

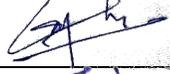


NEXTLEAP AERONAUTICS

Leap A10 Agricultural UAS Maintenance Manual

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1. Introduction

Maintenance is an often underestimated but critical aspect of owning and operating any complex machinery. Proper maintenance is the cornerstone of safety. Regular inspections and servicing can help identify potential issues before they become hazards, ensuring the safety of operators and bystanders. A well-maintained UAS is a reliable one. By following the maintenance protocols outlined in this manual, one can minimize the risk of unexpected breakdowns and ensure that the UAS operates at its best when you need it. Neglecting maintenance can lead to costly repairs or even the premature replacement of components. A well-maintained UAS is more cost-effective in the long run. Proper maintenance extends the lifespan of the UAS, protecting investments and maximizing its operational utility. Regular maintenance ensures that the UAS functions at its peak performance, providing you with accurate and efficient results in agricultural applications.

2. Life of Components

The UAS components have different rated lives depending on the structural integrity of the component and the usage of the component. Certain components undergo high stresses during the UAS operation as compared to other components. Components that undergo high stresses are called critical components and failure of these critical components may cause catastrophic damage and so, lives of these components are as significant as the usual primary components – airframe, landing gear, motor, propeller and battery. Lives of critical components and primary components are given in below table.

Component	Life
Battery	269 Charging Cycle
Propeller	500 Flying hours
Motor with ESC	
Landing Gear	10,000 Cycles (Landings)
Airframe	9000 hours

Table 1: Life of components

The components must be replaced after the specified life span. Life of a component is completed either by the flight time or the duration for which the component has been installed on the UAS, **whichever comes first**. On reaching the stated operational hours or a period of **5 years**, whichever is earlier, the UAS shall be withdrawn from serviced and disposed as the procedure given in this document.

Component monitoring is important for keeping a track of the usage of UAS and its components. Component monitoring also helps the manufacturer and user to record a problem being encountered commonly in multiple UAS, so that necessary actions could be taken to prevent failure any more. Component monitoring can be done using operation logbook. Recording each flight in the operation logbook is therefore mandated for a user/pilot.

2.1 Prevention Against Deterioration of Strength

Deterioration of metallic materials, often referred to as corrosion or degradation, is a natural process that occurs when metals react with their environment. This deterioration can have a significant impact on the mechanical, structural, and aesthetic properties of metallic materials. There are several mechanisms by which metallic materials can deteriorate against which protection is available. These are described in the following sections.

2.1.1 Galvanic Corrosion

Galvanic corrosion occurs when two dissimilar metals are in contact with each other in the presence of an electrolyte (e.g., saltwater). The more anodic metal (the one that gives up electrons more easily) corrodes faster, while the more cathodic metal is protected. The max recommend difference is 0.25 V.

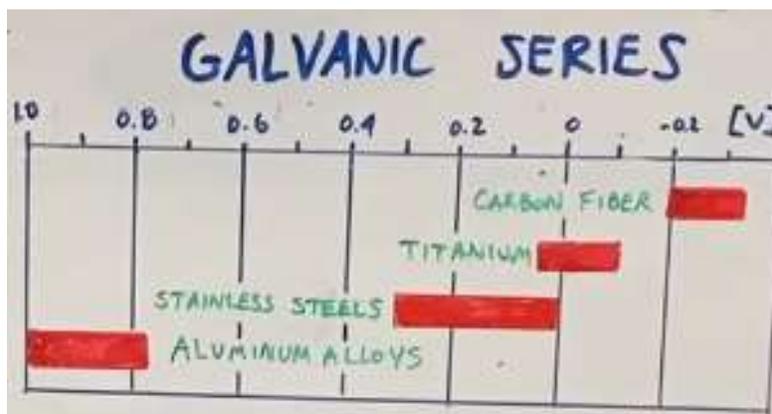


Figure 1: Galvanic corrosion chart.

Dis-similar metal combination	Criteria for acceptance
Aluminum to Carbon Fiber	Anodization of Aluminum
Aluminum To steel	Anodization of Aluminum
Steel to Carbon Fiber	Potential difference not greater than 0.25 V

Table 2: Galvanic Corrosion Table

The following picture shows the major interface portion between Carbon Fiber and Aluminum. Stainless steel is only used in fasteners which interface with both Carbon and Aluminum.

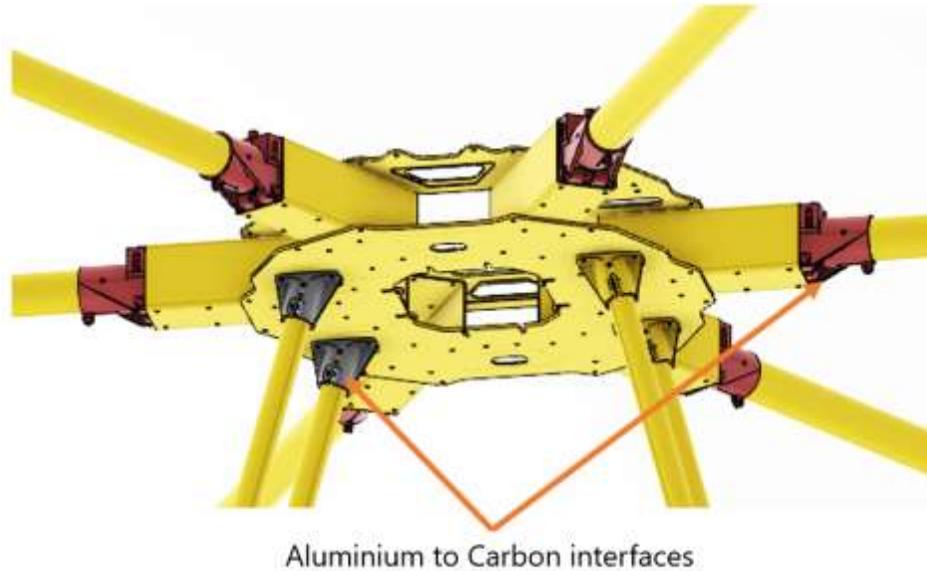


Figure 2: Galvanic Corrosion Zone

2.1.2 Wear and Tear

The folding mechanism for the motor arms is the part which will be subjected to constant wear and tear. To counter this, Stainless steel hinges and locking pins are used by the supplier in these parts to prevent wear. The landing gear skid which also faces constant impact load during every landing is also prone to wear and tear. To mitigate this risk, the landing gear skids are protected with a thick rubber-based cover to cushion the landings. Further, the condition of the cover will be inspected regularly before the flight to verify its condition and replaced if necessary.

The table below lists the parts which will be subjected to wear and tear and will require frequent attention to perform maintenance.

Component	Part Number	Mitigation Strategy
Folding Mechanism	NL_AGU_A10_FM000	Stainless steel hinges and locking pins to prevent wear.
Landing Gear Assembly	NL_AGU_A10_4003	Thick rubber-based cover to cushion landings.
Top Shroud	NL_AGU_A10_2027	Regular inspection before flight; replacement if needed.
Motor Propellers Set	HobbyWing X6 Plus	Regular inspection before flight; replacement if needed.
Battery Plate, lock & Straps	10L Tank	Regular inspection before flight; replacement if needed.
Battery Connectors	XT90	Regular inspection before flight; replacement at battery supplier facility.
Centrifugal Nozzle	RKI-3490	Regular inspection before flight; replacement at NextLeap Aeronautics factory.
Flat Jet Nozzle	C-XR-QJB8360-IND-A	Regular inspection before flight; replacement by end user.

Table 3: Component Wear Mitigation Strategies

3. Document Legends



This symbol indicates a situation or condition in which the pilot is required to exercise caution to minimise and/or eliminate exposure to safety incident.



This symbol indicates a situation or condition in which attention is paramount and user/pilot must not violate specified guidelines and rules specified in the documentation or MoCA regulations.

4. Safety Guidelines

The Leap A10 Maintenance Manual is a comprehensive guide to ensure the safe maintenance, repair, and upkeep of the UA. Proper adherence to safety protocols is essential to prevent accidents, injuries, and damage to the equipment during maintenance procedures.

General Maintenance Safety Guidelines:

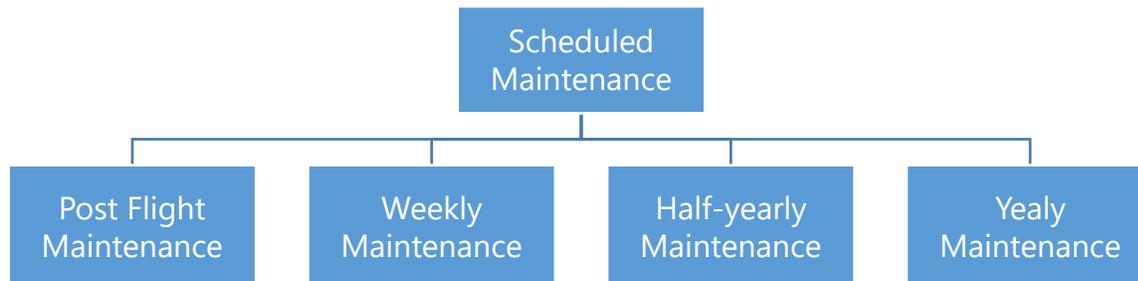
- Only trained and certified maintenance personnel should perform maintenance tasks on the Leap A10 hexacopter.
- Adequate knowledge of UAV systems, electronics, and mechanical components is essential.
- Wear appropriate PPE, including safety goggles, gloves, and any other necessary protective gear, when conducting maintenance procedures.
- Ensure a clean and organized work area to minimize the risk of tripping or falling.
- Have a fire extinguisher and first aid kit readily available.
- Battery Handling:
 - Batteries must be removed before starting any maintenance procedure.
 - Store and transport batteries in a LiPo bag.
- ESD Protection:
 - Use anti-static wrist straps and mats when handling electronic components to prevent electrostatic discharge (ESD) damage.
 - Store electronic components in ESD-safe packaging when not in use.
- Tool and Equipment Safety
 - Use only authorized tools and equipment for maintenance tasks.
 - Ensure all tools are in good condition before use.
- Lifting Safety:
 - Follow proper lifting procedures to prevent injuries
 - When lifting any heavy objects (≥ 10 Kg), wear safety shoes.

- Objects ≥ 25 Kg should be lifted by no less than two people.
- Use transporting equipment with the appropriate weight capacity.
- Documentation and Record Keeping:
 - Maintain detailed logs for all maintenance activities, including dates, performed tasks, and personnel involved.
 - Keep records of replaced components and their service life.

5. Scheduled Maintenance

Maintenance of any UAS should be a continuous process to ensure prolonged life span of the UAS and safety for the user, operator or pilot. The maintenance procedures could depend on the frequency of the use as well as periodic over time. Frequency of use maintenance would be required if the UAS is being used extensively and number of maintenance cycle would also be proportional to the operational cycle. On the other hand, periodic maintenance would be a must to do as per the maintenance schedule, irrespective of the operational condition of the UAS.

The maintenance procedure for Leap A10 UAS is split in to four parts.



- Post flight maintenance: Post flight maintenance should be carried out after every operational cycle of the UAS. Pilot or user must take responsibility of the post flight maintenance. This maintenance would include basic safety checks that needs to be carried out before the operational cycle can be closed.
- Weekly maintenance: Weekly maintenance should be carried out every week even if the UAS is not being used. This maintenance would include safety checks and subsystem cleanup to ensure normal working of subsystems such as spraying system. This needs to be done on the user end and should be logged in the maintenance logbook by the user.

- Half-yearly maintenance: This maintenance could be carried out on the manufacturer's end as this maintenance needs dismantling the UAS. It is a periodic maintenance which needs to be carried out every six months. This maintenance would involve dismantling the subassemblies to verify integrity of critical components.
- Yearly maintenance: Yearly maintenance would be carried out by the manufacturer. This maintenance would involve disassembly of the complete UAS and overhaul of each component. All the mechanical and electronic components would be stringently examined for any deformation, either structurally or in performance.

Every maintenance performed, either by user, pilot or manufacturer, must be recorded in the maintenance logbook. Maintaining a maintenance logbook will help the manufacturer to keep track of the component health and process cycles the UAS has undergone. Necessary actions could be taken by the manufacturer during the yearly maintenance overhaul.

5.1 Post Flight Maintenance:

5.1.1 Basic post-flight checks

Ensure that the battery is disconnected and check for battery or motor abnormal heating. Clean the UAS after every flight. Put on the propeller guards. Check the UAS for any physical damage. Put the propeller guards back on so that the propellers are not damaged while transportation. Inspect overall UAS visually for any physical damage. Fill up the operational logbook. Ensure that the motor power cables are not kinked while folding or unfolding.

5.1.2 Propeller state

Ensure that the propellers are not broken, or have a crack. Ensure that propeller has a smooth surface and no foreign object is present on the propeller. If in case of any physical damage, especially in case of a crash, replace the propeller with a new set of propellers.

5.1.2.1 Propeller Replacement

The M3 Allen key must be used to unscrew the M3*10 fasteners and remove the propeller & propeller mount. Place a new pair of propeller and propeller mount of same configuration and screw the M3*10 fasteners. If the fasteners are worn out, change the fasteners with exact same fasteners. Ensure that CW propeller is replaced only with CW propeller. Similarly, ensure that the CCW propeller is replaced with CCW propeller only.



Figure 3: Propeller Replacement

5.1.3 Motor-Propeller fitment

Ensure that the motor propeller fitment is intact. There is no visible gap between motor top surface and propeller bottom mount. Ensure that the propeller-to-propeller mount fasteners are tight enough and that the motor to propeller mount fasteners are tight enough. If deviation is found, unmount the propeller and mount again using the M3 Allen key, if the gap is still observed, replace the propeller. Refer to section 5.1.2.1 for propeller replacement procedure.

5.1.4 Leakage through spraying system pipes

Ensure that agrochemical being used is not leaking through the spraying system pipe. Also, ensure that the pipe connections are secure enough so that the agrochemical is not spilled over at place when the UAS is stationary. If a leak is found, check if the leak is through the connection or in between a pipe. The leak in connector can be attempted to eliminate by removing and inserting into the connector again, which, if does not stop the leak, the connector needs to be replaced. Contact Manufacturer for spare connectors.

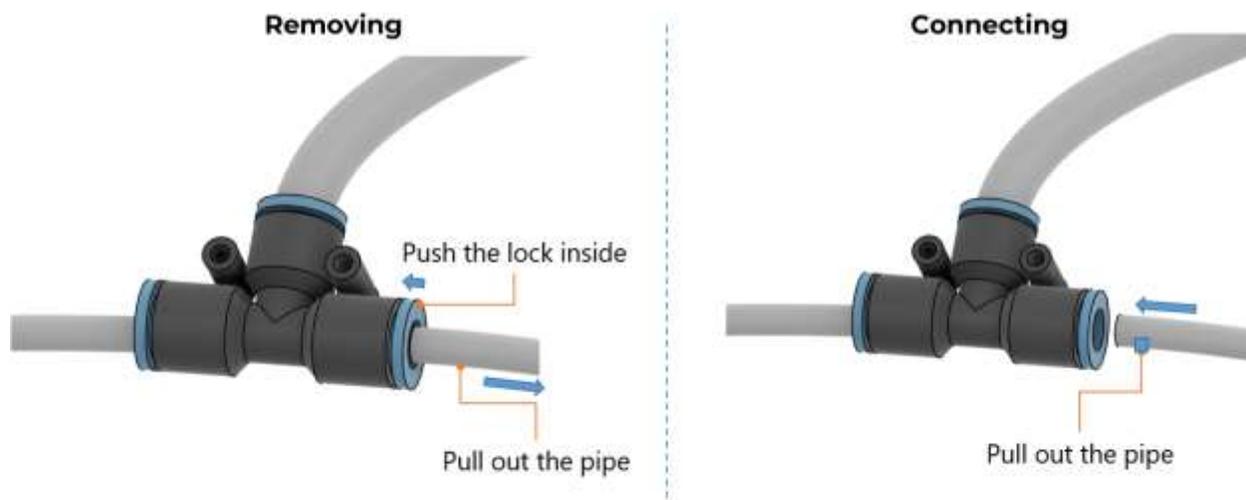


Figure 4: Reconnecting Connector

If the leak is observed to be in the pipe, *temporarily* seal the pipe with a leak proof tape and contact the manufacturer for replacement of pipe.

This is applicable to all the payload connectors included in payload assembly as shown in Figure 5 and Figure 6.



Figure 5: Payload Schematic for Centrifugal atomizer

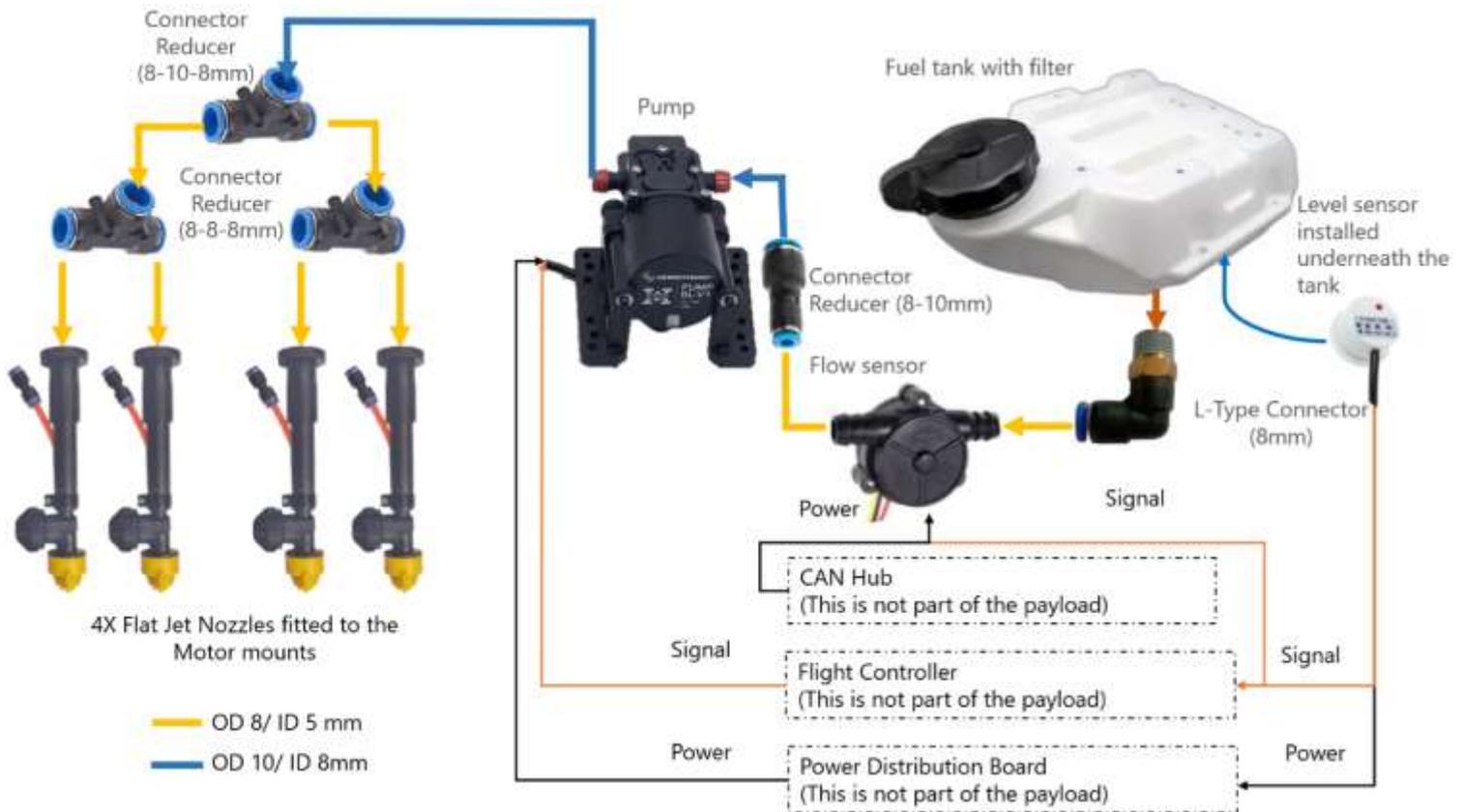


Figure 6: Payload Schematic for Flat jet

5.1.5 Landing gear anomalies

Ensure that the landing gear is not deformed or deteriorated due to hard landings. Check that the landing gear alignment is proper and the fasteners on the leg connectors are tight enough. Also, ensure that the landing gear is not bending on any part. If the landing gear fasteners are loose, tighten them with appropriate Allen key (M3). If any physical damage or deformation is observed, ground the UAS until maintenance. Contact manufacturer for inspection and replacement if required.

5.1.6 Empty agrochemical tank

Pour out agrochemical from the tank if any volume is remaining. A basic rinse from the water would ensure that the chemical remains of the agrochemical is washed out so that it won't react with the tank and potentially create surface thinning.



Ensure the traces of pesticides are cleaned and drained off as per the local rules and regulations. Ensure safety of personnel handling the pesticides, read the safety instructions of the respective chemicals.

5.1.7 Battery straps

Check that the batteries are held in position and battery straps are not loose. After the batteries are charged, ensure that the battery plate is present between the tank and the batteries.

5.1.8 Loose Fasteners

Check that all the Fasteners are secured correctly and that there are no loose fasteners. Use Nylok nuts or use Thread Locker Anabond 112 (activator not required) on blind fasteners to prevent them loosening.

5.2 Weekly Maintenance

5.2.1 Clean the spray system

Clean the spray system filters present in the tank. The filter can be removed easily once the tank cap is opened. Remove the filter and clean it with water. Also, clean the pipes from agrochemical residual by filling up the tank with clean water and running the pump.

Ensure the traces of pesticides are cleaned and drained off as per the local rules and regulations. Ensure safety of personnel handling the pesticides, read the safety instructions of the respective chemicals.

5.2.2 Check for corrosion

Check all the system, especially fasteners for corrosion. If any corroded component is found report to the manufacturer. If any corroded fastener is found, replace the fastener with exact same spare fastener.

5.2.3 Remove Nozzle Blockages

Ensure that the nozzles are not blocked. Remove the flat jet nozzles, open the knob and run a water jet through the nozzle. Immerse the flat jet nozzles in water completely for 2 minutes and attach back the nozzle to check if the any blockage is observed. For centrifugal nozzle, run the nozzle with clean water for about a minute at maximum pump throttle.

5.2.4 Inspect the tank for leakage

Certain concentrated agrochemical might react with the tank to deteriorate the tank walls. Inspect the tank for such leaks. Fill up tank completely up to 10 L and leave the UAS for couple of hours. Check the UAS vicinity for any water running by or check the tank water level. If the level is below 10 L, inspect for the wet region on the tank on the outer side and stop the leakage using a leak proof tape *temporarily*. Contact the manufacturer if a leak is found for a replacement of tank.



User must not attempt replacement or removal of tank at any point of time.
The tank replacement or removal must be done by company official only.

5.2.5 Check for motor alignment

Ensure that the motor alignment is normal to the ground. A marking on the arm assembly denotes the motor alignment. Ensure that the two lines are collinear. If deviation is observed, loosen the arm assembly fasteners, align the lines and re-tighten the fasteners.

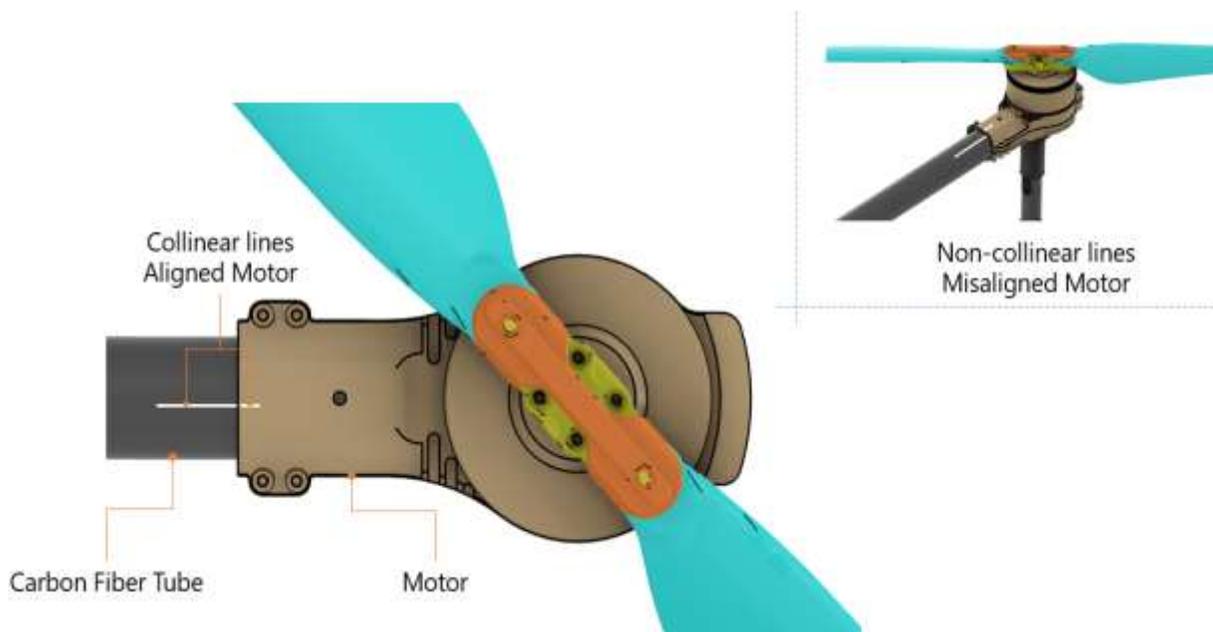


Figure 7: Motor Alignment Marking

5.2.6 Check for wires and pipe routings

Ensure that the wires and pipes are intact to their respective positions. Check that the wires and pipes are routed through the respective holders. Ensure that no wires or pipes are displaced, especially in the vicinity to the radars and nozzles. Wires and pipes should be routed as shown in Annexure A and B.

5.2.7 Secure connectors and mounts

Ensure that all the connector and mounts are securely holding the components and airframe. Tighten the fasteners with thread locking compound if required. Make sure that the fasteners are not overtightened to avoid extra stress in components.

Extra attention must be given to fasteners of primary structural elements (PSEs). A list of primary structural elements (PSEs) is given in Table 4 and the location for PSEs is shown in Figure 8.

