Sooryauday Aerial Vehicles Private Limited.

Plot No. 40, Sector 68, IMT Faridabad, Haryana - 121004
India.

SprayCoptor

Flight Manual V1.0

Document Name	Flight Manual
Document Number	SAV/SC/FM/01
Version Number	1.0
Date of Completion	07/09/2024

Preparing Organization	**Sooryauday Aerial Vehicles Private Limited.** Plot No. 40, Sector 68, IMT Faridabad , Haryana - 121004 India.
Document Name	Flight Manual V1.0
Document Number	SAV/SC/FM/01
Number of Pages	76
Date of Completion	07/09/2024
Prepared By	Mr. Rohan More Senior Software Engineer rohan@sooryauday.com
Reviewed By	Mr. Rohit Pandey Head - R&D rohit@sooryauday.com
Verified By	Mr. Pankaj Deval Director pankaj@sooryauday.com

UDAY NARANG
Digitally signed by UDAY NARANG
Date: 2024.09.08 15:30:34 +05'30'

Amendments to this Flight Manual shall be promulgated by means of revisions issued whenever necessary to cover corrections and to add or modify the contents. The page number and the revision number of the affected page must be changed accordingly. The list of effective pages must be amended accordingly.

Amendment Records

Version Number	Date	Author/Owner	Description of Change
1.0	23/08/2024	Mr. Pankaj Deval Director	Initial release

Document Name	Flight Manual
Document Number	SAV/SC/FM/01
Version Number	1.0
Date of Completion	07/09/2024

Table of Contents

List of Figure

List of Tables

1. Definitions and Acronyms

1.1. Acronyms

AAI	Airports Authority of India
ADC	Air Defence Clearance
ADS-B	Automatic Dependent Surveillance- Broadcast
AGL	Above Ground Level
AIP	Aeronautical Information Publication
ATC	Air Traffic Control
ATS	Air Traffic service
ARC	Aviation Research Centre
ARP	Aerodrome Reference point
BCAS	Bureau of Civil Aviation Security
BVLOS	Beyond Visual Line of Sight
CAR	Civil Aviation Requirements
DGCA	Directorate General of Civil Aviation
DGFT	Directorate General of Foreign Trade
EVLOS	Extended Visual Line of Sight
FIR	Flight Information Region
FRTOL	Flight Radiotelephone Operators License
FTO	Flying Training Organization
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
IAF	Indian Air Force
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
IPC	Indian Penal Code
MHA	Ministry of Home Affairs
MoCA	Ministry of Civil Aviation
MoD	Ministry of Defence
NOTAM	Notice to Airmen
NPNT	No Permission No-Take-off
NTRO	National Technical Research Organization
PPL	Private Pilot License
RF-ID	Radio Frequency Identification
RPA	Remotely Piloted Aircraft
RPAS	Remotely Piloted Aircraft Systems
RPS	Remote Pilot Stations
SARPs	Standards and Recommended Practices
SIM	Subscriber Identity Module
TSA	Temporary Segregated Areas
TRA	Temporary Reserved Areas
UA	Unmanned Aircraft
UAOP	Unmanned Aircraft Operator Permit
UAS	Unmanned Aircraft Systems
UIN	Unique Identification Number
VFR	Visual Flight Rules
VLOS	Visual Line of Sight
VMC	Visual Meteorological Conditions
WPC	Wireless Planning and Coordination Wing, DoT.

1.2. Definitions

- “Act” means the Aircraft Act, 1934 (22 of 1934).
- “Accident” means any accident associated with the operation of an unmanned aircraft system in which a person is fatally or seriously injured or where the unmanned aircraft system sustains significant damage or goes missing or is completely inaccessible.
- "Aeroplane" means any power-driven heavier than air aircraft machine deriving support for its lift in flight chiefly from aerodynamic reactions on surfaces which remain fixed under given conditions of flight.
- “Authorized Remote Pilot Training Organisation” means an organization authorized by the Director General for the purpose of imparting training.
- “Authorized testing entity” means an entity authorized by the Director General or the Quality Council of India for the purpose of testing unmanned aircraft systems for type certification.
- “Contracting State” means any country which is for the time being a party to the Convention on International Civil Aviation concluded at Chicago on 7th December 1944.
- “Digital sky platform” means the online platform hosted by the Directorate General of Civil Aviation for various activities related to the management of unmanned aircraft system activities in India.
- “Director General" means the Director General of Civil Aviation appointed under section 4A of the Act.
- “Drone” means an unmanned aircraft system.
- “Drone acknowledgement number” means the unique number issued by the digital sky platform under the voluntary disclosure scheme for unmanned aircraft systems in India.
- “Geo-fencing” means restricting the movement of unmanned aircraft systems within a defined airspace.
- “Green zone” means the airspace of defined dimensions above the land areas or territorial waters of India, up to vertical distance of 400 feet or 120 meter that has not been designated as a red zone or yellow zone in the airspace map for unmanned aircraft system operations and the airspace up to a vertical distance of 200 feet or 60 meter above the area located between a lateral distance of 8 kilometer and 12 kilometers from the perimeter of an operational airport.
- “Yellow zone” means the airspace of defined dimensions above the land areas or territorial waters of India within which unmanned aircraft system operations are restricted and shall require permission from the concerned air traffic control authority. The airspace above 400 feet or 120 meters in the designated green zone and the airspace above 200 feet or 60 meters in the area located between the lateral distance of 8 kilometers and 12 kilometers from the perimeter of an operational airport, shall be designated as yellow zone.
- “Red zone” means the airspace of defined dimensions, above the land areas or territorial waters of India, or any installation or notified port limits specified by the Central Government beyond the territorial waters of India, within which unmanned aircraft system operations shall be permitted only by the Central Government.
- “Hybrid unmanned aircraft” means a heavier-than-air unmanned aircraft capable of vertical take-off and landing which depends principally on power-driven lift devices or engine thrust for the lift during the flight regimes and on non-rotating airfoil for lift during horizontal flight.

- "Model remotely piloted aircraft system" means a remotely piloted aircraft system, with all-up weight not exceeding twenty-five kilograms, used for educational, research, design, testing or recreational purposes only and operated within visual line of sight.

- "Operator" means a person engaged in, or offering to engage in, an operation involving an unmanned aircraft system.

- "Person" includes an individual, a company, a firm, an association of persons, a body of individuals, a local authority, the Central Government, the State Government, and any legal entity, whether incorporated or not.

- "Prototype unmanned aircraft system" means an unmanned aircraft system developed for the purpose of research and development or obtaining a type certificate.

- "Quality Council of India" is the autonomous body set up by the Government of India jointly with the Indian Industry in a public private partnership to establish and operate national accreditation structure and promote quality.

- "Remote pilot" means an individual charged by the operator with duties essential to the operation of an unmanned aircraft and who manipulates the flight controls, as appropriate, during flight time.

- "Remote pilot license" means the license issued by the Director General to any individual.

- "Remote pilot station" means the component of the remotely piloted aircraft system containing the equipment used to pilot the remotely piloted aircraft.

- "Remotely piloted aircraft" means an unmanned aircraft that is piloted from a remote pilot station.

- "Remotely piloted aircraft system" means a remotely piloted aircraft, its associated remote pilot stations, the required command and control links and any other components as specified in the type design.

- "Rotorcraft" means a heavier-than-air aircraft supported in flight by the reactions of the air on one or more power driven rotors on substantially vertical axes.

- "Type certificate" means a certificate issued by the Director General or any other entity authorized by the Director General, certifying that the unmanned aircraft system of a specific type meets with the requirements specified under these rules.

- "Type of unmanned aircraft system" means all unmanned aircraft systems of the same basic design including all modifications thereto, except those modifications which result in a change in handling or flight characteristics.

- "Unique Identification Number" means the unique identification number issued for registering an unmanned aircraft system in India.
- "Unmanned aircraft system" means an aircraft that can operate autonomously or can be operated remotely without a pilot on board.
- "Unmanned Aircraft System Traffic Management System" means a system that provides traffic management for safe and expeditious flow of unmanned aircraft traffic and avoids collision between manned and unmanned aircraft through the collaborative integration of persons, information, technology, facilities, and services.

2. Do & Don't, Applicability of Drone Rule for Operations

2.1. Airspace Maps

The map of Indian Airspace published by the Central Government on Digital Sky Platform which gives details of the restricted or non restricted airspace for UAS flying.

2.2. Zonal Restrictions

Before starting an UAS operation, an operator should mandatorily verify the digital sky platform for any notification or restriction applicable to UAS operations in the intended area of operation.

2.3. Requirement of Permission

2.3.1. Operation In Red Zone

No person is allowed to operate an unmanned aircraft system in a red zone or yellow zone without prior permission.

2.3.2. Operation In Green Zone

No prior permission shall be required for operating an unmanned aircraft system in a green zone, subject to the provisions of rule 2.3

2.4. Dynamic Nature of Zoning

The Central Government may update the airspace map on digital sky platforms for unmanned aircraft system operations from time to time in order to change the status of an area from one zone to another and such change shall come into effect no sooner than seven days after the date of such update.

2.5. Temporary Red Zone

If there is an urgent need to temporarily prohibit unmanned aircraft system flights in any specified area, the concerned State Government or the Union Territory Administration or a law enforcement agency may declare a temporary red zone over such specified area, for a period not exceeding ninety-six hours at a time, by notifying it through the digital sky platform and highlighting it on the airspace map.

It is mandatory to check the Airspace Map on Digital Sky Platform before planning an UAS operation in the intended area.

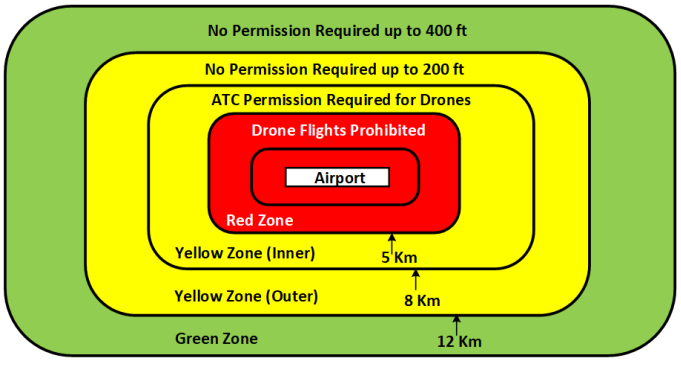


Figure 1: Drone Flying Zones - Permission Protocol

3. Specifications of "SprayCoptor" UAS

Table 1: SprayCoptor AGUAV Specifications

Sr. No.	Specification Description	Value
1	Manufacturer's Name	SooryaUday Aerial Vehicles Private Limited
2	Manufacturer's Address	Plot No-40, Sector-68, IMT Faridabad, Faridabad, Haryana, India - 121004.
3	RPAS Model	**SprayCoptor**
4	Model Description	SprayCoptor is a rotorcraft with hexa-copter 'X' configuration It is designed for spraying agrochemicals with a system that uses four flat spray nozzles. It has a tank that can hold 10 liters of chemicals used for farming, like pesticides or fertilizers. The machine is built using strong materials like carbon and Aluminium.
RPAS Details		
1	RPAS Category	Rotorcraft
2	RPAS Class	Medium
3	RPAS Subcategory	RPAS
4	Maximum Take-off Weight	**30.7 Kg**
5	Overall Dimension (L X B X H)	2030±20 X 1850±20 X 680±5 mm
Payload		
1	Details of Compatible Payload	Fixed Payload: Tank, Pump, Pipe, Flat Jet Nozzles, Connectors, Flow meter etc. Variable Payload: 10 Litre Max Liquid Payload
2	Variable Load/Consumables	10 L or 10 Kg Agrochemicals
3	Tank Max Capacity	11.4 L
4	Tank Material of Construction	ABS Plastic
5	Spray Nozzles	Flat Jet Spray Nozzles
6	Spray Width/Swath	4 - 5 m
7	Droplet Size	300 µm to 600 µm
Power Plant Details		
1	Motor Type	BLDC Motor
2	Power Rating	2399 W
3	No. of Motors	6
4	Battery Capacity	25000 mAh
5	Number of batteries	2 (Connected in series)
6	Battery Type	Lithium Polymer
7	Battery Voltage Range	20.4 V to 25.2 V
8	Propeller Details (Diameter, pitch, Maximum RPM)	Diameter: 24 inch, Pitch: 8.0, Maximum Speed: 5527
GPS/GNSS Equipment Details		
1	GPS/GNSS	Here 3 Plus
2	GPS Constellations	GPS: L1C/A GLONASS: L10F

