FULCRUM BRUSHLESS ESC INSTRUCTIONS

www.hifei.com

Thanks for purchasing *Fulcrum* brushless speed controllers manufactured by HIFEI Technology Co., Ltd. *Fulcrum* series ESC are specifically developed to supply stable and strong power for R/C aircraft, which will beyond your expected.
Please read the instruction carefully before running.

Safety

⚠ Please keep the propeller away from your body and others all the time when the battery is connected.

⚠ It is suggested that you remove the propeller when you are working on the airplane with the battery connected.

⚠ It is suggested that you remover the pinion when you are working on a helicopter with the battery connected.

⚠ Please observe all local laws regarding the flying of remote control airplane.

⚠ Never fly over others or near crowds.

⚠ Before beginning flying, turn on the transmitter BEFORE powering on the receiver. When finish the running, power off the receiver BEFORE turning off the transmitter.

⚠ Never disconnect the battery pack while the brushless motor is running, as this could cause damage to the speed controller and/or motor. And such damage would not covered under manufacturer's WARRANTY.

Features of Fulcrum V2 ESC

- 32-bit Microprocessor with up to 80MHz frequency.
- 4-15S Lipo support
- Max continuous current 300A / 350A in full throttle • Active FreeWheeling optional
- Motor PWM frequency 8-32K Hz
- Throttle resolution up to 1uS
- Throttle signal refresh rate up to 1K Hz
- Integrated RPM sensor to simplify the wiring for external Governor
- Optimized the Governor Algorithm to ensure the head speed more stable
- Fully CNC aluminum housing to efficient the heat dissipation.
- Built-In data Logger (logging parameters: battery voltage/current/throttle output/ temperature/motor RPM)
- Combine with WiFi dongle (sold separately) to program setting the parameters of esc and telemetry the real-time flight data to any kind of smart cell phone
- Max RPM 240000 with 2 pole motor (Heli Mode: Max electric RPM 160000)

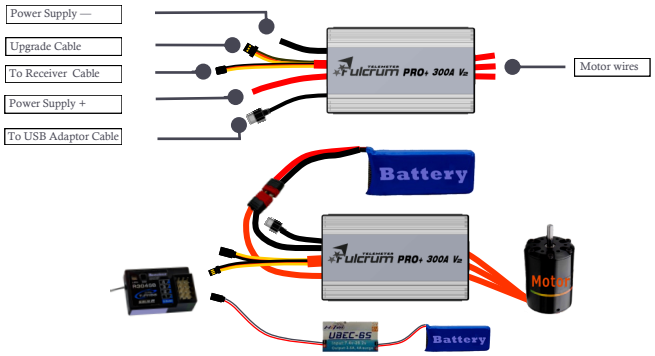
Specifications of Fulcrum V2 ESC

ESC	Voltage	Conti. Amp	Surge Amp (5s)*	BEC	Size(mm)	Weight (incl.wires)
Fulcrum pro 300A V2	4-15S Lipos	300amp	350amp	Couple-OPTO	119*73*26	400g

** Surge current could be reached under the condition of ESC in contact with 5mph airflow of 25℃ (77F) or cooler air at full throttle.*

Install your ESC

Please solder good quality connectors to ESC's motor wires and power wires before connect ESC to motor and battery. When connect power wires to battery, it is IMPORTANT to correctly connect positive to positive, and negative to negative. Swap any two motor wires' connecting can change the rotation direction.
In order to prevent and reduce any signal disturbance generated by ESC hardware, please install the ESC far away from receiver.



Note: we suggest you use Amass brand anti-spark connecotor when you run this esc.

***Step* ①:** Connect ESC to brushless motor;
Step ②: Connect receiver to the throttle channel of receiver;
Step ③: Connect receiver to ESC's receiver cable;
Step ④: Connect negative(-) cable of ESC to the negative of battery;
Step ⑤: Then connect positive **(+)** cable of ESC to the positive of battery.
Step ⑥: Power on the ESC, after two beeps ♪ ♪ ,it is ready to run.

Calibrate throttle of TX

Note: In the following 3 situations, it is required to calibrate the throttle range of transmitter.
-When it is the first time to use a new speed controller.
-When change a new TX or RX, or a set of new radio system.
-When upgrade the ESC into a new version of firmware.

Board Transmitter

1st: Connect ESC to motor, plug receiver lead of ESC to throttle channel of

2nd: Push joystick of transmitter to max throttle position, power on TX.

3rd: Power on receiver, connect ESC to battery. Motor emits three beeps in drop ♩♩♩ tones.

4th: Right after that, motor will emit two long beeps in flat tones, then pull joystick to zero immediately ♩♩

5th: Then motor emits two beeps in up tones. ♩♩ Calibrating is completed, it's ready to go.

Note:Fulcrum V2 ESC can not run in reverse. If throttle range were calibrated from reverse to neutral, the calibrating range will be invalid.

Parameters features

Fulcrum pro 300A ESC V2 is with default factory settings which are recommended for most applications. The programming options are provided for obtain optimum performance in different setup.

