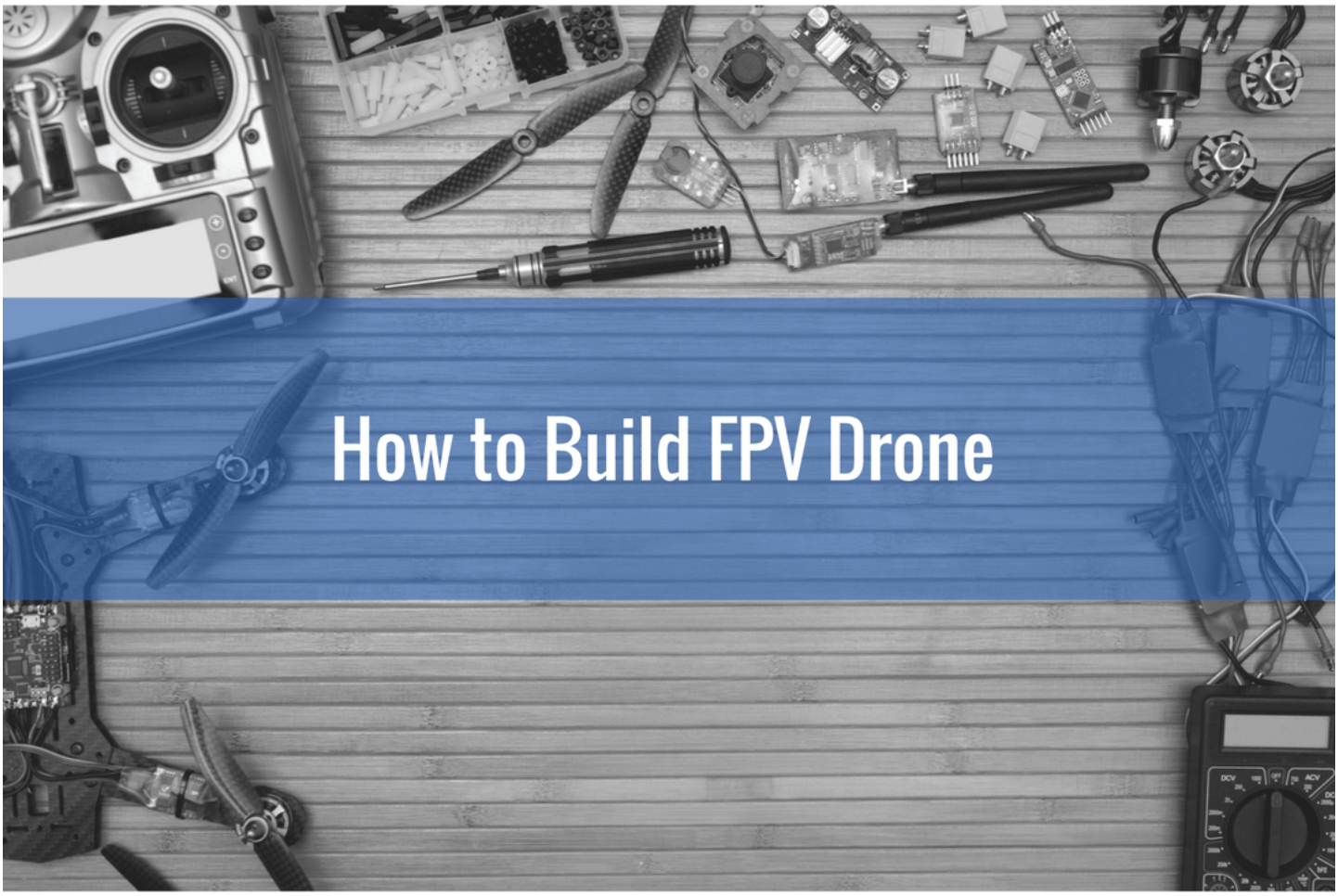
Drone Nodes



Guide

How to Build A Drone | Step by Step Guide

Flying a drone is an exhilarating experience! The **thrill of zooming in and out of epic locations completely immersed in the pilot's**

view is hard to beat. It is something that many people are keen to take up however they often are unclear on how to build a drone, where to start. The biggest obstacle for many is getting their hands on their first drone with many hobbyists opting to build their own.

To build your own drone can feel like an intimidating task, it did for me and there's a mountain of information to wade through before anything starts making sense. Fortunately, it's not as hard as it sounds and with a little guidance you'll be in the air in no time whilst picking up some practical skills! Initially, the idea might sound scary but I firmly believe that **anybody armed with the right information will be able to get on and do it relatively hassle free**.

Quick Navigation

A quick note on RTF Drones

A common question I often hear is **"Why would I want to build my own drone with so many great RTF (ready to fly) and BNF (bind n fly) options out there?"**

Model	Frame Size	Prop Size	Version	Details	Rate
Eachine US65	65mm	31mm	BNF	Review	★★★☆☆
Emax Tinyhawk	75mm	40mm	BNF/RTF	Review	★★★★☆

Model	Frame Size	Prop Size	Version	Details	Rate
Eachine Trashcan	75mm	40mm	BNF	Review	★★★☆☆
Happy model Mobula 7	75mm	40mm	BNF	Review	★★★★☆
Diatone GT R249+	115mm	2.5 inch	PNP	Review	★★★★½
HGLRC Sector 132	132mm	3"	BNF	Review	★★★½☆
Diatone GT R349	135mm	3"	PNP	Review	★★★★½

Model	Frame Size	Prop Size	Version	Details	Rate
Emax Hawk 5	210mm	5"	BNF	Review	★★★★★
Eachine Tyro 99	210mm	5"	DIY	Review	★★★½☆
Armattan CF-258	258mm	6"	DIY	Review	★★★★½

Many people have seen products such as the Eachine Wizard and the **Emax Hawk 5** which are certainly great drones for the price you pay. The problem is that in this hobby you are going to crash and when I say crash I mean a lot! Typically in a session I crash about ten times and find myself often having to fix my drone in order to get back in the air.

BNF Quad

Recommended BNF Drone

Emax Hawk 5

A combination of high performance, great flight dynamics and easy setup make the Hawk 5 the easiest route to competitive FPV racing drone.

Check Price

That said the Hawk 5 and **Sector 132** make great starting drones and will teach you a lot about the hobby. If you are the kind of person who just wants to get in the air and fly or simply don't have the time to build then these are some amazing options that will cover in our Top RTF Drones Article.

RTF Quad

Recommended BNF Drone

HGLRC Sector 132

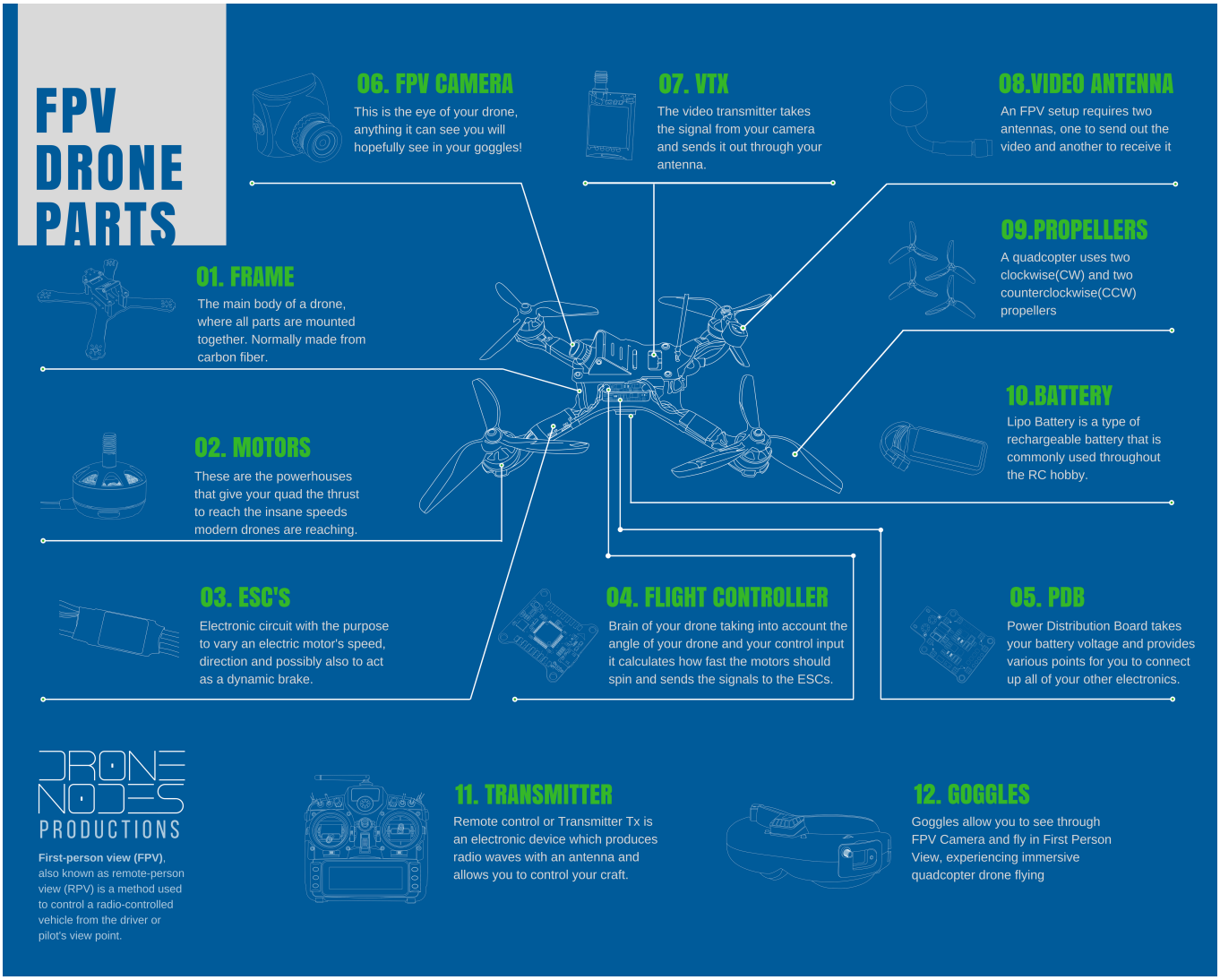
HGLRC Sector 132 is one of the cool budget cinewhoop drones. His preformance is suitable for complete beginner.

Check Price

By skipping the building part you will find it much harder to diagnose the problem and much harder to fit the new parts. If you understand your build completely you can often fix it without hassle and probably guess what's failed.

DRONE ANATOMY

Infographic representing main quad part's you will need to build fpv drone. We'll go through every single part and explain it's main functions. Click the image to zoom in!



BASIC TOOLS YOU NEED

When starting out you can get by with just a few basic tools. This list covers the **bare minimum** you need. Our [In Depth Quadcopter Tools Guide] covers all the nice to haves which will make the process much easier!

Tools

- A set of hex keys or drivers (sizes dependent on your frame choice)
- An M5 (8mm) nut spinner or ratchet
- A soldering iron and solder
- Wire Cutters/Strippers

Extra bits and bobs

- Cable ties
- Heat shrink
- Standoffs
- Electrical Tape
- Double Sided Tape
- Thread Locker (Loctite)

WHAT TYPE OF DRONE SHOULD I BUILD?

You may already have started searching for parts only to discover that they can be found in all sorts of shapes and sizes. The best way to categorize them is actually by prop size as follows:

Quads

2” Class Build

Typically very small and suitable for indoor use. They are great for practicing at home or in bad weather! These little rockets are becoming increasingly popular and some can hit up to 100mph!

> 2" Class

Example of 2" Class Build

Eachine Lizard

Lizard is flagship brushless micro drone from Eachine, under 100mm category. It has powerfull performance for this category. Check the details under the link.

Check Price

3-4” Micro Class Build

The smallest full size drone you should really be flying outdoors. These fly very similarly to their bigger brothers and are the perfect option for tight spaces. Check our indepth guide on micro drones.

3-4" Class

Example of 3" Class

Diatone GT R349

We covered Diatone under best micro drones section. It can run 4S batteries, and can easily ourun some 5" quads.

Check Price

Testing the perfect 3" Quad - Diatone GT349

The R349 is mostly similar to the R249+ except for a few changes. The changes include a 135mm wheelbase with the same 6mm wide and 3mm thick arms. The R349 is equipped with the Mamba stack which includes the F4 mini flight controller and 25A ESC's. The R349 again comes as a PnP version with the supported receivers being PPM, SBUS and DSM.

The motors have gotten larger to complement the larger frame to a 1408 sized 4000kv motor. The motors are definitely going to be power hungry which in turn results in a faster quad. The R349 is meant to be a 3" racer and hence to weight, Diatone ditched the Runcam Mini split V2 for a Runcam micro camera with the TX200U vTX.

The R349 definitely does as advertised. On a 3s battery, the quad may seem a little sluggish and slow but rips on a 4s battery. The stock PID's out of the box are still bad, though no vibrations can be felt on 3s but on a 4s battery definitely showed the oscillations.

Specifications	
Flight Controller	F4 mini flight controller STM32F405 MPU6000 Gyro
Frame	3K carbon fiber Wheelbase- 135mm
ESC	25A Continuous 3-4S Input voltage DShot600
Motors	1408 4000kv Max Thrust- N/A
Camera	700TVL CMOS , PAL/NTSC switchable
vTX	TX200U, 25mW/200mW 48CH switchable output power
Propeller	1940 3 blade 2540 3 blade
Recommended battery	500-850mah 4S(not included)

5” Mini Class Build

The most common type of Racing/Freestyle Drone. Often described as they most versatile due to the fact they offer a large amount of power yet have incredible maneuverability and are able to carry a HD camera such as a GoPro without a significant compromise on flight characteristics. Ninety percent of mini quads out there at this point in time fit this category. From various configurations you can check recommended racing drone kits that we used and tested.

My Armattan Chameleon

6” Mini Class Build

A more long range and efficient option, great for someone who would rather cruise at speed as opposed to race and perform fast tricks such as flips and rolls. This size is often used in a long range setup and are used to fly over scenic locations such as mountains.

Rotor Riot Butter Kwad

7+” Class Build

At this size you start to get into the **photography / videography** side of things. These drones are big enough to carry a camera with a stabalisation system and make use of other features such as GPS allowing them to hold their position and even return to home automatically.

