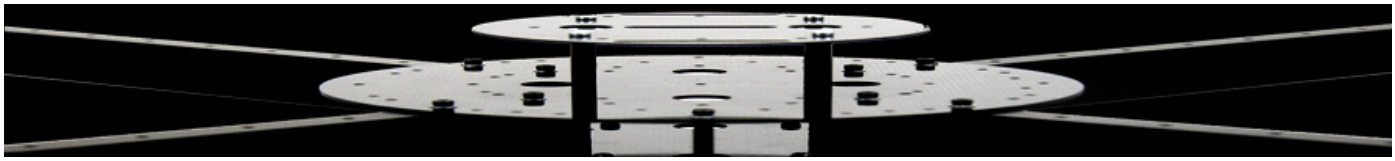
VulcanUAV

MULTIROTOR AIRCRAFT SYSTEMS



Vulcan D7 NYUAD

User Guide V1.01

www.VulcanUAV.com

NOTE: This is a generic user guide aimed at providing information on the use of 6 series Harrier Industrial aircraft variants. Some details of your aircraft may vary from those shown here, but the basics of operation should still apply. If you have questions about the specifics of your aircraft please contact us.

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 relyon 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 before flying.

Specification:

Airframe:

Configuration: X8 co axial folding
Diameter: 1580mm
Weight: ~ 14 Kg subject to spec (approx - no batteries or payload)
Max Take Off Weight: 38 Kg
Operating Voltage: 44.4v (nominal)
Max Speed: 60 Km/h
Max Altitude: 5000 feet ASL
RC Control Freq: 2.4 Ghz (subject to spec)
DataLink Freq: 868 Mhz
Video downlink: No
Motor Redundancy: Yes
Navigation: DayBright LEDs Red & Green (Port & Starboard)

Materials:

Frame plate: 3K Twill Pure Carbon Fibre
Main Frame Plate thickness: 2mm top 3mm bottom
Motor Mount Thickness: 3mm
Arms: 6082 Aluminium
Frame truss: 6061 Aluminium
Bolts: Hardened steel zinc coated or self colour
Nuts: Nylock
Pillars: Aluminium M3 threaded

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: 750A continuous at <50 degrees C
Dual independent 8AWG battery feeds w/ AS 150 connectors
16 AWG auxiliary power feeds
Eight speed controller connections
All connections soldered at PDB side or connected with XT30

Battery Mounting:

Side Trays with Anti slip
Dual battery straps

Payload and Landin Gear Mount:

4 x 7075 aluminium self locking quick release clamps

Motors:

KDE 7215
Kv (Motor Velocity Constant) 135 RPM/V
Kt (Motor Torque Constant) 0.0707 Nm/A
Km (Motor Constant) 0.2774 Nm/√(W)
Maximum Continuous Current* 85+ A (180 s)
Maximum Continuous Power* 4405+ W (180 s)
Maximum Efficiency > 93%
Voltage Range 22.2 V (6S LiPo) - 60.9 V (12S LiHV)
Io (@10V) 0.5 A
Rm (Wind Resistance) 0.057 Ω
Stator Poles 24 (24S28P, HE)
Magnetic Poles 22 (24S28P, HE)
Bearings Triple, 6900-2RS/6000-2RS
Mount Pattern M4 x ф35 mm, M5/M4 x ф40 mm
Stator Class 7215er ф4 mm (ф8 mm Internal)
Shaft Length 9.5 mm
Motor Diameter ф80.8 mm
Motor Length 44.5 mm
Motor Weight 555 g (640 g with Wires/Bullets)
Propeller Blade Size Up to 30.5”-TP (24.5”-DP Maximum on 14S)
Motor Timing 22° - 30°
ESC PWM Rate 16 - 32 kHz (600 Hz)

Electronic Speed Controllers:

KDE 95A HVC OPTO
Refresh Rate 600 Hz (50 - 600Hz Adaptive)
Maximum Peak Current 165 A (5 s)
Maximum Peak Power 7,325 W (5 s)
Maximum Continuous Current* 95+ A (180 s)
Maximum Continuous Power* 4,220+ W (180 s)
Maximum Efficiency > 98%
Voltage Range 11.1 V (3S LiPo) - 52.2 V (12S LiHV)
Internal BEC None (Opto-Isolation)
Maximum RPM 360,000 rpm (2-Pole)
PWM Rate Adaptive Dynamic Algorithm
Advance Timing 22° - 30° Dynamic Algorithm
ESC Size 37 mm (W) x 82 mm (L)
ESC Weight 78 g (114 g with Wires/Bullets)
Power Leads 12 AWG, 200°C
Motor Leads 13 AWG, 200°C
ESC Control Lead 22 AWG, 3-Wire JR (W-R-B)
ESC Programming Lead 22 AWG, 3-Wire JR (O-R-B)
Power Connects ϕ4.0 / ϕ6.5 mm Matched Pair
Motor Connects ϕ4.0 mm Female

Propellers:

28” x 9.4” carbon fibre fixed
Four bolt fitting

Flight:

Max Speed: 50 mph

Rate of Climb / descent: Adjustable - 2 m/s default recommended

Max Operating Altitude: 5000 feet ASL

Operating Temp: 0C - 35C unless otherwaise stated

Max Take Off Weight: 38 Kgs

Max wind resist: 20 mph

Max Payload: ~ 21 Kgs split between battery and payload according to requirements

Weather: Dry and light rain weather operation

Flight Time (with recommended batteries):
No payload: ~40 mins
5 Kgs payload: ~25 mins
10 Kgs payload: ~20 mins
15 Kgs payload: ~15 mins
(flight time estimates subject to the usual factors that affect flight time)

Max Distance from pilot: 500m

Max Range: Subject to flight time, speed and weather conditions

Control Link Frequency: 2.4 Ghz

Control Link Range: up 1.5 Km (straight line)

Data Link Frequency: 868 Mhz (subject to spec)

Video link: No

Autonomous Operation: Yes

Waypoint missions: Yes

Failure Modes: Multiple - subject to spec and requirements

Motor Redundnacy: Yes

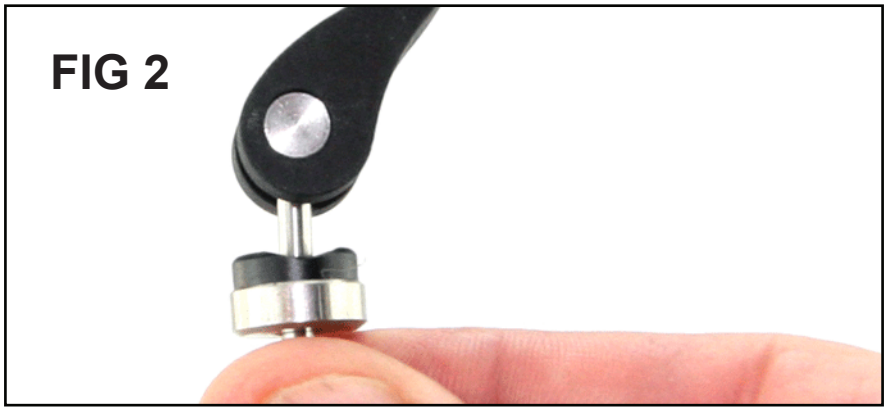
Airframe Folding - Operation and Adjustment

Your aircraft can be quickly folded for transportation using the tool free cam lever arm locking system. It is important to ensure this is used and adjusted correctly for safety and to ensure your aircraft frame remains as stiff as possible in flight.

Whilst these cam levers should not need adjusting often, it is important to monitor the tightness in pre flight checks and adjust as necessary.

Cam lever tightness should be adjusted using the nylock nut on the underside of the lever shaft. It is important that this is tight enough to ensure the lever is not easy to open and close, operation should be stiff but not so tight excessive force is required to close it. If it is too loose it will not offer full support for the frame and could come open during flight. The thrust bearing on the underside of the lever shaft will ensure the nylock does not come loose if the cam lever is twisted from above.

When adjusting or using the cam lever, ensure the curved underside of the lever is correctly seated in the nylon saddle (see FIG 2). If it is not aligned properly it will not close corectly and could come loose, or damage the cam lever when used.



Although the bearing on the underside of the cam lever will prevent the nylock from loosening, it is important to check the adjustment of the cam levers before each flight, just in case. Over time the nylon saddle will bed in and this could lead to loosening.

