MAYTECH VESC Manual V1.1

Ⅰ DISCLAIMER

1.1 Most of the content comes from the Internet. The content is collected and edited and filled by MAYTECH. MAYTECH is not the owner of copyright and disclaims the content will meet all of your requirement. The manual can be spread by users with no restriction. This manual is for reference only if you use the VESCs not from MAYTECH.

1.2 MAYTECH manufactures VESCs according to the OBM from http://vedder.se/ genuinely, even though the VESC hardware and firmware are the open source. MAYTECH does not change the electrical schematic diagram and PCB wiring and components version and the source codes. However, MAYTECH can not guarantee that there are not bugs in the official open source hardware & firmware. We suggest that the users make tests before using the products.

1.3 The high powered electric models, electric skateboards, electric bicycles, electric motorcycles and electric scooters are with risk. Please take a careful look at the manual. MAYTECH have no control over the use, installation, application, or maintenance of these products, thus no liability shall be assumed nor accepted for any damages, losses of costs resulting from the use of this item. Any claims arising from the operating, failure or malfunctioning etc. will be denied. We assume no liability for personal injury, property damage or consequential damages resulting from our product or our workmanship. As far as is legally permitted, the obligation for compensation is limited to the invoice amount of the product in question.

Ⅱ. FEATURES

◆ The hardware and software is open source. Since there are plenty of CPU-resources left, the customization possibilities are almost endless.

◆ STM32F4　32Bit ARM microcontroller.

◆ DRV8302 MOSFET driver / buck converter / current shunt amplifier.

◆ IRFS7530 MOEFETs.

◆ 5V 1.5A output for external electronics from the buck converter integrated on the DRV8302.

◆ Voltage: 8V – 60V (3s to 12s LiPo).

◆ Current: Up to 240A for a couple of seconds or about 50A continuous depending on the temperature and air circulation around the PCB.

◆ Firmware based on ChibiOS real time OS.

◆ PCB size: slightly less than 40mm x 60mm.

◆ Current and voltage measurement on all phases.

◆ Regenerative braking.

◆ DC motors are also supported.

◆ Sensored or sensorless operation.

◆ A GUI with lots of configuration parameters.

◆ Adaptive PWM frequency to get as good ADC measurements as possible.

◆ RPM-based phase advance (or timing/field weakening).

◆ Good start-up torque in the sensorless mode (and obviously in the sensored mode as well).

◆ The motor is used as a tachometer, which is good for odometry on modified RC cars.

◆ Duty-cycle control, speed control or current control.

◆ Seamless 4-quadrant operation.

◆ Interface to control the motor: PPM signal (RC servo), analog, UART, I2C, USB or CAN-bus.

◆ Wireless WII nunchuk (Nyko Kama) control through the I2C port. This is convenient for electric skateboards.

◆ Consumed and regenerated amp-hour and watt-hour counting.

◆ Optional PPM signal output. Useful when e.g. controlling an RC car from a Raspberry Pi or an android device.

◆ The USB port uses the modem profile, so an Android device can be connected to the motor controller without rooting. Because of the servo output, the odometry and the extra ADC inputs (that can be used for sensors), this is perfect for modifying an RC car to be controlled from Android (or Raspberry Pi).

◆ 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 input)

    Rapid duty cycle changes (ramping)

    High RPM (separate limits for each direction)

◆ When the current limits are hit, a soft back-off strategy is used while the motor keeps running. If the current becomes way too high, the motor is switched off completely.

◆ The RPM limit also has a soft back-off strategy.

◆ Commutation works perfectly even when the speed of the motor changes rapidly. This is due to the fact that the magnetic flux is integrated after the zero crossing instead of adding a delay based on the previous speed.

◆ When the motor is rotating while the controller is off, the commutations and the direction are tracked. The duty-cycle to get the same speed is also calculated. This is to get a smooth start when the motor is already spinning.

◆ All of the hardware is ready for sensorless field-oriented control (FOC). Writing the software is the remaining part. However, Many user not sure if FOC will have many benefits for low inductance high-speed motors besides running a bit quieter.

◆ Added acrylic conformal coating protects the VESC against moisture, dirt, dust, thermal shocks, and scratches that could corrode, short circuit, or otherwise damage the VESC. It also insulates against high-voltage arcing, shorts, and static discharges.

Ⅲ. SOME NOTES BEFORE USING VESC

3.1 Both DC motors and BLDC motors can work with VESCs.

3.2 Please make sure your motors current/voltage is under VESC control. The VESC current/voltage range is 8-60V 50A continuous current.

3.3 The VESCs can work with the sensored motors and motors with encoders and sensorless motors.

3.4 Please check your speed signal type. The VESCs can accept such signals:

3.4.1 PPW: It is called PWM in RC industry.

3.4.2 ADC: It is called Voltage Signal in E-bike industry.

3.4.3 I2C: WII Remote Kama dongle.

3.4.4 UART: Mobile Bluetooth Adapter.

Moreover, you can use the USB or Can Bus to control the speed.

3.5 Please make sure if the power supply is from the batteries or the power adapters.

3.5.1 If the batteries are used, the Max. Discharge current must be higher than the motors Max. Current.

3.5.2 If the power adapters are used, we give you some advice:

3.5.2.1 Please use the linear adapter, not the switch adapter.

3.5.2.2 Please turn the breaking off, or the power adapter will be damaged, because the VESC outputs high voltage when regenerative braking occurs.

3.6 Download the APP or software "BLDC TOOLS" to your smart phones or computers. It is the GUI to adjust the VESC parameters.

3.6.1 Please make sure that the "BLDC TOOLS" version is same with the VESC hardware.

3.6.2 MAYTECH only offers the "BLDC TOOLS" for Windows OS. For Android or Linux or Mac OS, the users should compile it themselves, or download it from other websites.

3.7 The GUI screen shots and parameters are obtained from these platforms:

MTVESC50A VESC: Firmware version 2.18; Hardware Version 4.12;

BLDC TOOLS for Windows OS;

MTO6374 Motor KV 190，with Hall Sensor;

MTSKR1512Wirelss remote controller：1ms-2ms PPM

3.8 The VESC MTVESC50A default setting:

3.8.1 BLDC senslorless mode

3.8.2 The speed signal is 1ms-2ms PPM. The motor starts one-way rotating when the pulse width is above 1.5ms. The Maximum speed is 2ms. The braking range is 1-1.5ms.

Ⅳ. POWER WIRES CONNECTION:

The VESC can be connected to the motor by soldering directly or with high quality connectors. Always use new connectors, which should be soldered carefully to the cables and insulated with heat-shrink tube. The maximum length of the battery pack wires shall be within 6 inches.

◆ Solder appropriate connectors to the battery wires.
◆ Insulate all soldering connectors with heat shrink tubes.
◆ Connect ESC to the motor wires.
◆ Controller Red and Black wires connects to battery pack Red and Black wires respectively.

Note：If the battery voltage is higher than 30V, there will be spark when the VESCs are connected with the batteries. So the XT60/XT90 anti-spark connectors are recommended.

Ⅴ. HOW TO USE A NEW VESC?

MTVESC50A VESCs default setting can make most BLDC motors work. Considering the safety, please connect the VESC with the PC first to check the parameters and make motor auto-detect.

5.1 Connect the VESCs to the motors and batteries.

The motors should be no-loaded. Connect the VESC to the PC via the USB cable when the VESC's red light turns off.

5.2 If it is the first time to connect the VESC with the PC, Windows will give you a reminder that the new hardware was found. Then Windows will install the the driver automatically. It will not install the driver again if Windows has installed it before.

5.3 The new added COM Port will be found in the Window Device Manager. It can be showed like this, COMX. The "X" can be different numbers.

5.4 Open BLDC Tools and choose the COMX, then click "connect". It shows green at the lower right corner when the connection successes.

