quadcopter Documentation

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Contents

This site holds various information about my quadcopters. This will help me remember how to do it all again if I need to and may even help someone else embarking on a similar journey.

Overview

This section contains information on various aspects of a multicopter.

Flight Controller

This section contains information on flight controllers.

Buzzer

Fitting a buzzer is useful for a number of reasons. A buzzer provides a simple mechanism to warn you of low battery. Just fly it past you every so often. This is especially useful if you don't have an OSD.

When a buzzer is connected, three beeps immediately after powering the board means that the gyroscope calibration has completed successfully.

If you arm/disarm via the control stick, holding the stick in the disarm position will sound a repeating tone. This can be used as a lost-model locator so long as the quad still has a functioning receiver.

Modes

Flight Controllers typically provide a few different modes of operation. These have different names; some of the common names are manual, acro, angle, horizon, rate, etc.

Lets use the Naze32 as the reference. It provides 3 different operating modes; Angle, Horizon and Rate. If you are intending to flying a quad for acrobatics you will want to be flying in Rate mode.

Rate Mode

This is the default mode that the Naze32 operates in. This mode is also commonly referred to as *Manual* or *Acro* mode. Rate mode uses the input from the gyro sensor along with the stick inputs and translates it into the rate at which the quad rotates on that particular axis.

This mode provides pilots with fine control over the motion of the quad allowing the pilot to perform banked turns and precise corrections needed to get through small gaps.

Angle Mode

Angle mode provides attitude control preventing your quad from exceeding 50 degrees in any direction. It uses the accelerometer and the gyroscope to keep the quad levelled.

Once you learn how to fly a quad you may only ever use this mode in an emergency if you lose orientation. Beyond that it is quite limiting for flying anything exciting.

Other flight controllers, such as DJI's NAZA, calls this mode Attitude Mode. DJI's NAZA also provides another similar mode, GPS Attitude, which uses the GPS position as another input to the levelling function.

Horizon Mode

Horizon mode provides an operating mode between Angle mode and Rate mode. It provides levelling stabilization while the pitch/roll stick is near center, then rate mode at its endpoints.

This mode provides pilots with a stabilized flight but still perform rolls and flips when really pushing on the pitch/roll stick.

Super Expo Mode

This setting was intially called *acro plus* but that term has since been deprecated in favour of *super expo*.

At high stick inputs the flight controller applies a proportion of the requested stick input.This mode is used in conjunction with a configuration setting called acro_factor. If *acro_plus* factor is 50, then at full stick deflection the PID authority is reduced by 50% and input control is switched directly to the gyros. This results in fast rolls and importantly, just as much control at all other times.

```
set super_expo_factor = 50
```

PIDS

PID stands for Proportion, Integrate, Derivative control system approach.

PID 1

This is the 32bit rewrite of the original MultiWii 8bit flight control algorithm.

PID 2

This PID setting is called LuxFloat.

Motors

This section discusses quadcopter motors.

KV Rating

The motors used on quadcopters come with a KV rating. The KV rating does not refer to kilo-Volts but rather to a velocity rating constant which relates to the motor's revolutions per minute when a 1V potential is applied to the motor with no load.

Propellors

As a general rule of thumb: the higher the KV rating of the motor the smaller the propellor should be. A lower KV rated motor with a correspondingly larger propellor lifts more weight, uses less current and should be easier to fly steadily. Conversely, higher KV rated motors with correspondingly smaller propellors allow for geater speed but at the cost of reduced efficiency.

Propellors are designated using three measurements. The first is the length. This is typically given in inches. The second measurement is the propellor pitch. The pitch rating defines how far the propellor would drive forward for a single revolution. The greater the pitch the greater the thrust. Thirdly is the bore measurement which refers to the hole in the centre of the propellor.

So a propellor that has a designation of 9545 has a length of 9", will drive forward 4.5" when 1V is applied and has a bore measurment of 5mm.

Batteries

The community standard is the Lithium-Polymer or LiPo battery. These kinds of batteries are light weight, compact and offer high discharge rates. These kinds of batteries are made up of multiple cells. A single cell provides a nominal 3.7 Volts. To provide higher voltages these cells are connected in series and have a "S" designation. So a 4S battery holds 3.7 x 4 = 14.8 Volts.

LiPo batteries also carry a "C" rating which indicates the maximum discharge rate. The "C" stands for capacity. So a 25C battery can discharge at 25 times its capacity.

The third important measurement for a battery is its capacity which is provided in milli-Amp hour (mAh) values. So a 2200 mAh battery with a 25C rating can discharge 25 x 2200 = 55000 mA or 55 Amperes.

With an understanding of this information you should now be able to determine the appropriate battery for your quad. The discharge rate should be higher than the combined draw from your ESC's and motors.

Very quickly after you start playing with quadcopters you discover the world of quadcopter acrobatics and drone-racing.

Builds

This section contains information on the various multicopter's I have built.

DJI F450

This section covers the build and configuration of my DJI F540. This unit was the first quadcopter I owned. I received the DJI Flame Wheel F450 multi-rotor along with a Spektrum DX6i transmitter as a birthday gift.

The f450 came as an almost ready to fly package (un-assembled) as my wife new that I would enjoy building it up from scratch and learning all about it.

When I was building this unit I didn't know anyone who had built up a drone so I didn't have anyone to ask about their setup. From my internet searching it looked like there are a few different ways to set up the same transmitter and flight controller.

Hardware

This section of the documentation covers how I installed the FC and the associated GPS receiver, LED status device and connected the Spektrum AR610 receiver that came with the Spektrum DX6i transmitter.

Flame Wheel F450

My F450 came with red and white motor struts. There was no instruction about which color should be used for the front and the rear and I didn't find any common convention from some brief internet searches. I used the white struts for the two front motors and the red struts for the two rear motors.

Motors

The F450 is a QuadRotorX configuration and when coupled with the NAZA M the motor numbering is as follows:

```
2    1
 \  /
  X
 /  \
3    4
```

The DJI propellors use a color coding to help identify which motor they should be used on. Propellors with a silver color at the centre are for the counter clockwise (CCW) motors and propellors with a black centre are for the clockwise (CW) motors.

Motor	Direction	Prop Color
1	CCW	Silver
2	CW	Black
3	CCW	Silver
4	CW	Black

Once the motors were connected to the ESC's and mounted I tested their spin direction using a very flimsy piece of paper. By gently bringing the piece of paper to the spinning motor it will get pull to the spin direction.

If any of the motors are spinning in the wrong direction switch two of the ESC wires to alter the direction.

DJI NAZA-M LITE

The NAZA-M LITE provides the brains of the quadcopter. It comes as a set of discrete devices that are covered in more detail below.

FC

The Flight Controller (FC) is the brains of the flight system. The FC connects to the motor's electronic speed controllers (ESC) and the remote control receiver.

The FC has a built-in Inertial Measurement Unit (IMU) that consists of one 3-axis accelerometer, one 3-axis gyroscope and a barometer for sensing the attitude and altitude.

The FC should be placed as close as possible to the center of the frame. The line on the top of the FC should be aligned with the center line of the craft and should be pointing to the nose. This will result in the motor ports facing the front of the craft.

The FC came with lots of 3M double sided tape strips which I used to stick it in place to the F450 base plate. I connected the motor wires before sticking the FC in place.

Connections

NAZA FC	NAZA VU	NAZA LED	NAZA GPS	Spektrum AR610
A				AILE
E				ELEV
T				THRO
R				RUDD
U				GEAR
X1				
X2				AUX1
X3	VU			
LED		LED		
EXP			GPS	
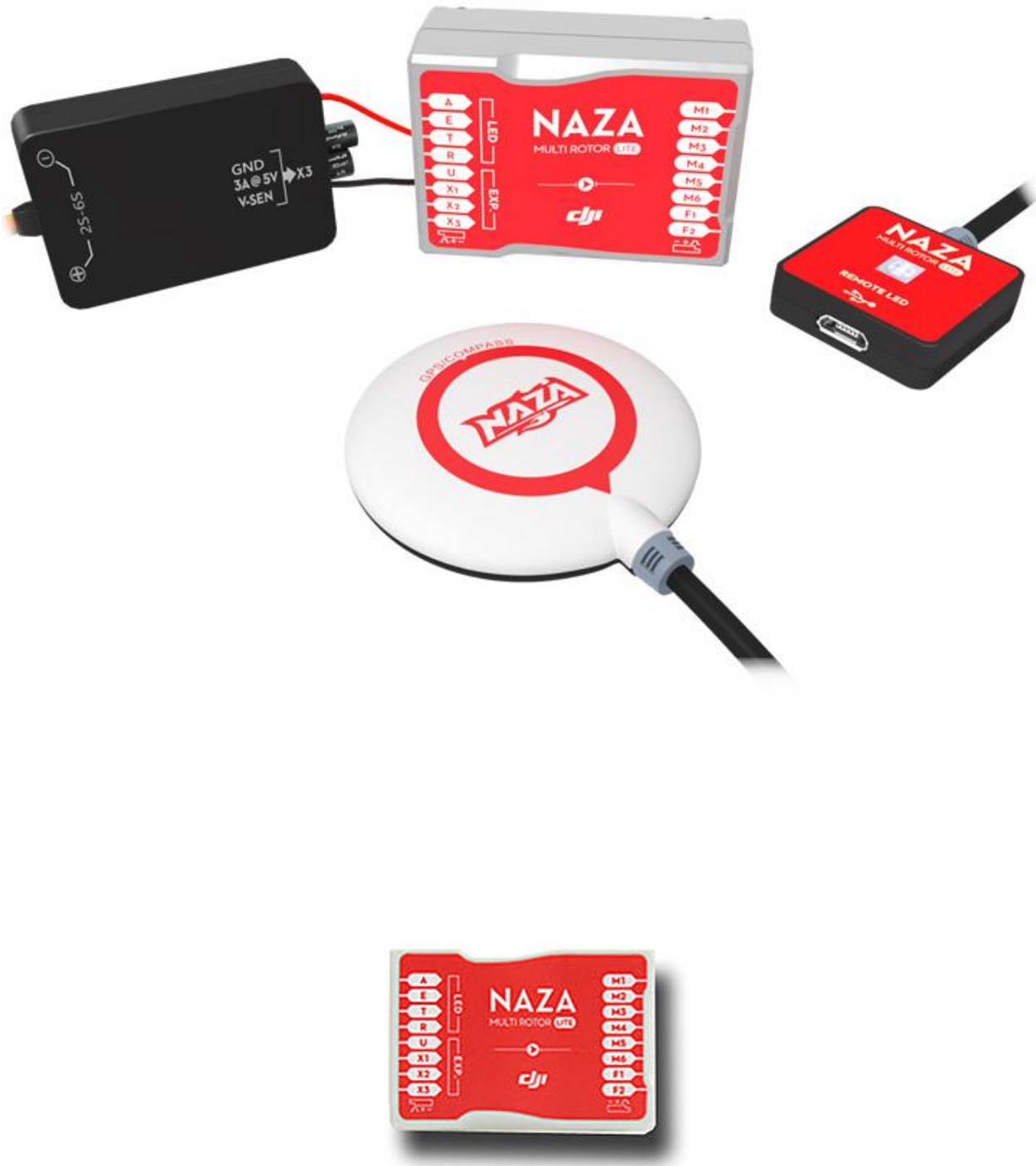
VU

The VU device monitors the battery Voltage and provides a regulated power feed to the FC.

