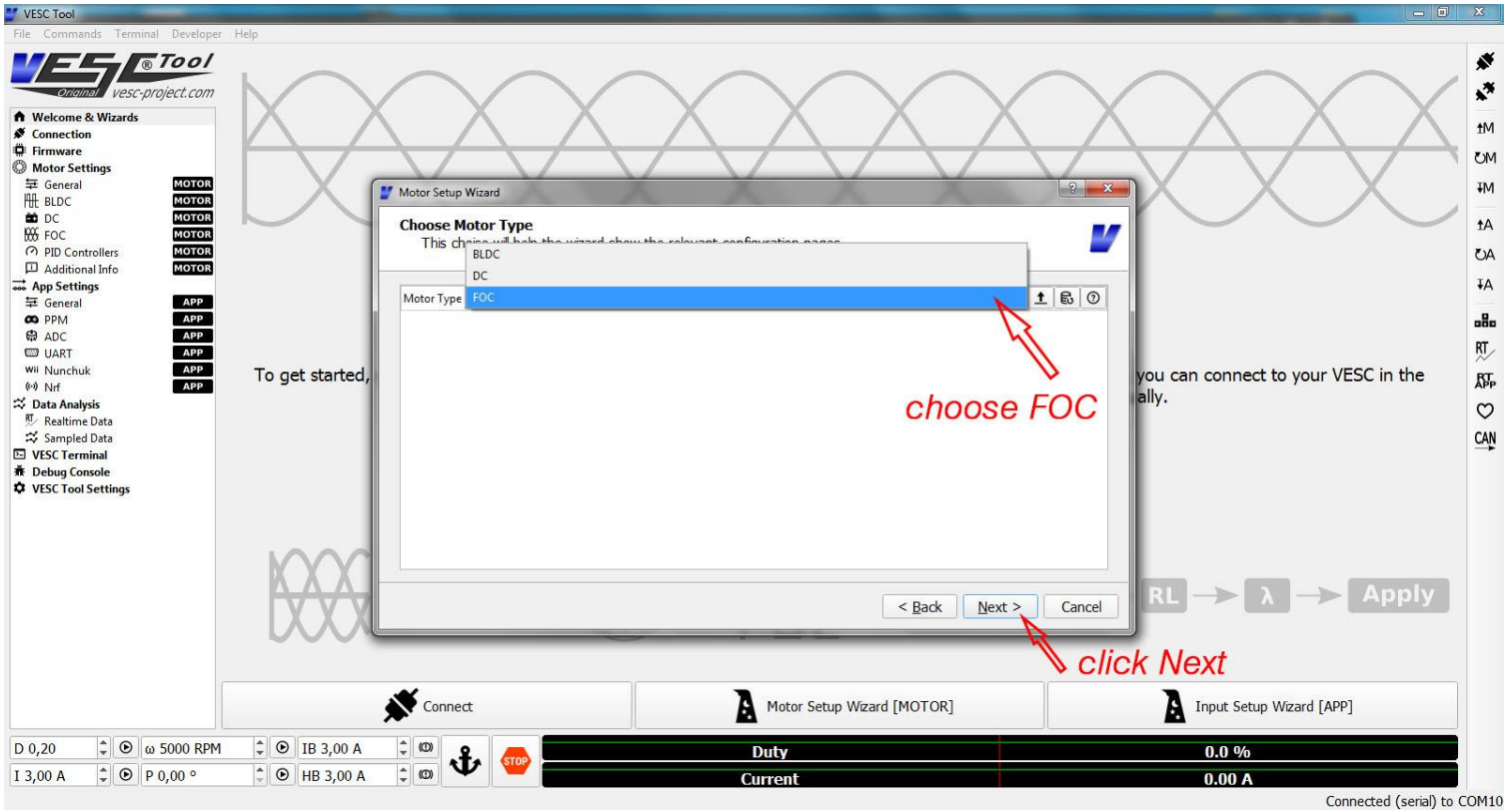


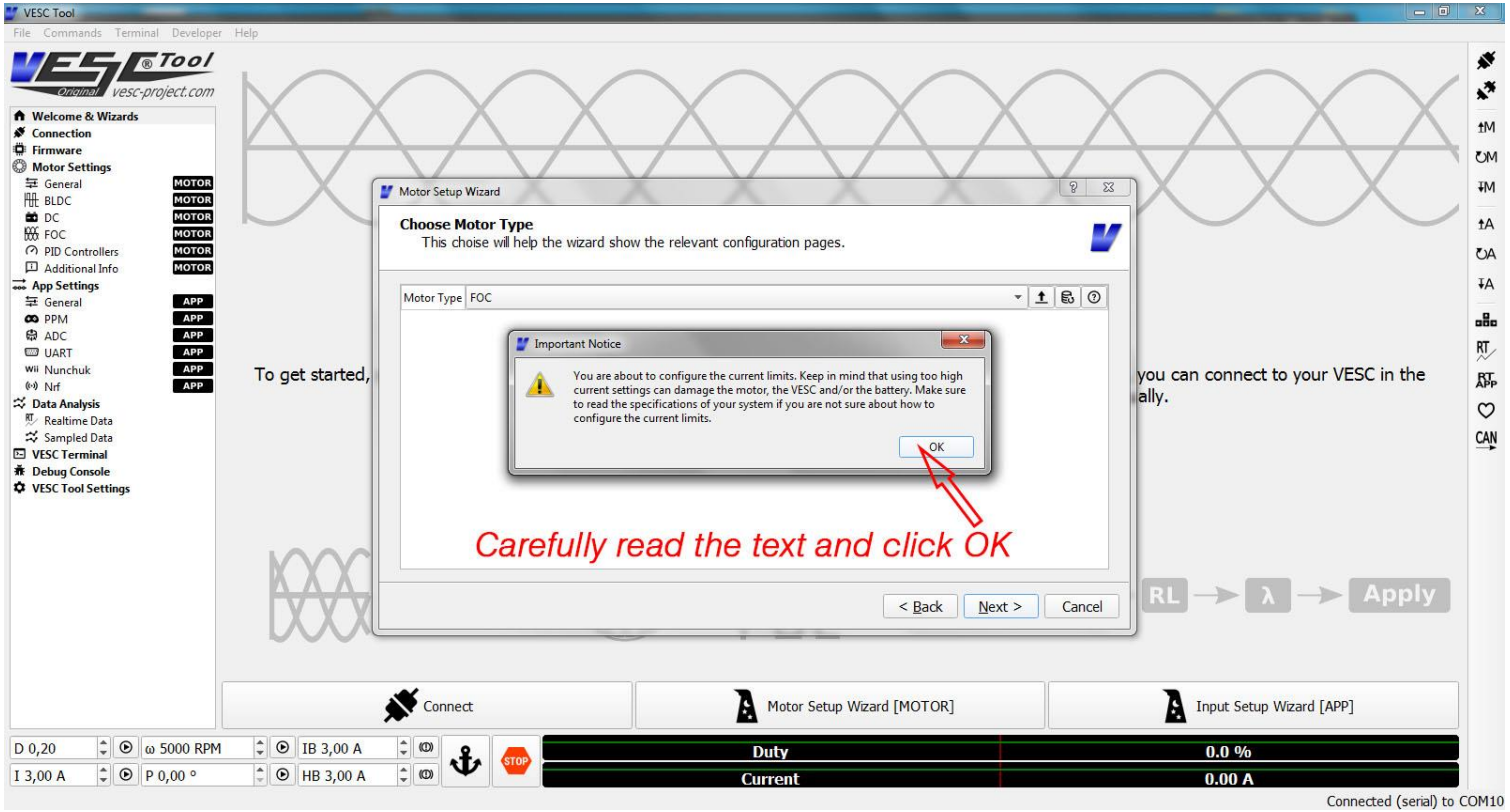
Now we get the following options:

FOC = Field-Oriented Control
Advanced control mode (sinusoidal, silent, more efficient,
better motor sensor operation).
May cause damage to 3rd party hardware!

BLDC = Trapezoidal Control
More simple control mode (block commutation), noisier, hall-sensor operation
less accurate at this stage. Safer for operation of 3rd party hardware.

DC = Only for DC motors. Use phase wire A and C only!