SI	Name	Part No	Quantity	Material
----	------	---------	----------	----------

1	Carbon Fiber Tube	NL_AGU_A10_1011	6	Carbon Fiber
2	Carbon Fiber Tube Rectangular	NL_AGU_A10_1012	6	Carbon Fiber
3	Landing Gear Tube	NL_AGU_A10_4001	4	Aluminium 6061 T6
4	Landing gear skid tube	NL_AGU_A10_4003	2	Carbon Fiber
5	Landing gear Mount	NL_AGU_A10_4004	4	Aluminium 6061 T6
6	Landing gear tank mount	NL_AGU_A10_4005	4	Aluminium 6061 T6
7	Bottom Plate	NL_AGU_A10_2021	1	Carbon Fiber
8	Top Plate	NL_AGU_A10_2022	1	Carbon Fiber

Table 4: List of PSEs

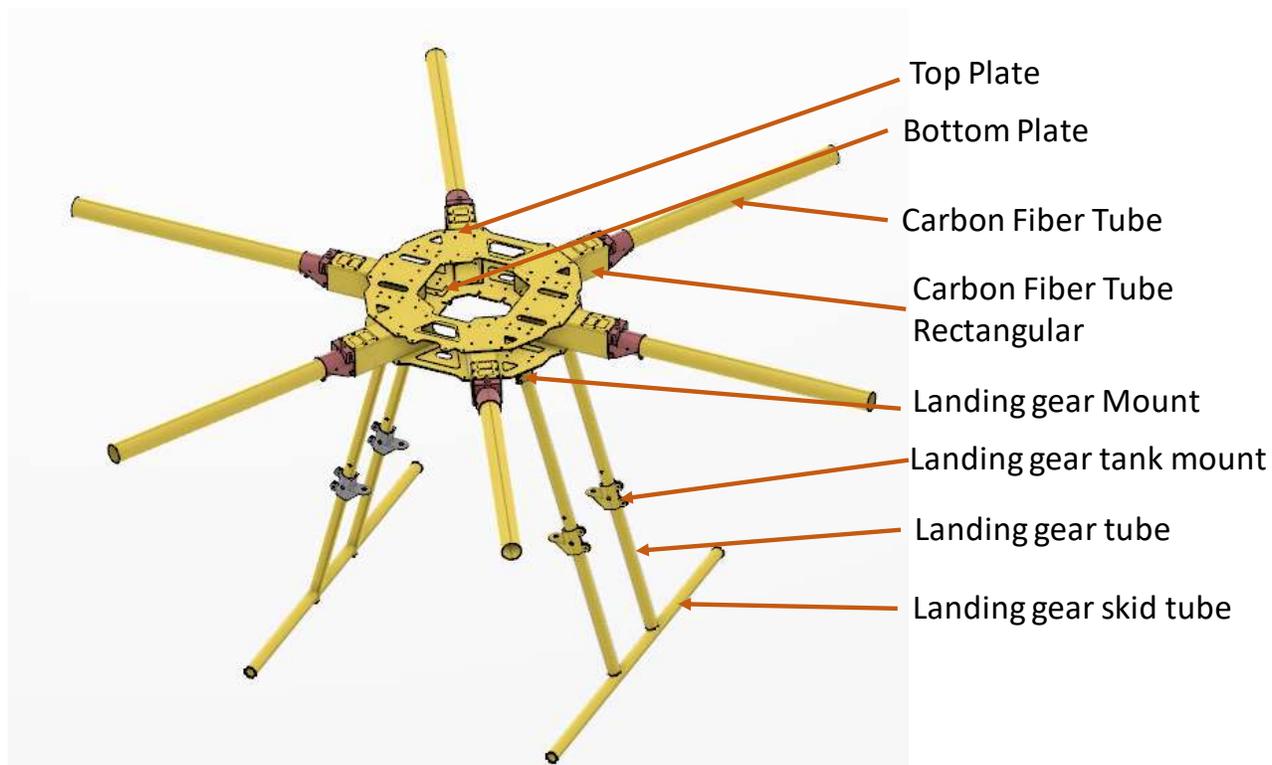


Figure 8: PSEs in Airframe Assembly

5.2.8 Propeller Replacement Post Life

Propeller Life is stated to be 500 hours. Once the propellers life is completed, it should not be used past the propeller life. Propellers can be replaced with ease using a M3 Allen Key. Propeller rotation direction must be same before and after replacement. Refer to section 5.1.2.1 for propeller replacement procedure.

5.3 Half Yearly Maintenance

The following operations require removing the tamper proof cover of the UA and shall only be performed by the manufacturer or an authorized service center.

5.3.1 Dismantle the subassembly

Dismantle to the subassembly level to access individual assemblies. Check if any subassembly is damaged. The components are inspected for any physical damage. Check for internal fasteners and tighten them if required.

5.3.2 Assembly wiring and electronic components

Check that the electronic components are not damaged. Ensure that the connectors are not loose, if found, remove the connector and replace with a new connector, especially battery connectors.

5.3.3 Heating inspection

Ensure that the electronic components and battery are not overheating. Check for any heat traces or burn marks near electronic components. Ensure that the wires are not leaving any heating traces. If any component is showing heating issues, replace the component. If wires are showing heating issues replace the wires, similarly, if the batteries are showing heating issues, replace the batteries (also verify from battery logbook).

5.3.4 Landing gear deformation

Check that the landing gear is not deformed or bent due to hard landings. If some anomaly in landing gear is observed replace the component. Inspect for any physical

damage such as cracks or bend on the carbon fiber tubes in landing gear. If found, replace the landing gear tubes.

5.3.5 Battery Check

Perform a battery charge and discharge test and note down the time taken for battery charge and discharge for UAS battery as well as Radio controller battery. If the time taken by battery for charging or discharging has deviated from datasheet, change the batteries. Also, inspect the batteries for bulges or heating traces, which, if found, replace the batteries and dispose the original batteries.

5.3.6 Arm assembly checks

Check that the propulsion system state is normal. Ensure that the folding mechanism does not have any physical damage and that the folding-unfolding is not very loose. Remove the propeller and check for the folding mechanism of the propeller. Change the propeller set and ensure that the propeller set has been changed by the user once. Perform an empty motor test on 100% throttle and ensure that the motor does not make any abnormal sound or has resistance, and run on an approximate maximum RPM of 5500 RPM. Inspect for any physical damage such as cracks or bend on the carbon fiber tubes on arm. If found, replace the arm tubes.

5.3.7 Check for any hardware tamper

Check that the void tape is still intact. Remove the existing void tape, clean the components using acetone and apply a new void tape. Check that the thread locker and araldite are still intact and the tamper avoidance casing is not breached. If any anomaly is found, check the flight logs for any possible crash potentially causing the hardware tamper. If no such crash is found, record the UAS as tampered.

5.4 Yearly Maintenance

The following operations require removing the tamper proof cover of the UA and shall only be performed by the manufacturer or an authorized service center.

5.4.1 Deformation of plastic components

Check if the plastic components are deformed or damaged. Check for flight controller casing. If found broken, check the logs for any crash potentially causing damage. If crash is found, replace the 3D printed component, else mark the UAS as tampered.

5.4.2 Electronic systems and peripherals

Check the electronic components, peripherals and sensors for any malfunction. Test the components on calibrated systems and re-calibrate the components if required. If the component is malfunctioning or successful calibration cannot be performed, replace the component.

5.4.3 Disassemble on part level

Disassemble the UAS to individual part level and inspect each component for physical damage or deformation. Ensure that no corrosion has occurred on any component. If any physical damage, deformation or corrosion is observed replace the component.

5.4.4 Navigational and indicator lights

Check if the navigation lights on the motors are working as intended. Ensure that the indicator lights on GNSS are working properly. If any deviation from desired behavior is found, replace the component.

5.4.5 Connectivity range test

Perform a connectivity range test. For a distance of 100 m, if the data link range is found to drop drastically, the radio controller and receiver pair must be replaced. The replacement

5.4.6 Check Motor Alignments

Motors should be always facing directly upwards. A slight deviation from the upwards facing direction of motors would cause force vectoring and imbalance during flight. Motor alignment during frequent maintenance (weekly maintenance) can be done using the alignment reference line on motor and carbon fiber tube, but this alignment reference line must be again calibrated with spirit level during major maintenance (Yearly maintenance).

6. Unscheduled Maintenance

User can keep the UAS from being damaged or showing errors by following the scheduled maintenance to ensure prolonged use of the UAS. Sometimes, even after scheduled maintenance, some components could be damaged or malfunction between the intervals of scheduled inspections. These malfunctions can completely ground the UAS or even worse, can result in a catastrophic damage or crash if operated in malfunctioned state.

It is important to keep an eye out on each UA component, especially critical components for damage and get the parts replaced if damaged between scheduled inspections or scheduled maintenance intervals.

There is no specific timeline on which this maintenance has to be carried out. It should be a continuous process. This type of maintenance has to be carried out as soon as the component gets damaged and since it is especially applicable to critical components, it is recommended the user, operator or pilot should not try to fly or power on the UA in such condition even if the UA is capable of powering on.

The critical components identified by the manufacturer are:

- Mechanical Components:
 - Arm Connectors: The three types of landing gear mounts – Landing gear mount, Tank Connector & Tee joint undergo huge stress values during landing cycle of the UA. Furthermore, these connectors are used to hold on the landing gear arms.
 - Landing Gear Arms: Landing gear arms experience compression when the UA is landing and the weight of the UA is also resting on these landing gear arms, which makes them vulnerable to damage on prolonged usage. These landing gear arms also play an important role in landing the UA in stable condition, making it a critical component.
 - Arms: The six arms of the UA bear all the thrust load of the UA. This thrust load is also variable and continuously acting on the UA when airborne. Slight

deviation in shape or size of these arms can result in imbalanced moments, causing an uncontrollable flight and losing stability.

- Folding Mechanism: The folding mechanism keeps the arms in unfolded condition. A broken folding mechanism might result in bending or folding of the arm and the thrust would
- Electronic Components:
 - Mission Management Computer: This component helps the UA to take decisions during flight. Failure of such a component can make the UA behave in unpredictable ways. The Mission Management Computer must be in functional state with all the sensors (Barometer, Compass, IMU, etc.) in working state for UA to work properly.
 - GNSS: The UA mainly rely on MMC and GNSS for estimating its position in 3D space and make maneuvers based on real-time position. Furthermore, the GNSS is the primary source of getting position. The UA might incorporate errors in the maneuvers when the GNSS is malfunctioning which might lead to crash.
 - Telemetry: UA needs to constantly be connected to a UCS and be in a closed feedback loop not only to feed the UCS with real-time flight parameters, which can be looked upon by the pilot to take flight decisions, but also to receive commands from UCS. Failure in doing so might result in uncontrollable flight.
 - Radar: The two types of radars used in Leap A10 makes detect and avoid feature available to the UAS. Obstacle Detection Radar and Radar Altimeter are used for this feature. If certain radar is failed, consequently, the UAS might fail to detect an obstacle or the terrain altitude, potentially causing a crash.

- Pump: Pump is used to enable the fluid (agrochemical) flow through the spray system. It supplies the nozzles which are placed at a higher altitude as compared to tank with this fluid. Failure in such a system would result in making the UA unusable as the primary agenda of flying an agri-drone is to spray agrochemical.
- Camera: Camera helps the pilot to fly the UAS even if it is not in visual line of sight (while it is connected to through the telemetry). If camera fails, pilot would not be able to fly it in conditions where the arming location and mission location are far away.
- Power Brick: Power brick supplies power to the MMC, without which the UA would not take decisions or provide any feedback on real time state of the UA. Moreover, a faulty power brick might create a power surge mid-flight, which will leave the UA behavior unpredictable.
- Power Distribution Board: Power distribution distributes the battery power between different UA components. It is useful for supplying power to certain critical components such as propulsion system. Without accurate functional of this component, either the performance of the UA might deviate or, even worse, the UA might behave unpredictably
- CAN Hub: CAN hub is the CAN protocol extension being used in the UA to connect both the radars to MMC. This extension is required because the CAN protocol ports available on the MMC are not sufficient for all the peripherals of the UA. If the CAN hub fails, detect and avoid feature of Leap A10 would not function.
- Flow Sensor: Flow sensor is used to detect the consumed fluid data so that the system is aware of the remaining fluid quantity in the tank. Although, this sensor would not cause any catastrophic damage, the sensor is important for full functionality of the UAS.

- Level Sensor: Level sensor is used to detect the presence of fluid in the tank and is used to enhance the efficiency by implementing the RTL capabilities during low tank content. Failure to do so would not cause any catastrophic damage but will surely reduce the functionality of the UAS.
- Safety Switch: Safety switch is the crucial MMC peripheral to command the UAS that it can be safely armed. Failure in the safety switch might keep the UA from arming.
- Buzzer: Most UAS states are conveyed to the pilot using specific buzzer sequences. A pilot must be aware of the state of the UAS, which might miss out if the buzzer is faulty.
- Propulsion System: Propulsion system manufacturer quote a life span of the motor and propeller, after which it is not recommended to use these components. The propulsion system must be swapped out with a new set once the life span is over. Furthermore, crash can damage the motors, which might result in uneven thrust distribution and hence instability. Hard landings can also damage propellers.

All these critical components must be replaced when they show a sign of malfunction. These critical components can also induce problems when the wrongly assembled. Hence, attention needs to be given during replacing the components. A standard operating procedure is established for replacing these components, which must be followed to ensure correct integration with the system.

6.1 Component Replacement Standard Operating Procedure

All the below mentioned component replacement procedures should be done by manufacturers and in the manufacturer's facility only.

The batteries should be disconnected, removed from the system, and stored in a Battery Safety Bag.

It is recommended to unmount the propellers before starting any component replacement procedure. Similarly, removing both flat jet nozzles and centrifugal nozzles from the assembly is advised.

After the component replacement is completed on the UA, the UA must undergo acceptance tests. The acceptant tests after component replacement would be the same as production acceptance test (Refer **NLA-AGU-A10-QAP-3, Page no. 70**). These tests include ground and flight tests, which account for full functionality test of the UA.

6.1.1 Tamper-Proofing Removal Procedure

Wherever mentioned in the process of individual component replacement procedure in Section 6.1, remove the tamperproof casing before beginning the maintenance procedure by following below given steps.

1. Carefully check all tamper proofing components to identify any sign of tampering by the end user.
 - a. Check that the tamper proof box free of any physical or chemical damage.
 - b. Check that the araldite added on the top plate is intact and there is no sign of tampering.
 - c. Check that the void tape is intact and there is no impression of void tape replacement.
2. Remove the void tape simply by peeling off the tape.
3. Heat the araldite placed on the fasteners to remove the araldite and open the fasteners using M3 Allen Key.

4. Take out the tamper proofing box.

6.1.2 Replacing Tamper-Proof Casing

Tamper proof casing needs to be mounted after maintenance procedure has been carried out. To replace the tamper proof casing and other tamper avoidance components, follow the below given procedure

1. Ensure that the complete maintenance procedure has been carried out properly and no steps are incomplete.
2. Clean all required surfaces.
3. Put a "Do Not Open" Sticker on a new tamper proof casing.
4. Put the new tamper proof casing on position and fix it with four new fasteners with Anabond 112. Do not reuse the fasteners that were removed during removal procedure.
5. Put a new void tape on and around tamper proof casing as shown in Figure 49 of NLA-AGU-A10-SYS-ARC document. Apply araldite on the fasteners shown in Figure 49 of NLA-AGU-A10-SYS-ARC document and let dry.
6. Ensure that the tamper proofing is correctly established.

6.1.3 Landing gear mounts and joints

The location of the landing gear mounts and joints are shown in Figure 9.

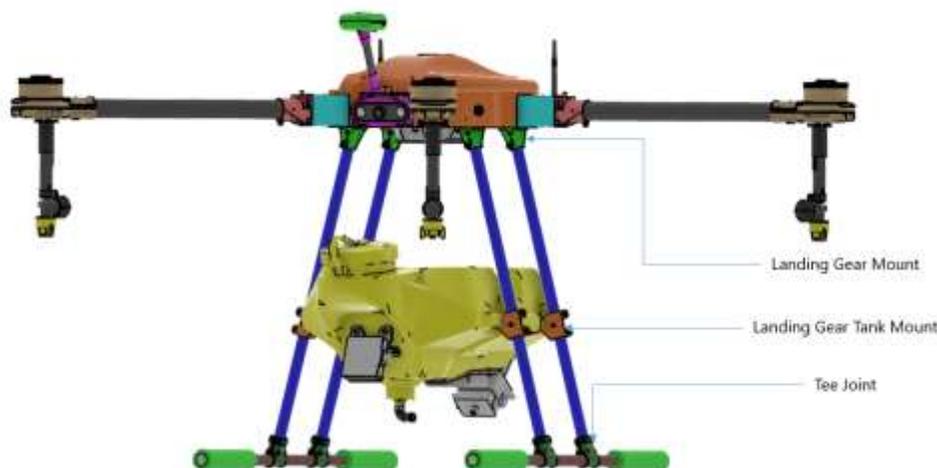


Figure 9: Landing gear mounts and joints location

6.1.3.1 Landing gear mount

Landing gear mount replacement require at least two people. The wires and signal cables for peripherals attached onto the tank keeps the hub assembly to be completely removed and kept aside. A magnetic Allen key is required for replacing landing gear mount without completely disassembling the UA. Follow the steps to replace landing gear mount

1. Remove the receiver antennae by rotating them counter clockwise. Remove the top cover by unbolting the six M2×10 socket head fasteners around the top cover.

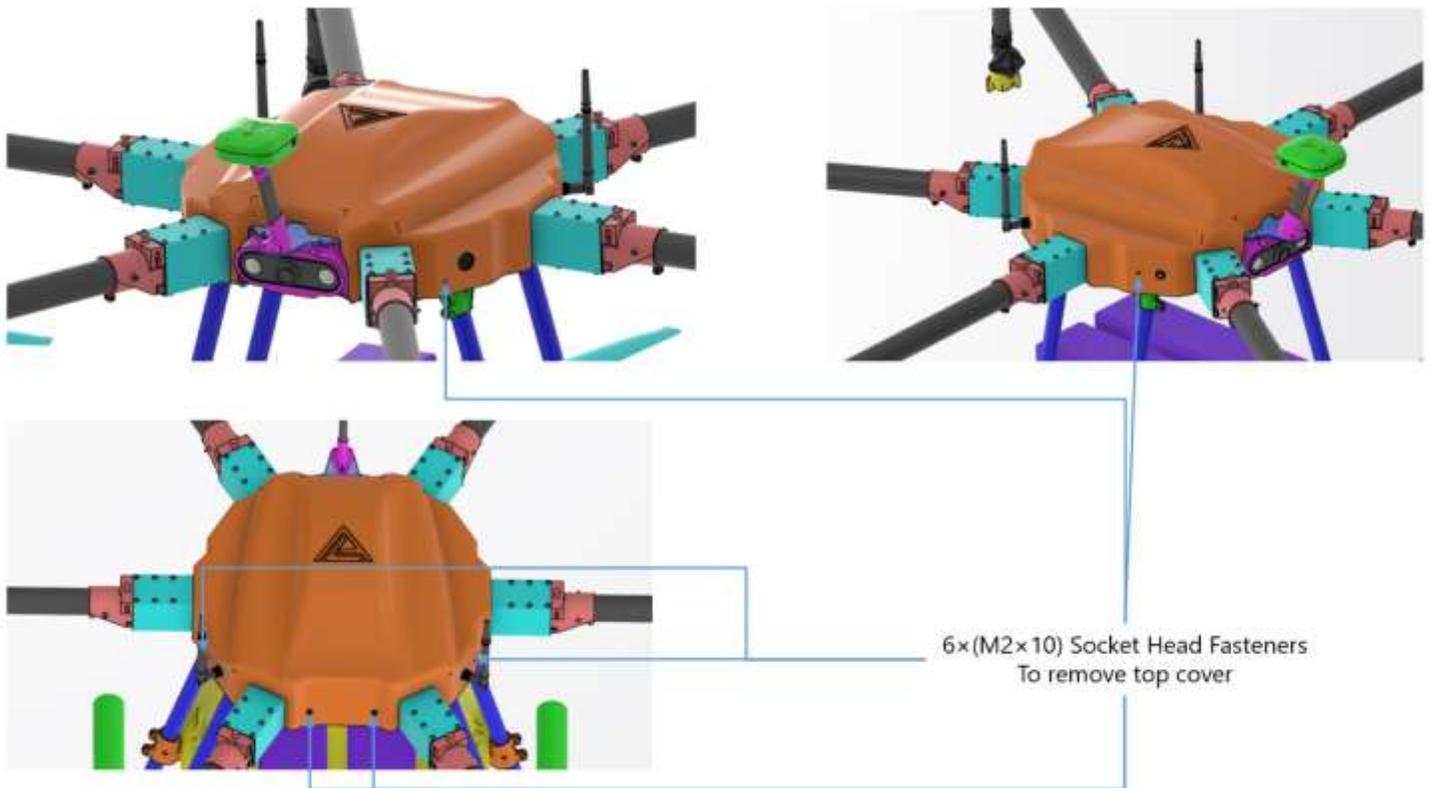


Figure 10: Top cover bolt location

2. Unbolt the M3×30 button head fastener that goes through the landing gear mount and landing gear tube.

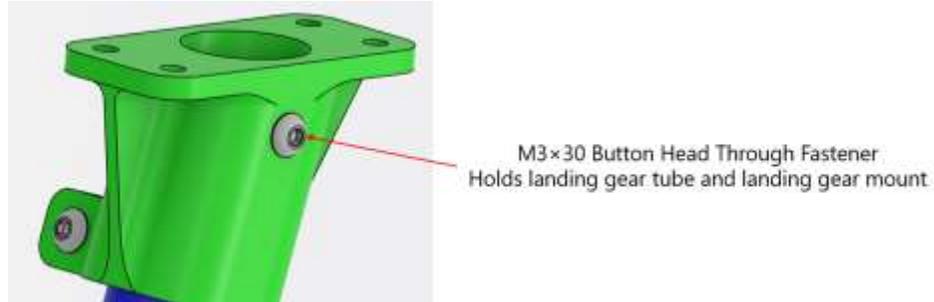


Figure 11: Landing gear mount through fastener location

3. Insert a M3 magnetic Allen key in the bolts of top plate and unbolt the fasteners present underneath the top plate. The hub assembly will come loose and one person needs to hold the hub assembly in air such that the wires and signal cables are just not experiencing tension.

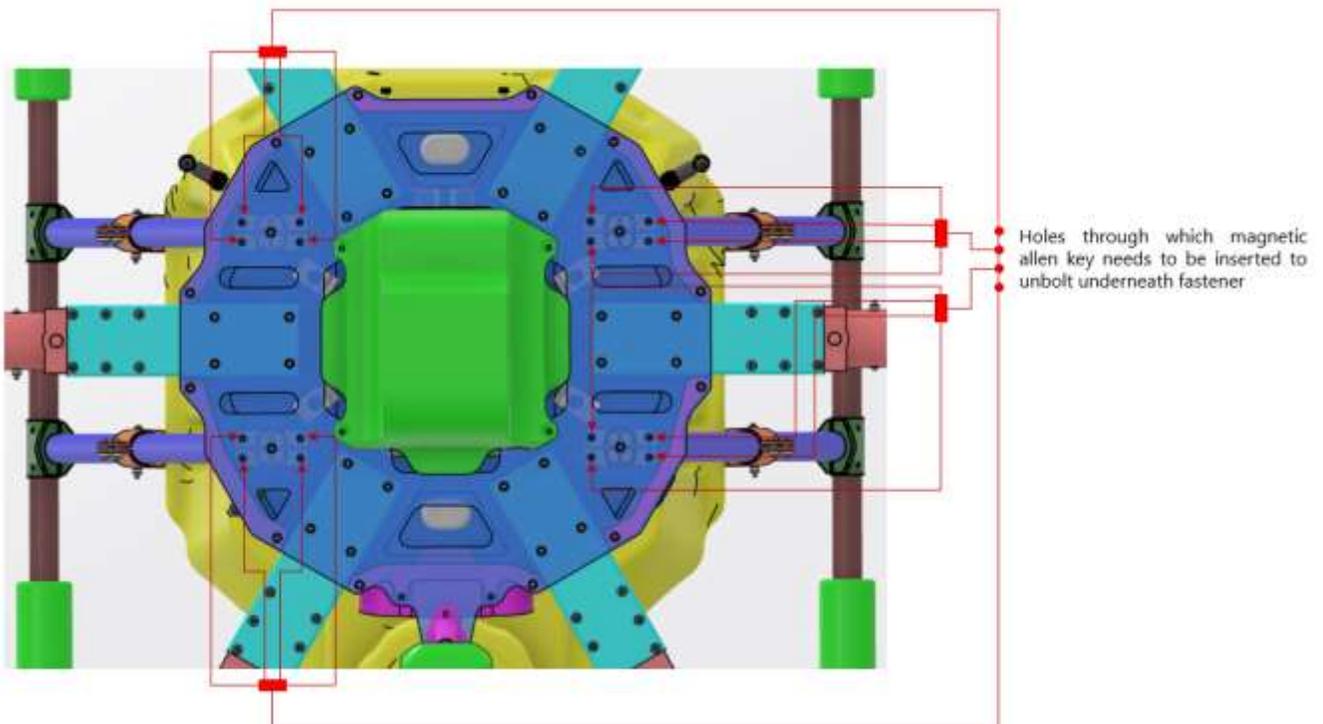


Figure 12: Top plate holes location

- Unbolt the M3×10 button head fasteners present on the side of the landing gear mount and remove the landing gear mount.

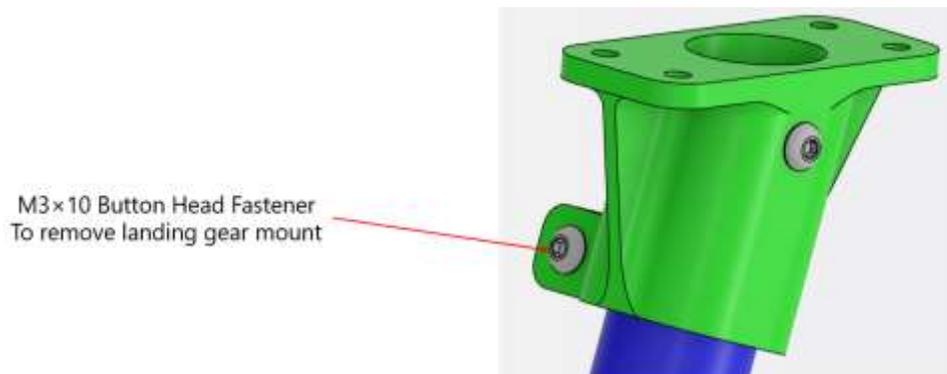


Figure 13: Landing gear mount fastener location

- Place new landing gear mount on landing gear arm such that the angle of the landing gear mount shaft comes in outward direction. Fix the landing gear mount by bolting the M3×10 button head fasteners and M3×30 button head through fastener.