TBS Discovery Pro

These are **typically flown in a self leveling mode** as opposed to acro mode used for the smaller quads and have larger batteries allowing them to go much further.

Hopefully that gives you an idea of which size you want to build.

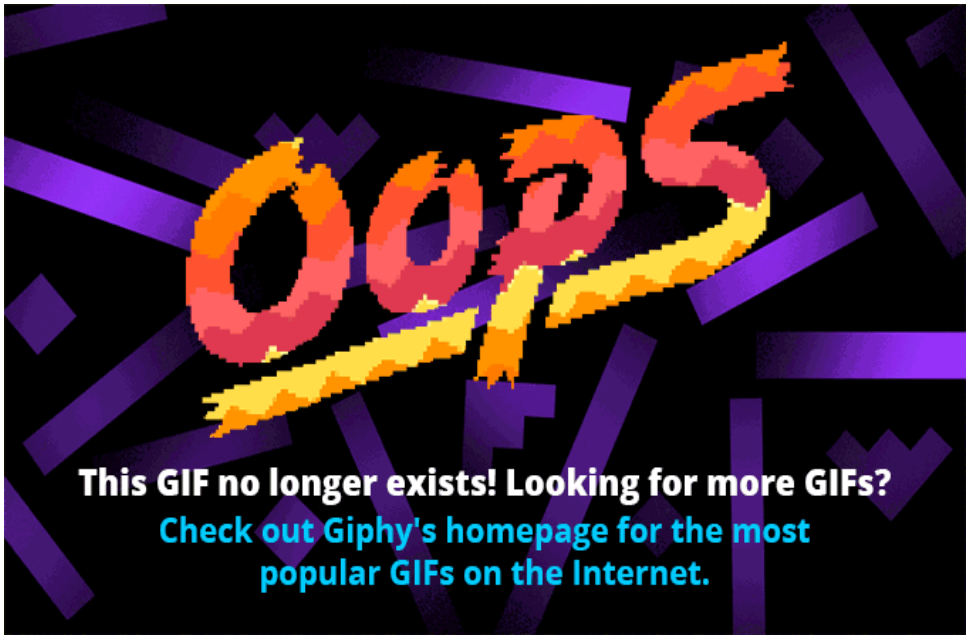
When choosing a size please **bear in mind the smaller you go the less space you have to work with when you build**. On the other hand a smaller quad is often cheaper and the lower weight will reduce the chance of damage during a crash.

My **personal recommendation for a first drone would be a 5”** as they are easy to build and have enough power to lift a HD camera.

The **5" Drone also has the most readily available supply of parts** meaning that everything is as cheap as it can be and easy to get hold of.

Of course you don't have to just stick to one drone! Check out Stu from UAV futures wall of quads! His YouTube channel provides teardowns and flight videos of nearly every drone out there to help you decide.

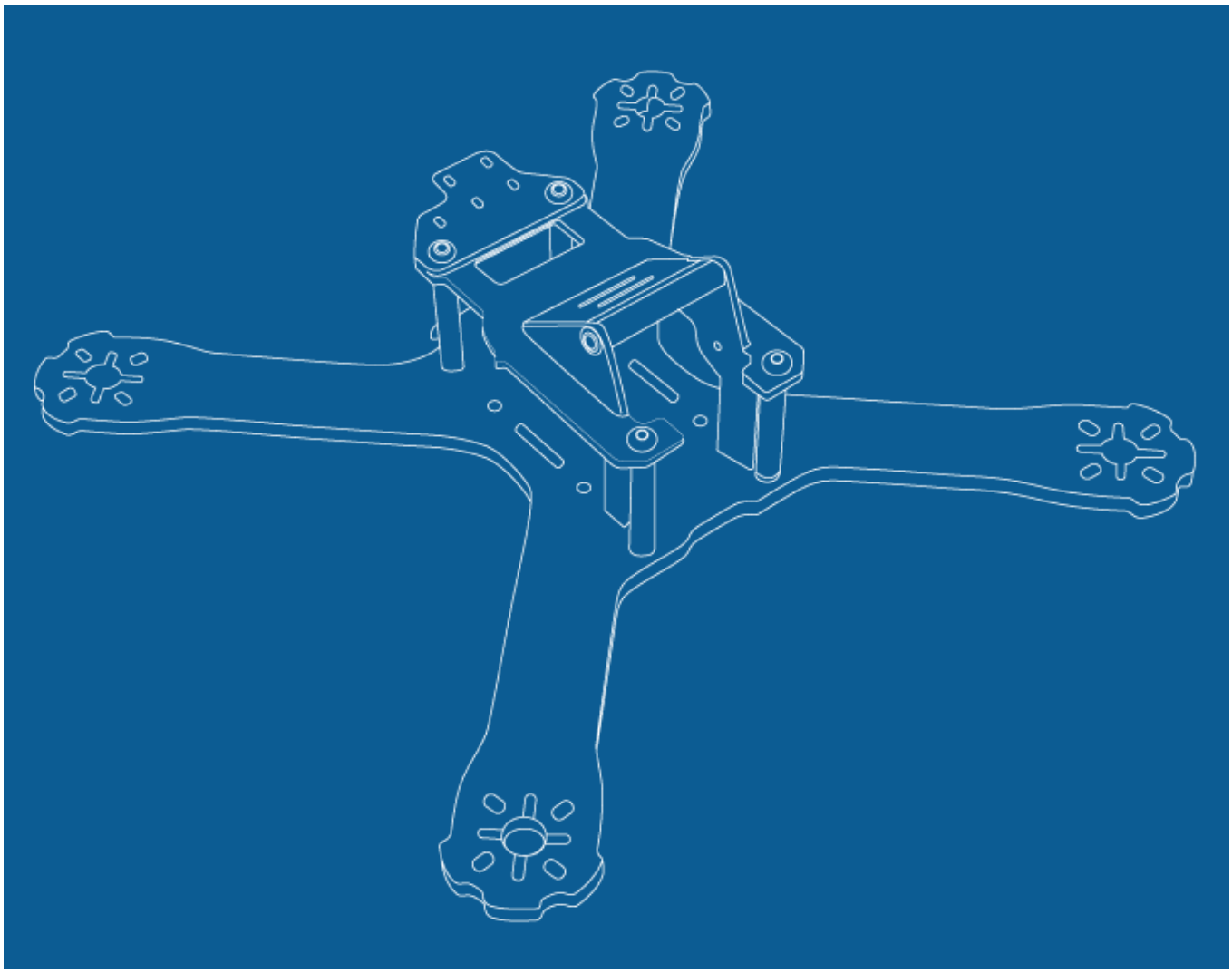
DRONE PARTS - CHOOSING THE RIGHT COMPONENTS



So now you have a good idea what kind of drone you would like to build the next step is to **choose suitable components**. Each build is going to vary person to person but **almost all builds will follow the same basic parts**. For each component I'll explained what it does, the choices you'll have to make and the bare minimum you should look for spec wise.

Let's Dive in:

Frame



This is your starting point! This is the main body of your build where you mount all your parts and get everything together. Frames are normally **made from carbon fiber** and are assembled with various mounting hardware such as standoffs or aluminum sections. They can come in all kinds of shapes and sizes, we covered quadcopter frames in detailed guide.

Choices you'll have to make:

Light weight racer or freestyler? - Racing Drones are typically minimal frames that are light and nimble. Freestyle Drones however fly better with a little weight as it allows them to carry momentum through various stunts. A Freestyle drone typically requires more protection as they are often flown higher and over harder surfaces.

Top mounted or underslung battery? - This will affect the center of gravity but could leave the battery more vulnerable. The closer the centre you can make it the smoother your drone will fly.

Is there an spot to mount a HD camera? - If you want to carry one of course! Race drones normally opt not to due to the extra weight. For many frames 3D printed options are available.

Do you want swappable arms or a one piece design? Swappable arms can reduce downtime but also increase weight.

Can I fit all of my components in that space? Do you see space to mount all your components, this could limit you options later down the line.

For 5"+ frame sizes you should be looking for at least 4mm thick arms, for 3" - 4" you can go down to 3mm and for 2" just 2.5mm. Any thinner than this will break too easy.

For 5"+ frame sizes you should be looking for at least 4mm thick arms, for 3" - 4" you can go down to 3mm and for 2" just 2.5mm. Any thinner than this will break too easy.

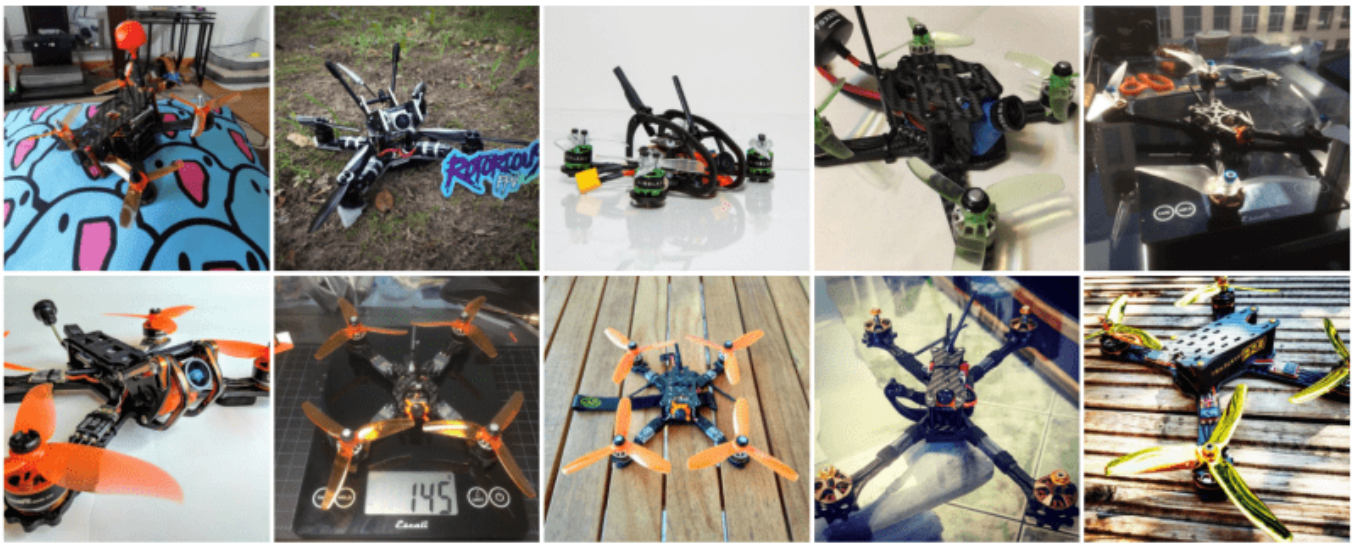
You may of seen frames sized by motor to motor distance eg 220mm. The following table shows you a rough conversion of what you should look for size wise.

Prop Size	Rough Frame Size	Min Arm Thickness
2"	95mm	2.5mm
3"	130mm	3mm
4"	180mm	3mm
5"	220mm	4mm
6"	250mm	4mm
7"	300mm+	4mm

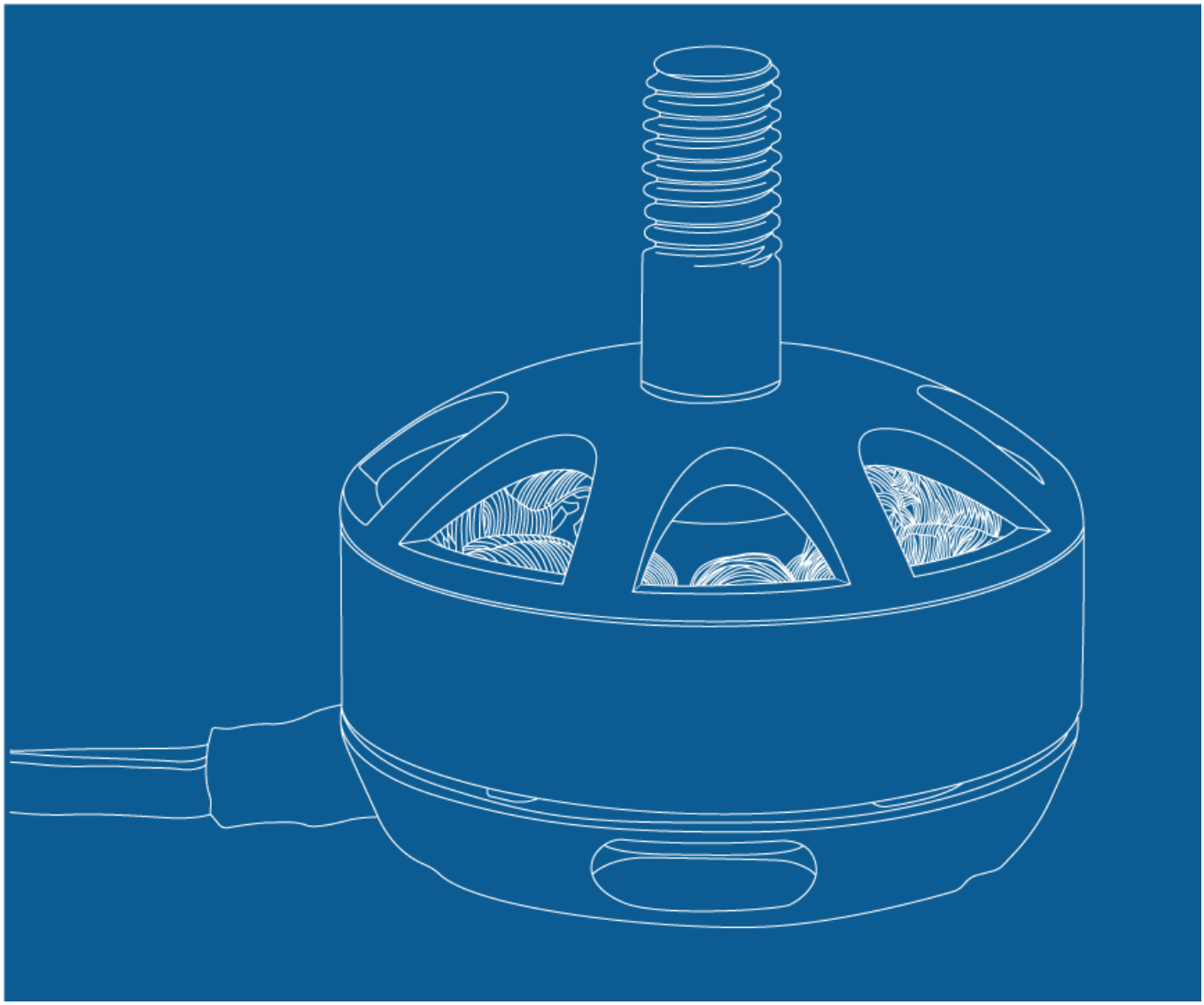
There's a lot to consider here! If you get stuck or are unsure have a look at pilots whose flying style you like and find out what they are flying. Many top pilots have build videos that explain the key points of their frames and why they choose to fly them.