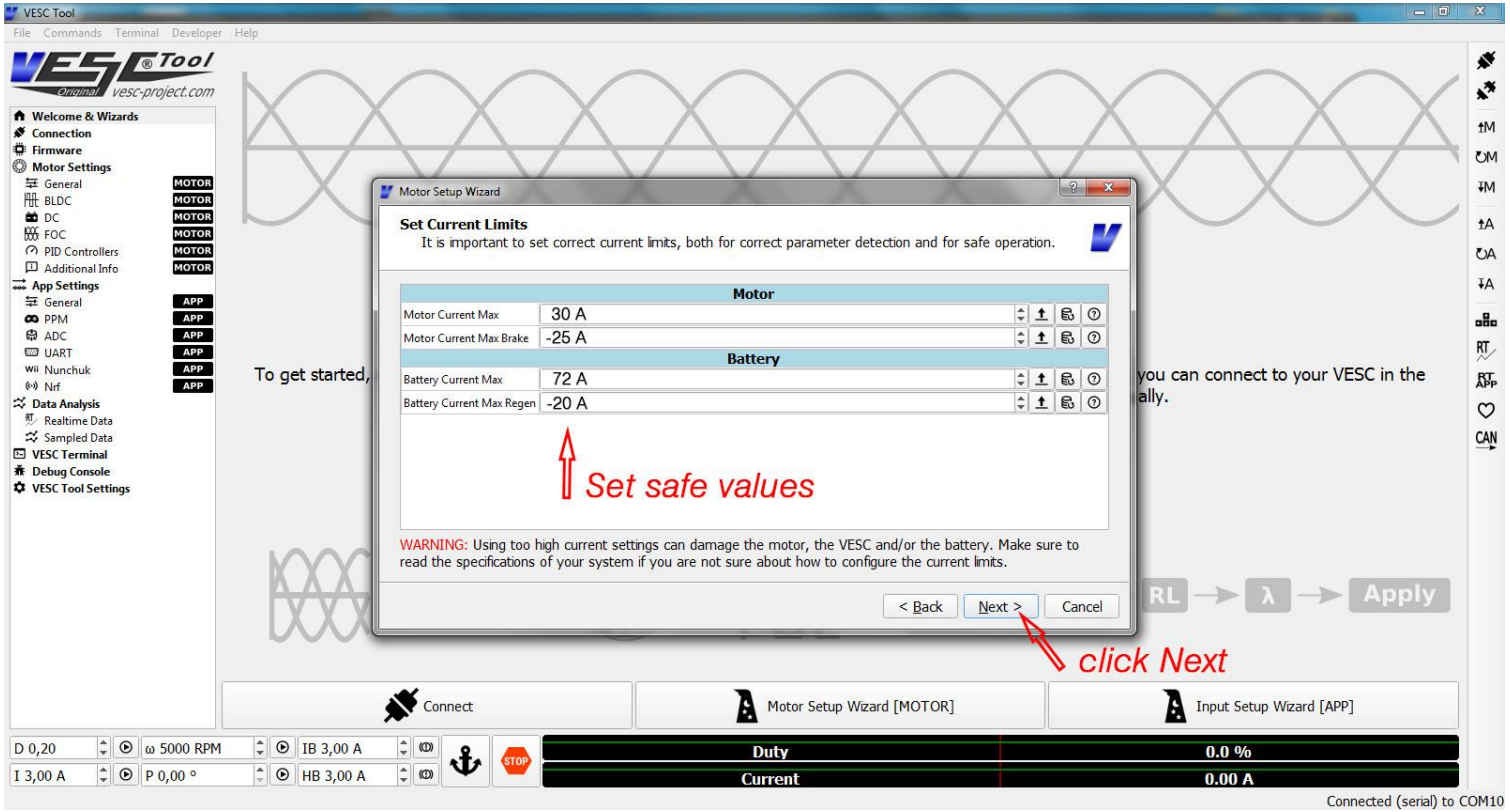


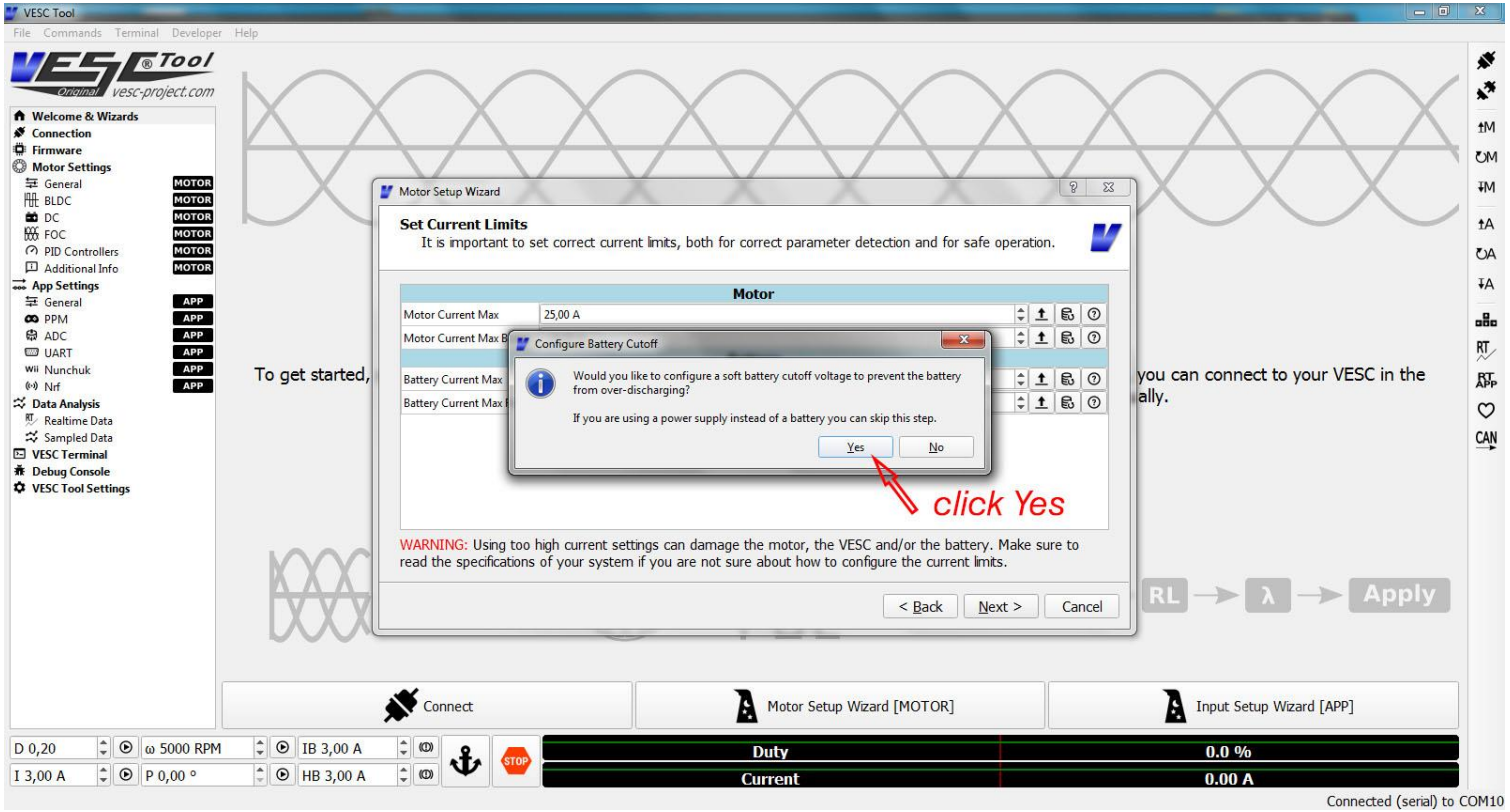


The following explanations will help you to configure your current limits correctly:

Motor Current Max: The maximum current your motor can handle continuously (Ampere). Please refer to the motor specifications of your motor. You may use lower values to de-power your setup.

Our motor can handle 50A, but we will only set it to 30A to get started. You can boost your settings once you feel comfortable. A safe approach towards higher values is highly recommended (e.g. start with 15A only).
Hint: This value can be greater than the *Battery Current Max* value, resulting in a higher motor power output at part throttle. At max throttle the *Battery Current Max* is the limiting value if set lower than *Motor Current Max*.
Motor Current Max Brake: The maximum current output you allow your motor to produce when operated as a generator. Electric vehicles may use the motor as a brake, generating energy when slowing down the vehicle. The energy produced will be stored in the battery. In this tutorial we will set the value to -25A to get started. The value should not be higher than the max. continuous current specification of the motor.
Hint: Higher values will result in stronger brakes if the *Battery Current Max Regen* settings allows the storage of the current generated.
Battery Current Max: The maximum continuous current your battery is rated for. Please refer to your battery specifications for safe settings. LiPo-pack batteries are usually C-rated. A 5800mAh, 25C rated battery can handle **5.8A x 25=145A max.** Manufacturers often overrate the batteries and cutting the value in half is recommend. We will use 72A max for safety reasons.
Hint: Since our Motor Current Max is set to 30A, we could use 30A for the battery as well.
Technically there is no reason to use a higher value than the Motor Current Max.
Battery Current Max Regen: The maximum current you allow the VESC to push towards your battery or battery management system (if incorporated in your system) when braking. This value should not exceed the maximum charge current rating of your battery or capability of your battery management system. Our battery is 5C rated for charging. We use a 5800mAh battery. 5.8A x 5 = 29A max. charge current. Again: Better be pessimistic with those values! We will set it to -20A.
Hint: Since this value is lower than the *Motor Current Max Brake* (-25A), the firmware will limit the ampflow towards the Battery to -20A, regardless of the higher value we specified for *Motor Current Max Brake* (-25A). In consequence our maximum motor brake force is limited by the lower *Battery Current Max Regen* value.