Serial Connection

COM4

Connect

VESC Firmware Version 2.18 *Picture 5.4*

5.5 Choose Motor Configuration >> Motor and click Read Configuration. It will read the VESC settings and check if the parameters are same with the below picture. If it is not same, please revise the parameters, then click Write Configuration to download the new parameters.
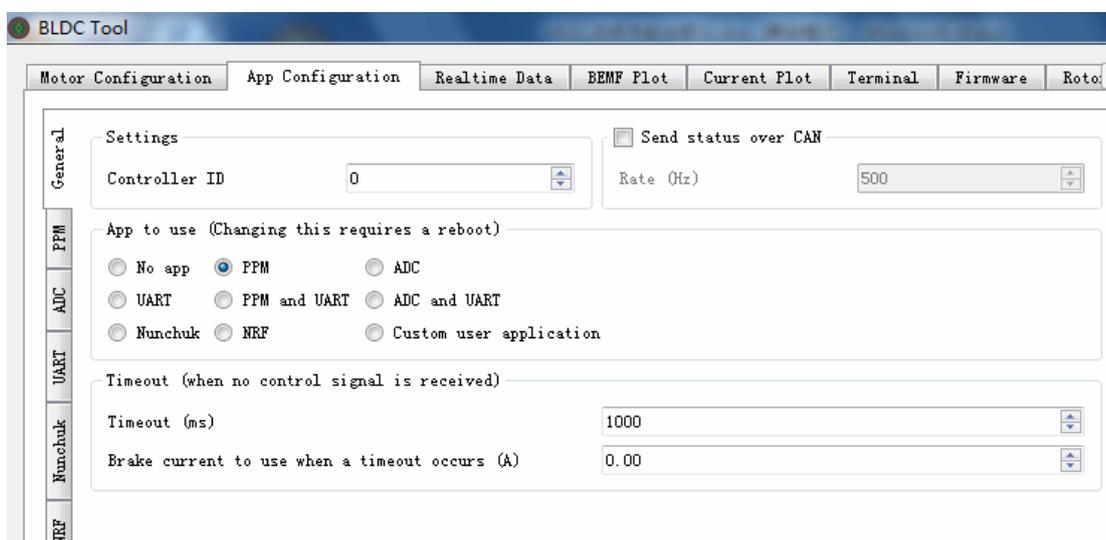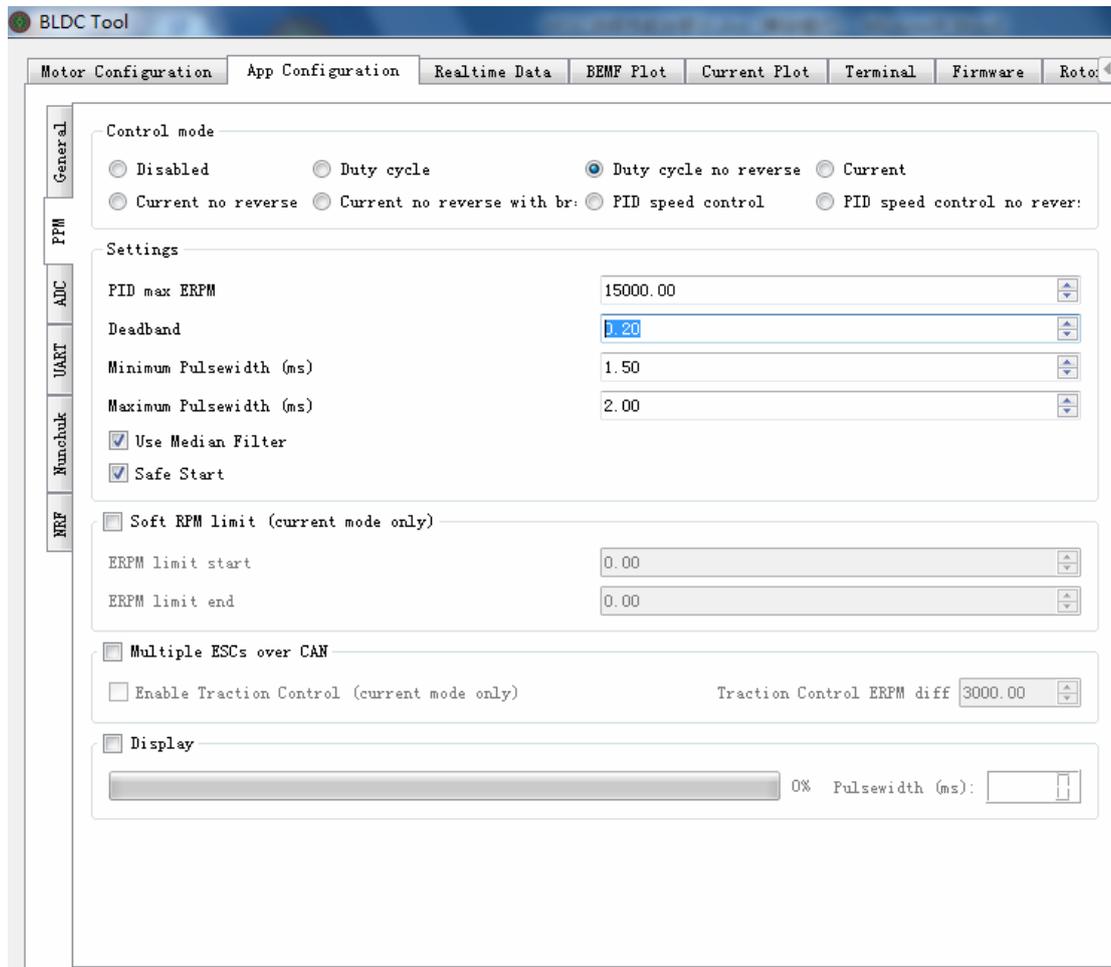
Picture 5.5
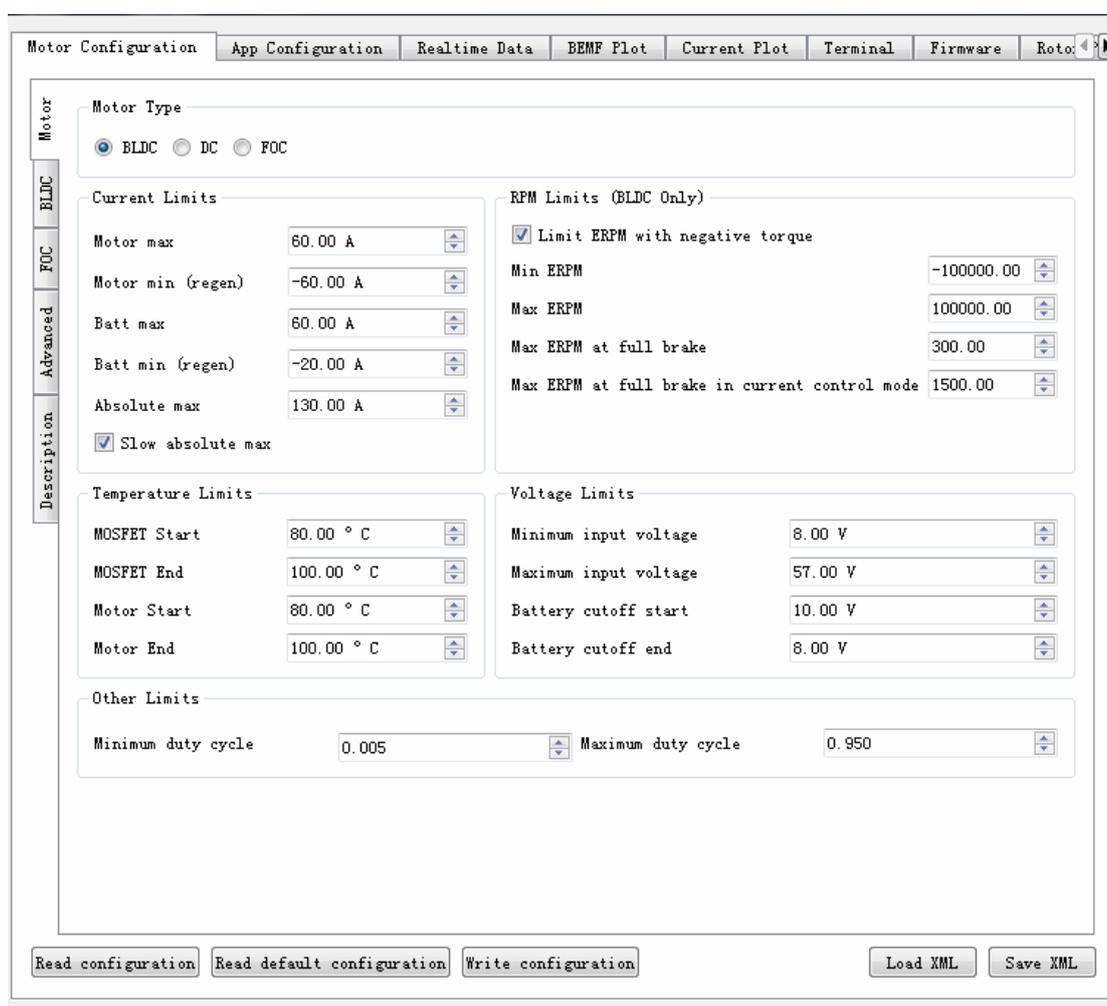
5.6 Choose Motor Configuration >> BLDC and click Read Configuration. It will read the VESC settings and check if "Motor Type" is BLDC. Then click Start detection. The motor will rotate 3 seconds suddenly. Many parameters will be detected after the motor stops. Then click "Apply" to apply these parameters.   If the motors does not rotate, it might be the connection problem with VESCs and motors, or the default setting is not suitable for the motor. In this case, please check the connection with VESCs and motors, or adjust the start-up current and the minimum rotate speed manually. Click Write Configuration to download parameters after the Motor detection is finished correctly.
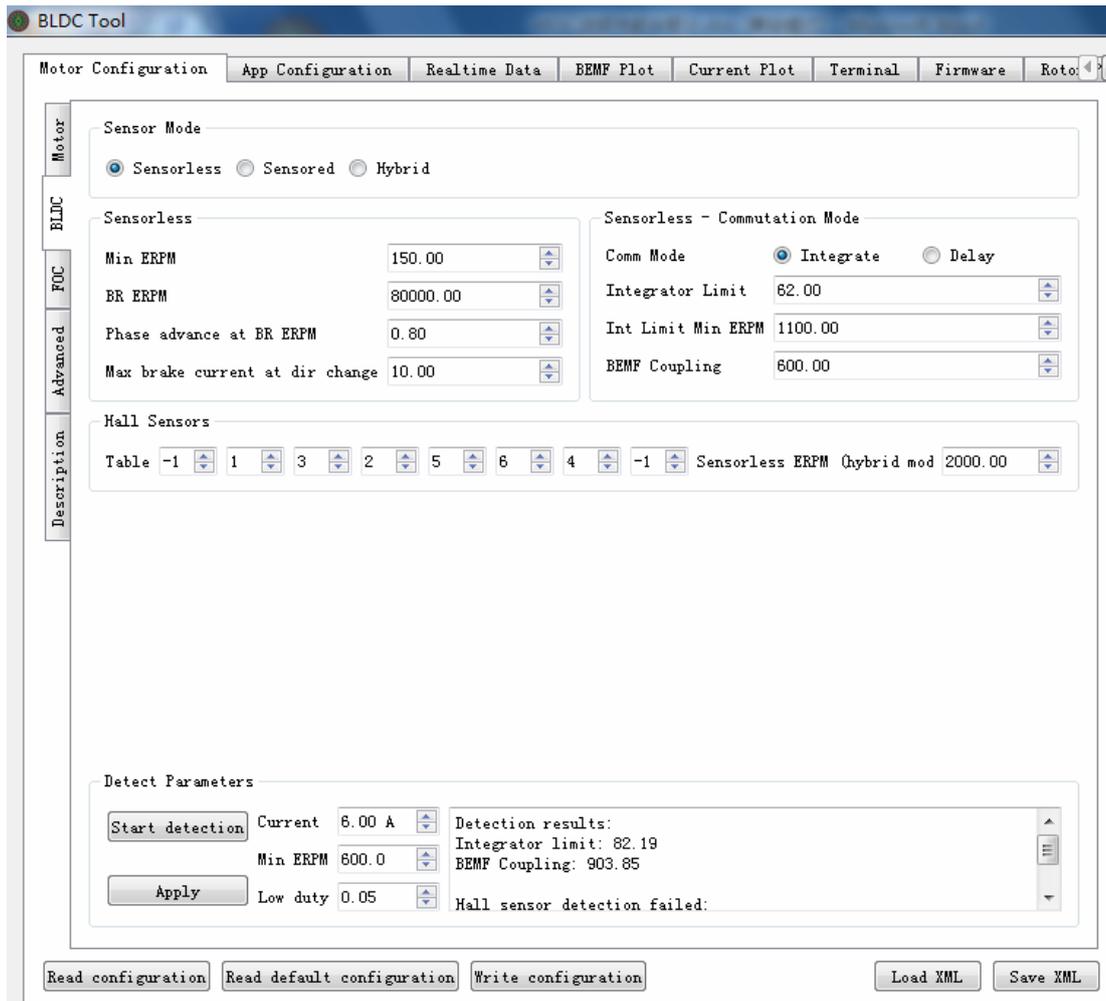
Picture 5.6

