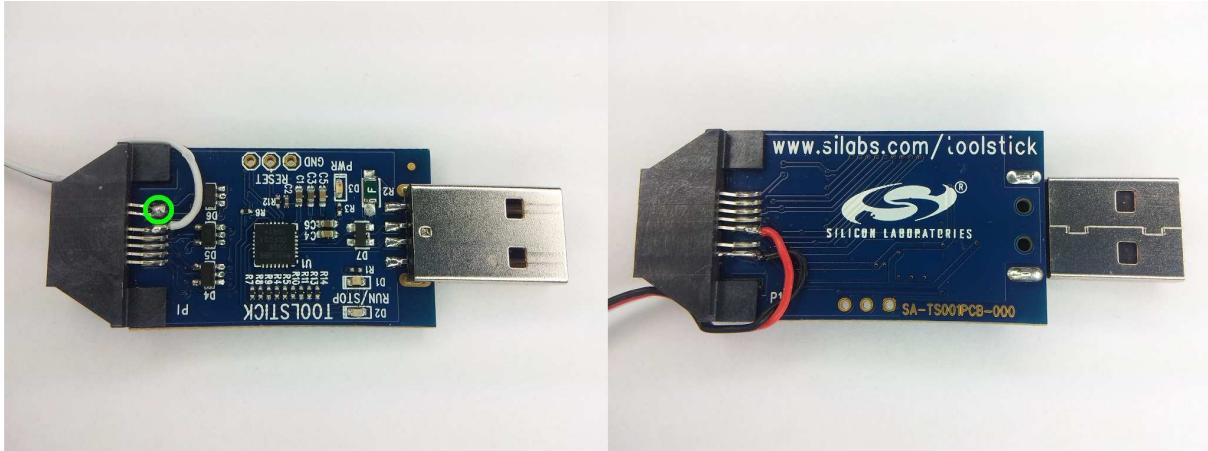


# Programming hardware and software options for flashing BLHeli SiLabs ESCs

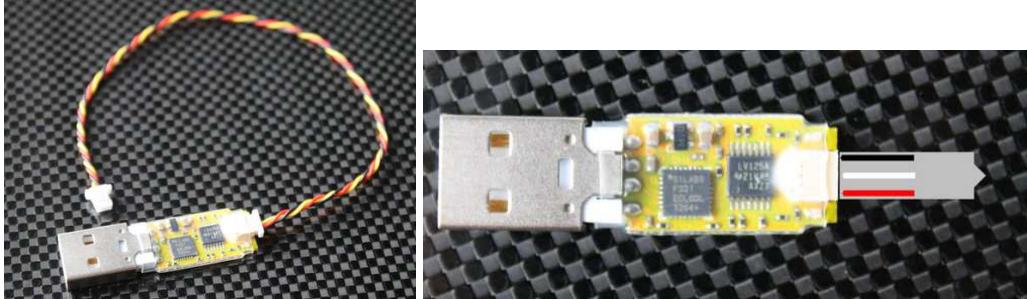
Toolstick:



The green circle in the above image indicates where two pins on the connector shall be shorted.

The black, red and white circles in the ESC images are the Toolstick programmer connections according to the wire colours in the images in the rest of this document.

USB Flashing stick:



This stick is sold under a variety of names from many sources.

## Hawk stick:



## Arduinos and AVRs:

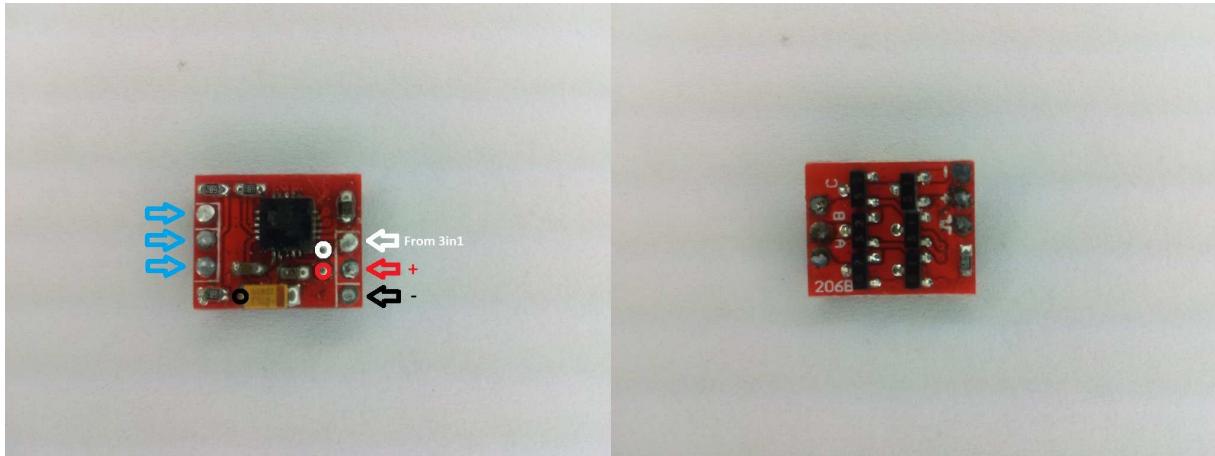


Links to further information on tools and software can be found here:

[https://docs.google.com/spreadsheet/ccc?key=0AhR02IDNb7\\_MdEhfVjk3MkRHVzhKdjU1YzdBQkZZRIE#gid=0](https://docs.google.com/spreadsheet/ccc?key=0AhR02IDNb7_MdEhfVjk3MkRHVzhKdjU1YzdBQkZZRIE#gid=0)

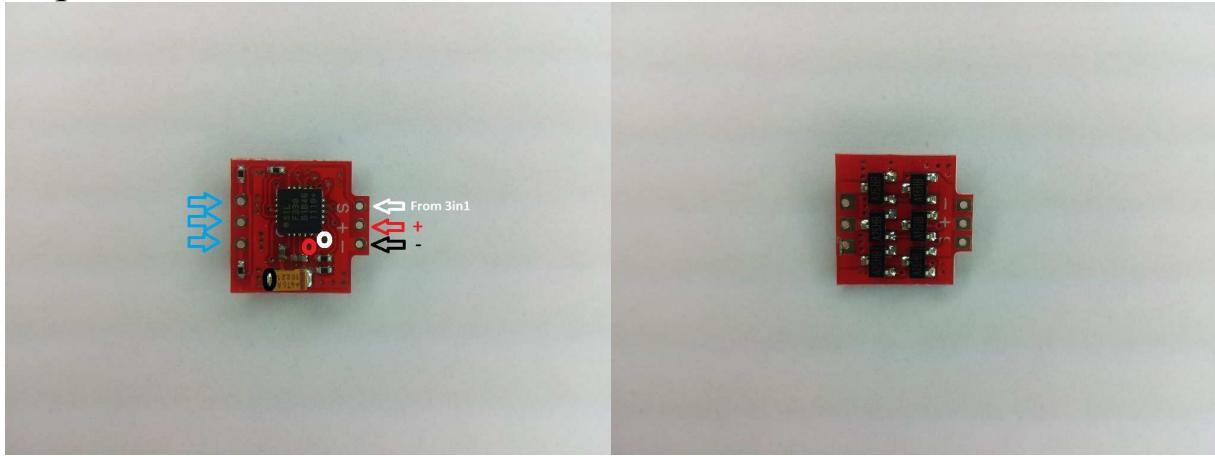
# ESCs supported by BLHeli SiLabs

DP 3A:



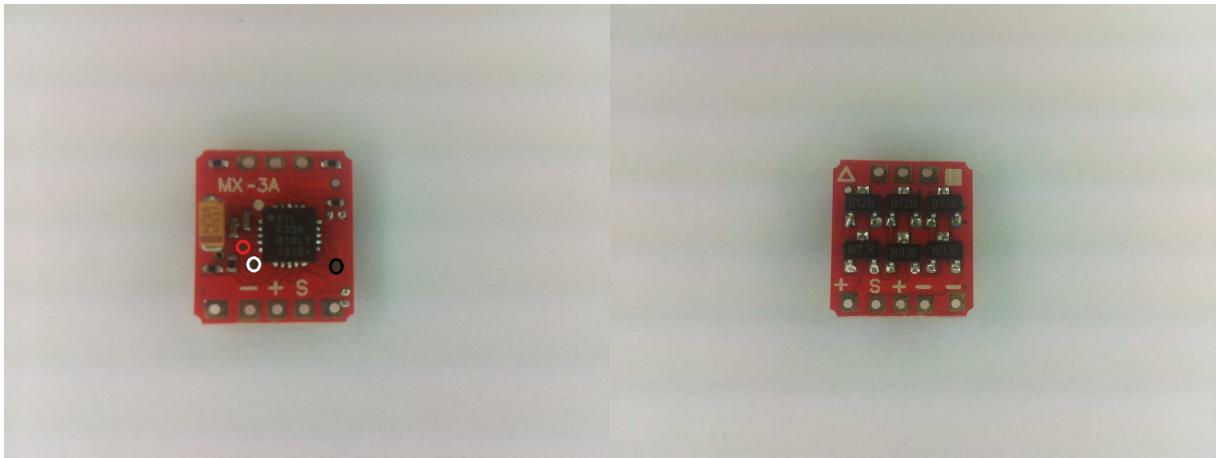
The ESC supports 1S operation only. It supports damped light mode.  
Switching speed is fast, <0.5us.  
Fet resistances are approximately 40mohm for N and 90mohm for P.

Supermicro 3.5A:



The ESC supports 1S operation only. It supports damped light mode.  
Switching speed is fast, <0.5us.

## MX 3A:

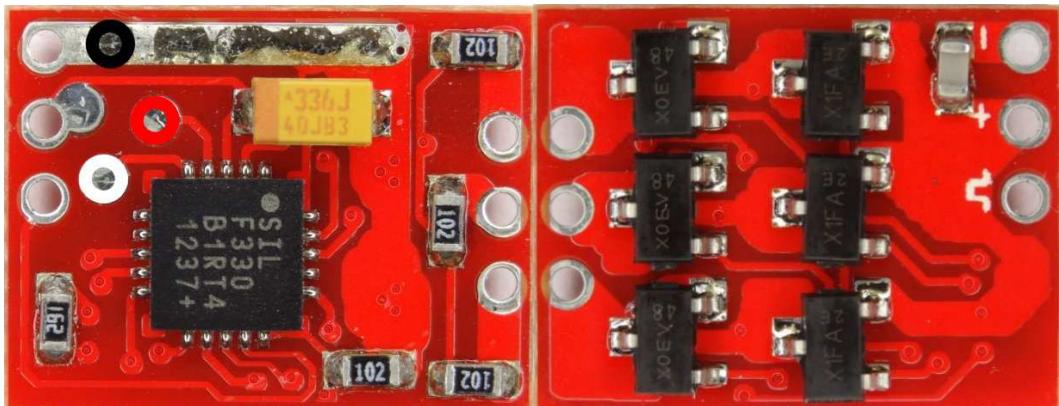


The ESC supports 1S operation only. It supports damped light mode.

Switching speed is fast, <0.5us.

The ESC is sold with the “Supermicro 3.5A” version of the code.

## EAZY 3A:

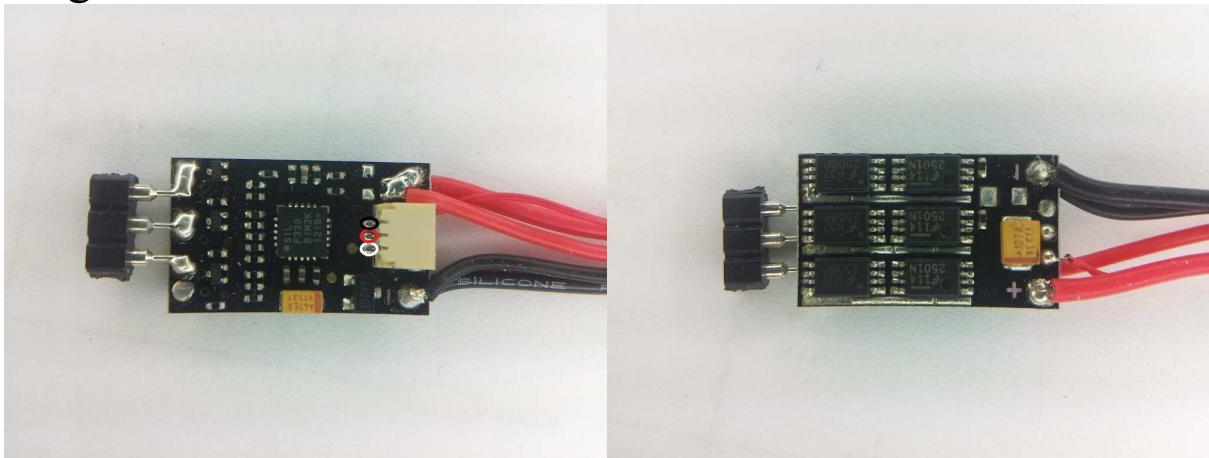


The ESC supports 1S operation only. It supports damped light mode.

Switching speed is fast, <0.5us.

This ESC is almost identical to the XP 3A, but has different resistor values in the voltage sensing network.

## Origin 10A:



The ESC supports 1S operation.

Switching speed is not fast, ~5us (on 2S) for pfet to go off.

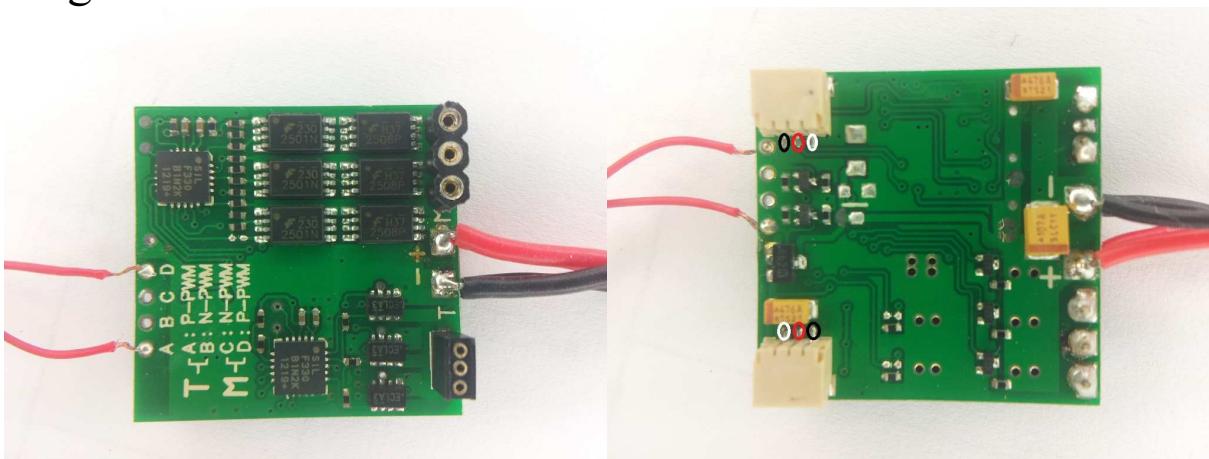
Fet resistances are around 10mohm for N and 10mohm for P (typ at 2.5V).

The ESC has a dedicated connector for programming.

It is sold under many brand names, Oversky, Hawk, Xtreme, Airbase and probably more.

The ESC is sold with the “XP 7A” version of the code.

## Origin double:



The ESC supports 1S operation, and has both a 10A main and a 3A tail ESC.

Switching speed of main is not fast, ~5us (on 2S) for pfet to go off.

Switching speed of tail is fast, <0.5us.

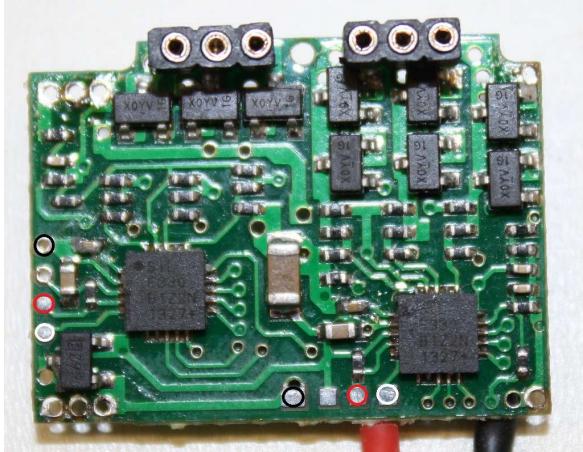
Main fet resistances are around 10mohm for N and 10mohm for P (typ at 2.5V).

The ESC has dedicated connectors for programming.

It is sold under many brand names, Oversky, Hawk and probably more.

The ESC is sold with the “XP 7A” code version for main, and the the “DP 3A” version for tail.

## Align 150MRS:

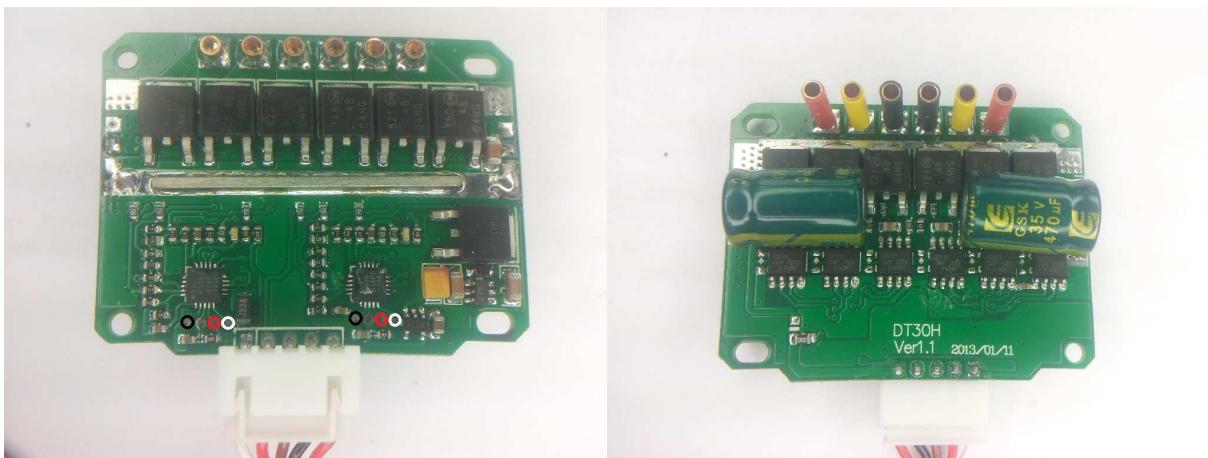


The ESC supports 2S operation.

Switching speed is not so fast for main, quite fast for tail.

The ESC can be flashed with the “XP 7A” code version for main, and the “XP 7A fast” version for tail.

## Tarot double 30A:



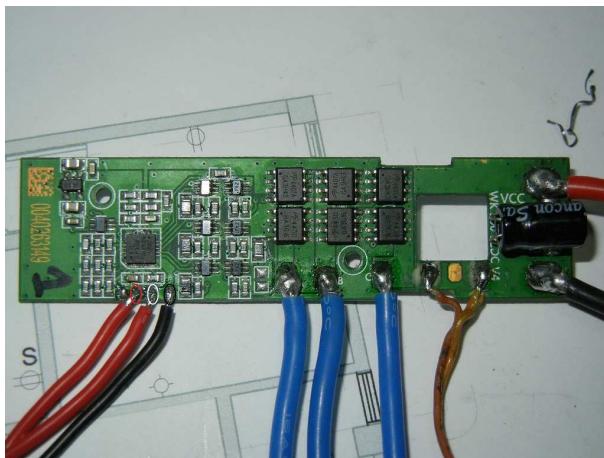
The ESC supports 2S to 6S operation.