VESC Tool
File Commands Terminal Developer Help
Welcome & Wizards
Connection
Firmware
Motor Settings
General
BLDC
DC
FOC
PID Controllers
Additional Info
App Settings
General
PPM
ADC
UART
Nunchuk
Nrf
Data Analysis
Realtime Data
Sampled Data
VESC Terminal
Debug Console
VESC Tool Settings
Motor Setup Wizard
Set Current Limits
It is important to set correct current limits, both for correct parameter detection and for safe operation.
Motor
Motor Current Max
30 A
Motor Current Max Brake
-25 A
Battery
Battery Current Max
72 A
Battery Current Max Regen
-20 A
Set safe values
WARNING: Using too high current settings can damage the motor, the VESC and/or the battery. Make sure to read the specifications of your system if you are not sure about how to configure the current limits.
< Back
Next >
Cancel
click Next
To get started,
you can connect to your VESC in the
ally.
RL
λ
Apply
Connect
Motor Setup Wizard [MOTOR]
Input Setup Wizard [APP]
Duty
0.0 %
Current
0.00 A
Connected (serial) to COM10

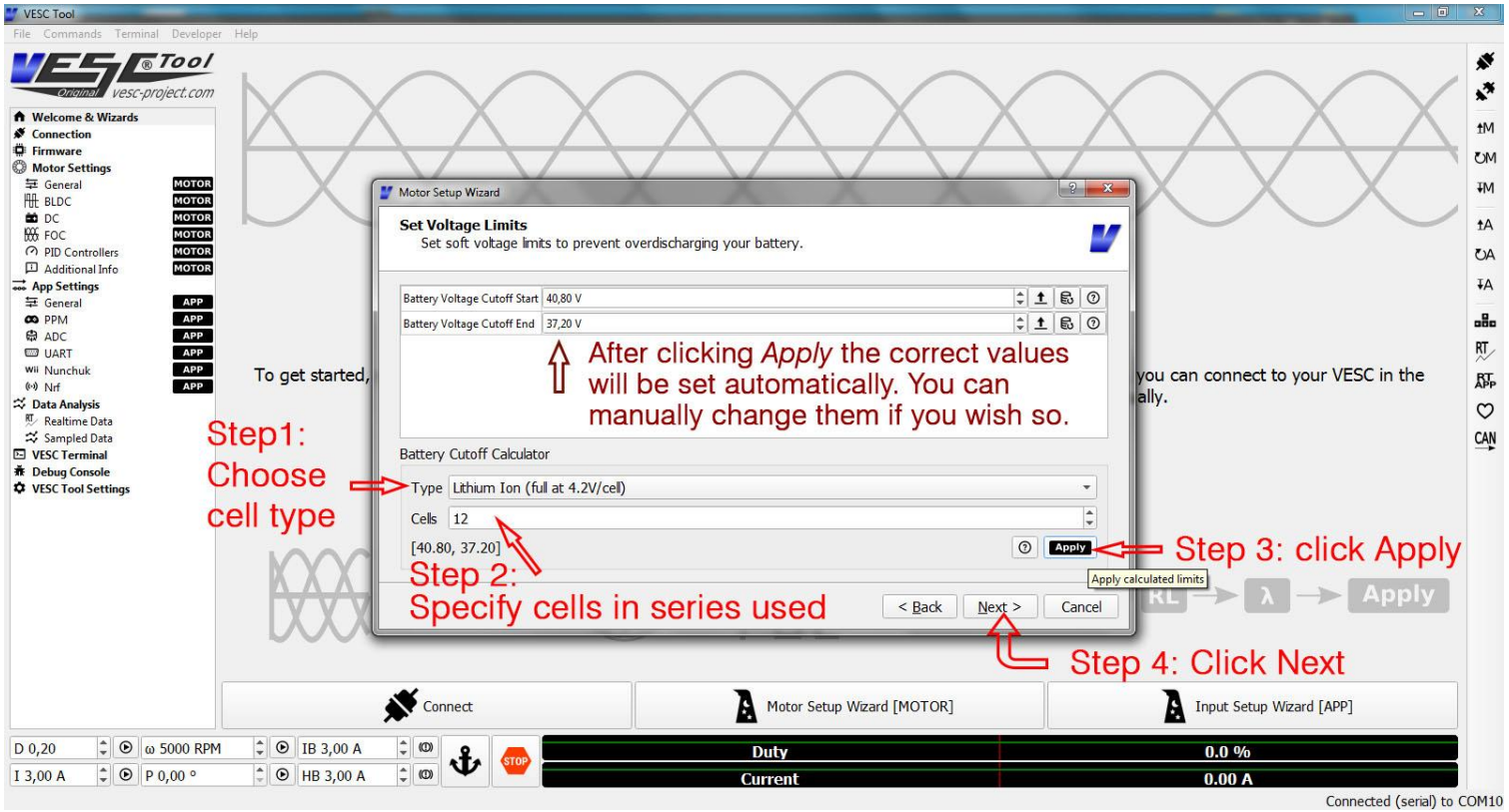


Now we will configure your battery cutoff voltage.

If you discharge your battery below a certain voltage, it will get damaged permanently. LiPo packs or Lithium ion Batteries usualy operate between 4.2V and 3.1V per cell. Do not allow your system to discharge them beyond 3.1V per cell! For this reason the VESC will measure your battery voltage and will start to softly cutoff the power at 3.4V per cell (Battery Votage Cutoff Start) and it will perform a hard cutoff at 3.1V per cell (Battery Votage Cutoff End).

You can also set custom values if your cells have different ratings.

Battery Voltage Cutoff End = number of cells in series x minimum cell voltage



Next step is the choice of motor sensors

Sensors help the VESC to know the rotor position in refenrence to the copper coils. This way the motor can perform a relatively smooth startup from 0 RPM. If your motor features sensors you should make use of them. At higher RPM, the VESC will use back EMFs to calculate the rotor position. The RPM for switching to back EMF operation can be defined later.

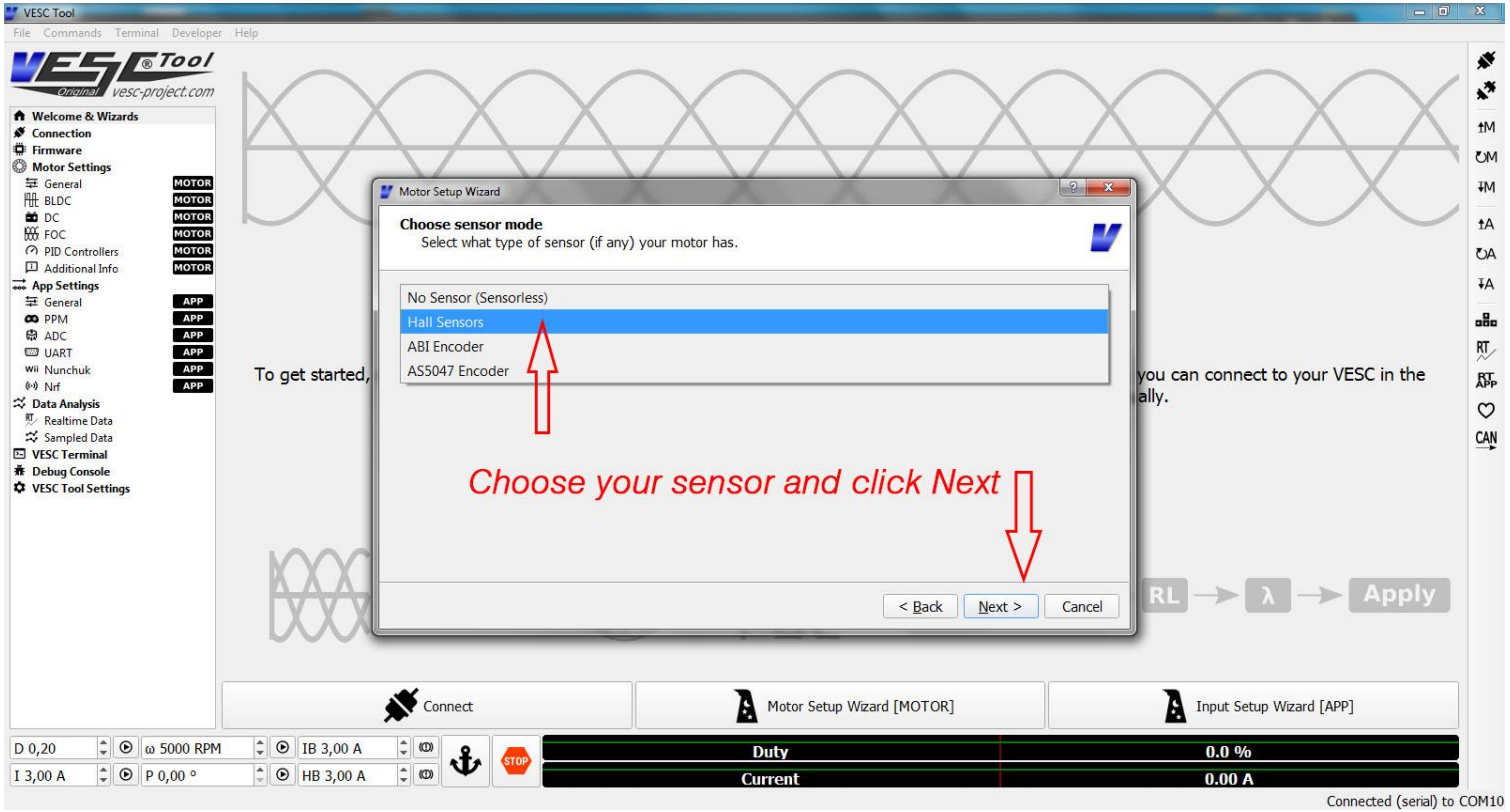
No sensors: without motor sensors the motor needs to turn a bit, so the VESC can calculate the rotor position from the back EMF current flow that the magnets will induce into the copper coils when they rotate around the the motor stator. Startup from 0 RPM is possible but a bit shaky.