The folding mechanism also includes a safety latch. This is quite simple and uses a bolt which will prevent the arm from folding if the cam levers were to come loose during flght. To fold / unfold the arm you must push down one end of the carbon fibre frame plate section that holds the safety latch bolt. This has been cut to allow this movement. Once the arm has passed the latch, release the carbon and the latch will move back in to place. See FIG 3 above.

Quick Release Clamps

The D series aircraft use Vulcan 12mm quick release clamps for attaching fixed landing gear to the aircraft and payload to the payload rails . See FIG 4 below. These clamps are made from 7075 aluminium and very strong. The design is self locking, so as you tighten the clamps to the rails, the two halves of the clamp rotate around the rail applying pressure to the thread and body of the key, locking the clamp to prevent loosening. It is important that these are done up firmly, but DO NOT OVERTIGHTEN. Even though these clamps are made from very strong aluminium, it is still possible to damage the thread if too much force is used.

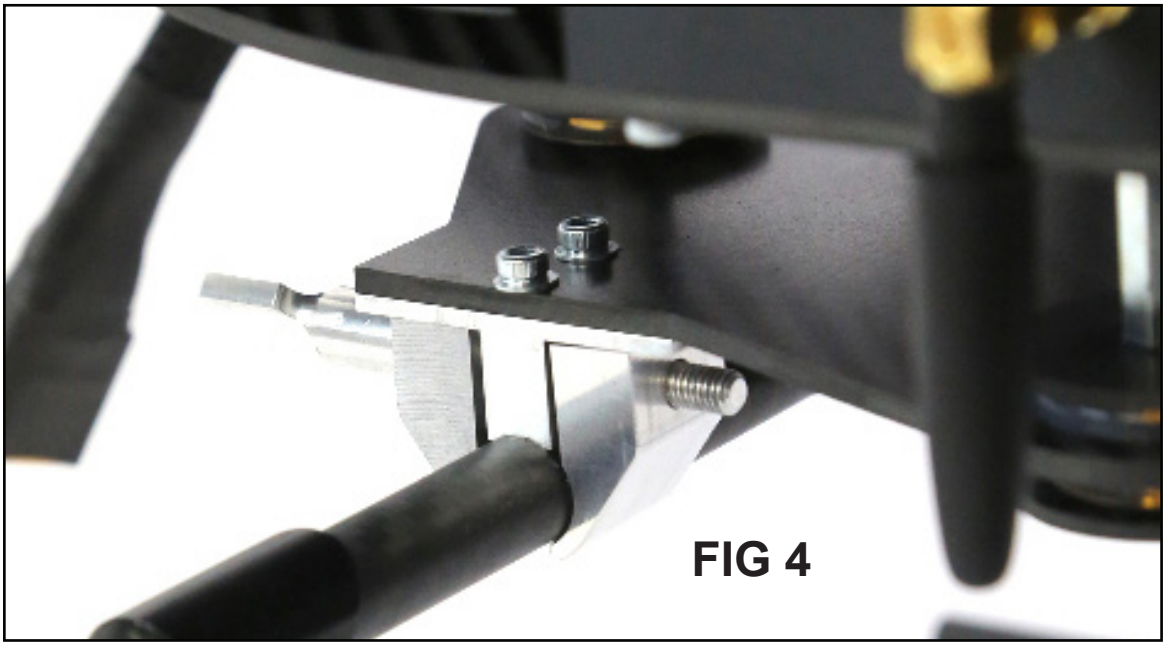


FIG 4

Landing Gear & Battery Mounting

The landing gear is attached using the four quick release clamps fitted to the underside of the aircraft. It has an integrated battery tray capable of carrying four batteries in two seried pairs, one pair each side.