		Beidou: B1I Galileo: E1 B/C
3	GPS Module Accuracy	±2.5 m
4	Autonomous Flight Termination System	Yes
5	Return to Launch in case of empty tank or battery threshold	Yes
6	Flashing Anti-Collision Strobe Lights	No
7	Navigation Lights/Bacon LED's	No
8	RFID	No
9	GSM Sim Card	No
10	Flight Controller with Data Logging Capability	Yes
11	SSR Transponder	No
12	Barometric Equipment	No
13	Detect and Avoid Capability	Yes
Remote Pilot Station (GCS)		
1	Ground Control Station Model	SkyDroid T12
2	GCS App and Version	AeroGCS GREEN V1.39
3	Operating Frequency	2412 to 2472 MHz
4	Max Transmission Range	15 Km
5	Operating Temperature	-10°C to +50°C
C2 Link (Command and Control)		
1	Equipment Details	SkyDroid T12
2	Frequency Band	2412 to 2472 MHz
3	ETA/WPC Serial Number	ETA-SD-20230403305 Dated: 14-04-2023
Performance Details		
1	Maximum Endurance	Case 1: Dispense Payload, Land, refill, repeat, Continue till battery failsafe: 17 Minutes Case 2: Dispense Payload, Continue Till Battery failsafe: 23 Minutes Case 3: Without Payload, Continue Till Battery failsafe: 24 Minutes
2	Maximum Range (In still Air)	1 Km
3	Maximum Operating Speed	10 m/s
4	Maximum Operating Altitude	40 m AGL (98.4252 feet)
5	Maximum Altitude Attainable (Ceiling Altitude)	1900 m AMSL (6233.596 feet)
6	Operating Temperature	-10°C to +50°C
7	Maximum Wind Resistance	0 - 6 m/s
8	Maximum Rotor RPM	5527
Documents/Manuals/In-box Items		
10	RPAS Flight Manual	Yes
11	Maintenance Inspection Schedule	Yes
12	RPAS Maintenance Manual	Yes
13	RPAS Operation Logbook	Yes
14	Battery Charging logbook	Yes
15	Drone Transportation Box	Yes

16	Tool Kit for UAS	Yes
Application		
1	Intended Application	Agricultural Spraying
Flight Modes		
1	Modes	Loiter, Auto, RTL, Brake
Failsafe		
1	Return to Launch (RTL)	RTL failsafe will be triggered in case of: ● C2 Link Loss Failsafe ● Low Battery Failsafe ● Geofence Breach by UAS ● Empty Tank/Spraying Complete

RC Failsafe: When the Remote Controller shuts down its Transmission to the UAV or the transmission is obstructed due to obstacles ao any environmental condition the UAV will try to reestablish the RC Communication for 5 seconds and if it is not reestablished as a failsafe the UAV will trigger the RTL.

Low Battery Failsafe: When the battery voltage reaches 41.2 V the UAV triggers the RTL.

Geofence Breach Failsafe: When the UAV Breaches the Fence given by the pilot during the plan for the auto spraying or it breaches the maximum range of 1000 m, the UAV will trigger the RTL

Empty Tank Failsafe: When the Tank gets empty during the spraying operation the UAV will trigger the RTL.

3.1. Items Included in the Box

Sr. No.	Item Description	Quantity
1	SprayCoptor UAS Set	1
2	Battery Charger	1
3	Battery Set	1
4	Remote Controller	1
5	Remote Controller Case	1
6	Remote Controller Charger	1
7	Drone Carrying Box*	1
8	Flight Manual	1
9	Maintenance Manual	1
10	Maintenance Inspection Schedule	1
11	Maintenance Logbook	1
12	Battery Charging Logbook	1 For Each Battery
13	Flight Logbook	1
14	Certificate of Conformity	1
15	Pneumatic Connector Spares for Spraying System	1 of Each Type
16	Tool Kit	1

*Note: * Indicates that the Drone Carrying box is optional.*

3.2. Components of SprayCoptor UAV

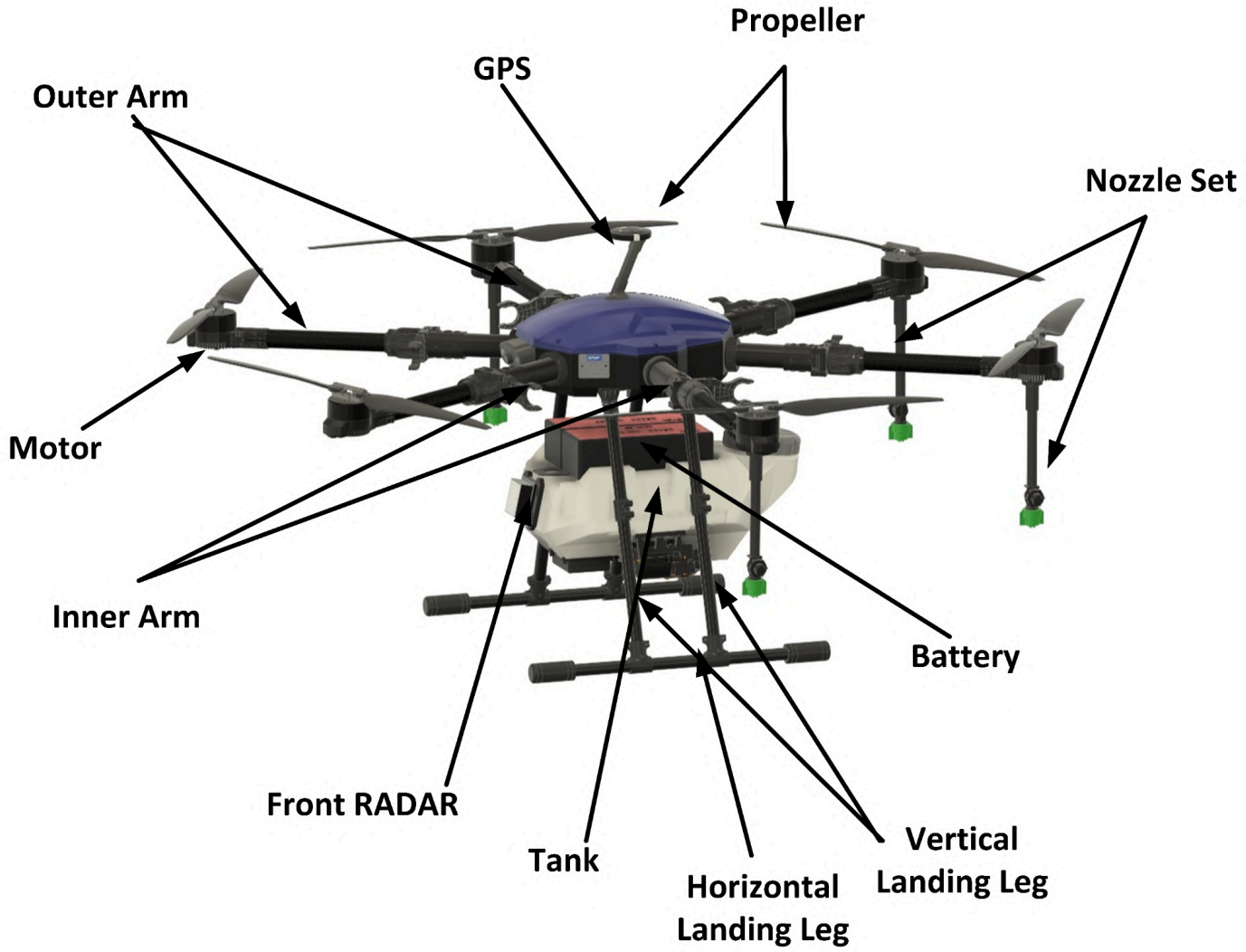


Figure 2: Components of SprayCoptor UAS

4. Ground control station (GCS)

4.1. Ground Control Station Hardware

The GCS (Ground Control Station) is an advanced transmitter system that allows for the seamless control of the "SprayCoptor" without the use of any external devices. This innovative technology leverages the capabilities of the SkyDroid T12 RC transmitter as a GCS hardware tool, which is further enhanced by the installation of the AeroGCS GREEN ground Control station software.

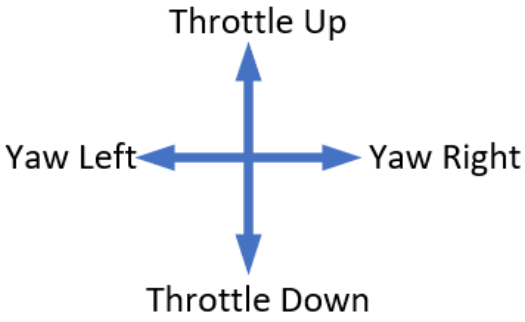
Together, these elements create a powerful control system that provides a comprehensive range of features for users. With the GCS, pilots can easily manage the aircraft's flight path, video transmission, gear control, and more, all from a single, streamlined interface. Additionally, the GCS includes a touch screen display that provides real-time system status updates, allowing for quick and easy adjustments as needed.

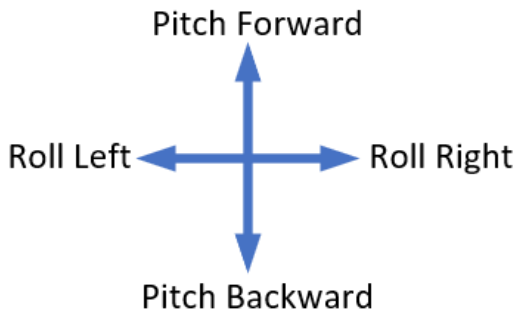
Figure 3: GCS hardware - Front

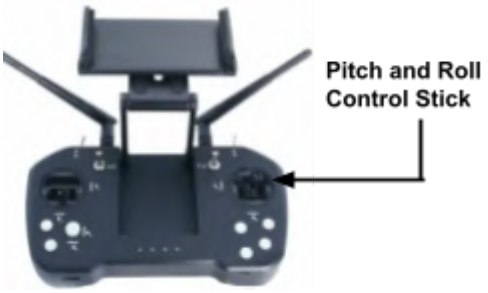
For Arming: Move Throttle JoyStick down and then to Right for 3 sec (To Arm Drone). Make sure the Safety Switch is Off.

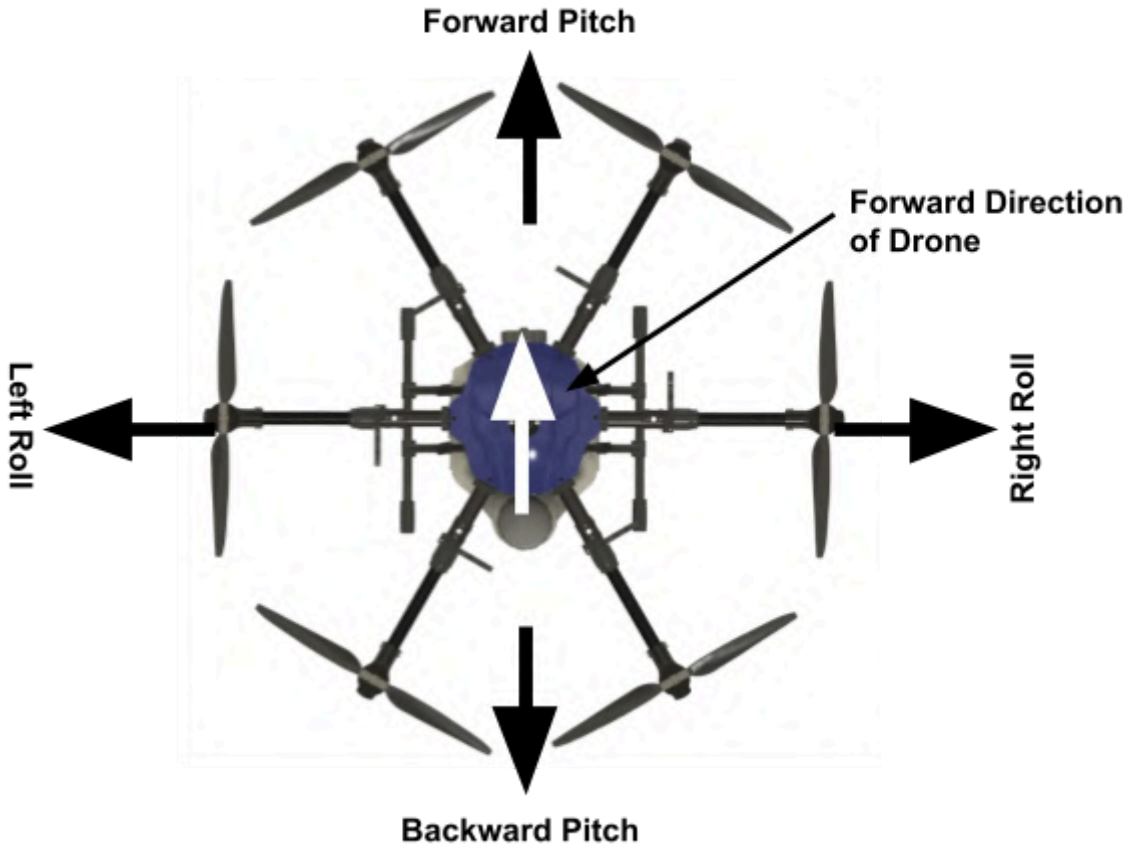
For Disarming: Move Throttle JoyStick down and then to Left for 3 sec (To Disarm Drone)

4.1.1. RC Controls









4.1.2. Sprayer Master Switch

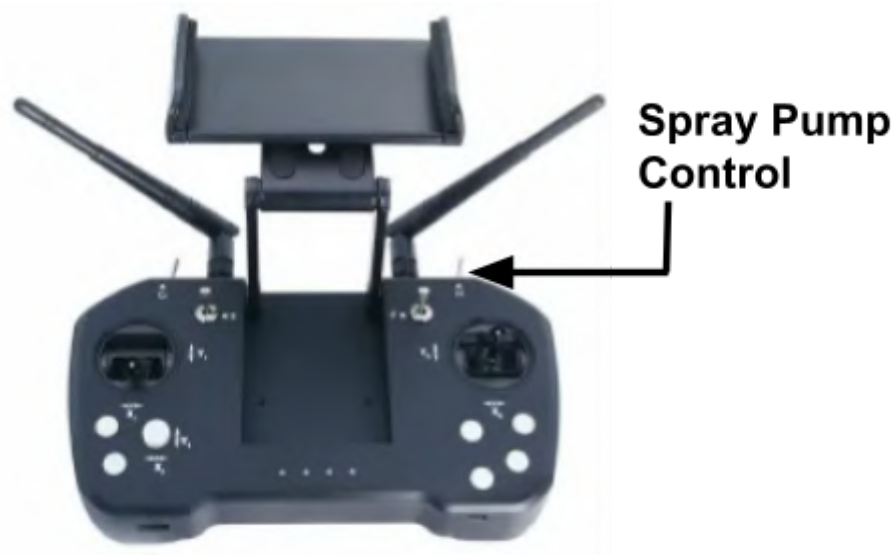


Figure 4: Sprayer Pump Switch on GCS

- To control the spray pump ON/Off, just press the '**C**' switch button once.

