

**VULCAN UAV**



# **Vulcan Raven**

## ***Heavy Lift MultiCopter***

Manual V2.0



[www.VulcanUAV.com](http://www.VulcanUAV.com)

## **Thank you for purchasing the Vulcan Raven.**

**The Raven is a very tough, heavy lifty folding airframe in the X8 configuration. Please follow these build instructions carefully, and we wish you many hours of safe and enjoyable flying!**

Note on parts - Part designs are always changing and being improved. Do not worry if the parts you have or hole patterns do not exactly match those shown in this manual, details contained here will still apply.

### **SAFETY NOTICE**

Multicopters can be dangerous and pose a significant risk of injury and damage to property. Always take all necessary safety precautions to avoid damage or injury to yourself and those around you!

Never fly near or over buildings, roads or people.

Always ensure you have plenty of space to fly with an uninterrupted view of your machine at all times.

Always stay well clear of moving propellers.

#### **Before flying.....**

Ensure all nuts, bolts and linkages are tight and cannot come undone.

Check your propellers are securely tightened, have no chips, cracks or dents and if they do, replace them as necessary. Propellers should be attached with nylock nuts or double nuts, never rely on a single standard nut to attach your propellers.

Ensure all electrical connections are secure with good contacts, well insulated and cannot come apart.

Make sure all onboard equipment such as batteries, cameras or any other payload is properly and securely attached and cannot come loose, shake, vibrate or move around during flight.

Always make sure all batteries are fully charged and range check your radio.

## Specification:

### Airframe:

Configuration: X8 co axial folding  
Diameter: 1150mm  
Max Take Off Weight: 24 Kg  
Max Batteries: 4 x Lipo  
Landing Gear: Fixed or Retractable  
Navigation: DayBright LEDs Red & Green (Port & Starboard)

### Materials:

Frame plates: 3K Twill Pure Carbon Fibre  
Lower Plate: 3mm thickness  
Top Plate: 2mm thickness  
Arms: Aluminium custom extruded.  
Bolts: Hardened steel zinc coated or self colour  
Nuts: Nylock  
Pillars: Aluminium M3 threaded

### Battery Mounting:

Anti slip mat  
Dual battery straps

### Folding Mechanism:

Dual cam lever locks for each arm, with additional safety latch.  
Thrust bearing on lower side of cam levers to prevent nylock nuts undoing when lever is twisted from above.

### Power Distribution Board:

Board Material: FR4 TG170  
Dual sided (positive side and negative side to prevent shorting)  
Rating: 400A continuous at <50 degrees C

### Anti Vibration Plate:

12 or 16 x Silicone Gel bushes each rated to load up to 650g  
3mm Pure carbon fibre plate  
12 or 16 x Steel standoff pillars

### Payload Mount:

2mm aluminium L brackets  
2 x 12mm pure carbon fibre tube with 2mm wall thickness.

## Assembly Guide:

### The Power Distribution Board (PDB)

The first thing to do in your build is prepare the power distribution board. This is a critical part of your multi rotor as it ensures reliable and consistent power supply to all the onboard systems that need power from the main battery packs, including ESCs and your flight controller. Many will have their own ideas about the best way to distribute power on their machine, and whilst this manual is not really aimed at power distribution, we have included some general good practice tips:

Always protect your internal wiring. Any movement of internal wiring can lead to wear of the insulation and eventually a failure, so we would recommend protecting all power wires with heatshrink or similar - any suitable tough covering that is resistant to wear and heat.

ESC control wires are thin and quite vulnerable, and are best protected with something other than heatshrink as the heat from the shrinking process may damage them. Nylon braiding is a good alternative, and although it is less resistant to heat than heat shrink, it is easier to fit over pre fitted plugs, and better looking, so a good choice for any wires that will be visible. If your PDB is of the correct specification and correctly assembled, there should not be excessive heat present.

Good solder joints are critical, and enough heat must be present to fully melt the solder and allow a good bond between the PDB and wires. If you are using our *Vulcan Power* high current PDBs, the thick copper in them will suck the heat from your soldering iron very quickly. So use a powerful iron with a large head that can retain it's heat. A Weller 80W iron with 10mm head is as good choice.