5.7 Choose App Configuration >> General and click Read Configuration. It will read the VESC settings and check if the parameters are same with the below picture. If it is not same, please revise the parameters, then click Write Configuration to download the new parameters. If the "APP to use" is revised, the parameters will be valid after the VESCs are re-started.

Picture 5.7

5.8 Choose App Configuration >> PPM and click Read Configuration. If it is not same, please revise the parameters, then click Write Configuration to download the new parameters.

Picture 5.8

5.9 Connect the servo signal cable to the receiver and turn on the remote controller. Click Display, you will see that the VESCs have received the remote signal.

Picture 5.9

5.10 Push the remote joystick to high position and the motors rotate. Pull the joystick to the lowest position and the motors break.

At this moment, it proves that your VESCs and relative equipment are all good. You can continue to adjust other parameters.

Ⅵ. ADJUST VESC PARAMETERS

6.1 Motor Configuration

6.1.1 Motor
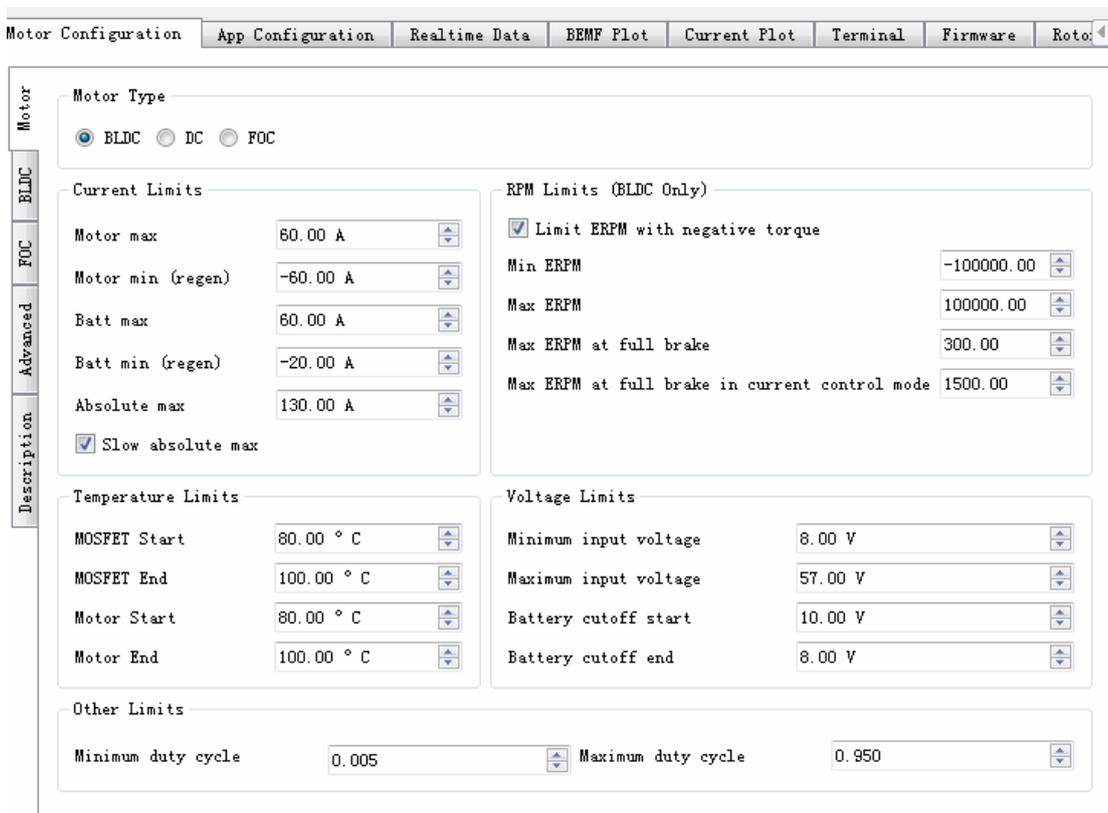
Picture 6.1.1

6.1.1.1 Motor Type: BLDC/DC/FOC

BLDC: Brushless Direct Current motor; Adjust speed via PWM

DC: Direct Current Motor; Adjust speed via PWM

FOC: Field-Oriented Control, is also called vector control and suitable for hub motors.