4.2. Ground Control Station Software

The **AeroGCS GREEN** Application is composed of two primary sections, the View section, and the Status Icons.

The View section is the primary area of the interface and is designed to provide users with a comprehensive view of the aircraft and its surroundings. This section is divided into several sub-sections, including:

- **Map View:** This subsection displays a live map of the aircraft's location, providing pilots with a clear view of the surrounding terrain, waypoints, and other relevant data.
- **Instrument Panel:** The instrument panel displays real-time information about the aircraft's altitude, speed, direction, and other critical flight data.
- **Camera View:** The camera view sub-section displays live footage from the aircraft's camera, allowing pilots to monitor the aircraft's surroundings and capture video or images as needed.
- **Flight Plan View:** This sub-section displays the aircraft's flight plan, including waypoints, altitude, and other critical information.

The Status Icons section of the interface provides users with real-time information about the aircraft's status, including battery life, GPS signal strength, and other critical data. These icons are designed to provide users with a quick and easy way to monitor the aircraft's health and act if necessary.

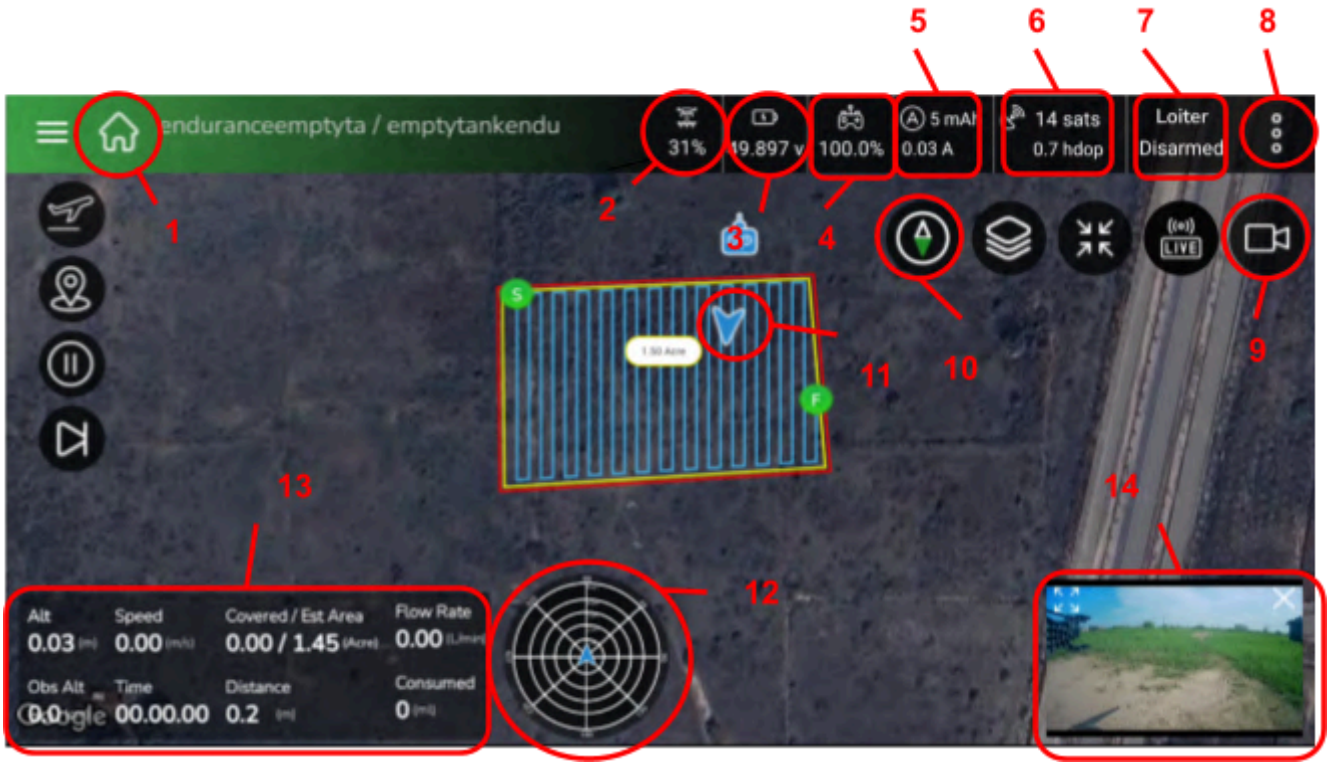


Figure 5: AeroGCS GREEN User Interface

- **1-Home Section:** It consists of all the auto and manual projects that we have created.
- **2-Pump Spray Rate**: This icon shows the spray pump rate in percentage. In manual mode, users can click on this icon to change the spray rate at any point of time. It is recommended to spray at 40% - 60%.
- **3-Battery Voltage:** It will show the current voltage left in the battery.
- **4-RC Signal strength:** It will provide the signal strength of C2 data link in the percentage.
- **5-Battery Consumption:** It will show the amount of current drawn by the system at a given time.
- **6- Satellite Status**: It will provide the number of satellites, HDOP value & GPS lock.
- **7-Flight Mode**: It will show the flight mode of the UAS and the arming state.
- **8-Main Menu**: It has all the settings options like connection, RC setup, Calibration, Sprayer, and flow meter settings etc.
- **9-Camera View**: - When you click on this icon, it will show the camera feed. Make sure, the RC controller is connected to the device via USB cable.
- **10-UAS Orientation:** It will show the UAS direction with respect to the GPS orientation.
- **11-HUD Orientation:** This Icon shows the current location and orientation of UAS and RC controller (If internet is active).
- **12-Obstacle RADAR Proximity Data**: This shows the location and of the obstacle in front of UAS, if the distance is less than 10 m, it will continuously beep the audible sound to inform about the obstacle ahead of it.
- **13-Instrument Panel**: This will give the rest of the information about UAS like the altitude, current forward speed, Flow rate of pesticides, Terrain RADAR altitude readings, Time of Flight and amount of pesticides consumed etc.
- **14- Camera View window:** This will show the live camera feed from the onboard FPV camera of UAS.

4.3. Smart Product Features

4.3.1. Obstacle Avoidance RADAR

Figure 6: Obstacle Avoidance RADAR

The SprayCoptor UAS boasts advanced features, including obstacle avoidance technology. These state-of-the-art technologies have been seamlessly integrated into the UAV to elevate safety and optimize flight performance during missions.

Obstacle Avoidance is a crucial feature in agricultural drones. It detects objects from 30 meters away and maintains a 10-meter distance in manual (Loiter), Waypoint Mission (Auto), RTL modes. This ensures safe and uninterrupted operations, enhancing the efficiency and reliability of agricultural tasks.

JIYI's R21 obstacle avoidance radar is specially engineered to detect potential obstacles in the UAV's flight path. When activated, these sensors can identify objects such as trees, buildings, or other obstructions and trigger the UAV to halt automatically. This proactive approach reduces the risk of collisions and ensures a seamless and secure flight experience.

However, while this feature significantly enhances the UAV's capabilities, it's imperative for responsible users to remain vigilant during flights and not solely rely on these sensors. Maintaining situational awareness and being prepared to assume manual control when necessary are critical aspects of safe UAV operation.

We strongly recommend familiarizing yourself with the operation and settings of these sensors, as outlined in the user Flight manual. A thorough understanding of these features will empower the user to leverage the UAVs full potential and ensure the accomplishment of safe and successful missions. The radar is installed in front of the drone and tilts upwards by 15 degrees. It should be noted that there is no obstruction in the range of 15 degrees in front.

Operate the UAS 2-3 m above the crop canopy for efficient spraying. Flying below 2 m altitude from crop canopy can result in obstacle detection. (Crop itself may get detected as an obstacle.)

Here is the image that shows the view of the obstacle avoidance system.

4.3.2. Terrain Following RADAR

Terrain following is an essential feature in drones, made possible by a JIYI's H30 terrain-following radar. This sensor enables the drone to adjust to the terrain's angle, allowing it to accurately follow the natural inclines and declines of the ground.

By matching the terrain's slope, the drone can maintain a consistent and optimal flight path, even over uneven or rugged landscapes. This capability improves the drone's maneuverability and stability, ensuring precise and efficient operations across diverse terrains and facilitating navigation through challenging agricultural environments with ease. **The Detection of the terrain starts from 2 meters above the ground.**

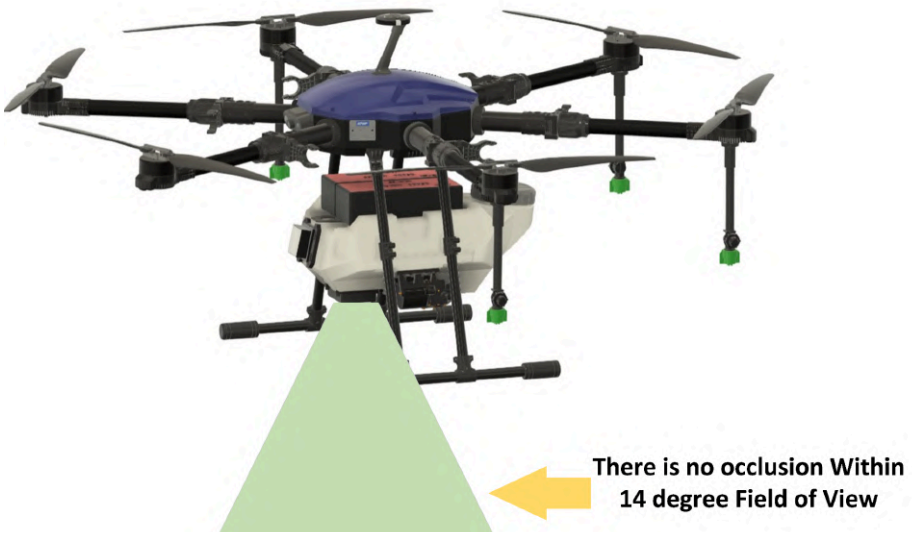


Figure 8: Terrain following sensor working schematic

5. Precautions Before Starting the Drone

5.1. Follow Safety Guidelines

To ensure both your safety and compliance with aviation regulations, it is of utmost importance to adhere to the directives issued by the Directorate General of Civil Aviation (DGCA) regarding the operation of UAVs within Indian airspace. These guidelines have been crafted to guarantee responsible UAV usage, mitigating any potential risks to individuals and property.

5.2. UAS Operation in HIRF is Restricted

It is strongly advised to not to fly the UAS against the areas affected by HIRF (High Intensity Radiated Field) or strong magnetic fields. HIRF denotes radio-frequency energy with the potential to negatively impact living organisms or the performance of electronic devices exposed to it. Users are cautioned against operating the UAV near RADAR installations, radio towers, High and Low voltage power lines or any other terrestrial, maritime, or airborne Radio Frequency (RF) transmitters.

5.3. UAS is IP53 Rated

Flying the SprayCoptor UAS is not recommended during rainy conditions, underwater, or within red and yellow zones. UAS is IP53 rated for its dust and water resistance. Dusts can enter the inside of the drone, but it can't damage the device. But on the water side, only resistant to water spray up to 60 degrees vertical angle.

5.4. Geofence Restrictions

The UAS is equipped with predefined fence parameters within its Autopilot firmware to limit its movement beyond the designated boundaries from its home location. These fence settings serve to control the UAVs movement during planned missions and offer adjustable boundary options.

5.5. No Dedicated Shock Absorbing Mechanism is Installed

The UAS has vertical take-off and landing capabilities, so, there is no dedicated shock absorbing mechanism installed. Make sure every landing is smooth. Harsh or hard landings may cause damage to the landing gears. Visually Inspect the landing gears after the flight, if any deformation/damage is observed, contact the manufacturer for technical support.

5.6. Day and VLOS Operations Only

UAS is only intended to be used during day operations within the visual line of sight of the operator. **Anti-collision strobe lights are not present on UAS**, so avoid the flights in low visibility weather conditions.

5.7. UAS Maintenance

Maintenance stands as a critical component in ensuring the peak performance and durability of your Agricultural UAV. It is important referring to the Maintenance Manual accompanying the UAV to maintain its optimal functionality. Timely maintenance and adherence to recommended service schedules not only enhance the UAVs efficiency but also contribute to safe and reliable operations. Neglecting maintenance may lead to reduced performance, potential malfunctions, and the voiding of warranties.