Switching speed is quite fast.

Fet resistances are around 3.4mohm for low side and high side (typ at 10V).

Both low and high side fets are Nfets.

## DJI Phantom 18A:

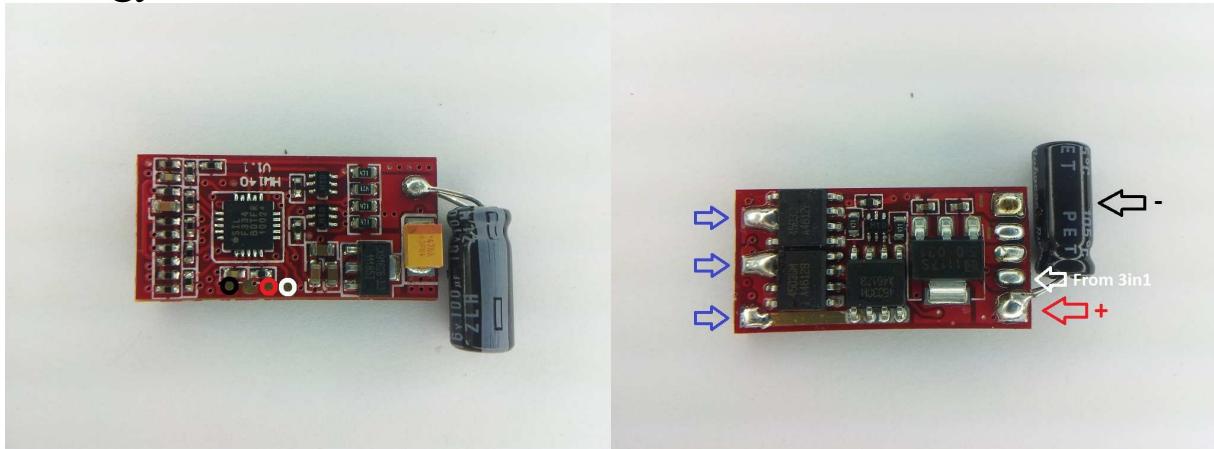


The ESC supports 3S operation.

Switching speed is not fast, several us for pfet to go off.

This ESC uses the same code as the Turnigy Plush 18A ESC.

## Turnigy Plush 6A:



The ESC supports 2S (to 3S) operation.

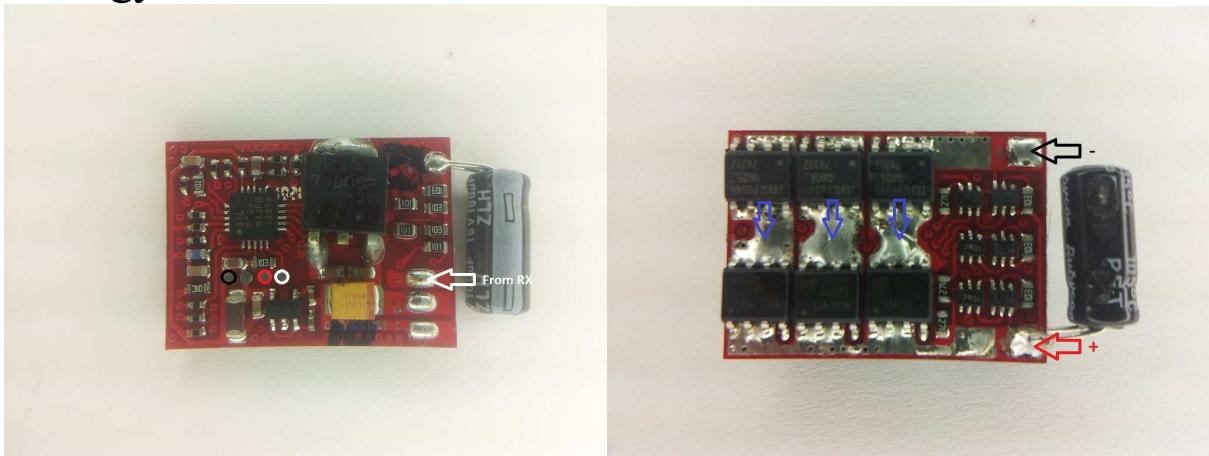
Switching speed is not fast, ~2.5us (on 2S) for pfet to go off.

Fet resistances are around 40mohm for N and 60mohm for P (max at 4.5V).

Also, there is a 2.5us delay in the fet driver that shifts throttle range up, and causes a step in the response from almost full to full throttle.

The ESC is also sold as Hobbywing Flyfun and HiModel Professional.

## Turnigy Plush 10A:



The ESC supports 2S to 4S operation.

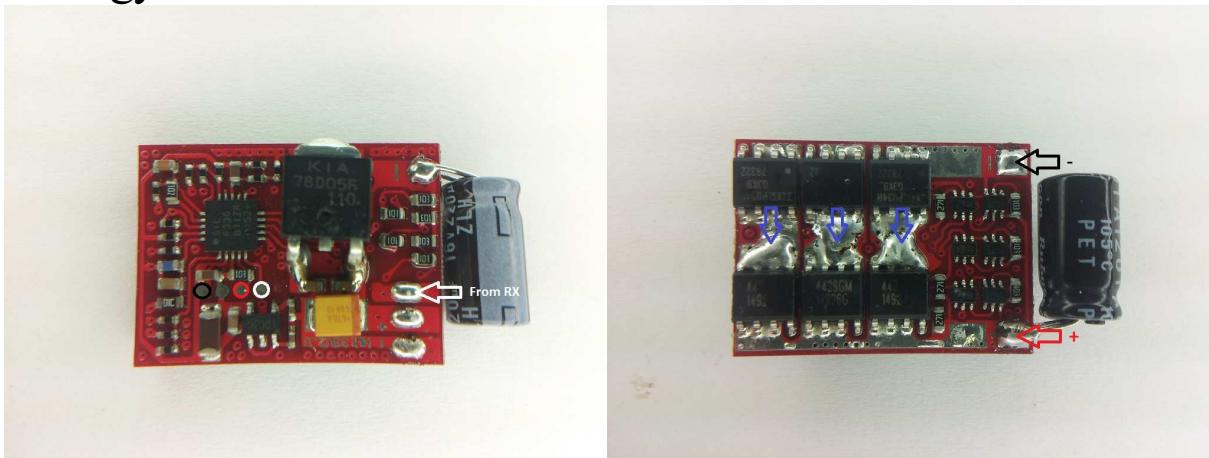
Switching speed is not fast, ~4.5us (on 2S) for pfet to go off.

Fet resistances are around 4mohm for N and 19mohm for P (typ at 4.5V).

Also, there is a 2.5us delay in the fet driver that shifts throttle range up, and causes a step in the response from almost full to full throttle.

The ESC is also sold as Hobbywing Flyfun and HiModel Professional.

## Turnigy Plush 12A:



The ESC supports 2S to 4S operation.

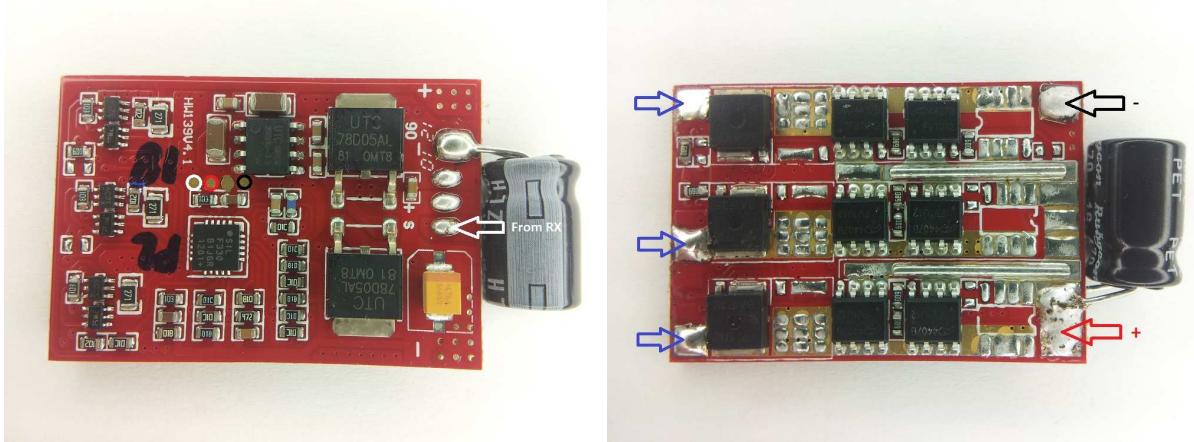
Switching speed is not fast, ~4.5us (on 2S) for pfet to go off.

Fet resistances are around 4mohm for N and 15mohm for P (typ at 4.5V).

Also, there is a 2.5us delay in the fet driver that shifts throttle range up, and causes a step in the response from almost full to full throttle.

The ESC is also sold as Hobbywing Flyfun and HiModel Professional.

## Turnigy Plush 18A:



The ESC supports 2S to 4S operation.

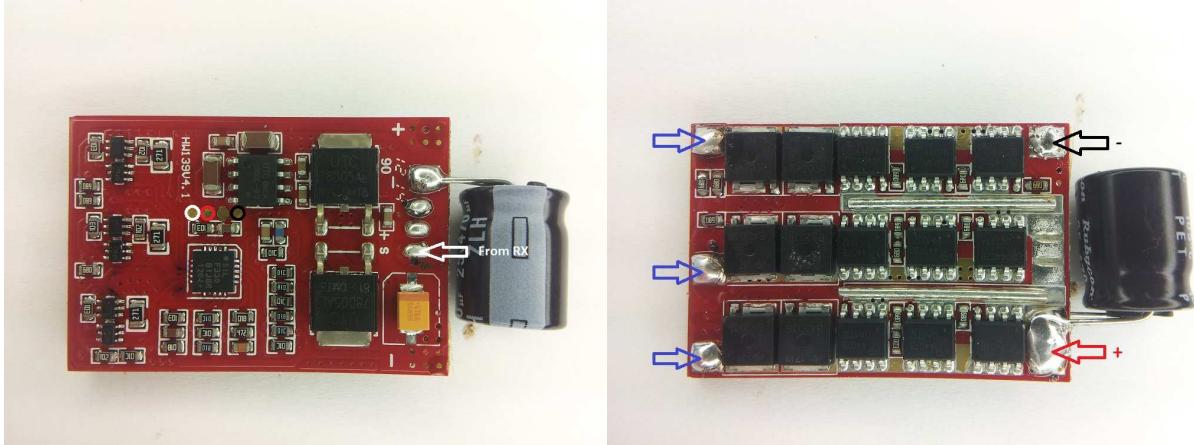
Switching speed is not fast, ~4.1us (on 2S) for pfet to go off.

Fet resistances are around 4mohm for N and 10mohm for P (typ at 4.5V).

Also, there is a 2.5us delay in the fet driver that shifts throttle range up, and causes a step in the response from almost full to full throttle.

The ESC is also sold as Hobbywing Flyfun and HiModel Professional.

## Turnigy Plush 25A and 30A:



The ESC supports 2S to 4S operation.

Switching speed is not fast, ~4.1us (on 2S) for pfet to go off.

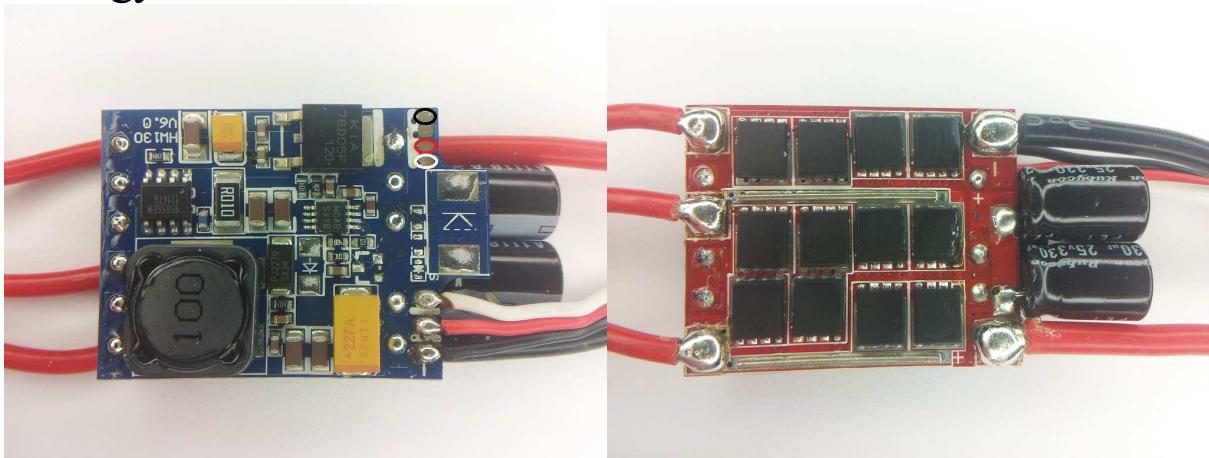
Fet resistances are around 2mohm for N and 6mohm for P (typ at 4.5V).

The only difference between the 25A and the 30A is an additional cooling plate (not shown in the picture).

Also, there is a 2.5us delay in the fet driver that shifts throttle range up, and causes a step in the response from almost full to full throttle.

The ESC is also sold as Hobbywing Flyfun and HiModel Professional.

## Turnigy Plush 40A:

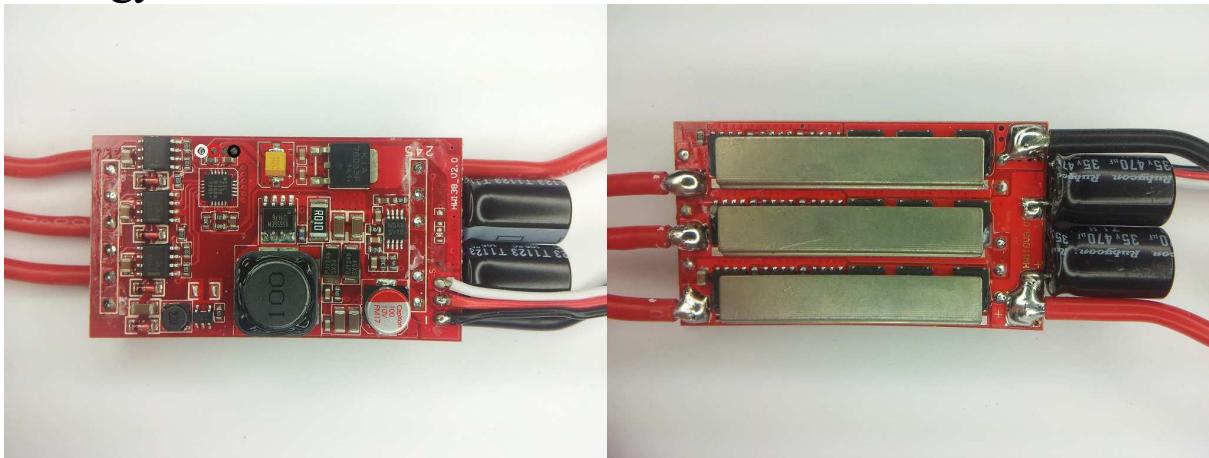


The ESC supports 2S to 6S operation. It supports damped light mode. Switching speed is quite fast.

Fet resistances are around 1.3mohm for low side and high side (typ at 10V). Both low and high side fets are Nfets.

The ESC is also sold as Hobbywing Flyfun and HiModel Professional.

## Turnigy Plush 60A:



The ESC supports 2S to 6S operation.

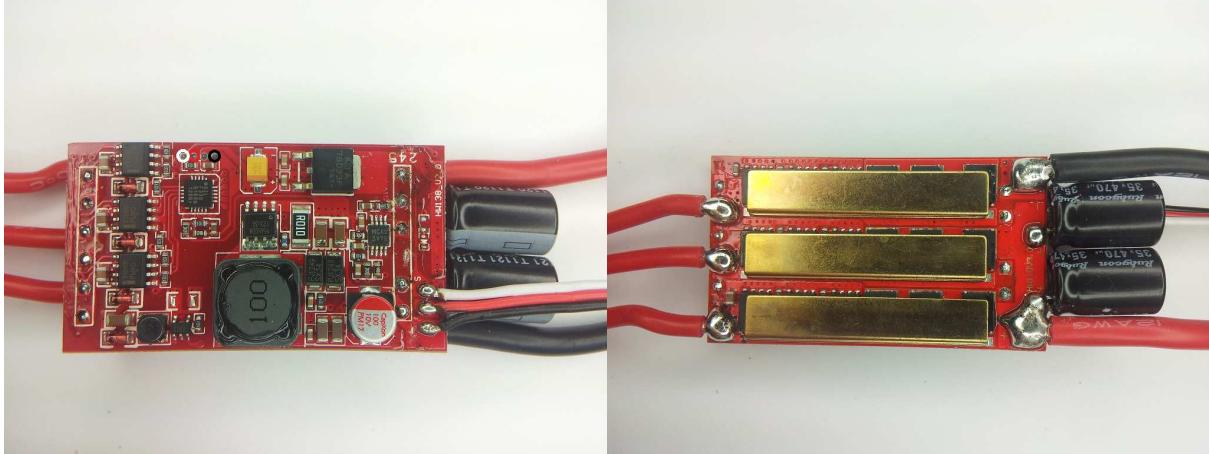
Switching speed is quite fast.

Fet resistances are around 0.7mohm for low side and high side (typ at 10V).

Both low and high side fets are Nfets.

The ESC is also sold as Hobbywing Flyfun and HiModel Professional.

## Turnigy Plush 80A:



The ESC supports 2S to 6S operation.

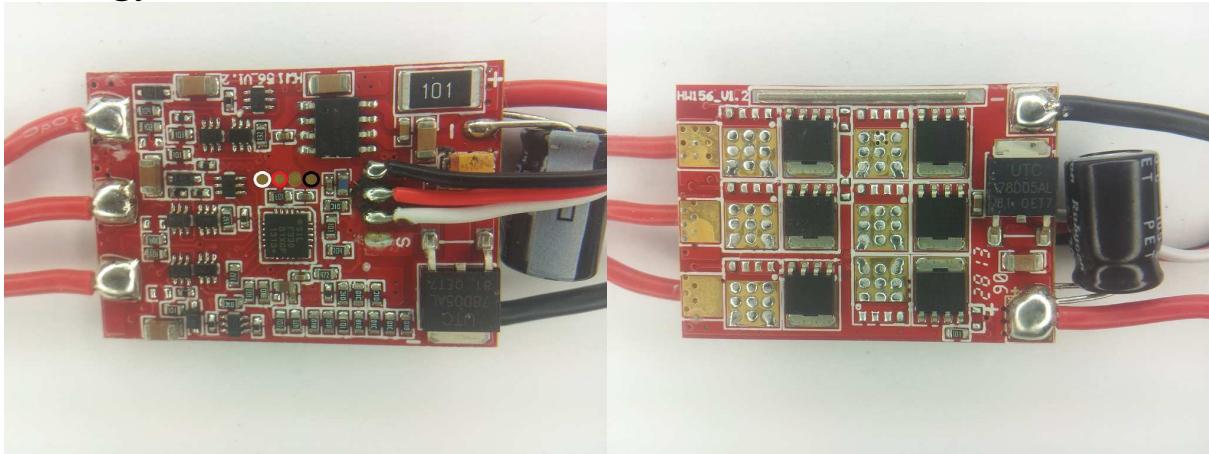
Switching speed is quite fast.