6.1.1.2 Current Limits:

Current Limits: The "Error" occurs and the red light flashes when the current exceeds the limits. The VESC will stop to output the signal. The negative sign means the reverse direction.

6.1.1.3 RPM Limits (BLDC Only) PWM:

Limit ERPM with negative torque :The power generation mode will be activated with high RPM.

Note: ERPM= RMP*Pole/2

6.1.1.4 Temperature:

Please add NTC resistors to the motor if you want to get the accurate temperature of motors. Connect the motor with VESC via the hall sensor cable.

6.1.1.5 Voltage Limits: The limiting value for the voltage.

Set the voltage limits of batteries to protect the battery and VESC.

6.1.1.6 Other Limits: Duty Ratio limits under BLDC PWM mode.

It can restrict the Min. & Max. of RPM.*2*

6.1.2 BLDC
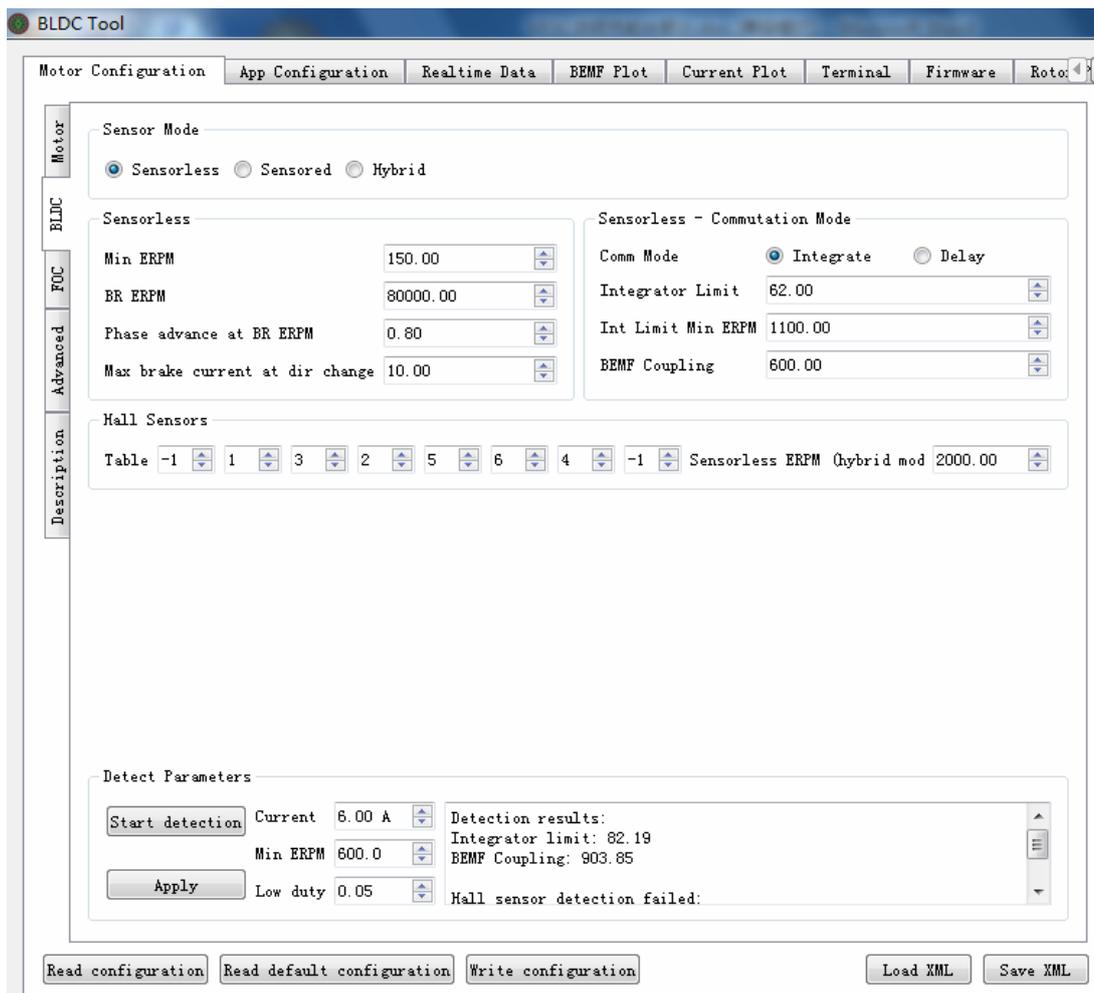
Picture 6.1.2

6.1.2.1 Sensor Mode: Sensorless / Sensored /Hybrid

Start up with senor mode and switch to sensorless mode with a certain RPM. It is called Hybrid Mode.According to feedback signals from Sensor & Sensorless mode, VESC can measure the commutation time.

6.1.2.2 Sensorless:

Note: BR ERPM is the ideal Max. ERPM.

Note: Phase advance at BR ERPM is the phase advance the ideal Max. ERPM.

6.1.2.3 Sensorless Commutation Mode: Integrate/Delay

Integrate: The parameters of Integrator Limit/Int Limit Min ERPM/BEMF Coupling will be filled automatically with Detect Parameters. Click "Start detection" and "Apply". The parameters will be detected.

6.1.2.4 Hall Sensors:

The parameters of Table will filled automatically with Detect Parameters.

6.1.2.5 Detect Parameters:

Detecting parameters is very important when a new motor is used. Click "Start Detect" when the battery and VESC and motor are connected. The motor will rotate for 3 seconds to be detected. The parameters of Integrator limit / Int Limit Min ERPM / BEMF Coupling will be

obtained automatically after the detection. If the hall sensor is connected, the parameters of Hall Sensor Table will be detected as well.

Note: Please be careful when "Start Detect" starts up.

Note: If the motor doesn't work with "Start Detect" clicked, please check the connection. Meanwhile, please try to adjust Current/Min ERPM/Low duty.

Note: Please click "Apply" to save the parameters after the detection. The Click "Write configuration" to download the parameters to the VESC.

Note: When Sensored or Hybrid Mode, even though the Hall Sensor Table can be detected automatically, there is deviation with the hall sensor installation position. We suggest to adjust the phase sequence manually to figure out the combination with the lowest current.

6.1.3 FOC

FOC(Field Oriented Control) makes the motor more smooth and less noise and even saving much power, but not all motors support FOC, please confirm it with your motor vendor. The FOC control algorithm involves professional knowledge and terms. Please take a look first before configuration.