5.8. Tank Level Filling

For safe operation, please fill the agricultural drone tank up to the 10-liter mark, even though the maximum capacity is 11.4 liters. Overfilling may compromise stability and safety during operation and affect the regulatory requirements.

Figure 9: Maximum Tank Filling Marking on Tank

5.9. PSEs Inspection

PSEs should be inspected after every flight for wear and tear due to operation. Check for any damage and distortion. Get it replaced if necessary by the manufacturer.

6. Packing and Unpacking of UAV

Figure 10: Packed/Folded configuration

Figure 11: Fully opened/Ready-to-Fly configuration

7. Subsystems of SprayCoptor UAS

7.1. Propulsion System

The SprayCoptor UAS achieves its maneuvers by employing a system of six BLDC (Brushless Direct Current) motors. Each of these motors is equipped with a 24-inch folding propeller. These motors are strategically arranged in alternating clockwise (CW) and counter clockwise (CCW) configurations, which effectively cancels out rotational inertia and ensures maximum stability during flight.

The SprayCoptor UAS motor system is powered by a 50.4 V electrical supply, capable of delivering a maximum thrust of 11.9 kg per rotor at sea level. This results in a combined thrust of 71.4 kg, providing substantial lifting power. The 2480 propellers are designed for high strength and are lightweight, offering excellent consistency and dynamic balance. They perform exceptionally well even at high RPMs. Lighter propellers have a lower moment of inertia, which means the motor requires less torque to achieve the same RPM. This characteristic leads to quicker RPM adjustments, enhancing the drone's responsiveness and overall flight performance.

7.2. Battery

The SprayCoptor relies on 2 x 25000 mAh Lipo batteries for its flight power source. It is imperative that both of these batteries adhere to the same specifications and have undergone a similar number of charge and discharge cycles. Consequently, the two batteries comprising a single flight pack should be maintained as a matching set to ensure consistent and reliable performance during flight operations. This practice helps maintain balance and uniformity in the power supply, contributing to the overall safety and stability of the UAV.

7.3. Electrical System

The power from the flight packs is linked through the main power plugs, which connect to a central power distribution board (PDB). This particular PDB is rated for a continuous power input of up to 480 A, demonstrating its robust capacity to manage power distribution effectively.

The flight controller, designed for enhanced reliability and streamlined integration, plays a pivotal role in managing the UAVs functions.

Each of these 6 propulsion units is directly connected to the PDB, drawing power directly from the batteries via the Electronic Speed Controller (ESC). The ESC facilitates the transmission of power, data from both the batteries and the flight controller to the propulsion system, ensuring smooth and efficient operation. This setup contributes to the overall efficiency and performance of the SprayCoptor UAS.

7.4. Payload

The SprayCoptor UAS has been designed to ensure safe operation while carrying a 10-liter pesticide payload. It is configured with a reliable propulsion system. This payload configuration comprises both fixed and variable components.

The fixed payload includes a sophisticated spraying system, featuring options such as flat jet nozzles along with essential components like pipes, pumps, tanks, and pipe connectors. On the other hand, the variable payload consists of agro-chemicals, which can be loaded up to a maximum of 10 kg or 10 liters, filling the tank made of ABS plastic material. The clearance from the ground to the bottom of the payload is 92 mm, providing ample space for operators to work on the tank and facilitate easy filling.

The tank itself has a total capacity of 11.4 liters, with a dispensing payload capacity of 10 liters. This additional capacity allows for accommodating frothing. It is crucial for users to fill the tank only up to the 10-liter mark, which is clearly indicated on the tank, ensuring safe and efficient pesticide dispensing.

The tank has 11.4 L available capacity but filling volume has been restricted to up-to 10 L or 10 kg. The mark of 10 liters is described on the tank.

The UAVs spray system offers a precise and efficient means of applying pesticides and fertilizers from the air. To use it, simply fill the tank with the desired liquid. During flight, the pump pressurizes and disperses the liquid through the nozzles. The system's adjustable flow rates and droplet sizes guarantee even coverage, minimizing wastage and expenses.

As the payload is the integral part of UAS, operators/users are not allowed to make any changes to the payload system. Only authorized persons from the manufacturer will install and do the necessary changes to the payload system.

Figure 12: Physical working of spraying system

7.4.1. Components of Spraying System

- **Battery:**

  This is the power storage unit and supplies to other components. GENX Lipo 6S1P 25000 mAh Battery is used. It has a capacity of 25000 mAh and nominal voltage of 22.2 V. The battery has a discharge rate of 25 C with a net weight of 3.135 Kg.

- **PDB:**

  PDB (Power Distribution Board) is a board that allows transferring the power from the battery to ESCs / Motors. The PDB has 8 different ports which can provide continuous live battery voltage. The PDB is capable of handling 480A current and capable of providing power for UAV.

- **Tank:**

  Stores the liquid inside it and has the storing capacity of 11.4 L but the filling is restricted to 10 L or 10 Kg.

- **Pump:**

  It is used to pump the liquid payload from the tank and raise sufficient pressure so that the liquid flows through the pipes and goes to the nozzle. The pump has a rating of 35 W with a maximum flow rate of 5 L/min. Voltage rating is 12V with a rated pressure of 0.48 MPa.

- **Flow meter:**

  Measures the flow of liquid from the tank to the spray system and gives PWM input to the Flight controller.

    - Measurement range: 0.5-5 L/min
    - Accuracy: 10 ml

- **Flat Jet Nozzle:**
  A flat jet nozzle, also called a spray nozzle, is a device that facilitates the dispersion of a liquid by the formation of a spray. Doubling the pressure while maintaining the same flow rate results in a doubling of the impact. Flat jet nozzles stand for high impact and uniform liquid distribution with spray angles up to 60°. Flat jet nozzles with low flow rates are especially suited for humidifying and spraying in general. The specifications for flat jet nozzles by EFT are given below.
    - Opening Flow: 4-5 L/min
    - Spray Width/ swath: 4 m
    - Working Pressure: 0.35 MPa
    - Droplet Size: 300-600 microns

A flat jet nozzle serves the purpose of spraying onto a surface or an object moving in a transverse direction with respect to one of the jet surfaces. Flat jet nozzles produce a thin, flat liquid sheet spreading outwards from the nozzle tip. These have been developed to reduce spray drift, which was beneficial to target deposition.

7.4.2. Leak Prevention and Inspection of Spraying Accessories Connections

- **Purpose:** The proper functioning of spraying accessories connections, including the tank, pump, flow meter, and pipe connectors, is crucial to the safe and effective operation of the drone spraying system. Ensuring leak-free connections is essential to prevent any inadvertent leakage of chemicals during flight.
- **Pre-Flight Inspection:**
- **Tank Connection:**

  Before each flight, ensure that the tank connection, where the chemical solution is stored, is securely fastened and free from any visible signs of wear or damage.

- **Pump and Flow Meter**:

  Inspect the pump and flow meter connections for any loose fittings, cracks, or signs of leakage. Ensure that all components are properly aligned and tightened.

- **Pipe Connectors:** Examine all pipe connectors, such as hoses and nozzles, for secure attachment. Verify that there are no kinks, blockages, or damage to the hoses that could lead to leaks.
- **Pressure Test before Take-off:**

  Check all the spraying connections, and then start the pump at 85% capacity and do a visual check on each connection for any sign of leakage. If some signs are observed, then rectify the connection before take-off.

- **Proper Connection Techniques**:

  Use appropriate fittings and connectors designed for the specific purpose, ensuring compatibility with the spraying system. When connecting or disconnecting accessories, follow the manufacturer's guidelines regarding tightening torque and sealing methods to prevent leaks.

- **Leak Testing:**

  Conduct a leak test on the entire spraying system, paying particular attention to the accessories' connections. Follow the procedures outlined in the "Conducting a Leak Test" section of the User Manual.

- **Maintenance and Servicing:**

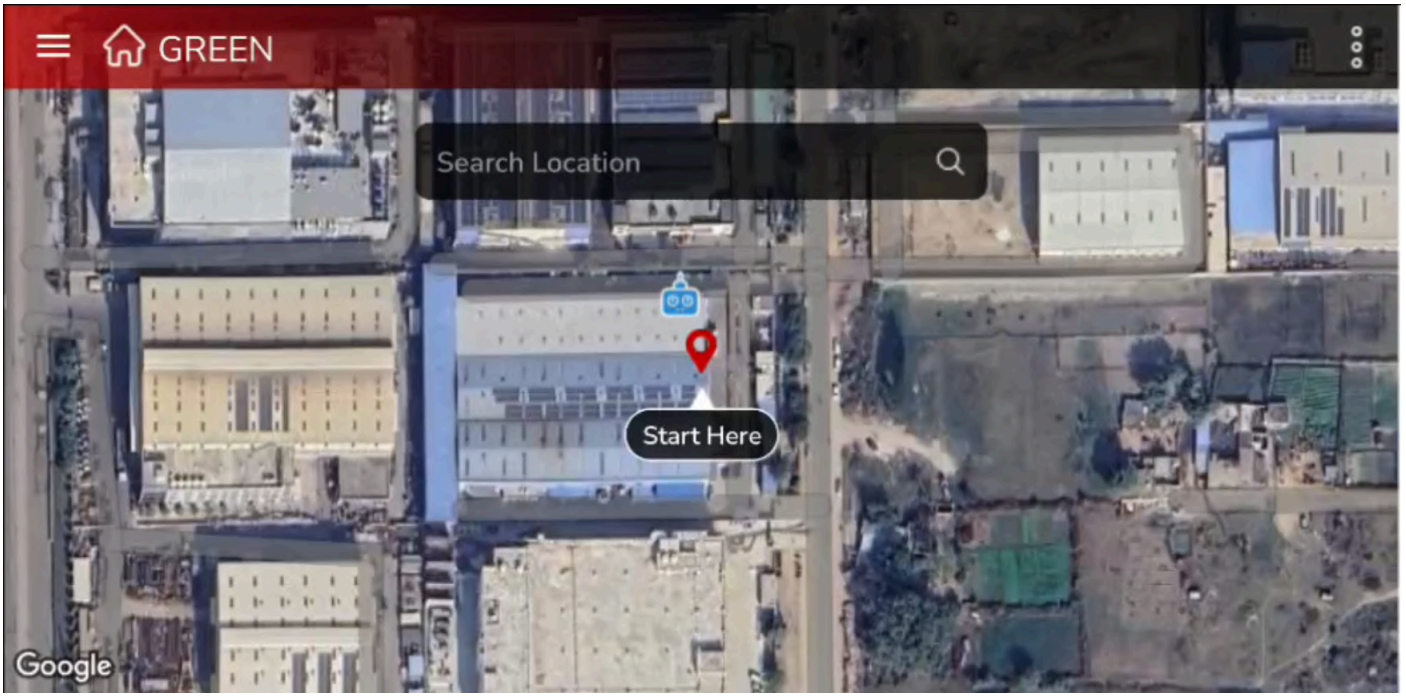
  Perform routine maintenance to inspect and maintain the spraying accessories connections. Replace damaged or worn components promptly. Lubricate moving parts as per the manufacturer's recommendations to prevent corrosion and maintain the integrity of connections.

7.5. Connecting UAV to AeroGCS ground control station

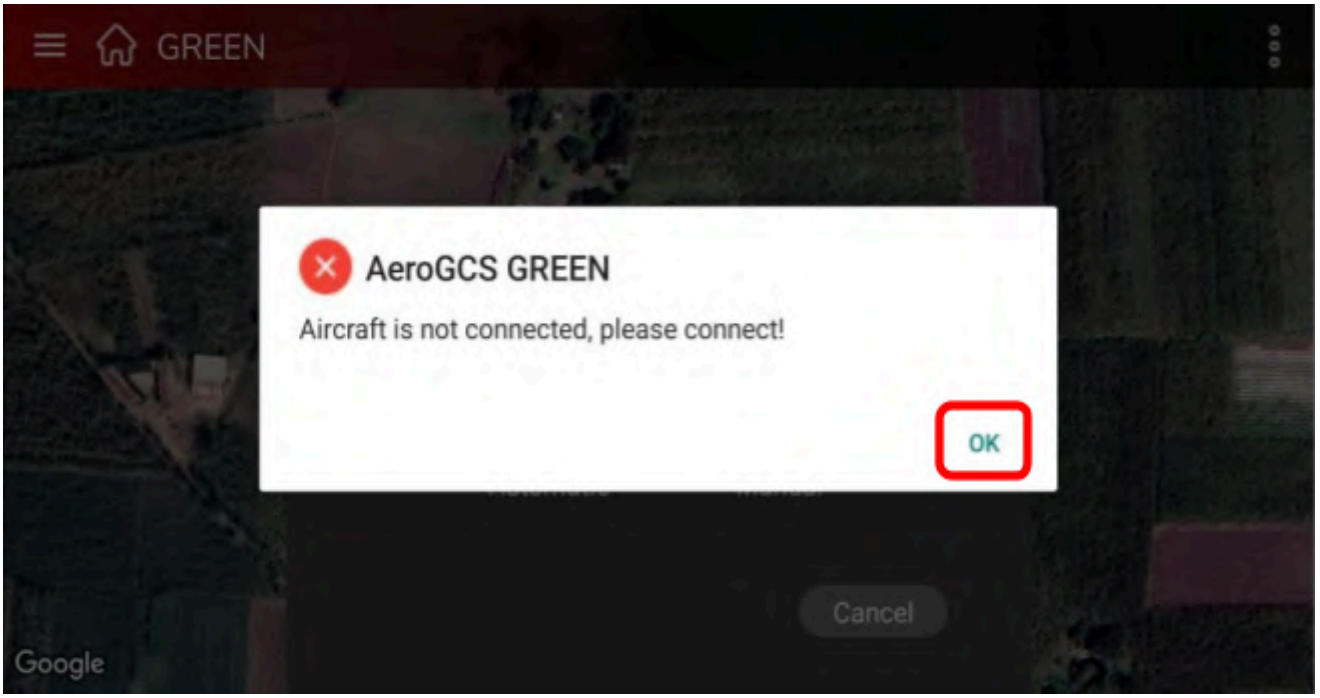
- Install AeroGCS GREEN Android app on your Android smartphone from Google Play Store.