Low voltage cutoff

Option 1: Auto	**Option 2: 4s Lipo(default)**
Option 3: 5s Lipo	Option 4: 6s Lipo
Option 5: 7s Lipo	Option 6: 8s Lipo
Option 7: 9s Lipo	Option 8: 10s Lipo
Option 9: 11s Lipo	Option10: 12s Lipo
Option 11: 13s Lipo	Option12: 14s Lipo
Option 13: 15s Lipo	

⚠ ***Recommended to set LVC at exact Lipos series number for better protect Lipo packs from over-discharging. ONLY WHEN battery packs are fully charged, 'Auto' can detect Lipo cells number correctly and it is suggested under this condition.***

Lipo cell Cutoff Voltage

Option 1: 2.5v	Option 2: 2.6v
Option 3: 2.7v	Option 4: 2.8v
Option 5: 2.9v	**Option 6: 3.0v (default)**
Option 7: 3.1v	Option 8: 3.2v
Option 9: 3.3v	

Current Limiting

Option 1:	Low over-current threshold, will shut down rapidly
Option 2: Medium (default)	Moderate over-current threshold, will shut down after a slight delay. Recommended for inrunner motors.
Option 3: Low	High over-current threshold, will shut down after a slight delay,. Recommended for outrunner motors. Only experienced modelers should use this option.
Option 4: disabled	Current limiting detection disabled. Only experienced model-

** Default setting is recommended. If you change the setting, damage to the controller as a result of over current will be not covered by the manufacturer's warranty.*

Brake Type

Option 1: Disabled (default)	Brake disabled is mainly used for helicopters.
Option 2: Soft brake	Soft brake provides 50% of full braking power. General aircraft use, with fixed or folding prop
Option 3: Hard brake	Hard brake is 70% braking power. Direct drive applications where more braking power is required. Hard brake should only be used below 12V.

Timing Advance

Option 1: Low (0°~15°)	Recommended for lower pole count motors. Gives more power and slightly less efficient.
Option 2: middle (5 °~ 20 °)	Recommended for most motors .Gives a good balance of power and efficiency.
Option 3: High (15° ~ 30 °)	Recommended for most of higher pole count motors
Option4:Auto(default)	Recommended for most of all brushless motors.
Option 5: 0°; Option 6: 2°; Option 7: 4°; Option 8: 6°; Option 9: 8°; Option 10: 10°; Option 11: 12°; Option 12: 14°; Option 13: 16°; Option 14: 18°; Option 15: 20°; Option 16: 22°; Option 17: 24°; Option 18: 26°; Option 19: 28°; Option 20: 30°	

⚠ ***0° and 30° timings are for special motors. ONLY when motor manufacturer requests the special timings, they can be used.***

Cutoff types

Option 1 : Hard cutoff	When battery voltage reaches cut-off voltage the motor will shut-down immediately. Motor can be restarted by closing the throttle to the lowest position and then move the throttle as normal.
Option 2: Soft cutoff (default)	When battery voltage reaches cut-off voltage, the ESC will slowly reduce motor power to zero , you will notice a decrease in power and it is time to land, the throttle maintains its full linear.

Start types

Option 1:Soft start	Recommended for helicopters
Option 2: Standard start (default)	Recommended for most of the fixed or folding prop airplanes, and some helicopters.
Option 3: Fast start	Recommended for fastest startup.

PWM switching rate

Option 1: 8 KHz (default)	Recommended for most brushless motors
Option 2: 10KHz	Recommended for low inductance motors
Option 3: 12KHz	
Option 4: 16 KHz	Recommended for very low inductance motors
Option 5: 20 KHz	
Option 6: 24 KHz	
Option 7: 28 KHz	
Option 8: 32 KHz	

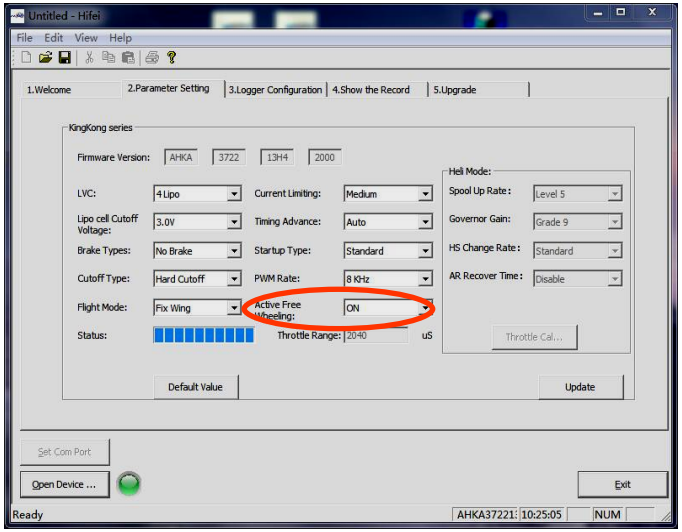
Fly Modes

Option 1: Fix Wing(default)	Recommended for fixed wing aircraft and EDF
Option 2: External Governor	ESC turn over the throttle signal to external FBL controllers such as VBar, Skookum,MB,BeastX etc
Option 3: Governor	ESC Internal Governor