Another great resource to use to help you decide on parts is Rotor Builds. The site shows off user created Drones and includes details

such has parts lists and build guides! It's a great place to find inspiration.



Quadcopter Brushless Motors



These are the powerhouses that give your quad the thrust to **reach the insane speeds** modern drones are reaching. There's alot of brushless motor choices out there for mini quad, it's hard to decide. When choosing motors, there are specs that comes with the motor provided by the manufacturer. You should be able to find detailed information about the weight, thrust, power, rpm etc.

When building the drone take a closer look at this specs in a motor:

Motor Size

The first point is the **size**, a motor size is typically noted in a **XXYY** format with the first two digits referring to the stator **diameter** in

mm and the second two being the **height of the magnets**. Basically the larger these numbers are, the higher torque the motor is able to produce, think of it like engine size with the drawback of larger sizes being the weight. In terms of performance higher torque allows the motor to hit it's target speed faster increasing the feel and response of the drone. This could be useful in the case of a heavier quad or when running heavy props.

KV

Another factor to consider is **kv**, this stands for the **motors velocity constant** which means how many RPM per volt your motor can give for example a 2300kv motor at full throttle on 10V would be spinning at 23000rpm. Selecting the kv value is like selecting a gear in a manual transmission. **Going low gives you more torque but less top speed and going higher will increase your top speed at the price of torque**. Generally speaking going higher requires either a big powerful motor or an incredibly light setup. A 3" setup for example will have a much higher kv rating when compared to a 5" design.

The following table lists some possible options for you depending on your prop size:

Prop Size	Recommended Stator Size	Recommended Magnet Height	Recommended Motor KV	Recommended ESC Size
2"	11	03 - 06	4000 - 8000	6 - 12A
3"	13-14	06 - 07	3000 - 4000	12 - 20A
4"	13-22 (Frame Dependent)	04 - 07	2400 - 2900	20A

Prop Size	Recommended Stator Size	Recommended Magnet Height	Recommended Motor KV	Recommended ESC Size
5"	22-23	05 - 07	2200 - 2800	20 - 35A
6"	22-23	06-08	2200 - 2800	30 - 40A
7"	300mm+	06+	1800 - 2300	30A +

When looking for a motor you should be able to find a specification table that gives you details on thrust with different props and amp draw which we will need to know later. Generally with a mini quad you should be aiming for a 10-1 thrust to weight ratio. The following table is an example from an Emax rs2205 Red Bottom motor which in early 2016 was a top performing 5" motor. These days it has average performance compared with the competition but would be great for a first build.

Motor type	The voltage (V)	Paddle size	current （A）	thrust (G)	power (W)	efficiency (G/W)	speed (RPM)
RS2205-2300KV	12	HQ5045 BN	1	62	12.00	5.17	6400
			3	162	36.00	4.50	10080
			5	236	60.00	3.93	12070
			7	311	84.00	3.70	13730
			9.1	374	109.20	3.42	15100
			11	439	132.00	3.33	16320
			13	490	156.00	3.14	17350
			15.3	548	183.60	2.98	18350
			17.3	611	207.60	2.94	19210
			20.7	712	248.40	2.87	20080
	16	HQ5045 BN	1	76	16.00	4.75	7220
			3	183	48.00	3.81	10790
			5	283	80.00	3.54	13030
			7.1	352	113.60	3.10	14720
			9.1	426	145.60	2.93	16180
			11	497	176.00	2.82	17150
			13	560	208.00	2.69	18460
			15	628	240.00	2.62	19270
			17	692	272.00	2.54	20270
			19	754	304.00	2.48	21060
			21	812	336.00	2.42	21840
			23.3	878	372.80	2.36	22590
			25.4	936	406.40	2.30	23210
			27.3	997	436.80	2.28	23920
			29.9	1024	478.40	2.14	24560

Further reading:

Quadcopter Brushless Motor Guide

A great resource for researching and comparing motors is Miniquad Test Bench: which is run by Ryan Harrell. On the site Ryan gives feedback on most modern motors and provides all the data for you to evaluate and draw up your own comparisons. If you are unsure if you have the right sized motor look at some of the props is spinning and see if it fits in with your expectations.

ESC's

These small components known as **electronic speed controllers** are what produces the three phase AC current needed to drive your motors. The flight controller sends a signal to the ESC to let it know how fast it wants it to spin the motor at a given point in time. You will need one esc for each motor, you can either get **four separate ESCs** to mount them on the arms or get an **all in one board** that sits inside your frame if you have the room.

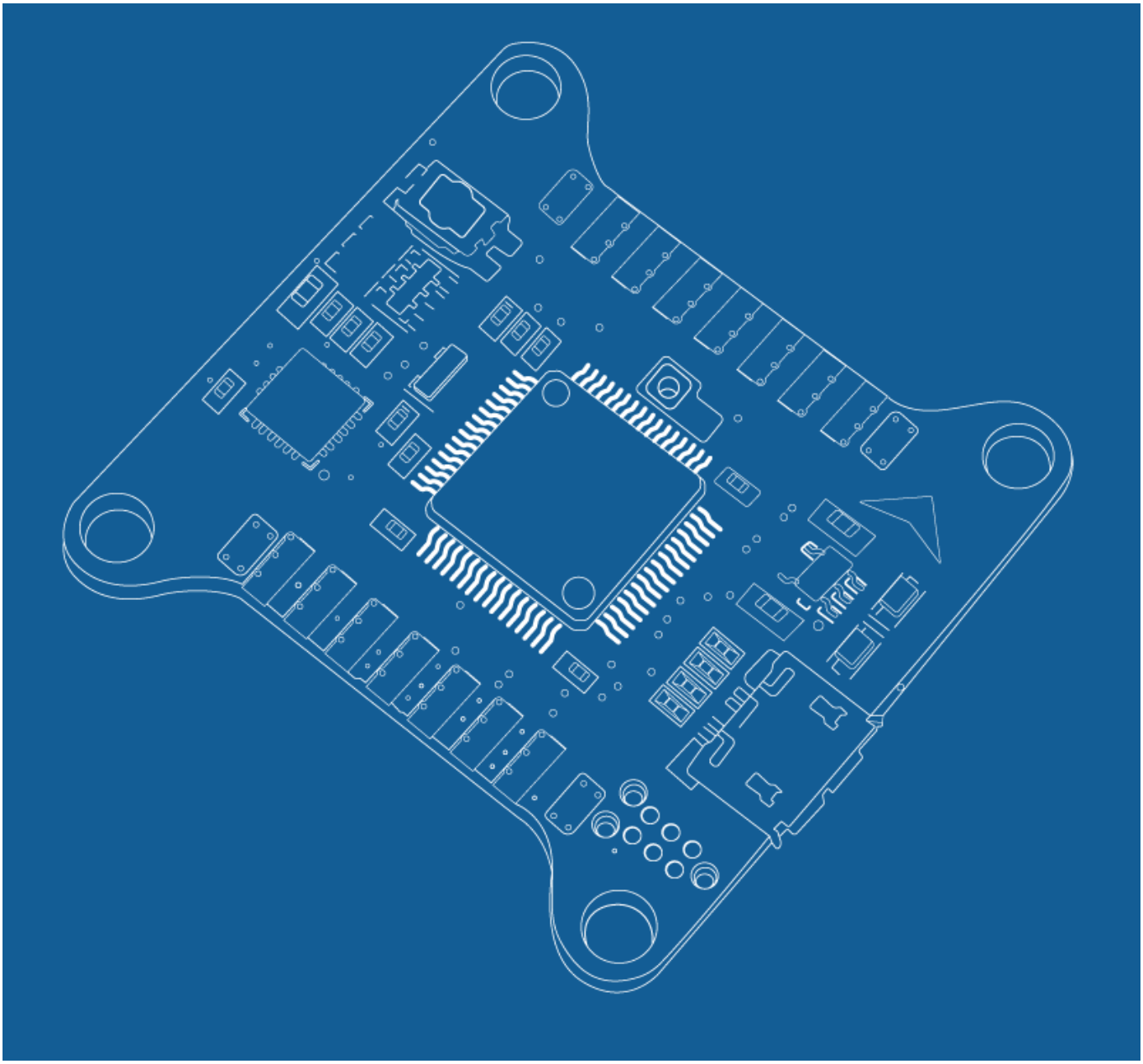
Things to Consider:

The amp Draw of your Setup! Remember those motor tables you were looking at? You'll notice that there is an amp draw column. You will need your ESCs burst current to exceed this value or they could burst into flames up mid flight!

ESCs are reasonably intelligent and can run on different software. At the time of writing you should only really consider ESCs running **BlHeli_S** or **KISS ESCs**. The old **BlHeli** or **Simon K** software is now outdated.

The ESC can talk to the flight controller through various protocols (think of them as languages). The current standard protocol is **Dshot**, if an ESC does not support **Dshot 600 or greater** it is not worth considering these days.

Flight Controller



The **flight controller is the brain of your drone** taking into account the angle of your drone and your control input it calculates how fast the motors should spin and sends

the signals to the ESCs. Flight controllers are normally built for certain software such as Betaflight, KISS or Raceflight so your software choice may effect your decision.

The cheapest and most popular option is currently **Betaflight**, **KISS** on the over hand is said to be smoother but is more expensive and finally Raceflight is a newer more cutting edge development.

Things to consider

Processor - at the heart of all flight controllers is a micro processor that works hard to keep you in the air, we are only really using F3 or F4 chips so I would recommend choosing a flight controller with one of these. The F7 chip is slowly coming in however we are not really making use of it yet. The older F1 chips present in the CC3D and NAZE 32 boards are now outdated and will not be supported by future software updates.

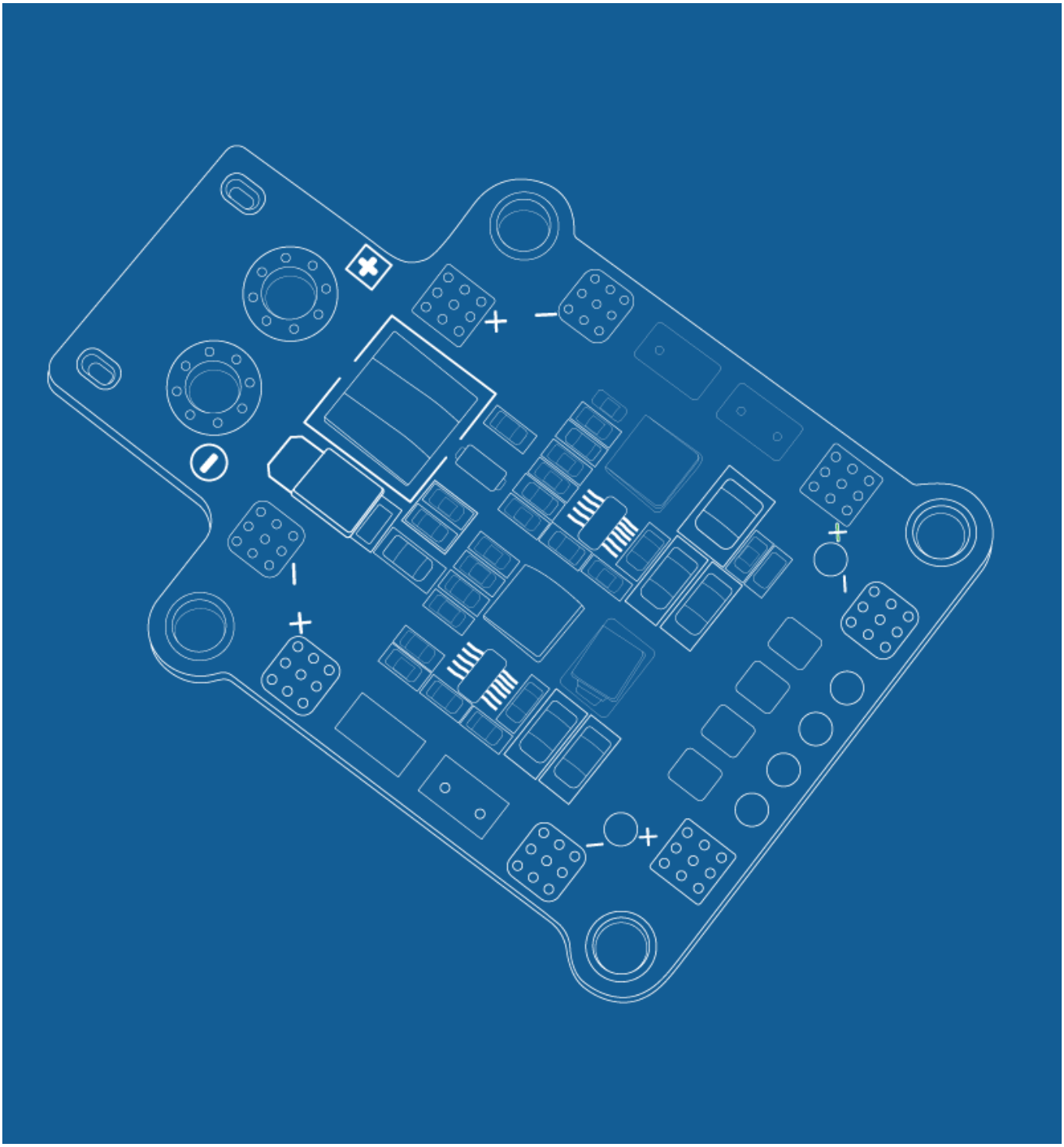
All in One or Separate - Many modern flight controllers are **incorporating the PDB into the flight controller** itself! This is great for tighter builds as you only need one board in the stack and wiring is simplified. The only negatives are that they are normally more densely populated giving you less room to solder wires and often require connections on both sides. The **Betaflight F3** is a great example of an all in one flight controller.