Hall sensors: A transducer that varies its output voltage in response to a magnetic field. Usually a set of three sensors are acurately positioned inside or outside the motor to roughly determin the position of the rotor.
Commonly used, not very precise, good enough to guarnatee a smooth startup of a vehicle from standstill.

AS5047 Encoder: This is a chip sensing the magnetic field of a diametrally magnetized magnet, attached to the motor shaft. The precision is very high (14 bit) and allows very accurate determination of the rotor position.

ABI: Output signal of an incremental rotary encoder (mechanical, optical or magnetic).

Our motor has Hall sensors, so we will choose Hall sensor operation.



Next step is to measure your motor parameters

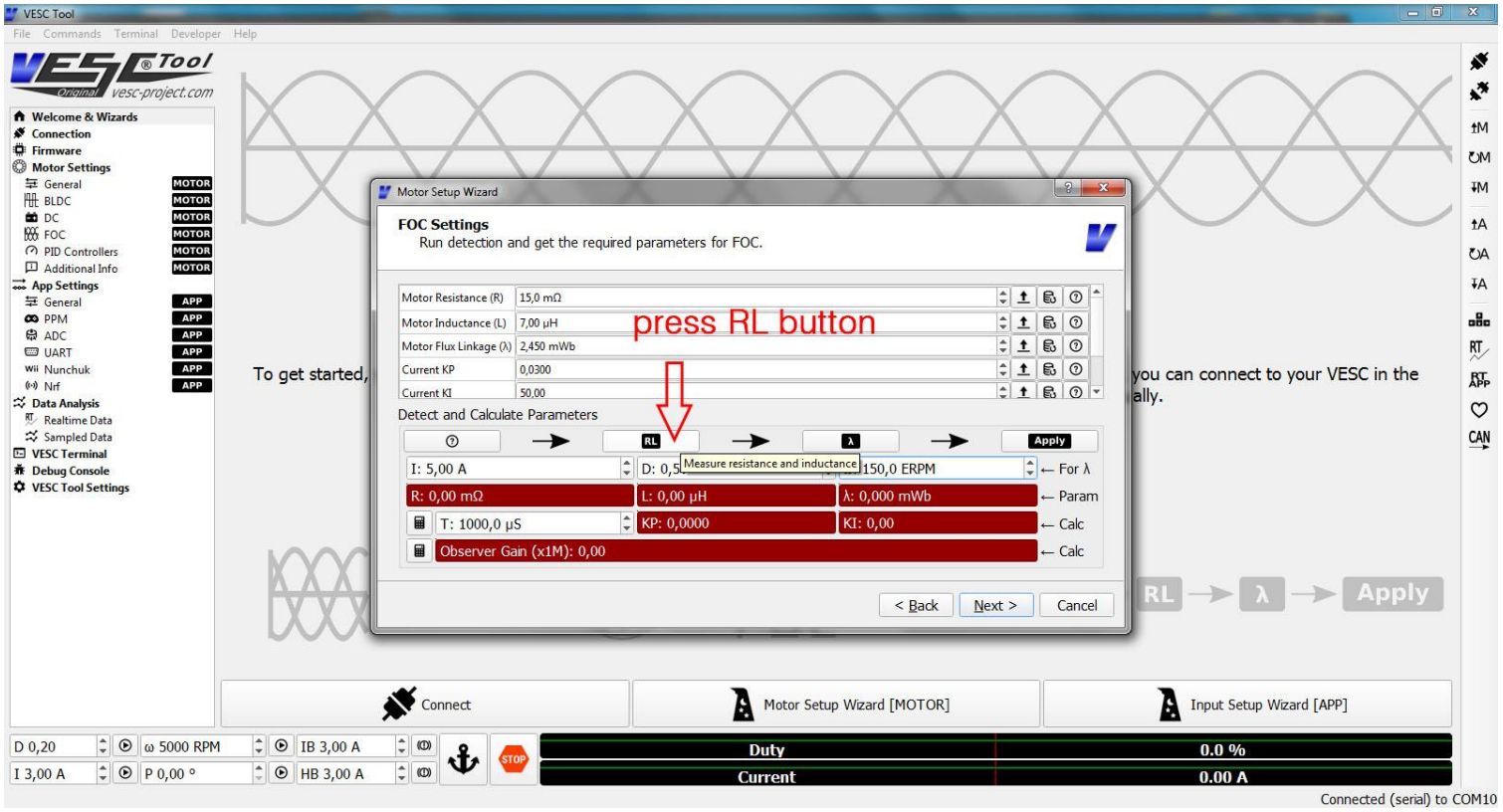
For the best possible result, do the detection without attached drive train, propellers etc.

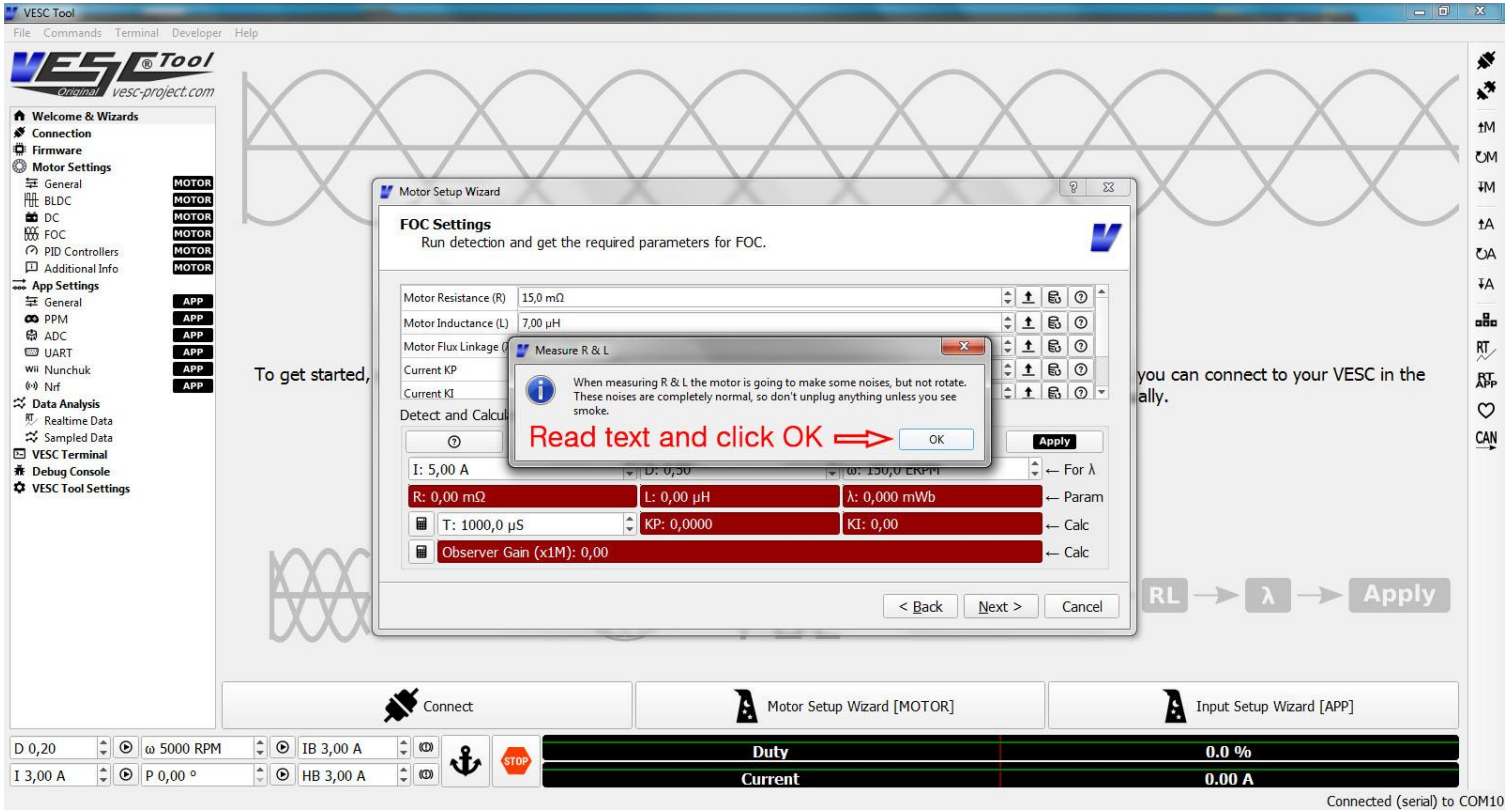
Every single motor is unique and the VESC needs to know certain parameters to run the motor. The VESC needs to know the motor resistance, electrical inductance and flux linkage (λ). From these basic values other values can be calculated that are essential for the motor operation. So that ‘s what we will do now.