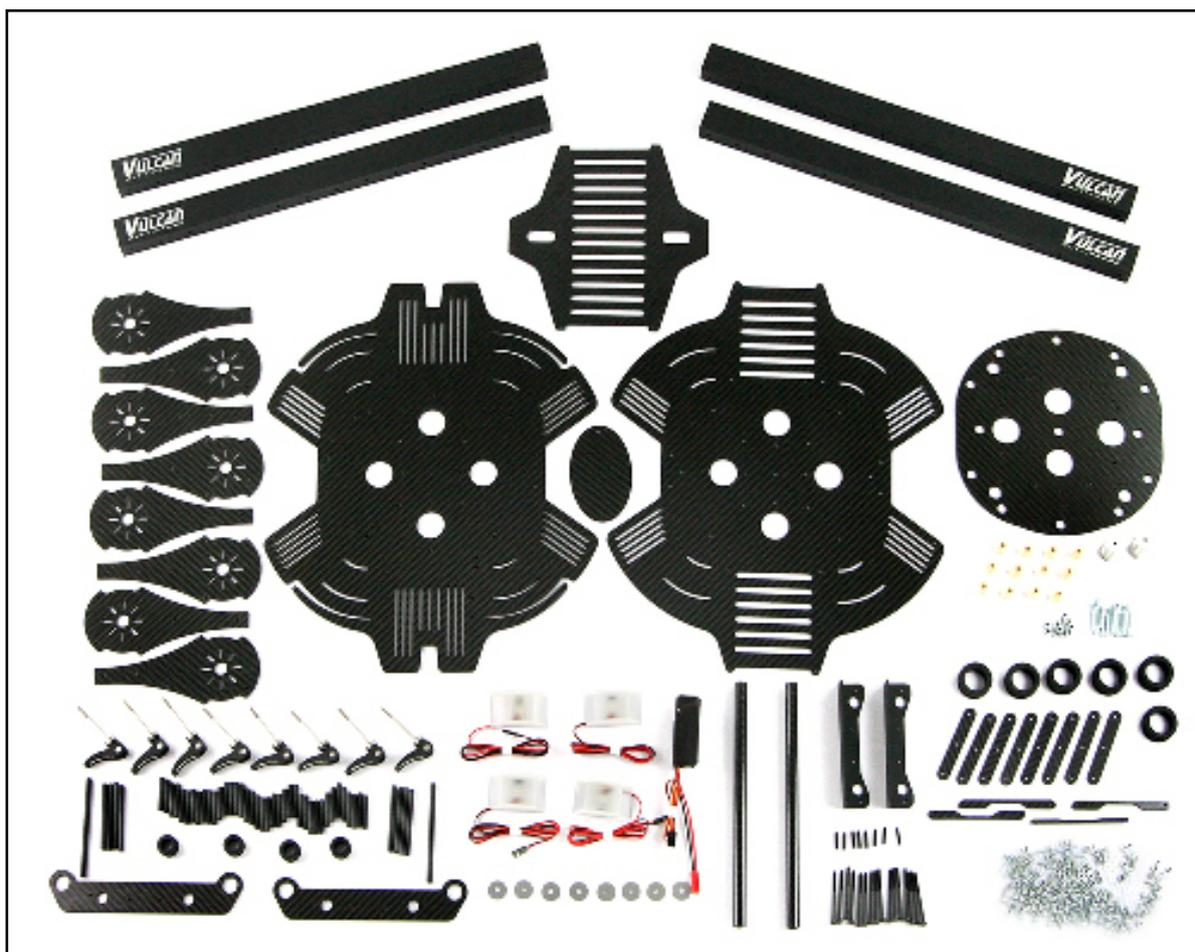
It is a good idea to run multiple independent battery connections for redundancy, rather than use battery splitters when using multiple LiPo batteries.

It is wise to run several auxilliary power feeds from the board to supply power to anything you may need now or in future. This will save you having to open the frame and solder in more feeds in future should you find you need them.

Use thread lock on PDB mountings to ensure there is no way the PDB can come free over time, or a short will occur. Carbon fibre is highly conductive.

## Parts Included

It should be noted that kit contents and part design may change slightly over time as aircraft design is adjusted. Do not worry if the exact parts you have are different to those shown, this manual will still apply.



## Motor Mounts & Arms

First, it is good practice to protect your motor wires from abrasion, especially where they enter and leave the arm, pass by the bolts, or if they need to go around any sharp edges such as the motor mount. Heat shrink is a good choice for this. See FIG 1 below.

Also check the edges of the metal arms where wires enter and leave and make sure there are no sharp edges. If they feel sharp, gentle use of a small file will smooth them.



We strongly recommend when heat shrinking your wires you do so with the wires flat in a line of three, and not as a bunch. This will make inserting bolts through the arms when wires are present much easier. See FIG 1 above.

Once you have protected your wires, fit two motors to two motor mounts with 8mm M3 bolts and washers. Ensure you get the angle of each motor such that the wires run easily around the sides of the motor mounts. Do this before fitting the mount to the arm as it is easier to thread the motor wires before mounting bolts are in place. Use thread lock on the motor bolts, but be careful not to get any thread lock in the motor.