Fet resistances are around 0.5mohm for low side and high side (typ at 10V).

Both low and high side fets are Nfets.

The ESC is also sold as Hobbywing Flyfun and HiModel Professional.

## Turnigy Plush Nfet 18A:



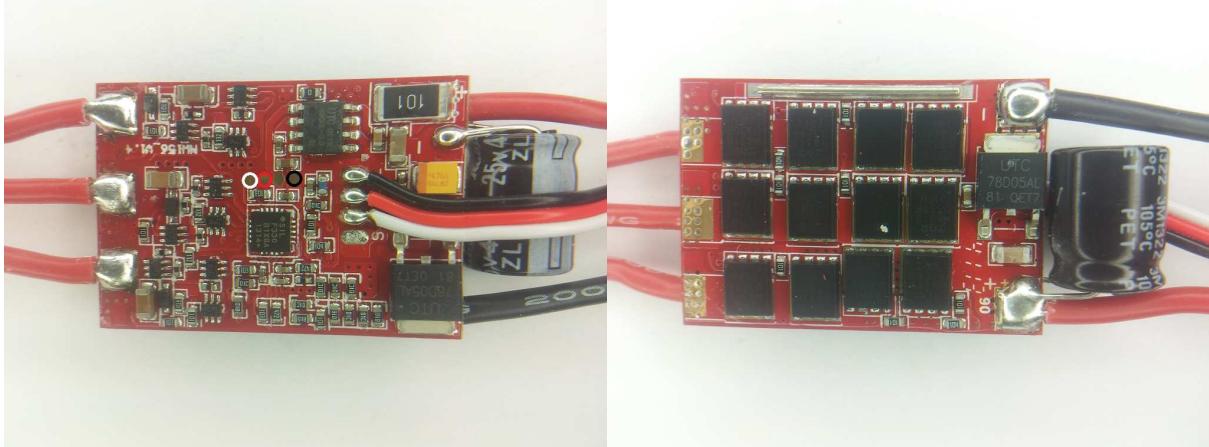
The ESC supports 2S to 4S operation. It supports damped light mode.

Switching speed is quite fast.

Both low and high side fets are Nfets.

The ESC is probably replacing the older N and Pfet hardware

## Turnigy Plush Nfet 25A and Nfet 30A:



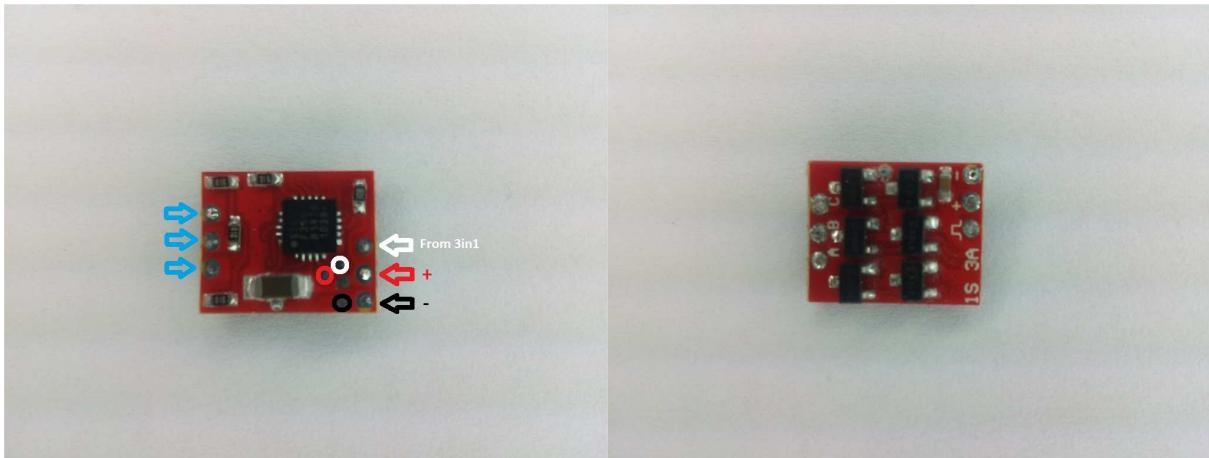
The ESC supports 2S to 4S operation. It supports damped light mode.

Switching speed is quite fast.

Both low and high side fets are Nfets.

The ESC is probably replacing the older N and Pfet hardware

## XP 3A:

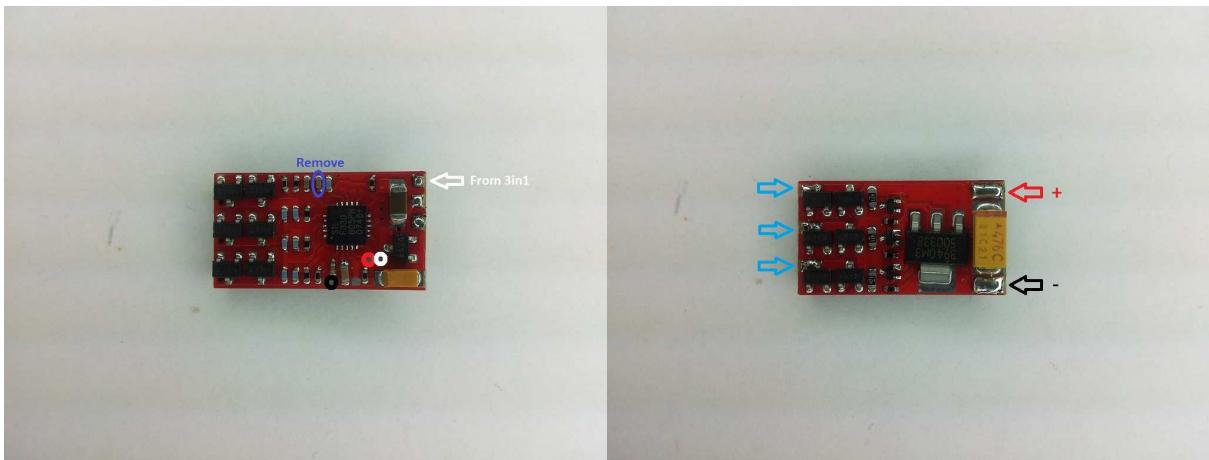


The ESC supports 1S operation only. It supports damped light mode.

Switching speed is fast, <0.5us.

Fet resistances are approximately 30mohm for N and 60mohm for P.

## XP 7A:



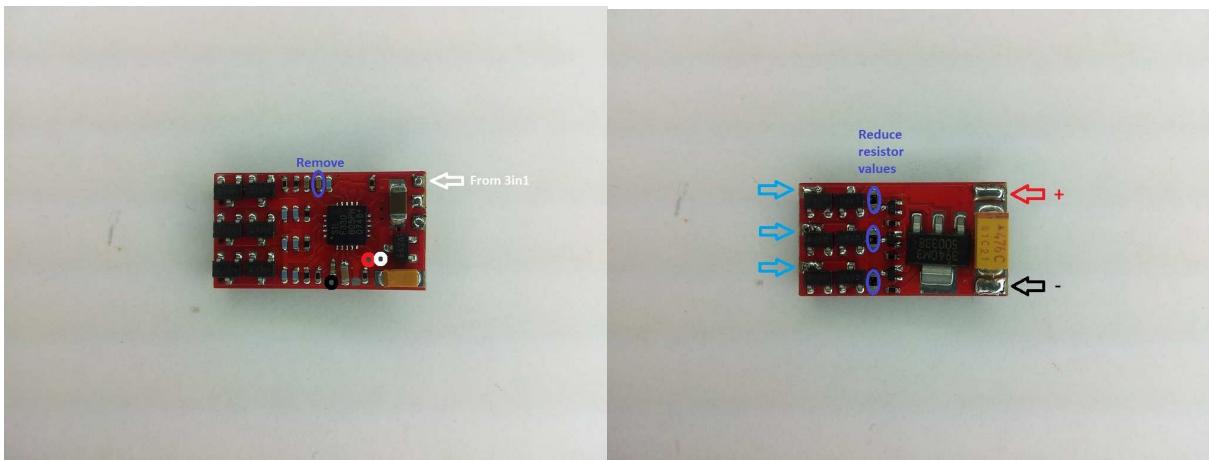
The ESC supports 1S to 2S operation.

Switching speed is not fast, ~5us (on 2S) for pfet to go off.

Fet resistances are around 12mohm for N and 30mohm for P (typ at 2.5V).

The circled capacitor in the image above should be removed for high frequency input signals (pwm > 1kHz, e.g. mCPX v1).

## XP 7A Fast:



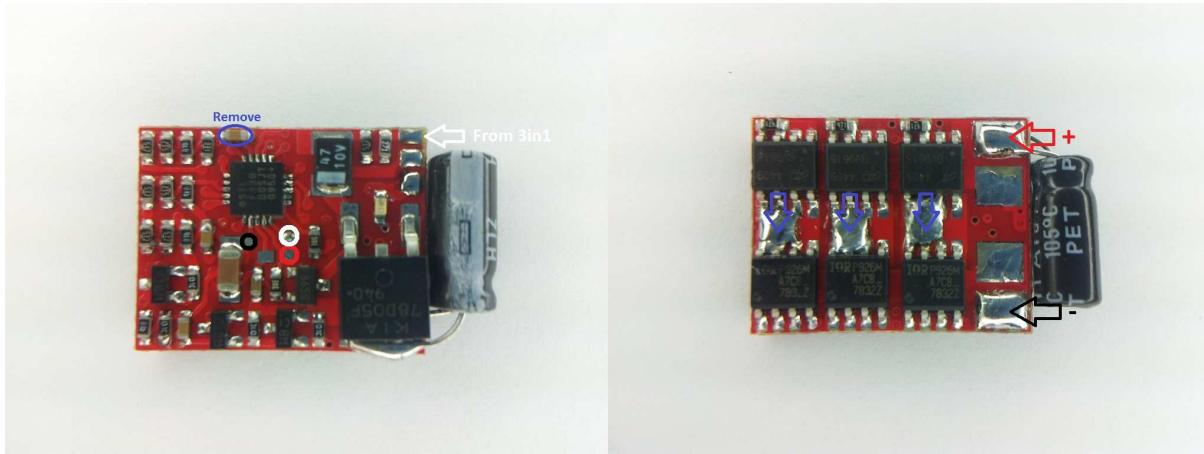
This is a modified version of an XP 7A esc, primarily targeting 2S tail operation. The ESC supports 1S to 2S operation. It supports damped light mode.

Switching speed is modified to be faster, ~1.6us (on 2S) for pfet to go off, thereby enabling damped mode operation.

The resistors marked in the picture above are originally 470ohm. They have to be modified to be between 150ohm and 180ohm. Paralleling the original 470ohm with 270ohm gives a final resistance of 170ohm, which is suitable.

The circled capacitor in the image above should be removed for high frequency input signals (pwm > 1kHz, e.g. mCPX v1).

## XP 12A:



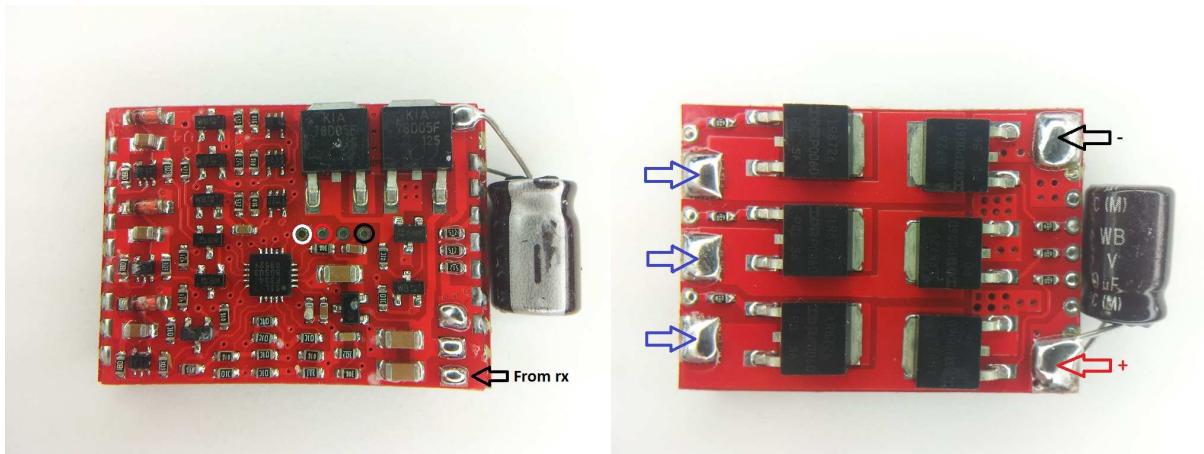
The ESC supports 1S to 3S operation.

Switching speed is not fast, up to ~9us (on 3S) for pfet to go off.

Fet resistances are around 4mohm for N and 10mohm for P (specified at 4.5V, fets are not specified for operation below 4.5V).

The circled capacitor in the image above should be removed for high frequency input signals (pwm > 1kHz, e.g. mCPX v1).

## XP 18A:



The ESC supports 2S to 4S operation.

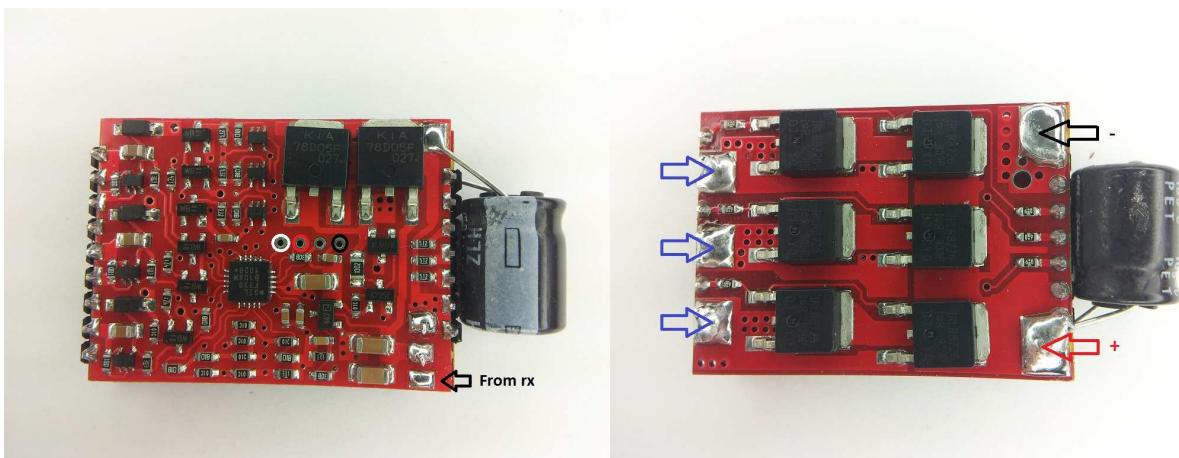
Switching speed is quite fast, <0.5us , except ~2us for high side to go on.

Pwm is applied to the high side.

Fet resistances are around 6mohm for low side and high side (typ at 4.5V).

Both low and high side fets are Nfets.

## XP 25A:



The ESC supports 2S to 4S operation.

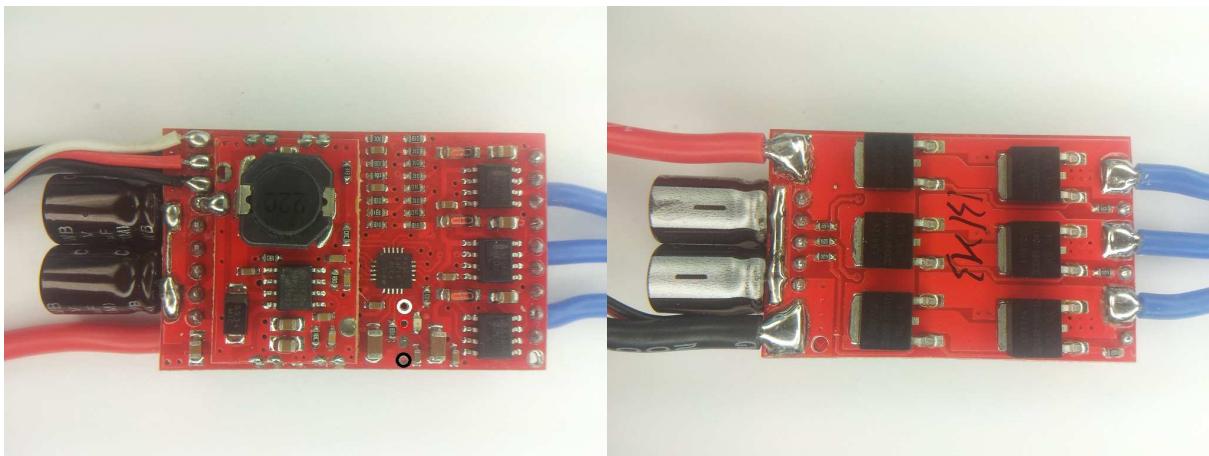
Switching speed is quite fast, <0.5us , except ~2us for high side to go on.

Pwm is applied to the high side.

Fet resistances are around 3mohm for low side and high side (typ at 4.5V).

Both low and high side fets are Nfets.

## XP 35A SW:

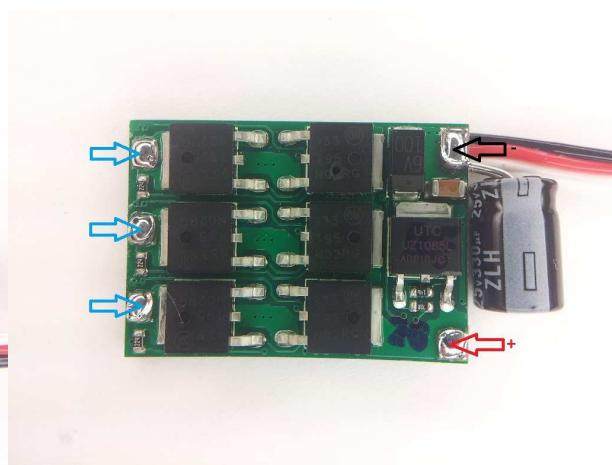
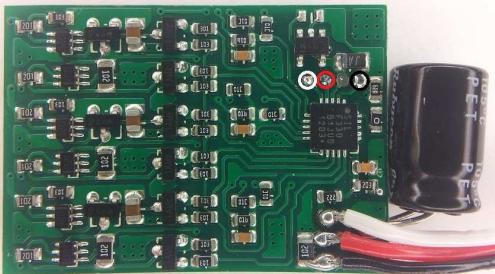


The ESC supports 2S to 4S operation. It supports damped light mode.

Switching speed is quite fast.

Both low and high side fets are Nfets.

## Turnigy AE 20A:



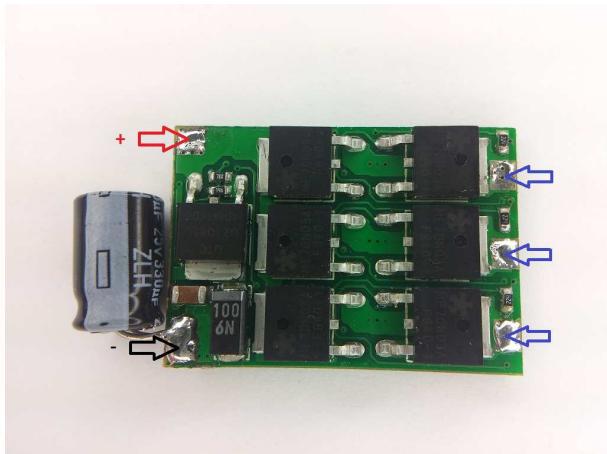
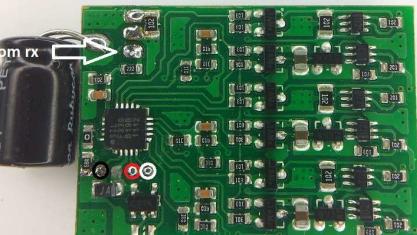
The ESC supports 2S to 4S operation.