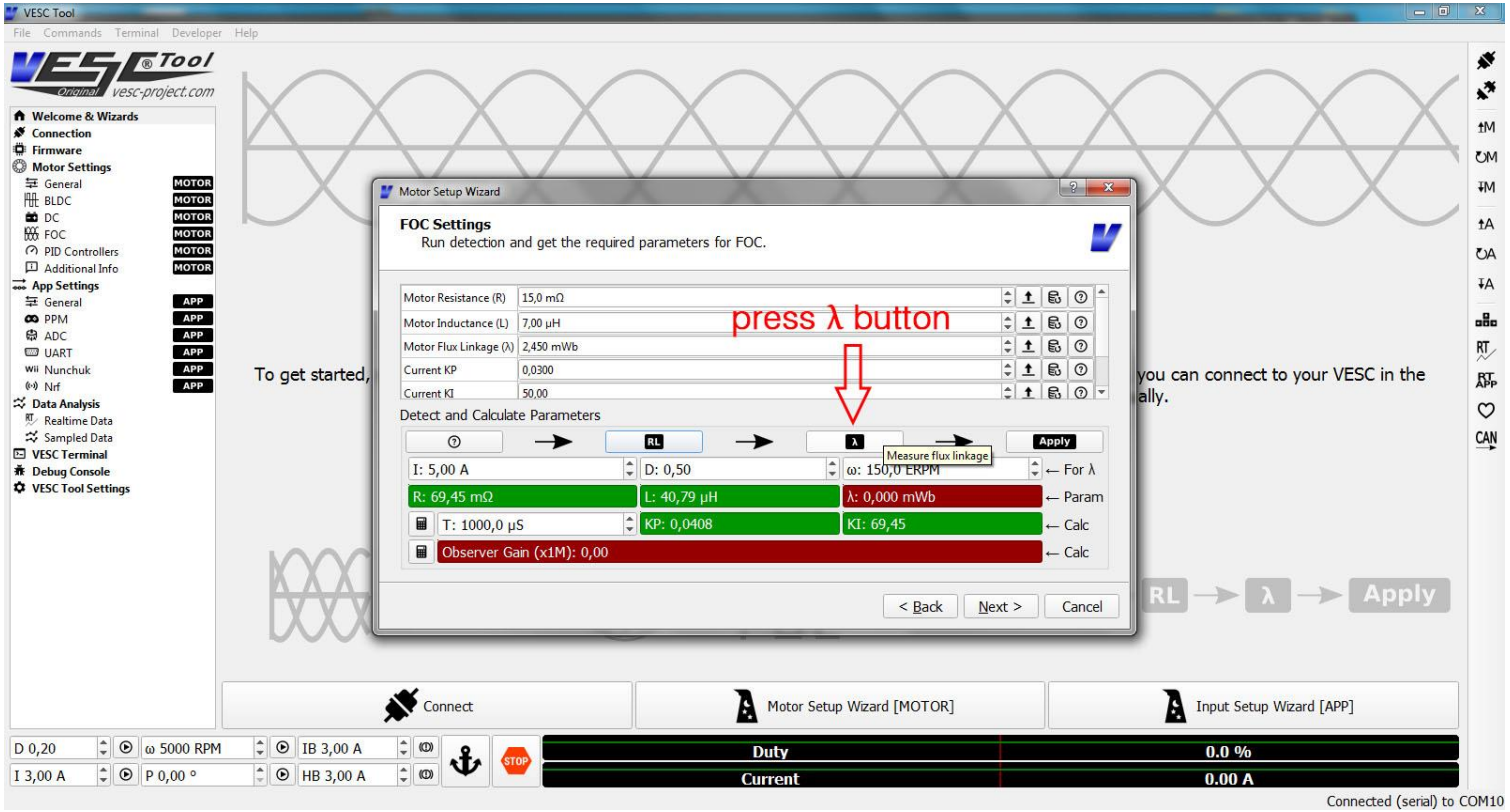
Step 1:measure RL
The motor will make a loud humming noise

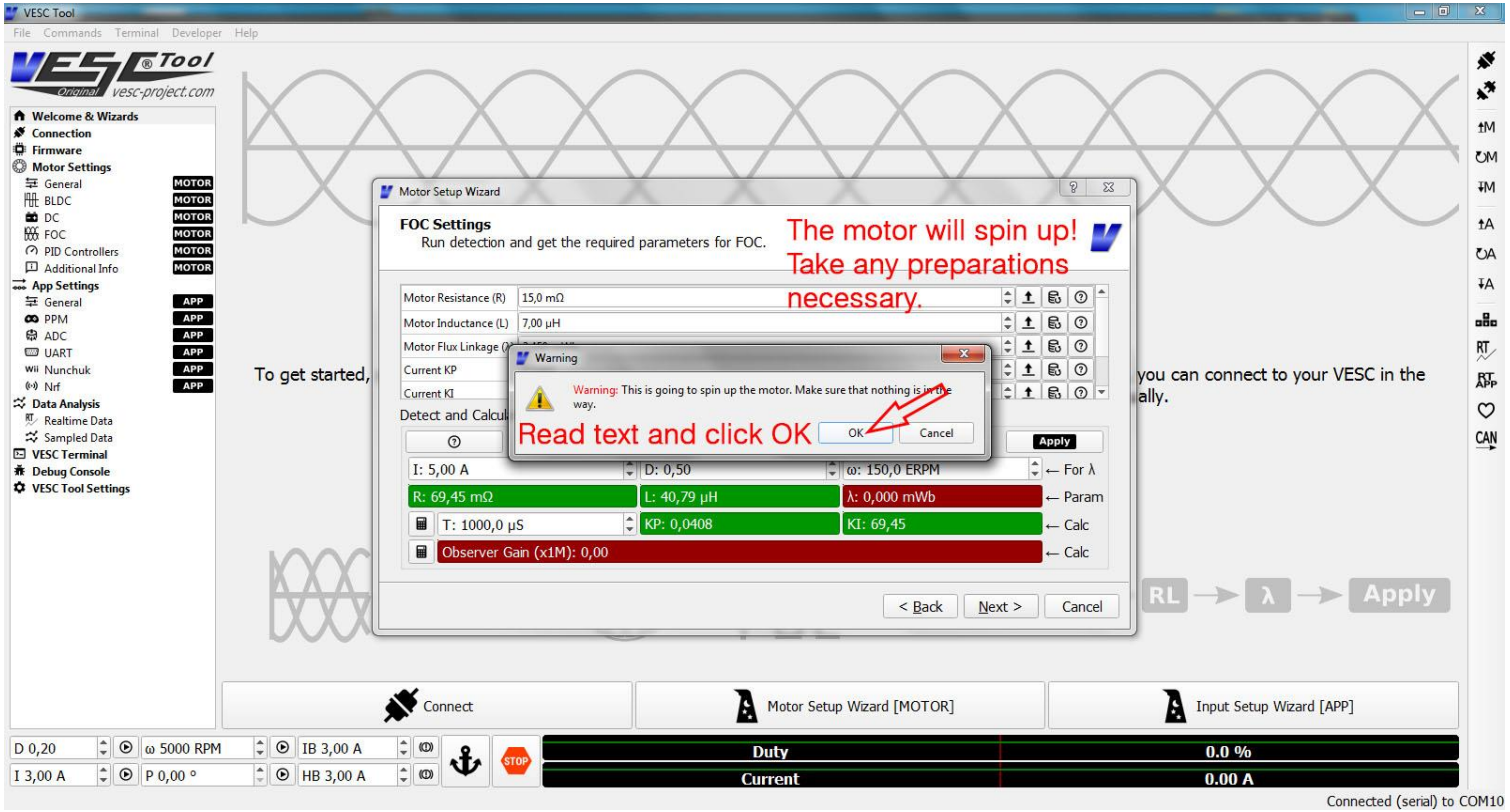
Step 2:measure λ
The motor will spin up. Make sure to disassemble propellers or lift up your vehicle from the ground or take any preparations necessary to allow your motor to spin up freely.