4 x 30mm pillars with M3 10mm bolts are used to join the motor mounts, and this is the point to also fit the LEDs. Always use thread lock on the pillar bolts. The LEDs are fitted between the motor mounts with two pillars running down through the LED housing. See FIG 2 below. We recommend that the wires from the LEDs run from the top of the LED under the top motor mount and down the arm. Always protect the LED wire from damage. You may find using braiding easier than heat shrink for this, but the choice is yours. You will find it easier to insert all three sets of wires down the arm together rather than trying to insert the LED wires after the motor wires. It is also a good idea to mark which set of motor wires come from the top and bottom motor at this point in order to identify them later. Repeat for all four pairs of motor mounts.

Now fit the assembled pairs of motors and mounts to the arm. Take care when inserting the bolts through the arms not to damage the wires. Fit the mounts to the arms using 3 x M3 45mm bolts with washers and nylock nuts.

**DO NOT OVERTIGHTEN THE NUTS!** If you do you can crush the arm!

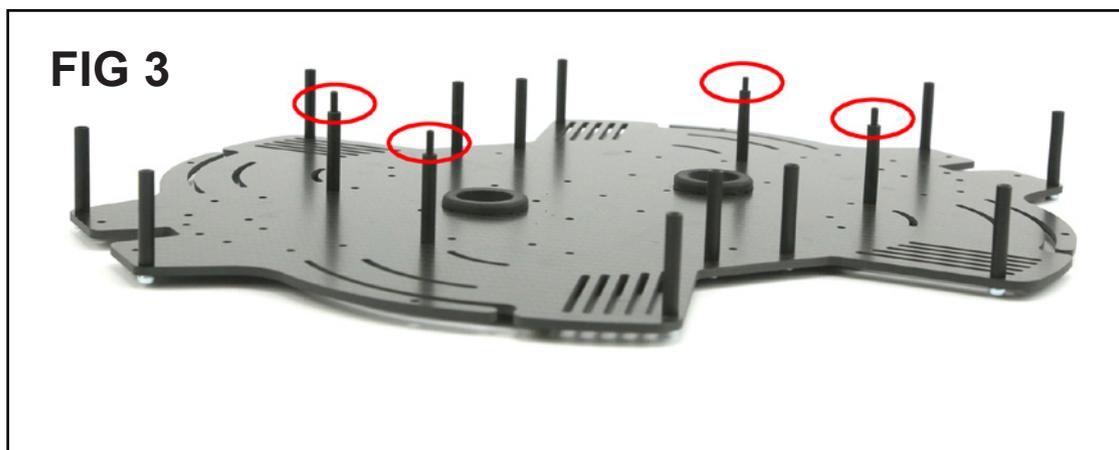
The nylock nuts will ensure they do not come loose, although you should always check nuts regularly for tightness.

Note: One arm in this image does not have LEDs fitted to show how the pillars are installed.



## Frame Centre Plates

Start by fitting two 25mm grommets and attaching 30mm aluminium standoff pillars using 10mm M3 bolts to the lower frame plate (see FIG 3 below). Note the 4 marked pillars are fitted with an M3 16mm threaded studs that will go up through the top frame plate. Use thread lock on the bolts holding the pillars.