Switching speed is quite slow.

Fet resistances are around 5mohm for low side and high side (typ at 10V).

Both low and high side fets are Nfets.

## Turnigy AE 25A:



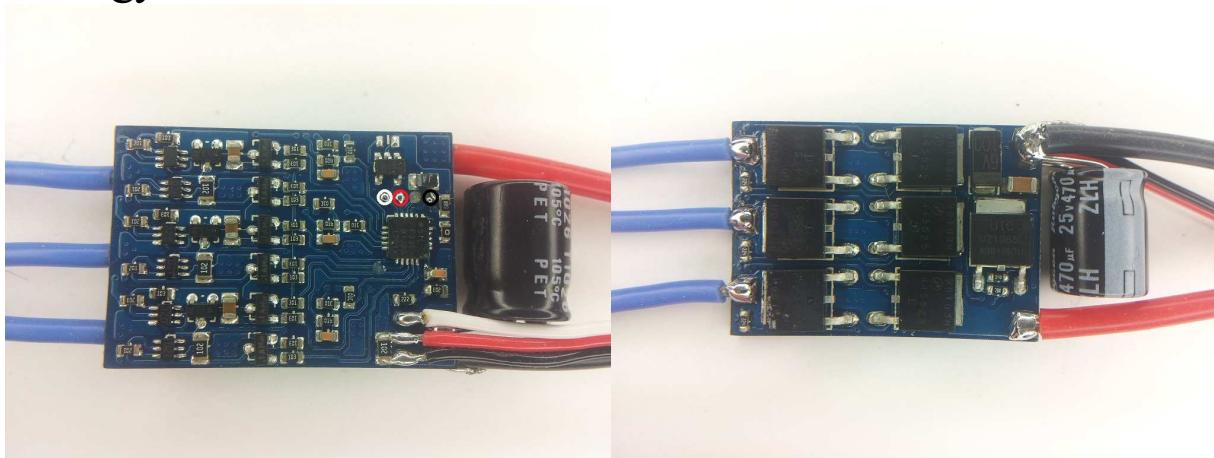
The ESC supports 2S to 4S operation.

Switching speed is quite slow.

Fet resistances are around 5mohm for low side and high side (typ at 10V).

Both low and high side fets are Nfets.

## Turnigy AE 30A:



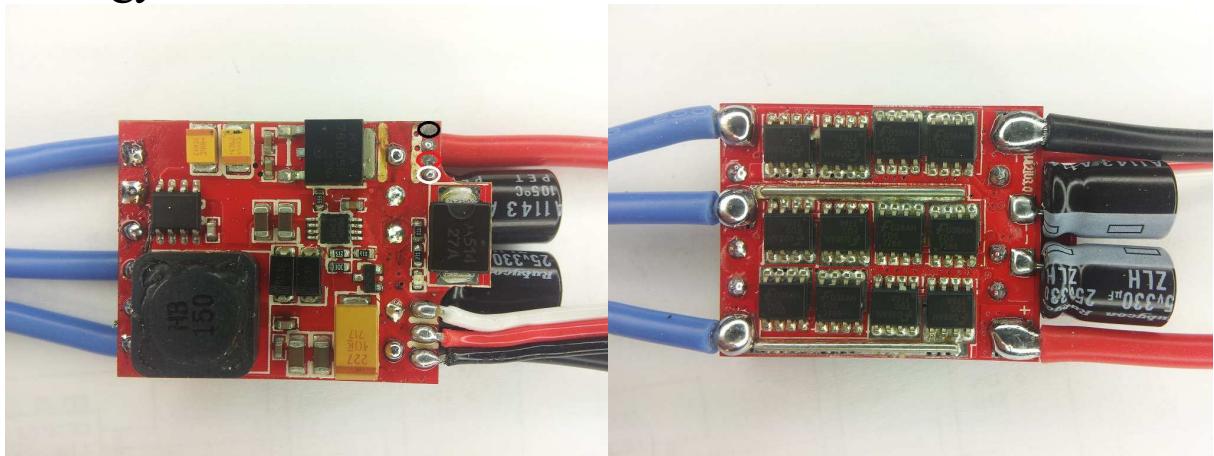
The ESC supports 2S to 4S operation.

Switching speed is quite slow.

Fet resistances are around 4mohm for low side and high side (max at 10V).

Both low and high side fets are Nfets.

## Turnigy AE 45A:



The ESC supports 2S to 6S operation. It supports damped light mode.

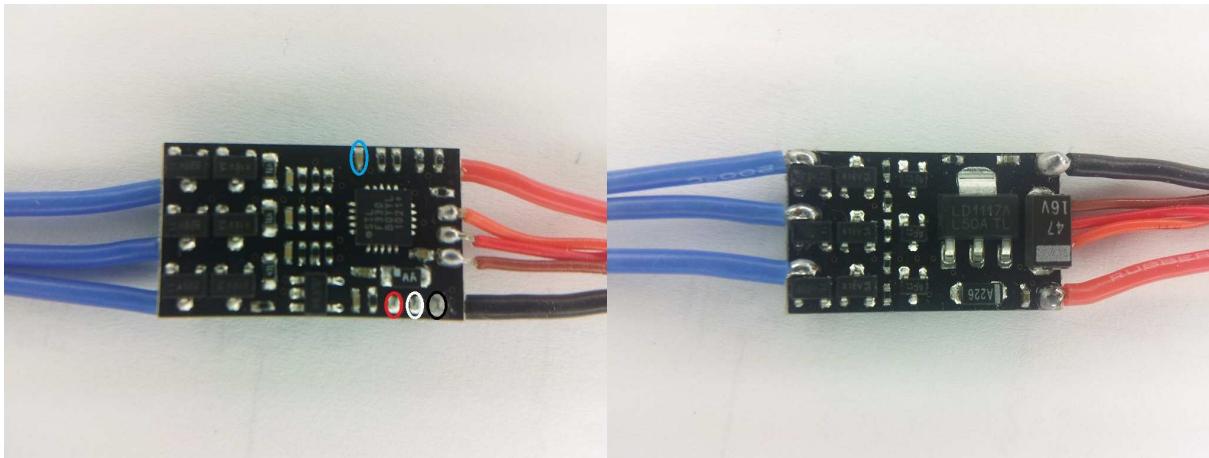
It supports dual voltage BEC.

Switching speed is quite fast.

Fet resistances are around 1.5mohm for low side and high side (typ at 10V).

Both low and high side fets are Nfets.

## RC timer 6A:



The ESC supports 2S operation.

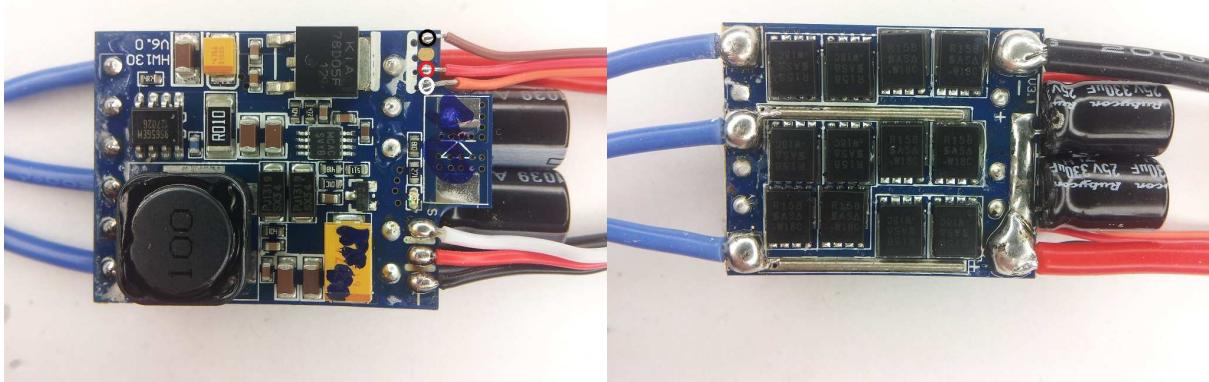
Switching speed is not fast, ~5us (on 2S) for pfet to go off.

Fet resistances are around 12mohm for N and 30mohm for P (typ at 2.5V).

The circled capacitor in the image above should be removed for high frequency input signals (pwm > 1kHz, e.g. mCPX v1).

The ESC is also sold as RCX 6A.

## Turnigy KForce 40A:



The ESC supports 2S to 6S operation. It supports damped light mode.

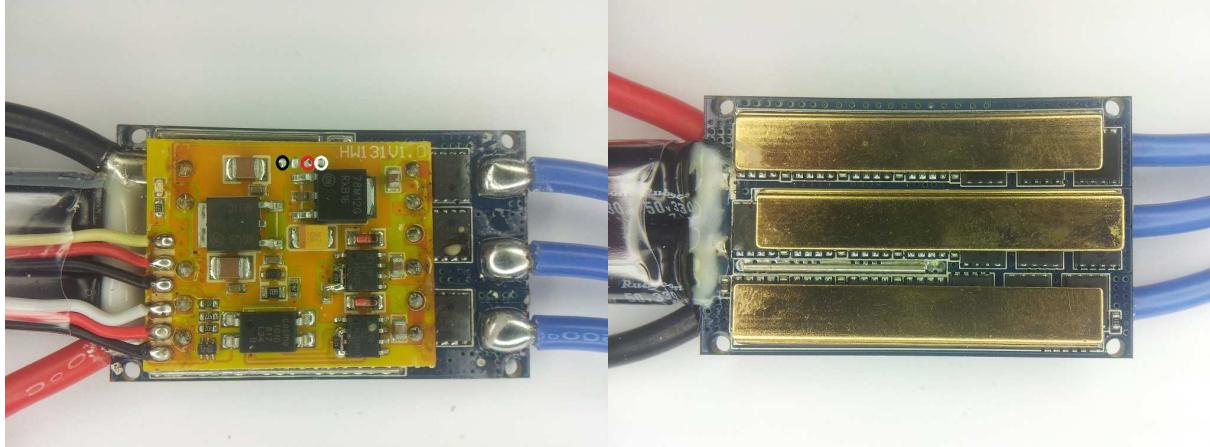
It supports dual voltage BEC.

Switching speed is quite fast.

Fet resistances are around 0.7mohm for low side and high side (typ at 10V).

Both low and high side fets are Nfets.

## Turnigy KForce 70A HV:



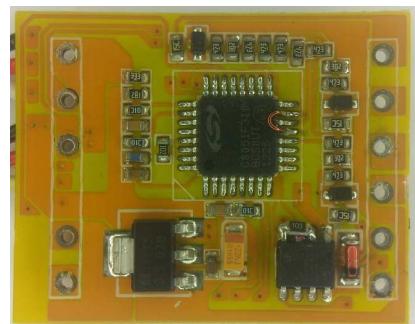
The ESC supports 5S to 12S operation.

Switching speed is quite fast.

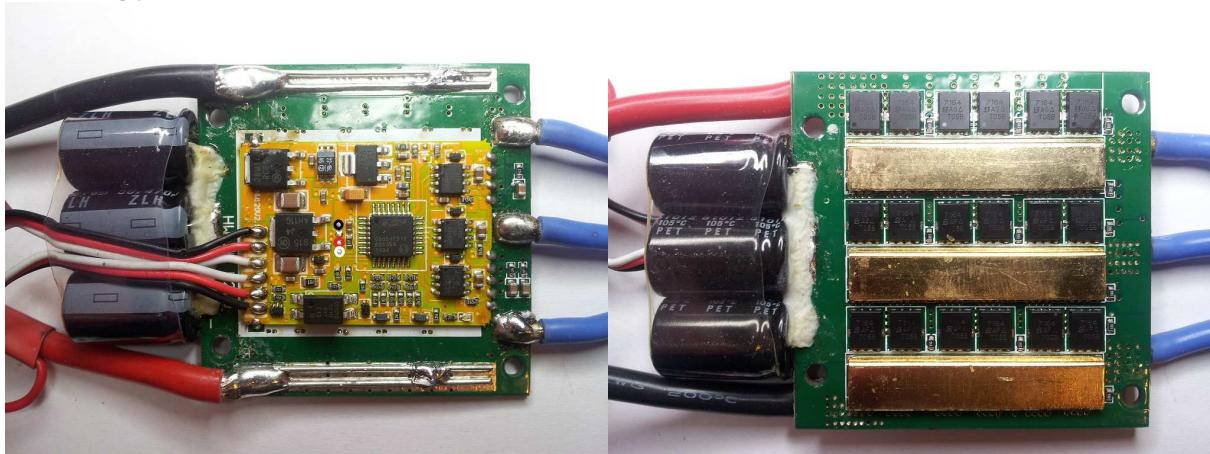
Both low and high side fets are Nfets.

The ESC needs a modification, and in order to do it, the two boards must be separated.

Two pins on the MCU must be bridged as shown.



## Turnigy KForce 120A HV:



The ESC supports 5S to 12S operation.

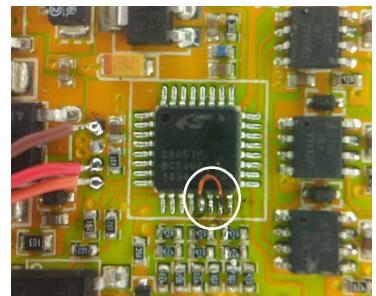
Switching speed is quite fast.

Fet resistances are around 0.8mohm for low side and high side (typ at 10V).

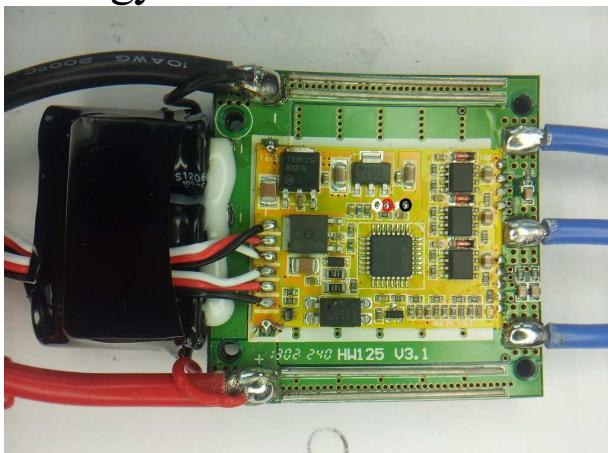
Both low and high side fets are Nfets.

The ESC needs a small modification.

Two pins on the MCU must be bridged as shown.



## Turnigy KForce 120A HV v2:

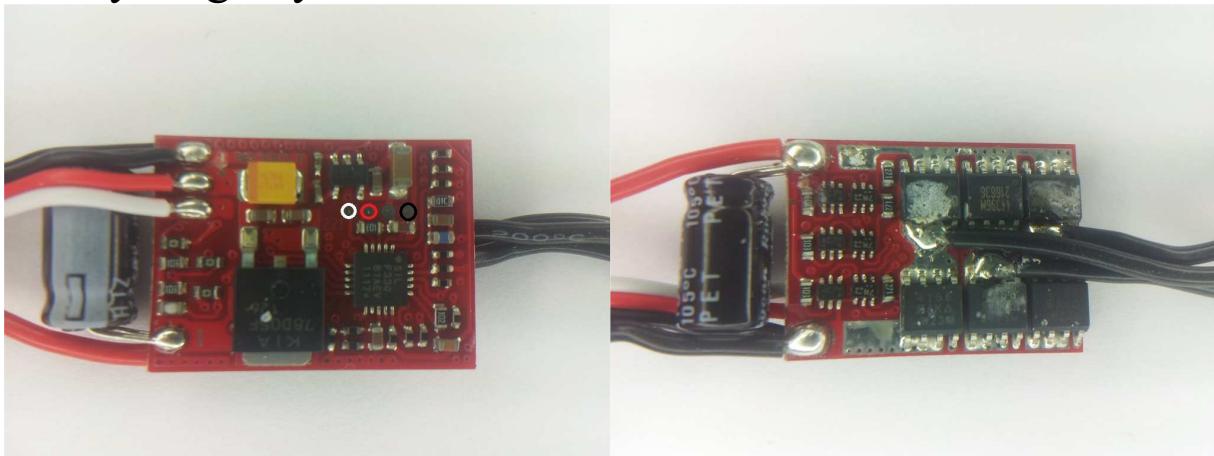


The ESC supports 5S to 12S operation.

Switching speed is quite fast.

Both low and high side fets are Nfets.

## Hobbywing Skywalker 12A:



The ESC supports 2S to 4S operation.

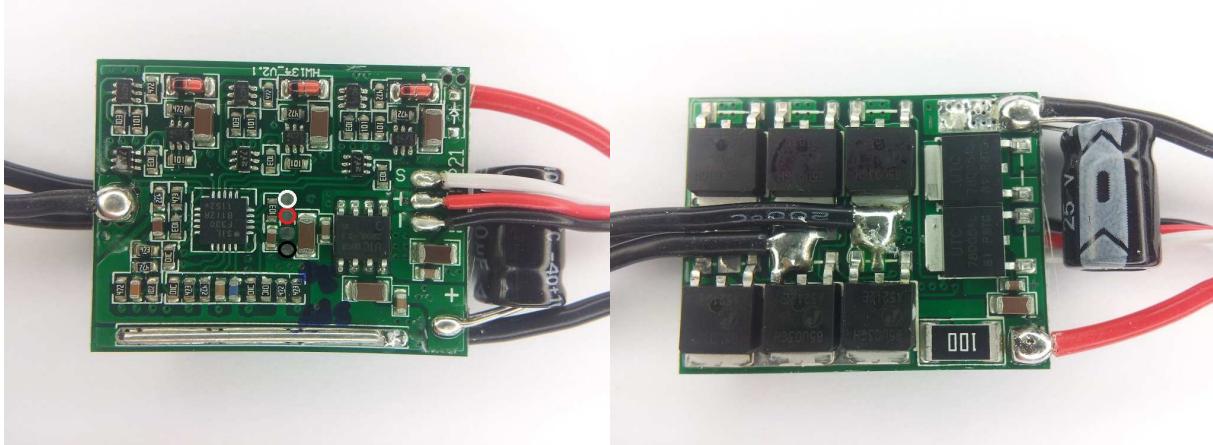
Switching speed is not fast, ~4.5us (on 2S) for pfet to go off.

Also, there is a 2.5us delay in the fet driver that shifts throttle range up, and causes a step in the response from almost full to full throttle.

The ESC is the same as the Plush 12A.

It uses the same code as the Turnigy Plush 12A.