The VU device can be connected to a variety of batteries from a 2S (7.2V) to a 6S (26.0V). I have a 2200mAh 3S battery.

The VU module connects to the X3 port on the FC.

GPS

The GPS/Compass module provides the FC with position and direction information.

The NAZA logo marked on the module should face the sky and the orientation arrow should point forward.

The GPS/Compass module came with a little carbon rod and two end pieces. I glued the end pieces to the carbon rod and stuck the GPS/Compass module to the top using a piece of 3M double sided tape. I then secured the base to one of the rear facing motor struts using the strut screws. This placed it towards the back of the craft close to the EXP port on the FC that it plugs in to. All the loose cable was secured with cable ties to make it tidy.

LED

The LED unit provide visual status while operating the quadcopter and the USB interface for connecting the FC to the NAZA Software Assistant program.

Spektrum DX6i Transmitter

I am using a Spektrum DX6i transmitter.

Spektrum AR610 Receiver

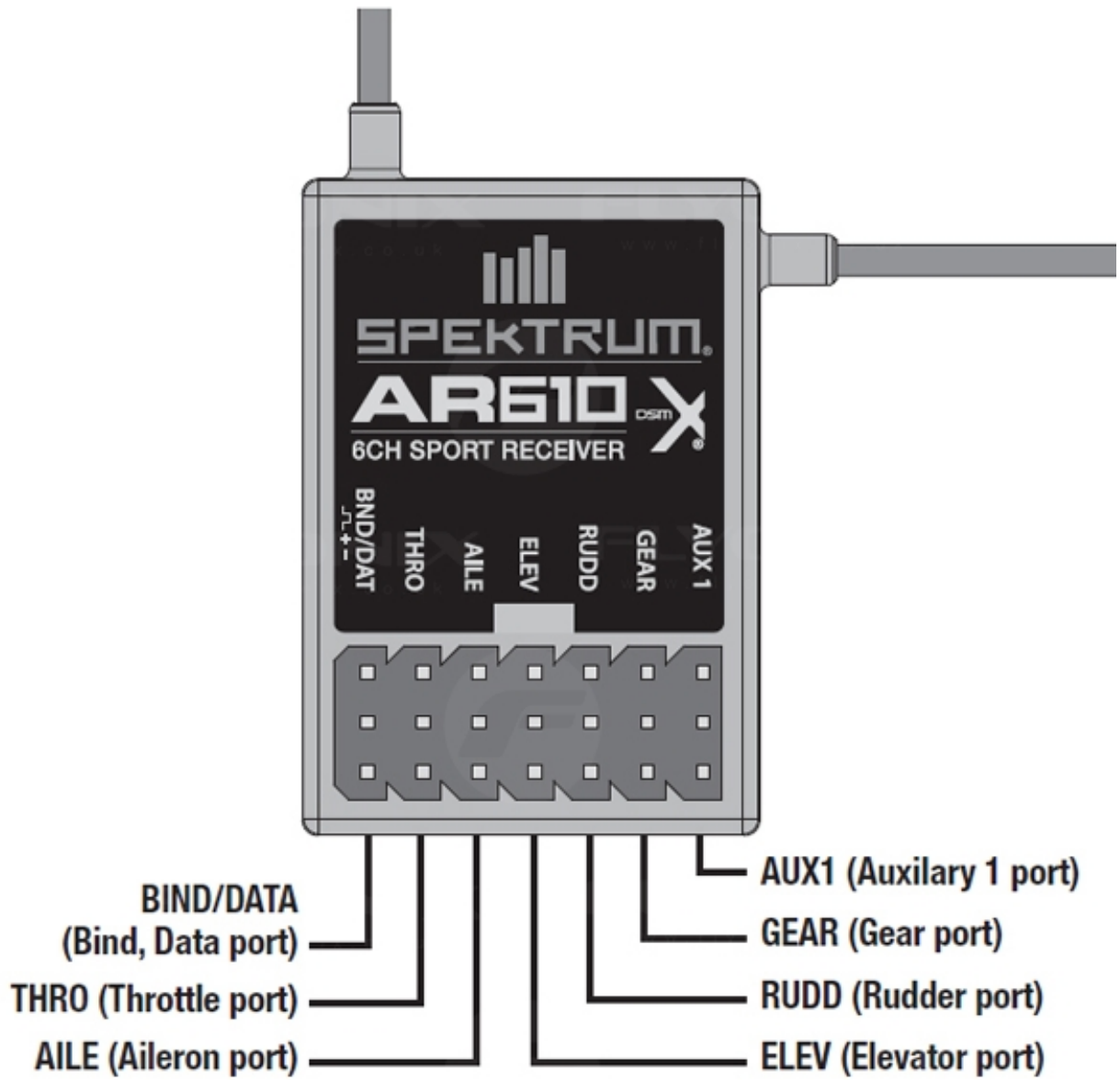The DX6i came with a AR610 receiver so I'm using that on this quadcopter.

Binding

Follow the bind procedure detailed in the section *Binding Receiver*.

Now that the receiver is bound the actions on the transmitter will be relayed to the receiver and passed on to the FC. We can now start configuring the transmitter settings.

BIND/DATA
(Bind, Data port)

THRO (Throttle port)

AILE (Aileron port)

AUX1 (Auxilary 1 port)

GEAR (Gear port)

RUDD (Rudder port)

ELEV (Elevator port)

Battery Charger

I have purchased a Casal C66 battery charger. This takes a DC input anywhere from 11 - 30V. I can easily use this charger at home and, more importantly, I can take this charger along with a small 12V battery to the park so I can charge a battery while I'm flying with the other one.

I cut the end off the fly-lead and soldered on a EC3 connector matching my batteries.

It seems that the XT60 connector is the one primarily used in the quadcopter community so I'll be using that on my next quadcopter.

Mini-S OSD

For FPV flying I bought the Mini-S OSD on eBay from gadgetextreme primarily so I could see the battery voltage while flying FPV. The OSD is covered in the *On Screen Display (OSD)* section of the FPV section.

Software

The DJI NAZA-M LITE Assistant software is used to configure the MC. I downloaded the OSX version of the DJI NAZA-M LITE Assistant and installed it on my Macbook Pro.

The following sections covers how I configured each panel within the DJI NAZA-M LITE Assistant application.

Connect a USB cable between the NAZA-M LITE's LED unit and a PC. The LED will display a green steady light.

Basic

This section of the documentation covers how I configured settings in the Basic panel of the DJI NAZA-M LITE Assistant application.

Aircraft

I selected the QuadRotorX configuration which was the second option.

```
M2   M1
 \ /
  X
 / \
M3   M4
```

Mounting

In the hardware section I mentioned that I had set up the MC in the centre of the bottom plate with the line on the MC pointing out the nose of the multi-rotor. This is my best attempt at guessing the quadcopters centre of gravity.

I have the GPS unit mounted which requires knowledge of its offset from the centre of gravity to perform correctly.

I originally had the GPS puck mounted on the carbon rod which set it up about 6cm from the top plate. After some early acrobatitcs trials it had been easily ripped off from a hard crash. I have since discarded the carbon rod and now mount it on the rear right strut using double sided tape. This reduces the likelyhood of damage to the GPS unit.

The offset measurements I'm using for the GPS unit are:

Co-ord	Dist
X	-8 cm
Y	8 cm
Z	-4 cm

RC

I set the Receiver Type to Traditional.

When the transmitter has been successfully bound to the receiver then moving the control sticks will result in the sliders moving in the Command Sticks Calibration area.

I chose to leave the REV/NORM settings set to NORM and made an reversing changes on the transmitter.

Note: If you modify and channel settings (especially the throttle) you should re-bind the receiver so that the failsafe throttle setting is properly set.

Gain

The default gain settings seem to work fine for my setup. I did briefly mess around with them but reverted back to the default values.

Basic	Value
Pitch	145%
Roll	145%
Yaw	150%
Vertical	130%

Attitude	Value
Pitch	130%
Roll	130%

Advanced

This section of the documentation covers how I configured settings in the Advanced panel of the DJI NAZA-M LITE Assistant application.

Motor

In this area of the Advanced Panel you can alter the motor idle speed and set motor cut-off type.

Motor Idle Speed

The Motor Idle Speed can be modified between 5 different settings, from Low through to High.

I left mine set to Recommended which is the default setting.

Cut Off Type

The motor Cut Off Type can be altered between Immediately and Intelligent.

I set mine to Intelligent.

Immediate

When the Cut Off Type is set to Immediate, once the motors have started and the throttle has gone over 10% then the motors will stop immediately (irrespective of Control Mode; e.g. GPS Atti, Manual) when the throttle stick is brought back under 10% again.

In this mode if you move the throttle stick over 10% within 5 seconds of the motors stopping the motors will re-start (no CSC action is needed).

Intelligent

In this mode different control modes use different ways of stopping the motors.

In Manual Mode, only executing the CSC action can stop motors. In Atti Mode or GPS Atti Mode, any one of following four cases will stop motors:

1. You don't push throttle stick after motors start in three seconds.

2. Executing CSC.

3. Throttle stick under 10% for more than 3 seconds and after 3 seconds landing.

4. The slope angle of the multi-rotor is over 70°, and throttle stick under 10%.

Failsafe Settings (F/S)

I set my failsafe settings to 'Go Home and Landing'.