Active FreeWheeling

Option 1: (default)	OFF
Option 2:	**ON (helicopter mode)**

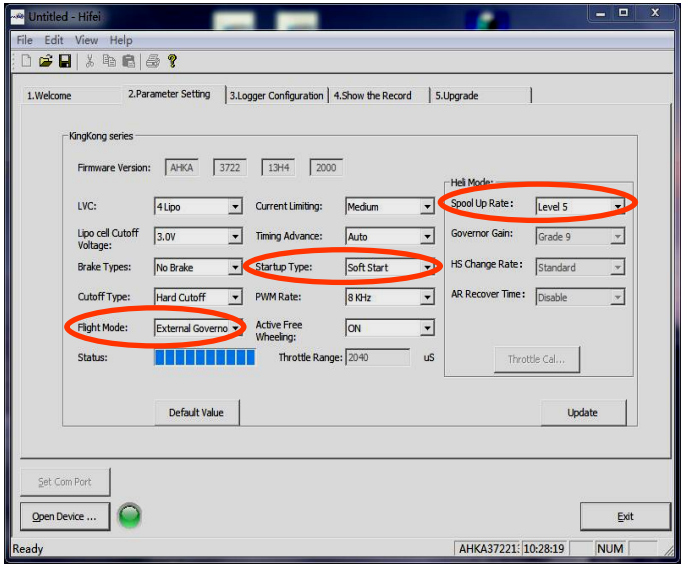
Active FreeWheeling comes in when, instead of running at partial throttle through the FET body diodes, as one FET switches off, the "freewheeling" diode switches on to allow the "freewheeling" current to flow through it instead of it's body diode. Since the resistance of the FET is much much lower than its body diode, so much less heat is dissipated. ESC's that are equipped with active freewheeling are able to operate over a wider range of throttle percentages due to the more optimized PWM algorithm that is used. This means that you can run lower head speeds without having to re-gear or worry about your ESC blowing up! ***We strongly recommend you to option Active Freewheeling 'On' as you option the Governor Mode*** ***(helicopter mode)***



There are two Governor Modes in Flight Mode, they are: **External Governor** and **Governor.**

External Governor

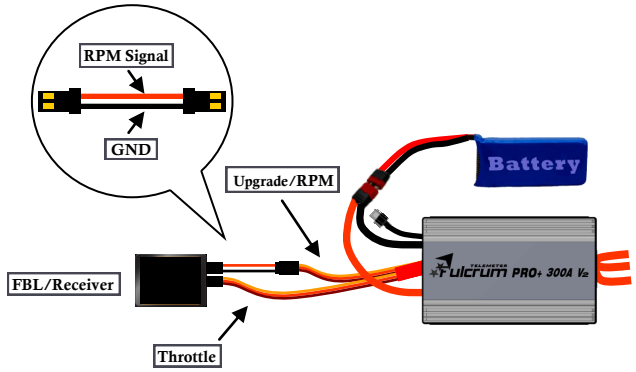
When you option this one, Fulcrum V2 ESC will act as an ESC without Governor function, ESC's governor function will be taken over to outside FBL system (such as Vbar/mini Vbar/ Skookum/MB/BeastX). in this case, the start type have to be set with 'soft start' and only one of Heli mode parameters can be option is: Spool Up Rate.(see the following screenshot).



RPM Sensor

Fulcrum III SHV has a built-in RPM sensor to provide the rpm signal to the third party devices such as Vbar/mini Vbar / Skookum/BeastX Plus, and the RPM signal specification as following:

RPM Signal Voltage: 3.3v
RPM Signal Duty Cycle : 50%
Internal Resistance: 510 Ohm



⚠ ***Please read instructions of Flybarless devices carefully and understand the specifications before connecting ESC RPM sensor cable to the devices.***

Governor

The Governor mode acts as an RPM control. Throttle stick position determines the RPM that the motor runs and the controller will attempt to hold that RPM regardless of load changes and battery voltage decreasing . Thanks to Active Freewheeling ,the motor RPM control could be available as long as the throttle level exceed 30%. In Governor Mode, the' brake' MUST always disable, 'Soft Cutoff' and 'Soft Start' MUST be optioned.

Note: we strong recommend to open the Active Freewheeling when Governor is option

Spool Up Rate

Spool Up Rate indicates the startup spool up rate, the default setting is Level 3, higher level numbers means to approach the head speed faster.

Governor Gain

The default setting of Governor Gain is grade 9, the higher grade number means the higher gain.

Head Speed Change Rate

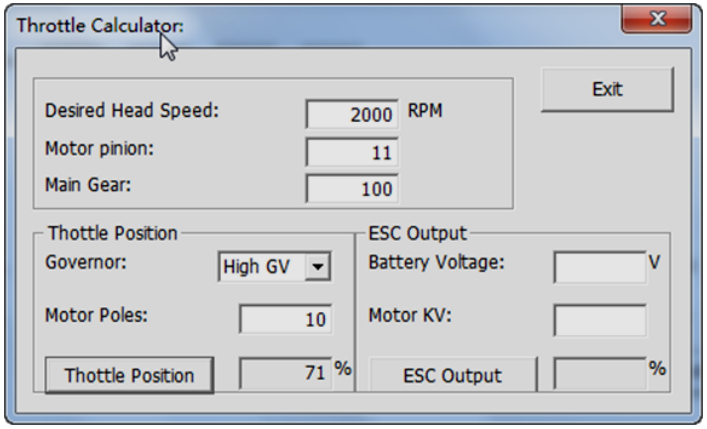
The default setting of Head Speed Change Rate is standard, this setting indicates the change rate between 2 different head speed switching (for example, throttle curve switch up from Normal to Idle1 or Idle1 to Idle2 ,vice versa). The "Head Speed Change Rate" value also determines the speed at which the head recovers.