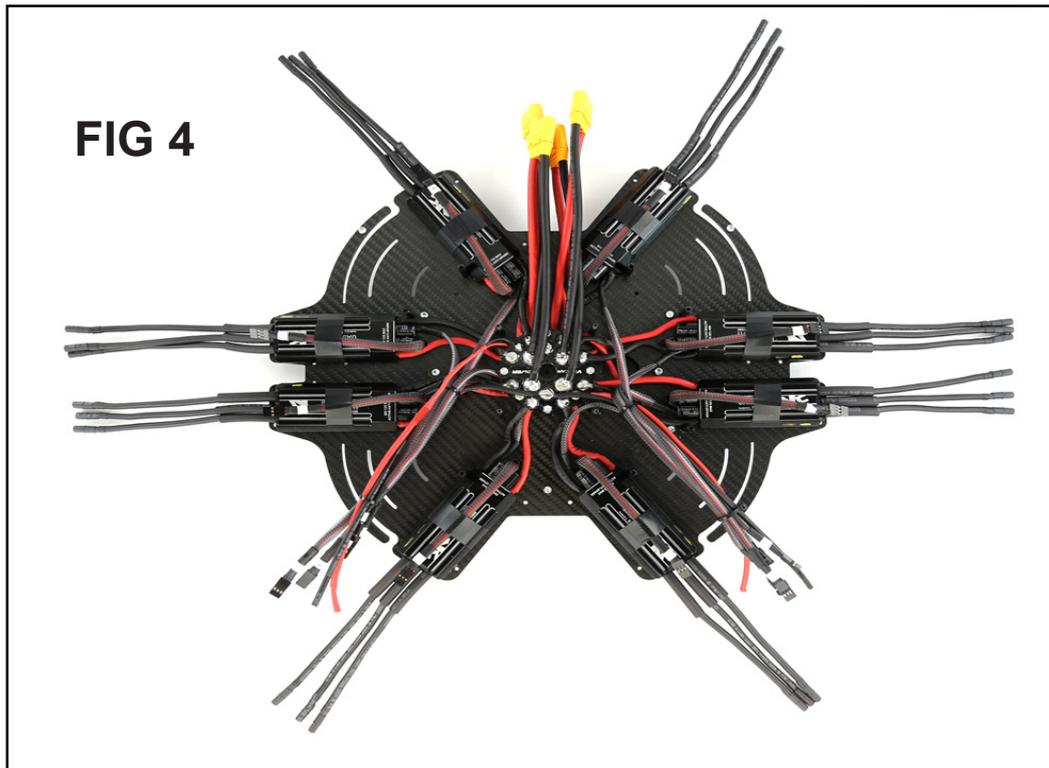


Before fitting your power distribution board (PDB), ESCs and other internal electronics to the frame plate, now is a good time to fit retract mechanisms if you are using them. The Raven lower frame plate is pre drilled for different retracts including FoxTech and Secraft. These are attached with M3 bolts to the lower frame plate at the sides. Which holes to use should be clear when looking at your retracts.

Once the retracts are fitted it is time to fit internal electronics and power systems. As people use different internal electronics and components, this manual does not cover this part of the build process specifically, but as a guide see FIG 4 below.

As a general rule it is good practice to protect all internal wiring against wear or damage. There are different ways of doing this, heat shrink and / or braiding are both good options. It is very important that when you assemble your frame no wires are trapped, and that all wires are properly secured and cannot move. As this is a folding frame, it is also very important to check how the wires are affected by movement of the arm, and to ensure that no wires are rubbed, pulled or trapped during the folding process.

**NOTE:** A bit of careful thought and forward planning about where to run wires, how to keep them in place during use, and where to run them up onto the top plate (or out underneath) to best fit the installation of other components, can save a lot of time later.



## Assembling & Fitting the Anti Vibration Plate

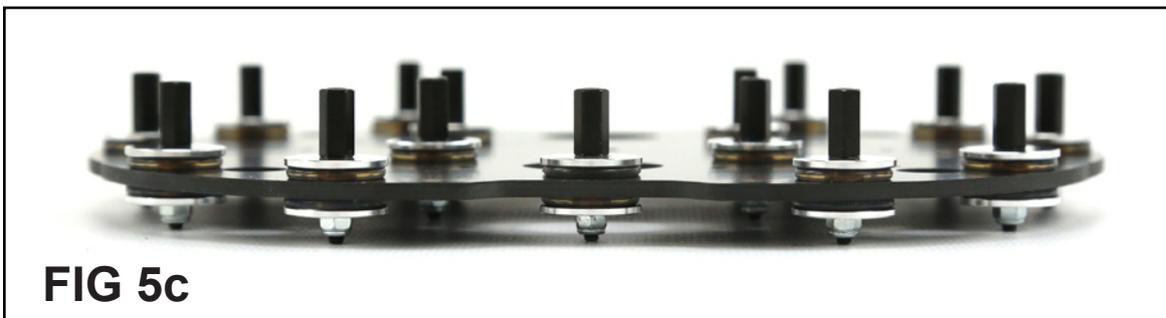
Next you need to assemble and fit the anti vibration plate.