Intelligent Orientation Control (IOC)

Typically when flying a multi-rotor drone the forward direction remains aligned with the direction that the nose is pointing. The Intelligent Orientation Control (IOC) settings let you change this using two different approaches. The first is called Home Lock and the second is called Course Lock.

Home Lock

When the Naza MC is switched to Home Lock IOC mode the forward direction of the multi-rotor always points away from the home point. Conversely, the backward direction always moves back toward the Home Lock position.

Note: The multi-rotor must be in ATTI or GPS mode and be further than 10m away from the home point.

There are 2 ways to record the forward direction in Home Lock mode; automatically and manually.

The current position of the quadcopter will be automatically recorded as the home point when the throttle is first moved AFTER 6 or more GPS satellites have been found.

During the same flight	STEP1: Record	STEP2: ON	STEP3: OFF	STEP4: ON again
Course Lock				
Switch Setting	Record forward direction	Set switch S1 at GPS or ATTI. position, S2 at Course Lock position	Set switch S2 at OFF position	Toggle switch S2 from OFF to Course Lock
Home Lock				
Switch Setting	Record home point	Set switch S1 at GPS position and S2 at Home Lock position	Set switch S2 at OFF position	Toggle switch S2 from OFF to Home Lock

Usually — Home point

In home lock — Home point
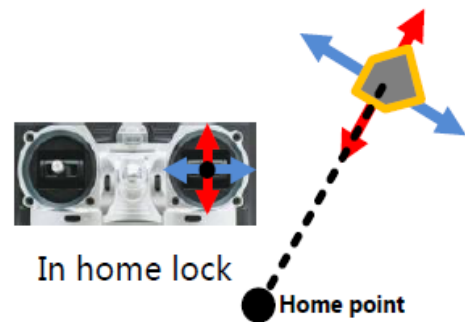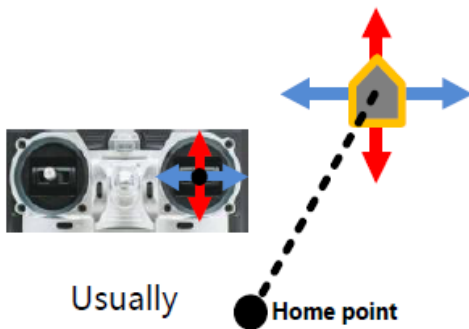
After 6 or more GPS satellites have been found a new home position can be manually set by toggling between Course Lock and Home Lock quickly 3 - 5 times.

Course Lock

When the Naza MC is switched to Course Lock IOC mode the forward direction is always that of the recorded nose direction.

There are 2 ways to record the forward direction in Course Lock mode; automatically and manually.

When in course lock mode the forward direction will be automatically recorded 30s after starting the quadcopter.

To manually set the forward direction toggle quickly between Course Lock and Off 3 to 5 times (Off -> Course Lock -> Off represents one transition).

Transmitter

In this section I describe how I configured the Spektrum DX6i to control the NAZA-M LITE on my DJI F-450 multi-rotor drone.

The first step is to create a profile in one of the 9 available slots in the DX6i's model memory.

Initial Setup

1. Power on the transmitter.
2. Press the Scroll button to bring up the ADJUST LIST menu.
3. Scroll to select the MODEL SELECT option and select a free slot.
4. Once the profile has loaded scroll to the end of the list of options and select SETUP LIST.
5. Set MODEL TYPE to ACRO.
6. Scroll back to List to go back to the previous menu.
7. Select MODEL NAME and give the model a description. I named mine `DJI-F450`.

Now that we have a dedicated profile in the transmitter we can bind the receiver to this transmitter.

Binding Receiver

Insert the Bind plug into the BIND/BATT port of the AR610 receiver. Power up the receiver. I powered it up using the throttle cable from the MC and connected a battery to the MC via the VU device. The receiver starts to flash with its orange LED. While holding the Trainer switch on I then powered on the transmitter. The transmitter starts in binding mode and after a short while the receiver stopped flashing and then the orange LED came on steady on the receiver.

This indicates that it has successfully bound with the transmitter. Take power away from the receiver and then turn off the transmitter.

It is recommended that you bind the receiver twice. The binding procedure locks in the throttle level setting that will be applied in the case that the transmitter signal is lost.

The first bind establishes the communication channel from the transmitter to the receiver so you can begin configuring your device. After you play around with the various settings you may end up reversing one or more of the channels. This may reverse the original throttle setting saved during the initial bind. It is important to re-bind to ensure that the correct throttle signal will be applied if the transmitter signal is lost.

Configure Transmitter

It is best to connect the NAZA Assistant software while performing this configuration step so that the results are immediately visible. So, connect the MC with the NAZA Assistant software by plugging a USB cable from the PC to the LED device. Power on the transmitter and check that the transmitter stick controls move the channel sliders on the NAZA Assistant's Basic -> RC display.

Control Sticks

Moving the Aileron and Rudder control sticks on the transmitter resulted in the opposite action happening at the MC. This can be resolved by reversing the direction in the NAZA Assistant software or on the transmitter. I made a choice to keep the software assistant channel settings in the NORM mode so I reversed the AILE and RUDD channels on the transmitter.

1. Enter the ADJUST LIST menu by clicking the scroll button.

2. Enter the SETUP LIST menu.

3. Enter the REVERSE menu.

4. Reverse the AILE channel.

5. Reverse the RUDD channel.

6. Exit the REVERSE menu.

7. Exit the SETUP LIST menu.

Control Modes

Now we come to configuring the MC Control Mode. The DX6i has a number of 2 position switches but the Control Mode has 3 states so really requires a 3 position switch to move between Manual, Atti and GPS attitude control modes.

We will have to use more than one switch on the transmitter to create a three position effect.

The configuration that we're aiming for is to be in GPS Attitude mode when all the switches are off. Flipping the GEAR switch on will move the Control Mode into the Manual mode. So, when all switches are off we can use the GEAR switch to move between GPS and Manual. If we now switch the MIX switch on we can use the GEAR switch to move between GPS and Attitude. Turning the ELEV D/R switch on in any of the modes will move the Control Mode into the Failsafe mode.

Assuming the transmitter is on and the correct profile is loaded, let's get going...

1. Enter the ADJUST LIST menu by clicking the scroll button.

2. Enter the SETUP LIST menu.

3. Enter the REVERSE menu.

4. Reverse the GEAR channel.

5. Exit the REVERSE menu.

6. Scroll to the end and select ADJUST LIST menu.

7. Enter TRAVEL ADJ menu.

8. Ensure that the GEAR switch on the transmitter is off.

9. Monitor the NAZA Assistant's Basic -> RC -> Control Mode Switch display and modify the GEAR Travel Adjust to move the Control Mode selection to GPS (the GPS item will be highlighted blue). I ended up using +85%.

```
TRAVEL ADJ

THROv100% AILE>100%
ELEV^100% RUDD>100%
GEAR^ 85% FLAP^100%
```

10. Now flip the GEAR switch on. The goal here is to adjust the GEAR settings so that the Control Mode goes into Manual mode. I ended up using -75%.

```
TRAVEL ADJ

THRO^100% AILE>100%
ELEV^100% RUDD>100%
GEARv 75% FLAP^100%
```

11. Exit the TRAVEL ADJ menu.

12. Enter the MIX1 menu. The goal here is to alter the settings such that when the MIX switch is off the GEAR switch moves between GPS and Manual and when the MIX switch is on the GEAR switch moves between GPS and Attitude modes. Flip the MIX and GEAR switch on and modify the settings until the Attitude mode is selected.

```
     MIX1

GEAR>   GEAR ACT
Rate D   0% U -106%
SW MIX     TRIM INH
```

13. Exit the MIX1 menu.

14. Enter the MIX2 menu. The goal here is to configure the settings such that the Failsafe mode is selected irrespective of whether the Control Mode was GPS, Attitude or Manual.

```
     MIX2

GEAR -> GEAR ACT
Rate D - 50% U - 53%
SW ELE D/R  TRIM INH
```

15. Exit the MIX2 menu.

For reference, I found the following video helpful for configuring parts of my system though I managed to simplify it a little by not needing any sub-trim modifications. This video did not cover setting the IOC configuration.

Intelligent Orientation Control

I used the flaps channel to configure the IOC settings. The IOC settings supports 3 modes; Home Lock, Course Lock and Off. Once again the DX6i only has 2 position switches so I'll be using the FLAP switch to alternate between Off and Home Lock. I can't really see me using the Course Lock option so this is not a great loss.

1. Enter the ADJUST LIST menu by clicking the scroll button.

2. Enter FLAPS menu.

```
      FLAPS

       FLAP  ELEV
NORM  v 86      0
LAND  ^ 80      0
```

Test Configuration

With all the transmitter switches off, power on the transmitter and connect the MC to the NAZA Assistant software using the USB cable so we can verify the correct Control Modes are being used.

Monitor the NAZA Assistant's Basic -> RC display. By default, with the GEAR switch in the off position, the Control Mode should indicate GPS mode. Flip the ELEV D/R switch and the Control Mode should move to Failsafe. Turn the ELEV D/R switch off, the mode should return to GPS.

Turning the GEAR switch to on should move the Control Mode to Manual. Flip the ELEV D/R switch and the Control Mode should move to Failsafe. Turn the ELEV D/R switch off, the mode should return to Manual.

Turn the Gear switch off again to return to GPS.

Now Flip the Mix switch on. The Control Mode should remain in GPS Mode.

Flip the GEAR switch on and the mode should now change to Attitude Mode. Flip the ELEV D/R switch and the Control Mode should move to Failsafe. Turn the ELEV D/R switch off, the mode should return to Attitude.

With this test we can see how to change into any of the Control Modes and how the ELEV D/R switch changes MC into Failsafe mode from any of the GPS, ATTI or Manual control modes.

In summary:

```
GPS:      GEAR 0  MIX:0
Manual:   GEAR 1  MIX:0
GPS:      GEAR 0  MIX:1
Attitude: GEAR 1  MIX:1
Failsafe: ELEV D/R
```

Now move to the NAZA Assistant's Advanced -> IOC display. With the FLAP switch in the off position the IOC mode should show that it is in the Off mode. Flip the FLAP switch and the IOC mode should change to the Home Lock mode.

Configure Receiver Failsafe Settings

Receivers can be configured with failsafe settings that will be applied when the receiver loses connection with the transmitter.

The Spektrum AR610 receiver that I'm using apparently only supports failsafe settings on the throttle channel. Other devices can support other channels.