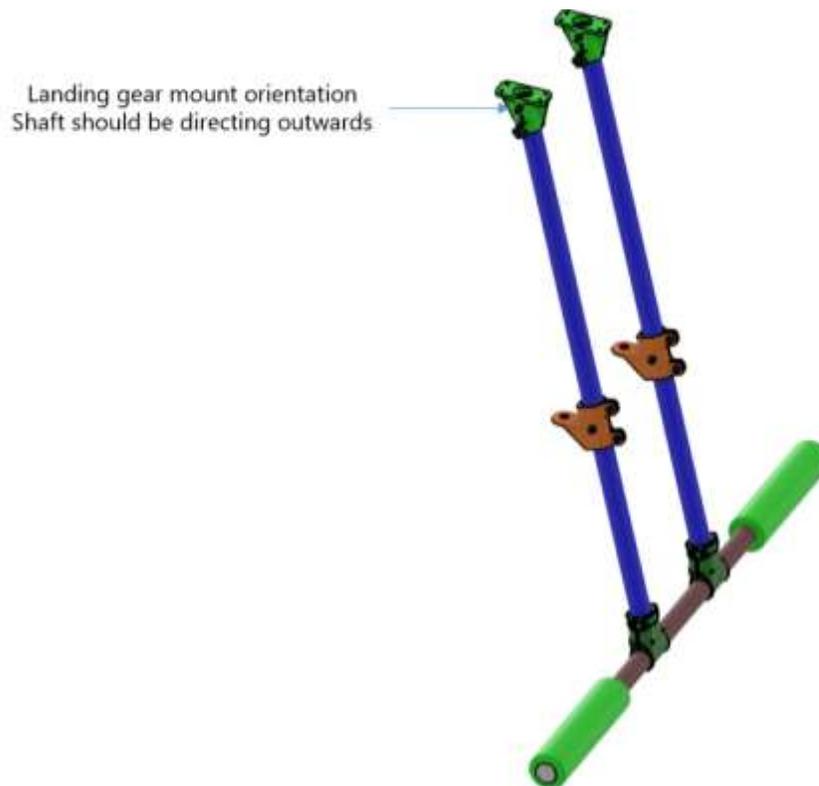


Figure 14: Landing gear mount orientation

6. Place the hub assembly back on the position and using the magnetic Allen key insert and bolt the fasteners that were removed in Step 2 through same holes.
7. Place the top cover in position and fix the same six M2×10 socket head fasteners around the top cover. Put the antennae back into the assembly by rotating the antennae in clockwise direction.

6.1.3.2 Tee joint

Tee joint can be removed by removing the landing gear skid tube consisting the tee joint. At least two people are required for tee joint replacement. Follow the steps to replace the tee joint.

1. Unbolt the four M3×12 socket head fasteners present on the tee joint and remove the landing gear skid tube from the assembly. One person can tilt and hold the UA while other person can remove the landing gear skid tube.

**If a single tee joint has to be removed, unbolt only the upper two M3×12 socket head fasteners present on the other tee-joint. This will keep the second tee-joint undisturbed*

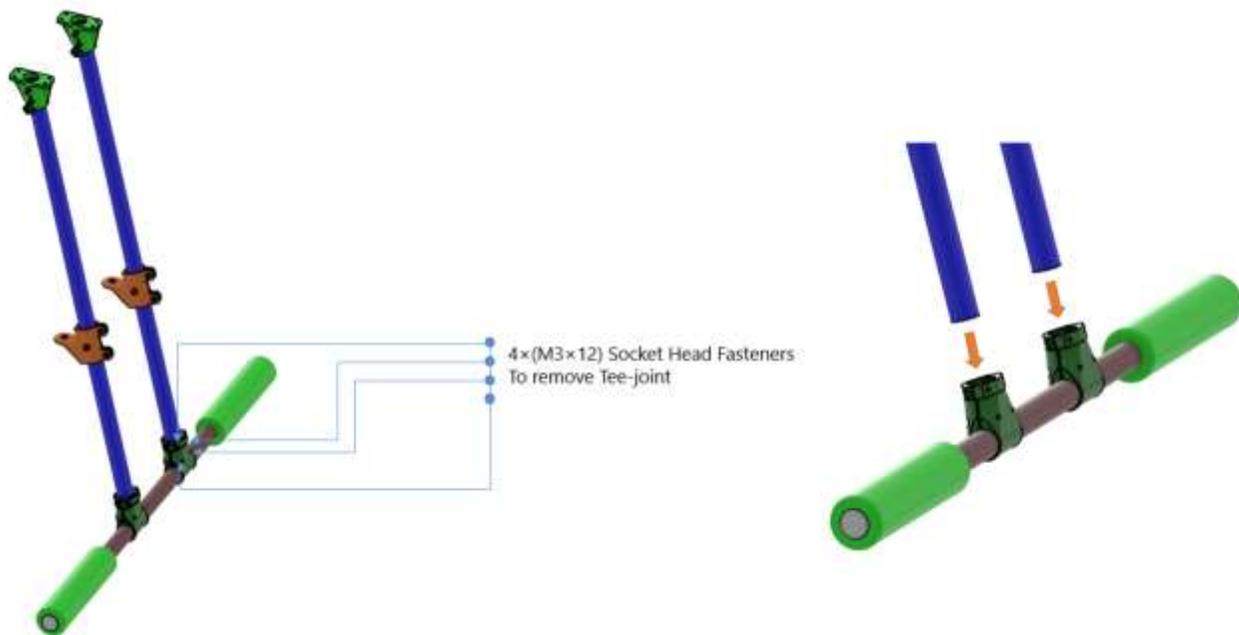


Figure 15: Tee joint fastener location

- Widen the mouth of the tee joint and unclamp the tee joint from the skid arm.

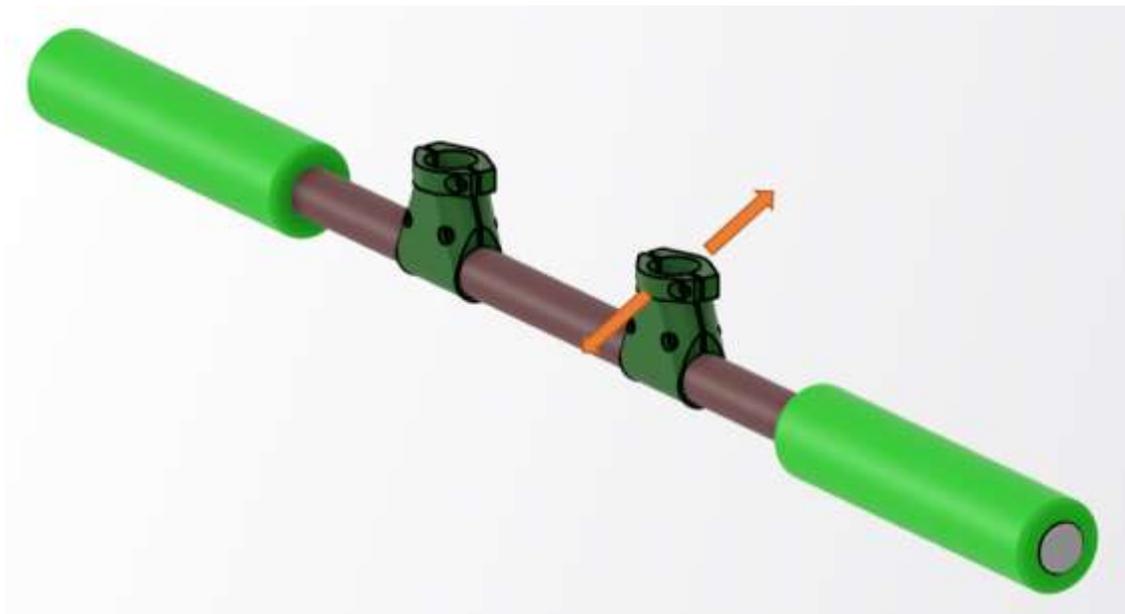


Figure 16: Tee joint mouth

- Clamp a new tee joint such that it is inclined in the inner side of the assembly. If only a single tee joint is replaced, refer the inclination and match with the undisturbed tee joint present on the same landing gear skid tube.

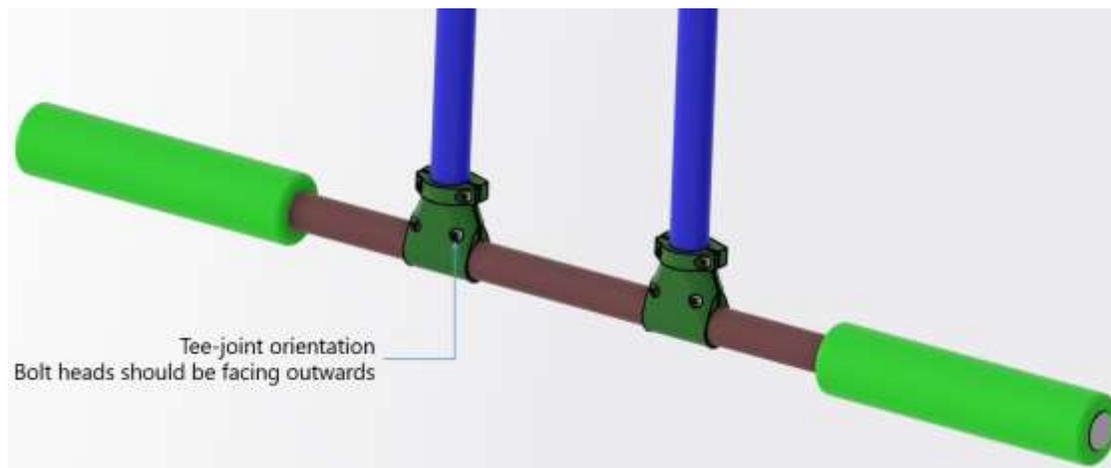


Figure 17: Tee joint orientation

- Insert the tee joint in the LG arm and fix it by bolting the M3×10 socket head fasteners at location shown in Figure 15.

6.1.3.3 Landing gear tank mount

Landing gear tank mount can be removed by removing the landing gear skid tube consisting the tee joint. At least two people are required for landing gear tank mount replacement. Follow the steps to replace landing gear tank mount.

1. Follow Step 1 from section 6.1.3.2.
2. Put a support below the tank such that the support will hold the tank even if the supports are removed. Unbolt the M5×50 fastener holding the tank and the landing gear tank mount.

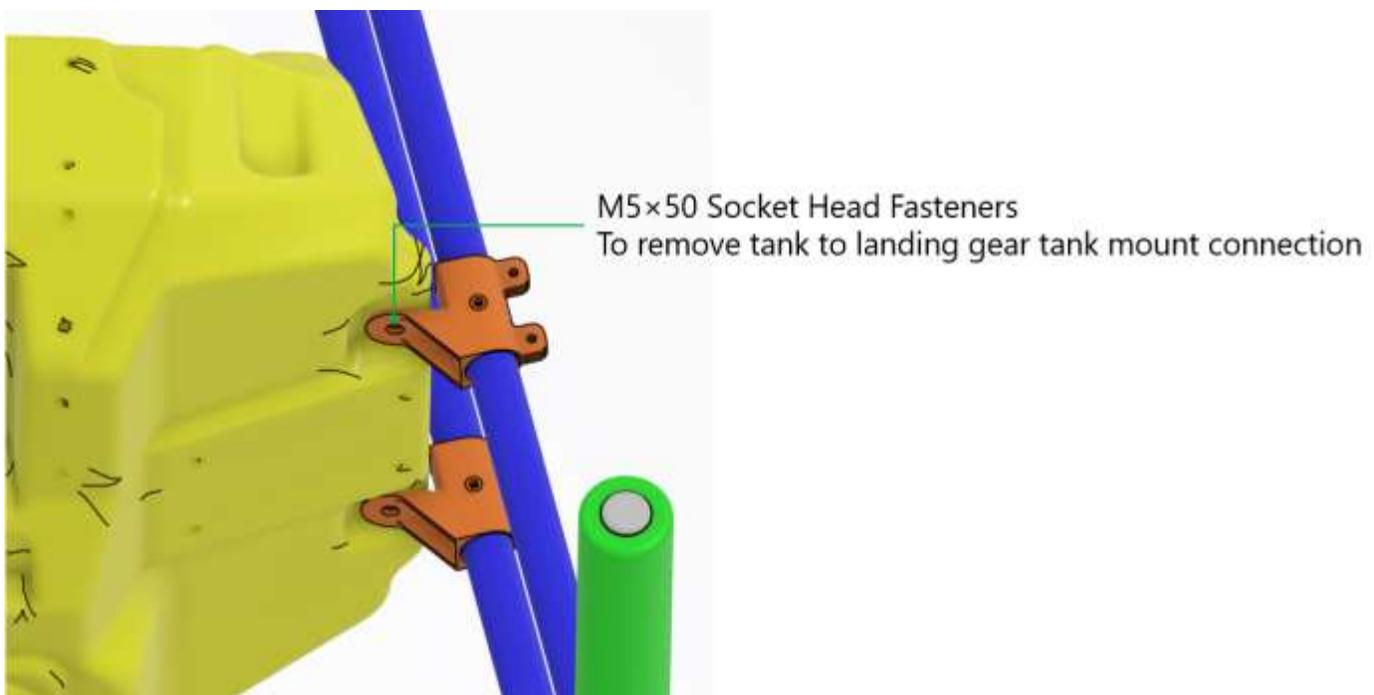


Figure 18: Landing gear tank mount fastener

- Unbolt the M3×10 & M3×30 button head fasteners present on the side of the landing gear tank mount and remove the landing gear tank mount by sliding it out of the landing gear tube from bottom.

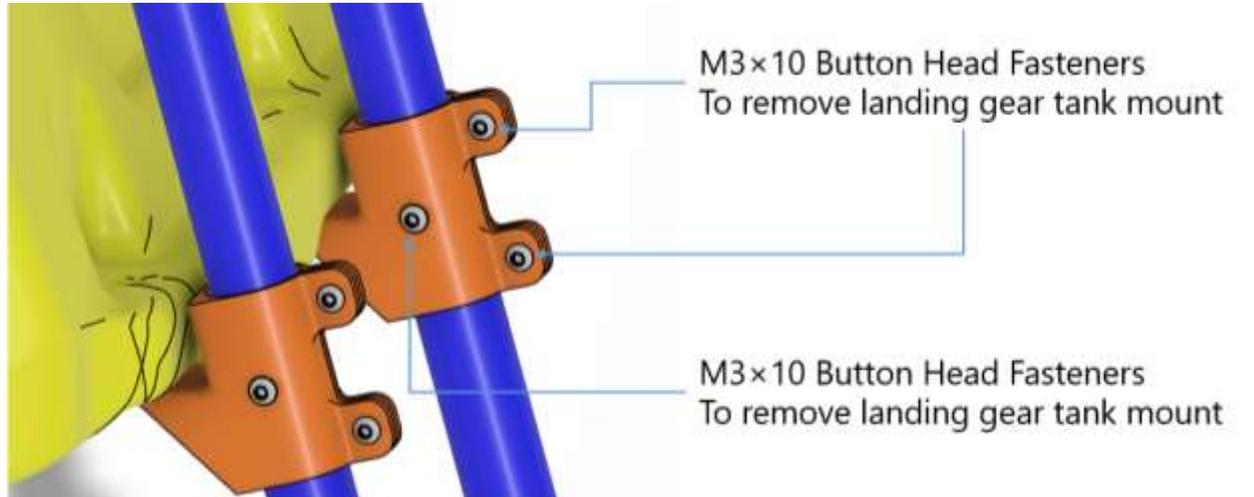


Figure 19: Landing gear tank mount fastener location

- Slide in new landing gear tank mount from bottom on landing gear arm such that the angle of the landing gear tank mount wedge comes in inward direction. Fix the tank connector by bolting the M3×10 & M3×30 button head fasteners.

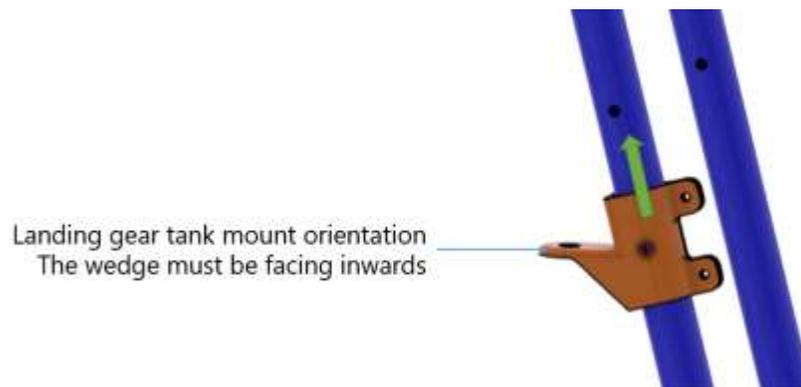


Figure 20: Landing gear tank mount orientation

- Follow step 4 from section 6.1.3.2.

6.1.4 Landing Gear Arms

The location of the landing gear arms is shown in Figure 21

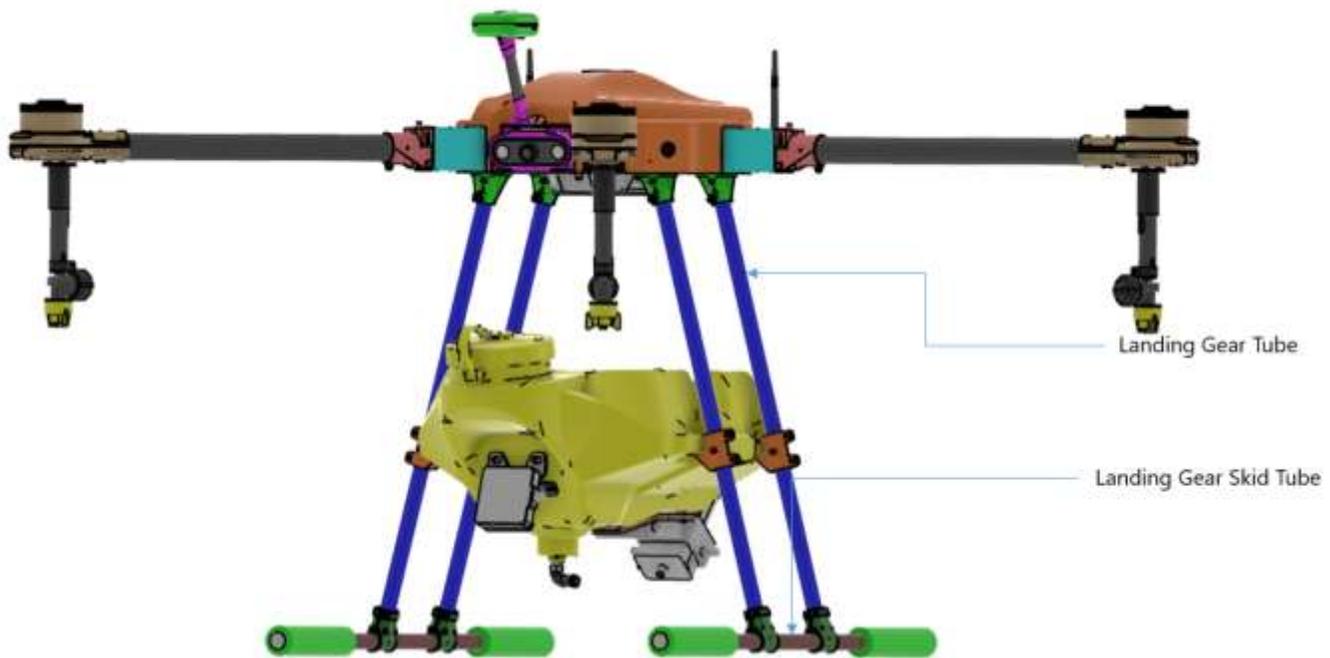


Figure 21: Landing gear arms location

6.1.4.1 Landing Gear Tube

Landing gear tube can be replaced by removing the landing gear skid tube consisting the tee joint and loosening the landing gear mount and landing gear tank mount such that the landing gear tube can slide out of the assembly. At least two people are required for landing gear tube replacement. Follow the steps to replace landing gear tube:

1. Follow Step 1 from section 6.1.3.2.
2. Follow Step 3 from section 6.1.3.3.
3. Follow Step 2 from section 6.1.3.2.
4. One person can hold the UA while other can unbolt the M3×10 socket head fasteners present on the side of the landing gear mount and slide out the landing gear tube from the assembly.

- Slide in a new aluminum tube having dimensions 540×18 mm (Length×OD) through landing gear tank mount and eventually into the landing gear mount.



Figure 22: Aluminium rod in assembly

- Fix the landing gear tube by bolting the M3×10 socket head fasteners and M3×30 socket head through fastener present on the landing gear mount (as shown in Figure 11 & Figure 13)
- Bolt the M3×10 socket head fasteners present on the landing gear tank mount. (as shown in Figure 15)
- Follow step 4 from section 6.1.3.2.

6.1.4.2 Landing Gear Skid Tube

At least two people are required landing gear skid tube replacement. Follow the steps to replace landing gear skid tube.

- Follow Step 1 from section 6.1.3.2.
- Remove both landing gear skid rubber from the assembly by sliding out of the landing gear skid tube. The landing gear skid rubber has less tolerance and hence it must be

pulled out with strong force. One person can hold the landing gear skid tube and other person can pull the landing gear skid rubber.



Figure 23: Remove landing gear skid rubber

3. Follow Step 2 from section 6.1.3.2. for both tee joints.
4. Clamp the two tee joints on a new carbon fiber rod having dimensions 580×18 mm (Length×OD).
5. Put the two-landing gear skid rubber that were removed in Step 2. This process will also require strong force to push the rubber in the landing gear skid tube.
6. Follow step 4 from section 6.1.3.2.

6.1.5 Carbon Fiber Tube

To remove carbon fiber tube on which the motor is mounted, the propulsion system needs to be removed. For this the PDB connections for that particular motor must be removed, which might be difficult for someone having big hands, which is why the central stack of electronics needs to be pushed in the opposite direction. This is done from Step 3, 4 & 12 described below. If the person performing the carbon fiber tube replacement is able to remove the motor to PDB connection, they might Skip steps from 3, 4 & 12.

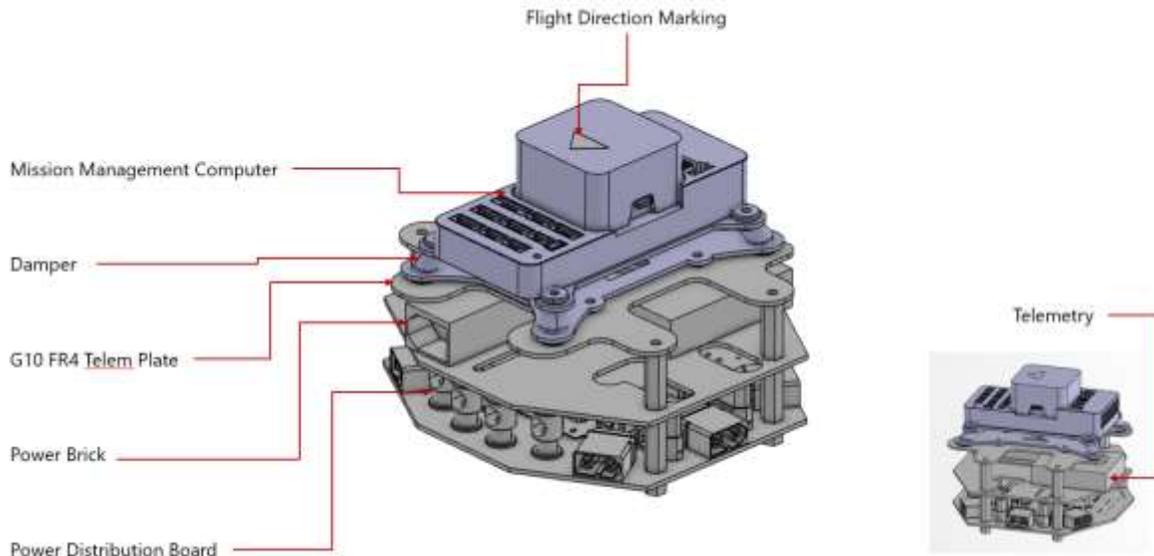


Figure 24: Central electronics stack

**This replacement procedure also needs extra care in identifying the correct motor arm number and its connection to PDB and MMC. Identify the motor arm number based on the front (flight) direction of the UA as given in Figure 25 and check Annexure A – Power Schematic & Annexure B – MMC Signal Schematic for the power and signal connections for that particular motor arm.*

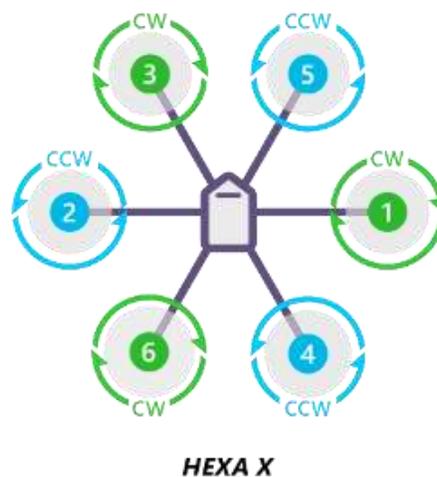


Figure 25: Motor number relative to front (flight) direction of UA

1. Follow Step 1 from Section 6.1.3.1
2. Break-open the tamper proof casing bolts.

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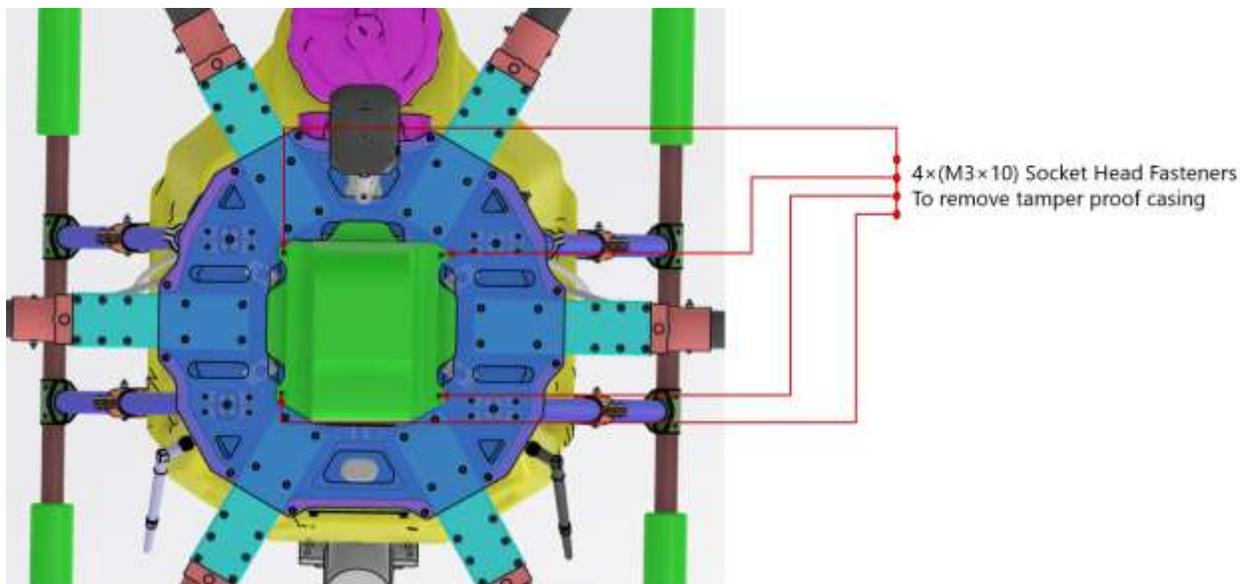


Figure 26: Tamper proof casing fasteners

3. Unbolt the four M3×10 socket head fasteners present on the bottom of the bottom plate securing the central electronics stack in place.
4. The central electronics stack can be moved a little to access the cable wires. Ensure while moving the central electronics stack, wires are not put into high tension.

