**Thanks for purchasing *Fulcrum* brushless speed controllers manufactured by HIFEI Technology Co., Ltd. *Fulcrum* series ESC are specifically developed to satisfy the requirements of high voltage and high power. Please read the instruction carefully before running.**

## Safety

⚠ The brushless ESC are for R/C electric powered model airplane and helicopters, which are not toys. ONLY adults can run it correctly according to this instructions, young children must run it with guardianship of adults.

⚠ Please keep the propeller away from your body and others all the time once 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 powered helicopter

⚠ 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, power on the receiver. When finish the running, power off the receiver BEFORE turn 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. Which would not be covered by the manufacturer's WARRANTY.

⚠ High Voltage! Never touch any terminal once power ON.

## Features

- 32-bit Microprocessor with up to 80MHz frequency.
- 40-120V support
- Max Power 30KW
- Active FreeWheeling optional
- Motor PWM frequency 8-32K Hz
- Throttle resolution up to 1uS
- Throttle signal refresh rate up to 1K Hz
- Built-In Anti-Spark circuit* (detail for fig.7)
- Integrated RPM sensor to simplify the wiring for external Governor
- Optimized the Governor Algorithm to ensure the head speed more stable
- Built-In data Logger ( logging parameters: battery voltage/current/throttle output/ temperature/motor RPM)
- Solid CNC housing

## Specifications

| ESC | Voltage | Max Power | BEC | Size (mm) | Weight |
|---|---|---|---|---|---|
| Fulcrum III SHV | 40-120V | 30KW | Yes | 226x173x53 | 1.8Kg |

## Install your ESC

Please make sure the washers and screw of battery and motor have to be fixed tightly (see Fig 3).
When connect power wires to battery, it is IMPORTANT to correctly connect positive to positive, and negative to negative. Exchanging any two motor wires' connections could change the rotation direction.
In order to prevent ESC from any signal disturbance generated by ESC hardware, please install the ESC far away from receiver.

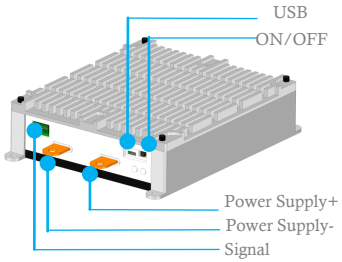



Fig. 1: Front Panel

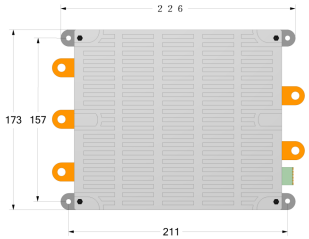



Fig. 2: Install Dimension

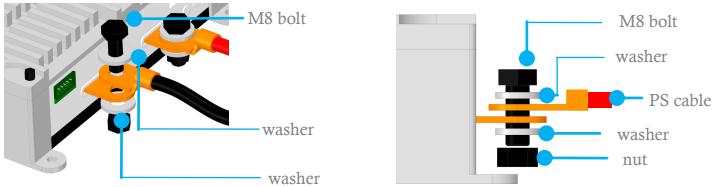



Fig. 3: Cable connection

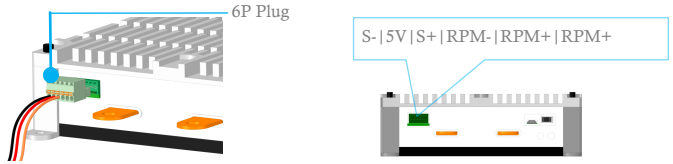



Fig. 4: Signal wiring diagram

⚠ **WARNING : High Voltage!!! Never touch the any one terminal once ESC power on.**

**Step 1:** Keep the Switch at the OFF position—Switch button is on the right top of ESC's power supply side.
**Step 2**: Connect ESC to brushless motor;
**Step 3**: Connect the 6P plug (which assembles with signal wires) into the 6P port (pls view Fig.4);
**Step 4**: Connect the signal wires to the throttle channel of receiver;
**Step 5**: Connect negative(-) cable of ESC to the negative of battery.
**Step 6:** Connect positive **(+)** cable of ESC to the positive of battery.
**Step 7**: Switch on the ESC, the green LED will light (pls view Fig.7)

## 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.***

### Transmitter

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

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

Push joystick to max throttle position

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

**4th:** In the following, motor will emit four long beeps in flat tones. ♩♩♩♩

After any one beep of the four long beeps, pull joystick to zero immediately

Pull joystick to zero throttle position

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

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

## Program ESC by PC

**Hifei USB Linker** is an adapter to link Fulcrum ESC to PC, then it can easily fully program ESC, upgrade ESC firmware, and read logging data of Fulcrum ESC through Hifei software. Hifei software can be downloaded from www.hifei.com.