Please detect motor parameters first and ditect λ、R、L、CC(TC Kp Ki) if you use FOC. The Hall Sensor Table should be detected as well if the Hall or Encoderare used.
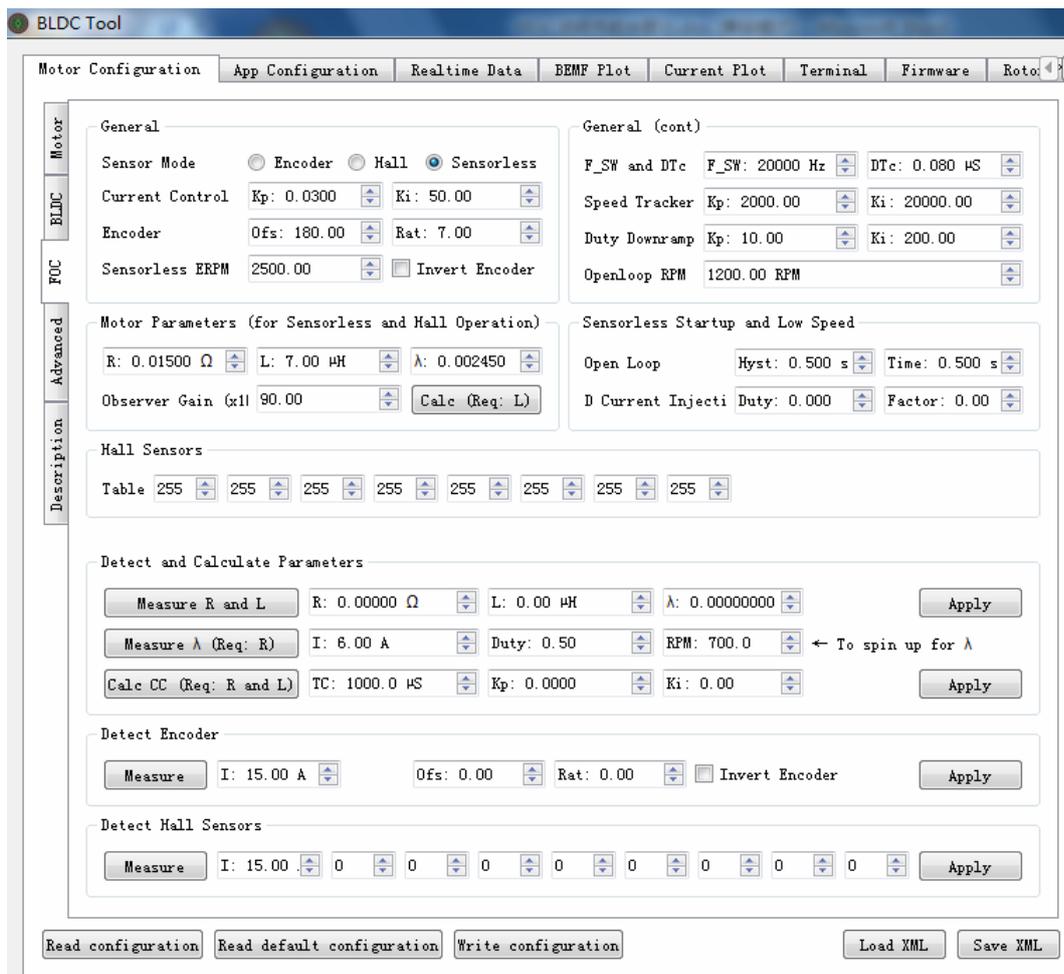
Picture 6.1.3

6.1.3.1 Click "Measure λ" when I / Duty / RPM are filled.

Picture 6.1.3.1-1

Click "Apply" after "λ" is detected. It will be filled in "Measure R and L" and "Motor Parameters".
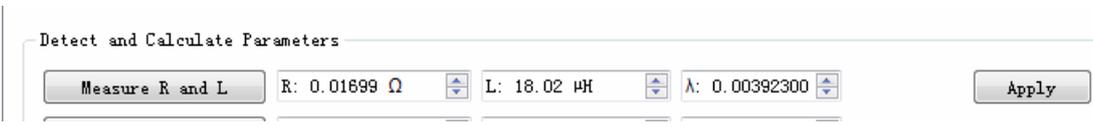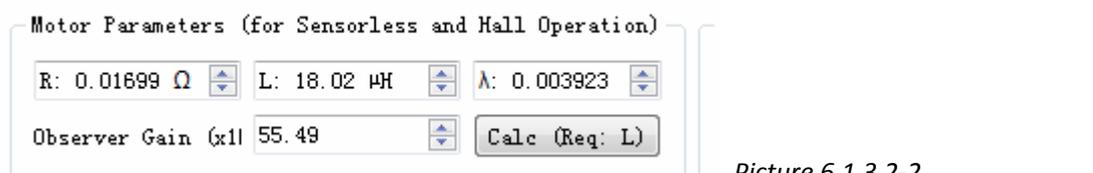

Picture 6.1.3.1-2
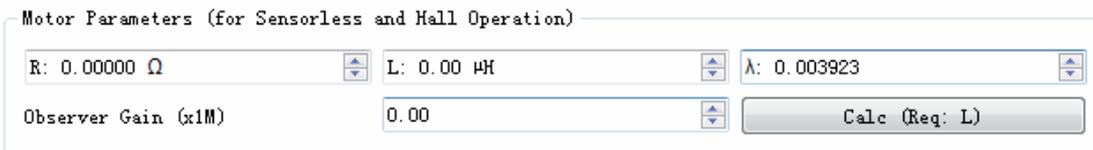
Picture 6.1.3.1-3

6.1.3.2

Click "Measure R and L" after "λ" is filled. The R & L parameters will be detected, then click "Apply".
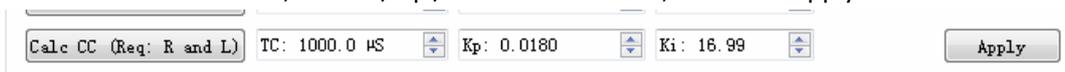
They will be filled into Motor Parameters automatically.

Picture 6.1.3.2-1

Picture 6.1.3.2-2

6.1.3.3

Click "Cale CC", and TC / Kp / Ki will be detected, then click Apply.

Picture 6.1.3.3

6.1.3.4 General

Current Control : P/I value under current control mode.

Encoder: Encoder parameters.

Sensorless ERPM: Sensorless mode will be activated when ERPM is higher than the value you set.

6.1.3.5 General(Cont) : General(Cont) Speed Counter setting.

F_SW and Dtc: Sampling frquency and Deadband time.

Speed track: P/I value of speed track.

Duty downramp: P/I value of Duty downramp.

Open RPM : The open-loop control is activated when the ERPM is higher than the value you set.

Motor Parameters (for Sensorless and Hall Operation)setting , please refer to 6.1.3.1-6.1.3.3

6.1.3.6 Sensorless Startup and Low Speed:

Open Loop: hysteresis and time

D Current Injection: D-axis is DC component axis in the stator and with the same direction of rotor field.

It can better detect the rotor position with current injection.