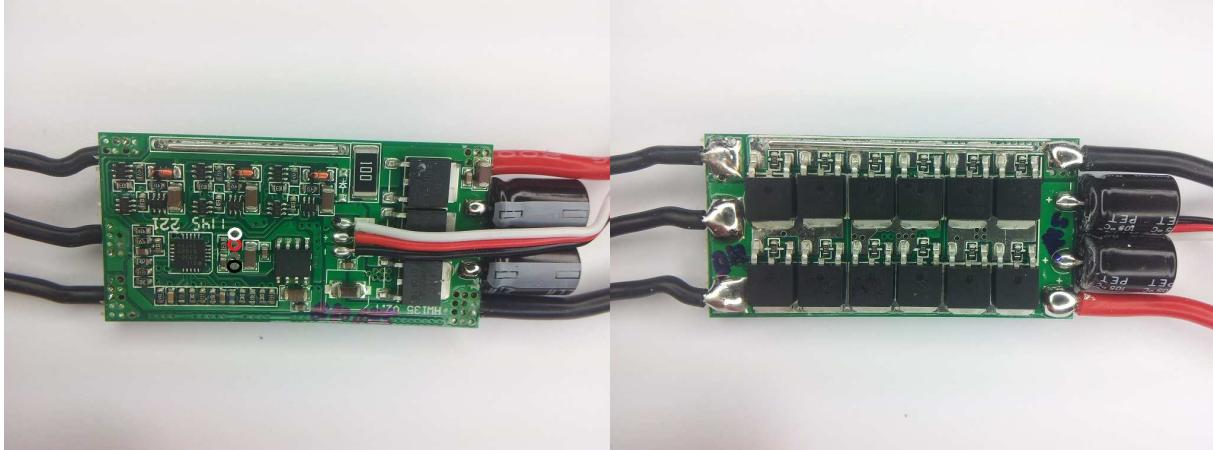
## Hobbywing Skywalker 20A:



The ESC supports 2S to 3S operation. It supports damped light mode. Switching speed is quite fast.

Fet resistances are around 6mohm for low side and high side (max at 10V). Both low and high side fets are Nfets.

## Hobbywing Skywalker 40A:

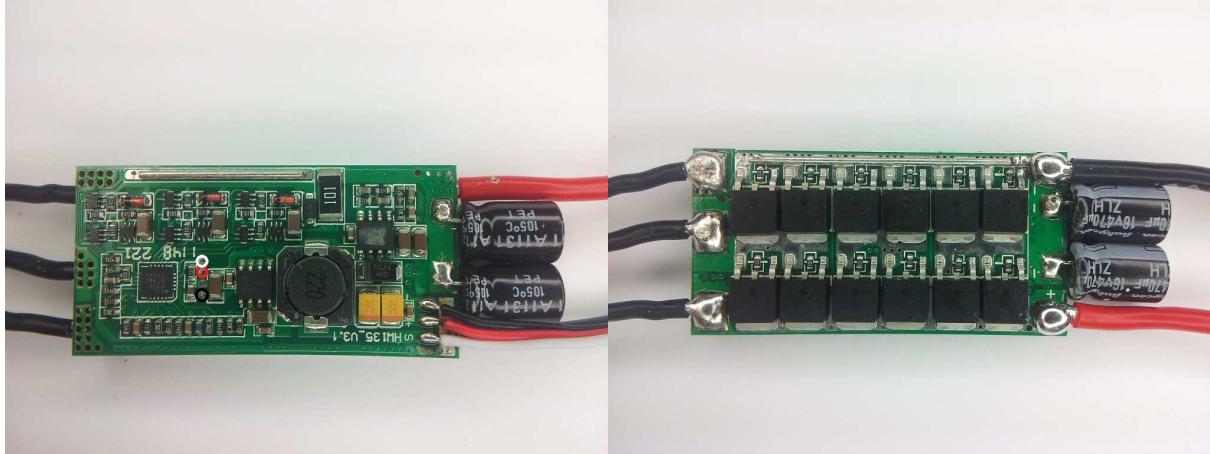


The ESC supports 2S to 3S operation. It supports damped light mode. Switching speed is quite fast.

Fet resistances are around 3mohm for low side and high side (max at 10V). Both low and high side fets are Nfets.

The ESC has a linear BEC.

## Hobbywing Skywalker 40A UBEC:



The ESC supports 2S to 4S operation. It supports damped light mode. Switching speed is quite fast.

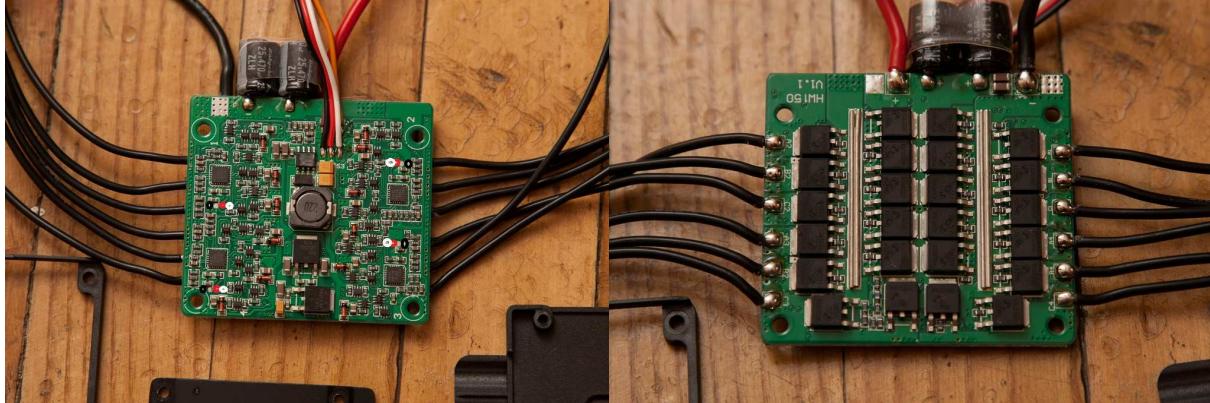
Fet resistances are around 3mohm for low side and high side (max at 10V).

Both low and high side fets are Nfets.

The ESC has a switch mode BEC.

It uses the same code as the Hobbywing Skywalker 40A with linear BEC.

## Hobbywing Skywalker Quattro 20A:



The ESC supports 2S to 3S operation. It supports damped light mode.

Switching speed is quite fast.

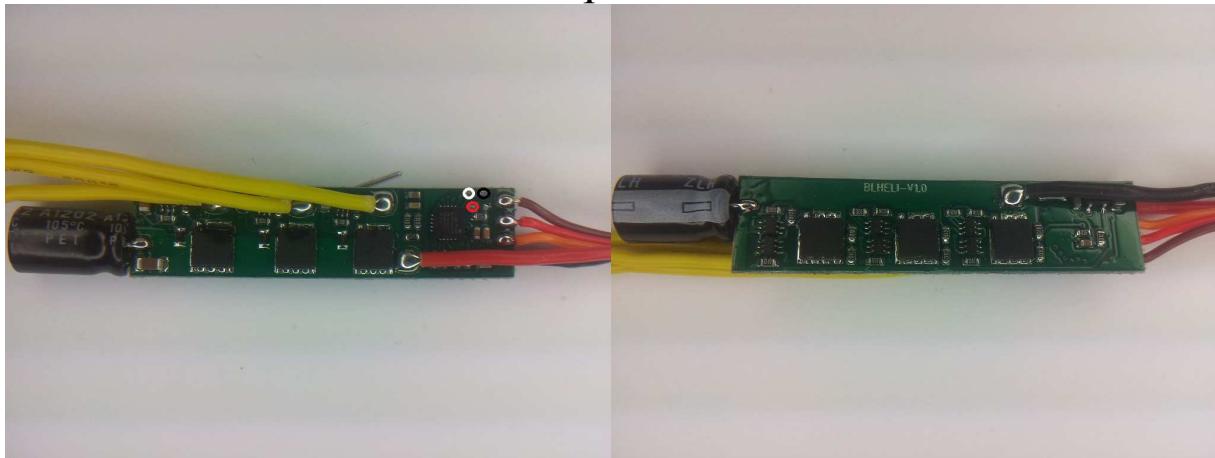
Fet resistances are around 6mohm for low side and high side (max at 10V).

Both low and high side fets are Nfets.

The ESC is also sold as Q brain 20A and 25A.

This ESC uses the same code as the Hobbywing Skywalker 20A ESC.

## HiModel BLHeli Multi 20A opto:



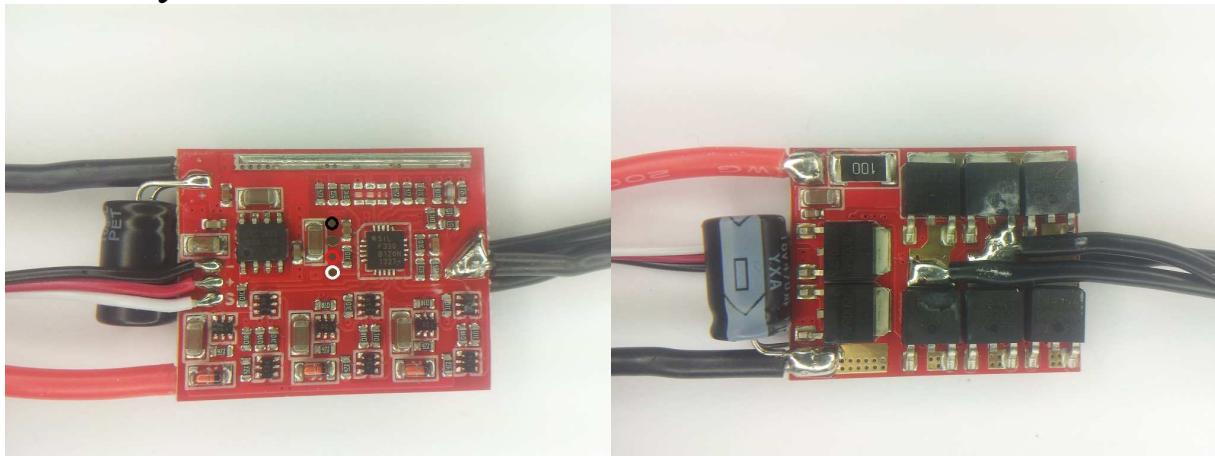
The ESC supports 2S to 4S operation. It supports damped light mode.

Switching speed is quite fast.

Both low and high side fets are Nfets.

This ESC is sold with the "Hobbywing Skywalker 20A" code.

## FVT SkyIII 30A:

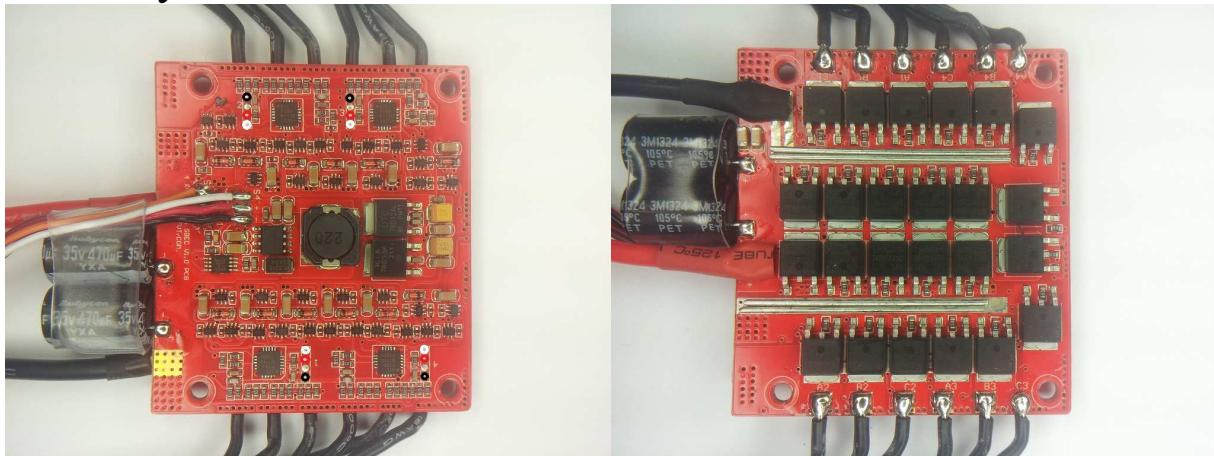


The ESC supports 2S to 4S operation.

Switching speed is quite fast.

Both low and high side fets are Nfets.

## FVT SkyIII 30A 4in1:

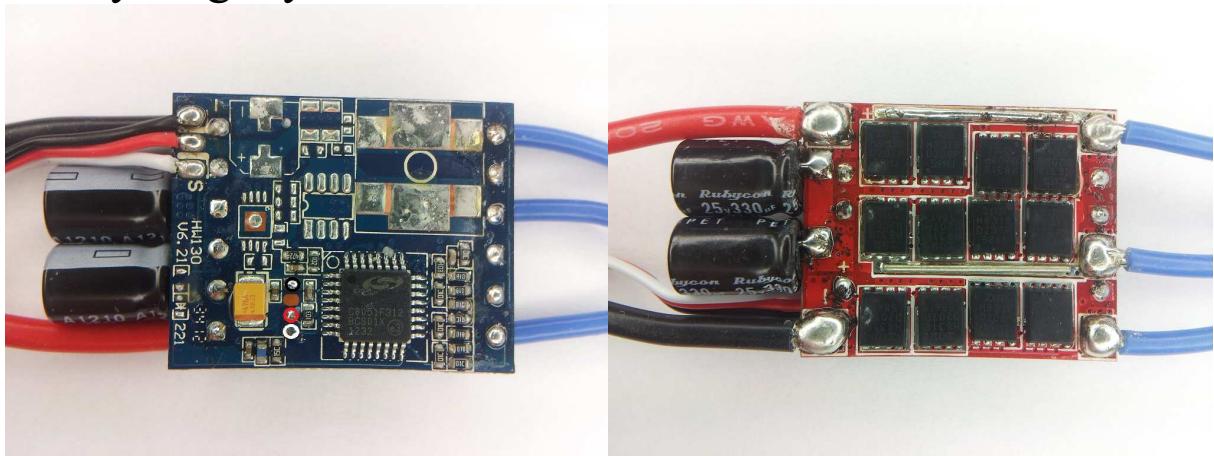


The ESC supports 2S to 6S operation.

Switching speed is quite fast.

Both low and high side fets are Nfets.

## Hobbywing Flyfun 40A OPTO:



The ESC supports 2S to 6S operation. It supports damped light mode.

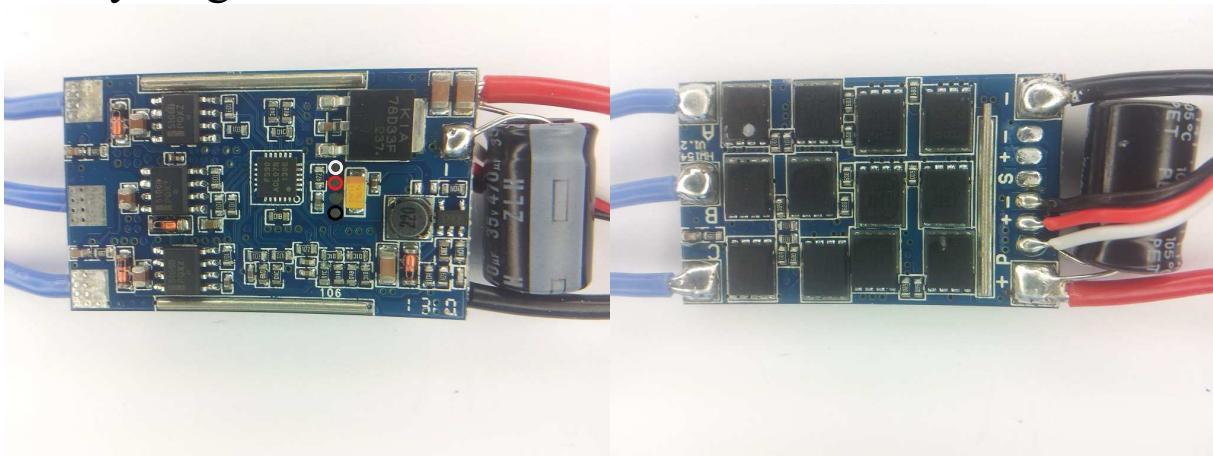
Switching speed is quite fast.

Fet resistances are around 1.3mohm for low side and high side (typ at 10V).

Both low and high side fets are Nfets.

This ESC uses the same code as the Plush 40A ESC.

## Hobbywing Platinum Pro 30A OPTO:

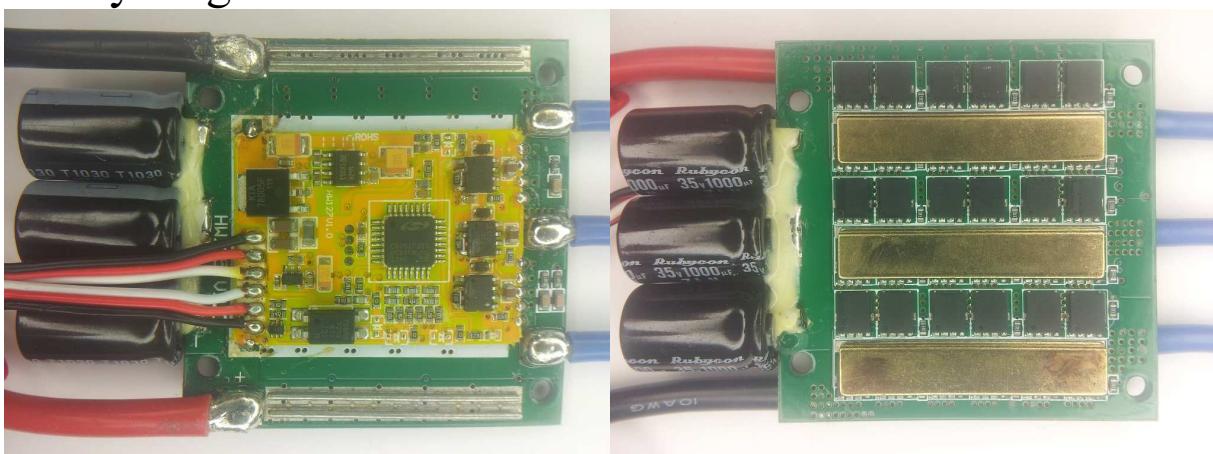


The ESC supports 2S to 6S operation. It supports damped light mode.  
Switching speed is quite fast.

The MCU runs at 50MHz.

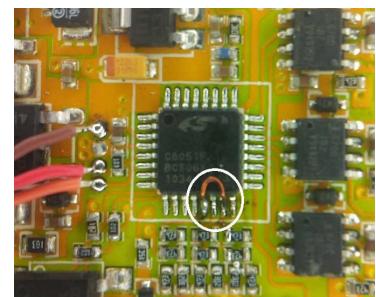
Fet resistances are around 1.25mohm for low side and high side (typ at 10V).  
Both low and high side fets are Nfets.

## Hobbywing Platinum Pro 150A OPTO:

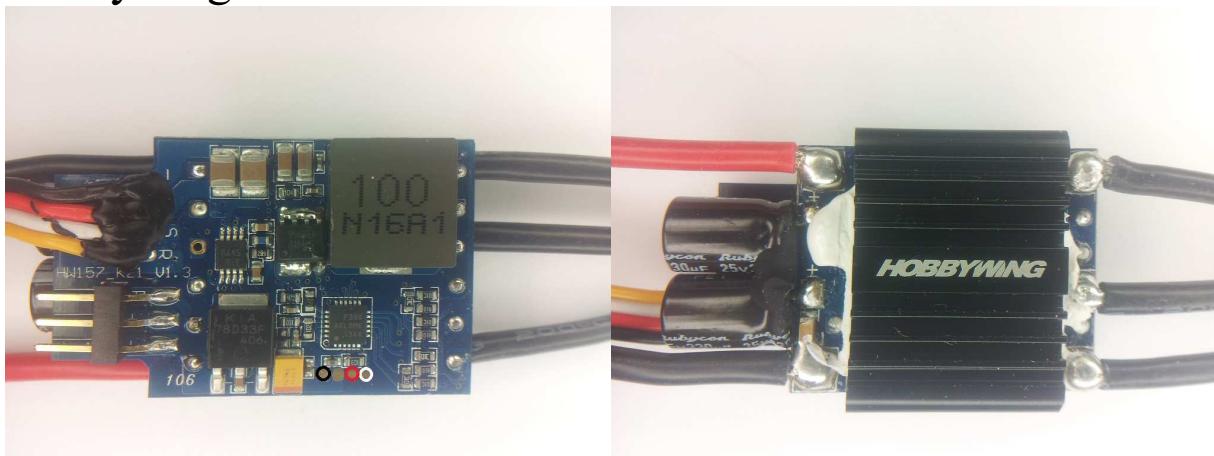


The ESC supports 2S to 6S operation. It supports damped light mode.  
Switching speed is quite fast.  
Both low and high side fets are Nfets.

