

Brushless setup - driving esc's - firmware settings. Revised Jan 01, 2017.

Unfortunately much of this information is 12 months old, and no longer correct. I will rewrite it soon. Jan. 19th Jan 2017.

This page follows on from the first brushless page with a little more detail about setting up a silverwared FC to control a quad with brushless motors. There are instructions for H8 mini green, H8 mini blue, H101 and CG023 boards, for setting up either PPM, PWM or Dshot. These instructions assume the dual version firmware of the H8 mini green and H101 firmwares are used, as opposed to the acro only versions that are also available. It does not cover setting up 3D flying with the H101 board, refer to SirDomsen's H101 Brushless Mod page for 3D info and setup.

PPM, PWM and DSHOT

Most brushless quads use a PPM signal to drive their esc's. Also, PPM is used by model aircraft receivers to control the servo's and an esc for the motor, so it is basically the conventional way to drive an esc.

Dshot is a digital throttle signal sent to the esc in the form of a binary number, as opposed to a pulsewidth or pulse position signal. The esc's do not need to be calibrated when using Dshot. Dshot can be run on BLHeli_S esc's with BLHeli firmware revision 16.5 or later.

However, the default signal from a silverwared FC is a PWM signal that drives the brushed motors with an FET. This PWM signal can be used to drive an esc if you can connect to the esc with BLHeliSuite and set the "Enable PWM Input" to on. When enable pwm input is set to on, the esc will accept either PWM or PPM signals, it is auto-detected by the esc. If the enable pwm input is set to off, (this is the default BLHeli setting), the esc will only work with PPM signals. In later BLHeli firmware revisions from around 16.4 onwards, PWM input enable is no longer an option, and Dshot was introduced. From Revision 16.5 onwards, the esc's can auto-detect PPM or Dshot signals, but cannot use brushed PWM signals.

PPM and Dshot

With PPM output you can technically run any standard esc regardless of the esc firmware, even if it does not support BLHeli firmware, however, if you are going to buy some esc's for a build it is recommended to purchase esc's that have, or can use, BLHeli firmware

If you have BLHeli flashable esc's and want to connect to it to check or change the settings, you will need an interface between BLHeliSuite and the esc. Many people use an Arduino Nano, which is only a few dollars, and the Nano can be flashed by BLHeliSuite to become the interface to connect to many different esc's. An alternative is to buy an esc programmer for your particular esc's, and this will serve as the BLHeliSuite/esc interface instead of the Arduino Nano.

PPM and DSHOT FIRMWARE SETTINGS FOR H8 MINI BLUE, CG023, H8 MINI GREEN and H101.

In a nutshell, these are the esc drive options for the following firmwares:

H8 mini blue: PPM or oneshot, both with adjustable freq option. Select "USE_ESC_DRIVER" in hardware.h Esc settings are in drv_esc.c. A Dshot 150/300/600 beta version is being tested right now (May 2017).

CG023: PPM, oneshot or oneshot42 all with adjustable freq option. Select "USE_ESC_DRIVER" in hardware.h Esc settings are in drv_esc.c. A Dshot 150/300/600 beta version is being tested right now and is included in the current CG023 firmware (May 2017). The settings are found in the drv_dshot.c file.

H8 mini green: PPM with adjustable freq, oneshot125 option, Dshot150 and Dshot300. Select "USE_ESC_DRIVER" or "USE_DSHOT_DRIVER" in hardware.h Esc settings are in drv_esc.c or drv_dshot.c

H101: PPM with adjustable freq, oneshot125 option, Dshot150, Dshot300, and bi-directional (3D) control. Select "USE_ESC_DRIVER" or "USE_DSHOT_DRIVER" in hardware.h Esc settings are in drv_esc.c or drv_dshot.c

How to set up the Dshot esc driver:

The H8 mini green and H101 have a Dshot option that can be selected if you want to use it with Dshot compatible BLHeli_S esc's. The Dshot esc driver is selected in hardware.h. Then, in drv_dshot.c, select either DSHOT150 or DSHOT300, and adjust the IDLE_OFFSET number if you need to, in order to set the desired "idle" speed.

Note for Dshot: The signal can only be taken from before the FET (FET gate) for it to work. The Dshot driver (drv_dshot.c) has no provision to set the polarity.

How to set up the PPM esc driver:

In **hardware.h** - the esc PPM driver is selected instead of the default PWM driver

In **drv_esc.c** - the esc min throttle, esc max throttle and throttle_off values are set

Change the code in the **hardware.h** file to look like this to enable the esc PPM driver:

```
//#define USE_PWM_DRIVER
#define USE_ESC_DRIVER
//#define USE_DSHOT_DRIVER
```

For the **drv_esc.c** file changes, have a look at the BLHeli [screenshot](#) of this esc. Notice the values in the bottom right corner in BLHeli, PPM Min Throttle 1148 and PPM Max Throttle 1832. These are BLHeli default values, and they need to be entered into the drv_esc.c file as shown below.