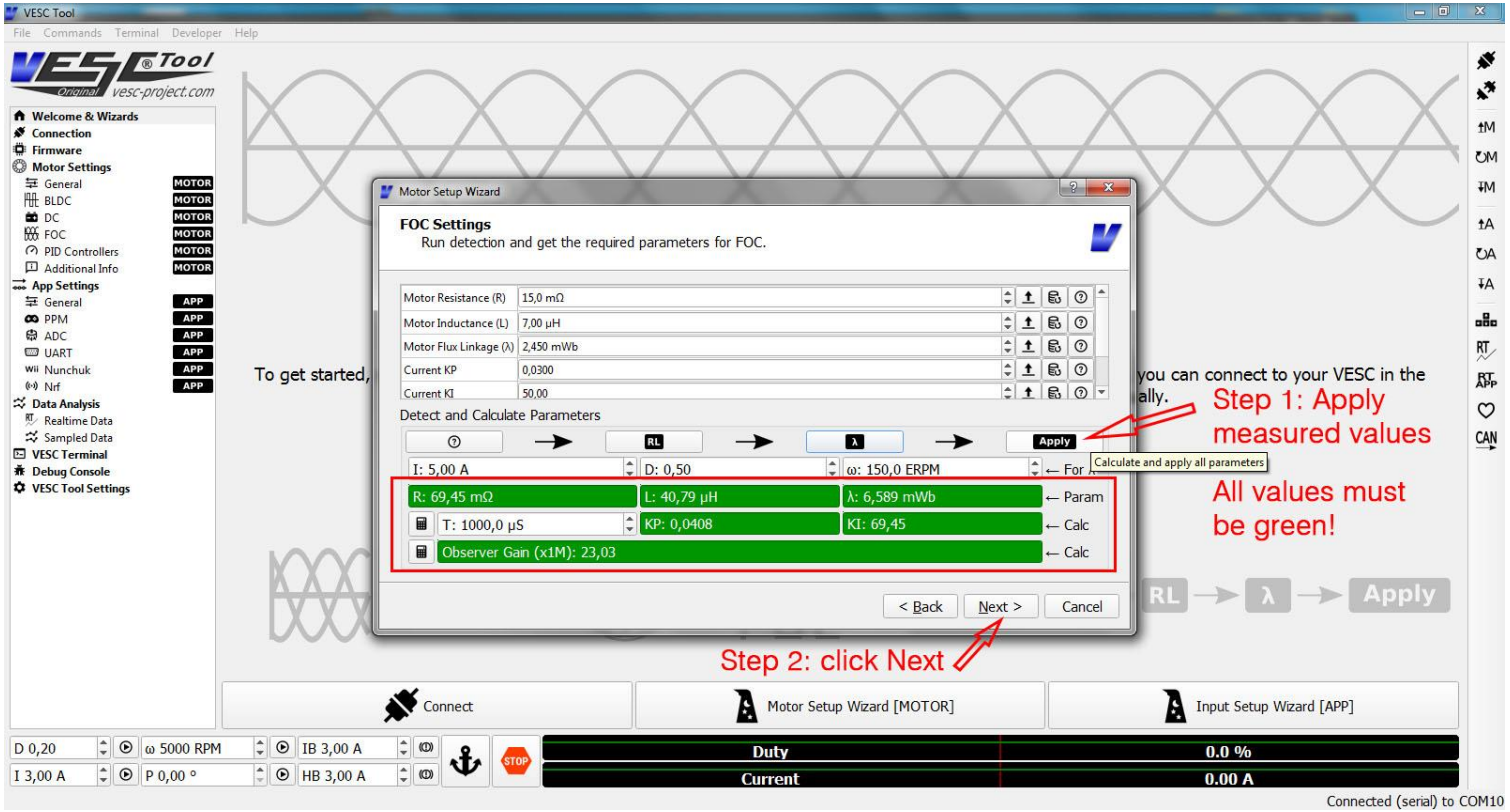
Step 3: Apply values

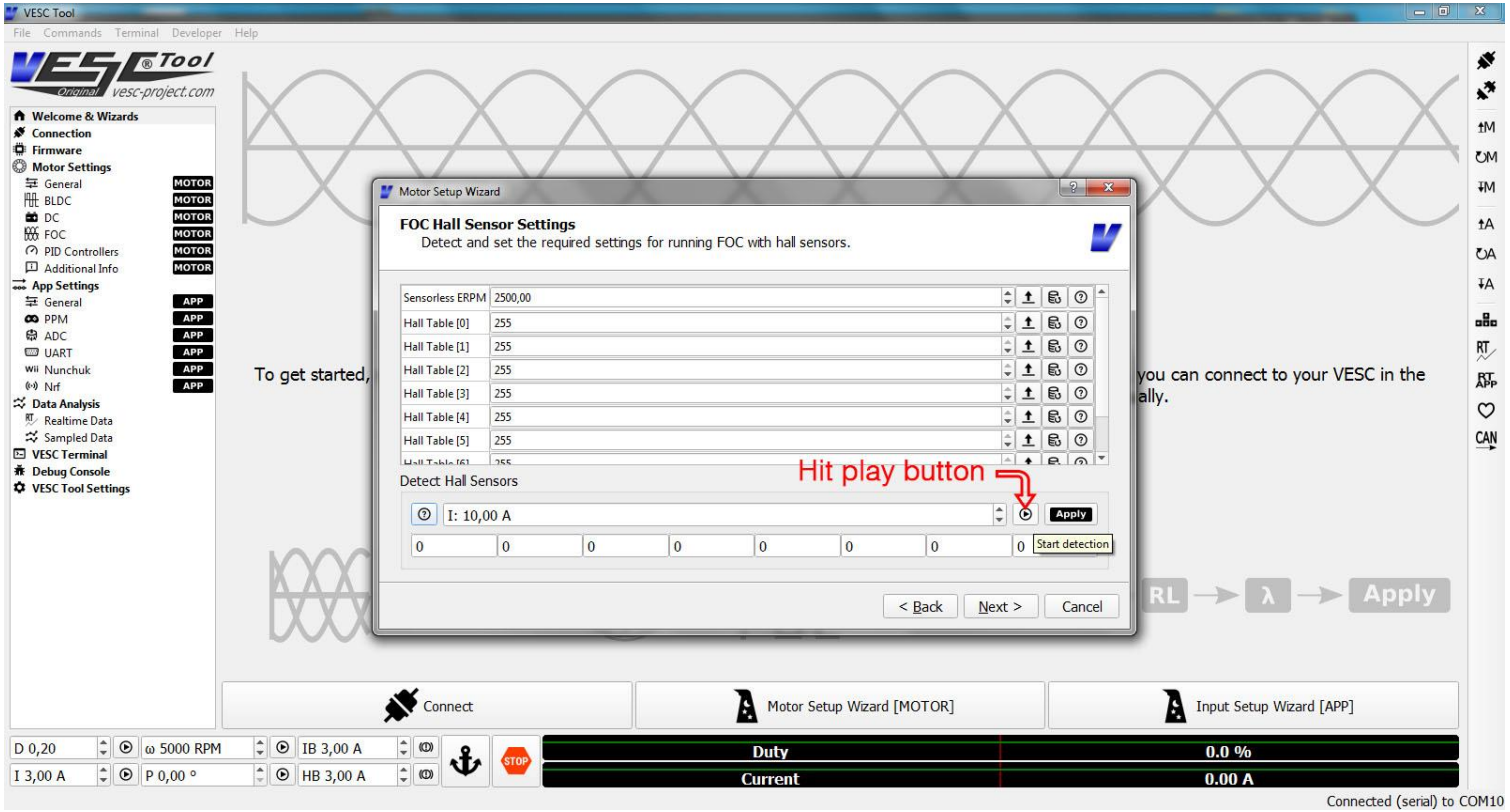



VESC Tool
File Commands Terminal Developer Help
Welcome & Wizards
Connection
Firmware
Motor Settings
General
BLDC
DC
FOC
PID Controllers
Additional Info
App Settings
General
PPM
ADC
UART
Nunchuk
Nrf
Data Analysis
Realtime Data
Sampled Data
VESC Terminal
Debug Console
VESC Tool Settings
Motor Setup Wizard
FOC Settings
Run detection and get the required parameters for FOC.
Motor Resistance (R) 15,0 mΩ
Motor Inductance (L) 7,00 µH
Measure R & L
When measuring R & L the motor is going to make some noises, but not rotate. These noises are completely normal, so don't unplug anything unless you see smoke.
Read text and click OK
OK
Apply
I: 5,00 A
R: 0,00 mΩ
L: 0,00 µH
λ: 0,000 mWb
T: 1000,0 µS
KP: 0,0000
KI: 0,00
Observer Gain (x1M): 0,00
< Back
Next >
Cancel
To get started,
you can connect to your VESC in the
ally.
RL
λ
Apply
Connect
Motor Setup Wizard [MOTOR]
Input Setup Wizard [APP]
D 0,20
ω 5000 RPM
IB 3,00 A
I 3,00 A
P 0,00 °
HB 3,00 A
Duty
0.0 %
Current
0.00 A
Connected (serial) to COM10