The ESC needs a small modification.  
Two pins on the MCU must be bridged as shown.

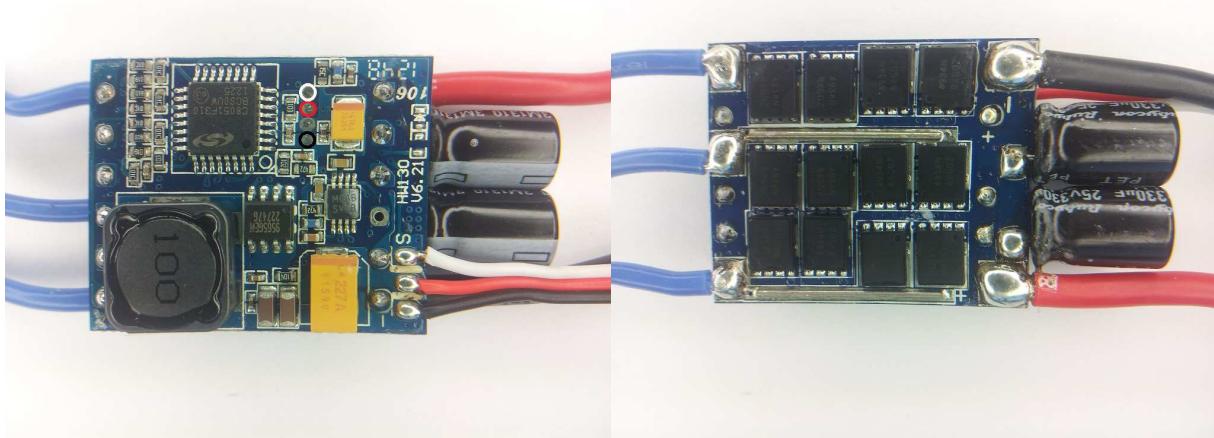


## Hobbywing Platinum 50A v3:



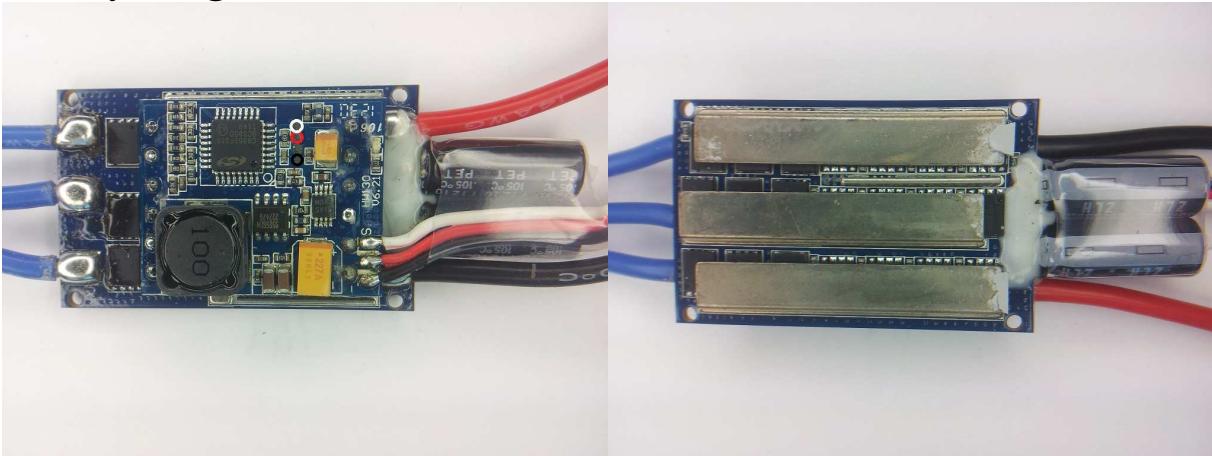
The ESC supports 2S to 6S operation. It supports damped light mode.  
It supports triple voltage BEC and RPM output.  
Switching speed is quite fast.  
The MCU runs at 50MHz.  
Both low and high side fets are Nfets.

## Hobbywing Platinum Pro 40A:



The ESC supports 2S to 6S operation. It supports damped light mode.  
Switching speed is quite fast.  
Fet resistances are around 0.75mohm for low side and high side (typ at 10V).  
Both low and high side fets are Nfets.  
This ESC uses the same code as the Plush 40A ESC.

## Hobbywing Platinum Pro 60A:

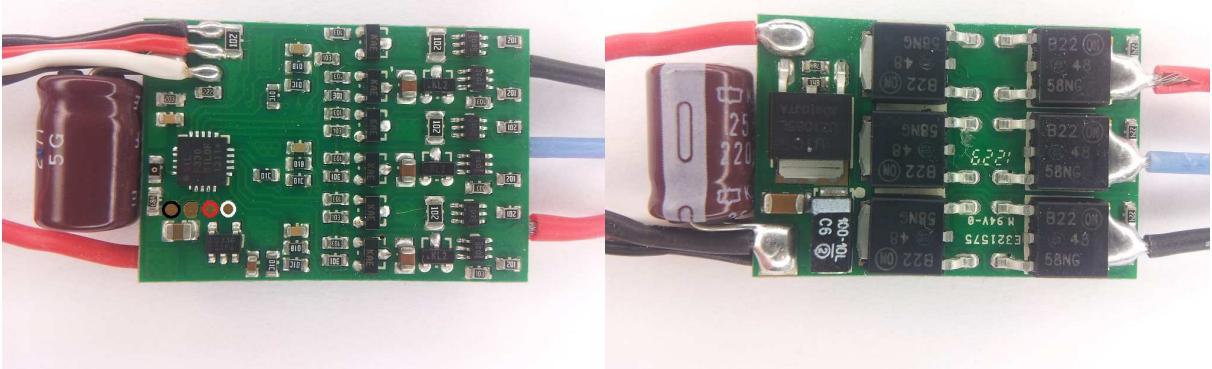


The ESC supports 2S to 6S operation. It supports damped light mode.  
Switching speed is quite fast.

Fet resistances are around 0.68mohm for low side and high side (typ at 10V).  
Both low and high side fets are Nfets.

This ESC uses the same code as the Plush 40A ESC.

## Align RCE-BL15X:

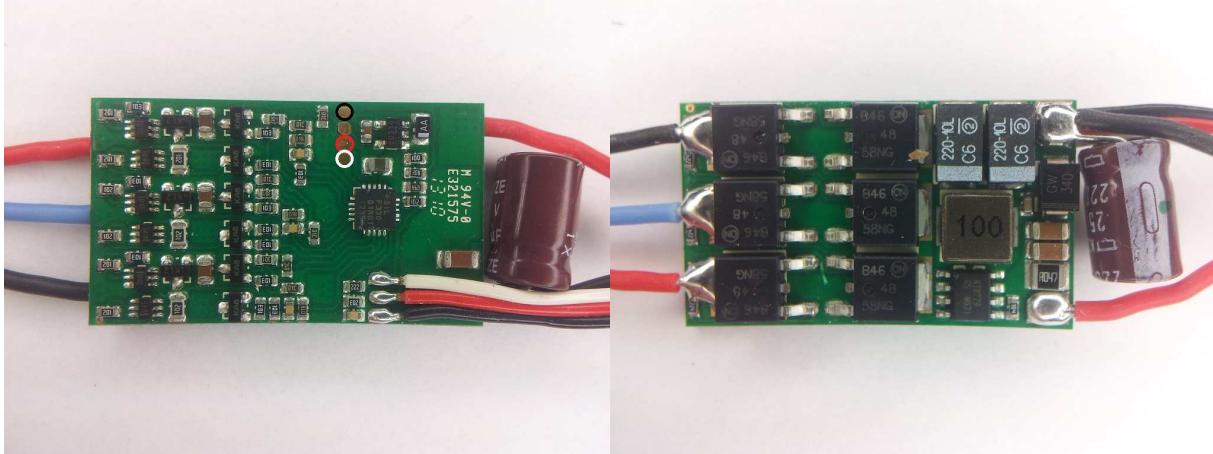


The ESC supports 2S to 4S operation.

Switching speed is quite slow.

Fet resistances are around 5mohm for low side and high side (typ at 10V).  
Both low and high side fets are Nfets.

## Align RCE-BL15P:



The ESC supports 2S to 4S operation.

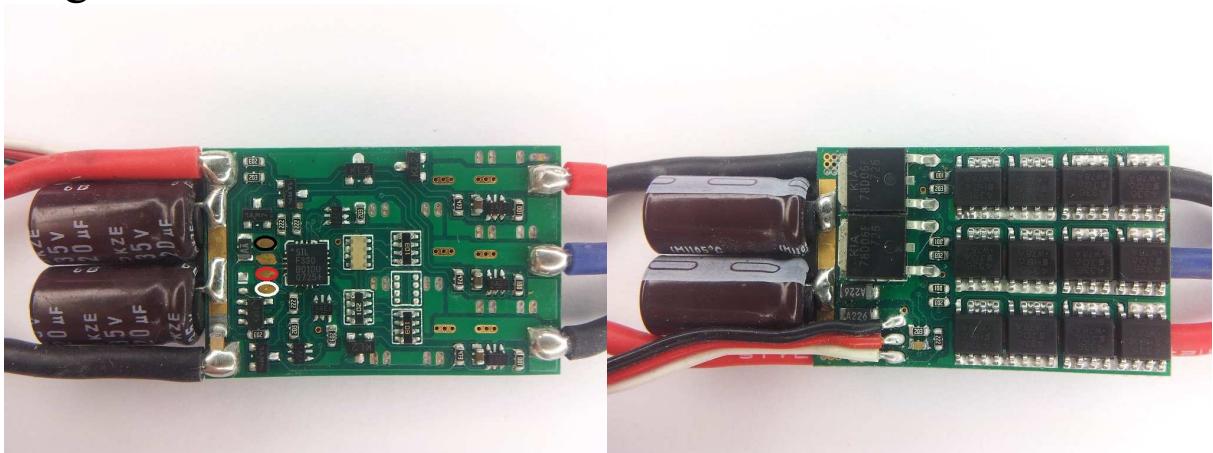
Switching speed is quite slow.

Fet resistances are around 5mohm for low side and high side (typ at 10V).

Both low and high side fets are Nfets.

The ESC has a switch mode BEC.

## Align RCE-BL35X:



The ESC supports 2S to 4S operation. It supports damped light mode.

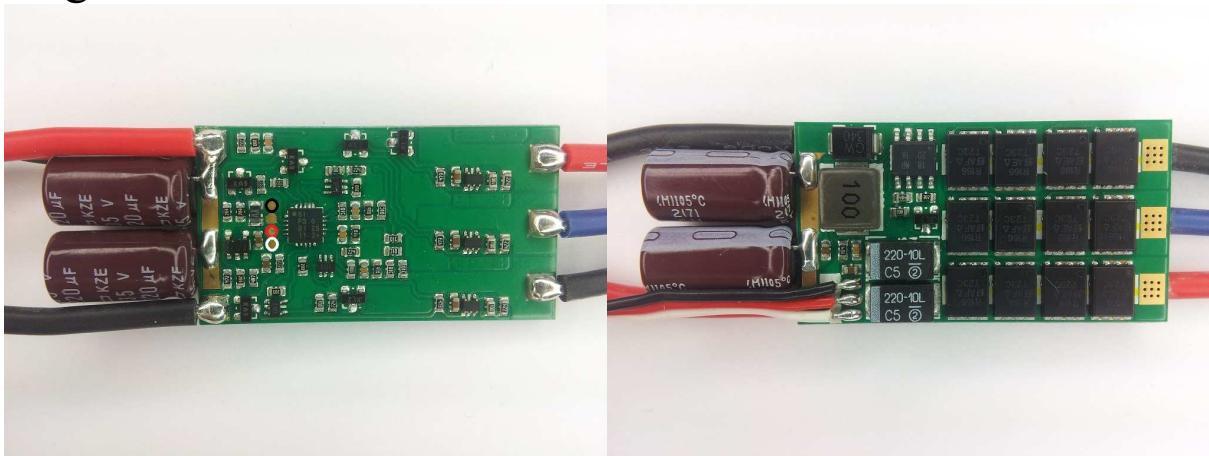
It supports dual voltage BEC, but beware that the low voltage is below 5V.

Switching speed is quite fast.

Fet resistances are around 1.3mohm for low side and high side (max at 10V).

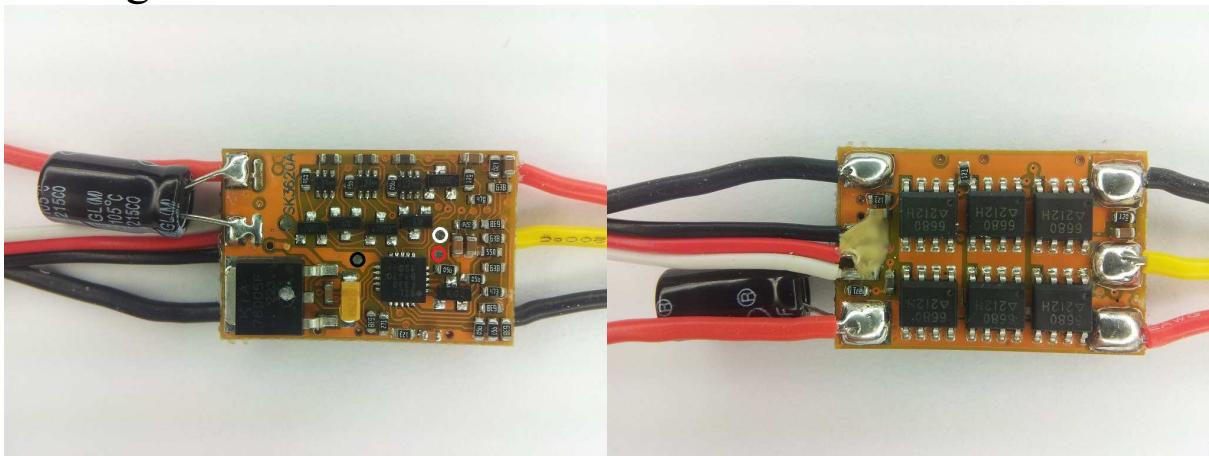
Both low and high side fets are Nfets.

## Align RCE-BL35P:



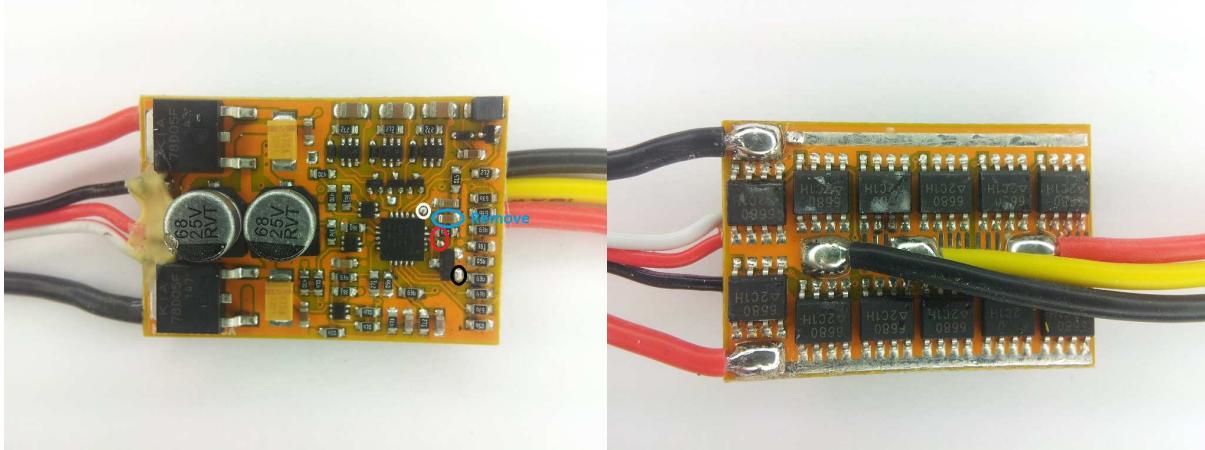
The ESC supports 2S to 4S operation. It supports damped light mode.  
It supports dual voltage BEC, but beware that the low voltage is below 5V.  
Switching speed is quite fast.  
Fet resistances are around 1.3mohm for low side and high side (max at 10V).  
Both low and high side fets are Nfets.  
The ESC has a switch mode BEC.

## H-King 10A:



The ESC supports 2S to 3S operation. It supports damped light mode.  
Switching speed is quite fast.  
Fet resistances are around 8mohm for low side and high side (max at 10V).  
Both low and high side fets are Nfets.  
The ESC is sold as "H-KING 10A Fixed Wing Brushless Speed Controller" and also as "SkyRC Swift 10A ESC For Airplane".

## H-King 20A:



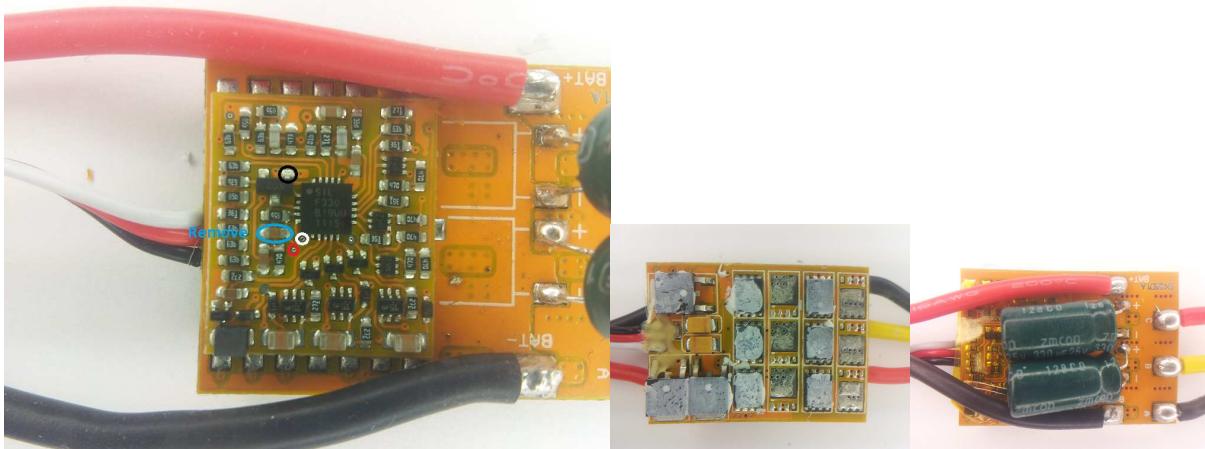
The ESC supports 2S to 3S operation. It supports damped light mode.  
Switching speed is quite fast.