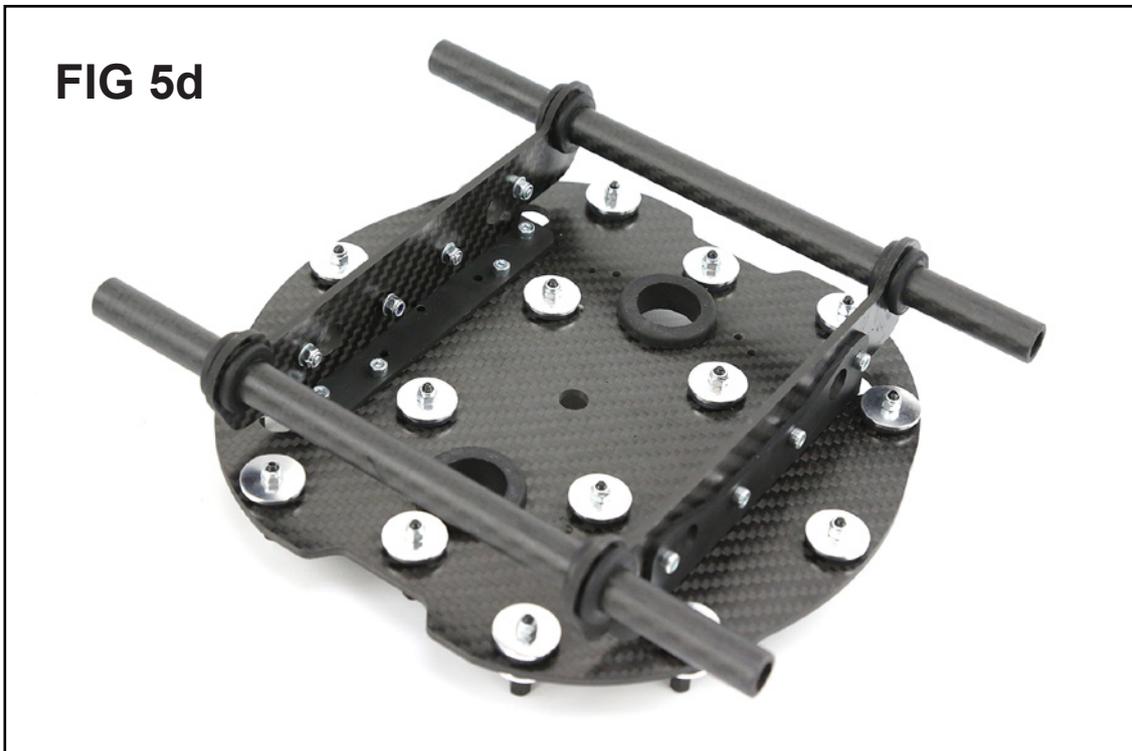
Assemble the plate using 12 or 16 silicone gel bushes according to the load it will carry. The plate is rated to around 8 Kg or 10.5 Kg max load depending on number used.

See FIG 5a to 5c below. The gels are fitted into the 12 x 9mm diameter holes around the outside of the plate, and if you are using 16 gels then fit the extra 4 into the four central 9mm holes.

The gels split in two and are fitted with the fat half on the underside of the plate. It is then sandwiched between 2 x 18mm aluminium washers with a 12mm steel hex pillar down through the centre. Fit a nylock nut to the end of the hex pillar and tighten fully compressing the gel until the nut touches the brass collar inside the gel. Do not over tighten. When tightening the nylock make sure you hold the pillar still and turn the nylock, if you turn the hex pillar you may damage the gel.

Once you have fitted all the gels, you will need to fit the angled aluminium brackets with their carbon B shaped mount plates and rails to carry the payload. See FIG 5d below. Brackets and mounts are fitted with 10mm M3 bolts, nylock nuts and washers. Grommets are fitted through the holes in the B shaped plates for the rails. The rails are a tight fit in the grommets, and are easier to insert with some lubrication such as WD40. It is also easier to fit the rails through the grommets before attaching to the aluminium brackets.





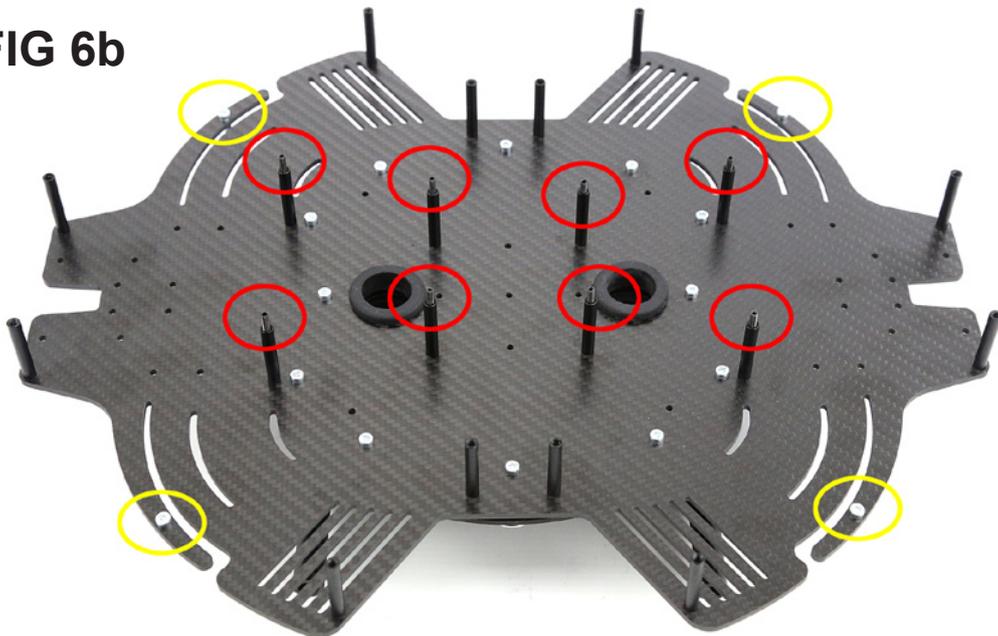
When fully assembled according to FIG 5d above, it is time to attach the anti vibration plate to the lower frame plate. The plate fits either way round with rails running fore and aft. Place the lower frame plate on top of the hex pillars, and fit 4 x 16mm studs through the four holes (in a square) in the centre of the lower frame plate and into the four central hex pillars. Use thread lock to prevent loosening. Hold the hex pillars with a spanner and turn the studs when fitting, do not allow the hex pillars to turn or you may damage the gels. Once the studs are fitted attach 4 x 30mm aluminium pillars to the studs. Use thread lock. These pillars also need to have 16mm studs fitted in the top to go through the top frame plate, see FIG 6b below. You should now have 8 x 30mm pillars inside the frame fitted with 16mm studs (marked in red).