AR Recover Time

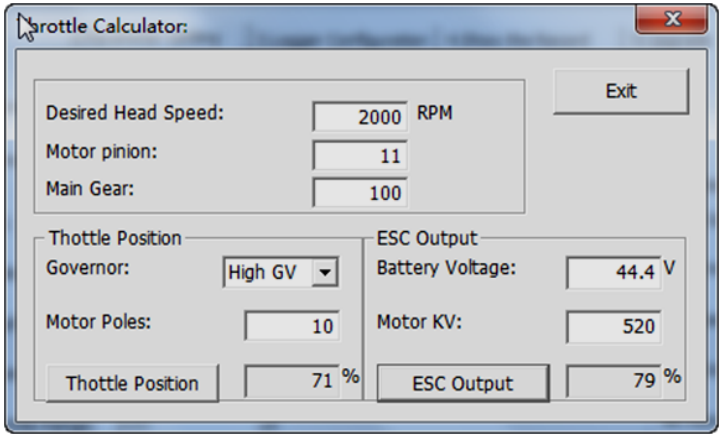
AR Recover Time is Autorotation Recover Time, it also can be understood as the recover time from Autorotation (TH=0) to Normal mode. The default setting is 'Disable', it indicates the AR is inactived. 10 to 60 Secs can be optioned to determine the recover time that Autorotation is actived, for example if you program the AR Recover Time to 30 secs, the AR will be available WITHIN 30 secs, in this period the motor can be ramped up to a preset head speed instead of soft startup, but more than this time (>30 seconds) will lead to the motor engaged with soft startup.

Throttle Calculator

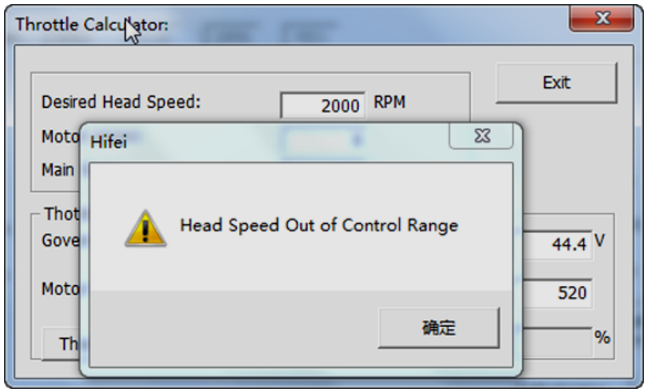
Throttle Calculator is a calculator to help you calculation the throttle curve according to your desired HS, Gear rate and motor poles. Please see the following screenshot:



Furthermore, fill out the battery voltage and motor KV can help you find out the ESC power output match with the pre-set head speed, HiFei recommends for optimum the ESC output to motor about 80% power, it ensure the ESC has enough reserve to compensate the battery voltage decreasing and load changing. Please see the following screenshot:



* Incorrect gear rate/motor KV probably results the ESC Output haven't enough reserve to compensate battery voltage decreasing and load change, in the case there is a tab pop out to indicate 'Head Speed Out of Control Range'. Generally you can Inc/Dec the tooth of motor pinion or Inc/Dec the Desired Head Speed to get the best match results. Please carefully check your heli configuration, make sure the desired heed speed is under control.



HiFei Software V6.01 operation

HiFei software V6.0 is specially for easy programming Fulcrum V2 ESC.
(Please download V6.0 from Hifei official website www.hifei.com)
What can be realized by V6.0?
Fully program Fulcrum V2 (incl. heli mode)
Upgrade firmware of Fulcrum V2
View logged data by Fulcrum V2

Computer OS request

- PC with Windows 7/8/10 operation system
- CD-ROM drive (or access to Internet)
- Available USB port
- 8 Megabytes hard disk space
- Computer screen resolution with 800X600, 1024X768*(recommended)* , 1280X1024

Hardware request

- Fulcrum V2 series ESC
- Hifei USB adaptor (it's a necessary adaptor to connect ESC to PC, purchase separately)

Install HiFei V6.01 to PC

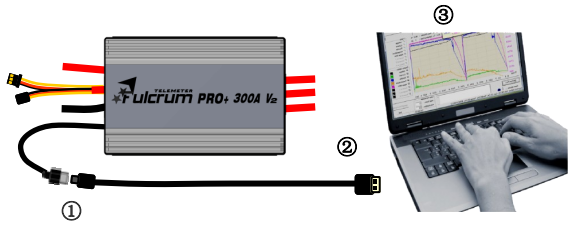
Download the V6.0 setup software from Hifei website and finish the installation according to the popped-up window guide.

⚠ ***If PC is 64 or 32 bit, when V6.0 1is completed installation, It is requested to back to directory folder of HiFei V6.01 and install driver of 64 or 32 bit by hand separately.***

⚠ ***If PC OS is Windows 7, We recommend you to installed V6.0 as administrator***

⚠ ***If you once changed PC font to big size, then it needs to change it to original size. Because big size font would possibly cause software interface cannot be showed in full.***

Connect ESC to PC



Step①: Correctly connect ESC's Wifi wire/to USB adaptor wire to USB adaptor
Step②:Plug the USB side of USB Linker to one of computer's USB ports
Step③:Run software "Hifei V6.01".