Fet resistances are around 4mohm for low side and high side (max at 10V).  
Both low and high side fets are Nfets.

The circled capacitor must be removed to allow programming!

The ESC is sold as "H-KING 20A Fixed Wing Brushless Speed Controller" and also as "SkyRC Swift 20A ESC For Airplane".

## H-King 35A:



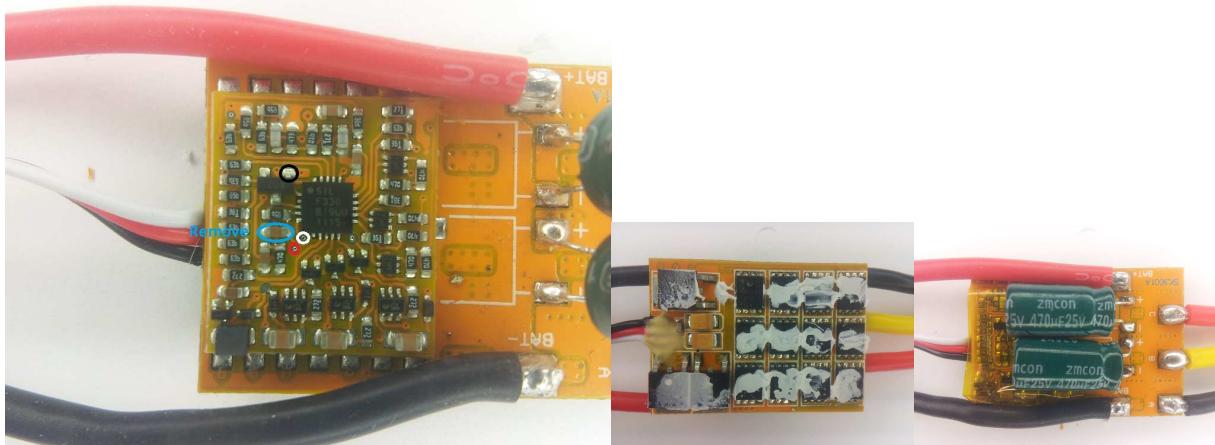
The ESC supports 2S to 4S operation. It supports damped light mode.  
Switching speed is quite fast.

Fet resistances are around 2mohm for low side and high side (max at 10V).  
Both low and high side fets are Nfets.

The circled capacitor must be removed to allow programming!

The ESC is sold as "H-KING 35A Fixed Wing Brushless Speed Controller" and also as "SkyRC Swift 35A ESC For Airplane".

## H-King 50A:



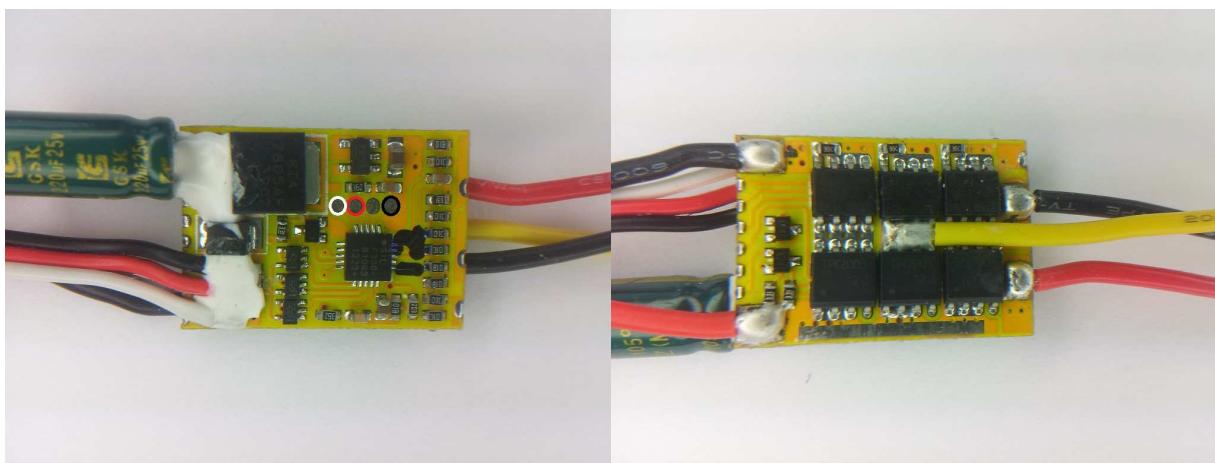
The ESC supports 2S to 4S operation. It supports damped light mode.  
Switching speed is quite fast.

Fet resistances are around 1mohm for low side and high side (max at 10V).  
Both low and high side fets are Nfets.

The circled capacitor must be removed to allow programming!

The ESC is sold as "H-KING 50A Fixed Wing Brushless Speed Controller" and also as "SkyRC Swift 50A ESC For Airplane".

## Polaris Thunder 12A:

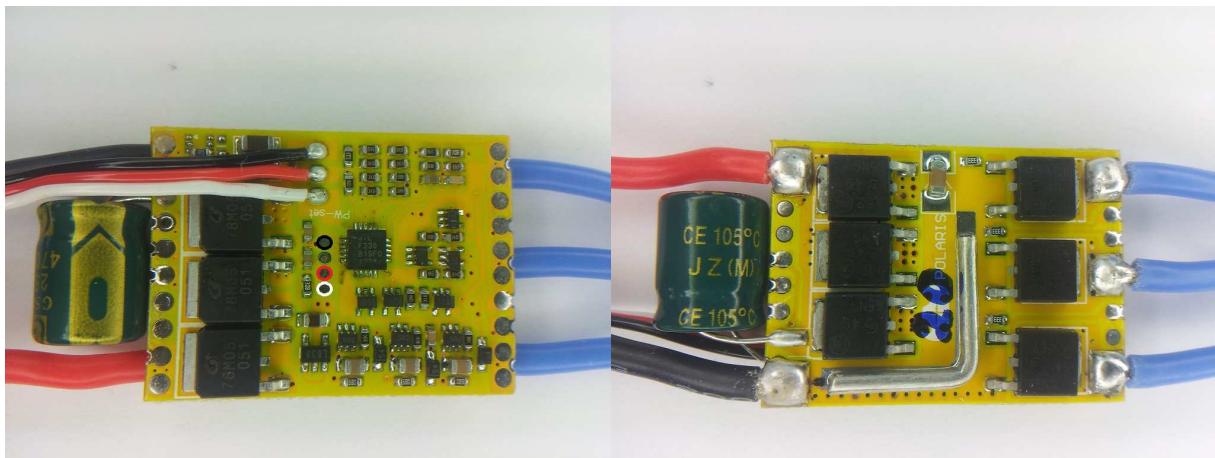


The ESC supports 2S to 3S operation.

Switching speed is slow.

Fet resistances are around 3mohm for N and 10mohm for P (at 10V).

## Polaris Thunder 20A:



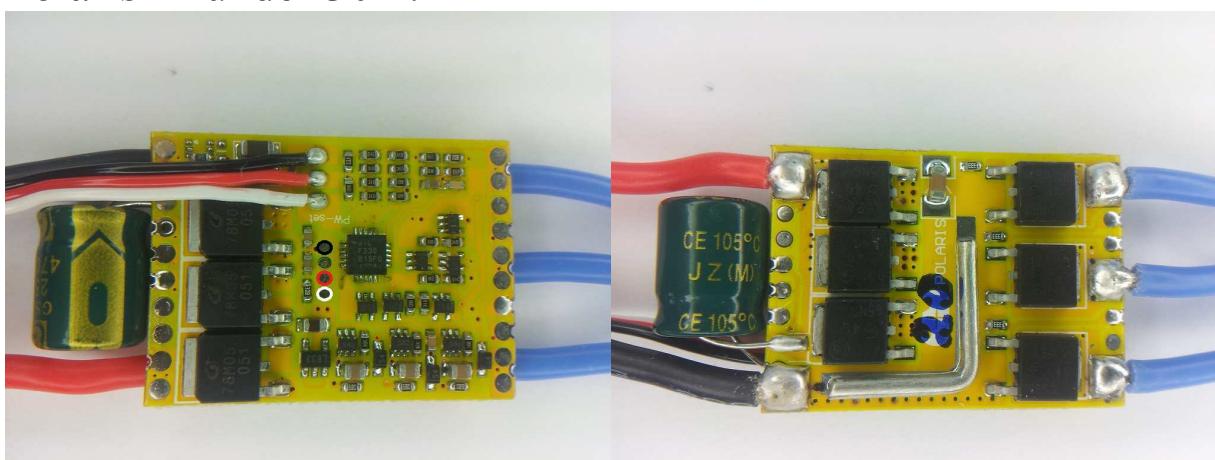
The ESC supports 2S to 4S operation.

Switching speed is slow.

Fet resistances are around 3.5mohm for low side and high side (at 10V).

Both low and high side fets are Nfets.

## Polaris Thunder 30A:



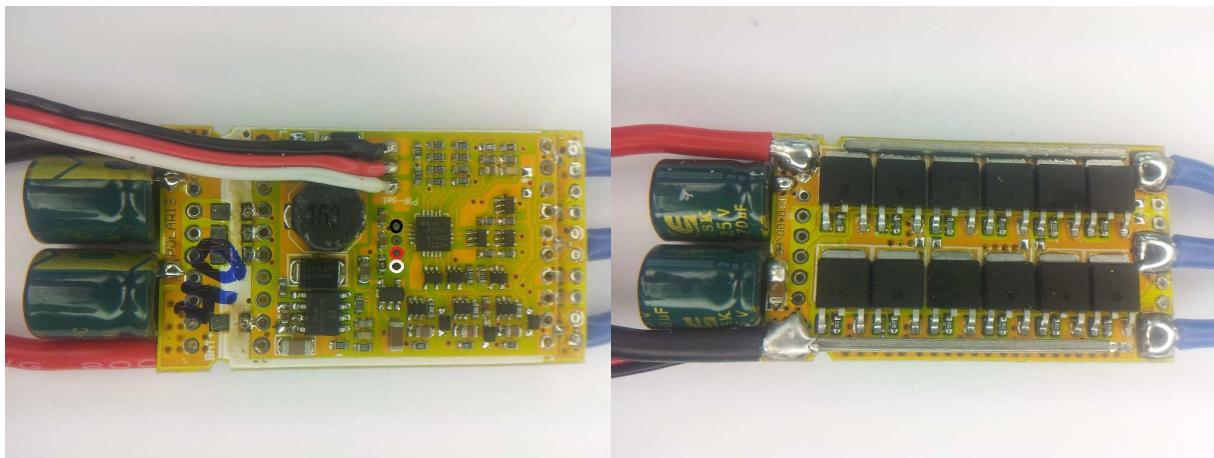
The ESC supports 2S to 4S operation.

Switching speed is slow.

Fet resistances are around 3.5mohm for low side and high side (at 10V).

Both low and high side fets are Nfets.

## Polaris Thunder 40A:



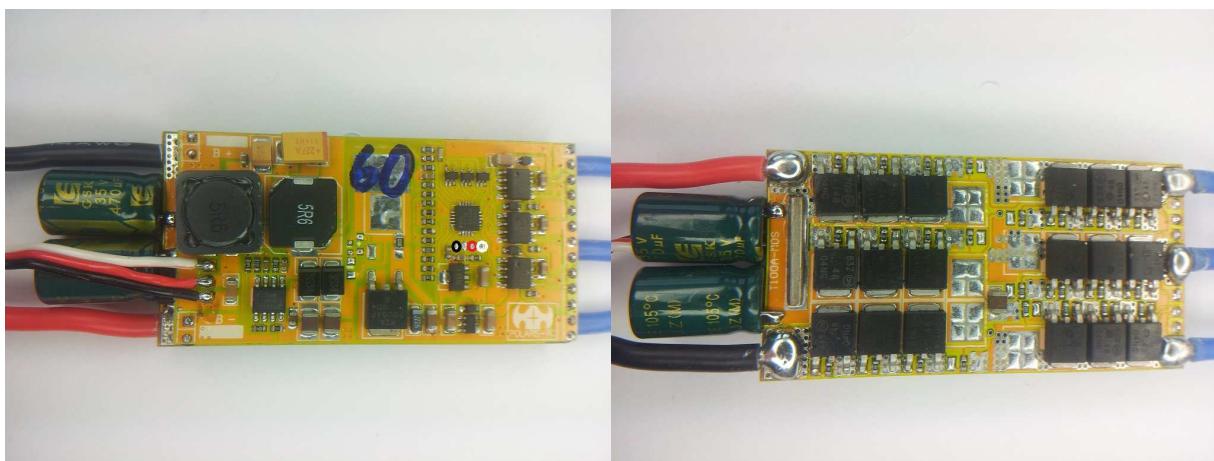
The ESC supports 2S to 4S operation.

Switching speed is slow.

Fet resistances are around 1.3mohm for low side and high side (at 10V).

Both low and high side fets are Nfets.

## Polaris Thunder 60A:



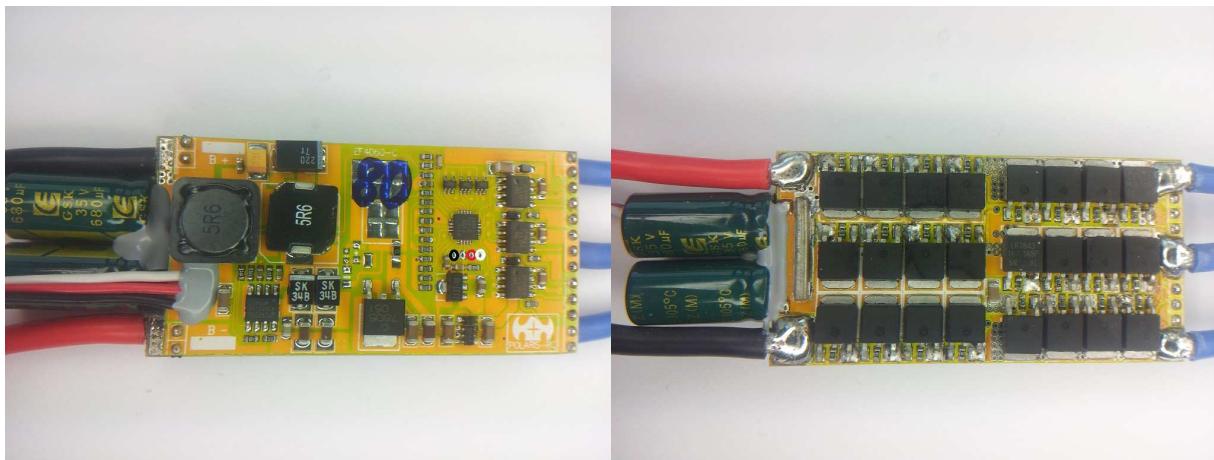
The ESC supports 2S to 6S operation.

Switching speed is quite fast.

Fet resistances are around 1.1mohm for low side and high side (at 10V).

Both low and high side fets are Nfets.

## Polaris Thunder 80A:



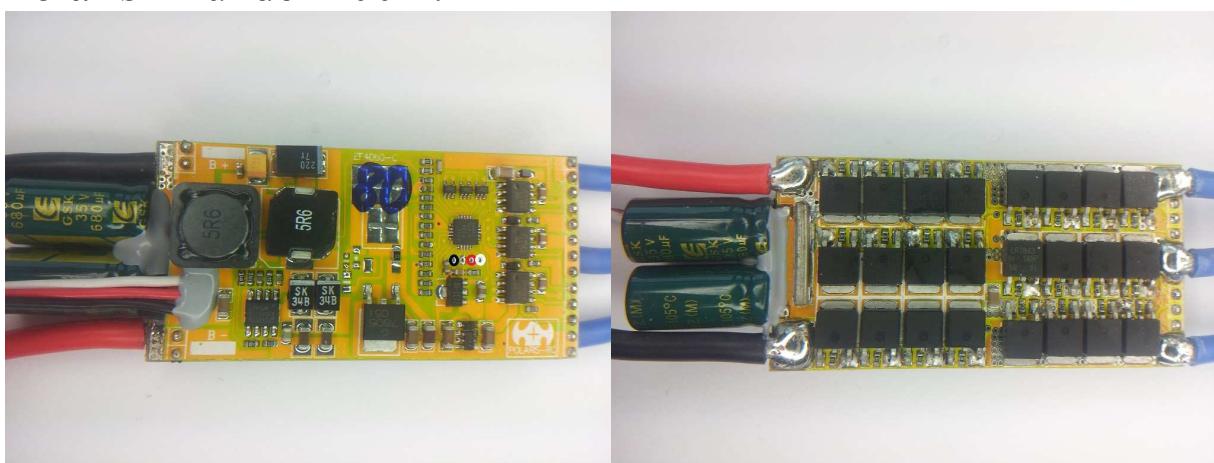
The ESC supports 2S to 6S operation.

Switching speed is quite fast.

Fet resistances are around 0.65mohm for low side and high side (at 10V).

Both low and high side fets are Nfets.

## Polaris Thunder 100A:



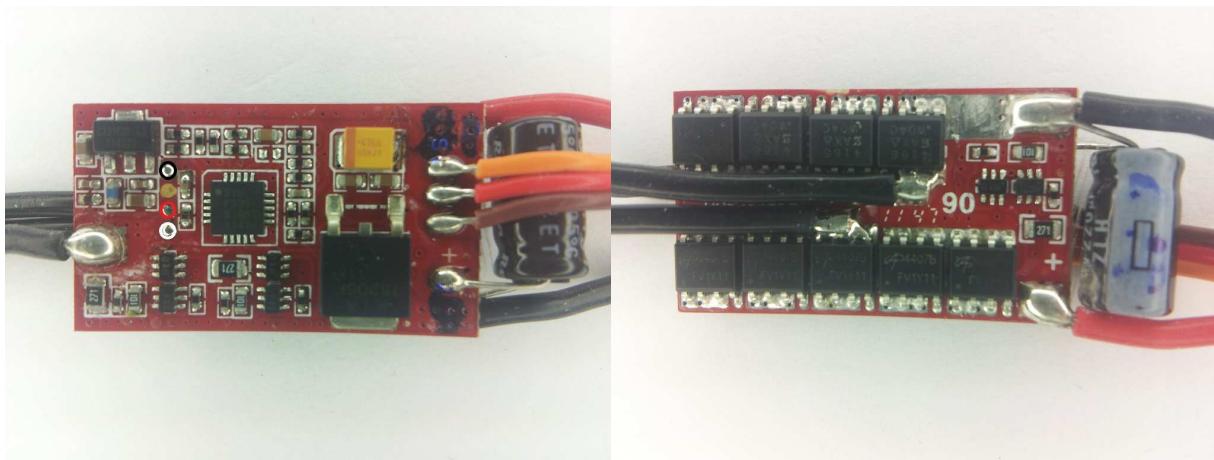
The ESC supports 2S to 6S operation.

Switching speed is quite fast.

Fet resistances are around 0.65mohm for low side and high side (at 10V).

Both low and high side fets are Nfets.