## Install Hifei software

Download the setup software of 'Hifei V6.0X' from website **(Support column)** and finish the installation according to the popped-up window guide.
When installation is finished, Hifei V6.0X' software icon is auto saved on computer desktop.

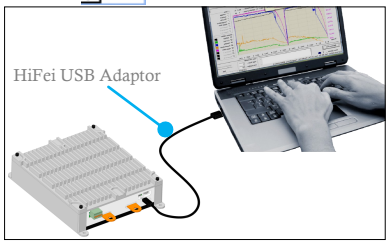



Fig. 5: Program setting the ESC

⚠ **WARNING: Use COMMON USB Cable will DAMAGE the ESC**

Step①:USB adaptor wire to ESC ;
Step②:Plug the USB side of USB adaptor to one of computer's USB ports;
Step③:Run software "Hifei V6.0X" as administrator.

## Parameters features

Fulcrum III SHV ESC come 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 | Option14: 16s Lipo |
| Option 15: 17s Lipo | Option16: 18s Lipo |
| Option 17: 19s Lipo | Option18: 20s Lipo |

***Note: Recommended to set LVC at exact Lipos series number to protect Lipo packs from over -discharging. ONLY WHEN battery packs are fully charged, 'Auto' can detect Lipo cells number correctly and if you choose 'Auto' option, it would be 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:<br>very sensitivity | Low over-current threshold, will shut down rapidly |
| **Option 2: standard (default)** | Moderate over-current threshold, will shut down after a slight delay. Recommended for in runner motors. |
| Option 3:<br>Insensitivity | High over-current threshold, will shut down after a slight delay,. Recommended for out runner motors. Only experienced modelers should use this option. |
| Option 4: disabled | Current limiting detection disabled. Only experienced modelers should use this option. |

***Note: 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

| | |
|---|---|
| **Option 1:<br>Disabled (default)** | Brake disabled is mainly used for helicopters. |
| Option 2:<br>Soft brake | Soft brake provides 50% of full braking power. General aircraft use, with fixed or folding prop |
| Option 3:<br>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<br>(0°~15°) | Recommended for lower pole count motors. Gives more power and slightly less efficient. |
| Option 2: middle<br>(5 °~ 20 °) | Recommended for most motors .Gives a good balance of power and efficiency. |
| Option 3: High<br>(15° ~ 30 °) | Recommended for most of higher pole count motors |
| **Option4:Auto<br>(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° | |

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

## Cutoff types

| | |
|---|---|
| Option 1 :<br>Hard cutoff | When battery voltage reaches cut-off voltage the motor will shutdown immediately. Motor can be restarted by closing the throttle to the lowest position and then move the throttle as normal. |
| **Option 2:<br>Soft cutoff<br>(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:<br>Standard start<br>(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: Fixed Endpoint (default)** | Recommended for fixed wing aircraft and EDF |
| Option 2: External Governor | ESC transmits 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** occurs 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 created. 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)***

## 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 would work when the throttle level exceed 30%. In Governor Mode, the' brake' MUST BE always disable, 'Soft Cut-off' and 'Soft Start' MUST be optioned.

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

**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.

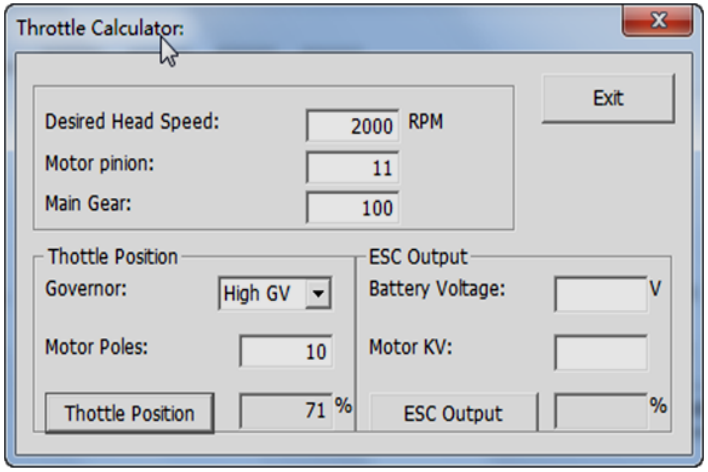
**Governor Gain** The default setting is grade 9, the higher grade number means the higher gain.