OSD (On Screen Display) - Flight controllers with an OSD chip onboard are capable of displaying all kinds of useful information on your video feed such as battery voltage, current draw and even an artificial horizon. I would highly recommend an OSD however they

can also be run separately to the flight controller or onboard the PDB itself.

UART Ports - External devices are often connected to the flight controller through UART ports. These devices include receivers, stand alone OSDs, telemetry systems and controllable video transmitters. For a first build you may not have to worry about these but for more feature rich drones you will need to make sure you have enough UART ports for what you want to achieve. I would always recommend you look at the pinout for your chosen board to make sure that it has connections for everything you need.

PDB - The Power Distribution Board



Your **PDB** takes your battery voltage and provides various points for you to **connect up all of your other electronics**. Typically a PDB will feature regulator to power your low voltage components such as the flight controller and camera. From other things take closer look at Voltage Requirements, Connector Locations and Maximum current draw.

Things to Consider:

Voltage Requirements - Components such as your flight controller most often require 5V to run off, some cameras may require 12V. If you power them directly from your battery they will most likely burst into flames! For this reason the PDB you choose should contain voltage regulators or BECS (battery eliminator circuits) to provide you with the power output you need!

Connector Locations - Your typical PDB provides connections for your battery, connections for four ESCs and then various low voltage pads (often 5V and 12V). When planning your build try to visualize where you want to put everything and if the pads are actually where you want them. Some battery connectors for example stick out to the side allowing you to directly connect an XT-60 connector. Others however simply have two pads requiring you to run a battery wire.

Maximum Current Draw - This is only really necessary if you have an incredibly powerful set up drawing more current than most. The PDB will often be rated to a certain current (typically over 100A). The same should be done on any regulators but again will only really be necessary with elaborate more power hungry set ups such as those running the RunCam Split.

FPV Camera

This is the **eye of your drone**, anything it can see you will hopefully see in your goggles! What's important here is that we can see clearly in all light conditions and that there is no lag in getting the image to us which could cause a crash. There a few very similar options here which will all work great. Most cameras also come with a load of mounts and cases to fit into any frame.

Things to consider:

Sensor Type - FPV Cams typically have either a CMOS or CCD image sensor inside. Typically CMOS cameras are cheaper and lighter but lack the ability to react quickly to changes in lighting. This Is quite necessary in FPV flight as we often face the bright sun followed by the darker ground, any lack of visibility could result in a crash!

You can get away with flying a cheap CMOS camera however a CCD will give you better results. Almost all CCD cameras use the Sony Super HAD II sensor which is the gold standard in FPV drones. Examples of this include the RunCam Swift or HS1177 variants.

There are also soe special cameras that make better use from CMOS such as the higher resolution Monster or Eagle cameras and the low light cameras such as the Owl or Night Wolf.

Resolution and Latency - I've grouped these two together as they go hand in hand, the higher resolution you run the more latency you are likely to see! Analogue cameras are rated in TVL which is the number of horizontal lines across the screen.

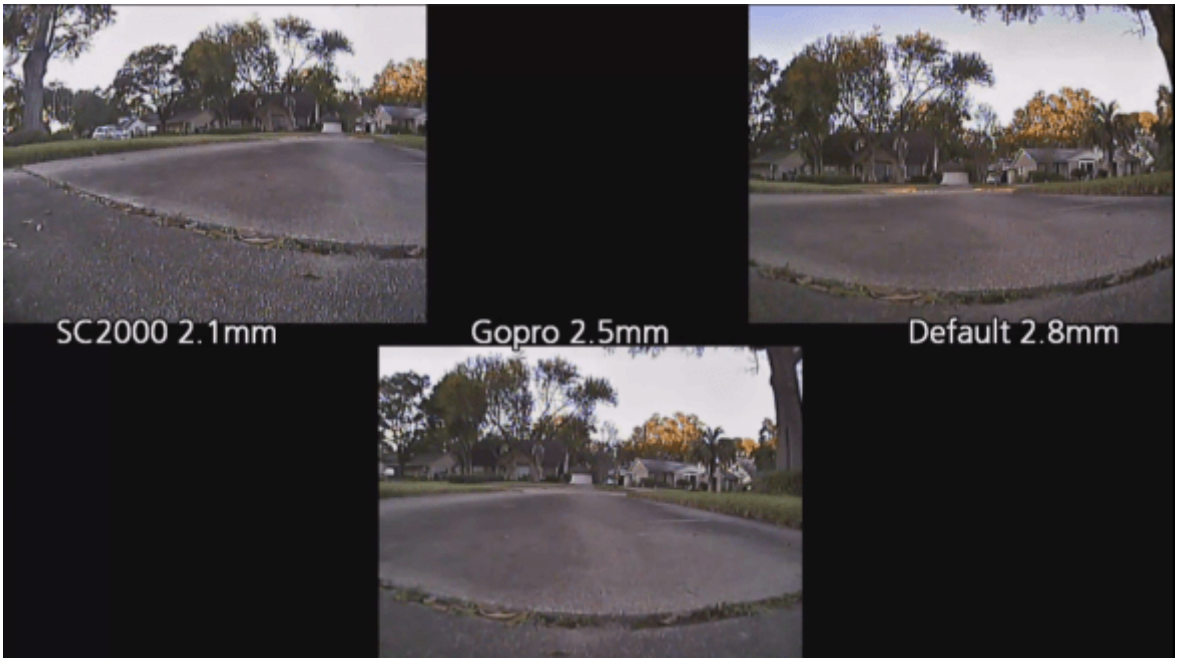
Due to the added latency I would recommend sticking with a camera the same resolution as your goggles (typically 600tvl). Another consideration is weather you want 4:3 or 16:9 resolution with 4:3 being the most common.

Camera Features - Some cameras have special feature such as the ability to monitor your battery voltage and display it on screen. Other options are low light cameras that can see in nearly total darkness. Mini and even micro cameras are available that may be a better choice for smaller builds whilst some cameras offer a microphone for audio feeds.

Lens - Different sized lenses give a different fields of view (FOV) which allow the pilot to see more around them. The higher the field of view the more fisheye effect you will also have to deal with.

2.8mm - The old standard, very narrow FOV
2.5mm - A great all rounder lens, same view as the GoPro!
2.1mm - A wide angle lens, this gives a great view for freestyle flying but may be too wide for racing.

A **comparison of lenses** can be seen in this video.



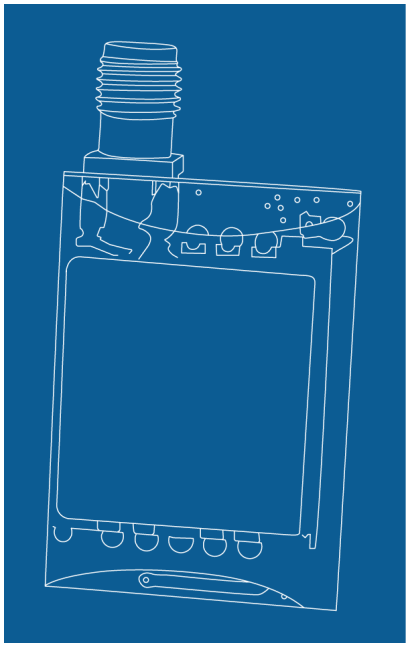
Video Transmitter (VTX)

The video transmitter takes the signal from your camera and sends it out through your antenna.

Things to consider:

Power Output - Different VTX's pump out your video at different power levels. These often range from 25mW to 800mW with some offering a means of switching power output.

Channel Options - Most modern VTX's can run the majority of channel bands including Raceband. As long as the VTX channel list is compatible with your receiver you should be fine!



Signal Quality - This one really comes down to who you'll be flying with, you'll notice that some VTXs offer the same power and channel options yet cost up to four times as much! The reason for this is that the cheaper VTXs spit out noise over a much wider range than the selected channel which can lead to interference in other pilots video feeds.

If you intend to fly on your own a cheap VTX will work great for you however if you intend to fly in larger groups or at race events you really need a clean transmitter like the TBS Unify Pro or the IRC Tramp.

Switching Options - If you do intend to fly with other people or at race events then you'll often have to change channel to ensure everyone can get clean video. Traditionally VTXs have a small push button you can use to cycle through video channels, bands and power levels, the channel is then shown via a LEDs on the VTX itself.

The more race friendly transmitters actually connect up to your flight controller and allow channel changing via an OSD or a Taranis Transmitter. Although it sounds like a little feature it makes a huge difference when flying in groups of over three pilots and is one I cannot go without anymore

Be sure to check what is legal in your country! Some VTX have limits of 25 or 200mW

Video Antennas

The best way to improve your video range or clarity isn't necessarily increasing the VTX output power but is actually getting a good pair of antennas. Those black dipole antennas you get with cheap goggles or VTXs referred to as 'rubber duckies' really don't perform well and are often binned and replaced with a high end antenna. An FPV setup requires two antennas, one to send out the video and another to receive it.

Thing

Anter

perfo m

poorl

innov sh

video ase

range

receiv

TBS Triumph

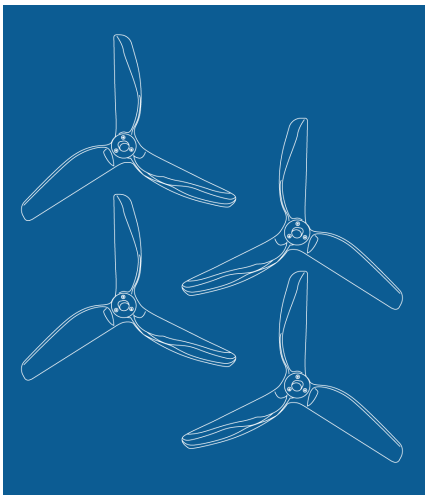
Connector Type - Antennas come with two connector types SMA and RP-SMA both can talk to each other fine but you need to make sure they match your VTX or goggles connectors. Failing that adaptors are available.

Polarization - The antenna itself can come in tow flavors RHCP and LHCP both work the same but they must match in order to get a signal. By having different polarizations it is possible to get more pilots in the air at once.

Robustness - Obviously the antenna on the drone will be subject to a lot more abuse than the one on your goggles! For this reason I recommend using your best/most delicate antenna as a receiver and using a durable protected antenna on the drone.

Drone Propellers

Hopefully you've already chosen your drone size in inches so you know your prop size! My honest recommendation for a beginner is to get a big box of cheap props as **you will break them incredibly quickly**. Props are often denoted as a AxBxC where A is the size in inches, B is the pitch (angle of the prop) and C is the number of blades.



A 5x4x3 for example is a 5" prop with a 40 degree pitch and three blades (triblade) this may also be described as a 5040 triblade and is coincidently a great place to start when looking for a 5" quad.

Other things to consider

Number of Blades - Whilst we started using two blades we soon learnt that adding more blades provided us with more grip and control preventing against drifting in corners. Props come from two

blades up to six blades with triblades being the most common option. Increasing the number of blades will increase current draw, add weight to the prop and reduce the maximum achievable top speed.

Current Draw - The higher the pitch of the prop the faster you can go but at the same time your motors will draw more current pushing your electronics harder and draining you battery faster! Adding more blades is also a sure fire way to shoot up the amps drawn. If you want to use a high pitched prop (45+) I would suggest getting some larger motors with more torque and some higher rated ESCs. (You can use MiniQuad Test Bench or manufacturers specification to check these!)

Weight - Often ignored the weight of your

Stiffness - This is information you are only really going to find from testing props or reading some reviews. Some props particularly the thin ones can bend when spinning reducing their effectiveness. Ones that bend however may survive a crash better than stiffer props that could simply snap on impact. Finding the right prop for you can be tricky

Special Profiles - Typically a prop has a curved airfoil surface designed to efficiently cut through the air and provide as much lift as possible. Some props are shaped slightly differently to modify their performance. Examples of this include:

- **Bullnose Props** - A bullnose prop is effectively the width and length of a larger prop cut down to the size it's intended for (ie 6" cut down to 5") This gives it a

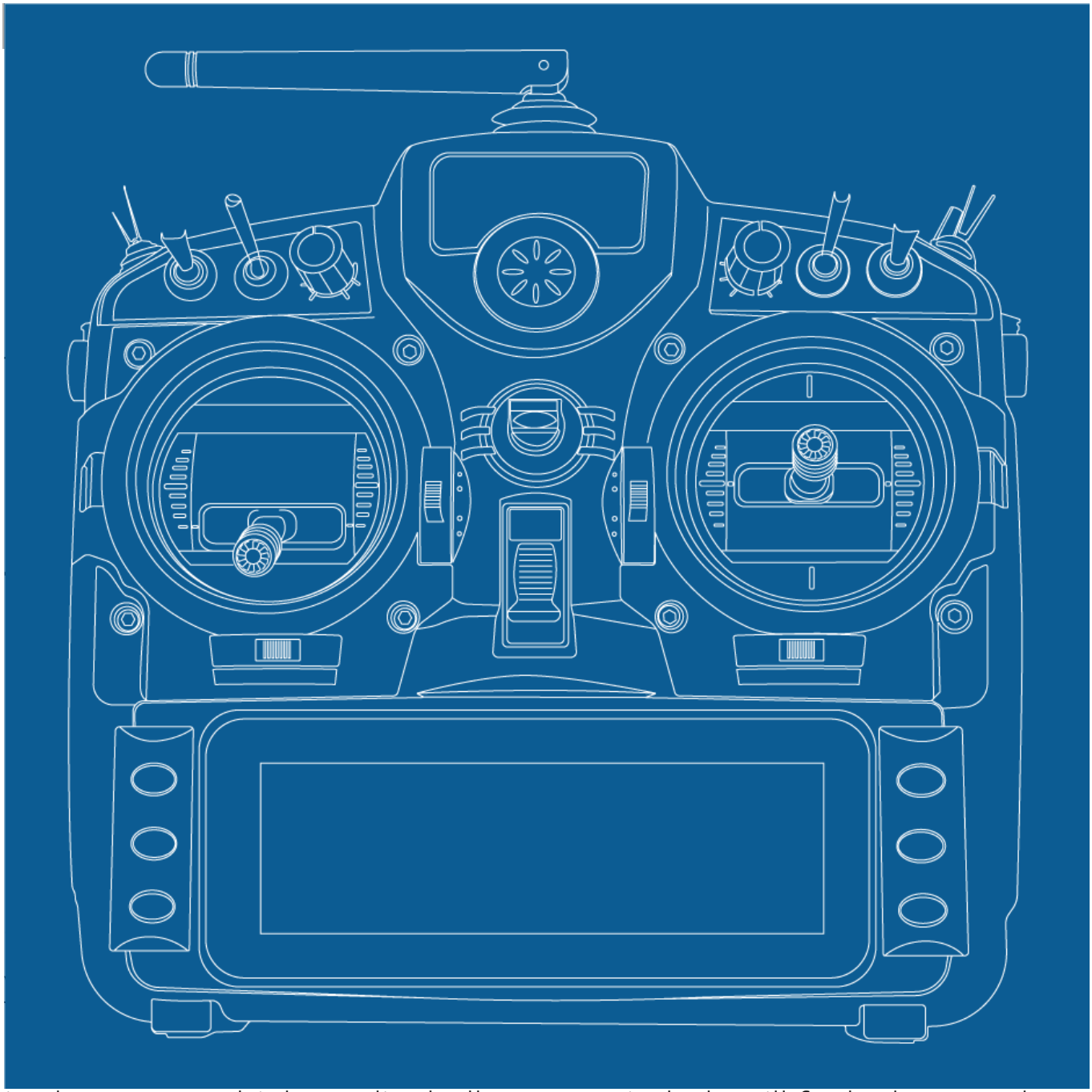
much wider profile with flat ends as opposed to round tips and provides more power.