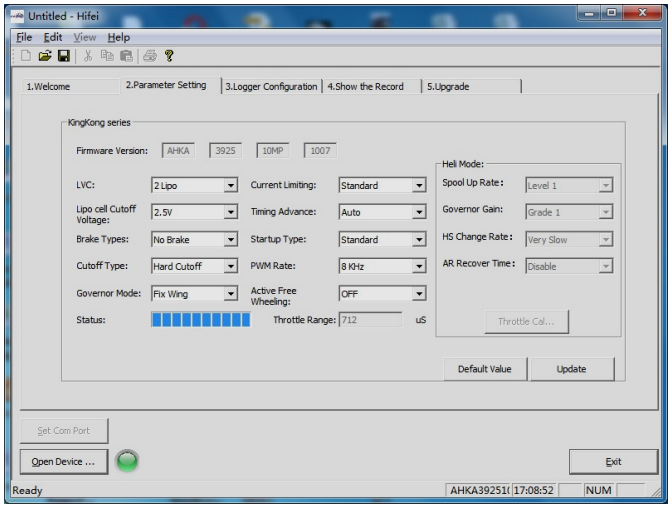
*** WARNING DO NOT USE STANDARD USB CABLE**

V6.01 tab 1 Welcome

- Open HiFei V6.01 by double clicking on the shortcut icon.
- Click on 'Open Device'.
**(If connection is right and successful, Fulcrum V2 ESC model will be displayed at the box below)*
- It's ready to use V6.0 for more operation

V6.01 tab 2 Parameter setting

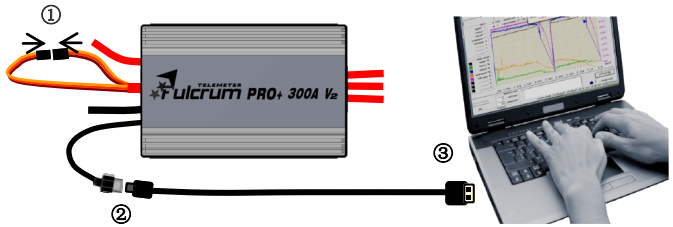
Click on tab 2 **Parameter Setting** to get into programming interface, select the options you want to change by down arrow, then click on **Update** to save the setting.



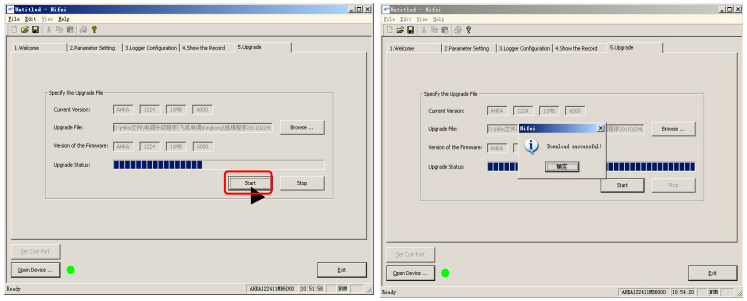
V6.01 tab 5 Upgrade

In **tab 5,** you can upgrade ESC's firmware if there is a new firmware for the ESC be released.
When upgrade the ESC, it needs to connect the cable to receiver with upgrade cable together. (Pls refer to the below diagram)

Each ESC has its specific firmware. You HAVE TO make sure you download a right one for your esc to upgrade, or your esc would be damaged. If you are not sure the upgrade firmware you download is right or not, please contact us, we are more than glad to help you. Email address: info@hifei.com

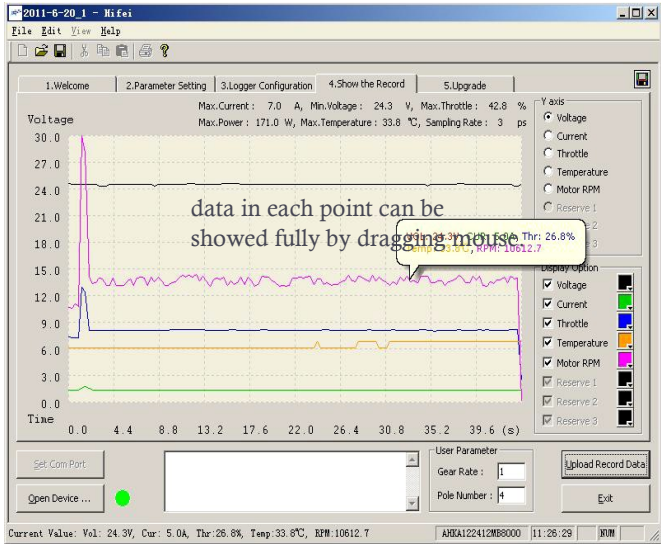


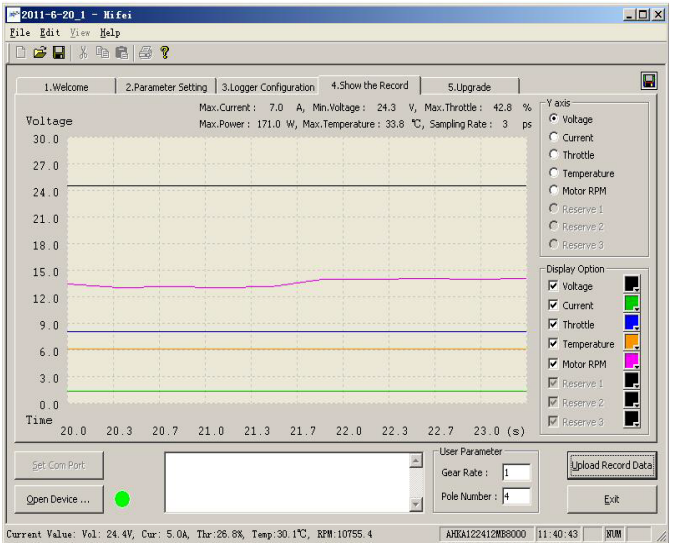
Step①: Short circuit upgrade cable with receiver wire.
Step②: Connect ESC's Wifi wire/to USB adaptor wire to USB adaptor
Step③: Plug the USB Adapter to an USB port of PC.