6.1.4 Advance

6.1.4.1 PWM mode (DC and BLDC only)

The PWM mode and Synchronous control is more stable than Bipolar control, but the response is slower. Nonsynchronous is not recommended.
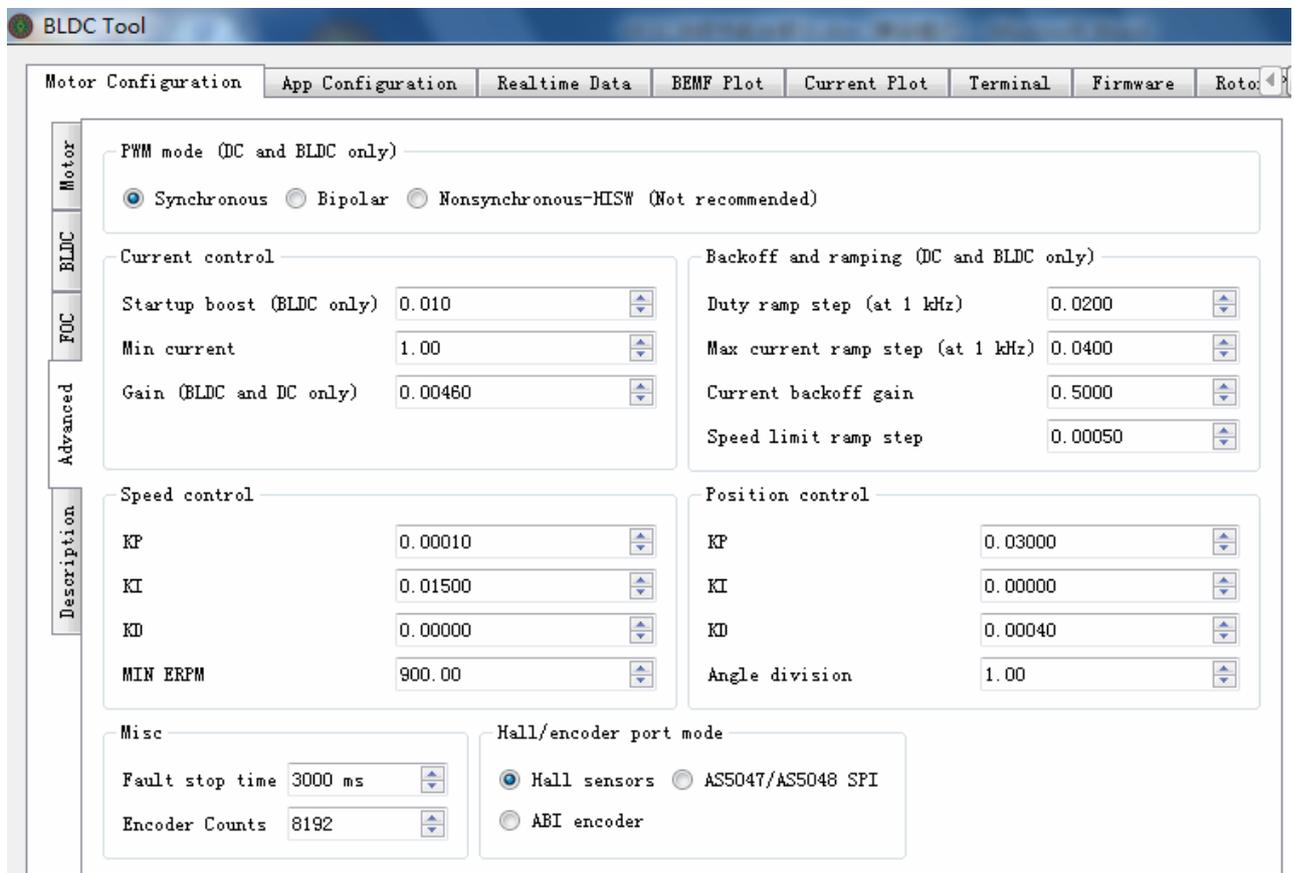
6.1.4.2 Current control

6.1.4.3 Backoff and ramping (DC and BLDC only) : Backoff and ramping parameters
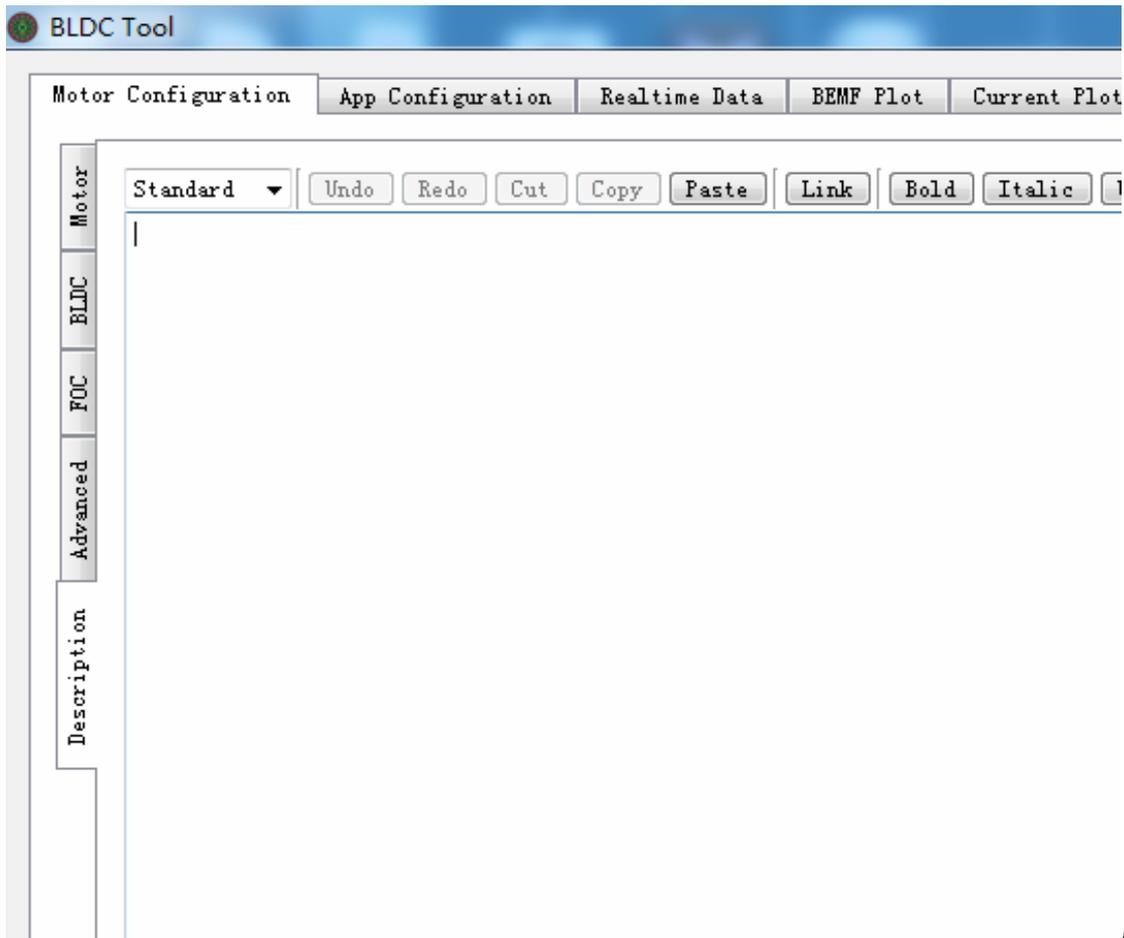
6.1.4.4 Speed Control

6.1.4.5 Position Control

6.1.4.6 Misc
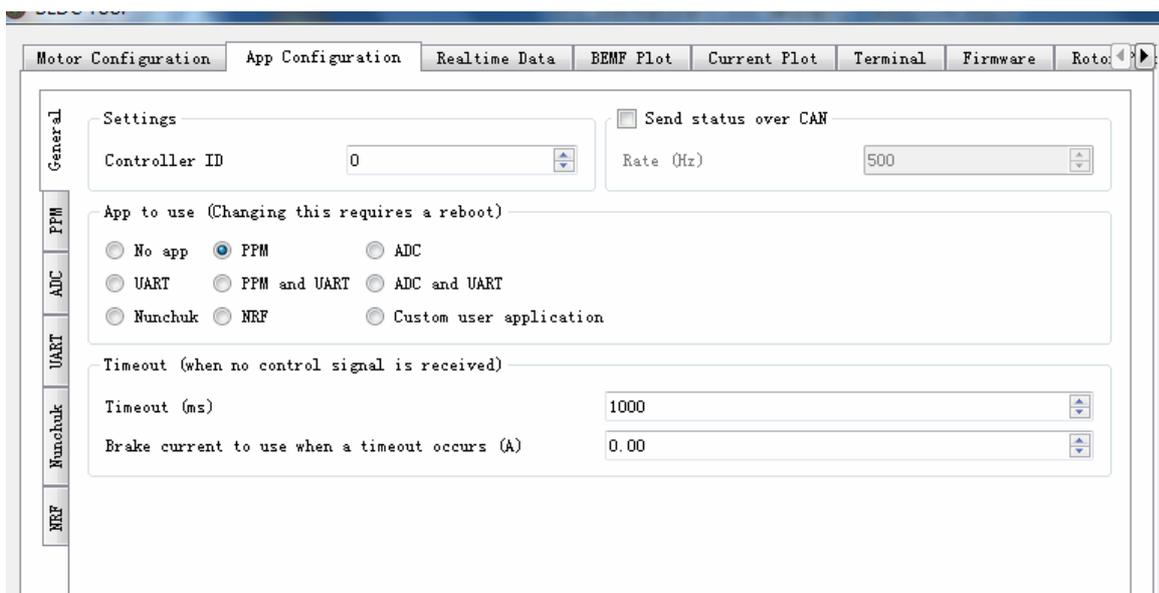
6.1.4.7 Hall/encoder Port mode

Picture 6.1.4

6.1.5 Description: Users can take notes here.

Picture 6.1.5

6.2 App Configuration : App Configuration input method

Picture 6.2

6.2.1 General

App to use is important parameters for the VESC.