With the transmitter turned off set the throttle level to about ~40%. This throttle level will become the failsafe setting applied by the receiver when it detects a loss of connection with the transmitter. The goal of this throttle level setting is to cause the quadcopter to stop and slowly descend.

> **Warning:** If you change the payload on the quadcopter you may need to reset the throttle level. Also, be mindful of this failsafe setting if you are over trees or over a large body of water!

Follow the bind procedure detailed in the section *Binding Receiver*.

Flight Test

This section covers the intial flight testing actions that I performed.

Calibrate Compass

The compass only needs to be calibrated once though you should repeat it if you make significant changes to the drone that might affect the compass.

Power on the quadcopter. Use the transmitter to quickly switch between GPS mode and Manual mode until the LED changes to a constant orange/yellow which indicates the start of the horizontal calibration. I find that I need to perform the switch combination 11 times to enter the calibration mode.

Keeping the quadcopter flat rotate it horizontally around 360 degrees. Once the rotation is complete the LED should change to green which indicates the start of the vertical calibration. Now orient the quadcopter on its side and once again rotate it around 360 degress.

When the final rotation is complete the LED should return to its normal sequence for the current control mode.

Status LED

To start with I'll typically be flying the GPS control mode so I wait until the status LED is showing a single green flash. It typically starts out with red flashes followed by a green and slowly the number of red flash dissappear as the better GPS satellite lock is achieved.

See the LED status chart below for the different indicators.

When operating in GPS mode I wait for the quadcopter to find the GPS satellites that cause it to show a single green flash.

Range Test

TBD

Control Mode (GPS)

	Manual	Atti	GPS Atti	IOC
Attitude status bad	🟥	🟥 🟡	🟥 🟢	🟥 🟡🟢
GPS satellites < 5	🔴🔴🔴	🔴🔴🔴🟡	🔴🔴🔴🟢	🔴🔴🔴🟡🟢
GPS satellites < 6	🔴🔴	🔴🔴 🟡	🔴🔴 🟢	🔴🔴 🟡🟢
GPS satellites < 7	🔴	🔴 🟡	🔴 🟢	🔴 🟡🟢
GPS Good	No	🟡	🟢	🟡🟢

Control Mode

Manual	No
Atti	🟡 🟡 🟡 🟡 🟡 🟡 🟡 🟡

When 🟥 appears, please hover the aircraft until disappears, so as to have better flight performance.

Sparking indications of Atti 🟡 and GPS Atti 🟢 are:

- Before motors start: **Single blink**, all sticks (except throttle stick) return to center; **Double blinks**, stick(s) (except throttle stick) not at center.
- After motors start and throttle stick is over 10% in 3 seconds: **Single blink**, all sticks return to center; **Double blinks**, stick(s) not at center.

Sparking indications of IOC 🟡🟢 are:

- Before motors start: 🟡🟢 blink, all sticks (except throttle stick) return to center; 🟡🟡🟢 blink, stick(s) (except throttle stick) not at center.
- After motors start and throttle stick is over 10% in 3 seconds: 🟡🟢 blink, all sticks return to center; 🟡🟡🟢 blink, stick(s) not at center.

Compass Calibration

Begin horizontal calibration	🟡🟡🟡🟡🟡🟡🟡🟡🟡🟡🟡🟡🟡
Begin vertical calibration	🟢🟢🟢🟢🟢🟢🟢🟢🟢🟢🟢🟢🟢
Calibration or others error	🔴🔴🔴🔴🔴🔴🔴🔴🔴🔴🔴🔴🔴🔴🔴🔴🔴🔴🔴

Others

Tx signal lost	🟡🟡🟡🟡🟡🟡🟡🟡🟡🟡🟡🟡🟡🟡🟡🟡🟡🟡🟡🟡
Low voltage / Other errors	🔴🔴🔴🔴🔴🔴🔴🔴🔴🔴🔴🔴🔴🔴🔴🔴🔴🔴🔴
Connect to PC correctly	🟢🟢🟢🟢🟢🟢🟢🟢🟢🟢🟢🟢🟢
System start and self-check	🔴🔴🟡🔴🟡🟡🟢🟢🟢🟢🟢

Starting the Motors

Use the Combination Stick Commands (CSC) to start motors. Simply pushing the throttle stick before takeoff will not start motors. You have to execute any one of following four Combination Stick Commands (CSC) to start motors.
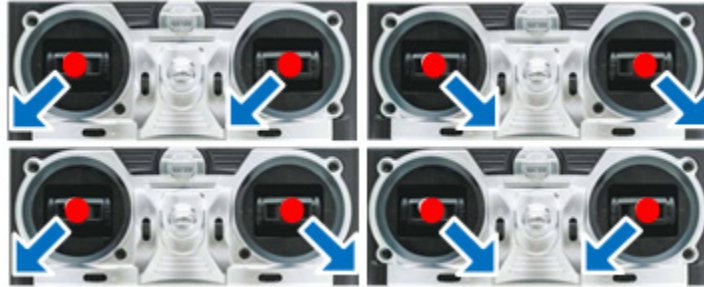
Transmitter Failsafe Test

Power on the quadcopter and fly striaght up a metre or two. Turn off the transmitter which will trigger the receiver to go into the configured failsafe setting. I had previously configure the throttle setting to be about 30% which upon testing was too low as the quadcopter came down very quick. I need to set it to a value that causes the quadcopter to very slowly descend.

IOC Test

I have previously set the NAZA Failsafe Settings to "Go-Home and Landing".

Out in the field power up the quadcopter and let it establish a home position lock. When an appropriate number (7+ according to DJI's LED status overview, see the section above about the LED) of GPS satellite are detected the status LED flashes a single green flash on the LED status indicator.

The current position of the quadcopter will be automatically recorded as the home point when the throttle is first moved after 6 or more GPS satellites have been found.

The NAZA will record the current nose direction as forward direction at the 30th second after you power on the multi-rotor. The LED will blink a sequence of green flashes quickly when the home location is successful.

Once the quad has established the home position fly it some distance away, it doesn't have to be far. The first time I tried it I only moved about 5m away.

In my configuration I use the ELEV D/R switch to move the control mode into Failsafe. Flick the ELEV D/R switch. The quad should go up to 20m and move back to the home location before descending.

Flight Log

This section records some of my early flights where I was trying to work out how to properly configure the MC and the transmitter as well as learn to fly the drone.

26/12/2015

This flight was just trying to get the thing off the ground so I could say I had made some progress. I had no idea what mode it was in (I think it was in manual). I had previously checked that the motors were

I managed to get it off the ground and up to about 3 metres high. I very gradually manoeuvred it around and then brought it down thankful I hadn't crashed it.

28/12/2015

This flight was aimed at testing the GPS Attitude mode. By this time I had finally configured the transmitter to be able to set the NAZA MC into GPS Attitude mode. I plugged in the battery and got the ESC tune. I observed the LED flashing green and red giving me an indication that it was in GPS mode. After a little while the red flashed disappeared indication a good GPS signal by staying green.

I then tried to slowly increase the throttle in an attempt to take off but the drone seemed very unstable and was making a weird whistling noise that I did not recall from the first flight. I tried a few times to increase the throttle but the instability and noise remained.

Eventually the drone tilted too far and then flipped over. Nothing was broken but I think I've got some investigating to do.

29/12/2015

I tried to fly the drone again but the wobble remains. As I power up the motors the struts begin to wobble and the strut holding motor 1 get quite violent. I'm not sure if it is cavitating. It looks like there is some kind of resonance that builds up and reinforces the wobble. Some internet searching indicates that it might be related to the flexible DJI legs connected to the bottom of the drone. I've taken these off and will try to fly it again.

30/12/2015

Success, I got it flying. There was still a bit of a wobble on take off. It's like the M1 strut takes off first which tilts the craft a bit. If I slowly increase the throttle it seems like it will flip over. If I really commit and push the stick up quickly it takes off and levels out. It's probably a mixture of inexperience and me not wanting the smash that drone before I've had a chance to fly it around. The longer legs definitely increase the wobble.

Now that I've got it flying I'll spend a bit of time doing lots of take off and some simple manoeuvring to get used to it. Then I'll begin testing out the capabilities of the MC and checking that the Failsafe works. Once that's done I guess I'll start flying it a bit higher and a bit further away.

FPV

This section covers how I added a First Person View (FPV) capability to my quadcopter.

Equipment

- ImmersionRC 25mW 5.8GHz Video Transmitter
- HS1177 1/3 Sony Super HAD II CCD, format: PAL, TV Lines: 600, Lens: 2.8mm, Power 5-22V
- Mini S-OSD On-Screen Display (OSD)
- FatShark Attitude V3 Goggles.

Video Transmitter

With this quad setup I am using the *ImmersionRC 5.8GHz 25mW Video Transmitter*.

FPV Camera

With this quad setup I am using the *Surveilzone HS1177 Sony Super HAD II 600TVL*.

To avoid any potential interference from the ESC on the main power bus I decided to power the camera from the 5V regulated supply provided by the video transmitter.

On Screen Display (OSD)

An on screen display overlays various bits of information, such as the battery voltage, onto the video image that provides additional situational awareness.

After spending some time searching around on the Internet for an OSD that would work well with the NAZA Lite I ended up purchasing a Mini-S OSD from gadgetextreme on eBay.

The Mini-S OSD provides other useful information onto the video display too such as GPS position, artificial horizon, etc. The status LED connected to the NAZA already provides a low battery status but when flying FPV I can't see that.

I found that someone had posted a useful installation guide on Youtube which made my installation pretty straight forward.

Disconnect the NAZA LED cable from the NAZA Lite and connect it to the mini-S LED input. Use one of the supplied cables to connect from the mini-S LED output back to the NAZA's LED input. The connector is not quite the same as the standard DJI connector but it fits in. Keep the black wire to the left when connecting it back to the NAZA. This cable allows the mini-S to obtain the Voltage and perhaps the mode (Manual, Attitude, GPS).

Disconnect the NAZA GPS cable from the NAZA Lite and connect it to the mini-S GPS input. Use one of the supplied cables to connect from the mini-S GPS output back to the NAZA's EXP input. Again, the connector is not quite the same as the standard DJI connector but it fits in. Keep the black wire to the left when connecting it back to the NAZA.This cable allows the mini-S to obtain the latitude and longitude.