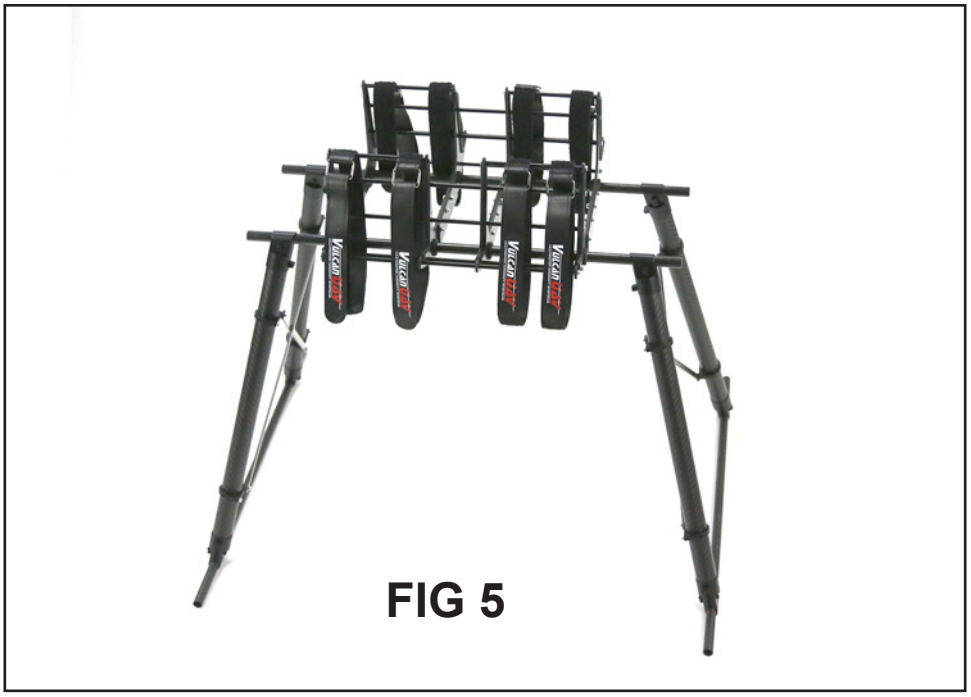


FIG 5

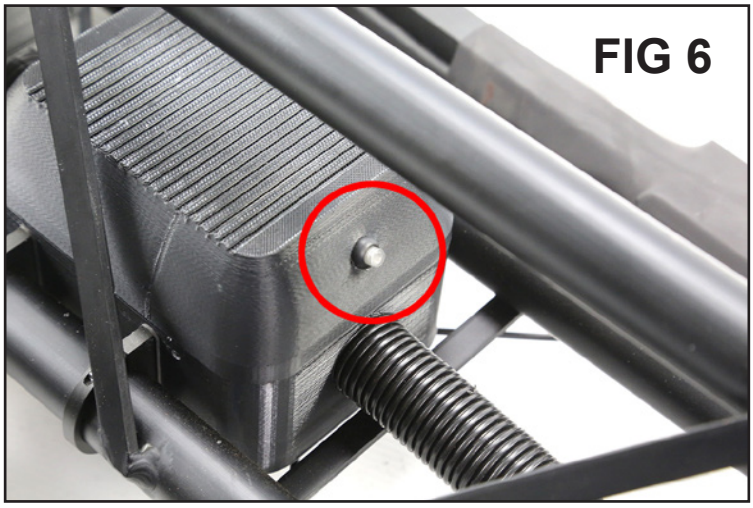
Batteries are mounted on the trays fitted to the landing gear, two on each side, end to end. Each side carries a pair of 6s 22Ah batteries that are connected in series pairs. Each series pair is connected to an independent power feed to the PDB for safety.

Battery trays are fitted with anti slip edging strip to ensure the batteries cannot slide during flght and are not damaged when installed. Batteries are secured with a pair of velcro straps for each pack. Packs need to be tightly held in place, and it is imperative that the batteries must not be able to come loose, move around or come away from the aircraft during flight so ***CARE MUST BE TAKEN*** when attaching your batteries. When connecting batteries ensure the leads are run in such a way that they cannot accidently get caught in the props, or come unconnected.

Arm Button

If you are familiar with the Arducopter flight code and Pixhawk (as used in this aircraft) you will also be familiar with the function of the ‘arm’ button. **It is *IMPERATIVE* that you are fully familiar with the function of Arducopter and Mission Planner before attempting to fly this aircraft! Correct and safe use of this aircraft is the responsibility of the pilot / operator!**

The ‘arm’ button used by Pixhawk flight controllers is most commonly found integrated into the GPS / compass module. In this aircraft the GPS / compass module is enclosed and inaccessible so an additional arm button has been added. This can be found on the back of the rea of the three electronics boxes.
See FIG 6 below.
Switch FLASHING - aircraft disarmed
Switch ON - aircraft armed



GPS Mast

The GPS mast can be folded for transport. Always ensure it is securely locked in place before flight. The locking lever should be firm to close. If it is too loose it can be adjusted be removing the cover under the latch and tighening the nylock nut inside the latch. Do not pinch the wire when raising the mast.