Figure 13: AeroGCS GREEN Starting Window

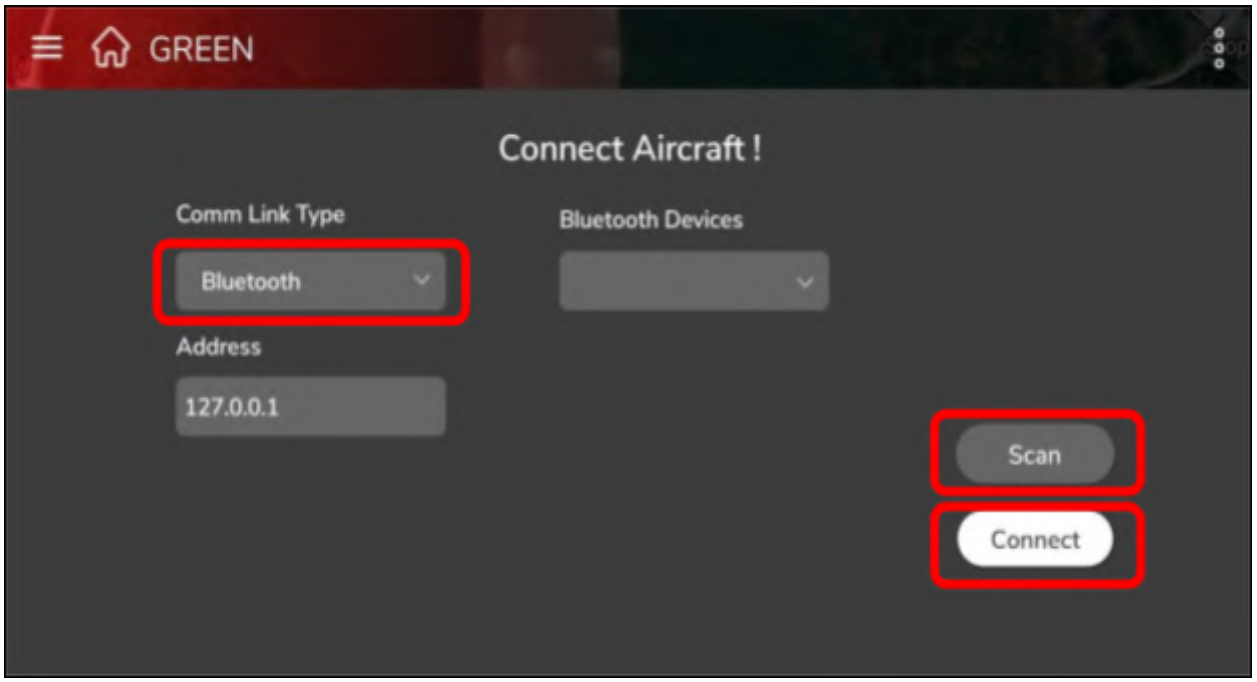
- Then click on the "**Start Here**" icon as shown in figure 14.



- After clicking on the Start Here icon, it will show two options for flying to start with. 1. Automatic 2. Manual. Select appropriate mode as per requirement.
- After you select either of the options, it will ask to connect it to the vehicle, click on **OK** to proceed for vehicle connection.



- Once you click on **OK**, it will redirect to Aircraft connection, select the connection type as Bluetooth, make sure that your smartphone Bluetooth is turned on. Click on the **Scan** button and select the appropriate Bluetooth device to connect.



- Once you select the appropriate transmitter device (T12), it will get connected and show all the GCS data as shown in the figure below. The Red connection status changes to Green which indicates the connection of UAS and the RSSI strength denotes the signal connection strength.

- Connection should be established once completely parameters are been loaded by the GCS
- Check for the flight parameters (Voltage, Signal Strength, Satellite count, HDOP, Mode, Arming State, Altitude etc) and ensure sensor readings are updated.

- After connection, GCS performs Pre Checks for critical parameters like Battery Level, Current Flight Mode and Number of satellites connected as shown in below figure. Click on **OK** to continue with the flight. If parameters are in an acceptable range, do resolve the problem before arming the drone.

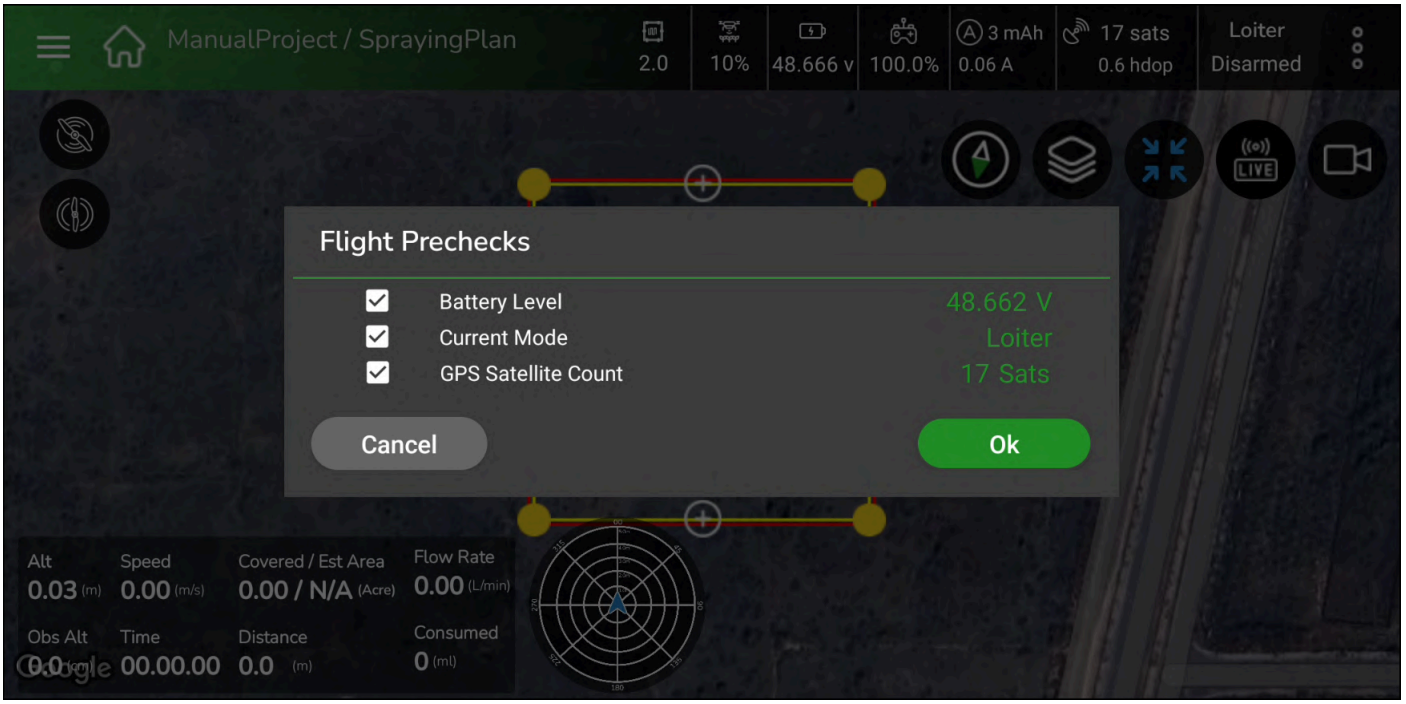


Figure 14: AeroGCS GREEN Pre-flight Checks

8. Calibration of Sensors

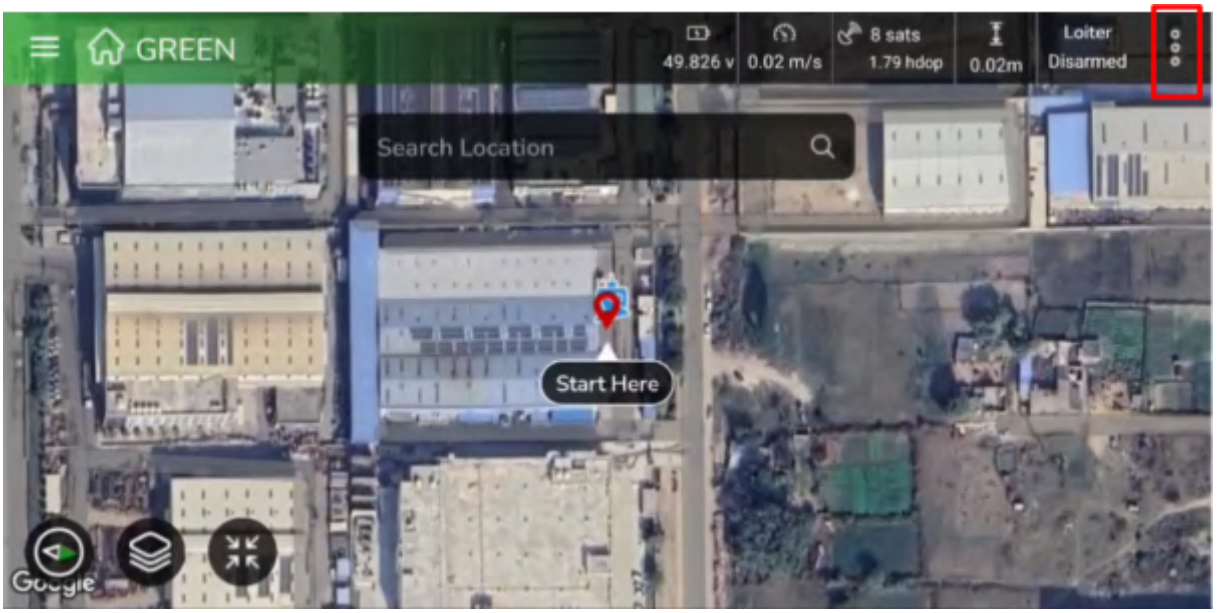
It is crucial to perform a thorough check of all the calibrations before taking off with a drone. This is because if any of the calibration processes are not completed correctly, the drone will not arm, and it will not be able to take flight.

Calibration is the process of adjusting and configuring the various components of a drone to ensure their optimal performance. There are different types of calibrations required for different components of the drone, such as the Compass, Accelerometer, Barometer, and remote controller.

8.1. Accelerometer Calibration

Here is a step-by-step guide on how to calibrate the accelerometer in AeroGCS Green:

- Launch AeroGCS GREEN software and Connect your drone.



- Go to the "**Settings**" menu as shown in the figure below.