Connect the camera's video signal to the mini-S VIDEO connector. The cable looms are all common so the colors are not representative of function. In this case the red wire is ground and the black wire should be connected to the camera's video signal.

Connect the Mini-S video out to the Video Tranmitter's video input.

The mini-S has a connector labelled TEST. Use one of the cable looms to connect from the TEST connector to the battery. Again, the cable looms are all common so the colors are not representative of function. In this case yellow is ground and white should connect to the battery positive.

There should now be one cable loom remaining which has green, orange, white, yellow, red and black wires. Connect this to the remaining connector on the mini-S.

To get the artificial horizon to work connect the NAZA's F1 and F2 to the mini-S using the red and black wires. The red wire connects to the NAZA's F1 and the black goes tothe NAZA's F2.

The white and yellow wires connect to the throttle so it can be shown on the OSD. This seemed a little redundant (my fingers are on the throttle) so I am not using these wires.

The orange wire can be connected to a spare channel on the receiver to change the OSD display theme. I only have a 6 channel receiver so will not be using this wire. Also, it is unlikely I would ever want to change the theme. I will just set one up that I like and use it.

The green wire can be connected to the RSSI output of the receiver however my receiver does not support this so I am not using this wire.

A FTDI connection can be made if the headers are soldered on. I have not yet needed to make any changes so these remain untouched.

Once it was all wired up I tested it out and it mostly worked fine though I had forgotten to enable the Gimbal F1 and F2 servo channels so the artificial horizon was not working. Once I fixed that by enabling the Gimbal control via the Naza Software Assistant it was all working as expected.

Note: Remember to enable the Gimbal outputs in the NAZA Software Assistant so that the Mini-S OSD can project the artifical horizon. The values may also need some minor tweaks to ensure the horizon line is perfectly flat.

One thing I noted was that the OSD connectors that take the LED and GPS inputs are quite loose. These will likely require some hot glue to tack them in more securely.

FPV Goggles

With this quad setup I am using the *FatShark Attitude V3 FPV Goggles*.

References

This section contains links to sites with useful information that helped me build and configure my quadcopter.

- DJI F450 User Manual
- DJI F450 Videos
- DJI FAQ
- DJI Flame Wheel Wiki
- DJI NAZA M Wiki

ZMR250

While building up my first multirotor (a DJI F450) I learned a lot about quadcopters. I was making a list of the various components and was planning on buying all the parts individually when a ZMR250 came up for sale from an aquantence from the local FPV community. I jumped at the chance to grab it; it was just the kind of vehicle that I needed as a total FPV noob. It was also significantly built up already. I just needed to get batteries, a FPV camera and a video transmitter.

The flight controller is a Naze32 Rev5 clone flashed with the latest Cleanflight firmware. The ESC's are Afro 12A flashed with BLHeli firmware. The motors are Dys BE1806-2300KV with Gemfan 5030 propellors.

The ZMR uses an X configuration and when combined with the Naze32 software the motor numbering is as follows:

```
4   2
 \ /
  X
 / \
3   1
```

Motor	Direction
1	CW
2	CCW
3	CCW
4	CW

Adjust sub-trim in Transmitter so that Roll, Pitch and Yaw are centered around 1500.

Reverse Aileron and Rudder in Transmitter so that right on transmitter moves the channel slider right.

I had a problem arming motors with the initial configuration. This was because the lowest that the trottle would go was still above the lowest motor value configured in the Cleanflight config app.

I used sub-trim on the throttle to bring the lowest value under the value set in the Cleanflight config app (i.e. to about 1030 which is below the 1060) minimum set in Cleanflight.

Arm: min throttle and yaw right. Disarm: min throttle and yaw left.

Receiver

I am using a *S603 Receiver*

Video Transmitter

I am using the *ImmersionRC 5.8GHz 200mW Video Transmitter*.

FPV Goggles

I am using the *FatShark Attitude V3 FPV Goggles*.

Problems

This quad was really problematic. After lots of investigation I finally determined that the cause was the 5V BEC unit soldered to the ZMR V2 PDB.

After some period of normal (beginner) flight time the quad would keel over as if the motor 1 had stopped. At the time I thought there was something wrong with the quad but I was also pretty new to flying them so it might have just been my noob skillz.

This resulted in two 2 Naze32 boards were destroyed. It was a weird problem. After the crashes the Flight Controller board would not power up at all. Then by the time I walked home to investigate further it would power up.

However, while I could arm and disarm the quad, the throttle would not work. Also, when I tried to plug it into Cleanflight I found that the USB interface was not functional. This exact same sequence happended to two Naze32's.

While flying Line of sight with a third Naze32 I observed it keel over and fall to the ground again. This time the flight controller was never able to be powered up even after waiting a while. However this board could still communicate with Cleanflight when I plugged it in.

Pulling the quad apart I finally found that the 5V BEC was not functioning anymore. Perhaps it was getting hot after a length of flight. Perhaps it was just flaky right from the start. At this point I am assuming that as it was degrading it probably fed 12V to the 5V output intermittantly, which consequently damaged the first two flight controllers.

I am going to replace the integrated PDB with a very simple stackable unit.

Rebuild

I sourced a stackable PDB from a fellow quad flyer and commenced the rebuild. It took a solid weekend. The motor connections to the ESC's remained the same but everything from the other side of the ESC needed to be re-wired.

Once the rebuild was complete I attempted to connect it to Cleanflight but could not for some reason. I assumed that maybe there was nothing loaded on the Naze32 by default so I attempted to flash a new version of betaflight

I went to the Silabs.com site the to their *Interface and Drivers* page to find the CP21XX driver package for OSX. This was called *CP210x USB to UART Bridge Drivers*. Silicon Labs >> Products >> MCUs >> USB to UART Bridge VCP Drivers. Once I had updated the driver I was able to successfully flash the Naze with both Cleanflight and Betaflight. I left the Naze with Betaflight.

Use transmitter sub-trim to adjust mid-point of roll, pitch and yaw to around 1500. Then use travel adjust to attempt to get range from 1000 to 2000. Typically I can get it to about 1030 - 2000.

For some reason I was having trouble disarming. This was because I could only get the yaw down to about 1055 but the min_check was set to 1040.

To fix this I used the CLI to set the following:

```
set min_check = 1065
```

I originally had wired the power input for the video transmitter to the 12V BEC output. However, the power demands from the video transmitter must have been to much for the BEC to handle. Without the video transmitter connected the 12V output was just over 12V but when I connected the vide transitter it went down to 5V. I'm guessing that the video transmitter draws a lot of current that in turn drops the voltage.

I have since connected the video transmitter directly to the battery power input on the power distribution board.

After a crash I broke one of the arms on the ZMR. After replacing the arm I found that the motor on that arm no longer worked. I first spent some time replacing the ESC thinking that the problem was in the ESC but after swapping in a good ESC the motor still would not spin properly. I'm guessing that one of the phases on the motor was burnt out.

I didn't have a spare 1806 2300KV so I order some DYS 2205 2100 thinking that they should be fine on the ZMR. I'll replace the Afro 12A ESC's with FVT 20A eventually.

After fixing all these problems the ZMR still intermittently keels over just like it used to before. I've got new motors, new flight controller, new power distribution board which leaves just the ESC as the culprit. I am guessing that they fail when they get hot. It is very hard to replicate.

Alien 5"

The Alien is produced by ImpulseRC. From my perspective this is a high quality product. The engineering is really good, lots of thought has gone into this product from the designers.

Parts

Part	Description
Frame	Alien 5" (225mm)
FC	Motolab Tornado STM32F3 (Betaflight 2.4.0)
ESC	*FVT LittleBee 20A* (BLHeli)
Motors	Cobra 2204 2300kv
Propellors	*5040 HQProp*
Receiver	Storm S603 (Spectrum Compatible)
Flight Camera	*Surveilzone HS1177 Sony Super HAD II 600TVL*
Video Transmitter	*ImmersionRC 5.8GHz 200mW Video Transmitter*
VTX Antenna	FatShark 5.8 GHz SpiroNET RHCP
On-Screen Display	
Batteries	Zippy 1800mAh 3s 40C
Voltage Regulators	5V Polulu D24V5F5 (powering FC) 12 BEC (powering camera)
Goggles	*FatShark Attitude V3 FPV Goggles*
VRX Antenna	FatShark 5.8 GHz SpiroNET RHCP
Transmitter	*Spektrum DX6i*

As I don't have an OSD yet I have added a buzzer to provide a low battery warning. I have to fly it near me occasionally to hear it. It is surpisingly loud. I got a 9V - 14V buzzer and connected to the Lipo and buzzer signal pins on the FC.

Flight Controller

I am using the MotoLab Tornado F3 Flight Controller from ImpulseRC.

There are three separate power rails on the board.

Lipo voltage - Connected to a resistor network for VBAT monitoring and to the pads for an external switching regulator. 5V - Connected to the external regulator output, internal 3.3V regulator input, 5V PWM buffer, and external device interfaces including the SBUS and PPM receivers, 5V buzzer, serial LED and RSSI. 3.3V - Powers the CPU and gyro chip as well as the external DSM2/DSMX receiver on the SAT connector.

The Tornado does not have an on-board 5V regulator. 5V power may be sourced from an ESC BEC or from an external switching regulator. The board's 5V rail is expected to be provided by an external 5V regulator. ImpulseRC sell a 5V Polulu regulator to fulfill this need that perfectly fits the dedicated through-hole connectors provided for a 5V regulator.

Pinout Notes

- Pins marked "+" are LIPO voltage. LIPO input voltage is limited to 6S, depending on the regulator used. Pololu recommends an external 33uF 50V capacitor for over 20V inputs.

- The LIPO IN pins are connected internally to the VBAT monitor.

- Pins marked "V" are +5V ONLY. Do not connect anything over 5V to these pins.

- All of the numbered pins are PWM outputs.

- The LIPO "+" and BEC "V" pins have reverse-current blocking diodes to prevent powering ESCs from USB power.

- To bypass the BEC "V" input diode and output 5V on this pin, short the two-pad jumper below the PWM 1 input.