Now attach the rest of the hex pillars with 8mm M3 bolts down through the lower frame plate. Again it is important to ensure the hex pillars do not turn when fitting the bolts. It is important that thread lock is used, you do not want these bolts to come loose should you need to remove the plate later when the frame is assembled, as you will not be able to easily re tighten them once the frame is complete.

**FIG 6a**



**FIG 6b**



## Main Assembly

Once the anti vibration plate is fitted, you are ready to close the main frame and fit the arms. Before fitting the top plate, you must pre fit 4 of the 60mm pillars that will hold the standoff plate (see FIG 7 below). Attach with 8mm M3 bolts and use thread lock.



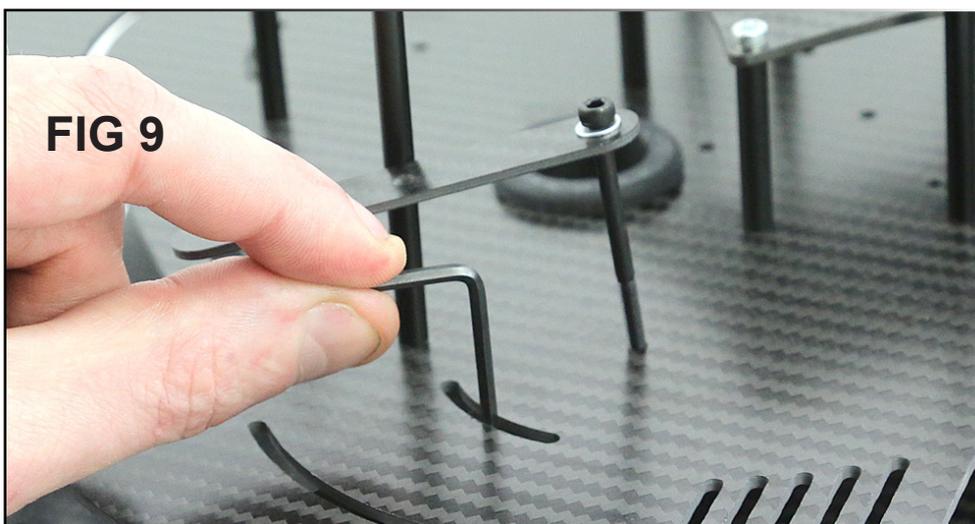
Now fit the top plate to the pillars in the lower frame plate using M3 8mm bolts and thread lock, making sure you have fed any wires through the necessary holes in the top and bottom plate before closing. Large holes for wires should be fitted with the 25mm grommets provided to protect the wires running through the holes. Be careful to ensure no wires are trapped, and that all wires are correctly located before closing the frame plates. Next fit 4 x 30mm pillars to the four studs in the square shape in the centre of the top plate, and fit the mini standoff plate with 4 x 8mm bolts. 60mm pillars to carry the standoff plate are fitted to the remaining studs. Use thread lock on all bolts and studs See FIG 8 below.



Once the frame plates are closed you can fit the arms. Arms should be slid into the frame making sure the motors wires run in the correct locations for the relevant ESCs. Motor wires that run to ESCs at the sides of the frame should run around the outside of the pillars near the end of the arms inside the frame.

To attach the arm, align the inner most hole in the arm with the correct hole in the frame plates. Take one M3 45mm bolt, fit a washer and then the carbon load spreader plate, and insert down through the arm. This can be tight, and the bolt must be carefully placed down the side of the wires, and then out of the lower hole.