- **RaceKraft Props** - Recently designed props designed by Racekraft have a varying pitch along the length of then prop. The idea is to provide maximum efficiency at approimately 60mph making these incredibly popular for racers and speed addicts!
- **3D Props** - 3D props are for those who want to be able to stop their motors in mid air and reverse the direction allowing them to fly inverted for as long as they want! Normal props are very inefficient when running in 3D mode so 3D props are usually completely flat running at a 45 degree pitch to keep them the same in both rotations. 3D flying is hard and not recommended for beginners! Check out Zoe FPV on YouTube to see some of the best 3D flying around! DJI Mavic Can't Touch My 3D Dancin'

Hopefully that gives you an idea of what to look for. This video by Rotor Riot shows some of the differences between the props and why pilots Chad Nowak and Mr Steele fly what they fly.

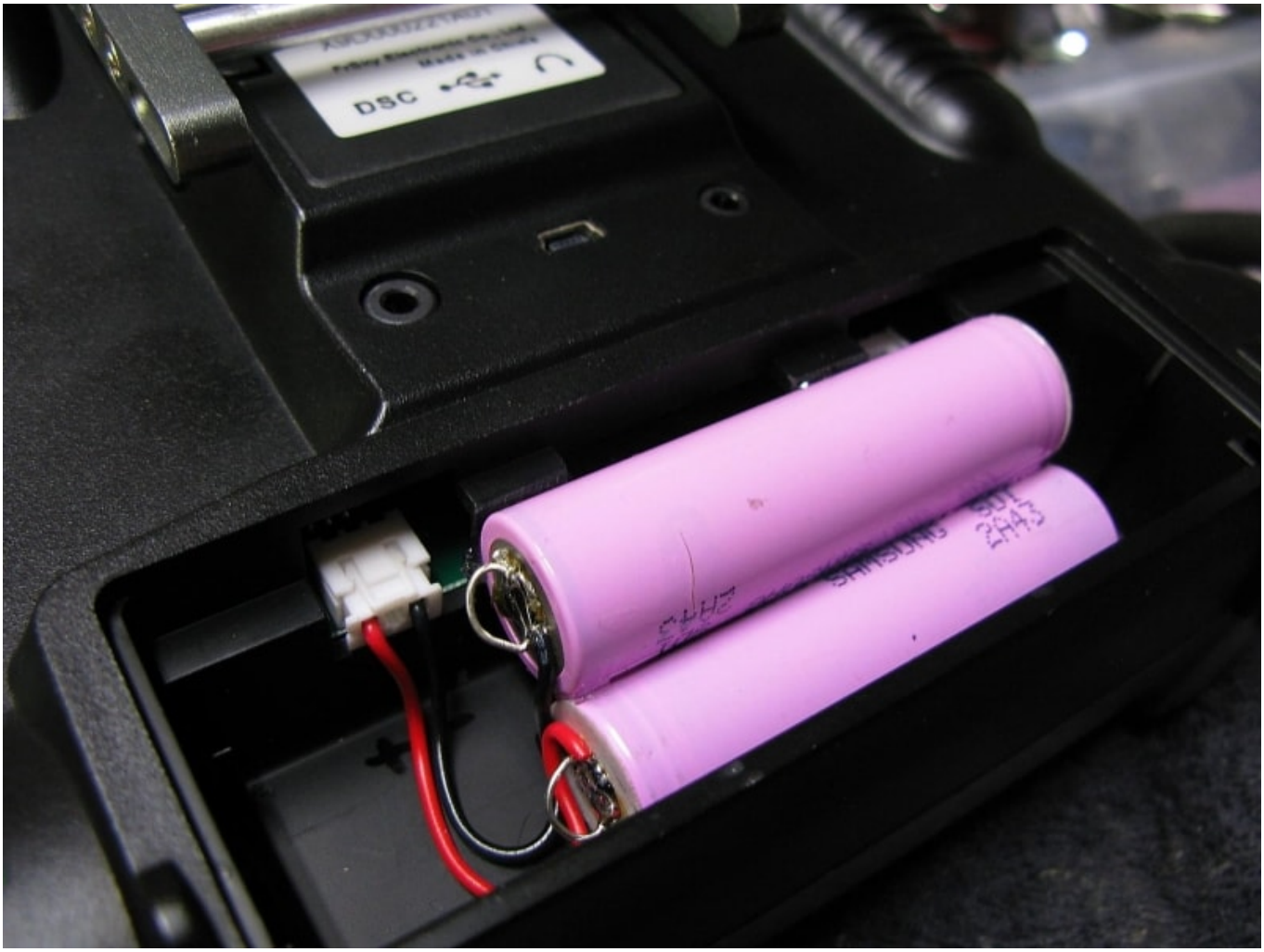
Transmitter and Receiver

I'll tell you what almost every other website or drone forum will tell you in terms of remotes.... If you can afford it get an **FrSky Taranis**! For the money you pay the Taranis really is an exceptional remote that can really do anything you can think of. Taranis wise your options would be either the QX7 or X9D and their deluxe plus or special addition variants.



in the remote, high quality hall sensor gimbals will feel a lot smother than cheaper versions.

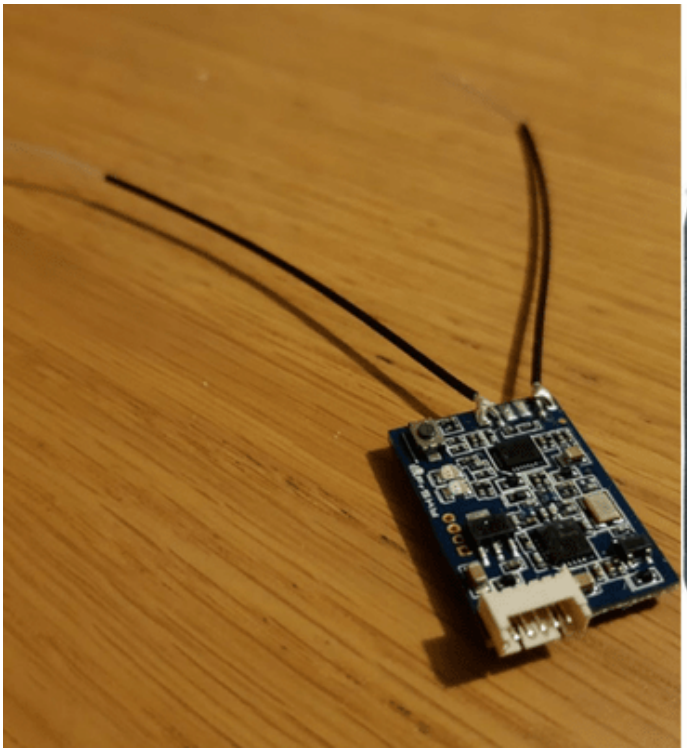
Batteries - Some remotes include rechargeable batteries whereas others rely on AA batteries. I would really recommend getting a system that can be charged as they will work out cheaper and last much longer. I had to modify my Taranis QX7 to be able to run some 18650 batteries like this:



Communications Protocol - All radios talk to their corresponding receivers in their own language with some communicating your stick inputs faster than others. What this means is you will experience quicker response times and have more control over the drone. You want to look for remotes/receivers that support either SBUS (FrSky) , IBUS (FlySky), DSM2 and DSMX (Specktrum).

Telemetry - The drone can actually send key information back to the remote allowing you to know when to land and all sorts. In order to do this both the telemetry feature needs to be on both the transmitter on receiver. Many remotes with this feature are able to talk to you and can read out customisable warnings to tell you when to land or when your signal is getting weak!

Receiver Options - When choosing your remote it's worth looking at what receivers are available for it. For example some are way to big for use in min quads however some are too small and lack a decent range. Look for a system that supports your needs a price point. If you do decide to go for a ready to fly drone with a receiver make sure that it is compatible with your remote! You will typically get a selection between FrSky, FlySky and Spectrum.

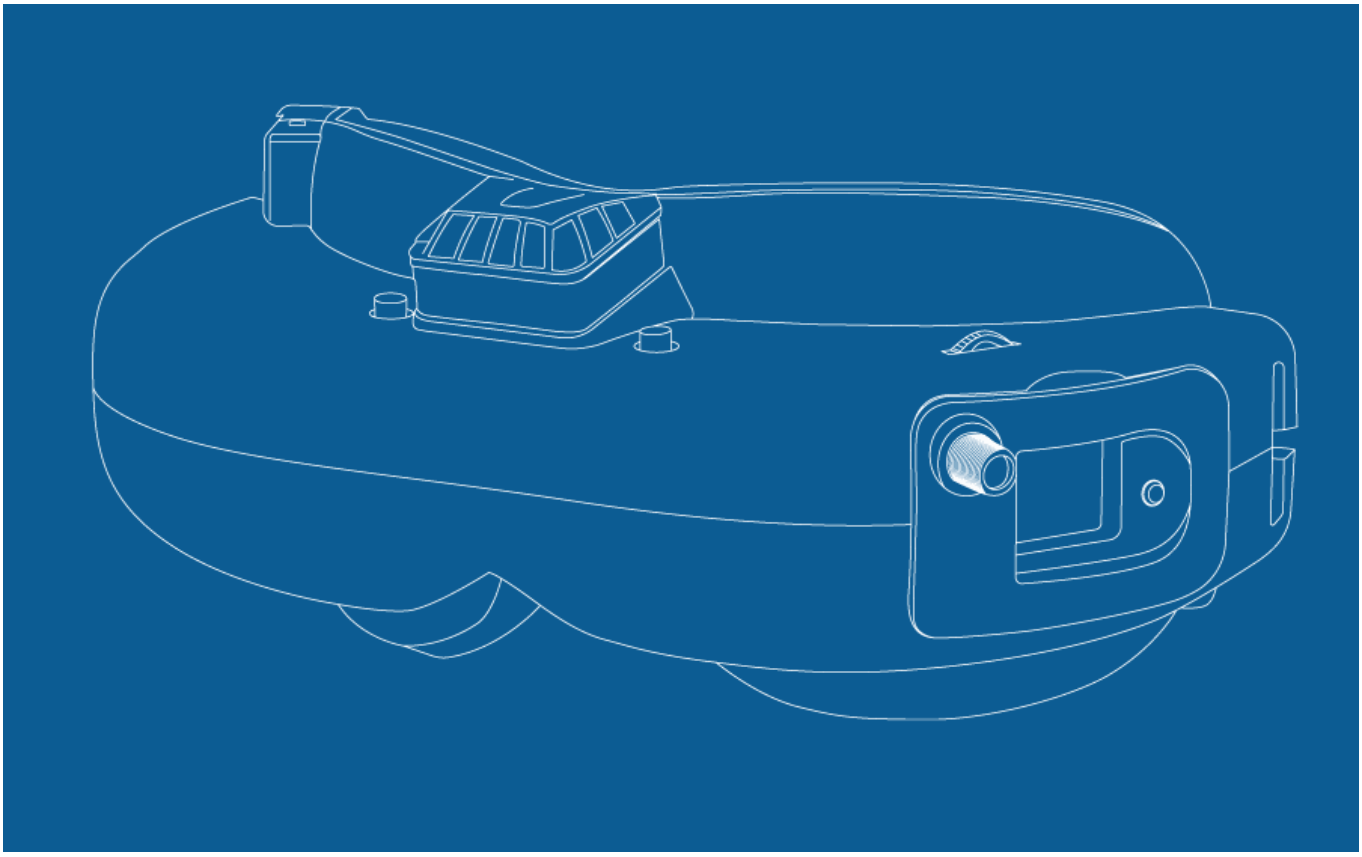


Customisation - Most remotes allow you to configure your basic channels and even set up audio alerts however some can offer so much more! I'm talking here about Open Tx which is the firmware running on the Taranis's and some other radios. This firmware is highly customisable and allows to do literally anything you can think of. Of course for some this may not be necessary but features such as fine turning my flight controller settings and changing my video channel through the remote are incredibly handy!

Note that in order to use some of these features the transmitter and receiver must support them.

Goggles

Just like transmitters goggles are a huge topic, so we covered them indepth in our FPV Goggles Guide! These can become the most expensive part of your setup with the only saving grace being the fact that you won't crash and break them.



Goggles often have a very high resale value if you don't like them! I often advise people to either get their hands on a very cheap pair with the goal of upgrading later or just go premium right form the off. Here are some of the basic things to look at:

Box Style or Visor - Goggles can take two forms, either the slick visor style (such as FatSharks) that feature a small display for each eye or the larger box style goggles that simply incorporate an LCD screen in a darkened box attached to your face. Box goggles can be up to ten times cheaper than some FatSharks but offer reasonable performance if you don't mind the form factor.

Resolution - As with most displays resolution will make the biggest difference in terms of performance and price. Of course or FPV cameras are not HD quality themselves however for a reasonable flight experience you should aim for no lower than 640x480 pixels. As with FPV cameras you can have 4:3 or 16:9 options and should really match the two.