Bottom View

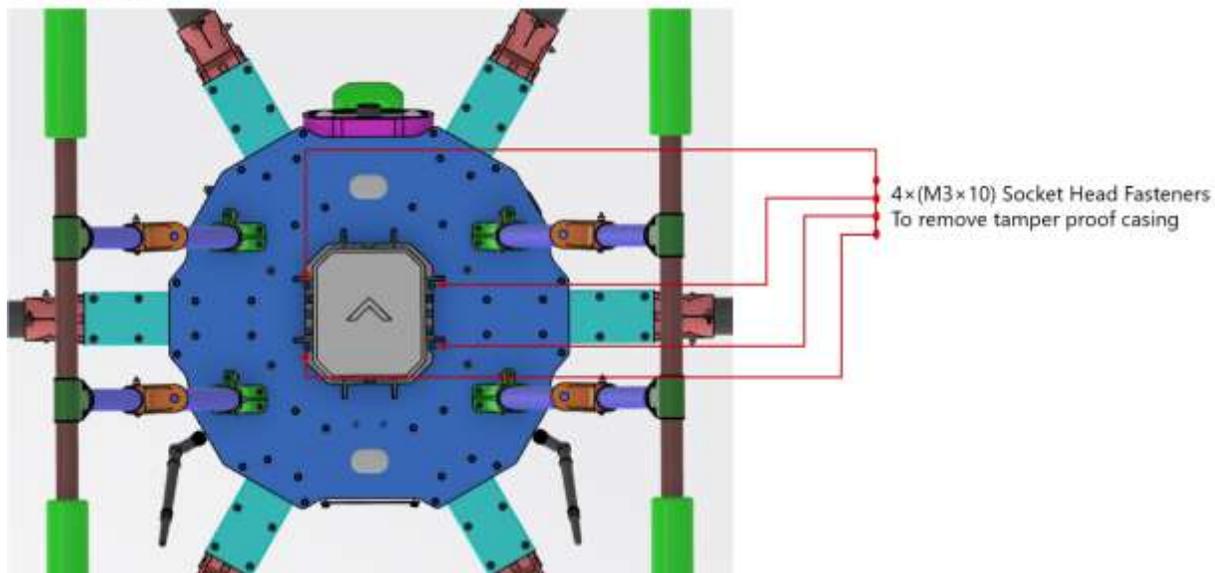


Figure 27: Fastener location securing central electronics stack in place

5. Remove the PDB power connection of the motor which is mounted on the carbon fiber tube being replaced.
6. Remove the MMC signal connection of the motor which is mounted on the carbon fiber tube being replaced and remove the signal wire from the wire holder.
7. Unbolt the M3×35 button head fasteners present side of the folding mechanism and slide out the carbon fiber tube and motor assembly.
8. Loosen the four M3×12 socket head fasteners present on the motor and two M3×10 socket head fasteners present at the bottom of the motor. Remove the motor and motor wire from the carbon fiber tube.
9. Fix the motor onto a new carbon fiber tube having dimensions 406×30 mm (Length×OD). Bolt the M3×12 socket head fasteners present on the motor and two M3×10 socket head fasteners that were removed in Step 8. If the motor arm for motor 1 or 2 is being replaced, ensure that the carbon fiber tube has a hole for centrifugal nozzle mounting.
10. Put the signal and wire cables through folding mechanism and rectangular tube and insert the carbon fiber tube into the folding mechanism. Bolt the M3×35 button head fasteners present side of the folding mechanism.
11. Connect the PDB and MMC connections. Route the signal wire through the outer slot of wire holder small present in the hub assembly and harness holder present against the main and aux pins of MMC.
12. Fix the central electronics stack at its position and bolt the M3×10 socket head fasteners that were removed in Step 4.
13. Fix the tamper proof casing and bolt the M3×10 socket head fasteners that were removed in Step 2. Put thread locking solution in these fasteners, clean the trace left by previously applied void tape using acetone and apply void tape on the tamper proof casing.
14. Follow Step 7 from Section 6.1.3.1

15. Loosen motor fasteners as done in Step 8 and align the motor with the help of spirit level. Align the motor such that it matches the level of ground and the rectangular carbon fiber tube. After aligning, tighten the motor fasteners again.

6.1.6 Folding Mechanism

1. Follow Step 1 to 6 from Section 6.1.5
2. Unbolt six M3×8 button head fasteners present on the carbon fiber tube rectangular and remove the folding mechanism from the assembly.

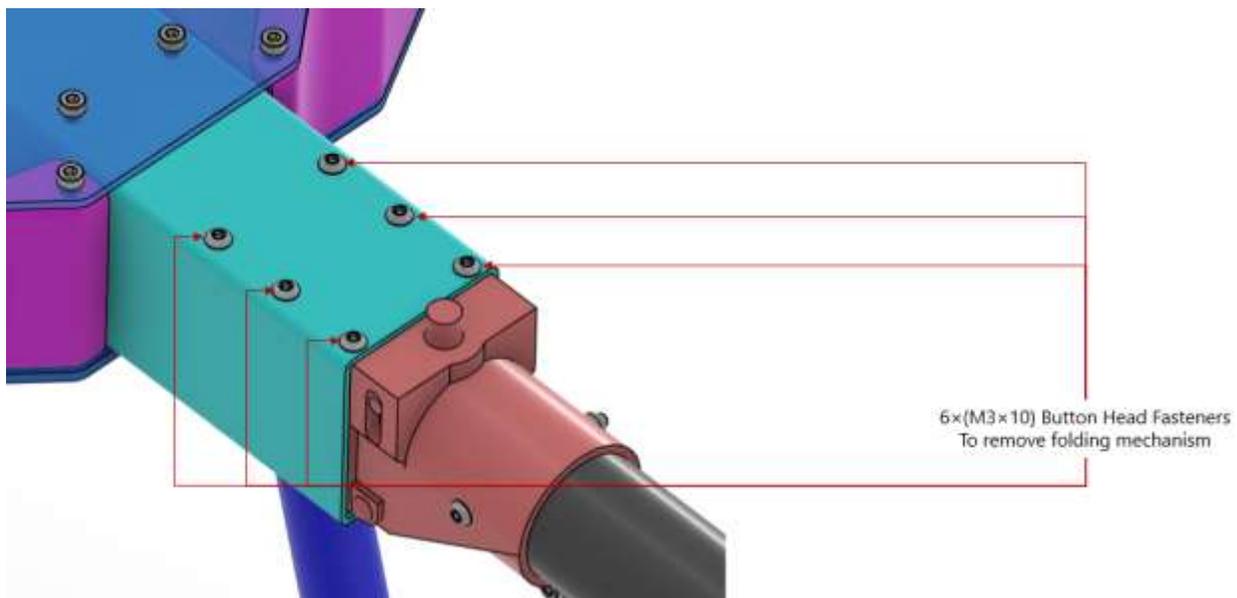


Figure 28: Carbon fiber tube rectangular fastener location

3. Slide in the new folding mechanism in the carbon fiber tube rectangular and fix it by bolting the six M3×8 button head fasteners that were removed in Step 2. Insert the folding mechanism such that the hinge comes on the downward direction.

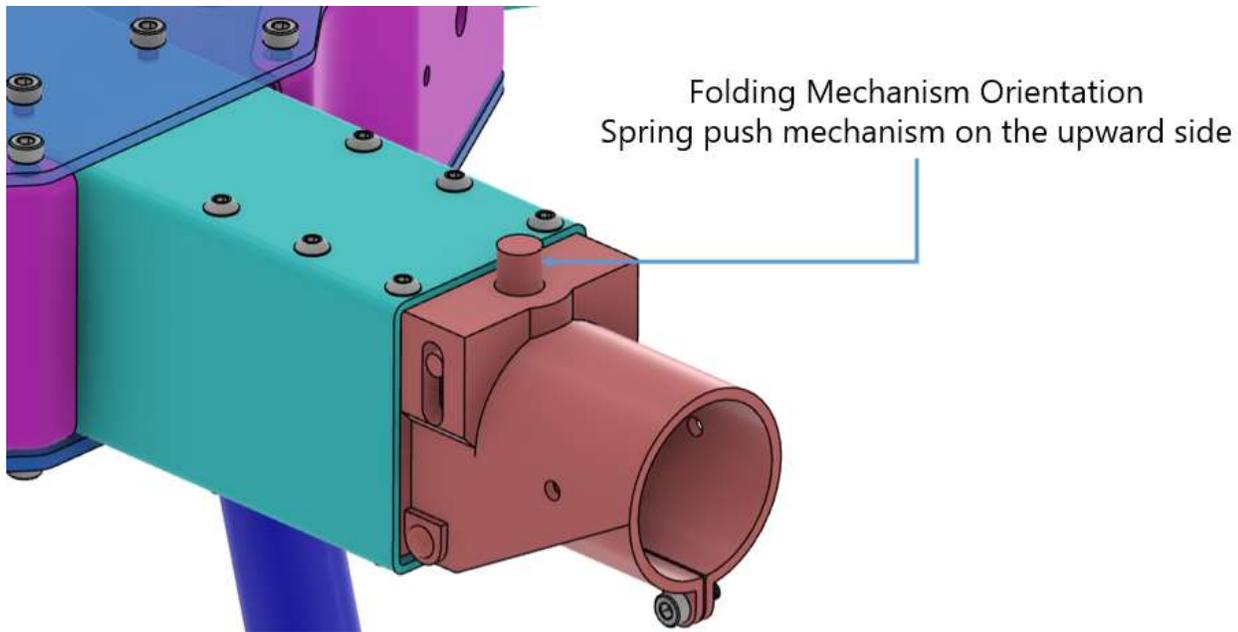


Figure 29: Folding mechanism orientation

4. Follow Step 9 to 14 from Section 6.1.5

6.1.7 Mission Management Computer

Mission management computer can be replaced by single person. Refer to Annexure B – MMC Signal Schematic to identify the signal connections to mission management computer after new MMC is installed. After mission management computer replacement procedure is completed, the UA must be subjected to software test to ensure that each system is working properly.

1. Follow Step 1 and 2 from Section 6.1.5.
2. Remove all the signal connection wire connected to the mission management computer and pull out the mission management computer with force. The 3M tape should also be removed once the MMC comes off. Clean the base on which the mission management computer was fixed (MMC damper) with acetone.
3. Let the acetone vaporize and put a new 3M tape (that came in package with new MMC) at the center of the damper.

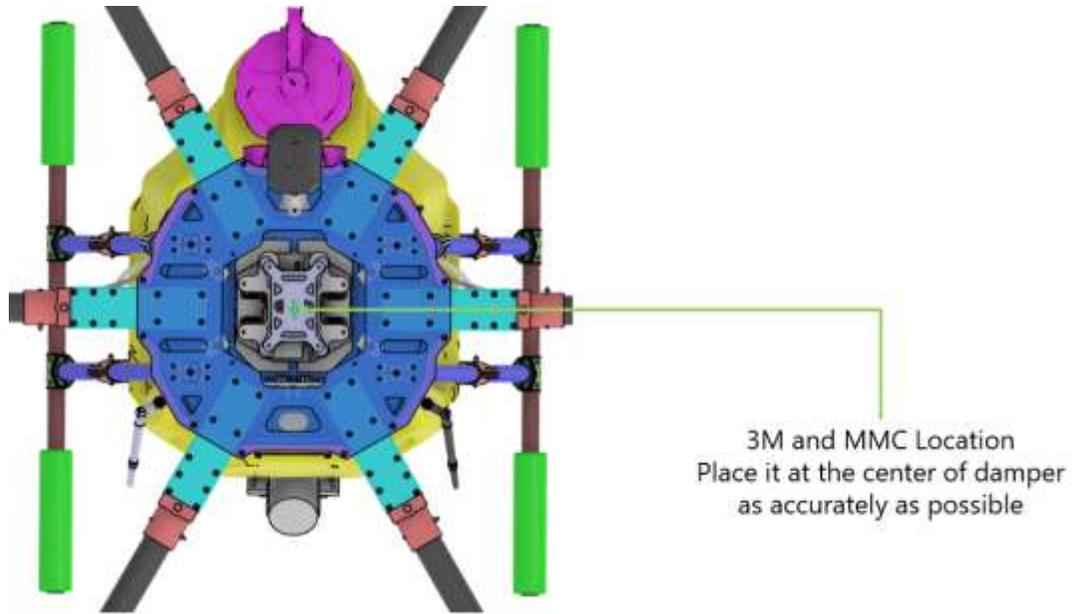


Figure 30: 3M tape and MMC location on damper

4. Place the new mission management computer on the 3M plate such that the center of MMC is lying on the center of the base as accurately as possible and ensure that the orientation of the mission management computer is such that the front direction mark on the MMC cube is pointing towards the flight direction of UA.

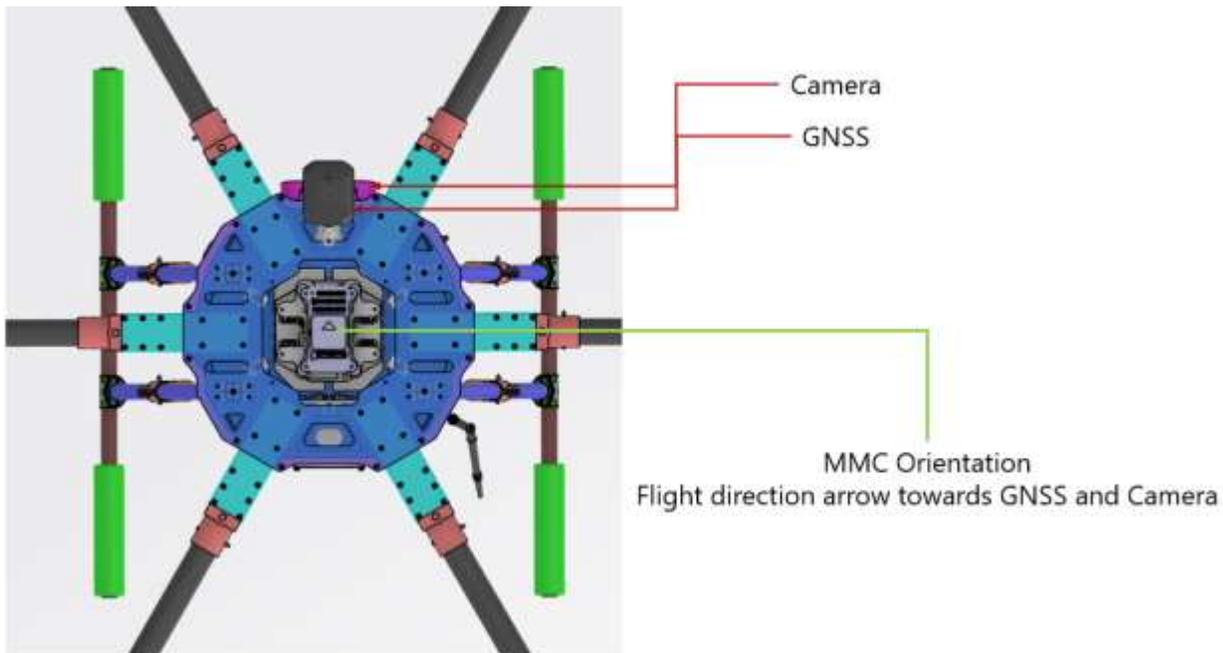


Figure 31: Mission management computer orientation

5. Connect all the signal connections to the MMC according to the signal schematic (refer Annexure B – MMC Signal Schematic).
6. Follow Step 13 and 14 from Section 6.1.5

6.1.8 GNSS

GNSS can be replaced by single person. Refer to Annexure B – MMC Signal Schematic to identify the signal connections to mission management computer after new GNSS is installed. After GNSS replacement procedure is completed, the UA must be subjected to software test to ensure that each system is working properly.

GNSS cannot be removed from the GNSS casing box as it is tamper-proved. The GNSS mount box has to be replaced in order to replace the GNSS.

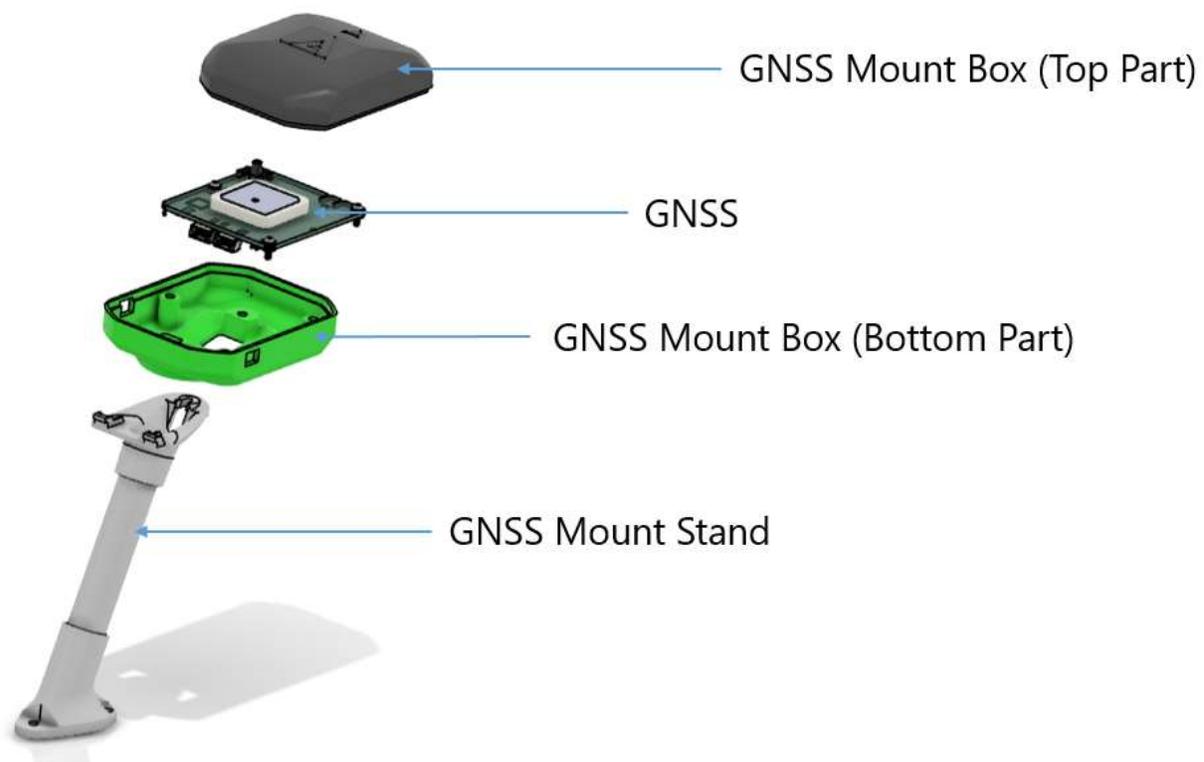


Figure 32: GNSS mount components

1. Follow Step 1 and 2 from Section 6.1.5.
2. Disconnect the GNSS CAN connection from MMC.



Figure 33: GNSS CAN connection in MMC

3. Unbolt the M2×8 socket head fastener present at the bottom of the GNSS mount box. Remove the GNSS mount box and CAN cable.
4. Take the GNSS CAN cable out of the hole present on the bottom part of the GNSS mount box as shown in Figure 34.

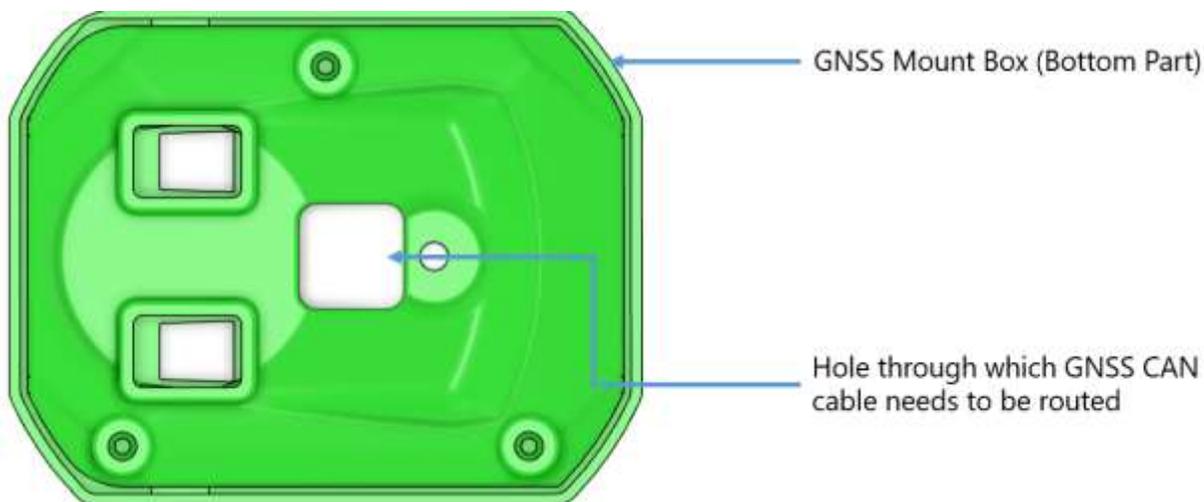


Figure 34: Hole to route GNSS CAN cable

- Put M2 nylon spacers on the three bolting holes of the bottom part of the GNSS mount box. Put a new GNSS into bottom part of the GNSS mount box, such that the three bolting holes on the GNSS match the bolt sockets on the mount box bottom part. The top GNSS should also be facing upwards. Place M2 nylon spacers on the three GNSS holes and bolt the GNSS on the bottom part of mount box with M2×8 socket head fastener.

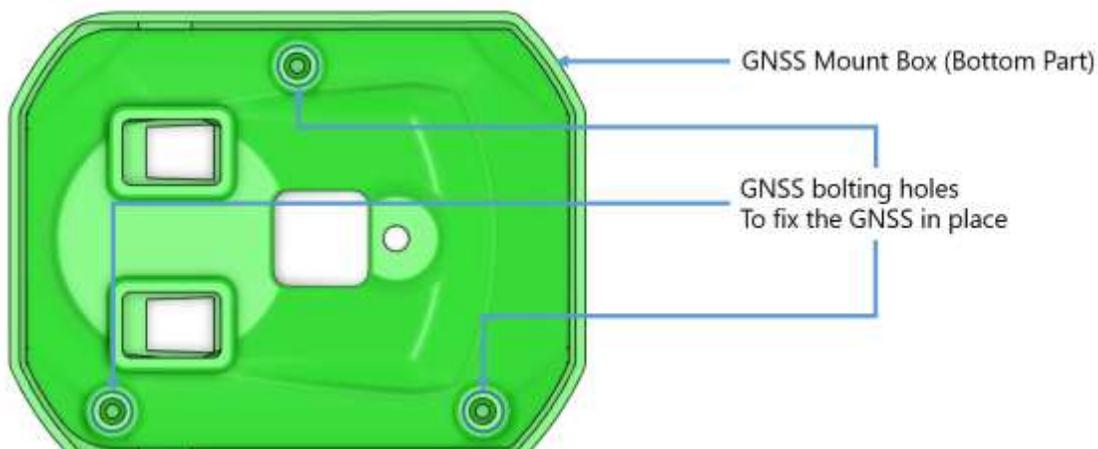


Figure 35: Bolting holes on GNSS mount box

- Snap the top part of the GNSS mount box and glue it with superglue. Place the GNSS mount box on the stand of GNSS mount and bolt the M2×8 socket head fastener that were removed in Step 3.
- Connect the GNSS CAN connection to MMC which was removed in Step 2.
- Follow Step 13 and 14 from Section 6.1.5.
- Put a small piece of void tape on the GNSS casing.

6.1.9 Telemetry

The telemetry has two components - ground unit and air unit. These two units are paired and need to be changed even if any one of the two is not working. The ground unit does not need any special replacement procedure. Follow the steps to replace the air unit

- Follow Step 1 and 2 from Section 6.1.5.

2. Remove all the signal connection from the MMC, the power brick connection and unbolt the four M3×10 socket head fasteners holding G10 FR4 Telem Plate and the MMC on the central electronics stack assembly. The MMC, MMC damper and FR4 plate can be removed.
3. Remove the two side plates-antenna by unbolting the eight M3×8 socket head fasteners present on top and bottom plate.