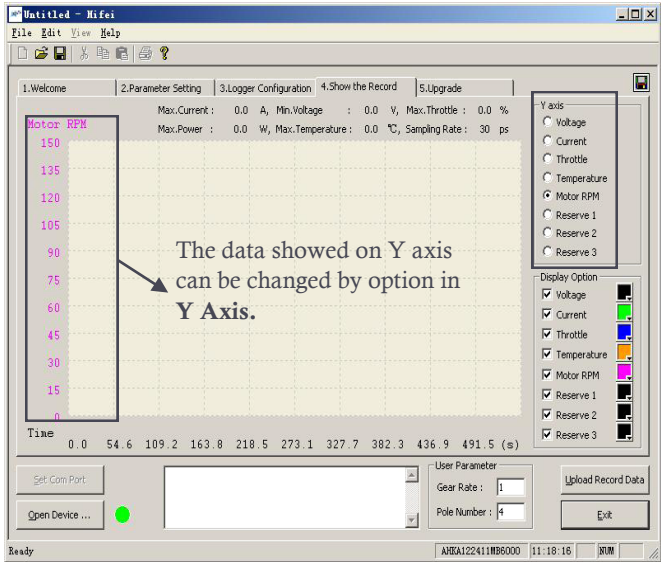


V6.01 tab 4 Show the Record

Show the Record will read the logged data of latest fly by ESC.
- Firstly, it is requested to input the **Gear Ratio** and motor **magnetic Poles** at the bottom.
- Click on **Upload the Record** at right bottom.
- Click on **Yes**, then it begins to upload data and finish uploading in a short time.







To magnify a range of data for more clearly view. left click mouse on beginning point, and click again to the end point, the period of data will be magnified. Right click mouse once will recover to original display.

V6.01 tab 3 Logger Configuration

Cycle Record

1) Not Reverse indicates when data logger memory space is filled up, it will stop logging.

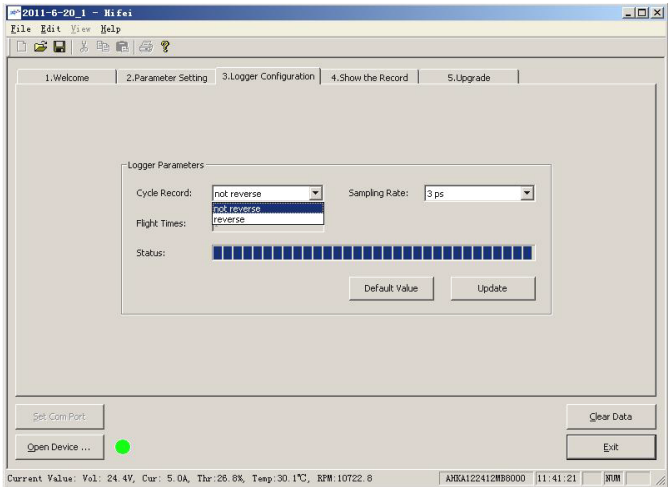
2) Reverse indicates when data logger memory space is filled up, it continue logging data indefinitely by overlapping the former data and do a cycle. *Default setting is Not Reverse.*

Sampling rate means the times that data logger samples per second. *Default setting is 3ps. **

** Higher sampling rate will fill up the memory space quickly and thus reduce the logging time when in 'not reverse' record type.*

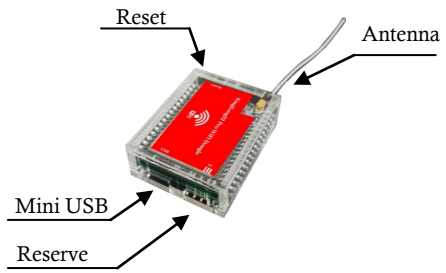
	Sampling Rate	Max logging Time	Mini running Time
Not Reverse Record	Once/ second	Approx. 68.1 minutes	> 60 seconds
	Twice/second	Approx. 34.05 minutes	> 30 seconds
	3 times/second	**Approx. 22.7 minutes**	**> 20 seconds**
	4 times/second	Approx. 13.62 minutes	> 10 seconds
	10 times/second	Approx. 6.81 minutes	> 5 seconds
	15 times/second	Approx. 3.405 minutes	> 3 seconds
	30 times/second	Approx. 2.27 minutes	> 2 seconds

Minimum running Time means the minimum time that ESC is requested to run. The time MUST be longer than reference in above form. Too short running will cause ESC logs little data that cannot be displayed in PC windows.



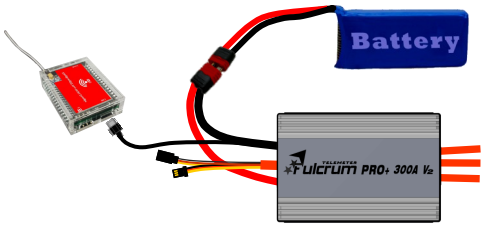
Flight Times is the total times that ESC records data. ESC being powered on is regards as once.