FOV - This stands for field of view and relates to how big the image looks in your goggles. A low FOV would be comparable to watching a TV in the distance whereas a higher one would be like being in an Imax theatre! Of course there becomes a point where things get too big and you need to find the sweet spot for you! I would suggest looking along the range of 30 to 60 degrees, the following image from Flite Test shows a comparison between some of the FatShark offerings. Typically box goggles will give you a much higher resolution and FOV for a lower price.

Receiver - Some goggles come with a built in receiver whereas it will be an add on module for others. Things to look for are features such as diversity which allow you to use two separate antennas to maximise your signal. Other features are channel searching and OLED displays, these features ay not be necessary for you if you are planning to fly alone or not too far.

HDMI - Some goggles have an HDMI input allowing you to use them to play on a drone simulator or watch a movie. Look for this option if you value this feature.

DVR - A DVR is a digital video recorder which takes your footage and saves it to a micro SD card for you to watch later. This is useful if you don't want to carry a HD camera however the DVR quality will be far lower than what you would expect.

Check out some of DVR footage from micro drone that can't carry a camera: ARMATTAN BUMPER - Maiden Flight RAW!

Quadcopter Batteries

Batteries come in all shapes and sizes and it's important to find the right ones for your build. Most frames or motors recommend a certain battery size in their suggested parts list. When it comes to batteries you can never have enough and I would recommend a minimum of four for a beginner.

Typical flights last from 2.5 to 4 minutes so only having one battery can quickly become tiresome!

Warning! Drones use LiPo (Lithium Polymer) batteries that are extremely volatile and dangerous if used incorrectly. Be sure to learn about battery safety before charging or using any LiPo batteries.

Things to consider:

Number of Cells - Typically you will see battery packs described in terms of the number of cells such as a 4 cell or just 4s. This refers to the number of cells in series with each cell having a maximum voltage of 4.2V. The total voltage of the pack can be found by multiplying the number of cells by 4.2 ie. 4 cells x 4.2 volts = 16.8V. The higher the voltage the more power the drone will have and the faster it will go. Choosing a voltage higher than your components are rated for will cause them to burn out.

Capacity - The capacity of a cell is rated in mAh which stands for milliamp hours. This means that a 1500mAh pack can give out 1.5A for an hours time, of course we want to pull far more than that so will get much shorter flight times. Increasing the pack size will give longer flight times however will add weight, there becomes a point where the drone can't lift the extra weight of a battery.

C Rating - The C rating is often what distinguishes a good battery from a bad one, it refers to how quickly a battery can discharge it's energy and is often the limiting factor in high performance drones. For example if we have a 1500mAh battery rated at 10C that means

it can give out a maximum of 15A when discharging, 10C is relatively low and will not give enough power for most drones of this size. I would recommend a C rating of at least 45 for most racing or freestyle setups. Note that some companies C ratings are not accurate and you should look at reviews to help select a battery - In general, you get what you pay for!

Chargers

Charging your lipo batteries will **require a specialist charger**. They need to be charged in such a way that their voltage is managed in order to prevent disaster. Luckily there are a lot of intelligent lipo chargers out there that take most of the hard work out for you with the key feature you need being balance charging.

I would advise not getting a cheap relatively unknown charger due to the risk of what could happen should something go wrong.

Warning! You should never charge your batteries unattended. NEVER!

Things to Consider:

Voltage - The important thing to make sure that the charger can handle your batteries, this will either be listed in the cell count or voltage specification.

Max Current or Power - This controls how fast you can charge your batteries, when charging we normally have to select a current to charge at. For most batteries this should be at 1C meaning a 1500mAh battery should be charged at 1.5A. Most chargers are either rated for a maximum current (Amps) or power (Watts) which is equal to the current multiplied by the voltage.

To sum that up a 4s (16.8V) battery with a capacity of 1500mAh will require 16.8V x 1.5A = 25.2W to charge in one hour. If our charger cannot deliver that kind of power than the battery will take longer to charge. If you want to say charge four batteries at once at this rate you would need a charger rated for at least 110W with a little headway. We can charge similar batteries at the same time by using a parallel charging board.

Power Supply - Electricity that comes from the sockets in your house is AC (Typically 230V AC in Europe or 120V AC in the USA). Our chargers and most electronic devices run on DC and require a

power supply to convert this down to say 12V. Some chargers have a power supply built in however often more expensive however some will require an external one that you will have to source yourself. If you don't understand this I would suggest you get a charger with a built in supply, you can tell this by looking at the voltage input of the charger and choosing one with a 230-120V AC input.

Parallel Charging - Most chargers have only one output, if you want to charge more batteries you will need a parallel charging board. I would suggest one with a built in fuse.

Warning! Parallel charging adds even more complications and risks. Be sure you read up and understand what you are doing before attempting to parallel charge! Please watch this Rotor Riot video that cover the basics.

HD Camera

This one is entirely optional but is necessary to **record your footage in a high quality viewable format**. This is almost a necessity if you want to show footage to friends or publish to YouTube. The downsides to adding a HD camera include an added weight and the risk of placing an expensive camera on a drone that has the potential to crash or get lost.

Things to Consider:

Weight - Any HD camera you add to your drone will have a direct effect on it's performance. For this reason you want to try to choose the lightest possible camera that gives you the quality of vide you need.

Mounting Options - You'll need a secure way to mount the camera to your drone, relying on rubber bands or cable ties can result in an expensive loss! Either look for a frame with built in mounting options or opt for a 3D printed case.

Video Quality - Obviously this is tied into price with the GoPro Hero5 Session currently being the gold standard for miniquad pilots. Not everyone wants to risk a $300 camera on a quad so cheaper and nearly as capable options such as the RunCam 3, Foxeer Legend and Xiaomi Yi are great choices. Look for cameras capable of higher framerates (60fps) for HD video with a wide field of view and dynamic range. YouTube has many comparison videos you can use to select the image you like best.

Robustness - Bearing in mind that these things are going crash frequently a high end camera with a mechanical lens is probably not the best choice! An action camera style is really what's needed here if you want to protect your investment.

A relatively new option is the RunCam Split which combines an FPV and HD camera in one device. The Split consists of an FPV camera with an extra board that mounts onto your stack which takes care of the HD recording. These are relatively cheap and solve the weight issues normally associated with HD cameras however aren't perfect. Here's a review from Joshua Bardwell, a hugely respected reviewer and teacher in the FPV community.

That covers the parts list, hopefully now you have an idea of the parts you want to use and we can get onto actually building your drone! There is no set right or wrong order to do this however I find my builds normally start from the PDB and work their way outwards. This allows you to systematically get everything up and running while giving you space to easily connect each wire when needed. If certain

components don't fit the order feel free to mix it up, this is only a guide line!

Lets Begin the Actual Build...

HOW TO BUILD A FPV DRONE - STEP BY STEP

Step 1: Assembling the Frame

The very first thing to do is assemble your frame (or at least the bottom section of it). Sadly frames often come flat packed as a series of carbon fibre parts meaning your going to have to put in some work to get them ready! When doing this take care to note where all the plates go and keep in mind where you intend to mount your components and run the wires.

Some people like to sand down or apply glue to the edge of the carbon fibre to protect the edges however this is not necessary on a good quality frame.

Warning! Tightening screws too hard will strip the screw heads or the internal threads on any aluminum parts, Do not force anything further than hand tight!

Tip - Our drones are actually very subject to vibrations and some screws can rattle loose! Using a small dab of thread locker on each screw can prevent this!

Step 2: Mounting the PDB

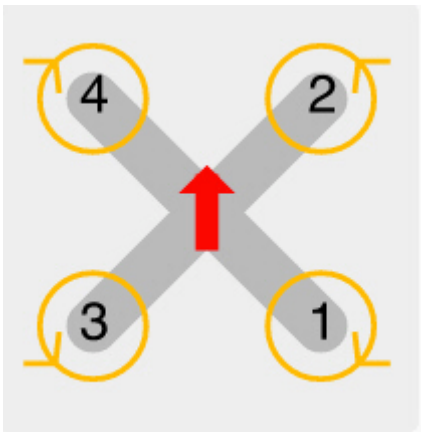
The first component I like to mount is the PDB, the reason for this is that everything connects to it and it is the central hub to your drone. To mount your PDB your are going to need to think about which direction you want to mount it, the main considerations are going to be where your battery is going to be and if you have an all in one board where you want your USB connector to face. To mount your PDB you are going to use nylon or rubber standoffs which normally fix through the frame and allow you to build up a stack of boards.

Tip - You should solder your battery connector and tin any pads before mounting your PDB, this gives you more space to work with.

Warning! Your carbon fibre frame conducts electricity, it is important that you space the PDB away from it so that no components, pads or wires can come into contact with any carbon fibre. This is true for all of the electronics in your build.

Step 3: Mounting the Motors

The next logical step is to mount your motors, if you have clockwise and anti clockwise motors you will need to pay close attention to your motor order. The diagram below shows Betaflight's quad X layout which is widely used in most modern software.



The motors can be fixed down with screws and again it is a good idea to use thread locker as opposed to tightening them too much

as you will be damaging the motor itself here.

Warning! Sometimes the bolts supplied with motors can be too long. If the bolt is able to touch the winding it will create a short and damage your components. Be sure to check for this before powering it up.

Step 4: Mounting the ESCs

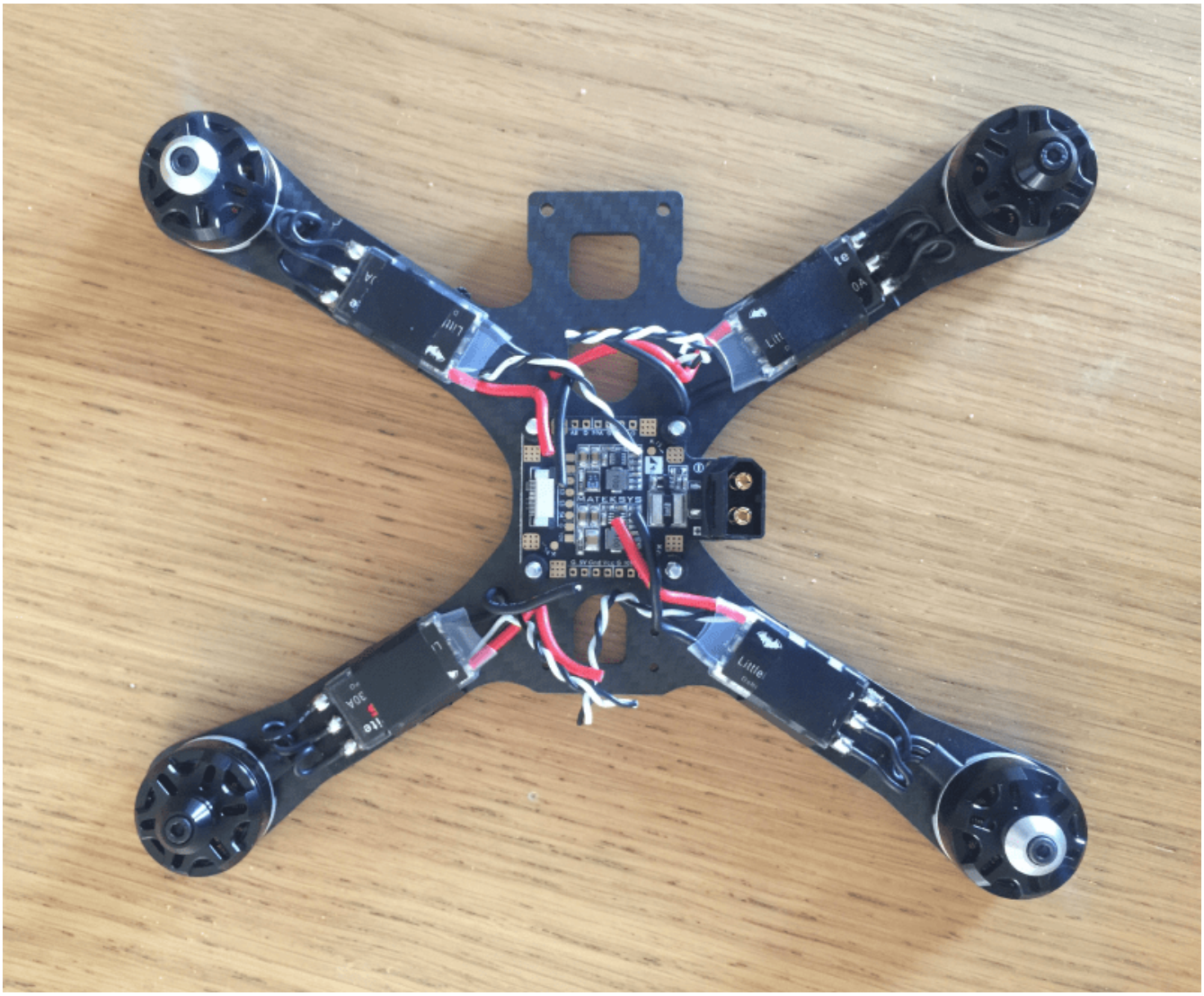
With the motors in place we can now mount the PDB and start to connect things up. If you have four separate ESCs the best place to mount them is on the arms. As with the PDB it is important that your ESCs do not come into contact with your frame. The best way to protect against this is to keep the ESC's protected by heatshrink. To actually mount them I use double sided tape to hold them in place and then wrap them in electrical tape after connecting them up.

If you opted for a four in one ESC you won't have to worry about all this, just mount it to your frame as described for the PDB!

Tip - ESC covers are available however a much cheaper option is to take an old prop blade and tape it over. This will defend the ESC from beings shredded by your props in the event of a crash. (I prefer to add these last once I've tested everything!)

Step 5: Connecting the ESCs to the Motors

With the ESCs in place it is time to start soldering! My first point of call here is the motors. **Each motor has three wires that will need soldering to the ESC pads.** With modern ESCs the order doesn't matter anymore as we can change the motor direction through software! Here's the basic procedure I like to follow:



1: Cut and strip the motor wires to the appropriate length

Tip - See that curl in my motor wires? I like to leave some slack as a crash can pull on some parts and damage them. Keeping some extra length on the wires gives me more options if I decide to go shorter. Remember it's much easier to cut wires than it is to extend them.

2: Tin the ESC pads and the ends of the motor, this will make soldering them much easier and faster

3: Solder each connection one at a time. You should bring the wire to the pad, heat both quickly and keep them still while they cool.