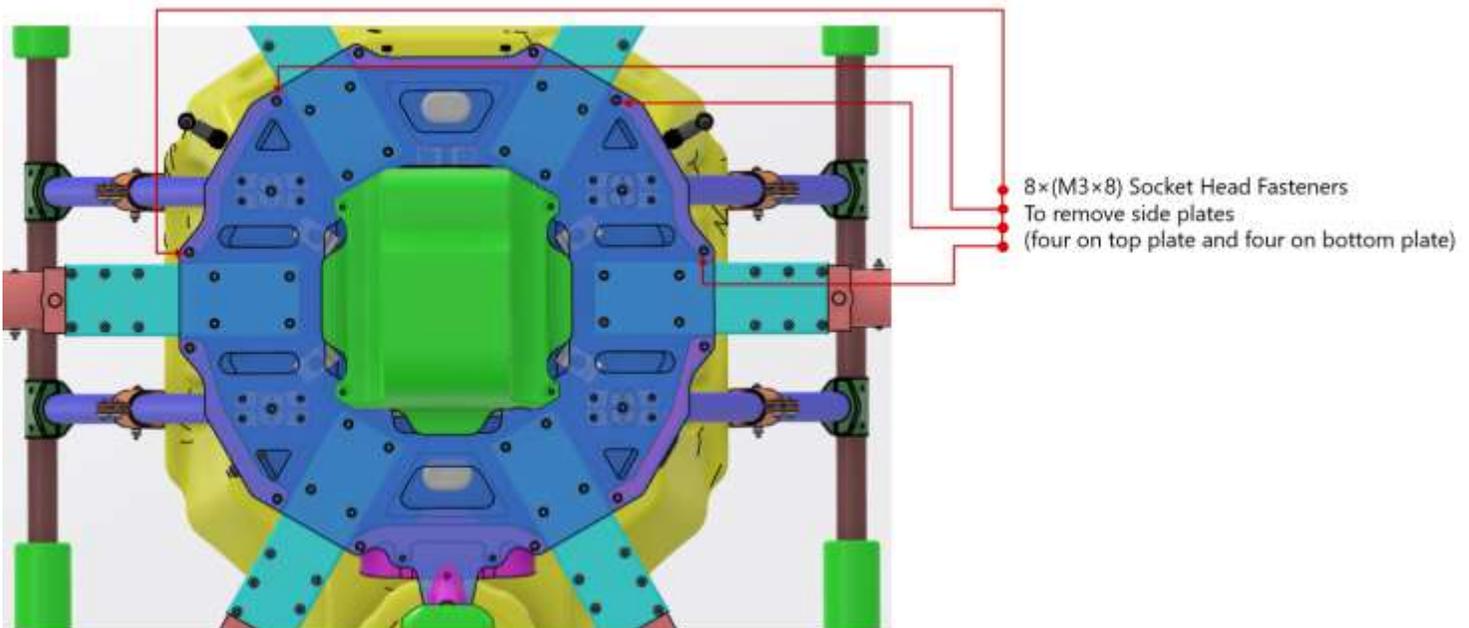


Figure 36: Side plate antenna fastener location

4. Remove the antennae mounts. To remove them, hold the antenna mount present at the front of the side plates-antenna and rotate the hex-bolt present at the back of the side plates-antenna in counter-clockwise direction.
5. Pull out the telemetry air unit from the electronics stack and remove the double-sided tape on which the telemetry was mounted. Clean the place with acetone and let it vaporize.
6. Route the new telemetry air unit antenna cables and take one out from the sides from which the side plates are removed each. Fix the antenna mount on the side plates by holding the mount and rotating the hex-bolt again in clockwise direction

7. Put a new double-sided tape on the place and put the new telemetry air unit on the double-sided tape.
8. Place and fix the side plates antenna on the original position by bolting the M3×8 socket head fasteners removed in Step 3.
9. Place the FR4 Telem Plate. With MMC and damper attached back to original position such that the MMC direction arrow face the flight direction and bolt the M3×10 socket head fasteners that were removed in Step 2. Make all the MMC signal connections as per the signal schematic present in the Annexure B – MMC Signal Schematic. Also, connect the power-brick camera power cable.
10. Follow Step 13 and 14 from Section 6.1.5.

6.1.10 Propulsion System

Propulsion system consists of propeller and motor. Life of both these components are restricted by the OEM. Apart from this life, if the propeller undergoes any physical damage, it should be replaced by following the steps mentioned in Section 5.1.2.1.

If the motor is malfunctioning, follow the steps to replace the motor:

**This replacement procedure also needs extra care in identifying the correct motor arm number and its connection to PDB and MMC. Identify the motor arm number based on the front (flight) direction of the UA as given in Figure 37: Motor number relative to front (flight) direction of UA, and check Annexure A – Power Schematic & Annexure B – MMC Signal Schematic for the power and signal connections for that particular motor arm.*

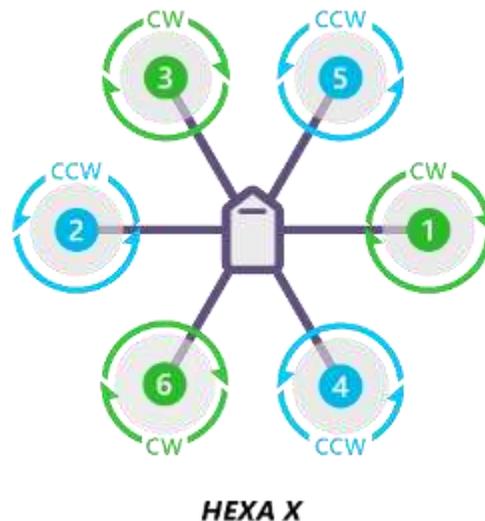


Figure 37: Motor number relative to front (flight) direction of UA

1. Follow Step 1 to 6 from Section 6.1.5.
2. Follow Step 8 from Section 6.1.5.
3. Route the nylon braided wires of a new motor through the carbon fiber tube, folding mechanism and rectangular tube. Folding the folding mechanism would make the work easier.
4. Align the motor with the help of spirit level. Align the motor such that it matches the level of ground and the rectangular carbon fiber tube. Ensure that the motor configuration is same as the one removed (CW and CCW). Check the motor rotation configuration as per the motor number given in Figure 37.
5. Fix the motor on the carbon fiber tube by bolting the six fasteners that were loosened in Step 8 from Section 6.1.5.
6. Follow Step 11 to 14 from Section 6.1.5.
7. Perform software and ground tests on the UA emphasizing on the motor tests.

6.1.11 Radar Replacement

Two types of radars are used in Leap A10. Obstacle Detection Radar is used for detecting obstacle in flight path and Radar Altimeter is used to detect the change in terrain altitude on which it is flying. Radar replacement can be done by a single person.

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6.1.11.1 Obstacle Detection Radar

Follow the steps to replace Obstacle Detection Radar

1. Follow Step 1 and 2 from Section 6.1.9
2. Unbolt the four M3 fasteners present in the spacers present on the PDB and remove the PDB from its place.

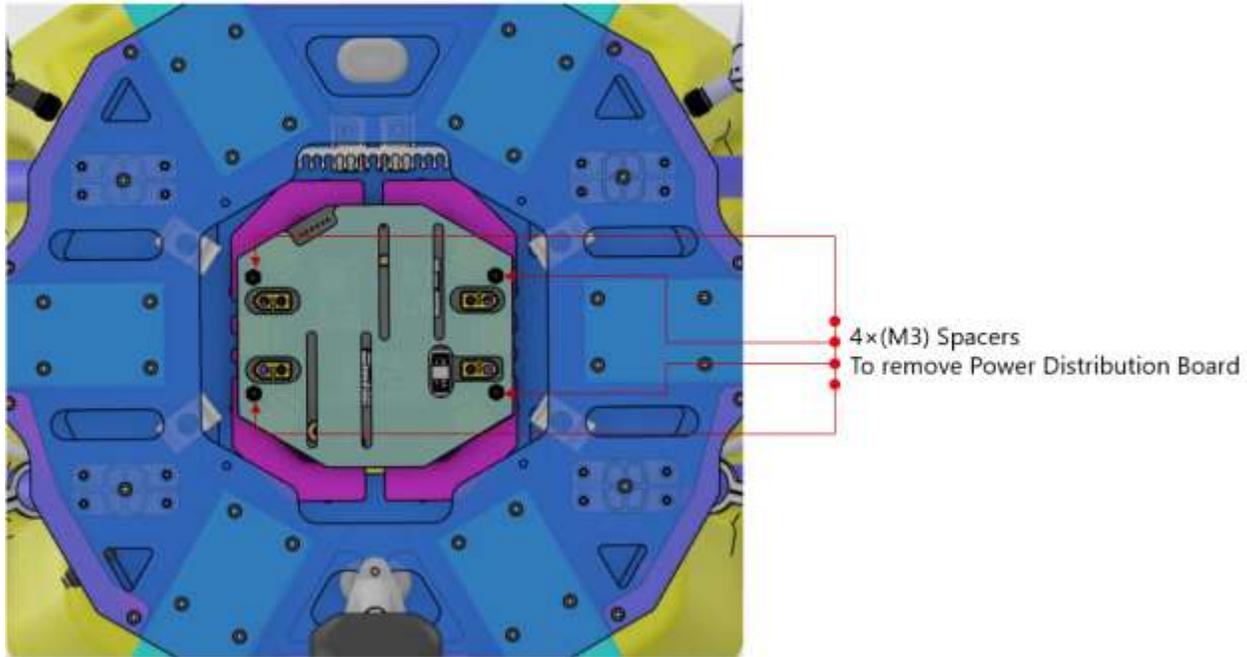


Figure 38: Power distribution board spacer location

3. Follow Step 3 from Section 6.1.5 **Error! Reference source not found.** and lift up the CAN hub casing such that the obstacle detection radar cable can be removed when disconnected. Slide up the obstacle detection cable and remove the cable.
4. Unbolt the four M4×8 socket head fasteners present on the obstacle detection radar mount and remove the obstacle detection radar and its mount from the assembly.

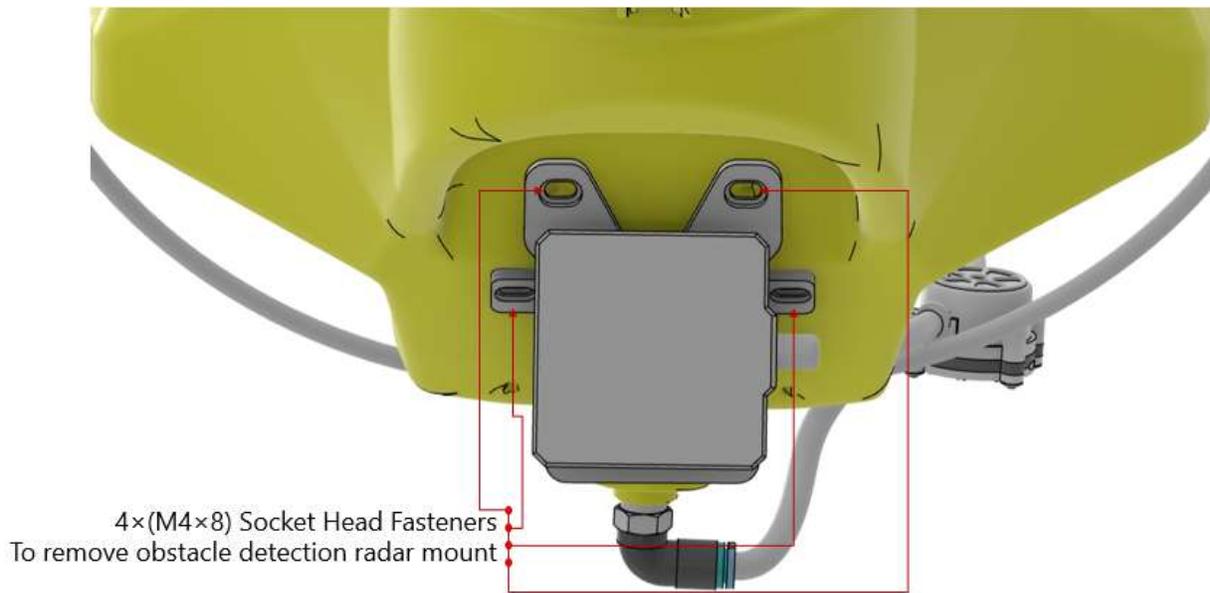


Figure 39: Obstacle detection radar mount fastener location

5. Unbolt the four M2.5×8 socket head fasteners holding the radar and the radar mount.
Remove the radar.

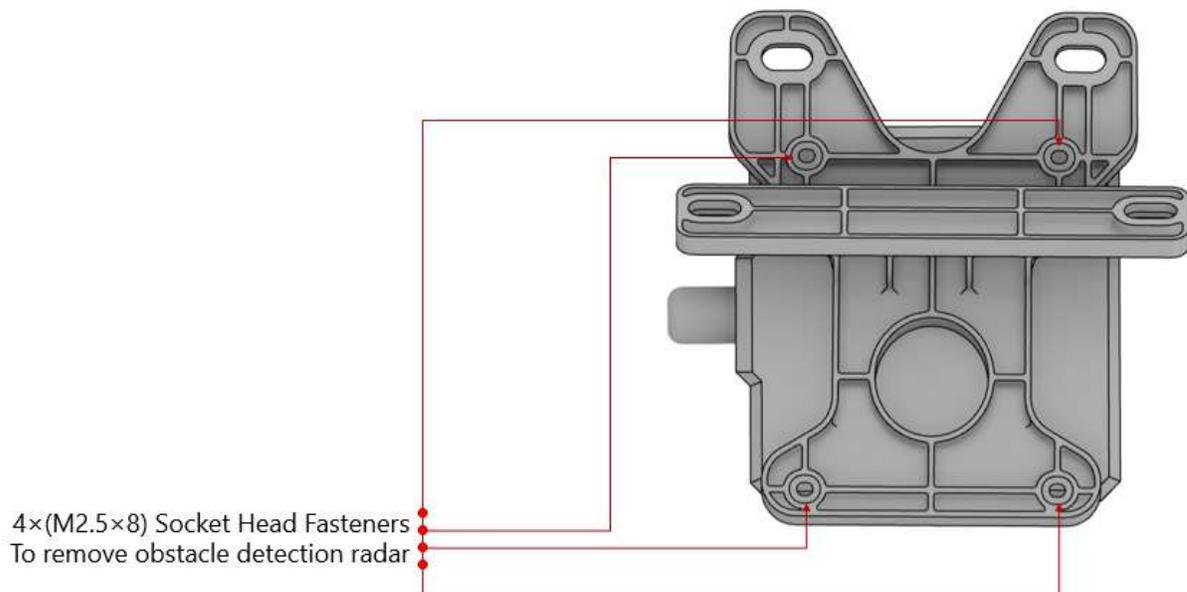


Figure 40: Obstacle detection radar fastener location

- Place the new obstacle detection radar on the radar mount (check the orientation in Figure 41) and bolt the four M2.5×8 socket head fasteners that were removed during Step 3.

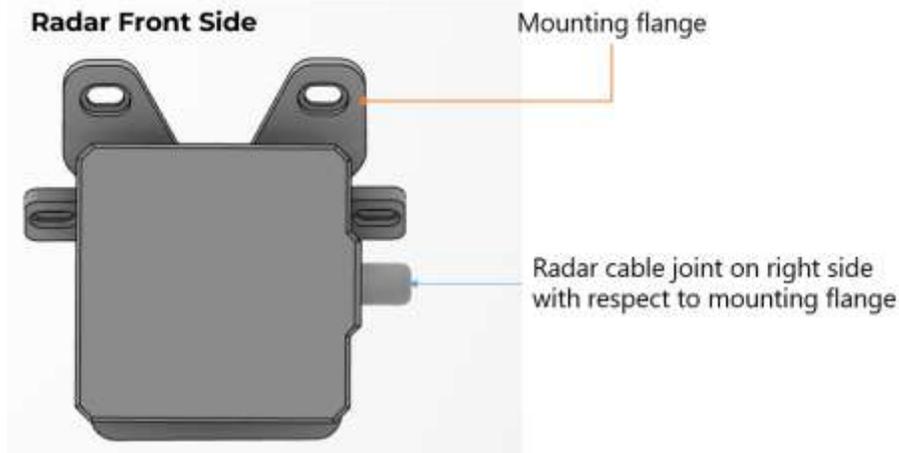


Figure 41: Obstacle detection radar orientation w.r.t. its mount

- Place the radar mount and radar on its position and bolt the four M4×8 socket head fasteners that were removed during Step 2.

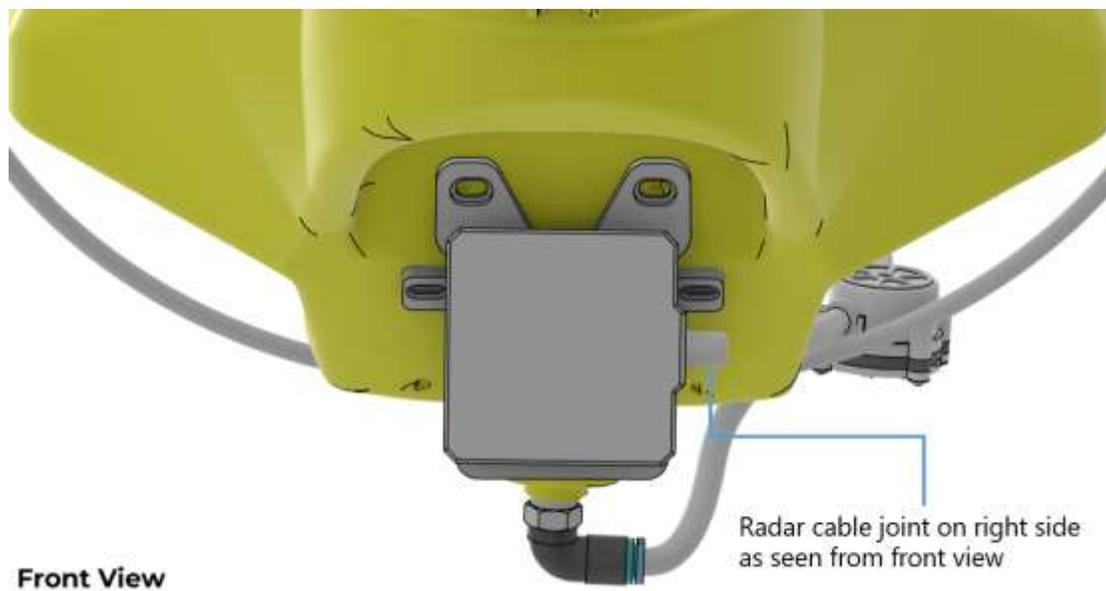


Figure 42: Obstacle detection radar mount orientation

- Connect the obstacle detection radar cable to the CAN hub that was removed during Step 1.

9. Perform radar test on the UA.

6.1.11.2 Radar Altimeter

It is suggested to keep the UA on an elevated area such table top such that the bottom of the tank is easily accessible.

Follow steps to replace radar altimeter.

1. Disconnect the radar altimeter cable from Can Hub.
2. Follow Step 2 and 3 from Section 6.1.11.1. In this step, instead of removing obstacle detection cable, remove radar altimeter.
3. Unbolt the four M4×8 socket head fasteners present on the radar altimeter mount and remove the radar altimeter and its mount from the assembly.

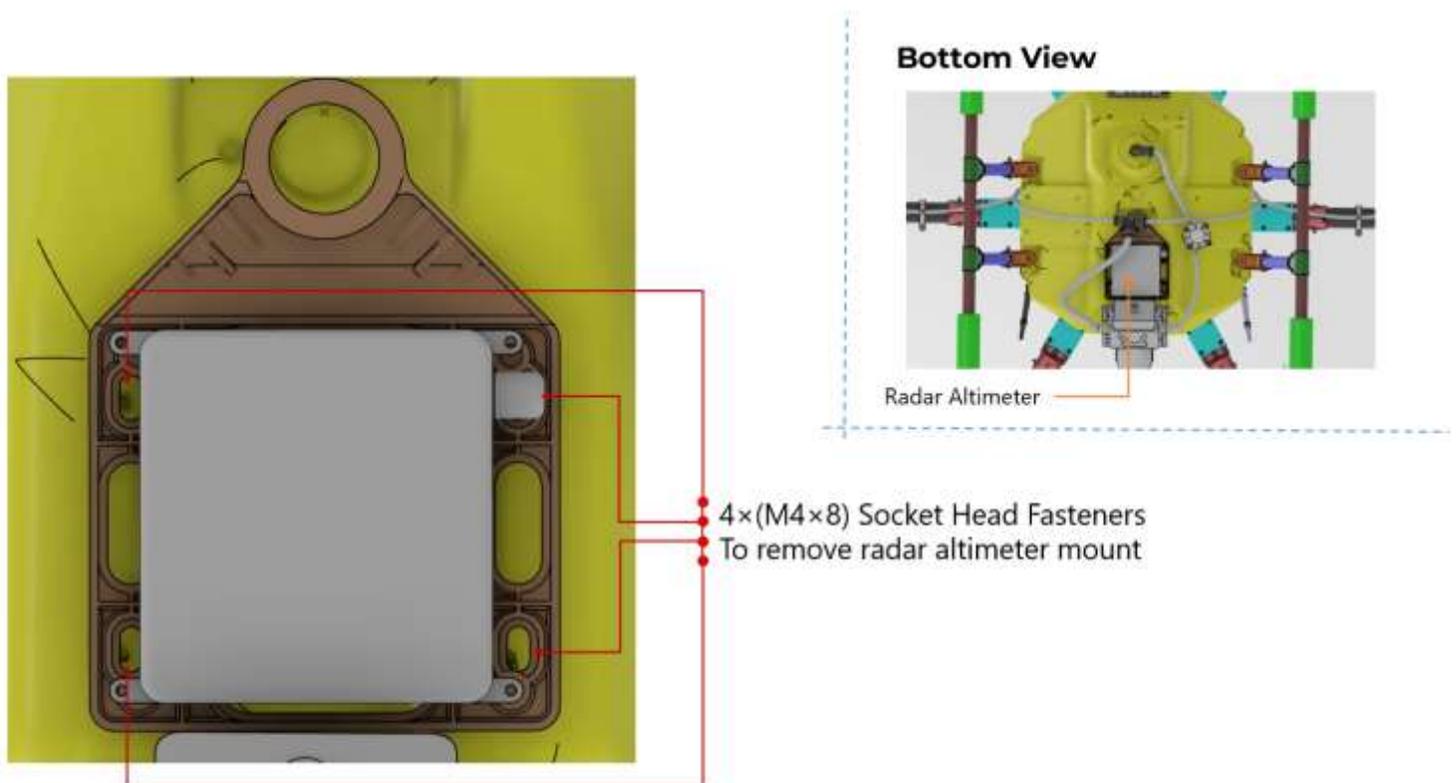


Figure 43: Radar altimeter mount fastener location

4. Unbolt the four M2.5×8 socket head fasteners holding the radar and the radar mount.
Remove the radar.

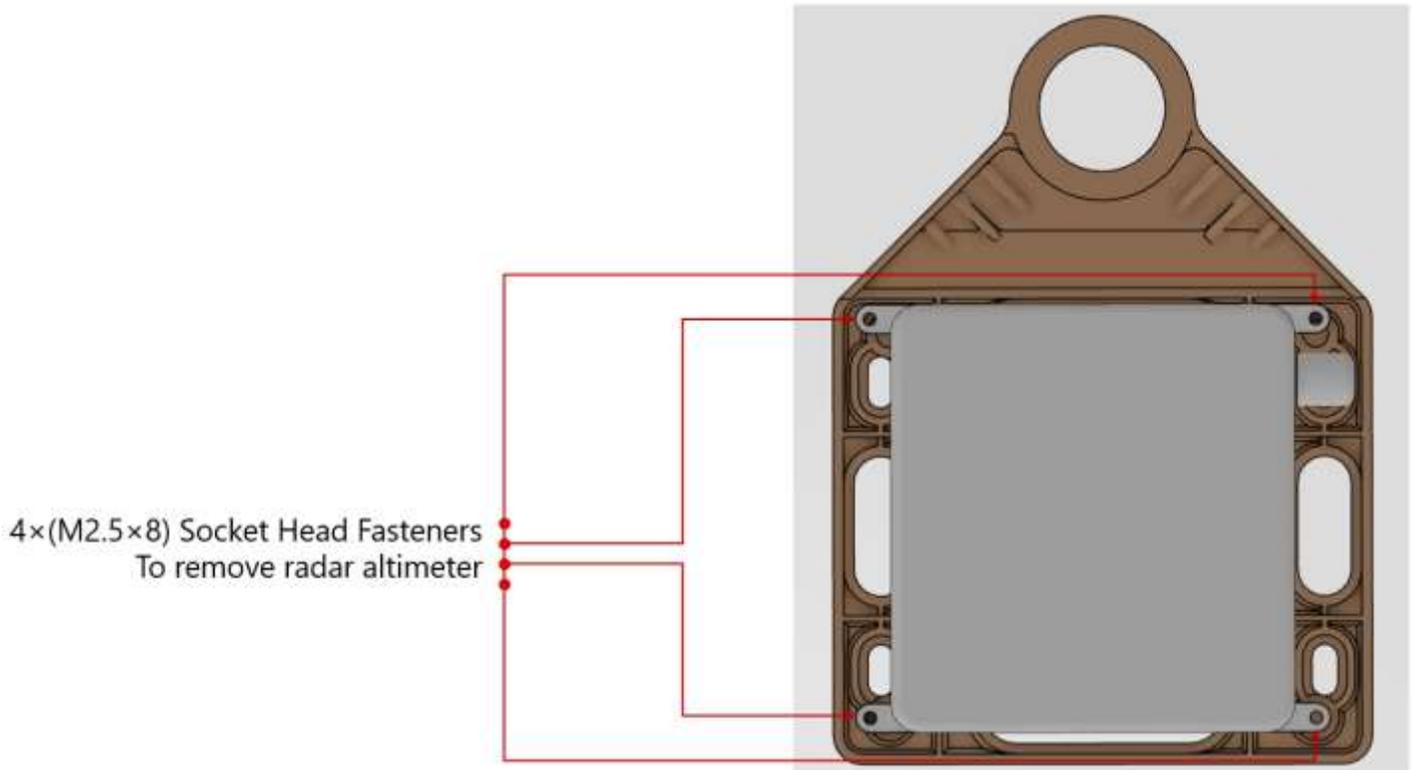


Figure 44: Radar altimeter fastener location

5. Place the new radar altimeter on the radar mount (check the orientation in) and bolt the four M2.5×8 socket head fasteners that were removed during Step 3.

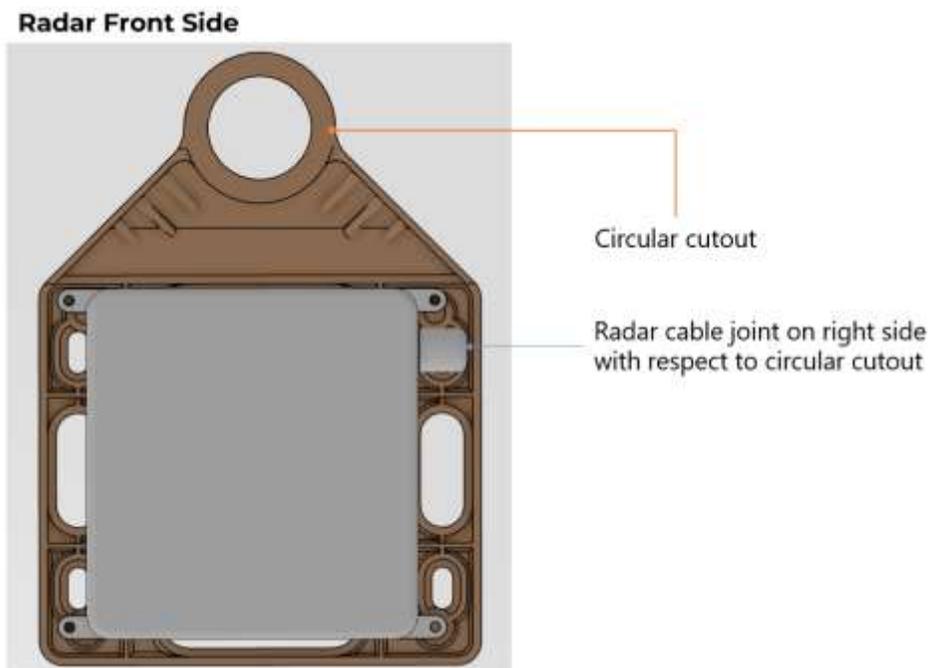


Figure 45: Radar altimeter orientation w.r.t. circular cut-out.