HiFei WIFI Dongle



Connect the WiFi dongle with Fulcrum V2 ESC

Figure 1 Wiring Diagram



Hardware Request

• Keep the length of USB cable no more than 500mm

• Compatible to any kind of smart mobile phone ,PAD or PC with iOS/Android/Windows Operation System

• Support all kind of browsers such as: Chrome, IE, Safia,Firefox,etc.

Connecting the WiFi Dongle

• Connecting the cable to ESC and WiFi dongle (Figure 1)

• Power on the ESC (the red LED of dongle will light a while and then black out) , waiting more than 20 seconds till the green led on dongle start to blink.

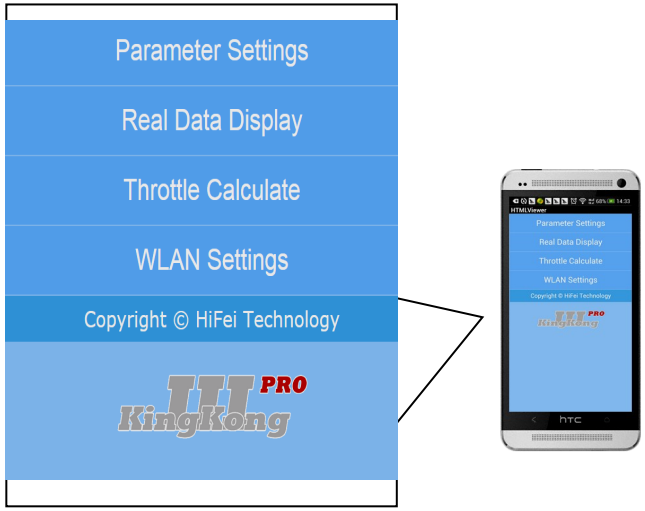
• Option **HiFei-KIII** in the WLAN list of your smart terminal

• Open your browser and input the default IP address & password as following:

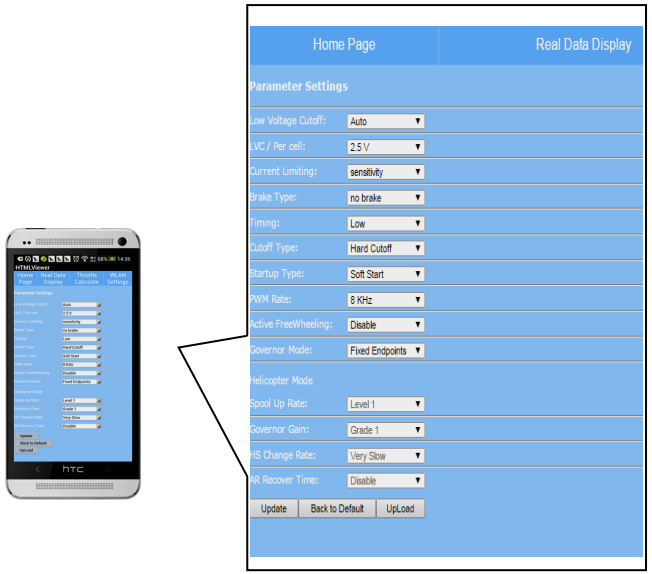
IP address ***192.168.1.16:2015***
Password ***12345678***

• Entered into the Home Page

Home Page

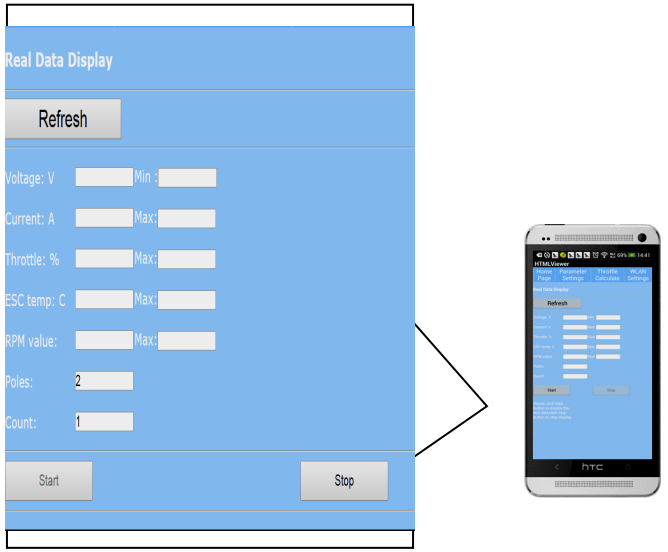


Parameters Setting

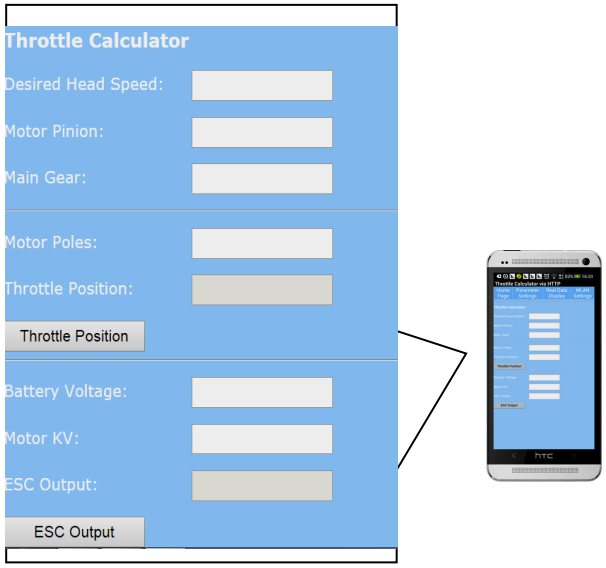


Note: the updated parameters will be available only after the ESC is re-powered up.