- The Pololu switching regulator may be mounted on top or bottom of the board. Observe the orientation.
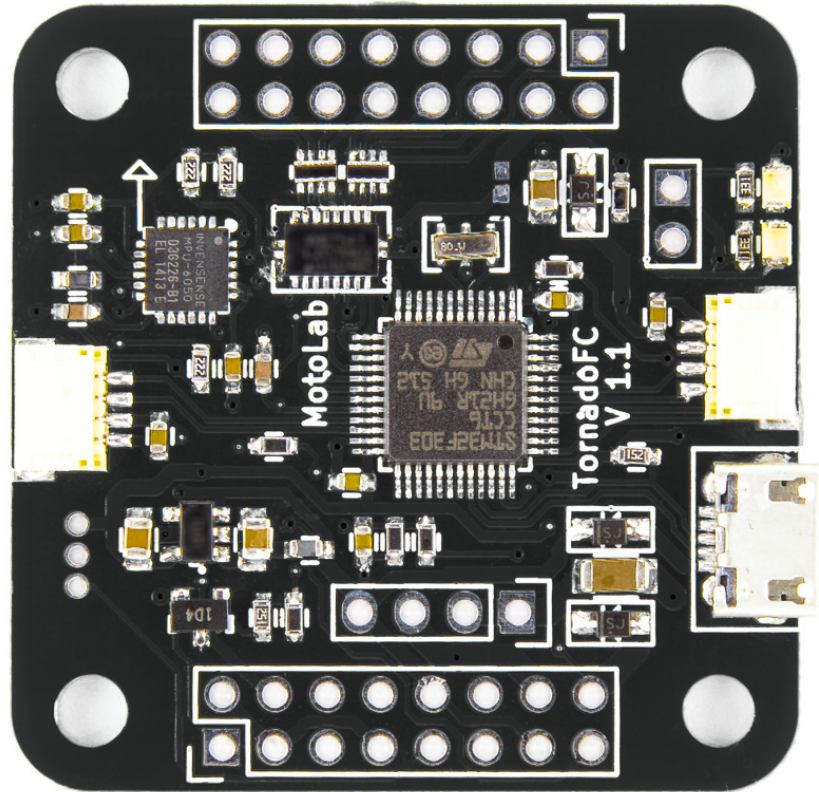
- If using an external 5V BEC of any kind (including a Pololu not mounted on the board), connect it to the pins labelled "BEC 5V IN".

- SAT RX and SBUS use UART 2.

- The "S" pin on the buzzer connection is the switched ground. Connect the + pin of the buzzer to either the lipo "+" or 5V "V" pin, and the - pin to "S".

SmartPort Telemetry

Cleanflight and Betaflight can send Smartport telemetry to the FrSky X-series receivers over a single wire. Connect TXOUT from either serial port to the S.PORT pin on the receiver. It only takes one wire because the ground connection is already made with the SBUS cable. The voltage divider for lipo monitoring is built into the Tornado.

To enable lipo monitoring over Smartport:

Enable VBAT and Telemetry on the Config tab Select Telemetry -> SmartPort and AUTO on the ports tab Set telemetry_inversion=on in CLI (This is the default in later firmware)

The lipo voltage shows up in OpenTX as VFAS. The most useful telemetry parameters seem to be VFAS, RSSI, and RxBt (receiver input voltage).

Firmware

The Motolab Tornado F3 comes with a version of Betaflight already installed. This is fine to use but it is recommended to run the most recent version. This will have fixes as well as new features.
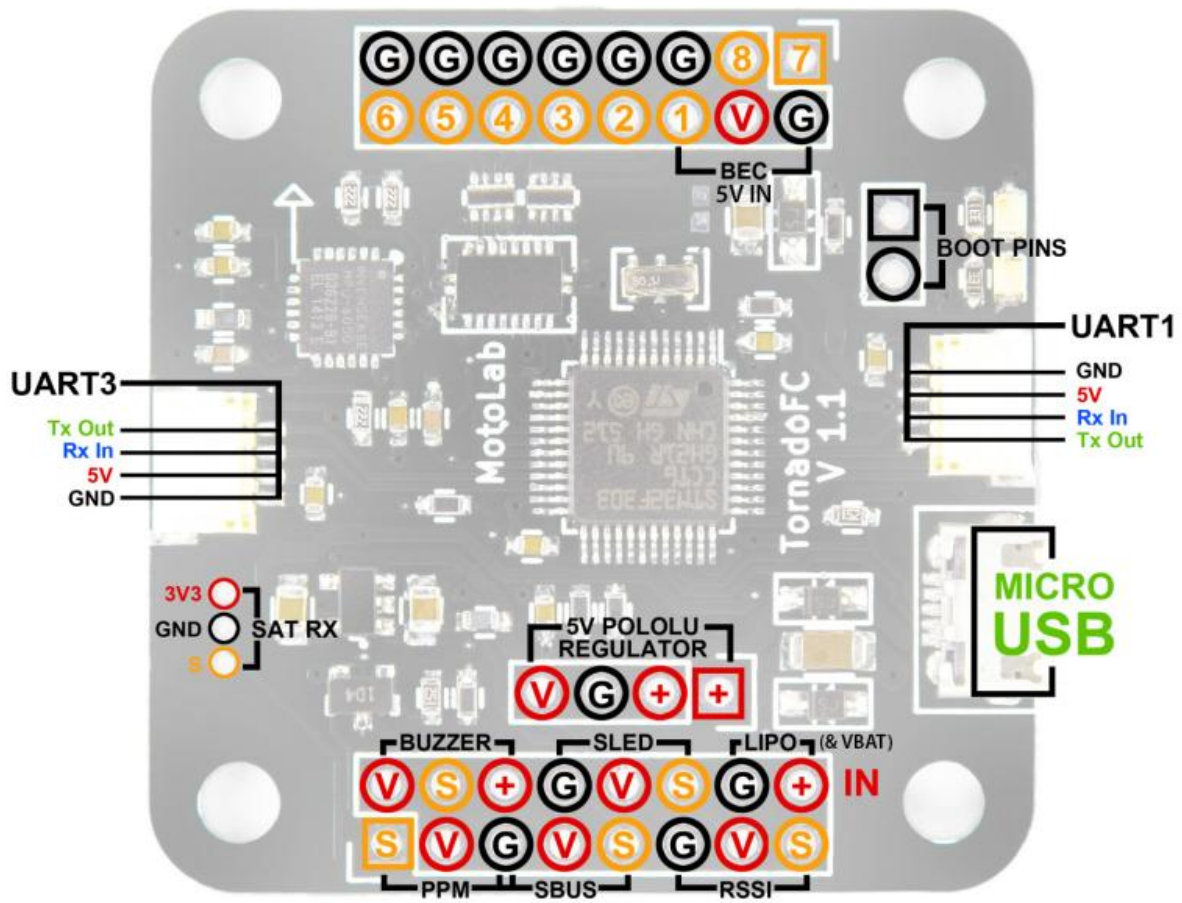
The Motolab Tornado presents itself as a USB device that supports DFU programming. DFU allows devices to have their firmware downloaded and uploaded over a USB transport. To put the Motolab Tornado F3 into bootloader mode, bridge the boot pins and connect the board to the USB. The bridge only needs to be made as the USB connection is made and can be removed after.

Once I enabled AIR_MODE I noticed that the quad would bob and bounce when I tried to land. These issues seems to have been encountered by many others. Until I find a good solution I bring the quad in close to the ground and then quickly disarm it as I land.

A good example was captured in this YouTube video:

Instructions

1. Go to the betaflight releases page.

2. Download the betaflight_MOTOLAB.hex file.

3. Open CleanFlight Configurator.

4. Bridge the boot pins and connect the Tornado F3 to the USB.

5. The 'device' pull-down on Cleanflight Configurator should change to DFU.

6. Select the Firmware-Flasher tab.

7. Click the Load Firmware [Local] button and choose the betaflight_MOTOLAB.hex file just downloaded.

8. Click the Flash Firmware button and observe the progress bar and status.

Your FC should now be flashed with the latest betaflight firmware.

Configuration

Modes: AIR_MODE, ACRO_PLUS

Electronic Speed Controller (ESC)

I am currently using the *FVT LittleBee 20A* ESC.

Batteries

As I have 20A ESC's I need to be looking for a battery capable of discharging at least 80A. So, I should be looking for a minimum of something along the lines of:

- 1300mAh 65C

- 1800mAh 45C

From my previous ZMR250 I have 3 *Zippy 1800mAh 3S 40C* batteries. The batteries that I'm using on my ZMR250, Zippy 40C (50C burst) 1800mAh should be OK as a stop-gap until I get more suitable batteries for this quad setup.

I recently got 3 Turnigy A-Spec 4S 1300 mAh 60C to use with this Alien build. I notice some power improvement. I also notice that there is terrible noise on my FPV video when running these batteries. I have a cheap 12V BEC that supplies the camera power which I am suspecting is the culprit of the noisy signal that is causing the video problems.

More recently I purchased 6 Dinogy 4S batteries. 3 1300 mAh and 3 18mAh.

Receiver

I am using a *S603 Receiver*

Video Transmitter

I am using the *ImmersionRC 5.8GHz 200mW Video Transmitter*.

FPV Goggles

I am using the *FatShark Attitude V3 FPV Goggles*.

Transmitter Configuration

I am using a Spektrum DX6i transmitter. The transmitter requires some adjustment so as to configure the mid-points of the channels around the 1500 value and to configure the channel span to support approximately 1000 - 2000 as expected by Cleanflight.

The Motolab Tornado F3 can drive the receiver when powered by USB which is convenient, meaning I don't need to plug in the battery to configure the flight controller.

So, I connect the quad to Cleanflight Configurator, turn on the transmitter then go to the receiver tab. In here I can see if the channels are configured correctly.

When its all configured correctly I'm expecting to see the values move right when I move the pitch up, the roll right and the yaw right. Initally the values were not spanning the ranges expected by Cleanflight and some of the channels moved the wrong way.

Reverse Channels

Reverse Aileron and Rudder in Transmitter so that moving stick right on transmitter moves the channel slider right in Cleanflight.

Travel Adjust

Adjust throttle travel to span approximately 1000 - 2000 in Cleanflight. To achieve this I adjusted the travel as well as modify the sub-trim.

- Throttle: +109%

Sub-Trim

Adjust sub-trim in Transmitter so that Roll, Pitch and Yaw have a minimum around 1020 and are centered around 1500.

- Throttle: down 27
- Aileron: left 29
- Elevator: down 28
- Rudder: left 54

Once these settings are made I noted the minimum and maximum throttle values and then went back into the Configuration tab to update the min and max throttle values.

When this was all done I could successfully arm and disarm the motors by using the standard approach:

- Arm: min throttle and yaw right.

- Disarm: min throttle and yaw left.