## Gaui GE183 18A:

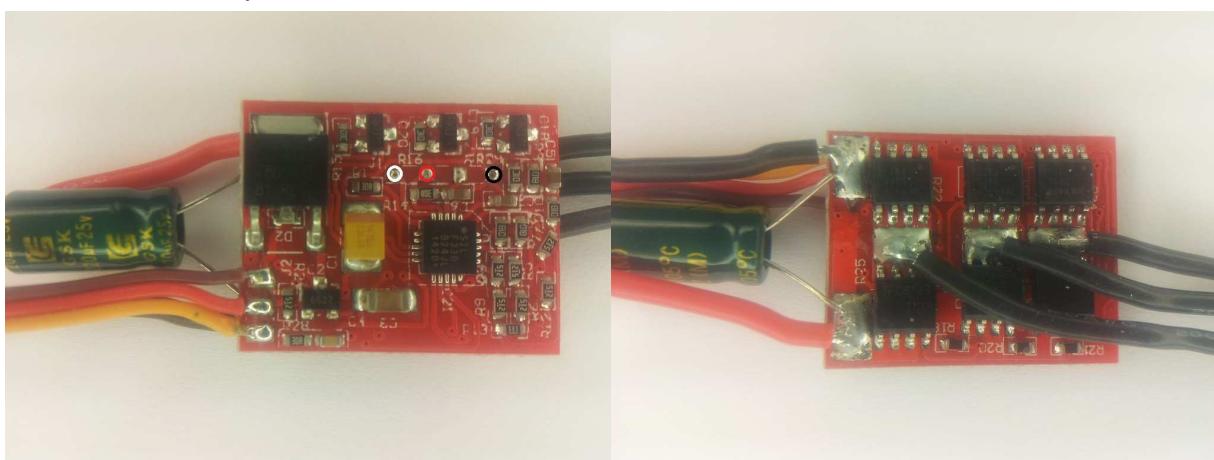


The ESC supports 2S to 3S operation.

Switching speed is slow.

Fet resistances are around 3mohm for N and 5mohm for P (at 10V).

## EMAX 12A:



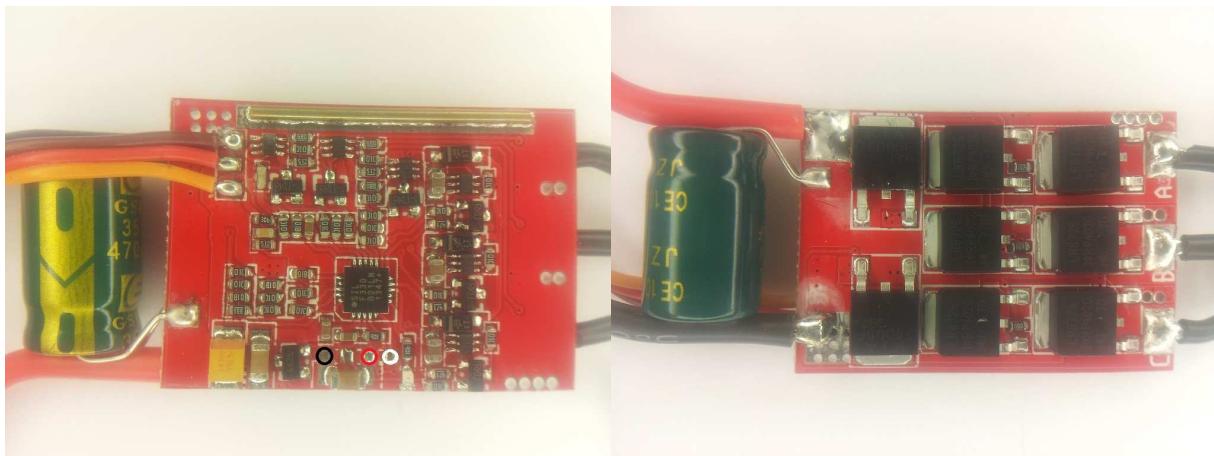
The ESC supports 1S to 3S operation.

Switching speed is slow.

Low side is Nfets and high side is Pfets.

It uses the "XP\_12A\_.." code.

## EMAX 20A:

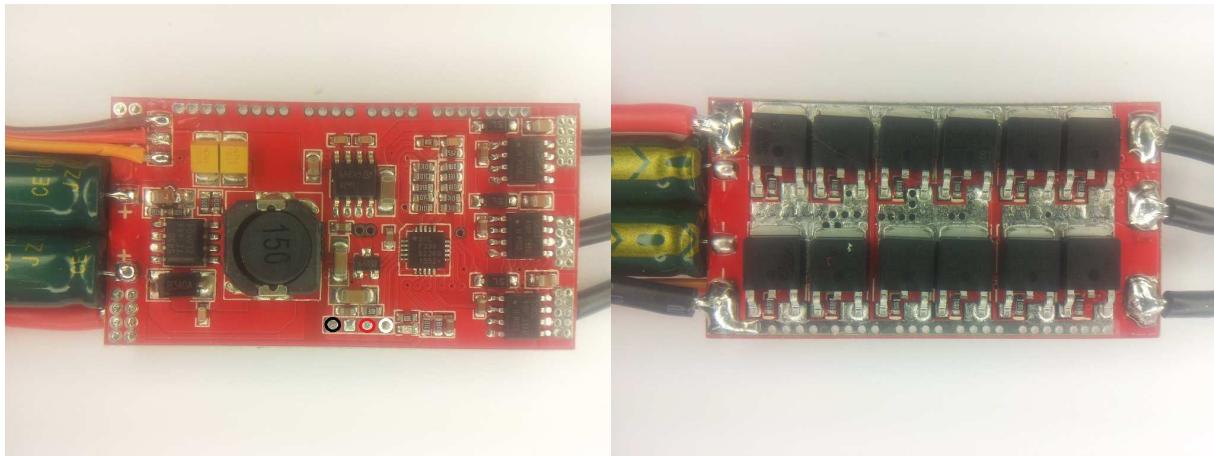


The ESC supports 2S to 3S operation. It supports damped light mode.

Switching speed is quite fast.

Both low and high side fets are Nfets.

## EMAX 40A:

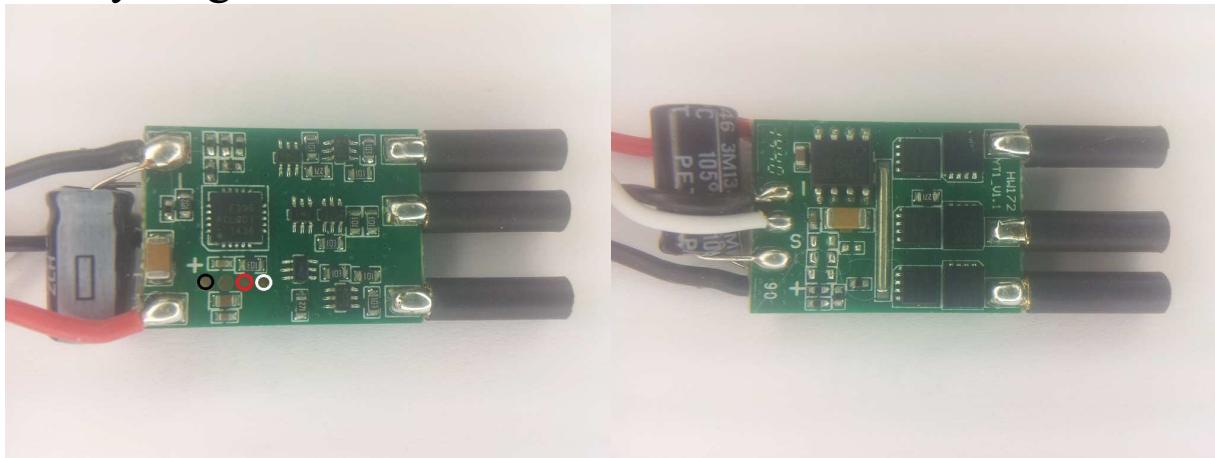


The ESC supports 2S to 6S operation. It supports damped light mode.

Switching speed is fast.

Both low and high side fets are Nfets.

## Hobbywing XRotor 10A:



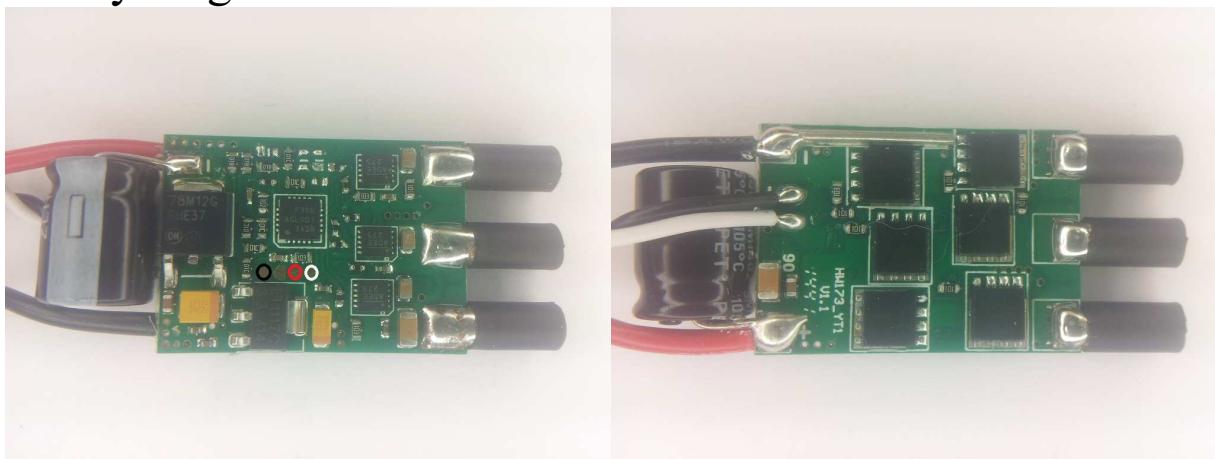
The ESC supports 2S to 3S operation. It supports damped light mode.

Switching speed is somewhat fast.

The MCU runs at 50MHz.

Low side is Nfets and high side is Pfets.

## Hobbywing XRotor 20A:



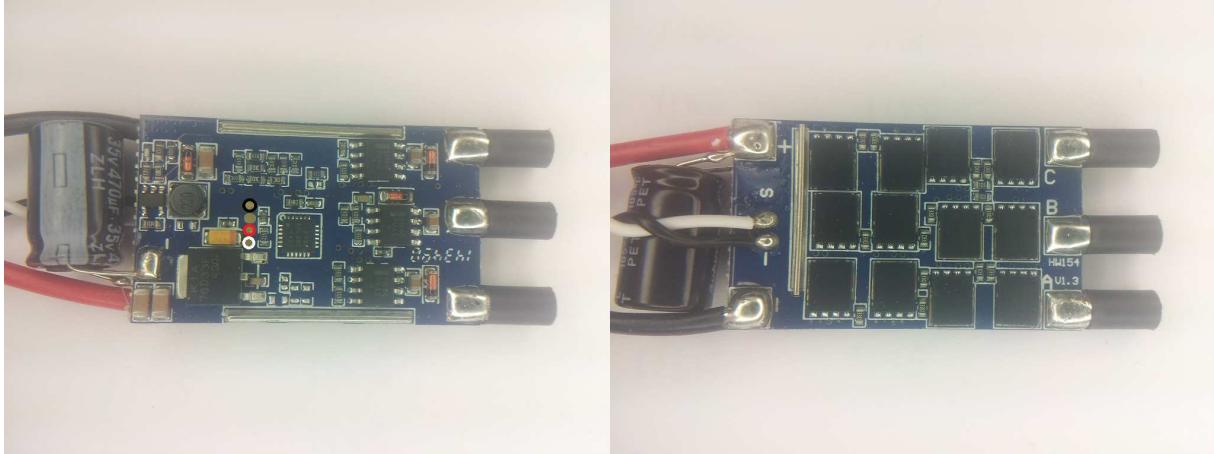
The ESC supports 3S to 4S operation. It supports damped light mode.

Switching speed is somewhat fast.

The MCU runs at 50MHz.

Both low and high side fets are Nfets.

## Hobbywing XRotor 40A:



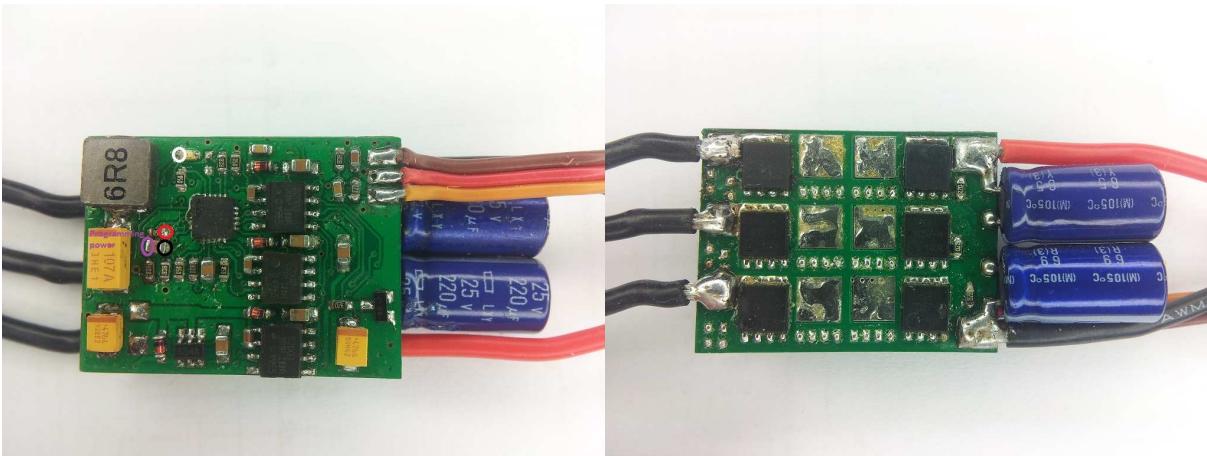
The ESC supports 2S to 6S operation. It supports damped light mode.

Switching speed is fast.

The MCU runs at 50MHz.

Both low and high side fets are Nfets.

## HiModel Cool 22A:



The ESC supports 2S to 4S operation.

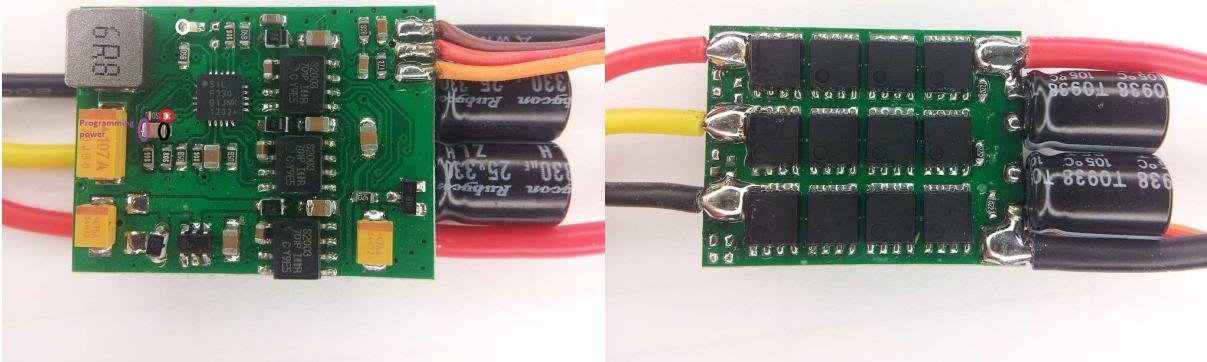
Switching speed in stock form is very slow.

Fet resistances are low according to FET markings. Around 2mohm for low side and high side (typ at 10V). Both low and high side fets are Nfets.

It has a 5V/4A switch mode BEC.

If programming an unmodified ESC, the ESC must not be powered. A 1S battery below 3.8V or similar shall be applied to the purple circle. The LED at the white circle may also have to be removed.

## HiModel Cool 33A:



The ESC supports 2S to 4S operation.

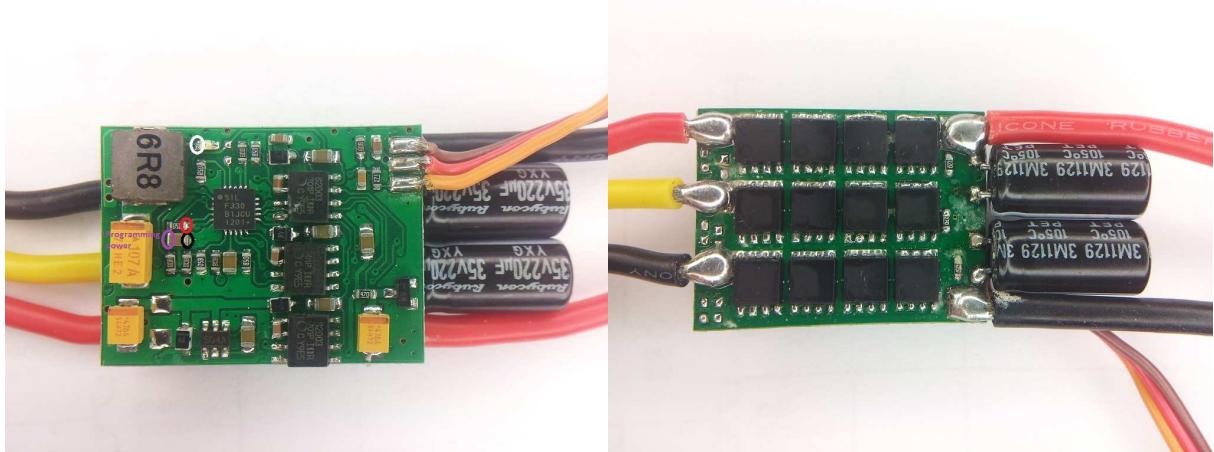
Switching speed in stock form is very slow.

Fet resistances are low according to FET markings. Around 1.5mohm for low side and high side (typ at 10V). Both low and high side fets are Nfets.

It has a 5V/4A switch mode BEC.

If programming an unmodified ESC, the ESC must not be powered. A 1S battery below 3.8V or similar shall be applied to the purple circle. The LED at the white circle may also have to be removed.

## HiModel Cool 41A:



The ESC supports 2S to 4S operation.

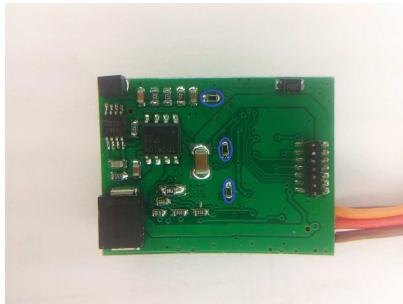
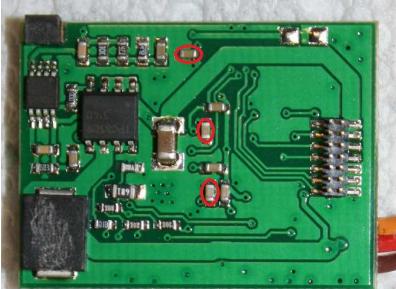
Switching speed in stock form is very slow.

FET resistances are low according to FET markings. Around 1mohm for low side and high side (typ at 10V). Both low and high side fets are Nfets.

It has a 5V/4A switch mode BEC.

If programming an unmodified ESC, the ESC must not be powered. A 1S battery below 3.8V or similar shall be applied to the purple circle. The LED at the white circle may also have to be removed.

## Recommended HiModel Cool 22A/33A/41A modification:



The left picture above shows the back side of the control board unmodified, for two different versions of it.

The three capacitors circled in red are on the MCU outputs to the Nfet drivers. These capacitors slow nFET switching. Also, the Nfet output lines should have pulldown resistors in order to ensure that the fets are off when the MCU is reset (as it is during programming).

Therefore these capacitors should be replaced by 10kohm pulldown resistors, as shown and circled in blue on the right picture (this is shown only for one version of the board).

With this modification, the ESC can safely be programmed and parameters changed (with configuration software like BLHeliSetup) with battery connected.