**Head Speed Change Rate** The default setting 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.

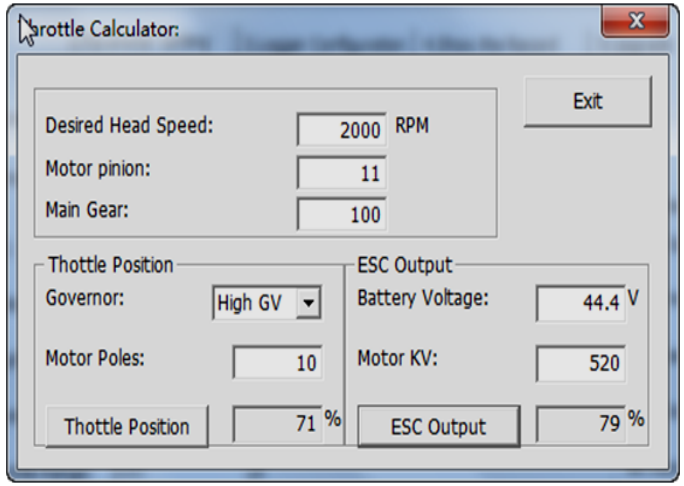
**AR Recover Time** is Autorotation Recover Time, it also can be understood as the recover time from Autorotation (TH=0) to Normal mode. The default setting is 'Disable', it indicates the AR is inactived.

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 over this time ( >30 seconds) will lead to the motor engaged with soft startup.

**Throttle Calculator** is a calculator to help you calculation the throttle curve as you expected. 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, which 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 cause the results that ESC Output haven't enough reservation to compensate battery which is caused by voltage decreasing or load changing, in this case, 'Head Speed Out of Control Range' pop-up screen will show up. Therefore, you need Inc/Dec the tooth of motor pinion or Inc/Dec the Desired Head Speed to get the best match results. Please check your heli configuration carefully, make sure the desired heed speed is under control.

# 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

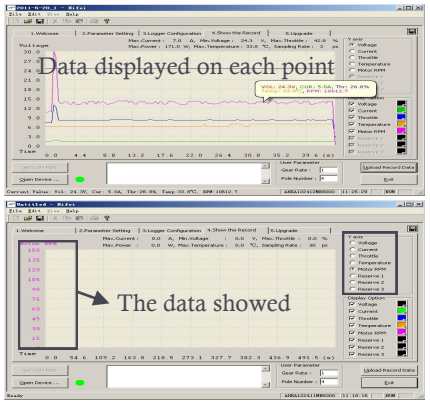
**Sampling rate** means the times that data logger samples per second.
*Default setting is 3ps. **
** Higher sampling rate will fill up the memory space quickly and thus reduce the logging time when in 'not reverse' record type.*

| Sampling Rate | Max logging Time | Mini running Time |
|---|---|---|
| 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 |

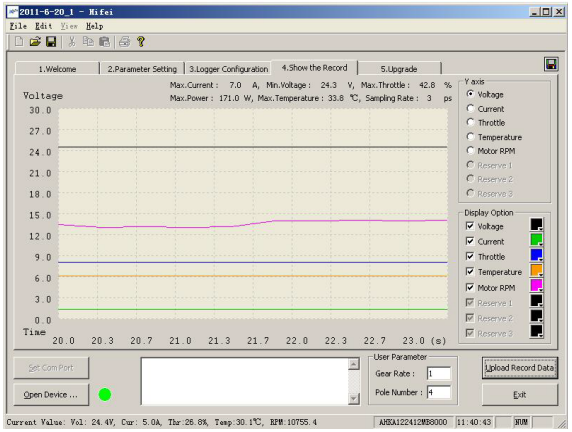
Minimum running Time means the minimum time that ESC is requested to run. The time MUST be longer than the time showed in reference table as above. Because too short running time will cause ESC logs little data and the data cannot be displayed in PC win-

## Show the Record

**Show the Record** will read the logged data of latest fly by ESC, the steps as below:
- Firstly, it is requested to input the **Gear Rate** 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.