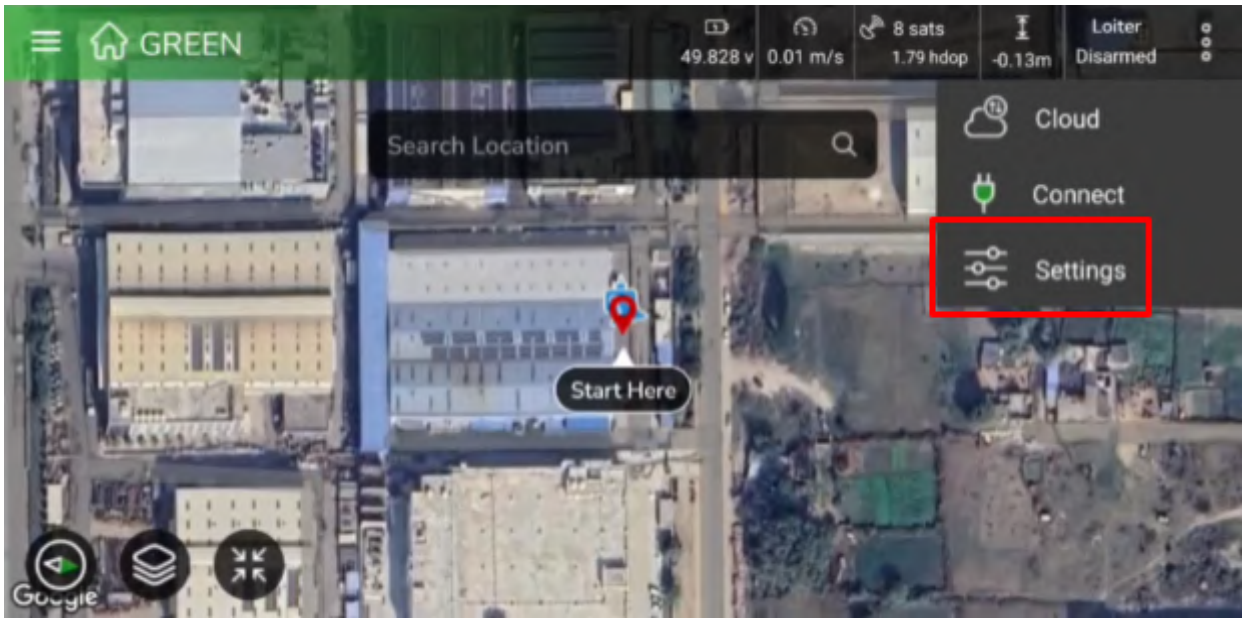
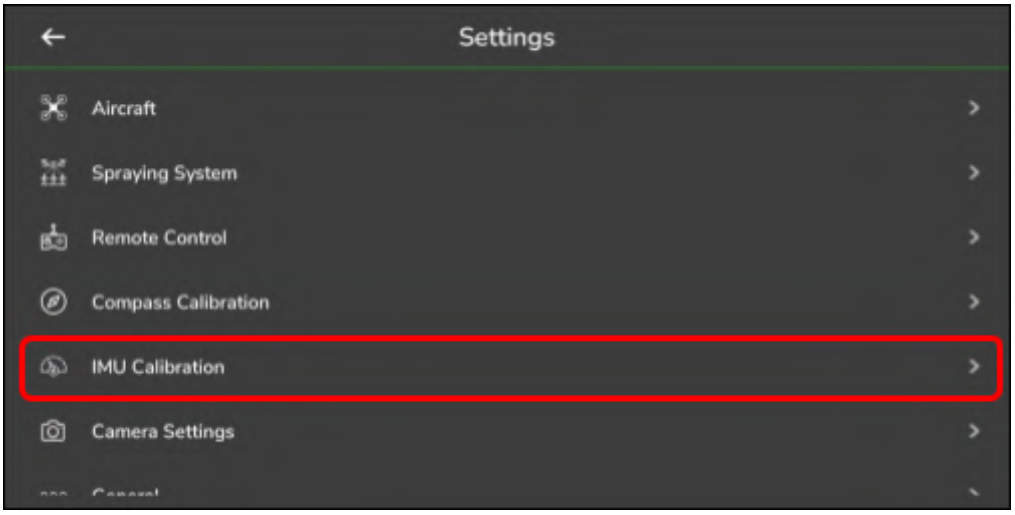


Figure 15: Settings Menu on AeroGCS User Interface

- Then select the IMU Calibration Option.



- From the options, select "**Accelerometer**" and click on the "**Calibrate**" button.

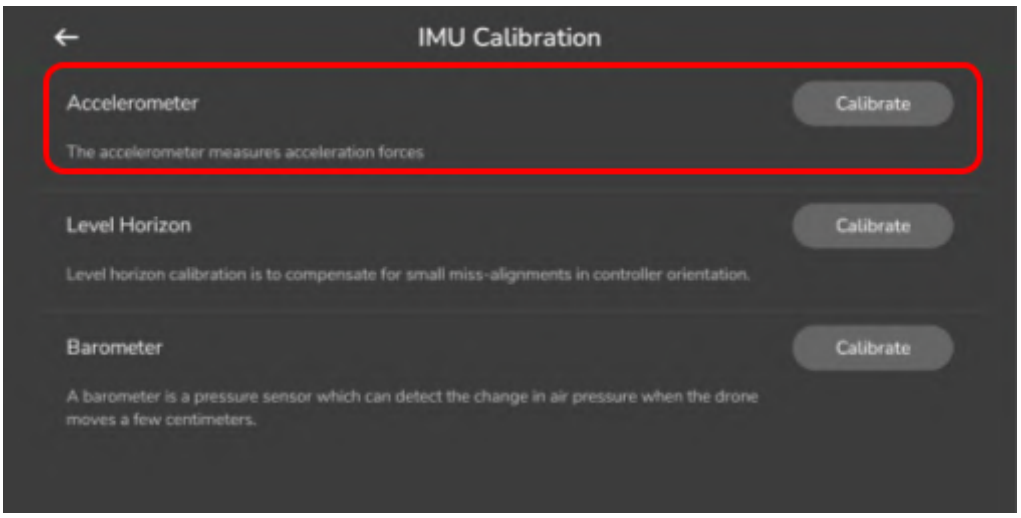


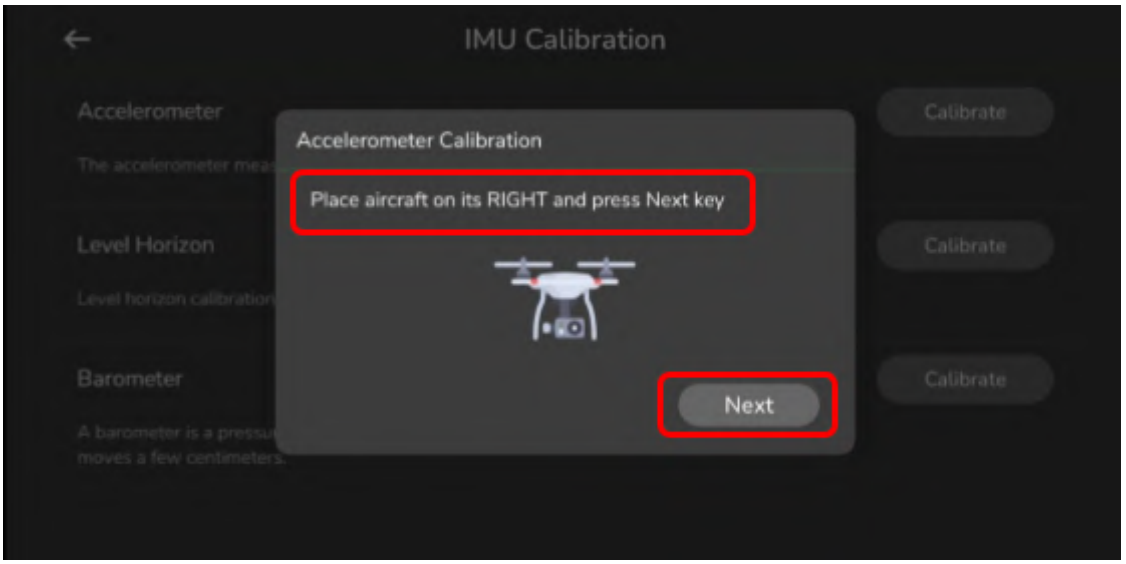
Figure 16: Starting Accelerometer Calibration

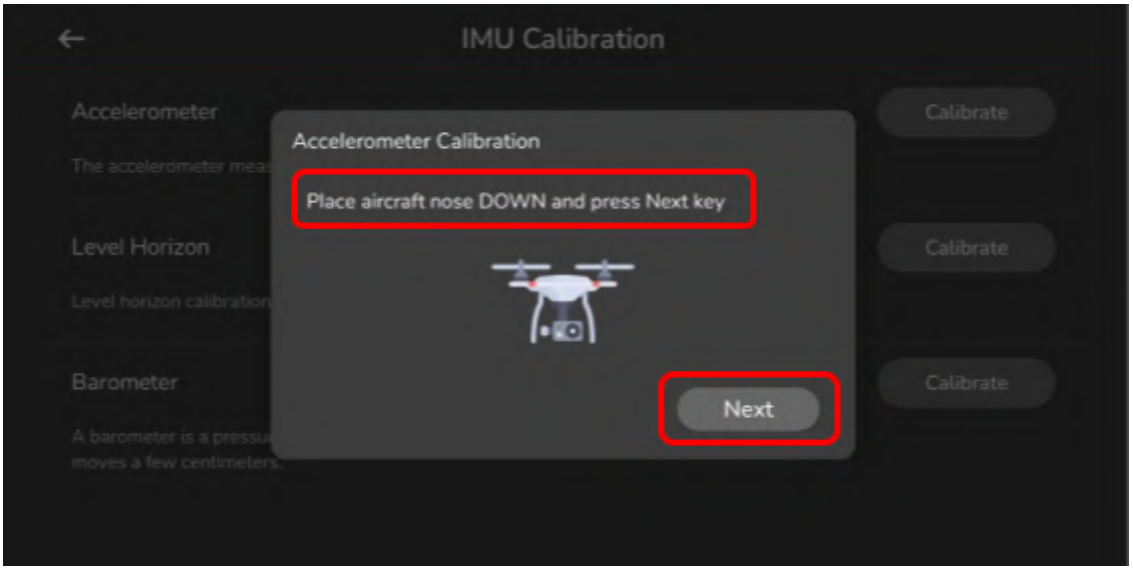
- Then Click on **OK** to begin the calibration process. Place your drone on a flat and level surface and click the "**Start**" button.

- Follow the on-screen instructions to tilt and rotate your drone in various directions. Make sure that vehicle is at 90 deg angle when we are holding it at some orientation.


IMU Calibration
Accelerometer
Level Horizon
Barometer
Calibrate
Calibrate
Calibrate
Accelerometer Calibration
Place aircraft at a level and press Next key
Next


IMU Calibration
Accelerometer
Level Horizon
Barometer
Calibrate
Calibrate
Calibrate
Accelerometer Calibration
Place aircraft on its LEFT and press Next key
Next


IMU Calibration
Accelerometer
Level Horizon
Barometer
Calibrate
Calibrate
Calibrate
Accelerometer Calibration
Place aircraft on its RIGHT and press Next key
Next



- Once the calibration process is complete, click the "**Restart**" button to save the calibration settings.

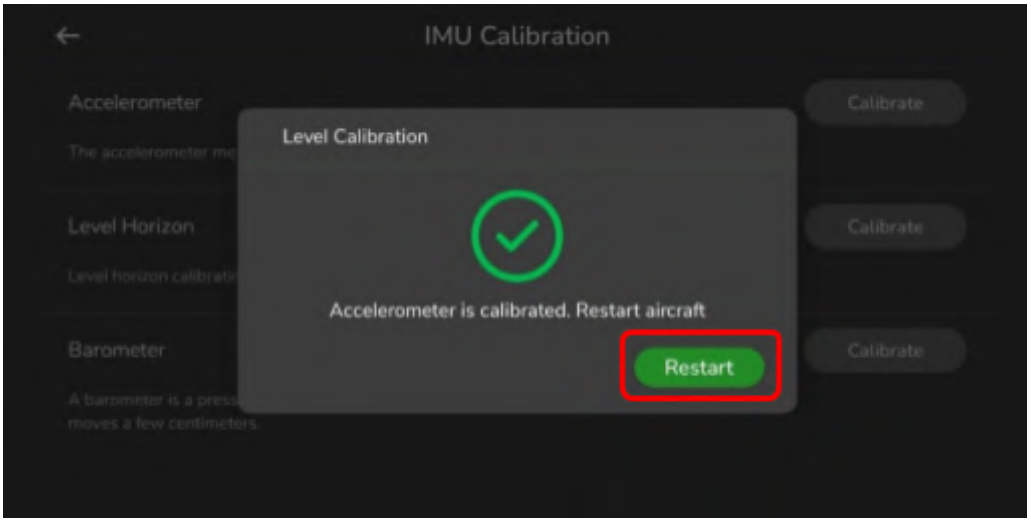


Figure 17: Accelerometer Calibration Successful

8.2. Level horizon calibration

- Make sure that Accelerometer is calibrated before doing horizon calibration.
- Again, go to IMU Calibration in Settings. And in Level Horizon, click on **Calibrate**.

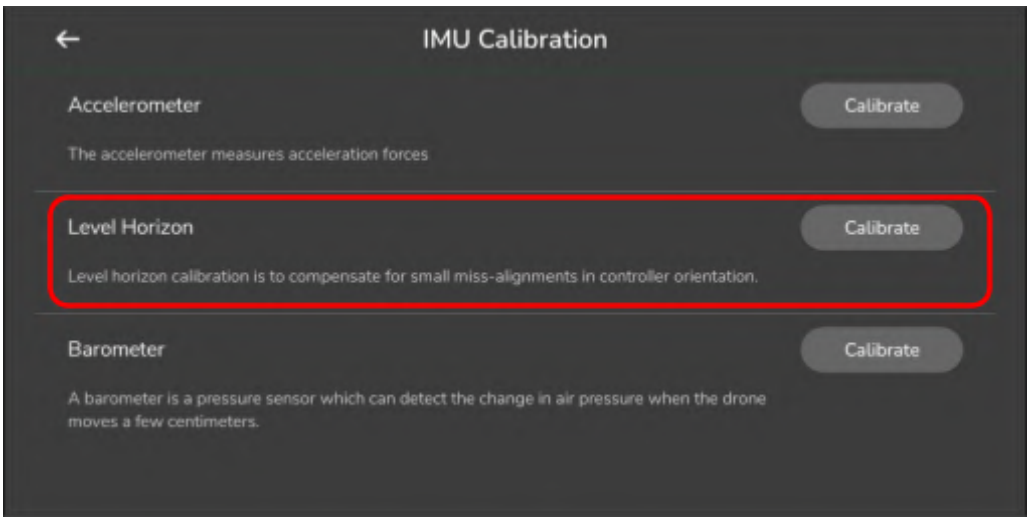


Figure 18: Level Horizon Calibration Start

- The calibration process will begin. Place your drone on a flat and level surface.