Picture 6.2.1

Select the input signal source, and you can control VESC with corresponding signal. (Please refer to 3.4) Then click Write Configuration. It will work after the VESC is restarted.

6.2.2 PPM: RC Model receiver signal, as well as PWM signal, controls the signal input with servo cables.

Picture 6.2.2-1
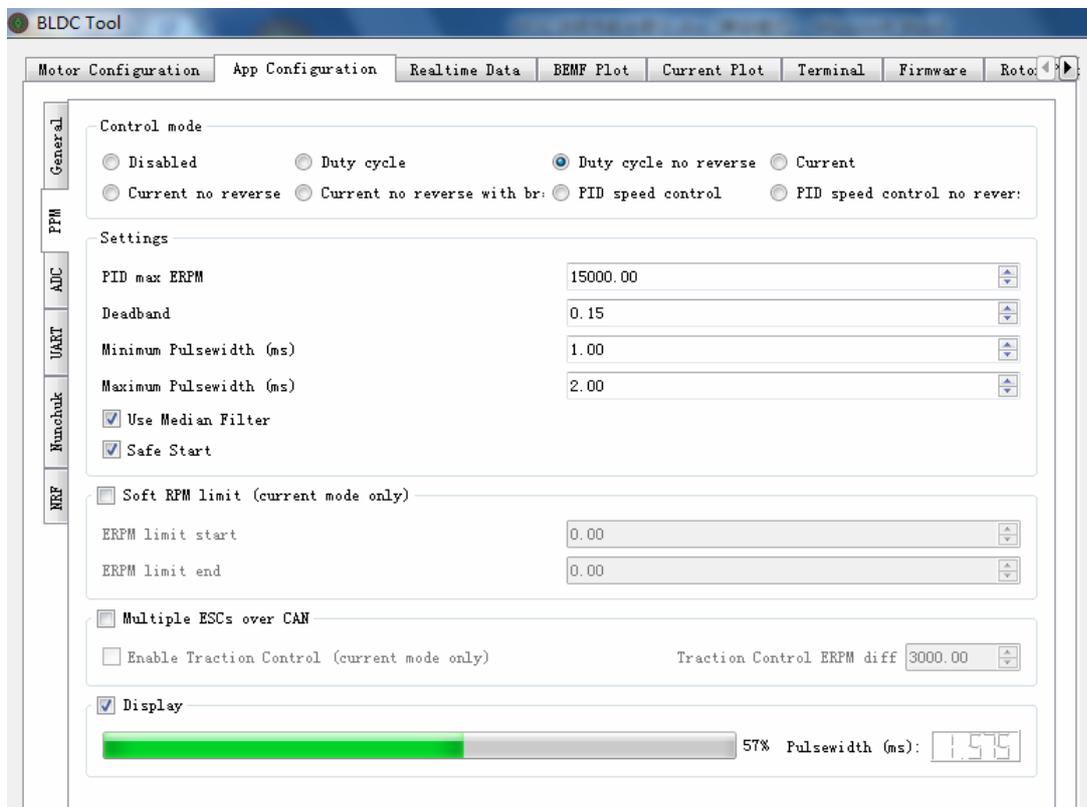
Picture 6.2.2-2

6.2.2.1 Control Mode:

Duty cycle / Duty cycle no reverse: Speed control

Current / Current no reverse / Current no reverse with Brake : Control the output current, and have the effect similar to torque control.

PID Speed control / PID Speed control no reverse: It is controlled by PID parameters when the speed changes. The PID parameters can be adjusted via "Motor Configuration--Speed Control".

6.2.2.2 Setting:

PID max ERPM: the maximum ERPM at "PID speed control/ PID speed control no reverse".

Deadband: It means the dead zone of receiver PPM with unit "ms". Please set it to 0.2ms when you use Maytech remote controller.

Minimum Pulsewidth (ms): The PPM signal pulse width with the lowest speed. Please set it to 1.5ms when you use Maytech remote controller.

Maximum Pulsewidth (ms): The PPM signal pulse width with the highest speed. Please keep the default setting (2.0ms) when you use Maytech remote controller.

User Median Filter: The filter can remove the interference of PPM signal.

Safe Start: Prevent the damage with sudden start-up.

*6.2.2.3* Soft RPM limit (current mode only) : To prevent danger from the high no-load speed.

6.2.2.4 Multiple ESCs over Can: To keep torques same when there are multiple ESCs working in harmony via Can Bus.

6.2.2.5 Display : To display the Duty of PPM signal

6.2.3 ADC: The voltage signal and control signal are input from ADC and ADC2 of the P3 Port. The ADC and ADC2 can input analog signal or switch signal.
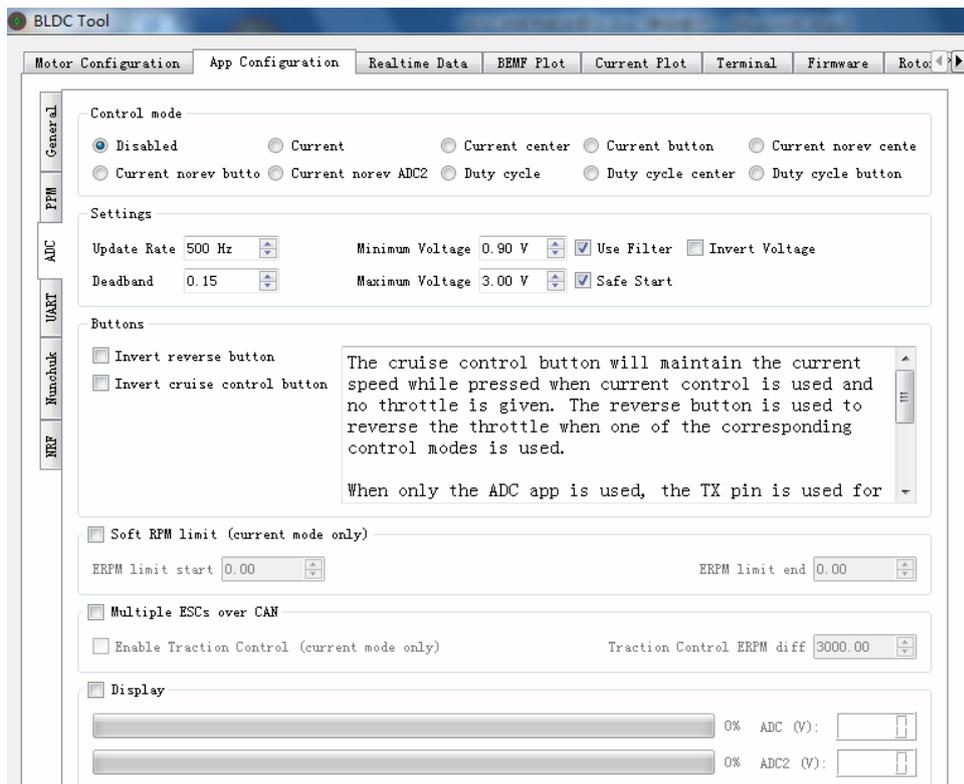
Picture 6.2.3-1
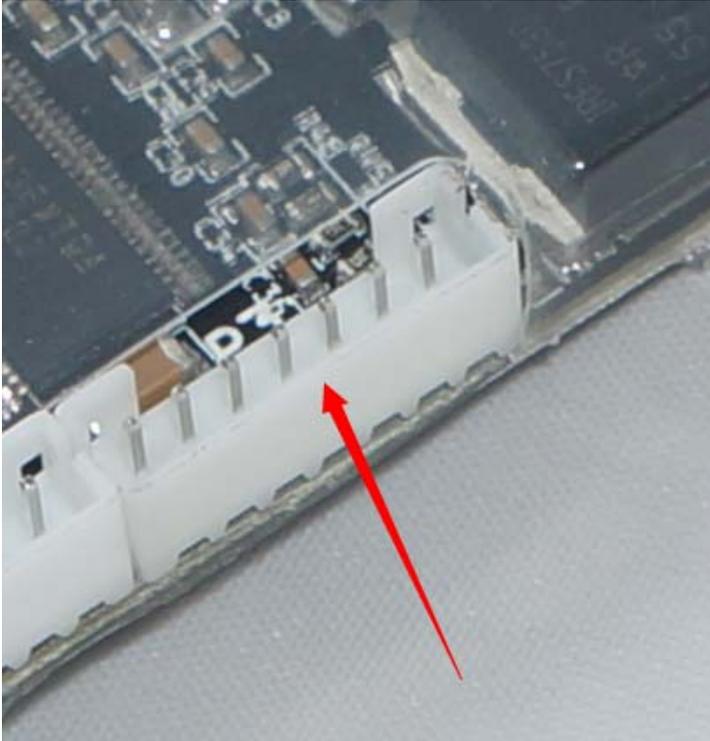
Picture 6.2.3-2

6.2.3.1 Control Mode:

Current / Current center / Current Button/ Current no rev center/Current no rev button/Current no rev ADC2 :Inputting the voltage analog via ADC or ADC2 can control the magnitude and direction of the current output. It seems like the effect caused by torque control.