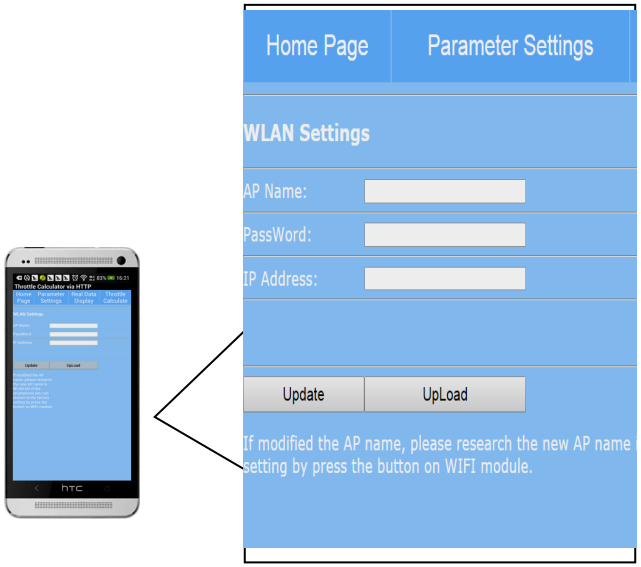
Real-time Flight Data Telemetry



Throttle Calculator



WLAN Setting



Note: After Updated the The AP name and IP Address, Please press Reset button in 1 second and release, the red LED will blink in 5 seconds and go to steady light, after that ,you have to re-power up the WiFi dongle to make the change available.

Q: It pops-up box ' Time out, device open failure' when click on 'Open Device' button.
A: There are three possible reasons to result from this problem. **1)** First is wrong polarity connection between ESC receiver lead and USB linker. Please check if the connection is correct and tight. In addition, Fulcrum V2 ESC is OPTO, it is requested to connect ESC to battery pack when connect them to PC. **2)** Second reason may because ESC were damaged in running. In this condition, please contact our after-service for repair. **3)** At last, it may because USB Linker is damaged.

Q: It pops-up box 'Invalid Com Port' when click on 'Open Device' button.
A: It because com port for ESC connection device is wrong or occupied by other devices. Please open 'Device manager' of 'My computer' to check the right com port number or change the com port number which be occupied to an available port number. Then open V6.0, select the right com port number and save it.

Q: It cannot upload data and pops-up a box 'C:\Program files\V6.01 \ xxx cannot be found'.
A: It because ESC run too short time and the logged data cannot be showed in window. Please clear the data and fly it again for a longer time than required minimum time.

Q: In the process of uploading data, it stops uploading and pops-up an error box 'Program: C:\Program Files\Hifei V6.01\Hifei V6.0.exe This application has requested the Runtime to terminate it in an unusual way. Please contact the applications support team for more information.'

A: The problem is because V6.01 is installed to 'C' and the security setting of 'C' stops the uploading. There are three ways to solve the problem. 1) First, if PC has more than one hard partitions, then change to install V6.0 to other hard disks from "C''. 2) If PC has only one hard disk 'C', you can try to install V6.0 to a flash disk. 3) Change security settings of 'C', select PC user as 'administrator' and let all the permissions of writing and reading below are allowed. Save the change. Then try to upload data again.

Trouble	Possible reason	Shoot methods
The ESC started to smoke right after it was powered on.	1. Backward installation of batteries. 2. The input voltage was beyond the ESC operating voltage.	1. Refer to the "+, _" mark (on the ESC/ battery) and plug the battery in. 2. Refer to the user manual and plug in a suitable battery.
The ESC was unable to start the motor after it was powered on. And no sound was emitted from the motor.	Poor contact between the ESC and battery connectors.	Reconnect all the connectors between ESC and battery or replace those connectors
When connect ESC to battery, there is no power beeps emitted from motor.	1.The battery voltage exceeds the range of ESC's working voltage. May it is too low or too high. 2.Motor is damaged, or the ESC is not well connected with motor.	1. Check battery's voltage and change suitable battery pack. 2.Check the connectors, ensure ESC is tightly connected with motor. Check motor whether it is good.
Motor shut down suddenly even at full throttle or when not decrease the throttle.	1.Battery voltage discharge and drop down to the set LVC, ESC cut-off output to motor to protect the battery. 2. Over-heat protection	1. Please stop the running and change a new battery pack. 2. Stop running for a while until ESC is cool down, check if water-cooling works.
The ESC was unable to start the motor after it was powered on, but the motor beeped "B, B, B, ..."	There was no throttle signal output from the TH channel of receiver.	1. Check if the transmitter and receiver are well bound. 2. Check if the throttle cable has been plugged into the wrong channel or reversely plugged into the TH channel on the receiver. 3. This ESC has no BEC output, a separate battery or UBEC is needed to power the receiver.

HIFEI Technology Co., Ltd.
Add.: 5/F F Building, E Zone of Dawn Urban Industrial Park, Gang An 2 Street, Cun Tan, Jiang Bei,Chongqing 400025
Tel: 86-23-6862 1580, 6862 6070
Fax: 86-23-6862 6070
www.hifei.com info@hifei.com