**NOTE:** Getting the bolts through the arms and past the wires without damaging the wires is not easy, so here is one way that can help. It is important that wires have been heat shrunk in a flat line of three. You will have two of these, and probably a thinner wire for the LEDs coming out of the end of the arm. You must position the wires so the two sets of three sit one above the other on one side of the arm. Once this is done insert something blunt and thin down through the middle hole of the arm through the slot in the frame plate. Make sure you angle it so all wires are on one side of it, then straighten and push it out through the bottom hole. See Fig 9 below, we have used a thin long hex key for this which has a ball end so as not to damage anything inside the arm. This will help hold the wires in place while you insert the inner arm bolt. Make sure the inner bolt goes down the same side of the wires as the hex key (or whatever you are using), and both sets of motor wires are on the same side of the bolt. Once the inner bolt is in place remove the hex key, insert into the outer hole making sure it remains on the same side of the wires. Then insert a cam lever into the middle making sure both sets of wires remain on the same side of cam lever by angling the shaft as you insert. Once in, remove the inserted tool from the outer hole and fit the final cam lever.



When the inner bolt and both cam levers are fitted, fit a second load spreader to the threaded end of the bolt and cam levers on the underside of the frame. Fit a nylock nut with washer to the inner bolt, and the thrust bearings provided, with a nylock nut to the ends of the cam levers. See FIG 11 below.

**NOTE:** The inner bolt should be loose enough to allow the arms to move, but tight enough to provide some resistance to movement. Close the cam levers and adjust the nylock nuts to get the correct pressure on the arm. The nuts should be tightened such that the cam levers can be opened by hand but are tight and difficult to open and close. If they are too loose the arms will not be properly supported. Always ensure the cam lever is sitting correctly in it's saddle before closing or adjusting.



Once arms are fitted, fit the safety latches. These are M3 8mm bolts with nylock nuts that fit the hole in the carbon slices in the lower frame plate. See FIG 6b above marked in yellow. You can also see the underside of one of these at the lower right side of FIG 11 above. To open and close the arm when these are fitted, gently bend the frame section downwards and rotate the arm over the bolt head.

## Standoff Plate

We would recommend fitting your flight controller and other electronics to the aircraft before fitting the standoff plate, as access will be easier. When this is complete, fit the main standoff plate using 8mm M3 bolts into the pillars already fitted to the top plate. 16mm studs will need to be used for the two pillars that are under the GPS puck holder. The GPS puck holder sits on 90mm or two 60mm pillars (joined with 16mm studs subject to clearance required). See FIG 12 below. These pillars can be extended as necessary with further studs and pillars.



## Final Points

The Raven can take up to four Lipo batteries, one on each side of the main frame and two on the standoff plate. Straps to hold them should be run through the slots provided. Always use dual straps for safety, and ensure the batteries cannot slide out from under them. Anti slip matting is always a good idea as it also offers some protection for the batteries.

Multicopter aircraft can be extremely dangerous, so it is important that safety is paramount when building your machine. Do not rush the build, ensure all wires are properly protected, and whenever fitting a part ensure that no wire is trapped, crushed or likely to be pulled during use, especially during folding. Always ensure all wires, and other components are properly secured and cannot come loose or move around during flight.

Before first flight, re check all bolts for tightness, ensure the arm locking mechanisms are all in place and are adjusted and working correctly, and ensure the arm mounting bolts and cam levers are properly adjusted. Cam levers should be able to be opened by hand, but should be tight and fairly difficult to open and close.

As a general guide ensure you double or treble check every setting in your flight controller, that all your motors are rotating in the correct directions and that the correct props are fitted to the correct motors. It is very easy to make a simple mistake at this stage which can prove to be a problem when you come to fly.

Please read all the information below and take careful note.

If you have any questions or are unsure of any aspects of this assembly, please feel free to contact us and we will be happy to help!

[info@vulcanuav.com](mailto:info@vulcanuav.com)

## General MultiRotor Operational Guidelines

### PRE FLIGHT CHECKS

The aircraft should be carefully checked before every flight:

- Check propellers for nicks and cracks, and if any are found the prop must be changed.
- Check prop fitting for tightness.
- Check all nuts and bolts, clips and other fittings on the aircraft for function and tightness.
- Check all wiring is properly secured such that it cannot move around, and that all plugs are properly connected and cannot come loose.
- Check all on board equipment for correct and secure attachment to the aircraft. All payload items and ancillary equipment, including cameras and gimbals, should always be attached to the aircraft with a secondary safety line in case of a failure of the primary mounting.
- Check charge level and physical condition of batteries. Ensure batteries are securely attached and cannot come loose, move, shake, vibrate or come away from the aircraft.
- Check all battery connections are tight and cannot come apart.
- Check the Centre of Gravity of your aircraft is correct.
- Always undertake a radio range check before flying, and ensure radio batteries are charged.
- Always set a timer with an audible alarm to remind you when you are getting near to depleting your flight batteries.
- If you are using a folding airframe, always ensure the folding mechanism is tight and / or correctly adjusted and cannot come undone during flight

### AIRCRAFT MAINTENANCE

It is the responsibility of the aircraft operator to familiarise themselves with all aspects of their aircraft. All on board equipment must always be used in accordance with the instructions and guidelines of the manufacturer of said equipment, and never used in any manner outside its intended use or operational limits.