Mix three switches on the transmitter into the Flaps channel to output onto channel 6 (e.g Aux2) channel. Using this configuration we can get four positions (0%, 25%, 75%, 100%). The Flap switch overrides the mix switches.

1. Enter the ADJUST LIST menu by clicking the scroll button.

2. Enter the FLAPS option and configure it as follows:

```
FLAPS


      FLAP   ELEV
NORM ^100      0
LAND v100      0
```

3. Exit the FLAPS menu.

4. Enter the MIX1 menu. The goal here is to alter the settings such that when the MIX switch is off the GEAR switch moves between GPS and Manual and when the MIX switch is on the GEAR switch moves between GPS and Attitude modes. Flip the MIX and GEAR switch on and modify the settings until the Attitude mode is selected.

```
      MIX1

FLAP>   FLAP ACT
Rate D    0% U − 90%
SW ELEV D/R  TRIM ACT
```

5. Exit the MIX1 menu.

6. Enter the MIX2 menu. The goal here is to configure the settings such that the Failsafe mode is selected irrespective of whether the Control Mode was GPS, Attitude or Manual.

```
      MIX2

FLAP>   FLAP ACT
Rate D    0% U − 55%
SW AIL  D/R  TRIM ACT
```

7. Exit the MIX2 menu.

The resulting setup operates as follows:

Switch	Value
None	0 %
AIL D/R	25 %
ELEV D/R	50 %
AIL D/R + ELEV D/R	75 %
Flaps	100 %

I use the Gear switch to switch between Angle mode and Acro mode. This is mostly just in case I get into trouble I can quickly switch into a self levelling mode.

I use the Flap switch to enable Air Mode and Acro Plus mode.

I use the AIL switch to enable the beeper mode. I still use the sticks to arm and disarm and I have found that by simply holding the stick in the disarm position will trigger the beeper to go off. This is just as good as the beeper mode.

FPV Camera

With this quad setup I am using the *Surveilzone HS1177 Sony Super HAD II 600TVL*. However, this unit is a custom unit from ImpulseRC. I think the only difference from the standard HS1177 is that the ImpulseRC version has the cable connector at the top left of the back instead of at the bottom.

The build instructions produced by ImpulseRC on their Youtube channel show the camera being powered by the 5V regulated power output from a ImmersionRC Video Transmitter. I am using the same video transmitter.

However, I found my camera just didn't produce a video signal when using this configuration. I would just see a black screen in my goggles. This was a real annoyance.

Removing all variables, I supplied the camera with 5V from a wall power pack and connected it to my TV. The video signal would briefly show a picture before blanking out then it would repeat this sequence forever. If I increased the power to 9V then the video signal was steady and reliable.

I had a ZMR250 PDB laying around so I removed the small 12V regulator BEC from that, packaged it up nicely so it could sit in-line between the battery and the camera. Physically it connects to the Alien PDB via JST connectors and sits between the camera and the flight controller stack.

I guess one good thing about this is that I should be able to run 3S and 4S batteries without damaging the Camera. Apparently the camera has a known issue running above 16V even though it states that it supports up to 22V.

When I use 4S batteries on with this 12V regulator I noticed that there is extra artefacts on my FPV video. The video image is still clear enough to fly with but there are undesirable horizontal lines across the screen of light and dark zones that progressively scan down. I am suspecting is the culprit of the noisy signal is the 12V regulator.

Settings

Controller: Luxfloat Looptime: ?

PID	P	I	D
Roll	1.5	0.04	20
Pitch	1.5	0.04	20
Yaw	4.0	0.04	10

Betaflight 2.6.0 Update

Controller: Luxfloat

PID	P	I	D
Roll	4.5	0.03	18
Pitch	4.5	0.03	18
Yaw	4.0	0.03	0

Rates

Rates	Value
Roll Rate	0.70
Pitch Rate	0.70
Yaw Rate	0.50
TPA	0
TPA Breakpoint	1500

LED Ring

The Alien supports an optional LED ring that is placed at the rear of the quad.

I came across a flitetest forum post that covered the LED ring in ome detail.

From there I came across a good youtube video showing it off.

Properllors

So far I have used the following propellors on this build.

- *5030 Gemfan*
- *5040 HQProp*
- *5046BN Gemfan*
- *5045 Triblade Gemfan*

One motor would keep spinning after stopping. Backed off screws a little and all good.

Parts

This section covers some of the parts I have used on one or more quads.

Transmitter

Spektrum DX6i

Video Transmitters

ImmersionRC 5.8GHz 25mW Video Transmitter

The dip switches on the back were covered by the clear heat shrink so I used a craft knife to gently trim it away so I could change the switch settings when needed.

Switch 4 is unused on this 25mW unit. The dip switch channel mapping is as follows:

Channel	Frequency (GHz)	1	2	3	4
1	5.74	On	On	On	X
2	5.76	Off	On	On	X
3	5.78	On	Off	On	X
4	5.80	Off	Off	On	X
5	5.82	On	On	Off	X
6	5.84	Off	On	Off	X
7	5.86	On	Off	Off	X

Swapping the standard antenna for a SpiroNET style antenna makes this unit much more usable.

ImmersionRC 5.8GHz 200mW Video Transmitter

This unit provides the same IRC/FS channels as the 25mW unit plus another 8 channels called RaceBand. These channels are much more widely spaced.
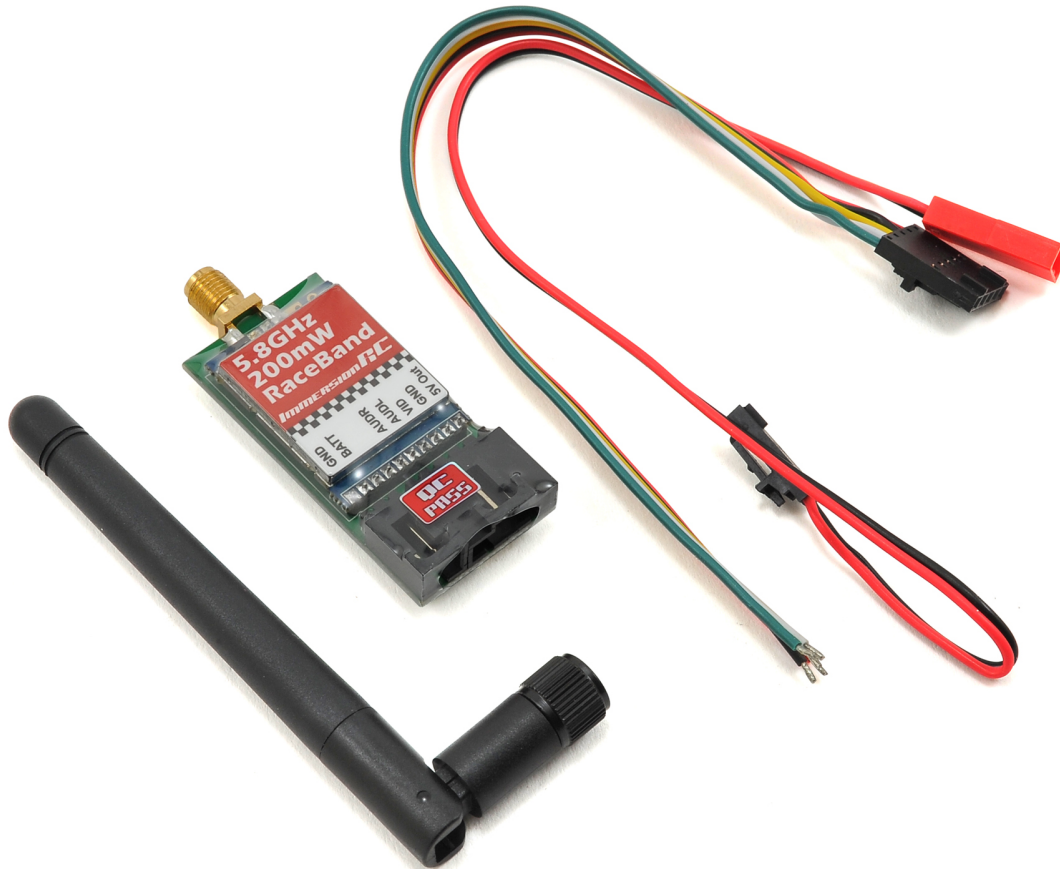
IRC/FS

Channel	Frequency (GHz)	1	2	3	4
1	5.74	On	On	On	Off
2	5.76	Off	On	On	Off
3	5.78	On	Off	On	Off
4	5.80	Off	Off	On	Off
5	5.82	On	On	Off	Off
6	5.84	Off	On	Off	Off
7	5.86	On	Off	Off	Off

RaceBand

Channel	Frequency (GHz)	1	2	3	4
1	5.658	On	On	On	On
2	5.695	Off	On	On	On
3	5.732	On	Off	On	On
4	5.769	Off	Off	On	On
5	5.806	On	On	Off	On
6	5.843	Off	On	Off	On
7	5.880	On	Off	Off	On
8	5.917	Off	Off	Off	On

FatShark Attitude V3 FPV Goggles

These googles are light weight and for me where a slightly cheaper alternative to the more expensive Dominator variant.

The goggles support DC in from 7 to 13V (e.g. 2S or 3S bttery). They have little screens that support VGA 640 x 480 pixels and provide a FOV of 32 degrees diagonal. They support adjustable inter pupil distance (IPD). They have a built in head tracker (that I'll never use) and are capable of showing a 3D video. They are compatible with the Fat Shark fan equipped faceplate too.

On the top left (above the antenna connector) of the goggles is the channel rocker switch. This switch can be rocked side to side to move sequentially through the available channels. An short audio beep is emitted when the channel

changes. A long audio beep is emitted when the channel limit (top or bottom) has been reached. This rocker switch can also be pressed to reset the head tracker.

In the middle is the display control 4-way rocker switch. This is used to control the brightness and contrast: left and right increases and decreases the display contrast while forward and back increases and decreases the display brightness.

On the right hand side is the power input and a composite output connector for displaying the video/audio feed on a TV etc.

They come with the following:

- a 1000mAh 7.4V Lipo battery,

- a charging cable,

- a Spironet right hand polarised antenna,

- an AV cable,

- a 5.8GHz 32 channel modular receiver supporting ImmersionRC/Fatshark, A, E and Race bands.

- a zipper carry case.