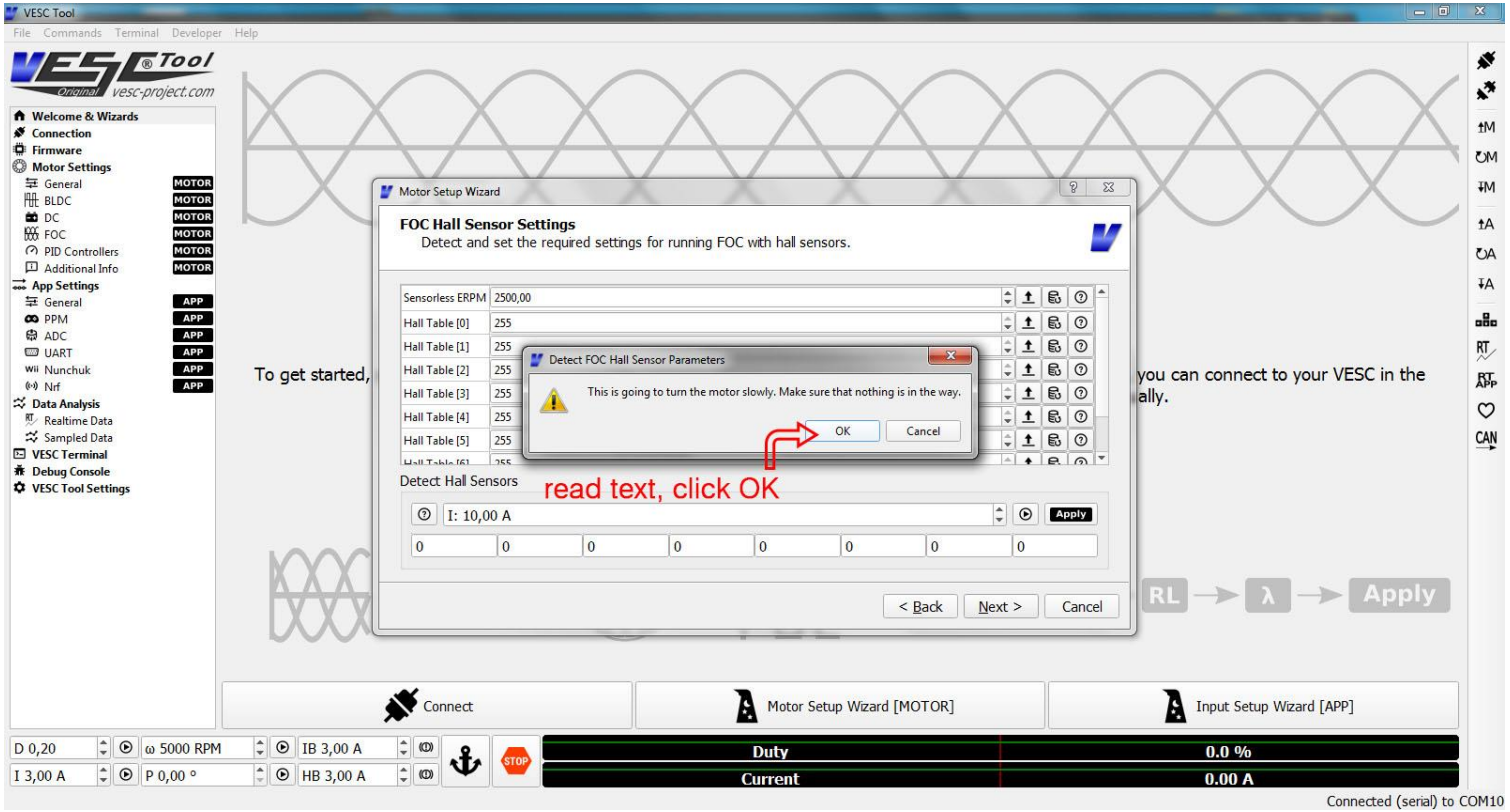

VESC Tool
File Commands Terminal Developer Help
Welcome & Wizards
Connection
Firmware
Motor Settings
General
BLDC
DC
FOC
PID Controllers
Additional Info
App Settings
General
PPM
ADC
UART
Nunchuk
Nrf
Data Analysis
Realtime Data
Sampled Data
VESC Terminal
Debug Console
VESC Tool Settings
Motor Setup Wizard
FOC Settings
Run detection and get the required parameters for FOC.
Motor Resistance (R) 15,0 mΩ
Motor Inductance (L) 7,00 µH
Motor Flux Linkage (λ) 2,450 mWb
Current KP 0,0300
Current KI 50,00
press λ button
Detect and Calculate Parameters
RL
λ
Apply
Measure flux linkage
I: 5,00 A
D: 0,50
ω: 150,0 ERPM
← For λ
R: 69,45 mΩ
L: 40,79 µH
λ: 0,000 mWb
← Param
T: 1000,0 µS
KP: 0,0408
KI: 69,45
← Calc
Observer Gain (x1M): 0,00
← Calc
< Back
Next >
Cancel
To get started,
you can connect to your VESC in the
ally.
Connect
Motor Setup Wizard [MOTOR]
Input Setup Wizard [APP]
D 0,20
ω 5000 RPM
IB 3,00 A
I 3,00 A
P 0,00 °
HB 3,00 A
STOP
Duty
0.0 %
Current
0.00 A
Connected (serial) to COM10

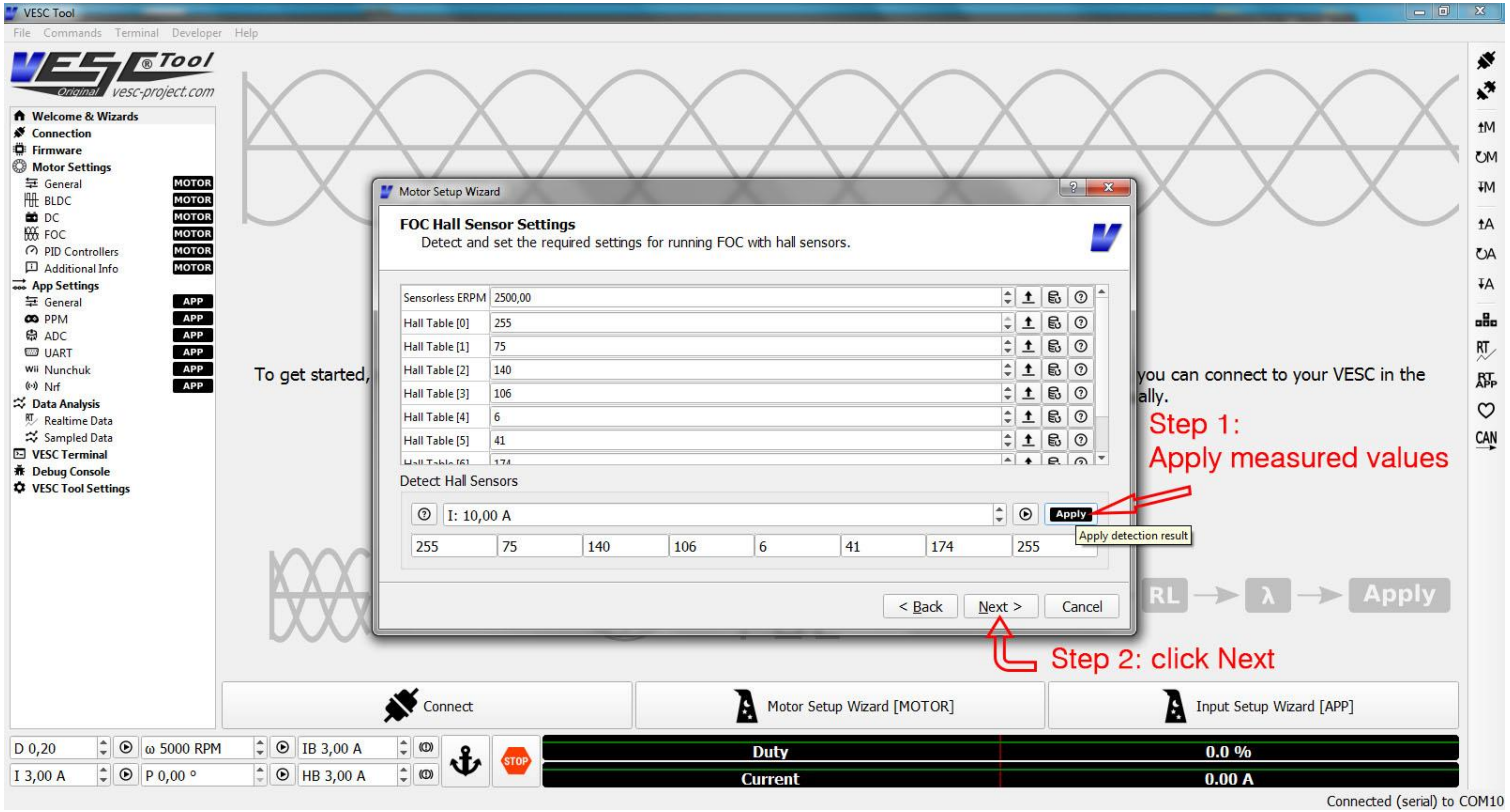

VESC Tool
File Commands Terminal Developer Help
Welcome & Wizards
Connection
Firmware
Motor Settings
General
BLDC
DC
FOC
PID Controllers
Additional Info
App Settings
General
PPM
ADC
UART
Nunchuk
Nrf
Data Analysis
Realtime Data
Sampled Data
VESC Terminal
Debug Console
VESC Tool Settings
Motor Setup Wizard
FOC Settings
Run detection and get the required parameters for FOC.
The motor will spin up! Take any preparations necessary.
Motor Resistance (R) 15,0 mΩ
Motor Inductance (L) 7,00 µH
Motor Flux Linkage
Current KP
Current KI
Warning
Warning: This is going to spin up the motor. Make sure that nothing is in the way.
Read text and click OK
OK
Cancel
Detect and Calcul
Apply
I: 5,00 A
D: 0,50
ω: 150,0 ERPM
← For λ
R: 69,45 mΩ
L: 40,79 µH
λ: 0,000 mWb
← Param
T: 1000,0 µS
KP: 0,0408
KI: 69,45
← Calc
Observer Gain (x1M): 0,00
← Calc
< Back
Next >
Cancel
To get started,
you can connect to your VESC in the
ally.
RL
λ
Apply
Connect
Motor Setup Wizard [MOTOR]
Input Setup Wizard [APP]
D 0,20
ω 5000 RPM
IB 3,00 A
I 3,00 A
P 0,00 °
HB 3,00 A
STOP
Duty
0.0 %
Current
0.00 A
Connected (serial) to COM10