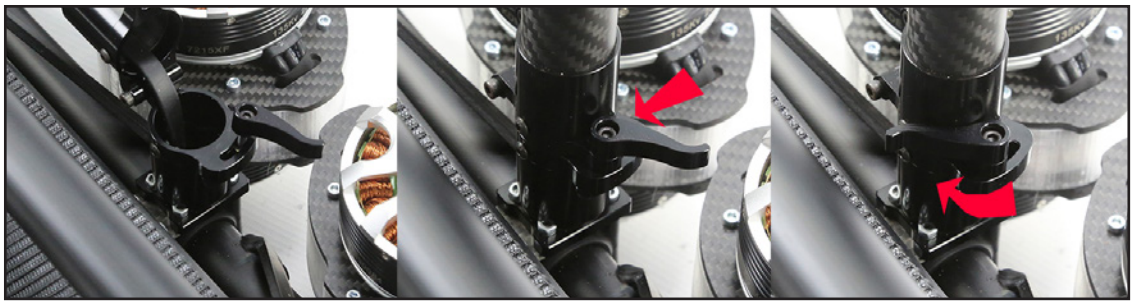


FIG 7

RC Transmitter

Transmitter switches are labelled. See FIG 8.

The ‘MODE’ switch is for changing flight modes. Always check the flight mode for each switch position in Mission Planner, and you can adjust the mode for each position as required.
NOTE: Position 1 mode in Mission Planner is RTL. DO NOT change this!

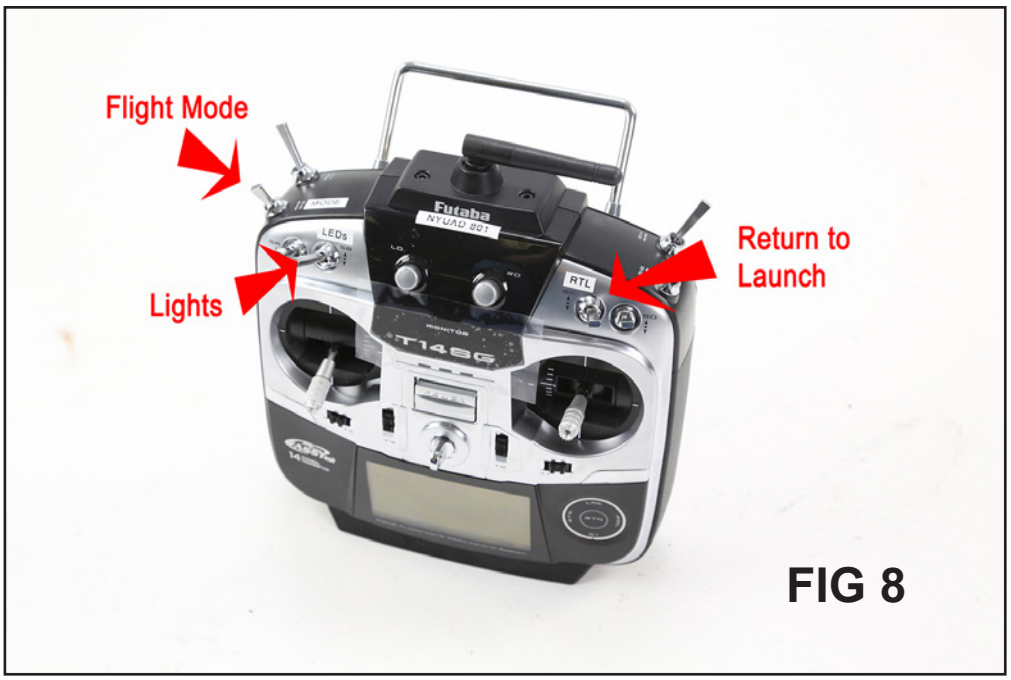


FIG 8

Switch marked RTL is for Return to Launch.
Up position is ‘OFF’, switch all the way down to initiate automatic Return to Launch. Remember this function is GPS and compass dependent, so do not attempt to use if the aircraft is showing any signs of poor GPS reception or compass interference.