Duty cycle/Duty cycle center/Duty cycle button : Inputting the voltage analog via ADC or ADC2 can control the value and direction of speed.

6.2.3.2 Setting:

Update Rate：ADC(transition of digital and analog) sampling frequency.

DeadBand：It means the dead zone of voltage. To avoid interference, it can be only recognized by VESCs when the voltage change range is larger than Deadband.

Minimum Voltage / Maximum Voltage : It means the minimum or maximum of input voltage signal.

6.2.3.3 Button:

Instructions of the "Button" in Current Button/Current no rev button/ Duty cycle button mode:
The cruise control button will maintain the current speed while pressed when current control is used and no throttle is given. The reverse button is used to reverse the throttle when one of the corresponding control modes is used.
When only the ADC app is used, the TX pin is used for the cruise control button and the RX pin is used for the reverse button. When the ADC and UART apps are used at the same time, the servo input will be used as the button. In this case it will be used for the reverse button when a control mode with button is selected, otherwise it will be used for the cruise control button.

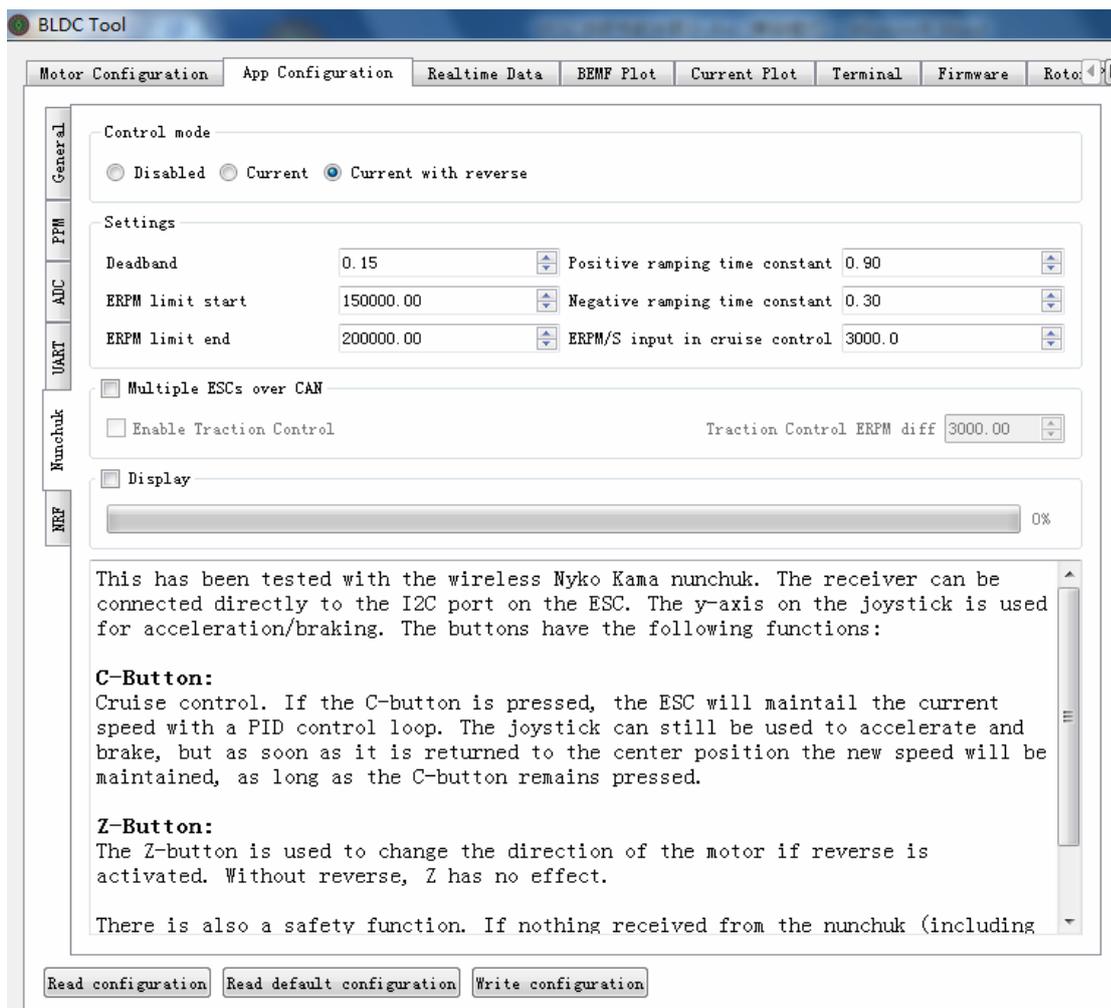*6.2.3.4* Soft RPM limit (current mode only): To prevent danger from the high no-load speed.

6.2.3.5 Multiple ESCs over Can: To keep torques same when there are multiple ESCs working in harmony via Can Bus.
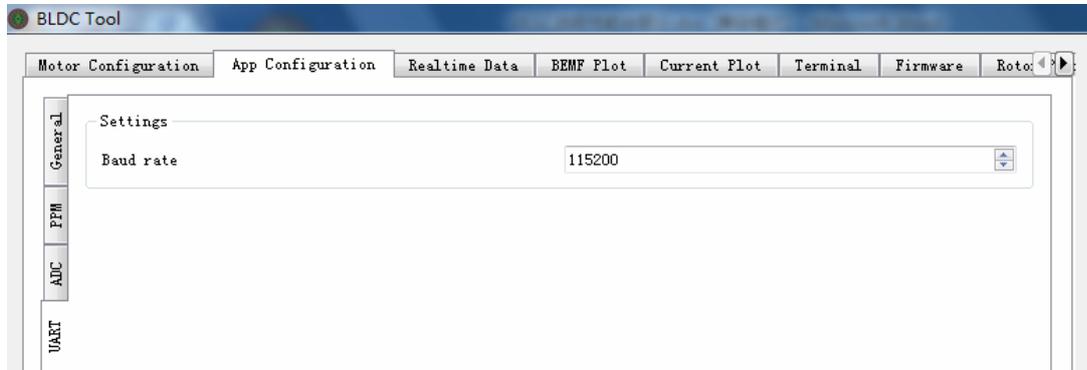
Picture 6.2.3.5

6.2.3.4 Setting：UART Port - Baud rate.

6.2.4 Numchuk：WII Numchuk -parameters of the remote controller

Picture 6.2.4

6.2.5 NRF: Parameters of the Bluetooth receiver.

6.2.6 GUI control

6.2.6.1 Contorl

In the condition of App Configuration, please set "Disabled" in PPM, ADC and Numchuk first. Then the interface will work.

Set the Duty value. Click "Duty" and the value is saved. The motor will rotate as the speed value you set.

Set the RPM value. Click "RPM" and the value is saved. The motor will rotate as the RPM value you set.

Set the Current value. Click "Current" and the value is saved. The motor will rotate as the Current value you set.

Set the Brake value. Click "Brake" and the value is saved. The motor will stop during rotating when you click "Brake".

Set the Position value. Click "Position" and value is saved . The motor will rotate as the Position value you set.

Note 1: The speed or current can not exceed the Max. Values of Motor Configuration.

Note2: If any function is activated, the motor will rotate until the next order is received. Click "Release Motor" and the motor stops.

6.2.6.2 Plot and Sample

This function is not tested yet and will be available in the near future.