The goggles have a switch that allows the internal receiver to be turned off. This is convenient when using the goggles with an external receiver which feeds a video signal into the goggles via the

Using the dip switches on the receiver the various bands can be selected.

Switch	Band	Name	CH1	CH2	CH3	CH4	CH5	CH6	CH7	CH8
0-0	1	Fat Shark/ImmersionRC	5740	5760	5780	5800	5820	5840	5860	5880
0-1	2	Band E (Boscam E)	5705	5685	5665	5645	5885	5905	5925	5945
1-0	3	Band A (Boscam A)	5865	5845	5825	5805	5785	5765	5745	5725
1-1	4	RaceBand	5658	5695	5732	5769	5806	5843	5880	5917

I ended up purchasing the faceplate to replace the rubber eye-cups. This makes the goggles much more comfortable to wear.

FPV Cameras

Surveilzone HS1177 Sony Super HAD II 600TVL

The Sony HS1177 Super HAD II CCD 600TVL camera supports power from 5-22V and has a 2.8mm lens which provides approximately 130 degree field of view. It seems to have a good reputation in the FPV community.

The HS1177 FPV camera comes with a short On-Screen Display (OSD) controller cable with some connectors on the end. These connectors are common for security cameras and can be confusing for the lay-person from the quadcopter community.

I happened to have a BNC to RCA adapter laying around from an old security camera setup. This converts the video signal onto a connector style that I can more easily connect to other equipment such as a TV. I also had a reconfigurable wall-wart power adapter that had the appropriate barrel power connector.

The only modification I made to the camera was to set the Wide Dynamic Range setting to ON as this prevents very bright objects (such as clouds) from causing other areas (e.g. the ground) in the view from becoming very dark.

```
Exposure -> DWDR --> ON
```

Once the focus is set it can be useful to hot-glue the focus locking ring into place as the intense vibrations present at all times on the quadcopter can work it loose over time.

Eachine TX01

This is a 25mW 5.8GHz 40 channel FPV transmitter that I bought this unit as the camera for a Tiny Whoop setup.

A short press on the button cycles the currently selected band's channels. A longer press (~2s) enters the band selector which cycles through the bands A, B, E, F, and Race. A long press (~5s) cycles between on ('=') and off ('0').

Once selected the settings are saved and retained.

Band	Name	CH1	CH2	CH3	CH4	CH5	CH6	CH7	CH8
A	Band A	5865	5845	5825	5805	5785	5765	5745	5725
b	Band B	5733	5752	5771	5790	5809	5828	5847	5866
E	Band E	5705	5685	5665	5645	5885	5905	5925	5945
F	Band F (Fat Shark/IRC)	5740	5760	5780	5800	5820	5840	5860	5880
r	RaceBand	5658	5695	5732	5769	5806	5843	5880	5917

Receivers

S603 Receiver

This receiver is a cheap alternative for a Spectrum branded receiver. These can be found on sites like banggood. I have ended up removing the receiver from its protective shell, remove all the pins, solder wires directly to the PPM pins and then wrap it in some clear heatshrink.

Bind Procedure

1. Ensure transmitter is off.

2. Insert bind plug into Bind port in S603.

3. Power up the S603 using 5 - 8 Volts supply. I used the PPM input lead to my Naze32.

4. The S603 should power up and the LED should be flashing.

5. Remove the bind plug from the S603.

6. Ensure that the throttle and Aux channel is set to desired failsafe position on the transmitter.

7. Turn on transmitter while holding down the bind switch (on my DX6i this is the Trainer switch). Keep holding it until the S603 LED goes steady. For me it transitioned through flashing fast, off, slow flashing before finally going steady. Sometimes it takes a few tries before it is set properly. If it doesn't end up with a steady LED then just repeat the procedure until it works.

8. That's it. Done.

On-Screen Displays

Micro Minim OSD

The Micro MinimOSD is pretty much the same as the MinimOSD only smaller. It has a 16x16mm size. It supports monitoring two batteries up each up to 4S size. It supports monitoring current too.

The information displayed by the OSD appears to be highly configurable though I am only planning on using it to overlay the battery voltage.

The board requires an external 5V supply. I can provide this from the 5V output on the ImmersionRC Video Transmitter that I am using.

I found a site showing how someone had used 90 degree header pins to reduce the overall volume required by the OSD when installed. This looks pretty good so I might just do the same thing. The pin out would end up looking something like this:

1	2	3	4	5	6
GND	BAT1	Cur	RSSI	Vi	Vo
GND	GND	5V	RX	TX	DTR

This layout provides the ability to access the FTDI pins to reconfigure the OSD and the most important (to me) sensor and video pins.
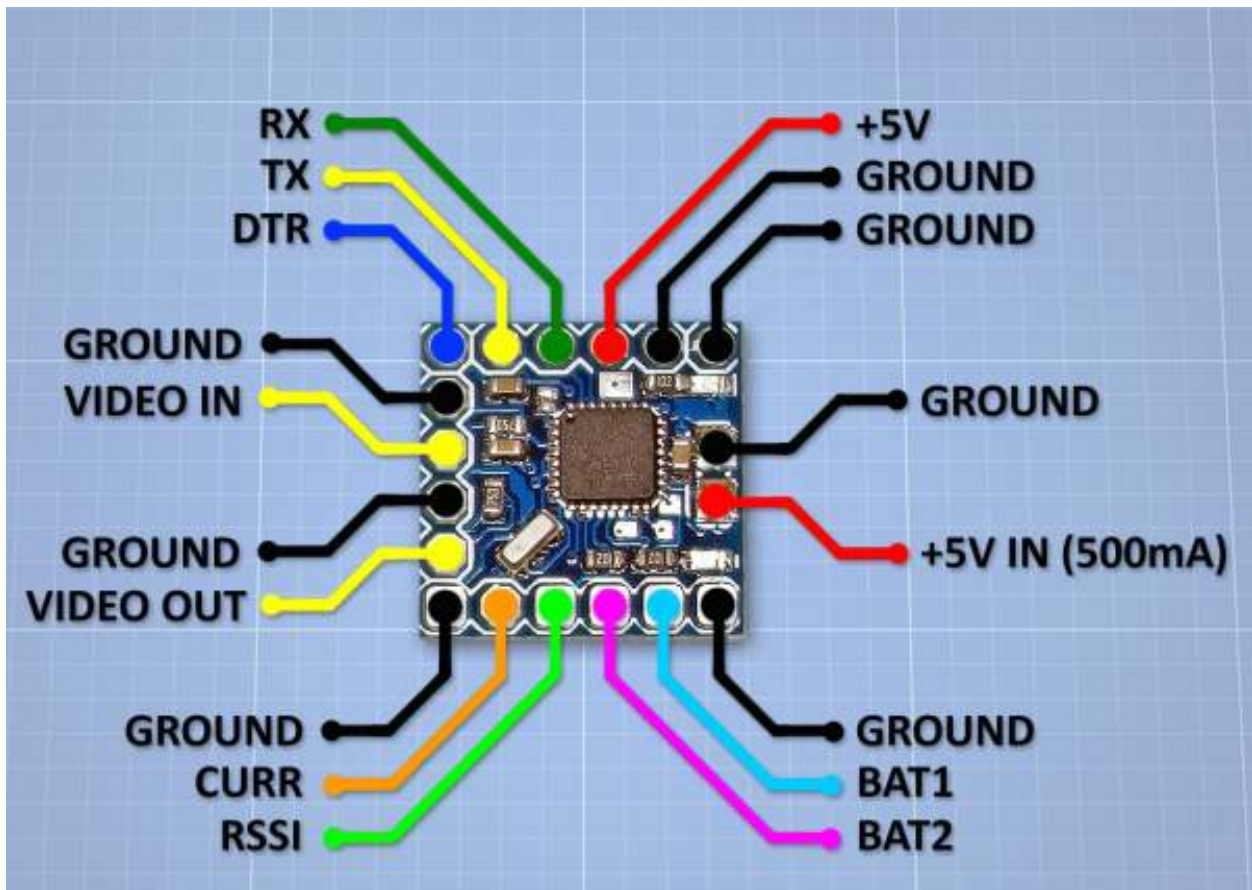
Action Cameras

Xiamoi Yi

The Xiamoi Yi is a cheap HD action camera similar to a GoPro. It provides a much cheaper option than a GoPro and hence can be put into harms way with less concern.

First step is to ensure you have the latest firmware running. Use this link.

A script exists to manipulate the camera to enable a feature like super view on a GoPro as well as increase the bit rate. Apparently the Yi's sensor is 1600x1200. When it records in 1080 (16:9) resolution it simply crops the image from 1600 to 1080. This cropping results in the vertical field of view being reduced, which can be undesirable.The script enables the whole sensor to be used but also results in a 4:3 resolution. The Yi takes this 4:3 image and stretches it to fit the 16:9 1080 frame resolution. This results in some distortion.

Here is the script.

Propellors

5030 Gemfan

These are cheap flimsy propellors which were ideal while I was learning how to fly. They are pretty forgiving, in many crashes they did not break. I bought a pack of 20 from an eBay store.

5040 HQProp

These propellors feel better quality than the Gemfans. They feel firmer, less give. However, these propellors break very easily in a crash.

5046BN Gemfan

These propellors were great while they lasted. I had been using the Gemfan 5030 while learning to fly and once I started getting better I gave these a go. These propellors seemed a bit more responsive, perhaps because of their pitch and also they are thicker. They were surprisingly quiet.

5045 Triblade Gemfan

Electronic Speed Controllers

Afro 12A

This ESC's use the SimonK bootloader and hence do not support the flight controller pass-through programming method to update the ESC firmware.

FVT LittleBee 20A

Batteries

Zippy 1800mAh 3S 40C

I bought these batteries for my ZMR250. I also use these on my Alien 5" too. They are rated as capable of 50C bursts.

Tunigy A-Spec 1300mAh 4S 60C

These are compact little batteries. I definitely feel the power difference capared to the 3S batteries I have. These batteries recommended charging at 1C was is really slow.

Dinogy 1300mAh 4S 65C

I bought these batteries from banggood.com. They are more compact than similarly specified batteries from other vendors. They support charge rates up to 5C which is convenient. However, on the back they recommend charge rates of 1C to 3C. Inconsistent.

Dinogy 1500mAh 4S 65C

I bought these batteries from banggood.com. They are more compact than similarly specified batteries from other vendors. They support charge rates up to 5C which is convenient. However, on the back they recommend charge rates of 1C to 3C. Inconsistent.