6. Place the radar mount and radar on its position and bolt the four M4×8 socket head fasteners that were removed during Step 2.

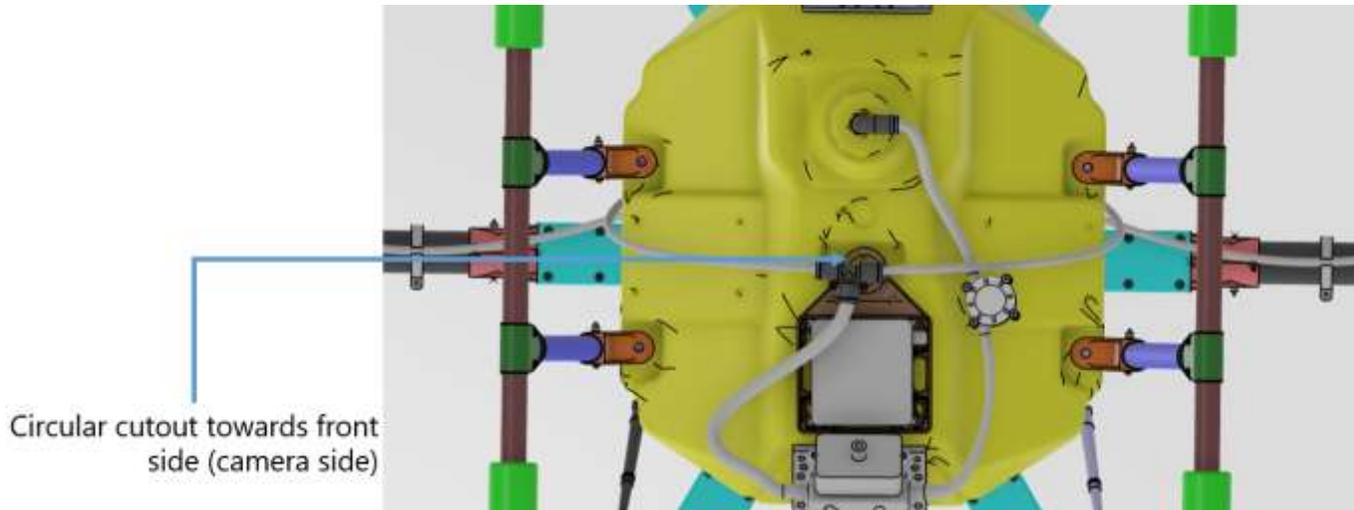


Figure 46: Radar altimeter mount orientation

7. Connect the radar altimeter cable to the CAN hub that was removed during Step 1.
8. Perform radar test on the UA.

6.1.12 Pump

The pump supplies the agrochemical to either centrifugal atomizer or flat jet nozzle. Hence, making the spray system work. If the pump is no longer able to supply the agrochemical through spray system, it can be replaced by one person. Follow the steps to replace the pump:

1. Disconnect the pump from the system. To do this rotate the lock cover present on the connector and unplug the connector from connector socket.
2. Disconnect the fluid tubes from both pump inlet and outlet.

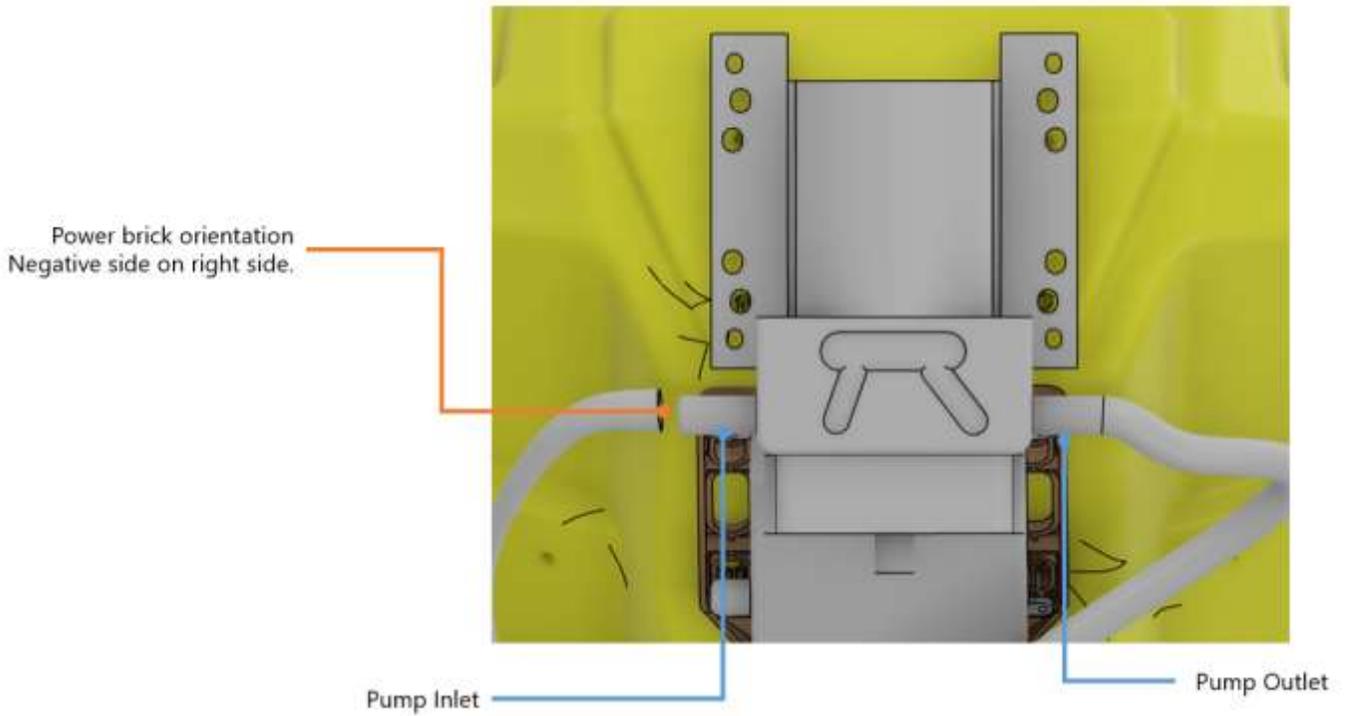


Figure 47: Disconnect the inlet and outlet tubes from pump

3. Unbolt four M4×10 socket head fasteners present on the pump and remove the pump from the assembly.

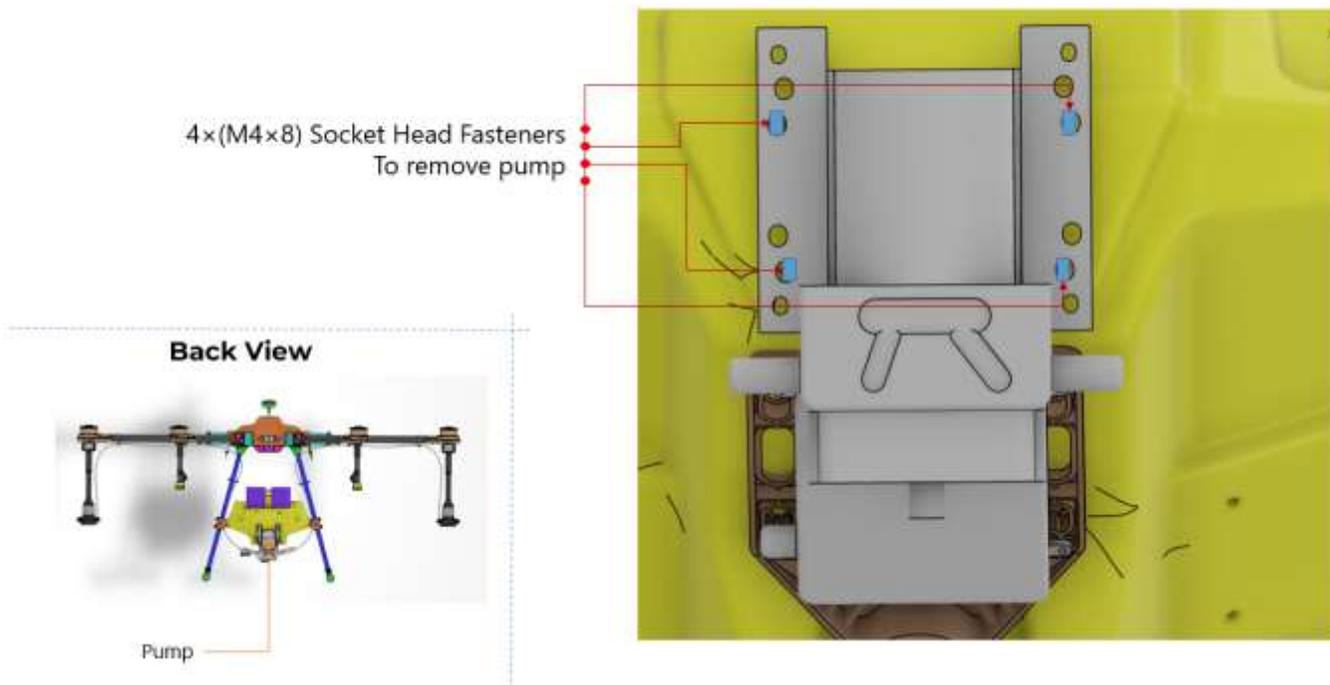


Figure 48: Pump fastener location

4. Place a new pump on the location (as per the orientation shown in Figure 49) and bolt the four M4×8 socket head fasteners that were removed in previous step.

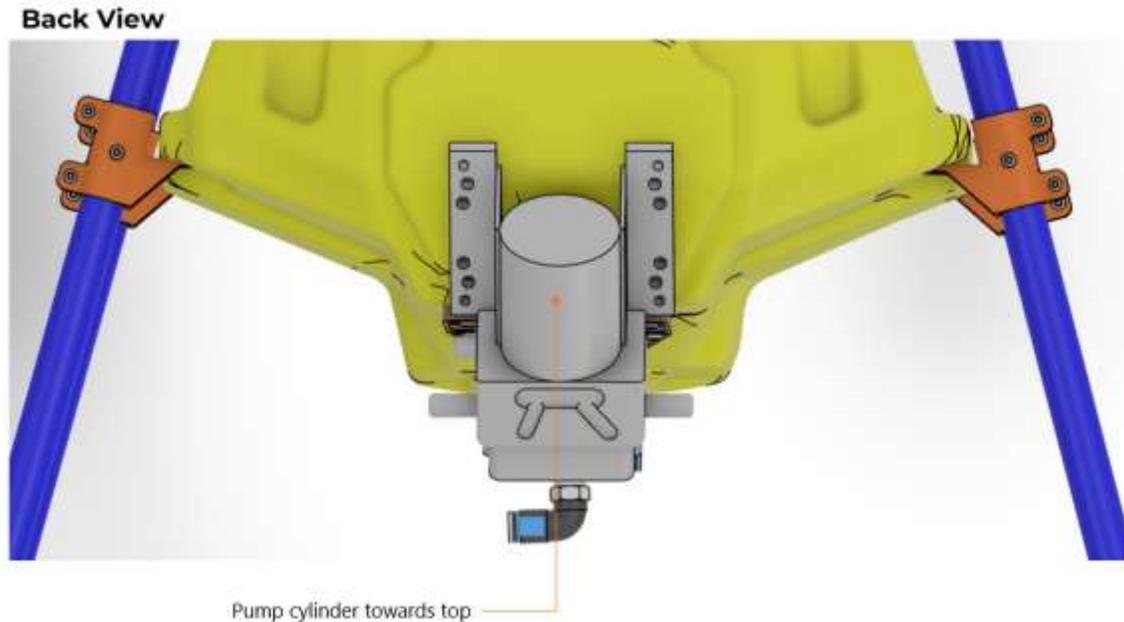


Figure 49: Pump orientation

5. Connect the fluid tubes that were removed in Step 2. Simply push in the tubes in the inlet and outlet of the pump. Use heat gun (which will temporarily expand the tube mouth) if the tubes are difficult to put in. If the tubes are observed to be plastically deformed on tube mouth and fit in loose, change the tubes by replacing the tubes till nearest connector. Refer Figure 4 to reconnect on the tubes on connectors.

6.1.13 Camera

1. Follow Step 1 and 2 from Section 6.1.9
2. Disconnect the Camera-PDB connection from the top left connector out of vertical PDB connectors.

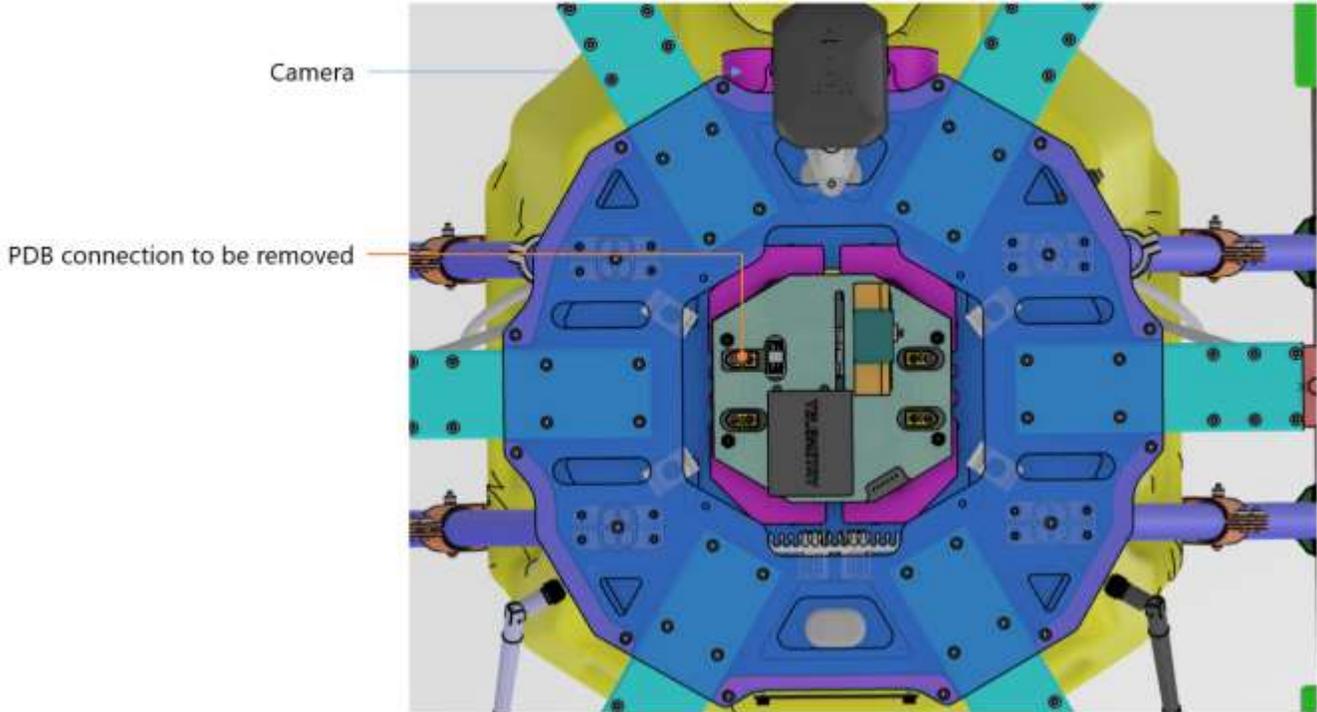


Figure 50: Camera-PDB connection to be removed

3. Disconnect the Camera to Telemetry connection by unplugging the (GND VCC R×1 T×1) connection from the telemetry air unit.

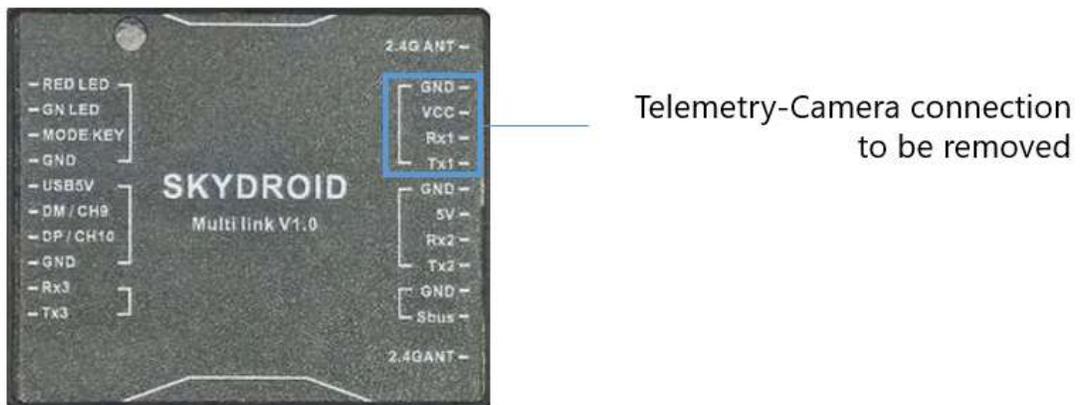


Figure 51: Telemetry-Camera connection to be removed

4. Unbolt the four M3×8 socket head fasteners present on top and bottom plate

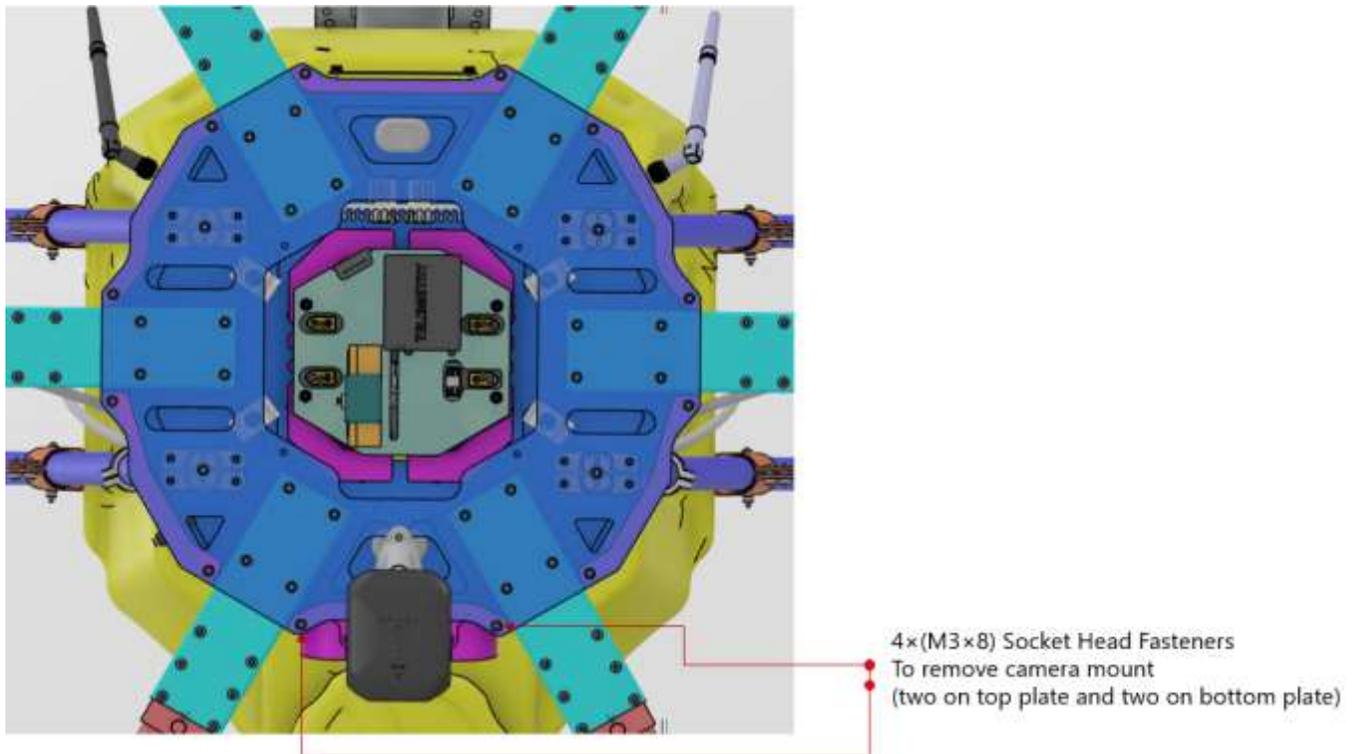


Figure 52: Camera mount fasteners location

5. Pull out the camera from the camera mount

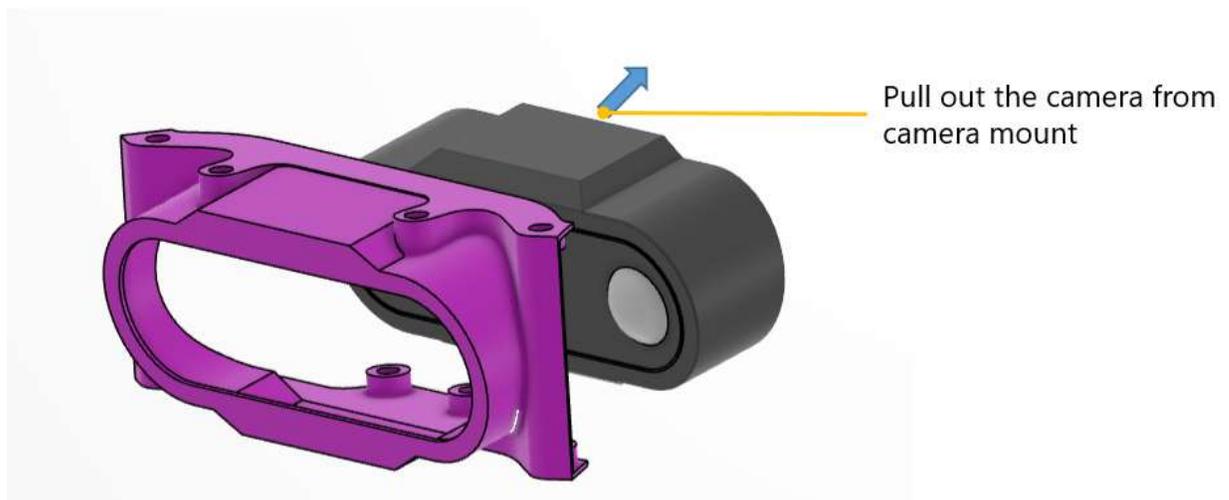


Figure 53: Camera and camera mounts

6. Insert a new camera in the camera mount such that the cable joint at the back of the camera comes on the top half of the camera mount.
7. Put the camera mount in the assembly back in initial position and bolt the four M3×8 socket head fasteners that were removed in Step 4.

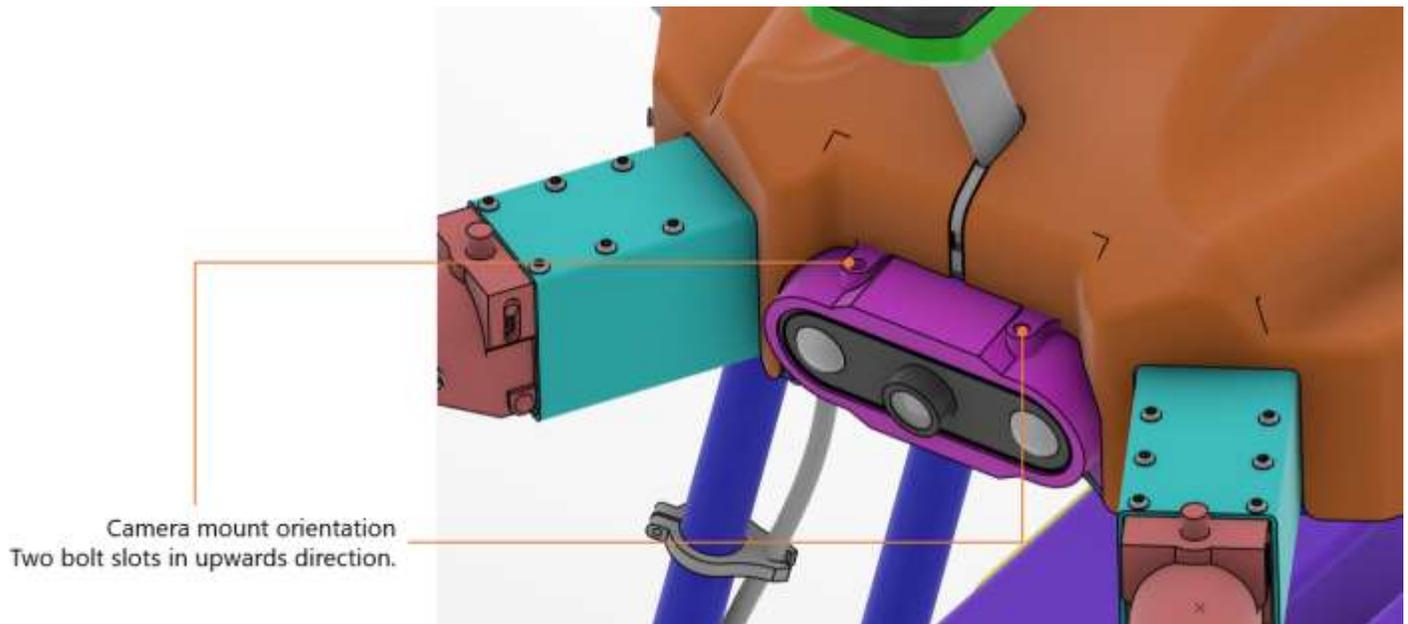


Figure 54: Camera mount orientation

8. Connect the telemetry-camera connection back which was removed in Step 3. The black cable in the four-pin connector must be connected to the GND pin on the telemetry air unit.
9. Connect the PDB-camera power connection that was removed in Step 2.
10. Follow Step 1 and 2 from Section 6.1.9

6.1.14 Power Brick

Power brick is an essential component in the assembly. It acts as the BEC (Battery Eliminator Circuit) for the mission management computer which works on a relatively lower voltage 5V. If the power brick is faulty, it might damage the cube and potentially create catastrophic risk.

1. Follow Step 1 and 2 from Section 6.1.9.

2. Unstrap the power brick and remove the old power brick. The zip tie used to fix the power brick can be cut down using a knife or scissors.
3. Place new power brick in position (orient as shown in Figure 55) and fix it with a zip tie.