## Firmware Upgrade

The Fulcrum III SHV ESC's firmware can be upgraded once new firmware for this esc is available. Before upgrade the ESC, there are two cables with 3 wires for each of them which is from 6P plug. Those two cables have to short-circuit as Fig. 6, and connect the Fulcrum ESC to computer with HiFei USB Linker.

***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***

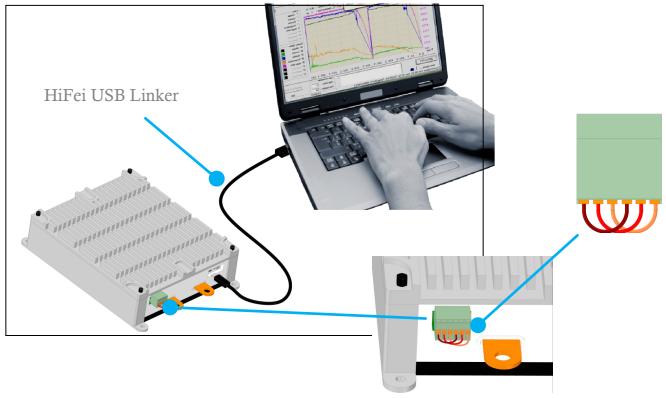



Fig. 6: Wiring Diagram of Firmware Upgrade

## 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

## Anti-Spark Circuit

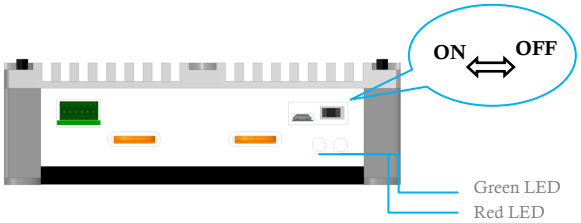
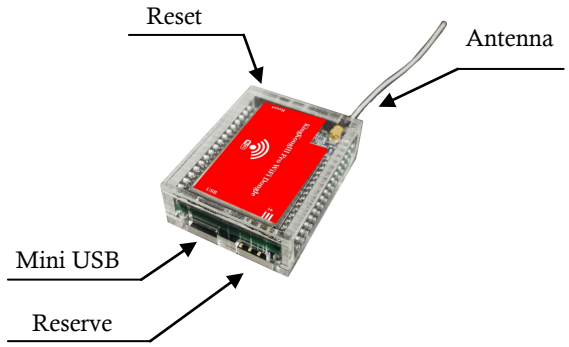



Fig. 7 : Anti-Spark operation procedure

Fulcrum III SHV has a built-in Anti-Spark Circuit, before you connect the power cable, please make sure to keep the ON/OFF switch at OFF position, after the power cable are connected, move the ON/OFF switch to ON position (the green LED light ) to power on the ESC.

## *HiFei WIFI Dongle (Sold Separately)*



## Connect the WiFi dongle with Fulcrum III SHV ESC

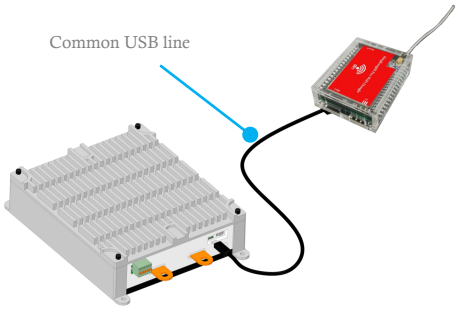



Fig. 8: Power on the ESC, connection with WiFi Dongle

**Note:**

**1) Keep the length of USB cable no more than 500mm**

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

**3) Support all kind of browsers such as: Chrome, IE, Safia,Firefox,etc.**

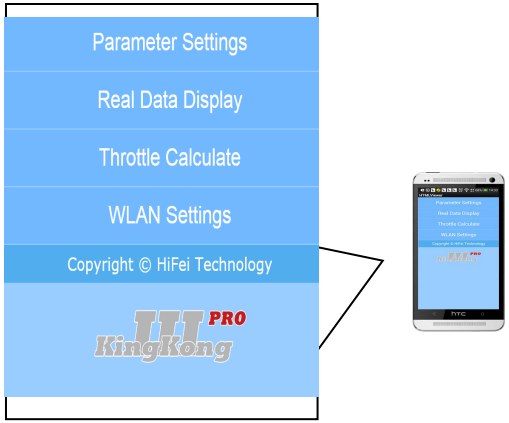
- Connecting the cable to ESC and WiFi dongle ( Figure 6)
- Power on the ESC ( the red LED of dongle will light a while and then black out) , waiting more than 20 seconds till the green led on dongle start to blink.
- Option **HiFei-KIII** in the WLAN list of your smart device
- Open your browser and input the default IP address & pass-word as following:

*IP address* *192.168.1.16:2015*

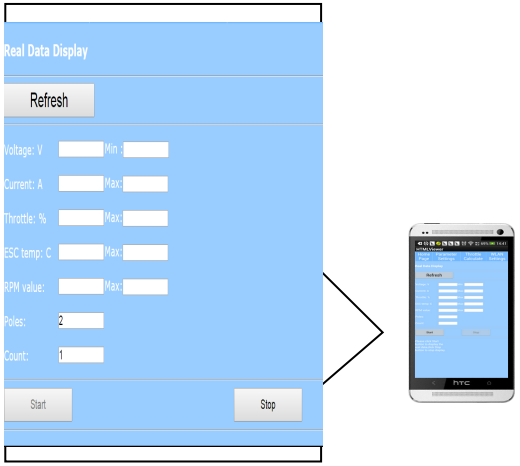
*Password* *12345678*

- Entered into the Home Page

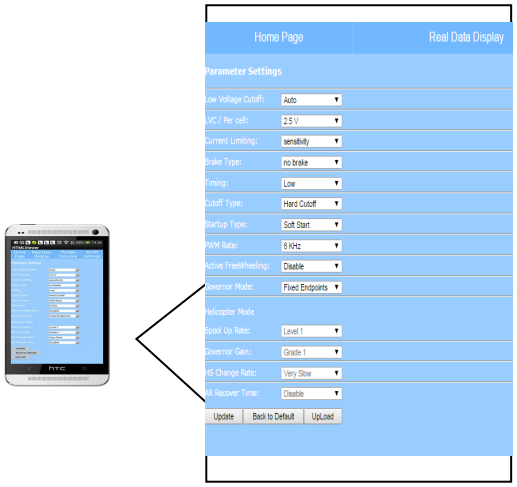
## Home Page




## Real-time Data Telemetry

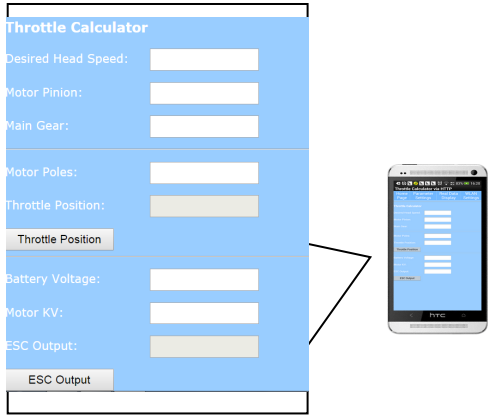



## Parameters Setting

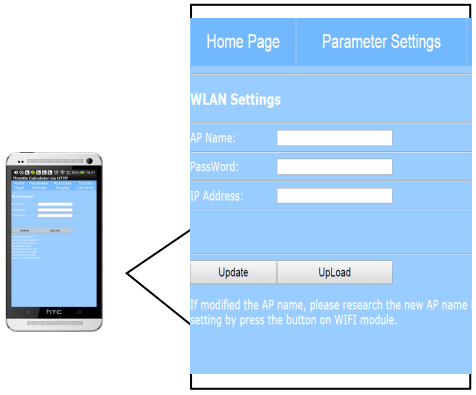



**Note: the updated parameters will be available only after the ESC is re-powered up.**

## 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.**

**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

**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.
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:** The first reason is that 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 run Hifei V6.01 as Admin, select the right com port number and save it. The second reason is that you might use standard USB-cable, instead of ours specialized USB-cable, so that our esc can not recognize 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 V6.01.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 V6.01 to other hard disks from "C''. 2) If PC has only one hard disk 'C', you can try to install V6.01 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.<br>2. The input voltage was beyond the ESC operating voltage. | 1. Refer to the "+, _" mark (on the ESC/ battery) and plug the battery in.<br>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 m** | 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.<br>2.Motor is damaged, or the ESC is not well connected with motor. | 1. Check battery's voltage and change suitable battery pack.<br>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.<br>2. Over-heat protection | 1. Please stop the running and change a new battery pack.<br>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.<br>2. Check if the throttle cable has been plugged into the wrong channel or reversely plugged into the TH channel on the receiver.<br>3. This ESC has no BEC output, a separate battery or UBEC is needed to power the receiver. |