Switch marked ‘LEDs’ is for naviagtion lights.
Up position is ‘OFF’, middle is ‘FLASH’ and down is ‘ON’.

Main battery voltage can be displayed on the screen of the handset. To change to this display screen simply press the large silver button under the throttle stick. See FIG 9 below.


T14SG
FUTABA CO. 01 44
T1 00:00.00
T2 00:00.00
14CH NVU-01
VPP #1
T14SG
TELEM.MON1
Rx-BATT. RECEIVER
0.0V
EXT-VOLT RECEIVER
0.0V
Main Aircraft Voltage

FIG 9

Pixhawk 2 Flight Controllers

If your aircraft is fitted with a Pixhawk 2 flight controller a micro USB access point will be fitted for connecting your computer directly to the flight controller.

Extensive details of the operation of the Pixhawk are available online. If your aircraft is using the ArduPilot code stack we recommend using Mission Planner as your flight planning software. This is free and can be downloaded from the internet. If your aircraft is using the PX4 code stack, we recommend using Q Ground Control for flight planning, also available free on the internet.

Data Link

To connect your Ground Control Station PC via the data link first connect a USB lead from the PC to the micro USB in the front of the data link ground unit. Always ensure antennas are connected before powering any transmitter. Antenna should be in the vertical position and separated in a shallow V shape.
You can then connect your GCS software (Mission Planner) to the flight controller via the data link in the same way as connecting directly with a wired connection.

NOTE: correct installation of drivers and setting of COM port is very important for operation of Mission Planner, Q Ground Control or other GCS software used. Details of this will be specific to your computer, which is beyond our control and therefore the responsibility of the operator.

VULCAN UAV
MULTIROTOR AIRCRAFT SYSTEMS

Harrier Industrial 6 Series
User Guide

Take your time to fully familiarise yourself with the operation of the GCS software you are using! It is the responsibility of the operator to fully understand the functioning and operation of this and errors made here may cause loss of control or the aircraft, crashes, damage to property, injuries or loss of life!
Vulcan UAV Ltd accept no responsibility whatsoever for the correct operation and use of the Pixhawk system or any of it's peripheral equipment, sensors, software, firmware or any other part of the system. This is an Open Source system and as such is used entirely at the risk of the operator.

Vulcan Harrier
6 series

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 and blade hinge bolts (folding props) 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. Ensure there are no signs of wear or damage to wires or connectors

 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 a 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.
If a multiple nut fitting is used then check for tightness before every flight. Do not overtighten or damage to the thread in the motor can occur, which could lead to a failure in flight.
Never use any kind of sharp object pushed into the motor to hold it from turning during tightening.
If you are using folding props ensure the blades are not loose in the hub.They should be able to rotate in the hub but not be completely loose and able to swing on their own.
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. This is particularly important when using carbon props as intternal damage can occur and this is not al;ways visible externally. If in doubt always replace the propeller.

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 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 you 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 tahn 7Kg, it is illegal to fly over, or within 50m of buildings or other manmade structures, vehicles, overhead cables, roads and people.
If ypour 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 site 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:

Due to the nature of multirotor aircraft, and the fact that their use, set up, software settings, physical and mechanical properties, payload and construction can all be altered by the user, Vulcan UAV Ltd, and it's associates, partners, officers, employees and assignees, remain completely harmless and free of liability or responsibility for any damage, harm, or claim arising from the purchase, assembly, use or misuse of any product(s) purchased from, or supplied by us.
Vulcan UAV Ltd makes no claim of guarantee, warranty or any other claim, expressed or implied, that any item supplied is suitable for any purpose, including the intended purpose. Furthermore, nothing said, written or implied by any person connected with Vulcan UAV Ltd shall invalidate any of the preceding disclaimer.
The user assumes all liability for all potential damages or claims that might arise from the use, purchase or handling of any items supplied by or purchased from Vulcan UAV Ltd.

General Multirotor Operational Guidelines

Vulcan UAV offer general guidlines for the safe use of multirotor aircraft (see above).Vulcan UAV make no claims or warranties as to their accuracy or completeness, they are for general guidance only. It is the responbsibility of the operator of the aircraft to ensure their aircraft is safe to fly and that they operate safely and within the law.