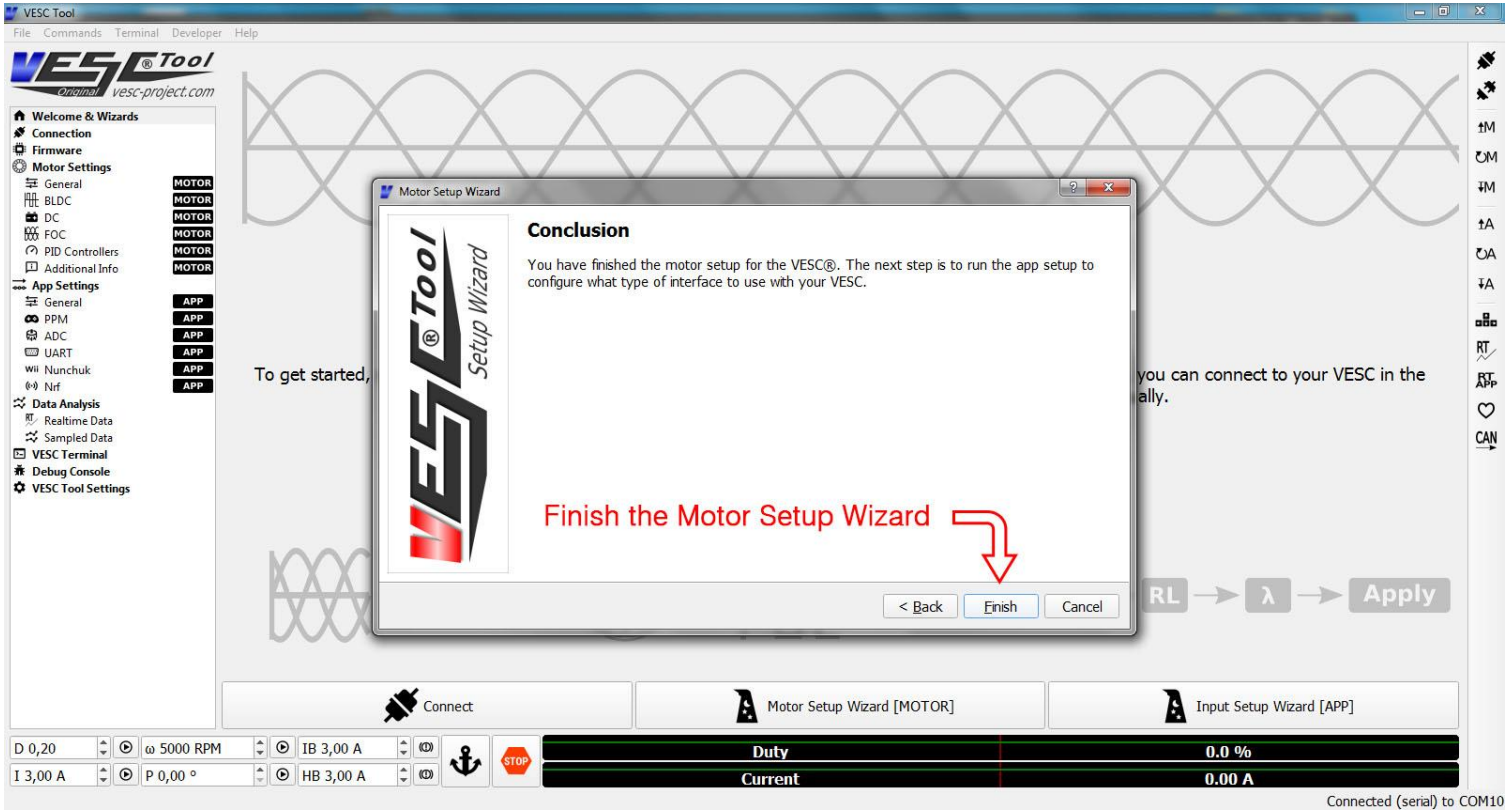

VESC Tool
File Commands Terminal Developer Help
Welcome & Wizards
Connection
Firmware
Motor Settings
General
BLDC
DC
FOC
PID Controllers
Additional Info
App Settings
General
PPM
ADC
UART
Nunchuk
Nrf
Data Analysis
Realtime Data
Sampled Data
VESC Terminal
Debug Console
VESC Tool Settings
Motor Setup Wizard
FOC Settings
Run detection and get the required parameters for FOC.
Motor Resistance (R) 15,0 mΩ
Motor Inductance (L) 7,00 µH
Motor Flux Linkage (λ) 2,450 mWb
Current KP 0,0300
Current KI 50,00
Detect and Calculate Parameters
RL
λ
Apply
Calculate and apply all parameters
I: 5,00 A
D: 0,50
ω: 150,0 ERPM
R: 69,45 mΩ
L: 40,79 µH
λ: 6,589 mWb
← Param
T: 1000,0 µS
KP: 0,0408
KI: 69,45
← Calc
Observer Gain (x1M): 23,03
< Back
Next >
Cancel
To get started,
you can connect to your VESC in the
ally.
Step 1: Apply measured values
All values must be green!
Step 2: click Next
Connect
Motor Setup Wizard [MOTOR]
Input Setup Wizard [APP]
D 0,20
ω 5000 RPM
IB 3,00 A
I 3,00 A
P 0,00 °
HB 3,00 A
Duty 0.0 %
Current 0.00 A
Connected (serial) to COM10



Make sure that your motor can rotate freely, since the motor will start to turn slowly now.


VESC Tool
File Commands Terminal Developer Help
vesc-project.com
Welcome & Wizards
Connection
Firmware
Motor Settings
General
BLDC
DC
FOC
PID Controllers
Additional Info
App Settings
General
PPM
ADC
UART
Nunchuk
Nrf
Data Analysis
Realtime Data
Sampled Data
VESC Terminal
Debug Console
VESC Tool Settings
Motor Setup Wizard
FOC Hall Sensor Settings
Detect and set the required settings for running FOC with hall sensors.
Sensorless ERPM 2500,00
Hall Table [0] 255
Hall Table [1] 255
Hall Table [2] 255
Hall Table [3] 255
Hall Table [4] 255
Hall Table [5] 255
Detect FOC Hall Sensor Parameters
This is going to turn the motor slowly. Make sure that nothing is in the way.
OK
Cancel
read text, click OK
Detect Hall Sensors
I: 10,00 A
Apply
< Back
Next >
Cancel
To get started,
you can connect to your VESC in the
ally.
RL
λ
Apply
Connect
Motor Setup Wizard [MOTOR]
Input Setup Wizard [APP]
D 0,20
ω 5000 RPM
IB 3,00 A
I 3,00 A
P 0,00 °
HB 3,00 A
STOP
Duty
0.0 %
Current
0.00 A
Connected (serial) to COM10


VESC Tool
File Commands Terminal Developer Help
Welcome & Wizards
Connection
Firmware
Motor Settings
General
BLDC
DC
FOC
PID Controllers
Additional Info
App Settings
General
PPM
ADC
UART
Nunchuk
Nrf
Data Analysis
Realtime Data
Sampled Data
VESC Terminal
Debug Console
VESC Tool Settings
Motor Setup Wizard
FOC Hall Sensor Settings
Detect and set the required settings for running FOC with hall sensors.
Sensorless ERPM 2500,00
Hall Table [0] 255
Hall Table [1] 75
Hall Table [2] 140
Hall Table [3] 106
Hall Table [4] 6
Hall Table [5] 41
Detect Hall Sensors
I: 10,00 A
Apply
Apply detection result
255 75 140 106 6 41 174 255
< Back
Next >
Cancel
To get started,
you can connect to your VESC in the
ally.
Step 1:
Apply measured values
RL
λ
Apply
Step 2: click Next
Connect
Motor Setup Wizard [MOTOR]
Input Setup Wizard [APP]
D 0,20
ω 5000 RPM
IB 3,00 A
I 3,00 A
P 0,00 °
HB 3,00 A
STOP
Duty
0.0 %
Current
0.00 A
Connected (serial) to COM10



Congratulations, you have finished the Motor Setup Wizard.

Please continue with the Input Setup Wizard.