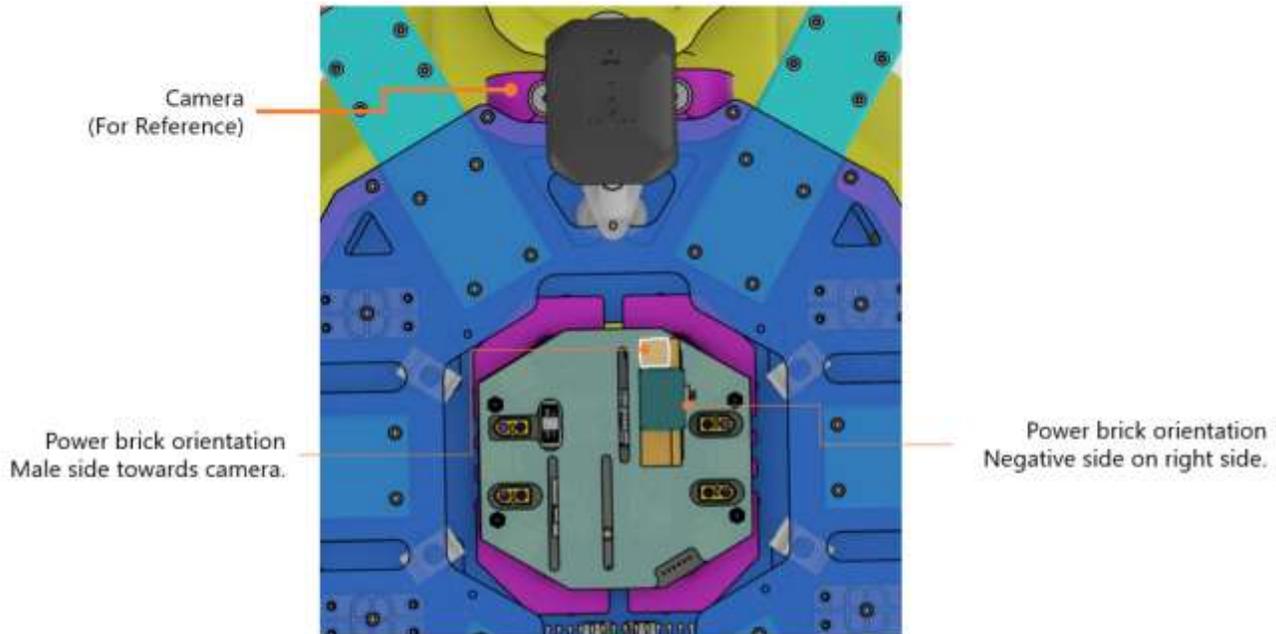


Figure 55: Power brick orientation

4. Follow Steps 9 and 10 from Section 6.1.9

6.1.15 Power Distribution Board

Power distribution board is used to distribute and supply power to every UA component, directly or indirectly. Working of PDB is very crucial for every component to work normally as the slight difference from required to supplied power to components, more or less would cause problem and imbalance in the system.

1. Follow Step 1 and 2 from Section 6.1.9
2. Remove Power brick and telemetry module from top of the PDB. Remove all the power connections from PDB.
3. Unbolt the four M3×10 socket head fasteners on each front landing gear tube and remove the PDB to battery connector (XT90 connector) from the front landing gears.

4. Unbolt the four M3 fasteners present in the spacers present on the PDB and remove the PDB from its place.

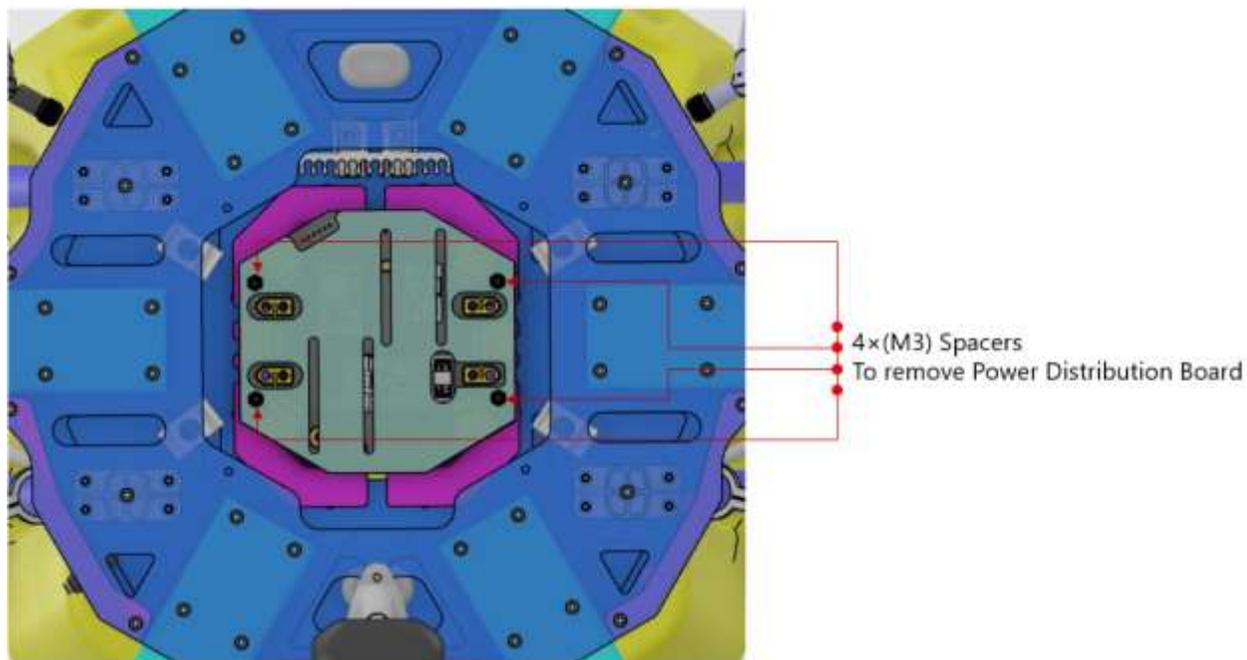


Figure 56: Power distribution board spacer location

5. Place a new PDB in place such that XT60 connectors are on the top, the power input ports for the PDB are towards the camera and route the power cables through the bottom plate. Bolt the spacers. Fix the PDB to battery XT90 connectors back to original position and bolt the four M3×10 socket head fasteners that were removed in Step 3.

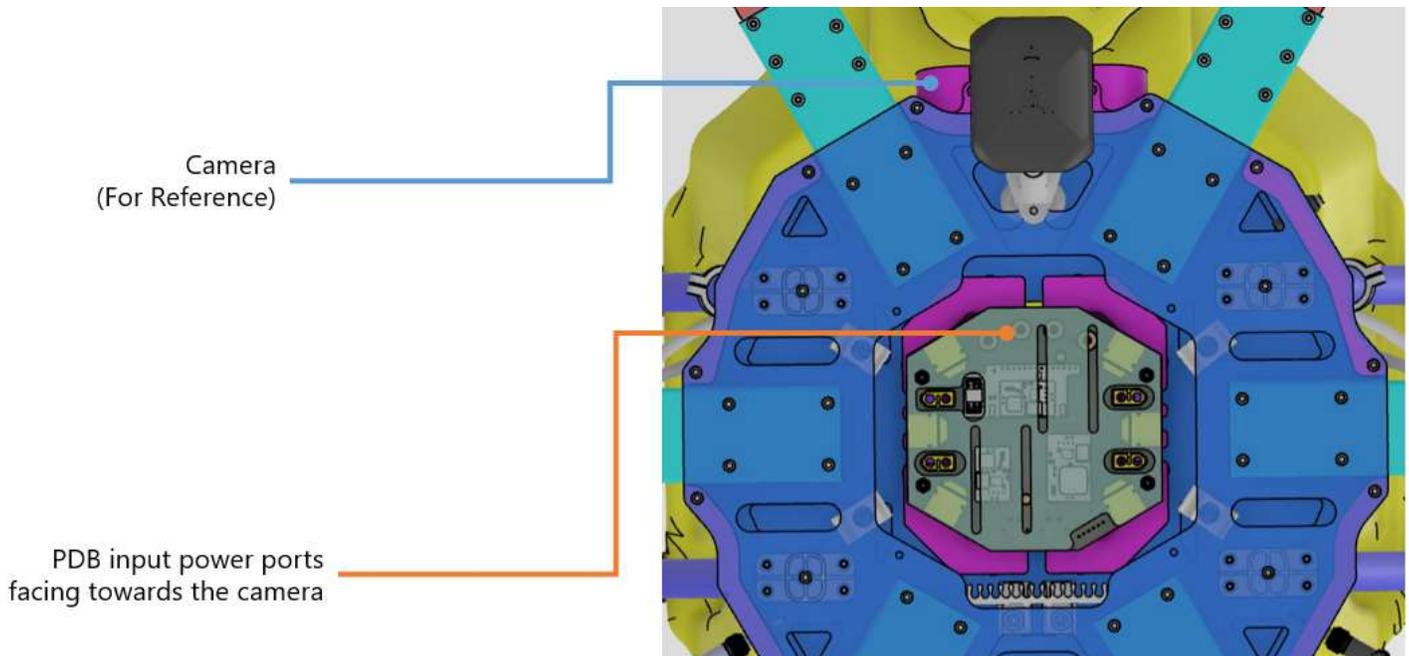


Figure 57: Power distribution board orientation

6. Place the telemetry and power brick to their initial position.
7. Follow Step 9 and 10 from Section 6.1.9.

6.1.16 CAN Hub

The UA is using the CAN hub CAN protocol extension to link the two radars to the MMC. The CAN protocol ports on the MMC are insufficient for all of the UA's peripherals, necessitating this addition. The Leap A10's detect and avoid feature would not work if the CAN hub failed.

1. Follow Step 1, 2 & 4 from 6.1.15. Skip Step 3 and push the PDB instead of removing completely from the assembly such that the CAN Hub is accessible.
2. Remove the obstacle detection radar and radar altimeter cable from CAN hub and remove the CAN Hub from the assembly.
3. Place a new CAN Hub in the initial position and orient the CAN hub such that the power cable joint of the CAN hub face opposite to the flight direction of the UA (UIN plate).

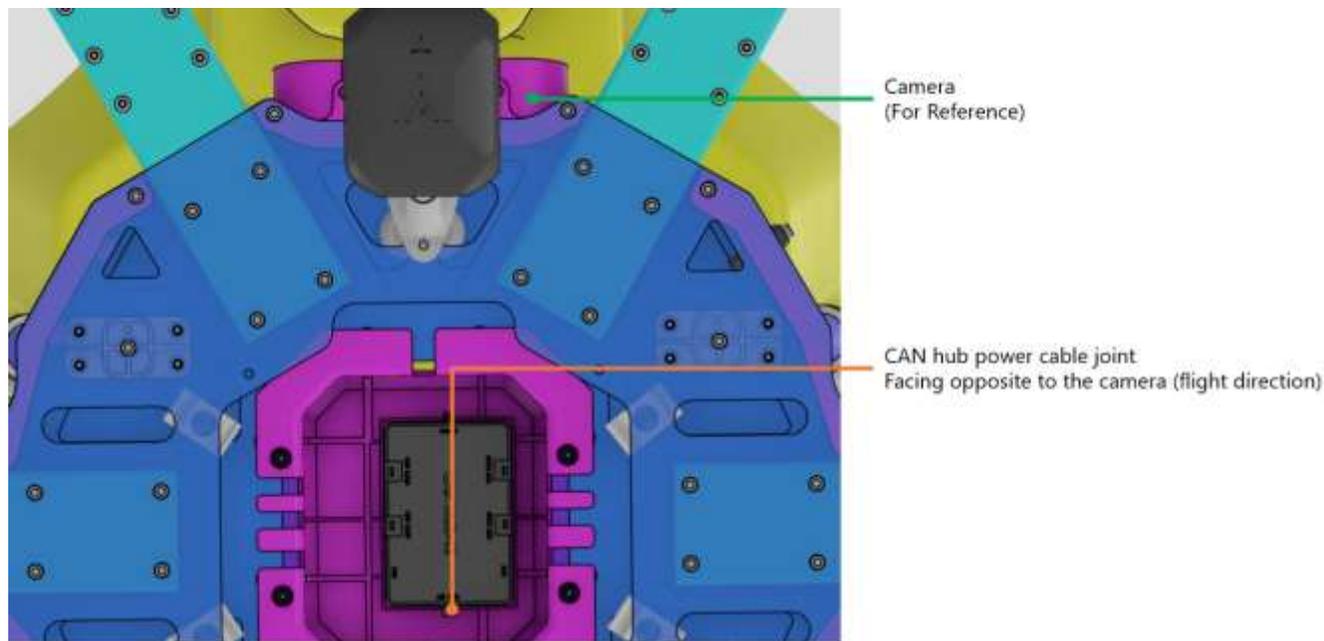


Figure 58: CAN hub orientation

4. Connect the obstacle detection radar and radar altimeter cable to CAN hub that were removed in Step 2.
5. Follow Step 5 to 7 from 6.1.15 with same PDB that was removed in Step 1.

6.1.17 Flow Sensor

In order for the system to know how much fluid is still in the tank, a flow sensor is utilised to detect the fluid that has been used. This sensor is essential to the UAS's complete operation.

1. Follow Step 1 from Section 6.1.16
2. Remove the flow sensor power connection from CAN hub 12 V power supply port.
3. Remove the inlet and outlet fluid tube connections of the flow sensor (similar to Step 2 from Section 6.1.12)
4. Place a new flow sensor and fix the flow sensor such that the fluid tube coming from the tank connects to the inlet of the flow sensor. The inlet marking is given on the flow sensor.

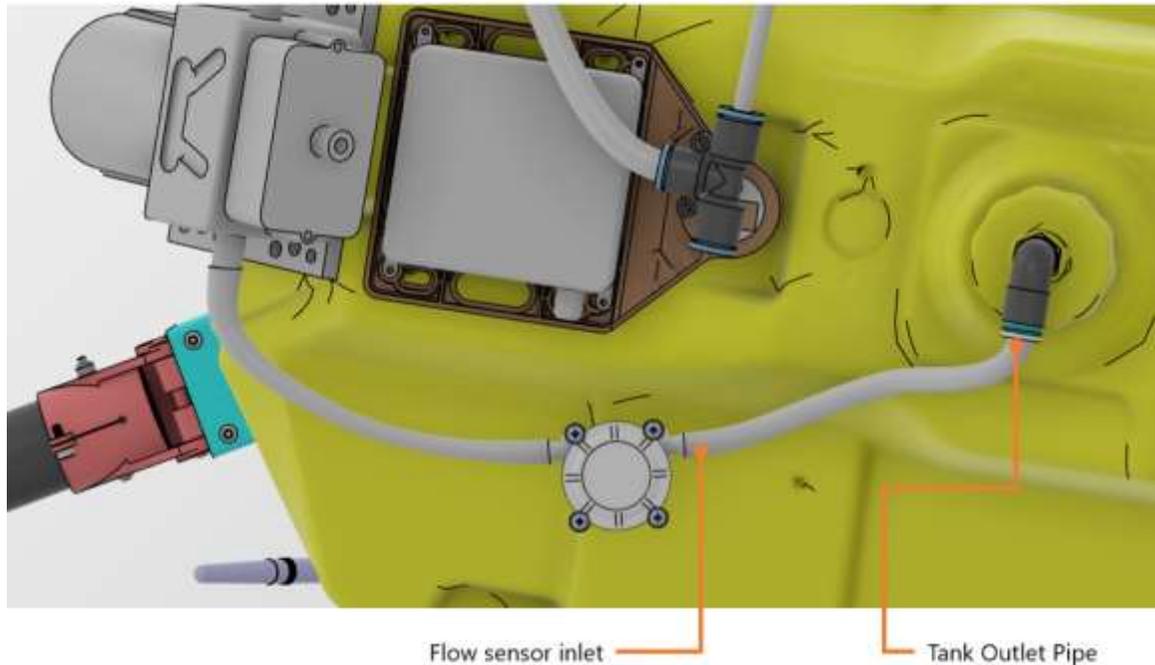


Figure 59: Flow sensor orientation

5. Route the flow sensor power and signal cables along with the landing gear tube and connect the power cable (which was removed in Step 2) to the CAN hub.
6. Follow Step 5 to 7 from Section 6.1.15 with same PDB that was removed in Step 1.

6.1.18 Level Sensor

The purpose of the level sensor is to indicate whether fluid is present in the tank and to improve efficiency by utilizing RTL capabilities when the tank content is low. While there wouldn't be any catastrophic consequences if this weren't done, the UAS's functionality would undoubtedly be diminished.

1. Follow Step 1 from Section 6.1.16
2. Remove the level sensor power connection from CAN hub 12 V power supply port.
3. Follow Step 2 from Section 6.1.11.2.
4. Remove level sensor from the radar altimeter mount.

5. Place a new level sensor on the radar altimeter mount and route the signal and power cable of the new sensor along with the landing gear tubes. Connect the power cable (which was removed in Step 2) to the CAN hub.
6. Follow Step 5 to 7 from Section 6.1.15 with same PDB that was removed in Step 1.

6.1.19 Safety Switch

The safety switch serves as a key component in the pre-flight and post-flight sequences, acting as a means to control the power supply to the propulsion system. Its primary purpose is to prevent accidental or unauthorized activation of the motors. Malfunction poses a potential safety hazard, as the operator may lose control over the UAV's propulsion system, resulting in unpredictable and potentially dangerous flight behavior.

1. Follow Step 1 and 2 from Section 6.1.5.
2. Unplug the safety switch connection from the MMC. The safety switch would be connected in the GPS1 port on the MMC.

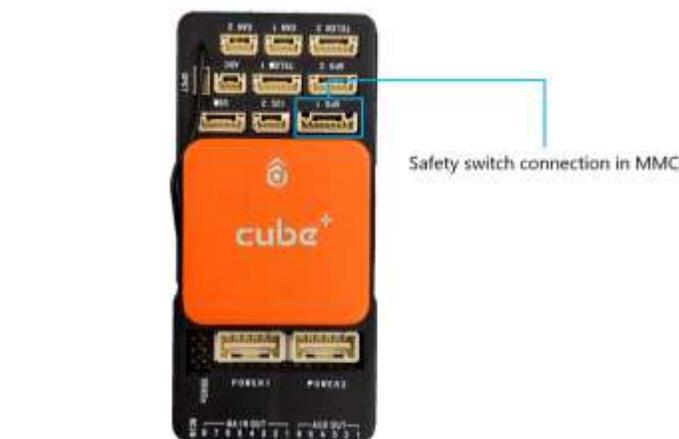


Figure 60: Safety switch connection in MMC

3. Unbolt the four (M3×8) socket head fasteners present on the top plate to remove the side plate – safety switch.

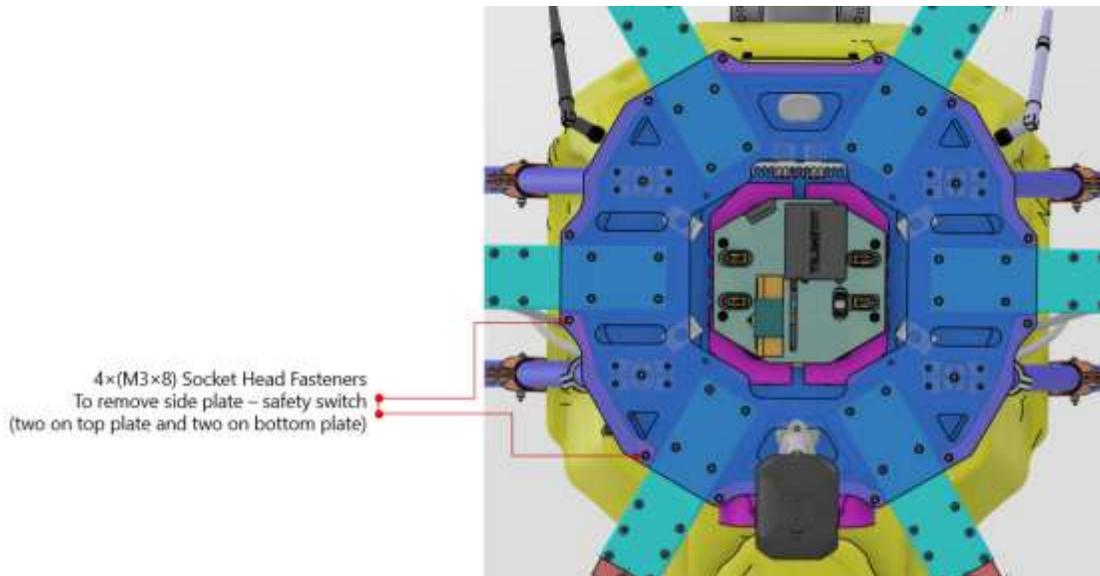


Figure 61: Side plate-safety switch fastener location

4. Remove the safety switch from the side plate – safety switch by pulling it out from the front side of the plate.
5. Put a new safety switch connector through the hole and mount the safety switch on the hole as shown in Figure 62.

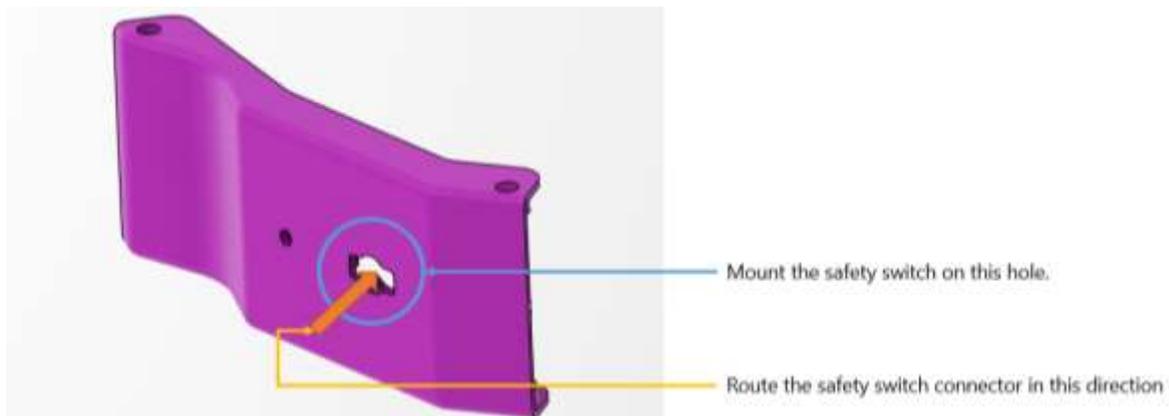


Figure 62: Safety switch mounting hole on side plate.

6. Route the safety switch connector wire and reconnect it to the MMC by plugging in to the GPS1 port of the MMC (same as Step 2).
7. Mount the side plate –safety switch and bolt the four (M3×8) socket head fasteners that were removed in Step 3.

8. Follow Step 13 and 14 from Section 6.1.5.

6.1.20 Buzzer

The buzzer is commonly employed to provide audible feedback during various stages of flight, such as arming and disarming the motors, low battery warnings, and other critical alerts. Malfunctioning could lead to a lack of awareness regarding the UAV's status, potential issues, or crucial warnings, increasing the risk of operating the UA under less-than-optimal conditions.

1. Follow Step 1 and 2 from Section 6.1.5.
2. Unplug the buzzer connection from the MMC. The buzzer would be connected in the USB port on the MMC.

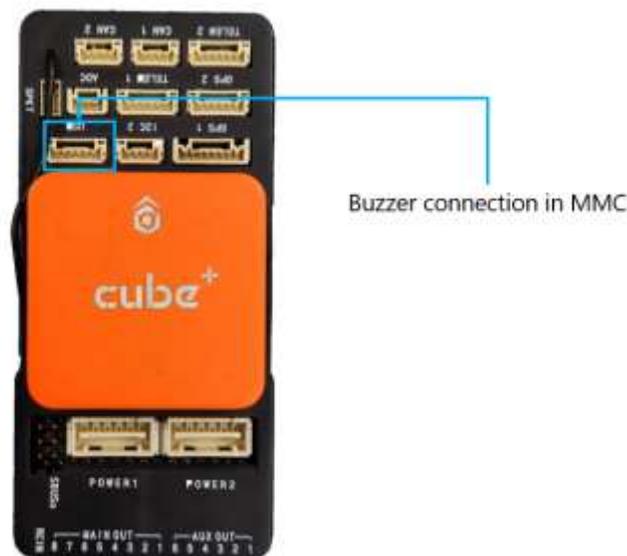


Figure 63: Buzzer connection in MMC

3. Unbolt the four (M3×8) socket head fasteners present on the top plate to remove the side plate – buzzer.

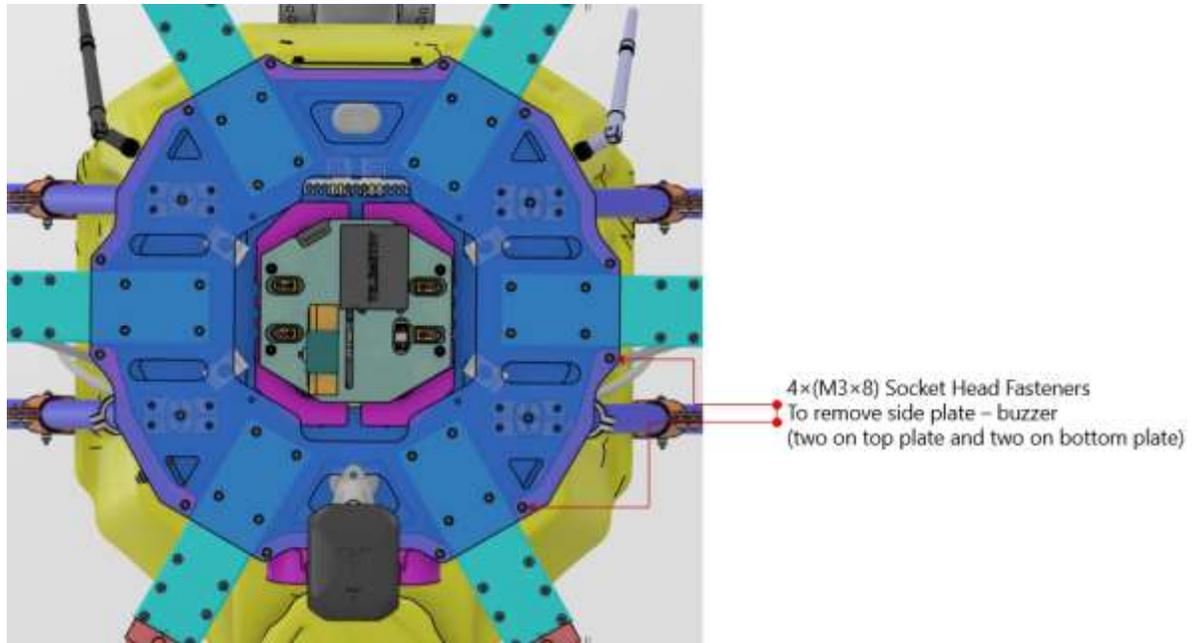


Figure 64: Side plate – buzzer fastener location

4. Remove the buzzer from the side plate – buzzer by pulling it out from the front side of the plate.
5. Put a new buzzer connector through the hole and mount the buzzer by bolting the M3x8 socket head fasteners on the hole as shown in Figure 65

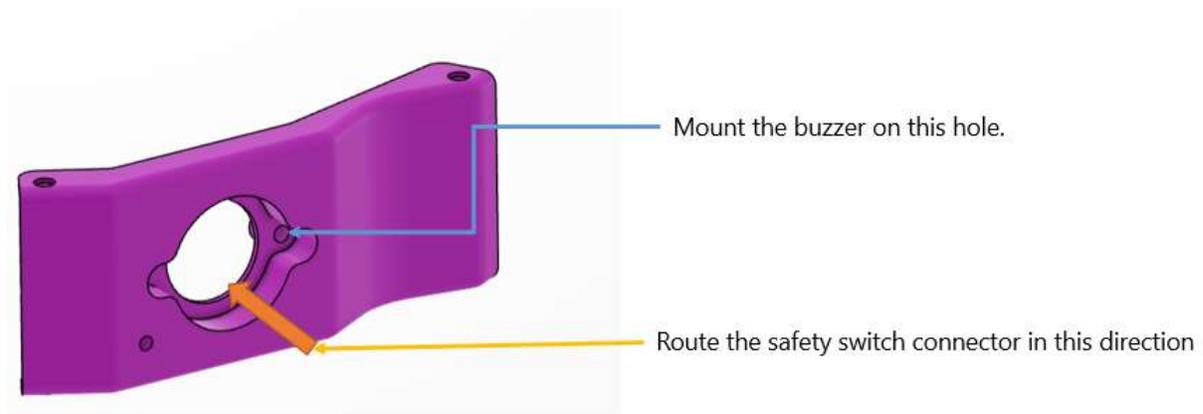


Figure 65: Buzzer mounting on side plate

6. Route the buzzer connector wire and reconnect it to the MMC by plugging in to the USB port of the MMC (same as Step 2).