Your aircraft is designed to operate within certain weight limits. Never exceed the limit of your aircraft lifting capacity. As a general rule, All Up Weight (AUW - also known as takeoff weight), should not exceed 60% of maximum thrust.

The aircraft should be checked regularly for any wear, damage, defects or other problems.

Always immediately change any parts showing signs of wear or damage of any kind.

### **Propellers:**

Propellers should always be balanced prior to use, and changed if they show any signs of damage whatsoever.

It is critical that propellers are tight and cannot come loose during flight, so if a single nut attachment is used, self locking nuts should always be used to attach propellers. Nuts should be tight but take care not to over tighten. Doing so can result in damage to the propeller hub which can lead to failure in flight. Over tightening can also cause damage to the propeller retaining nut and propeller shaft thread, which could also lead to loss of a propeller during flight.

Never use any kind of sharp object pushed into the motor to hold it still during tightening.

Take great care not to allow propellers to come into contact with objects when on the ground, for example when loading or unloading from a vehicle, as this can easily result in damage.

### **Motors:**

Motors contain powerful magnets, and they should always be kept well clear of small metal objects. It is very easy for a motor magnet to pick up something small like a washer, bolt, or even small shards or filings of metal with their magnets. If this occurs it can prevent the motor turning smoothly and operating correctly, can cause excessive and premature wear of moving parts, can induce a short circuit within the motor, which in the worst case, can lead to instant and catastrophic failure during flight.

The most common source of problems for motors is wear of the bearings, which can lead to vibration, reduction in performance, and in extreme cases to motors failure during flight.

Motors should always be checked for smooth operation, and early signs of wear to the bearings. Check motors regularly for play, or sideways or up and down movement in the motor shaft.

Motor bearings have are specified with a Mean Time to Failure (MTTF). Motors should be changed at 50% of this specified average bearing life span.

One of the clearest signs of upcoming bearing problems is a change in the sound of a motor during flight. Familiarise yourself with the sound of your aircraft and always take care to listen for any deviation in sound from normal.

Abnormal noise from vibration can also be a good indicator of something coming loose. Always land immediately if you notice a change in the sound of your aircraft.

### **Lithium Polymer Batteries:**

Lithium Polymer batteries (LiPos), can be extremely dangerous, and must be handled with care.

Always charge your battery on a hard, non flammable surface, and store in a fireproof container or LiPo bag.

Never leave your battery unattended during charging.

For maximum lifespan charge your battery slowly, ideally at 1C (1 x battery capacity), even if the battery is capable of a higher charge rate.

Batteries can get hot during use. If possible always charge your battery when cold.

Never allow your battery to discharge below 3.2v per cell, or permanent damage may result.

Never allow your battery to short.

When connecting your LiPos to your machine a spark can often result. This is normal.

Always make a clean and quick connection to minimise sparking. Multiple sparking during connection can cause problems for on board systems, especially those running software.

Never drop your battery or permanent damage can occur. This may not be visible but could lead to problems during use or charging.

If your battery ever becomes physically distorted or expanded during use or charging, immediately cease use or charging and replace the battery.

Always log flight times and charges with a particular battery. You should replace your batteries after around 100 cycles.

## **GENERAL FLYING LAW (UK)**

Under law, if your aircraft weighs less than 7Kg, it is illegal to fly over, or within 50m of buildings or other manmade structures, vehicles, overhead cables, roads and people.

If your aircraft weighs between 7 Kg and 20 Kg, this distance increases to 150m.

Exception can be made if you have full control over the area in which you are flying.

The maximum altitude allowed is 400 feet.

The aircraft must always remain in line of sight of the pilot and at a distance of no more than 500m. If autonomous operations are being carried out, maximum flight range is reduced to 250m and a competent pilot must always remain at the controls in case of problems.

Anyone flying a multirotor or any other radio controlled aircraft for pleasure must have third party liability insurance. The easiest way to obtain this is to join the BMFA (British Model Flying Association), where liability insurance is included in your membership fee. This insurance is only valid if all BMFA rules are followed, and flying is done at an approved BMFA site.

If you are intending to undertake any kind of commercial operations with your multirotor, you must be certified, and have written permission to fly from the CAA.

Liability insurance for commercial operations is mandatory.

## Disclaimer:

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