- Click the "**Done**" button after Level Horizon Completion.

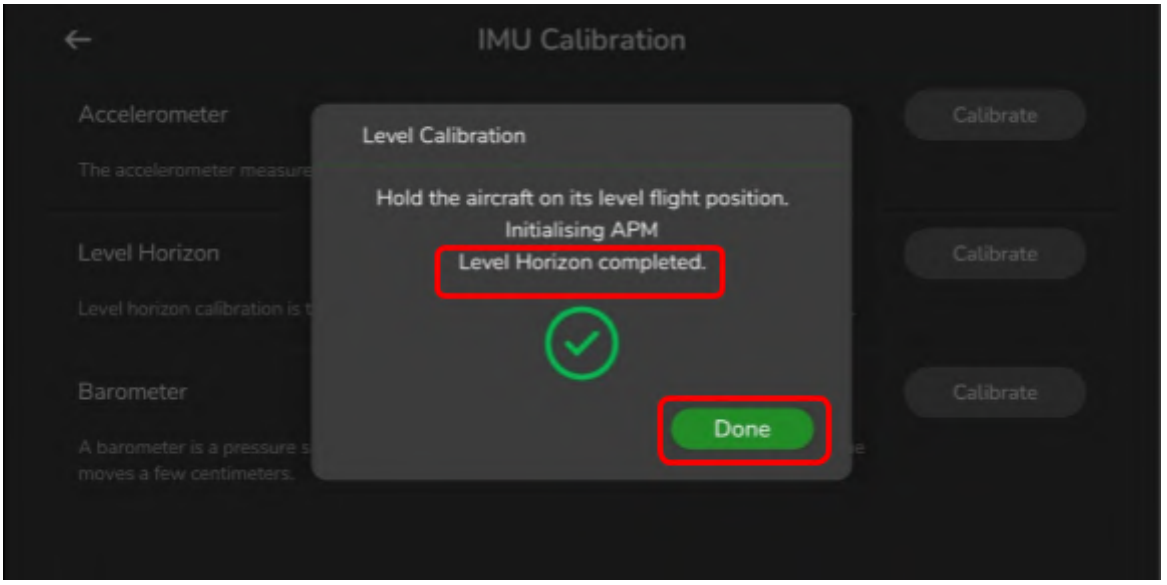
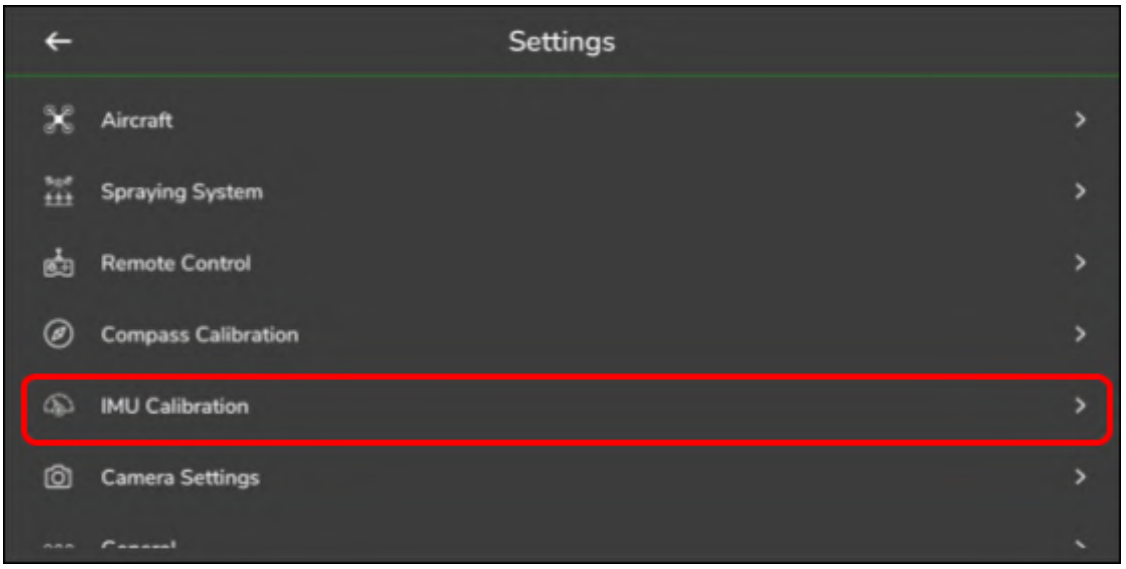


Figure 19: Level Horizon calibration Complete

8.3. Pressure calibration

- Place your drone on a flat and level surface.
- Go to the "**Settings**" menu and select the IMU Calibration option.



- Select the Barometer option and click on the "**Calibrate**" button.

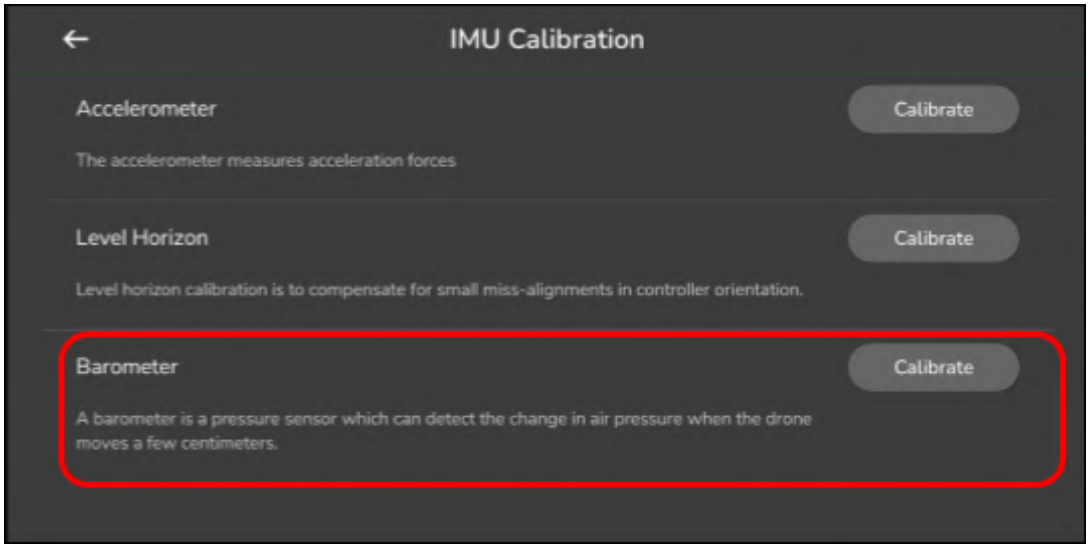
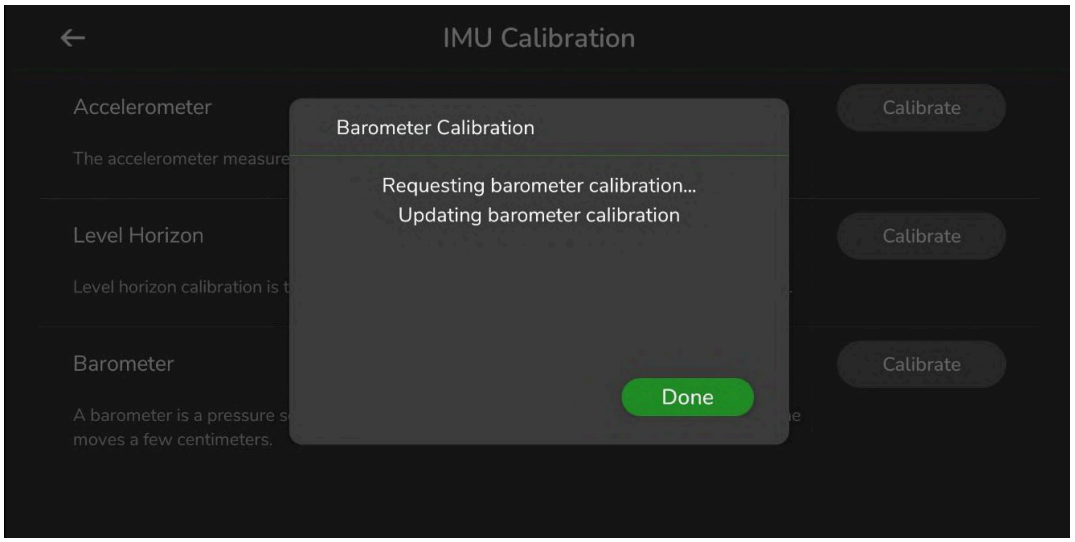


Figure 20: Barometer Calibration Starting



- Click the "**Done**" button after the calibration process is completed.

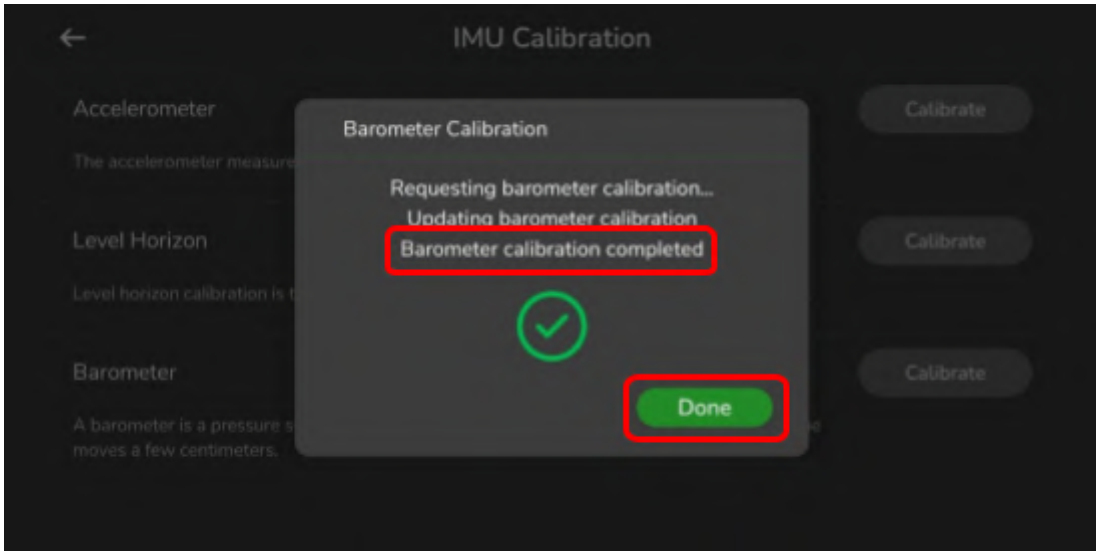
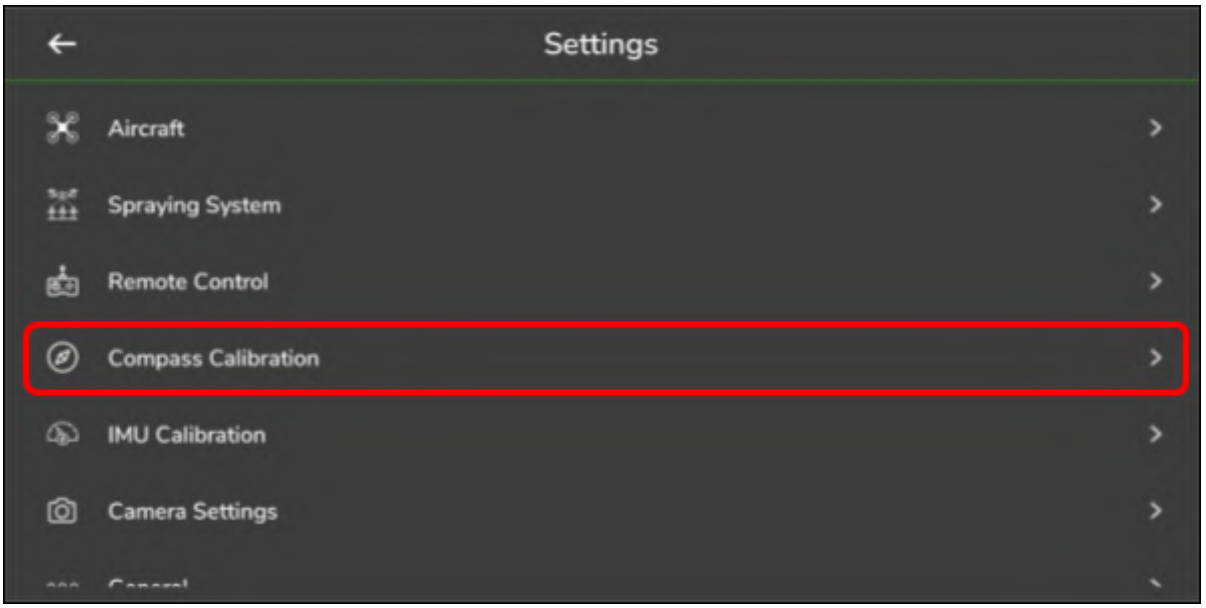


Figure 21: Barometer Calibration Complete

- Reboot the drone after barometer calibration by disconnecting the power supply from batteries for 30 – 40 seconds.