7. Mount the side plate –safety switch and bolt the four (M3×8) socket head fasteners that were removed in Step 3.
8. Follow Step 13 and 14 from Section 6.1.5.

7. Continuous Monitoring Process

After the UAS has been sold to customers continuous monitoring process is deployed to monitor its health over the life cycle. The regular maintenance process is described in the previous sections. This section describes two scenarios where Level 1 and Level 2 type of maintenance is performed, which provides inputs for the Continuous Health Monitoring Process. The life of each component has been provided in section 2 and the components are expected to perform accordingly. However, there may be scenarios due to which the Level 1 field repair and Level 2 recall-based repair may need to be performed. The pilots are trained to periodically share the flight logbook and battery logbook data with the company, which is used for continuous monitoring of UAS health. The following sections briefly describe the process of the repair and actions performed by the engineers.

7.1 Level 1 Process

When a customer support request is received by the company, a field engineer is assigned for the customer. The field engineer understands and analyzes the problem to take a decision whether the problem can be fixed on customer location or the UAS needs a transfer to company service center. If it is determined that the issue can be solved at the customer location, the assigned engineer arrives at the customer site prepared as per customer support request. The field engineer checks the flight logbook, battery logbook to ensure everything is in order, performs the inspection and tests of the UAS and records observations. If the engineer determines that the issue can be solved on the field, Level 1 repairs are performed for components as per standard operating procedure. Level 1 repairs do not require opening the top shroud and hence maintains the integrity of tamper protection. Components that can be replaced on the field are listed in the table below.

No	Part Description	Part no.
1	Propeller	HobbyWing X6 Plus
2	Landing Gear Tube	NL_AGU_A10_4001
3	Landing Gear Skid Tube	NL_AGU_A10_4003
4	Tee Joint	18MM Nylon Tee Joint
5	Skid Rubber	Landing gear Rubber Sleeve 18mm
6	Battery	25200mAH 6S

Table 5: Level 1 Field Service Replaceable Parts

All other components need to be serviced at the company’s service center.

The table below presents a Level 1 Field Service Report template to be filled in by the service engineer on site. When the field service report is filed, one copy is provided to the customer and the other copy is filed in company records as per Configuration Management Process.

The product warranty is verified and the component is replaced as per warranty terms and conditions agreed at the time of system acquisition.

Level 1 Field Service Report			
Report ID			
UIN		Serial Number	
Pilot Name		Engineer Name	
Customer		Place	
First Observation Date		Reporting Date	
Description			
Measures Taken by User			
Intervention Date			
External Inspection & Description	<input type="checkbox"/> Physical Damage(s)		
Tampering Inspection			
<input type="checkbox"/> Void Tape Intact	<input type="checkbox"/> Araldite Intact	<input type="checkbox"/> Tamper Proof casing intact	
Components Affected			
Repair Decision	<input type="checkbox"/> On Field Maintenance	<input type="checkbox"/> Company Maintenance	

Components Replaced	Component	Serial Number of Damaged Part	Serial Number of New Part installed
Root Cause Analysis			
Repaired Under Warranty	<input type="checkbox"/> Yes <input type="checkbox"/> No	UAS Active	<input type="checkbox"/> Yes <input type="checkbox"/> No
Remarks			
Field Service Engineer Signature	I have checked the flight log, battery log, maintenance log, analyzed the problems and performed necessary repairs as per customer request and company procedure. The UAS is now defect free to reenter service.		
	<input type="checkbox"/> Yes <input type="checkbox"/> No		

Table 6: Level 1 Field Service Report Template

Field	Description
Report ID	The report ID must be in format NLA-L1-FSR-UIN-NNNN, where UIN is replaced by UIN as per DGCA records and NNNN is the sequence number of the report starting from 1. Example: NLA-L1-FSR-45876234872-1, NLA-L1-FSR-45876234872-2 etc.
UIN	UIN number of the aircraft as registered with DGCA.
Serial Number	Serial number of the UA.
Pilot Name	Pilot’s name who is reporting the issue.
Engineer Name	Field engineer’s name who is attending the issue and filing the Field Service Report.
Customer	The owner of the UAS.
Place	Name of the Village/City/Town where the issue is being attended to.
First Observation Date	The date and time when the issue was encountered for the very first time. It is advised to users to intimate the issue immediately, irrespective of the severity of the issue.
Description	Describe the issue to the minute detail and problems encountered or function being blocked due to the issue. Note observations.
Measures taken by user	User/Pilot must not make any attempt to repair the UA by themselves. But, in case pilot has taken any action or attempted to solve the issue on their own, describe the actions taken.
Intervention Date	Date on which the issue is being addressed by engineer from the OEM.
External Inspection & Description	The engineer must inspect the UA and record its physical state.
Tampering Inspection	Engineer must inspect the tamper proofing components and determine if the pilot/user has tried to tamper with UA, and the same must be recorded in the Service Report.

Components Affected	List of components that the engineer conclude are damaged and need maintenance.
Repair Decision	Decision taken by the engineer to either solve the issue on field or send the UA to company service center for maintenance.
Components Replaced	Components replaced by the engineer along with mention of the serial number of components being replaced and serial number of the new component installed on the UA.
Remarks	Post maintenance comments/observations. If the engineer finds the UA to be tampered, record and communicate to OEM.

Table 7: Level 1 Field Service Report Template Field Descriptions

7.2 Level 2 Process

When a customer support request is received by the company, a field engineer is assigned for the customer. The field engineer analyzes the issue, checks the flight logbook, battery logbook to ensure everything is in order. If the engineer determines that the issue cannot be solved on the customer site, then depending on warranty terms and conditions the engineer takes the decision on how the UAS will be brought to the company service center. When the UAS arrives at the company service center, the field service engineer’s report is considered and full inspection and diagnostic is performed to determine the cause also considering flight logbook, battery logbook, previous maintenance data and confirm preliminary field report and avoid any other surprises. When the full diagnostic report is available, Level 2 repairs are performed for components according to the mentioned component replacement standard operating procedure by the maintenance engineer at the company premises. Level 2 repairs require opening the top shroud and hence the integrity of tamper protection must be restored at the end of maintenance. The components that can be replaced only in company service center are listed in the table below.

No	Part Description	Part no.
1	Motor	HobbyWing X6 Plus
2	Carbon Fiber Tube	NL_AGU_A10_1011

3	Folding Mechanism	ZDYJ30A
4	Carbon Fiber Tube Rectangular	NL_AGU_A10_1012
5	TFR-Mount with Brass Inserts	NL_AGU_A10_1013
6	OAR-Mount	NL_AGU_A10_1014
7	Landing Gear Tube	NL_AGU_A10_4001
8	Landing Gear Skid Tube	NL_AGU_A10_4003
9	Landing Gear Mount	NL_AGU_A10_4004
10	Landing Gear Tank Mount	NL_AGU_A10_4005
11	RADAR-Obstacle Avoidance	UAV-R21
12	RADAR-Terrain	UAV-H30
13	Flow Sensor	YF-S401
14	Level Sensor	XKC Y25 NPN
15	Pump	Hobbywing 5L
16	Top Shroud	NL_AGU_A10_2027
17	Top Plate	NL_AGU_A10_2022
18	Tamper Proof Casing	NL_AGU_A10_2030
19	Bottom Plate	NL_AGU_A10_2021
20	Mission Management Computer with Damper	Cube Orange +
21	Telemetry with Antenna	Skydroid T12 Air unit
22	Power Brick	Cube Orange +
23	Power Distribution Board with FR4 plate	Vector Technics Flight Core Mk2
24	CAN Hub	CAN HUB-12 MODULE FOR K++ & K3A
25	GNSS	Sierra True Nav Pro
26	CAN Hub Casing	NL_AGU_A10_5001
27	G10 FR4 Telem Plate	NL_AGU_A10_5002
28	Landing Gear Support	NL_AGU_A10_2028
29	Side Plate-Antenna	NL_AGU_A10_5010
30	Side Plate-Camera	NL_AGU_A10_5003
31	Side Plate-UIN	NL_AGU_A10_5004
32	Side Plate-SS	NL_AGU_A10_5005
33	Side Plate-Buzzer	NL_AGU_A10_5006
34	UIN Plate	NL_AGU_A10_2032
35	GPS Mount	NL_AGU_A10_5007
36	Camera	SKYDROID 3 IN 1 CAMERA
37	Buzzer	RS3480
38	Safety Switch	Hex Proficnc
39	Wire Holder L	NL_AGU_A10_5008
40	Wire Holder S	NL_AGU_A10_5009

Table 8: Components replaced during Level 2 Maintenance

The maintenance engineer at the company service center must also file a report in the format given below, to indicate the maintenance done and full list of parts replaced. A root cause analysis is also required to be performed and submitted. If there's no space on the paper, an additional paper can be used to provide the analysis.

Level 2 Company Service Report			
Report ID		Level 1 Report ID	
UIN		Serial Number	
Customer		Field Engineer Name	
Maintenance Engineer Name		Place of maintenance	
UA Reception Date		Maintenance Date	
External Inspection & Description	<input type="checkbox"/> Physical Damage(s)		
Tampering Inspection			
<input type="checkbox"/> Void Tape Intact	<input type="checkbox"/> Araldite Intact	<input type="checkbox"/> Tamper Proof casing intact	
Problems Identified			
Components Replaced	Component	Serial Number of Damaged Part	Serial Number of New Part installed
Root Cause Analysis			
Repaired Under Warranty	<input type="checkbox"/> Yes <input type="checkbox"/> No	UAS Ready for Service	<input type="checkbox"/> Yes <input type="checkbox"/> No
Remarks			
Signatures			
Maintenance Engineer		Maintenance Team Supervisor	

<p>I have checked the Level 1 field service report, flight log, battery log, maintenance log, analyzed the problems and performed necessary repairs as per company procedure. The UAS is now defect free to reenter service.</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> No</p>	<p>I have checked the Level 1 field service report, flight log, battery log, maintenance log, this report and necessary repairs are performed as per company procedure. UAS has passed post maintenance tests. The UAS is now defect free to reenter service.</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> No</p>
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Table 9: Level 2 Company Service Report

The product warranty is verified and the component is replaced as per warranty terms and conditions agreed at the time of system acquisition.

The Level 2 Company Service Report is maintained in company records for each UAS as per Configuration Management Process.

Field	Description
Report ID	The report ID must be in format NLA-L2-CSR-UIN-NNNN, where UIN is replaced by UIN as per DGCA records and NNNN is the sequence number of the report starting from 1. Example: NLA-L2-CSR-45876234872-1, NLA-L2-CSR-45876234872-2 etc.
Level 1 Report ID	Level 1 field service report ID.
UIN	UIN number of the aircraft as registered with DGCA.
Serial Number	Serial number of the UA.
Customer	The owner of the UAS.
Field Engineer Name	Field service engineer’s name who attended the customer issue on site.
Maintenance Engineer Name	Maintenance engineer’s name who is performing the maintenance at the company service center.
Place of maintenance	Name of the company service center where the maintenance is performed.
UA Reception Date	The date when UA was received at the service center.
Maintenance Date	The date on which the maintenance is performed.
External Inspection & Description	The engineer must inspect the UA and record its physical state.
Tampering Inspection	Engineer must inspect the tamper proofing components and determine if the pilot/user has tried to tamper with UA, and the same must be recorded in the Service Report.
Components Replaced	List of components that the engineer conclude are damaged and need maintenance.
Root Cause Analysis	Root cause analysis for the problem and damage to parts.
Repaired Under Warranty	Select if the UAS is repaired under warranty.
Ready for service	State whether UAS is ready to be put back into service.

Remarks	Post maintenance comments/observations. If the engineer finds the UA to be tampered, record and communicate to OEM.
Signatures	Maintenance Engineer and Maintenance Team Supervisor need to sign the form after service and tests.

Table 10: Level 2 Company Service Report Template Field Descriptions

7.3 UAS Health Monitoring Process

The UAS health monitoring process for Leap A10 UAS helps to identify and eliminate the issues that might be missed or overlooked during the design phase. Each pilot fills the flight logbook, battery logbook and maintenance logbook. The company will extract the data from these logbooks, problems and analyze for required action to be taken to eliminate the problem on the series of UAS.

UAS ID						
Comp Name	Comp ID	Last Replaced	Reasons & Root Cause	Number of Times	Improvement Action	Priority

Table 11: Continuous Health Monitoring & Improvement Data Collection

The above component monitoring table is created for each UAS. The data points taken from the Level 1 Field Service Report and Level 2 Company Service Report are entered into this dedicated excel file maintained on the secure company server for each client, each UAS. The data summarized in this Continuous Health Monitoring & Improvement Data Collection will be meticulously analyzed to develop an insight on the specific parts which are creating an operational or safety risk. The company will take required necessary action to resolve the issue and prevent it from recurrence. The actions for improvement will help improve the overall reliability of the system and performance in the field.

7.3.1 Root Cause Analysis

A Root Cause Analysis (RCA) is process will be put in place for identifying the underlying causes of problems. The purpose is to address these underlying causes to prevent the recurrence of the problem. A general procedure & template for conducting a Root Cause Analysis is described below.

RCA Process & Template	
Step	Description [Replace with actual data during RCA]
Problem Statement	Clearly articulate the problem or issue to be investigated. Be specific about the symptoms, when and where the issue occurs, and any other relevant details.
Team	A cross-functional team with members who have expertise in different aspects of the product, such as design, manufacturing, testing, and quality control are put together to perform the RCA.
Collected Data	The relevant data gathered from the field and company service records is collected for analysis.
Immediate Causes	Identify the immediate causes that led to the problem and as per previous root cause analysis. A second analysis may be performed. This could include specific components, processes, or environmental factors. Use techniques like the "5 Whys" to dig deeper into the chain of events.
Contributing Factors	List the broader factors that may have contributed to the immediate causes. This could be the design process, manufacturing procedures, supplier quality, or human factors.

Root Cause Analysis	Use one or more tools and techniques such as Fishbone Diagrams (Ishikawa), Fault Tree Analysis, or Failure Mode and Effects Analysis (FMEA) to systematically identify potential root causes.
Root Causes Priority	Evaluate the significance of each potential root cause based on factors like frequency, severity, and impact. Prioritize the most critical root causes that, if addressed, would have the most significant impact on resolving the problem.
Root Causes Verification	The root causes identified are verified through testing, analysis, or additional data collection.
Proposed Corrective Actions	Validate corrective actions applied to address each root cause. These actions should be specific, measurable, achievable, relevant, and time-bound (SMART).
Implemented Corrective Actions	Create a list of corrective actions to implement. This may involve changes to the product design, manufacturing processes, quality control procedures, or other relevant aspects.
Monitoring and Evaluation	Setup product performance continuous monitoring and assess as to whether the corrective actions effectively resolve the problem and changes are made as necessary.
Prevent Recurrence	Develop preventive measures and implement to ensure that the identified root causes do not lead to similar problems in the future. This may involve updating procedures, providing additional training, or making design improvements etc.

Table 12: RCA Process Template

Document the entire Root Cause Analysis process, including findings, actions taken, and outcomes as per template and share with relevant stakeholders.

8. Disposal

8.1 Precautions

Safety to be taken care of

- Only authorized and trained personnel should handle the Airframe component.
- Personnel should wear appropriate protective gear, including gloves and eye protection when handling the Airframe component.
- Personnel involved in the process should take precautions to avoid damaging the environment.

8.2 Record Keeping

- Records of the disposal should be kept for a minimum of five years.
- Keep a record of the disposal, including the date and location.

8.3 Procedure

Airframe disposal methodology typically involves a combination of recycling and/or scrapping the various components of an UAS.

Following are the steps in airframe disposal

- Dismantling: The first step in airframe disposal is to dismantle the UAV. This involves removing all the valuable components that can be reused. The Airframe

component should be properly packaged, labelled and transported to a certified disposal facility.

- Recycling: After dismantling, the remaining airframe is typically crushed and shredded, and the various materials are separated for recycling. For example, aluminium can be melted down and reused, while composite materials can be ground up or used in new products.
- Hazardous materials removal: Parts of an UAV may contain hazardous materials, such as batteries, fuel tanks, and hydraulic fluid. These materials must be removed and disposed properly.
- Disposal of non-recyclable materials: Materials such as insulation, are non-recyclable. These materials are typically sent to a landfill or incinerator for disposal.

8.4 Disposal Process – Carbon fibre parts

8.4.1 Procedure

- Remove the parts from the drone by using the appropriate tools.
- Disassemble the parts for proper disposal.
- The carbon fiber parts should be appropriately packaged, labelled, and transported to a certified disposal facility.

8.5 Disposal Process - Battery

8.5.1 Procedure

- Disconnect the Battery from the drone and ensure it is no longer connected to any power source.
- Dispose of the battery by following local regulations for hazardous materials. The battery should be properly packaged, labelled, and transported to a certified disposal facility or to the supplier of the batteries.

- Hazards that may be encountered during the disposal process may include flammable materials and hazardous chemicals. Personnel involved in the process should be trained to identify and mitigate these hazards.

9. Annexure A – Power Schematic

Figure 66 shows the power schematic of Leap A10. Follow this schematic to connect any power connection that was removed during maintenance process.

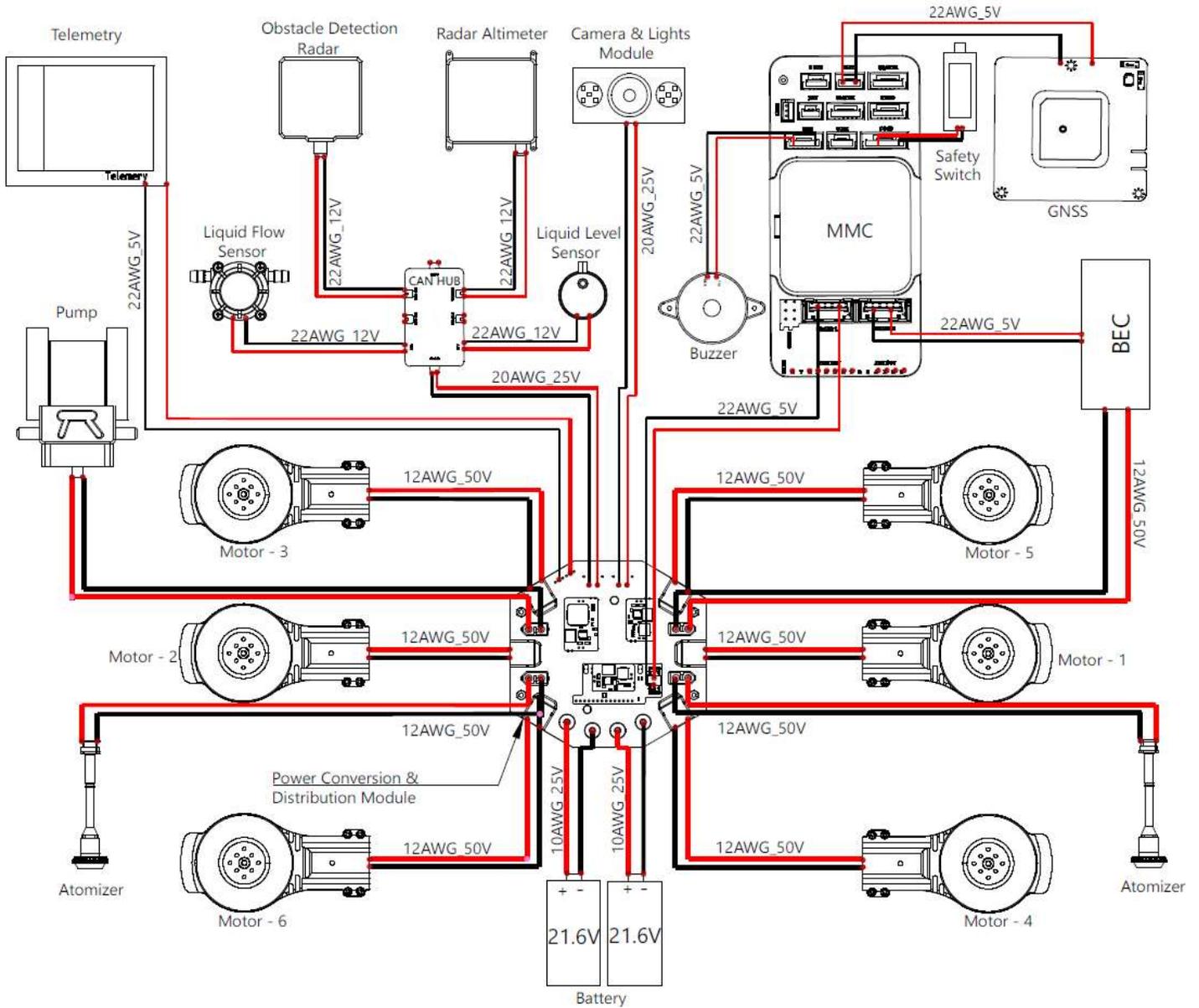


Figure 66: Power Schematic for Leap A10

10. Annexure B – MMC Signal Schematic

Figure 67 shows the signal schematic of Leap A10. Follow this schematic to connect any signal connection that was removed during maintenance process.

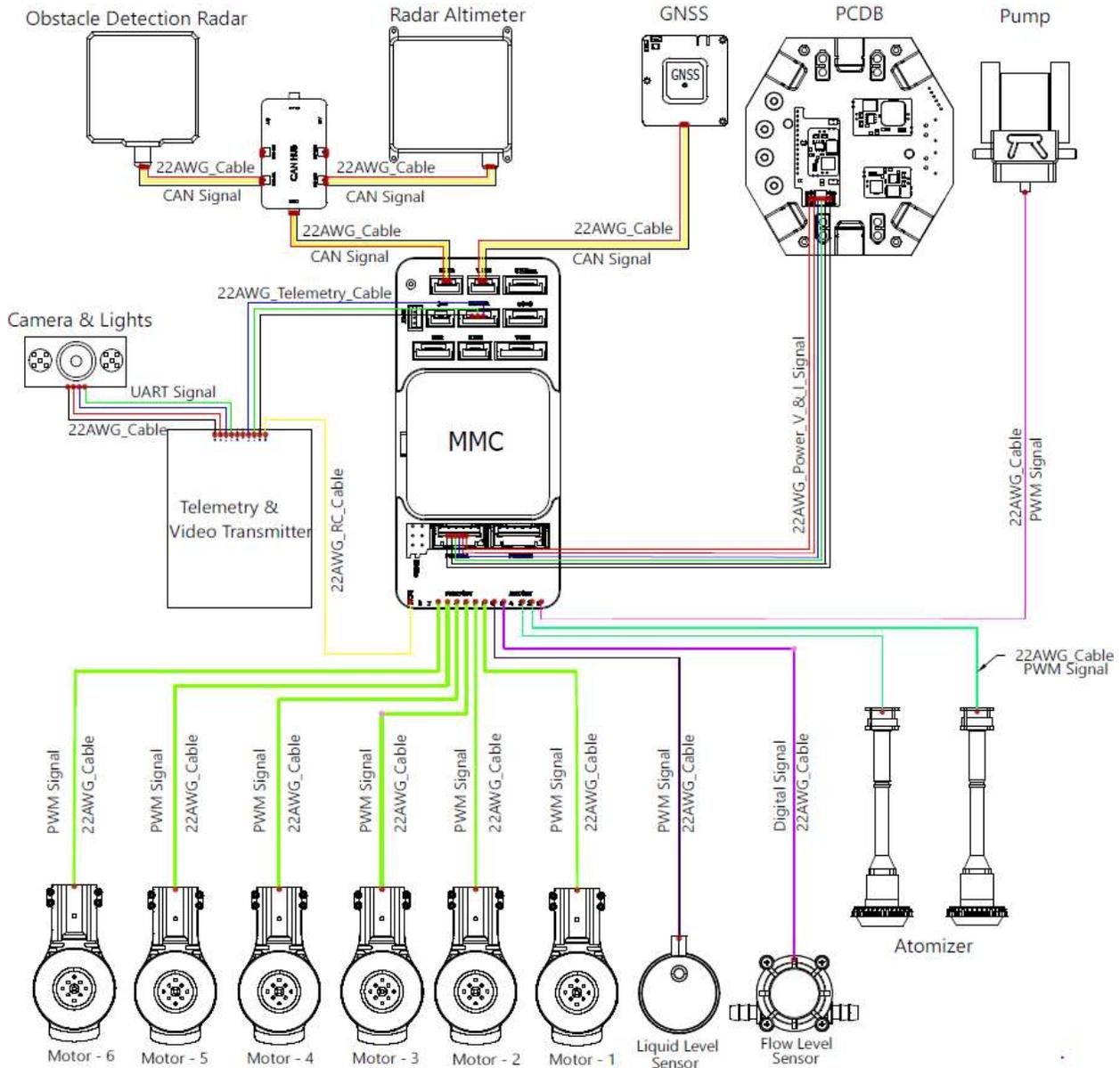


Figure 67: Signal Schematic for Leap A10