4: Check your connections, you are most importantly looking to make sure the joints are not overlapping or touching as this will cause a short. Hopefully you will have high quality shiny joints here and if not don't be afraid to redo them. Remember it only takes one of these joints to fail for your drone to fall out of the sky!

Armattan have actually produced a great video to help with the soldering ESCs which I suggest you follow, they also make some great products which you can check out on their site.

These same principles will be used for all solder connections on your drone!

Step 6: Connecting the ESCs to the PDB

We are halfway done with the ESCs! The next step is to connect them up to your PDB! Exactly the same principle as before is used here however you are connecting the positive (red) wires and the negative (black) wires to their respective pads. Again like with the motor wires I like to leave a little slack to keep things safe in a crash.

Warning! Unlike the motor wires getting these wrong WILL cause your quad to go up in flames! Double check everything and don't power up unless you are confident in your work!

Another great soldering reference for beginners is from Rotor Riot featuring the one and only Chad Nowak. In this video he covers the fundamentals of soldering your ESCs to the PDB in depth with some things to look out for! Soldering Tips

Step 7: The First Test!!!

With our power system set up we are now ready to perform our first test. I recommend checking and testing things as much possible for two reasons:

1. You can stop your whole setup going up in flames! If there is a problem with your PDB wiring for example at least it won't fry your flight controller and entire FPV system!
2. You can use the information later on to fault find other components. By eliminating possible causes we can solve future problems much quicker.

The first test which I always recommend you do before adding power is to check for any shorts with a multimeter. We can set our multimeter to a continuity mode which will emit a sound if wires are in contact. If we run a continuity check on the positive and negative

pins on your battery connector we should not see any continuity. If we get a beep then there is a short circuit meaning that something is wrong and plugging in a battery will result in damage to you or the drone!

FPV Know it all Joshua Bardwell has created a great video for you demonstrating how to perform this check. His channel has 1000+ videos with invaluable information that I suggest you take a look at to improve your understanding of all things FPV. I will be referring to some more of his videos later on.

If you've passed the continuity test you can now try plugging in a battery. Hopefully you will be hearing a beep from each ESC and may possibly see a small twitch from the motors. If there's any signs of smoke or fire, unplug immediately and inspect any areas of concern.

Step 8: Mounting the FPV System

With the power system ready the next thing to do is setup our FPV System meaning our camera and VTX.

Warning! Powering up the VTX without an antenna WILL fry it. Go ahead and connect your antenna now to prevent against this happening later! I always leave old dipole antennas on my spare VTXs to stop me forgetting.

Before we go powering up these components it's a good idea to get them mounted first. Typically cameras and VTXs come with connectors for the wires so we can simply plug them in once we've sorted or soldering. Hopefully your frame will have a designated space to mount the camera, if not you can use a little bracket that comes with most cameras.

Tip - Most cameras come with a spare case, take a look at your frame and try to work out which case will fit it best.

When mounting your camera one thing to consider is it's angle. Basically the steeper the angle will make your drone travel forward faster when you are trying to look straight ahead. For beginners I would recommend a starting camera angle of around 15 degrees. As you progress you can increase it up and find your sweet spot.

To mount your VTX you normally have to get a little more imaginative. Most frames do not have an obvious place to mount them so it's really going to come down to where you have space and what you have to work with. My recommendation would be to use cable ties or double sided tape to keep it secure either on the top or bottom plate of the frame. Check out this video of pro pilot Mr Steele assembling his top plate for some inspiration. I've shared it starting at the VTX time point but take a look form the start if you want to see his entire build.

Step 9: Connecting the FPV System

The best way to power camera and VTX is off the PDB as it allows for a neat connection to the flight controller, now is the time to check the specs for your components particularly the voltage inputs. Eg 12V or 5-19V

Note - some VTXs actually have power outputs to power cameras, if this is the case you can go ahead and use that for a cleaner layout!

Both the camera and VTX should have two wires to power them a positive and negative. Your PDB should have some low voltage pads such as 5V or 12V which you hopefully selected to match your other components! You should connect the positive (red) and the negative (black) wires to the matching pads. Two wires can share the same pad which would have them running in parallel.

Note - If you are running any kind of OSD either stand alone, on the flight controller/PDB the ground connections will have designated spots for the ground connections. You should use always use these to prevent noise effecting the video signal.

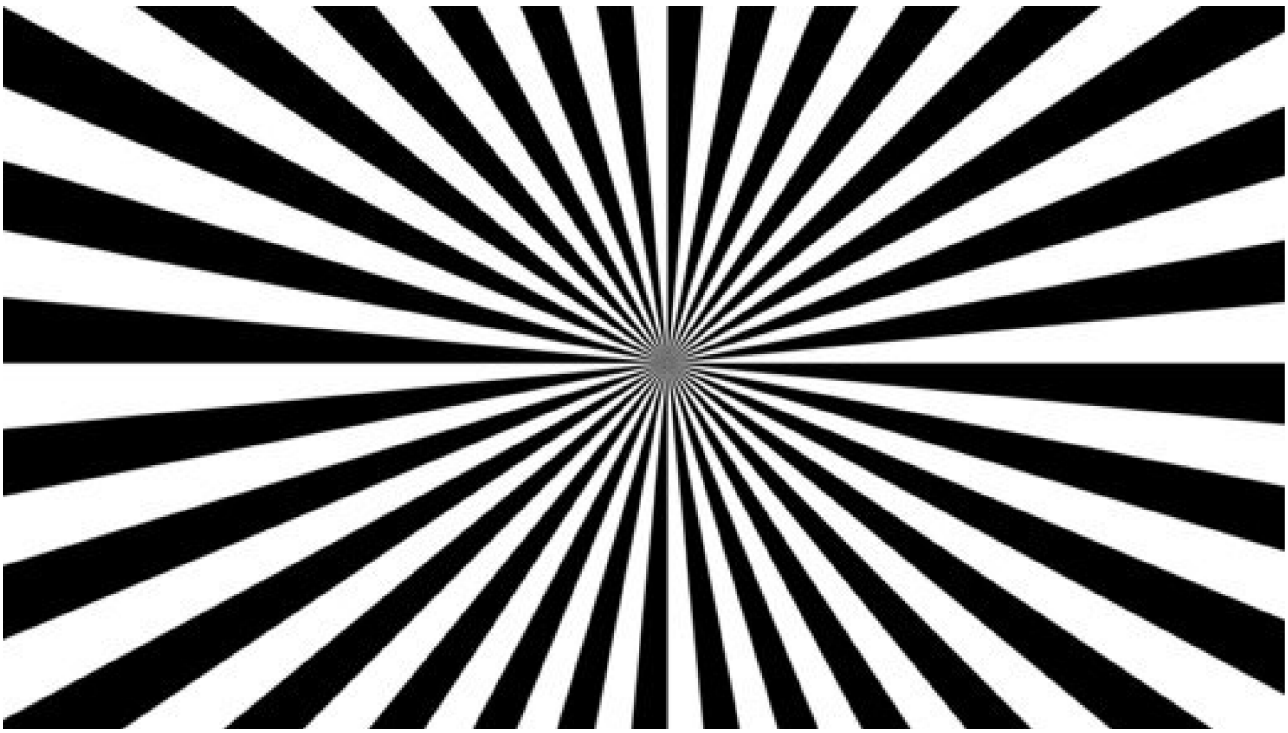
The final thing to do is to connect up the video signal. This wire (typically yellow) should come out from the cameras video out and directly in to the VTXs video in. For signal wires you do not have to worry about the voltage and can splice the two wires together.

Step 10: Test the FPV System

Tip - As we did with the power system use a multi meter to check that all connections are good and that there are no short circuits before powering anything up!

We can now go ahead and test the FPV system! **Again, makes sure that your video antenna is connected! I can't stress that enough anymore, you have been warned!** Plug in your battery and you should get some kind of LEDs illuminating on the VTX. You can now use your goggles and set both to the same channel via their respective controls. Channels are describe by a letter and then a number such as R4. The letter describes what band you are on where the number describes the channel itself. For now all that's important is that we have matching channels and that your picture is coming through nice and clear. If it isn't you may have to go back and check your wiring.

Hopefully everything is working and you can use this as an opportunity to focus your camera by twisting the lens and using the nut to lock it into position. Position the drone 2-3m away from a focus chart like the one below, when twisting the lens you are looking for the point where you can make out the lines closest to the centre.

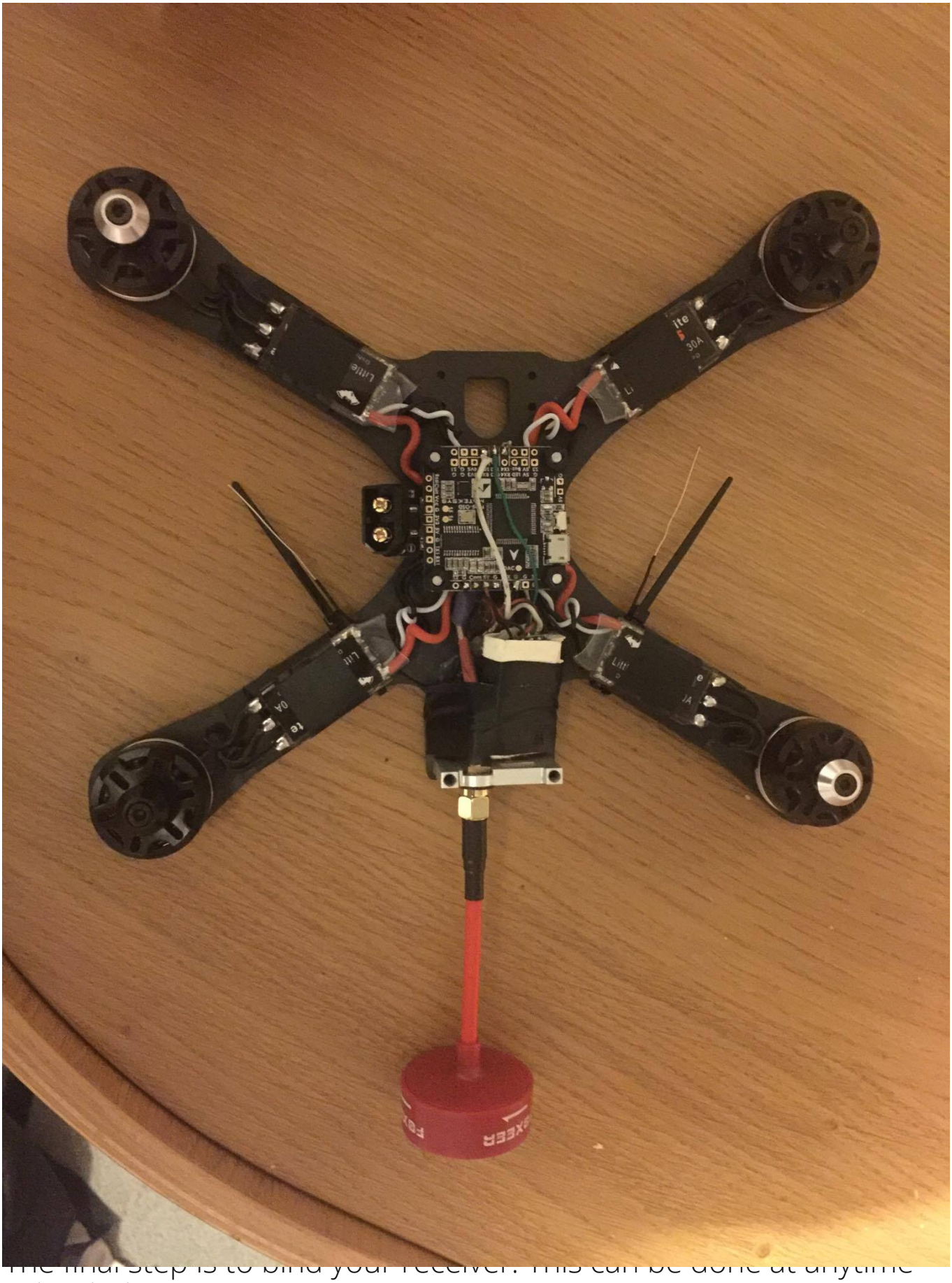


Step 11: Mounting and Powering the Receiver

We now need to mount and power our receiver. Typically these run on 5V (except Spektrum) and are connected to the 5V positive and ground pads on your PDB. We then will have a signal wire that we will later send to the flight controller, if your receiver supports telemetry you may have another wire for that.

You'll notice that your receiver has one or two antenna wires coming out of one end. Placement of these is critical to ensure that you get good signal and your quad doesn't lose signal and drop out of the sky (failsafe). Ideal placement for two antennas is at 90 degrees to each other in a V shape, you want to aim to keep the ends of them as far away from the carbon as possible to prevent them getting blocked.

I like to mount mine either sticking out from the arms or straight out the back. The ideal means of mounting them is by running a cable tie in the desired position and placing the antenna in some heat shrink to keep it protected.