Vulcan UAV Ltd – Terms & Conditions of Supply

Warranty

Section 1: Airframes, Parts & Components

Vulcan UAV Ltd warranties our parts against defects in manufacture for one year from date of purchase. In the case of components supplied by, but not manufactured by Vulcan UAV Ltd, the warranty remains as that provided by the manufacturer of the particular component. Due to the relatively fragile and vulnerable nature of multi rotor aircraft systems, and the fact that their safe care, storage, transportation, set up and operation are all entirely beyond our control, Vulcan UAV Ltd offer no warranty beyond that stated above on any component manufactured by or supplied by us.

Section 2: Ready to Fly Aircraft Systems

In the case of Ready to Fly aircraft systems, Vulcan UAV Ltd warranty against fault in assembly of the aircraft for a period of 1 year from date of purchase, subject to the following:

Part 1:

For the warranty to remain valid, the owner must undertake the following:

Be legally certified and properly trained by an accredited training organisation in the use of multi rotor aircraft systems, general flying safety and air law.

Fully familiarise themselves with all equipment and components of the aircraft, fully understand their correct set up and use, and ensure for themselves that all components are installed and set up correctly.

Conduct a thorough systems and physical aircraft check before each flight, undertake regular maintenance of the aircraft, and keep verifiable records of these procedures.

Ensure safe and legal use of the aircraft according to regulations in their country, territory or area of operation.

Ensure correct calibration, adjustment and positioning of all sensors on the aircraft at all times, including but not limited to those that could in any way affect flight performance.

Ensure compatibility of, and that there is no risk of interference between, any equipment carried by the aircraft and the aircraft systems.

Ensure the aircraft is not flown over weight, out of balance, or in conditions outside those stated in the specification of the aircraft.

Ensure solar activity, magnetic anomalies, RF sources and any other situational or external factors that could affect the performance of the aircraft are avoided, and are not allowed to affect the aircraft or any of it's on board systems.

Part 2:

For the warranty to remain valid, the following conditions must be observed:

No component or part of the aircraft, aircraft subsystems or accessories are removed, altered, adjusted or replaced, and that nothing is added to the aircraft beyond that originally supplied and fitted by Vulcan UAV Ltd. The only exceptions to this are adjustments that may be required prior to flight as mentioned in pre flight check lists. Normally this will only meanm adjustment of cam lever arm locking mechanisms and propeller blade tightness.

Vulcan UAV Ltd provide general guidelines on use and maintenance of the aircraft, however we make no guarantee whatsoever as to the correctness or completeness of said guidelines. Responsibility for this lies solely with the owner.

Whilst we use high quality components in all aspects of construction and installation, we cannot accept any responsibility or liability for the continued correct function of any or all components beyond the time of handover of the aircraft. This includes, but is not limited to, all hardware and software used in the aircraft and its control system.

It is important to note that the warranty on any and all components, whether installed in a complete aircraft system or not, extends only to the individual components themselves, and not to any other part or component affected by any failure or malfunction of any other component(s). In plain language this means that if an aircraft is damaged due to a component malfunction or failure, Vulcan UAV Ltd offers no warranty whatsoever except where a particular component failure or malfunction can be positively identified, and in such a case, warranty only extends to repair or replacement of said component according to the terms stated here.

Vulcan UAV Ltd accept no responsibility whatsoever for the correct function of open source software and firmware used in our aircraft. Use of open source code is inherently risky and therefore use is entirely at the risk of the owner / operator of the aircraft.

Disclaimer:
Due to the nature of multi rotor aircraft, and the fact that their use, set up, software settings, physical and mechanical properties, payload and construction can all be altered by the user, Vulcan UAV Ltd, and it's associates, partners, officers, employees and assignees, remain completely harmless and free of liability or responsibility for any damage, harm, or claim arising from the purchase, assembly, use, misuse or failure of any product(s) purchased from, or supplied by us. Vulcan UAV Ltd makes no claim of guarantee, warranty or any other claim, expressed or implied, that any item supplied is suitable for any purpose, including the intended purpose. Furthermore, nothing said, written or implied by any person connected with Vulcan UAV Ltd shall invalidate any of the preceding disclaimer. The user assumes all liability for all potential damages or claims that might arise from the use, purchase or handling of any items supplied by or purchased from Vulcan UAV Ltd.

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