A note from the first brushless page (written by the firmware author):

"The PPM limits are usually found in the esc driver file, and should be set correctly. They do not necessarily correspond with the esc set limits, they may be slightly different. Especially important is the "minimum" limit, as the brushless motors should never stop in flight. The minimum limit should be set slightly higher in the code for this reason. A throttle check should be used to make sure the motors never stop above zero throttle."

```
#define ESC_MIN 1160
#define ESC_MAX 1832
```

You can see I have added 12 to 1148 to get the 1160 ESC_MIN value, that is just a guess and will have to be fine-tuned for the quad. The final number might be 1170 for example, depending on the hardware in the quad. Another reason for adjusting the ESC_MIN value is to get a clean motor start, it can be adjusted to give a good "idle" speed where the motors will start and run reliably. If it is too high, the quad may lift off at minimum motor speed, so set it as low as possible, but high enough to still get consistent motor starts, and not stall during flight at low (but not "off") throttle position.

```
#define ESC_THROTTLEOFF 960
```

This tells the FC processor what signal to send to the esc to indicate throttle off condition. (It has nothing to do with BLHeli). 960 works for me, possibly any value from 900 to 1000 will work.

Finally, the PPM signal polarity needs to be set in drv_esc.c. If you are taking the signal from after the FET, from the motor output - (neg) pad, the signal must be inverted in the firmware because the FET also inverts it, (by inverting twice, the signal ends up having the correct polarity).

Setting the esc signal polarity for H8 mini blue and CG023:

If you are taking the signal from after the FET with pullup resistors to drive the esc, the polarity would be set

inverted:

```
// invert = signal after fets (may need 1k pullup resistor)
// commented = signal straight from CPU pins
#define ESC_INVERT_SIGNAL
```

If you are taking the signal from the gate of the FET (straight from the CPU pins) to drive the esc, the polarity would be set non-inverted, like this:

```
// invert = signal after fets (may need 1k pullup resistor)
// commented = signal straight from CPU pins
//#define ESC_INVERT_SIGNAL
```

Setting the esc signal polarity for H8 mini green and H101:

If you are taking the signal from after the FET with pullup resistors to drive the esc, the polarity would be set inverted:

```
// output polarity ( low - motor output with pullup resistor (500 ohms or
near) )
// enable for motor output after fets
#define INVERTED_PWM
```

If you are taking the signal from the gate of the FET (straight from the CPU pins) to drive the esc, the polarity would be set non-inverted, like this:

```
// output polarity ( low - motor output with pullup resistor (500 ohms or
near) )
// enable for motor output after fets
//#define INVERTED_PWM
```

PWM

For PWM (brushed motor output), a BLHeli flashable esc has to be used to enable the pwm input of the esc. To flash an esc, or just connect to it to check or change the settings, you will need an interface between BLHeliSuite and the esc. Many people use an Arduino Nano, which is only a few dollars, and it can be flashed by BLHeliSuite to become the interface to connect to many different esc's. An alternative is to buy an esc programmer for your particular esc's, and this will serve as the BLHeli/esc interface instead of the Arduino Nano.

When you connect an esc to BLHeliSuite, there is a box labelled "Enable PWM Input". In this box, the slider must be set to ON and the setting written to the esc by clicking on the Write Setup button. Then confirm the settings have been written by clicking on the Read Setup button. Note: BLHeli_S esc's do not support PWM Input. For BLHeli_S you must use the PPM method to drive the esc.

If you are using resistors (and therefore taking the signal for the esc's after the FET), the Input Polarity in BLHeliSuite must be set to Negative. If you are taking the signal from the gate of the FET, Input Polarity would be set to the default setting Positive.

PWM FIRMWARE SETTINGS

For PWM there are only a couple of things to change in the firmware in **config.h**. The motor PWM has to be set to 1kHz, 2kHz, 4kHz, 8kHz or 12kHz. These are the values that BLHeli firmware will accept. I have used mostly 8kHz. With PWM, you have to manually arm the esc by raising and then lowering the throttle.

For the H8 mini green and H101 board set (in config.h):

```
#define MOTOR_CURVE_NONE  
#define PWM_8KHZ
```

For H8 mini blue board and CG023 set (in config.h):

```
#define PWMFREQ 8000  
#define MOTOR_CURVE_NONE
```

For the H8 mini green, H8 mini blue, H101 and CG023 code, the min motor speed is also changed in config.h. The line `MOTOR_MIN_ENABLE` has to be uncommented, and the `MOTOR_MIN_VALUE` has to be set, usually to a value between 0.06 and 0.12 (lower for 3S and higher for 2S battery). This sets the minimum motor speed that the motors will spin at, and if it is too low, the motors will not start together cleanly. If it is too high, the quad may lift off at minimum motor speed, so start with a low value and work up. Silverxxx recommends testing it with the "motors_to_throttle" option, as that way you can clearly see if they start and run properly.

```
// limit minimum motor output to a value (0.0 - 1.0)  
#define MOTOR_MIN_ENABLE  
#define MOTOR_MIN_VALUE 0.07
```

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