Pre heat shrink

The final step is to bind your receiver. This can be done at anytime however some receivers have a dedicated bind button that can be hard to access later. Different transmitters have different methods of binding however they all normally involve powering on with the

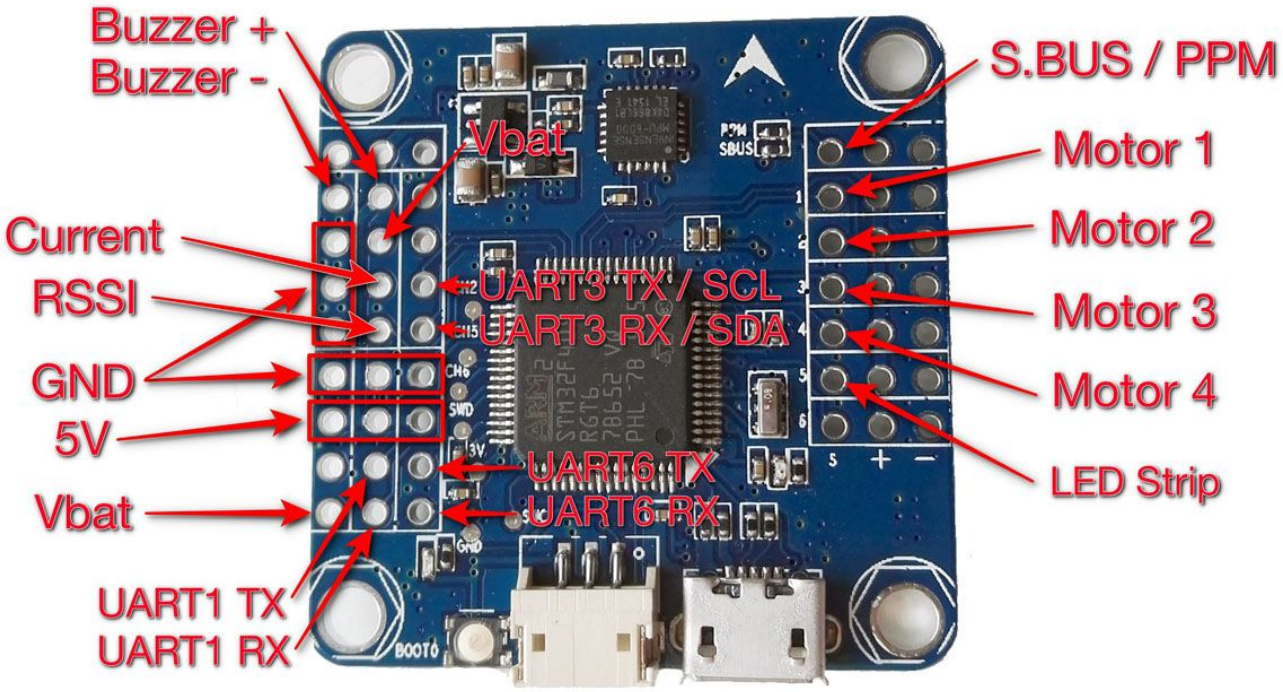
button held down and the transmitter itself in bind mode. Consult your transmitters manual for the details!

Warning! - One of the most important steps is to set up your failsafe. This stops the drone from flying away incase it disconnects from the remote and could stop it from injuring you or others. These will vary between different transmitter/receiver combinations.

Some transmitters have more to configure than others! This video shows Joshua Bardwell setting up everything in his special edition Taranis. How To Set Up FrSky Taranis and Betaflight / Cleanflight Configuration

Step 12: Wiring the Flight Controller

The final component to mount is the flight controller! **This is the brain of your drone and we will be connecting nearly all of our signal wires here.** The hardest part of wiring the flight controller is knowing what goes where since all flight controllers have a slightly different layout. The very first thing I suggest you do is **search for a pinout diagram of your board**, it should look something like this:



exactly what pads you are looking to solder making things much easier for you. Note that all the red and black power wires we have already soldered! The following diagram is for the boards that I am using, it is however a little unique as there is a ribbon cable connecting the PDB to the flight controller.

Typically you will be looking to connect the following wires to their respective pads:

Power - As with all other components we need to power them, almost all flight controllers require 5V however some have there own regulator and will run off battery voltage. You will need to check what input your flight controller requires for this.

Vbat - If your flight controller runs off of 5V it will still need to read the main battery voltage if you want to make use of features such as the OSD or beeper. You will often have a positive and negative wire to do this connecting to the Vbat and ground pads.

Motors - Each of the four motors will have one signal wire (typically white) and one round wire (black). Refer to the motor layout diagram for the order!

Receiver - You'll have one signal in wire to connect to either an UART RX port or a dedicated SBUS port etc. You may also have a telemetry wire which will connect to a different UART TX!

OSD - If you have an OSD you will have connectors for video in, video out and then grounds for both signals. It is important that you use these grounds for both your camera and VTX if you want clean video.

Some extras you could also include could be

Buzzer - This works as a mean to find your lost drone in a crash or to warn you if the battery gets low. Flight controllers typically have a + and - buzzer pad to use here.

LEDs - You can run all kinds of LEDs with all kinds of patterns on your drone which are great for distinguishing your drone whilst racing. LED strips are typically powered by any + and - 5V pads with a signal wire connecting to the flight controller. As with most components I would recommend powering your LEDs off of the PDB if possible.

Before you do anything think about your build and plan what you want to connect where. You can then start cutting your wires to length and running any underneath the flight controller. Once you are satisfied you can mount the flight controller on your stack using nylon standoffs, when you do this make sure you have the USB port on one side for easy access later.

Tip - You can use rubber standoffs or O-rings to 'soft mount' your flight controller! This dampens some of the vibrations read by the gyro giving a smoother flight characteristic.

You may have noticed that there is some kind of arrow or chevron on the drone which is used to represent the front of the drone. Luckily with software the direction of the drone can be set so I would recommend setting the board at the angle that works best for your setup.

Here's a image showing my flight controller fully mounted. Note how the USB is on the side and all of the necessary wires are routed underneath the board where possible. The reason for doing is to protect the wires from being pulled by the battery strap which sits close on my frame. My motor wires are hidden in this view but they actually connect to the PDB via a ribbon cable.

Flight Controller Fully Mounted

By now you should be well acquainted with Joshua Bardwell and of course has he a whole series of informative videos on wiring flight controllers that you should really watch! Your layout is likely to differ to mine so the best thing to do is learn how to understand the pinouts and wire any flight controller to meet your requirements.
Flight Controller Wiring For Beginners

Step 13: Completing the Build

If you've made it this far CONGRATULATIONS! You have done all of the hard work and are **99% there with your build!** The final touches are going to be the little things such **as completing the frame, heat shrinking or taping any extra components and fitting a camera mount**. On some builds you may want to save this step until you have completed the software configuration in case some components are difficult to access.

Tip - As we did with all other components you should take this chance to use a multi meter and check for any kind of short circuits before powering up the flight controller.

Warning! We still aren't ready to put the props on yet, we want to check that everything is working incase something goes wrong. Props are the last thing to install providing that you are 100% confident in everything else.

Step 14: Software Configuration

Software configuration is a huge article in itself with a massive amount to get through depending on your components and preferences that will be different for almost every build. All I can recommend is a **basic checklist of things to set until we have completed a full article**. Make sure you have installed a software

configurator such as **Betaflight** on your computer and connect up to the drone via a USB cable (you may need to install the relevant drivers for your flight controller)

1. **Flash your firmware** - Just like a computer runs Windows, OSX or Linux a flight controller runs different software versions. It's always best when setting up a new flight controller to update to the latest release of your firmware of choice. This is often done from the main screen of the configurator.
2. **Set up your Peripherals** - When you wired up our flight controller you may of connected things to one of the UART connections, your receiver will be connected to one of these that has been labeled as SBUS. We need to set up these ports in order to tell the flight controller what it's communicating with.
3. **Drone configuration** - We want to tell the drone which angle with mounted the flight controller at, which receiver we are using, how to talk to ESCs and set various limits such as the minimum throttle. There's a lot to set here which will be better explained in a future video.
4. **Set up your flight modes** - These modes need to be allocated to switches on your transmitter. For a beginner I would recommend setting an Arm switch and then a separate switch for Auto level and acro mode. Additional switches can be used for features such as buzzers.
5. **Set your rates** - Rates determine how sensitive your transmitter sticks are, for a beginner I would recommend leaving them at default and adjusting as your confidence grows.

Of course I couldn't not miss the opportunity to share one more Joshua Bardwell video with you! Here he is running a full Betaflight 4.1 setup showing you every step you can take.

Step 15: Final Test

Tip - As we did with the power system use a multi meter to check that all connections are good and that there are no short circuits before powering anything up!

With our software configured we are ready for our final test! Hours of your time have lead up to this moment and it's easy to get excited.

Warning! These are the tests where we are going to start spooling up the motors and all sorts could happen. Make sure you have no propellers on the drone under any circumstances!

The following things will need testing in you configurator:

Test 1 - Flight controller orientation.

We need to make sure the software knows where the front of the drone is, we should of set this up earlier but need to check it is correct. On your configurator you should see a 3D model of the drone, when you tilt your drone the model should update in real time. Confirm that it rotates in the right direction for roll, pitch an yaw.

Test 2 - Receiver Channels

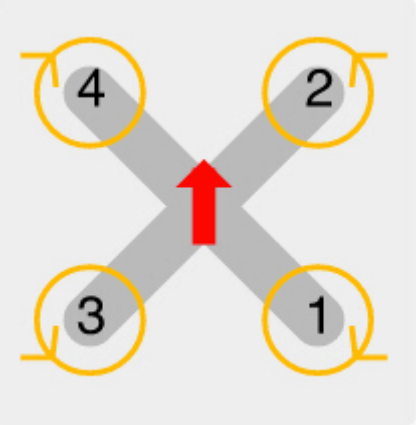
We need to make sure that our flight controller is talking to our

receiver correctly, to this you will need to plug in a battery. With the drone powered you should be able to view any stick inputs on a receiver tab whilst checking that your switches match your intended flight modes. If this is not working correctly it may be linked to settings on your remote.

Test 3 - Motor Rotation

This is where your drone will start to come to life! With the battery still in head to the motors tab and click a box to confirm that you have taken off all of your propellers! Each motor should have a slider now you can use to power each motor.

You should slide it up a little one at a time to check that the correct motor is spinning for each channel and that the motors are spinning in the correct direction. If they are not behaving correctly you will need to change them. Refer to your software's motor layout for the correct order.



Test 4 - Arming

We are ready to test that the drone arms and that you can control

the motors with your remote! Connect up your battery, power on your transmitter and try flicking your arm switch. You can now try moving the sticks and hopefully the motors will move! Make sure that your disarm switch is working as you may need to use this in case of an emergency. If you cannot get your drone to arm here are some of the possible causes.

Test 5 - Failsafe

We want to now check that the drone will cut out if we lose radio signal. If you don't have this correctly set up you risk either a fly away or the drone causing some damage if the remote is not powered up. To test the failsafe arm the drone and increase the throttle. With the motors spinning turn off the remote and see what happens, we are hoping that the drone cuts out within a second.

Test 6 - Anything Else!

With the important things all working you can now test out anything else like your OSD, beeper or telemetry to make sure everything is 100% before your maiden flight.

Test 7 - The Test Hover

If you've made it through all of these tests then that's it you've done it! **You are ready for your first test hover!** You can now attach your propellers and head to an open area with no other people to check if it flies! One thing to note is that propellers come in clockwise and anticlockwise varieties.

When attaching them make sure that you put them on the right way! This diagram from hobbyrc shows it nicely, make sure to put your props on nice and tight.

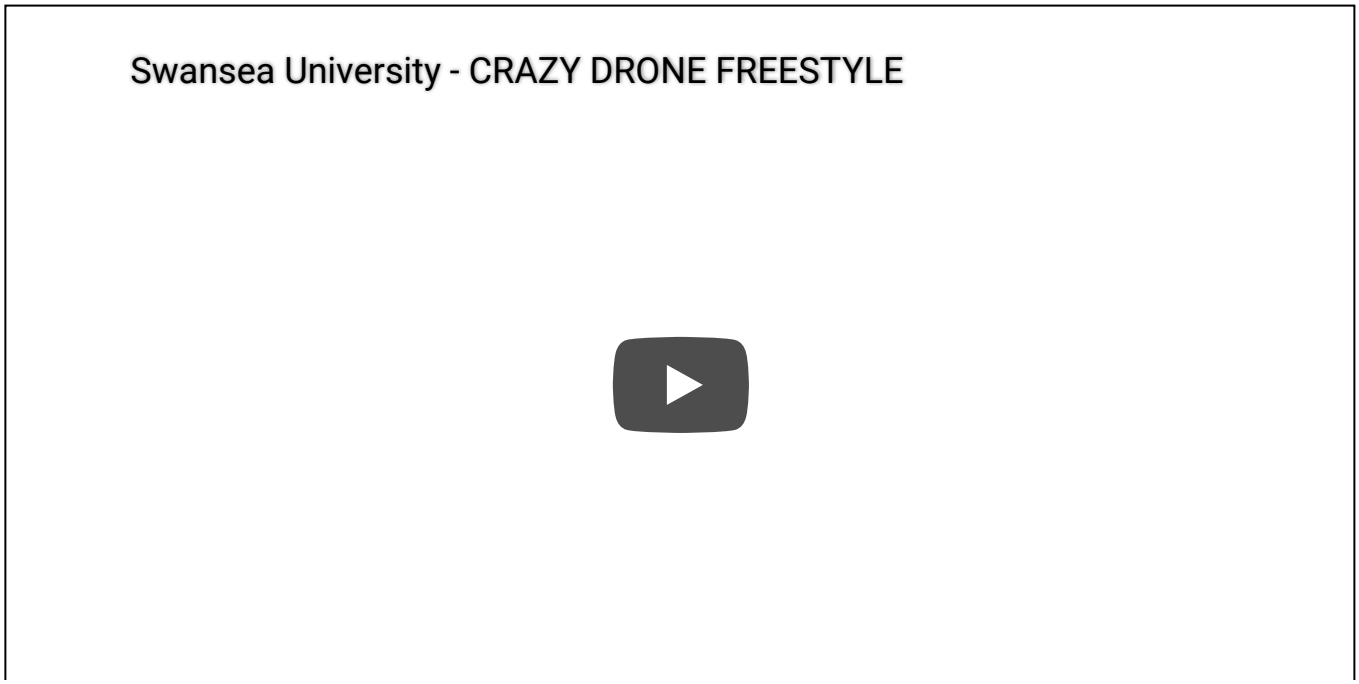
Place your drone far away from you, arm and gently increase the throttle and try to hover a few feet off the ground. Be ready to

disarm or drop the throttle incase it flips out. If anything does go wrong refer to this video: Quadcopter Flips On Takeoff: Solved

CONGRATULATIONS! - YOU'VE DONE IT!

If you've made it this far, and finished this indepth How to build a Drone guide, you've done it! Building your first drone is a big feat, you've had a mountain of information to get through and probably faced heaps of challenges along the way. **The result however is a drone custom to your requirements that you can be proud of.** Even better if anything ever goes wrong or breaks you'll know exactly how to fix it! Take care when flying it and look after it, there's nothing worse than seeing your pride and joy smash into hundreds of tiny pieces!

Thanks for sticking with me, you've read through enough now and must be excited. **Charge up some batteries and go flying!** Be warned however, **building and flying drones is an addictive hobby** you will always want one more! Hope to see you soon. Enjoy!



If you would like to build a drone with the same parts as mine link to the complete setup can be found here.

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Drone Nodes is an online communication platform that brings together experts and enthusiasts in drone research, start-ups, businesses, and educates about the newest technologies in the drone and FPV market.