8.4. Compass calibration

- Ensure that the drone is calibrated in a location free from any metal objects, electrical wires, or other sources of magnetic interference. (Mobile phones, smart watches etc.)
- Launch the **AeroGCS GREEN** application and connect the drone.
- Go to the Settings and click on the "**Compass Calibration**" option.



- In the compass option, click on "**Calibrate**" Button.

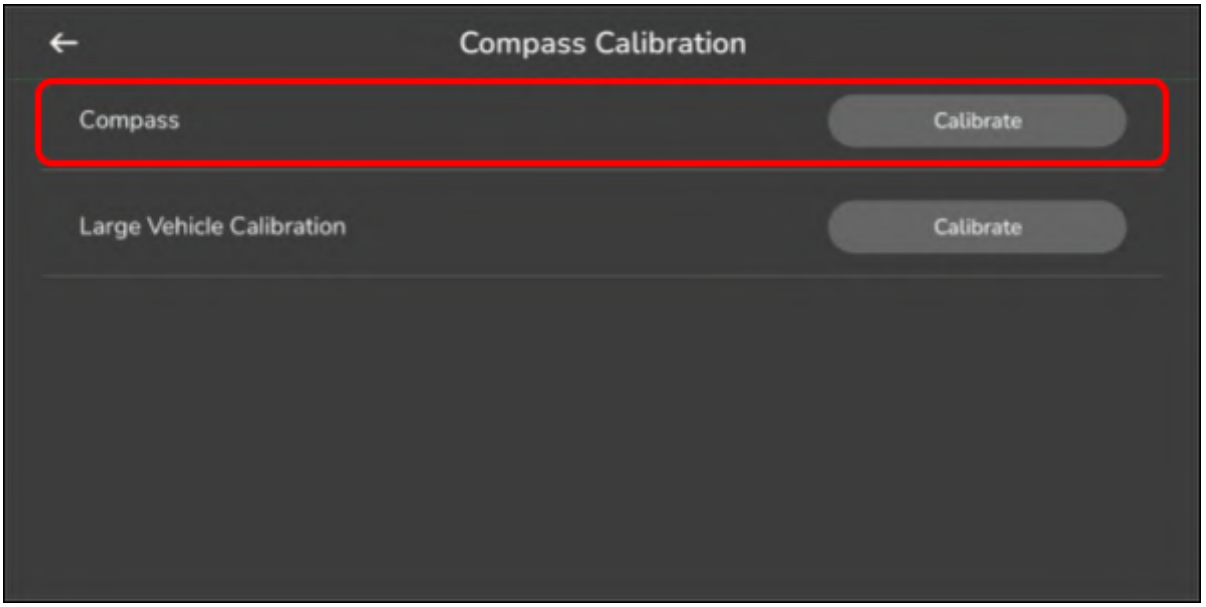
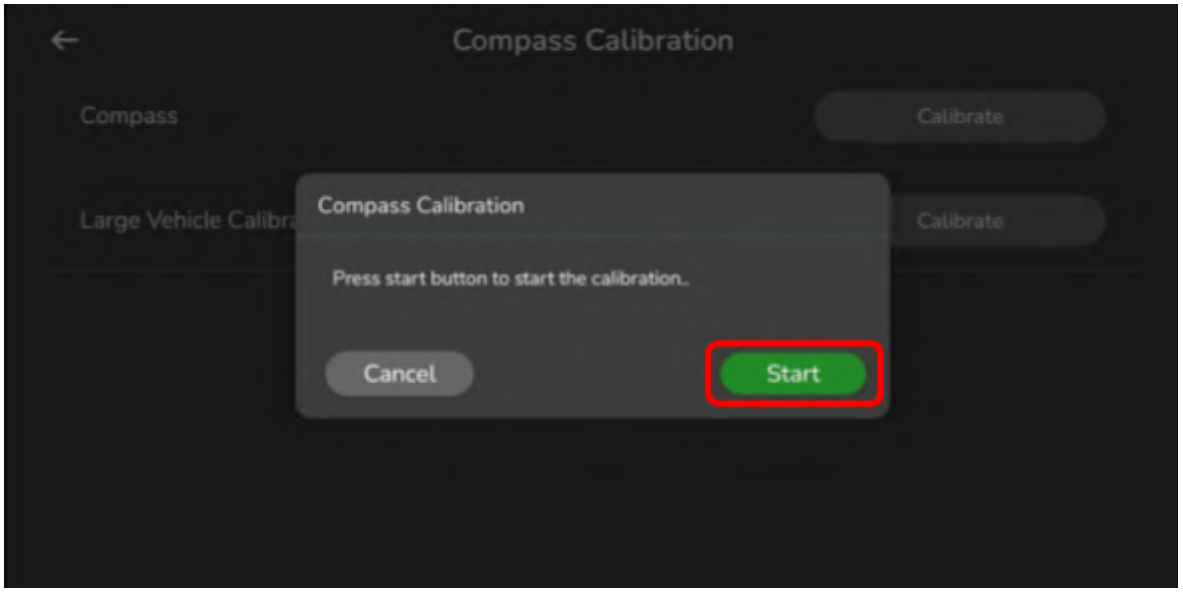
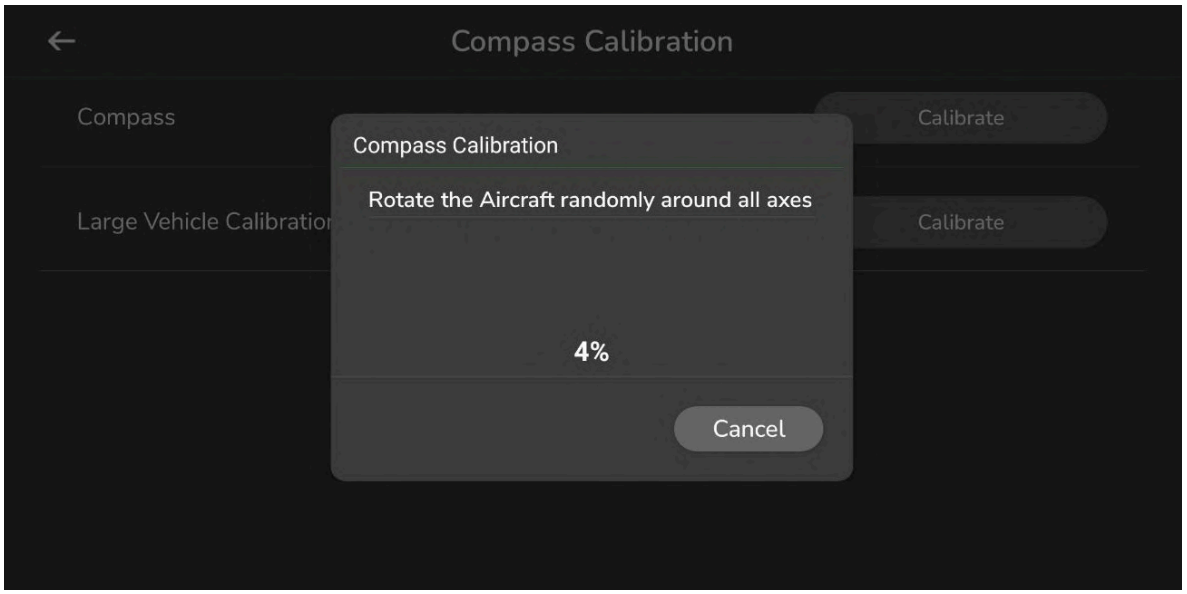


Figure 22: Compass Calibration Starting

- Then, click on the "**Start**" button to start the calibration process.



- Rotate the device to be calibrated in multiple axes, ensuring that the device remains level during the rotation.



- Rotate the Vehicle around all three axes in a full 360-degree rotation till the calibration percentage reaches 100%, ensuring that the device remains level and that the rotation is smooth and steady. Once complete, Click on the "**Ok**" button.

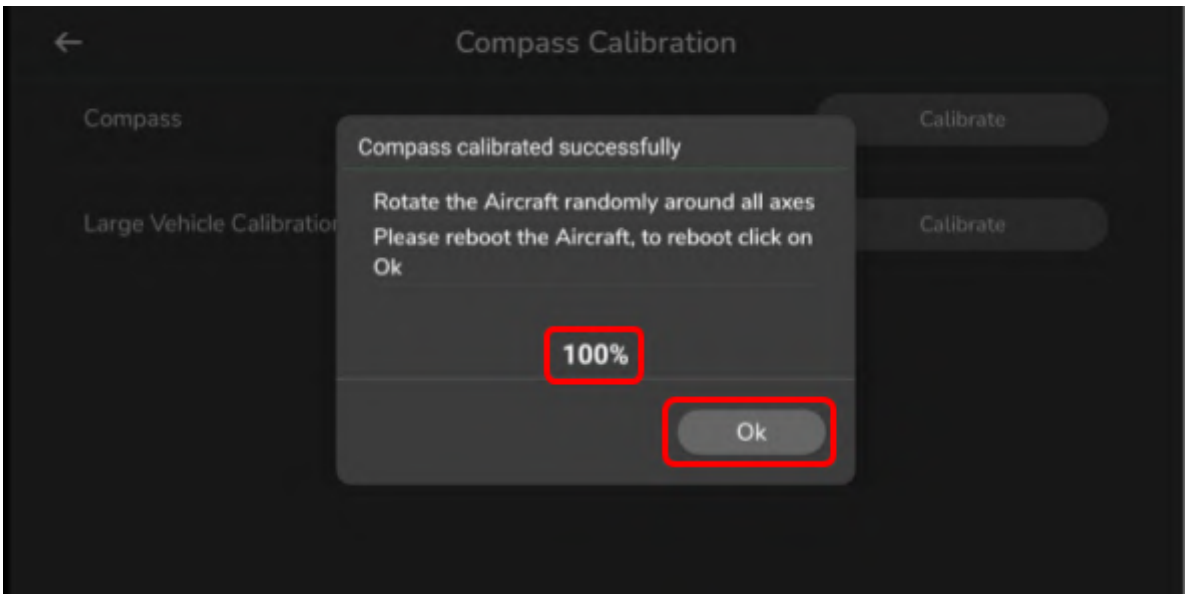


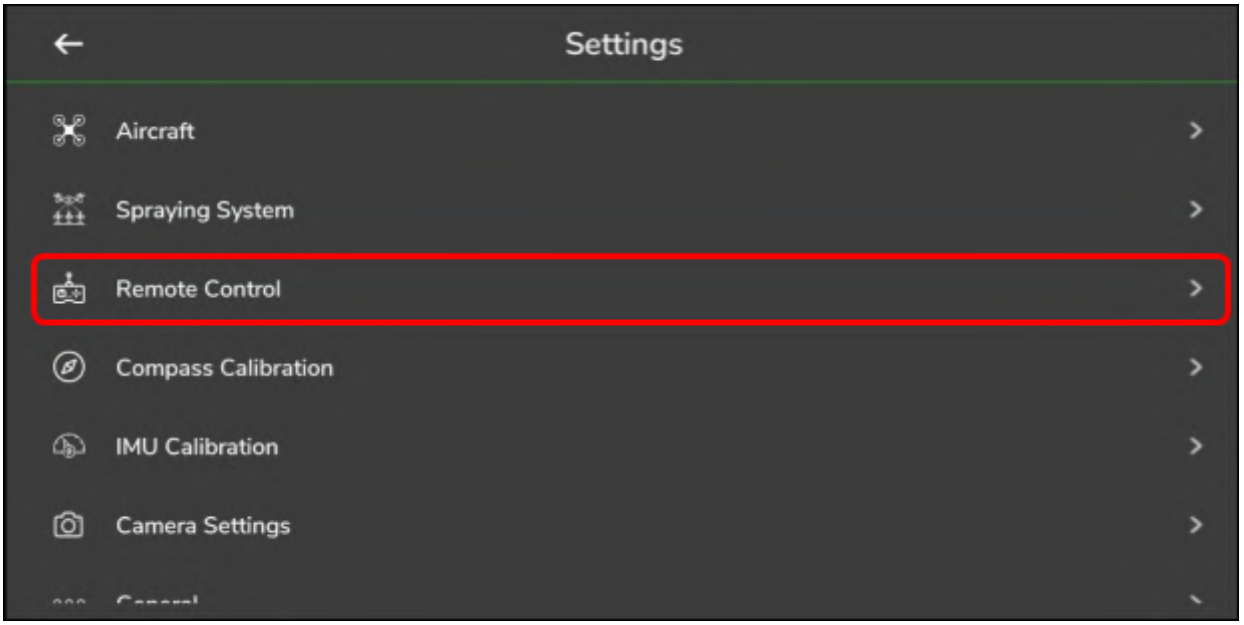
Figure 23: Compass Calibration Complete

- Reboot the drone after the compass calibration by disconnecting the batteries from the drone and connect them back after 30 – 40 seconds.

Note: The compass is very sensitive to electromagnetic interference and can produce abnormal compass data and lead to poor flight performance. Regular calibration is required for optimum performance. The GCS will give an error in case any Compass data is not calibrated and Calibration should be done prior to taking the flight.

8.5. RC Calibration

- Go to the settings and click on "**Remote Control**" Option.



- Click on the "**Calibrate"** button and move all RC sticks and switches to their extreme positions and reset all transmitter trims to center.

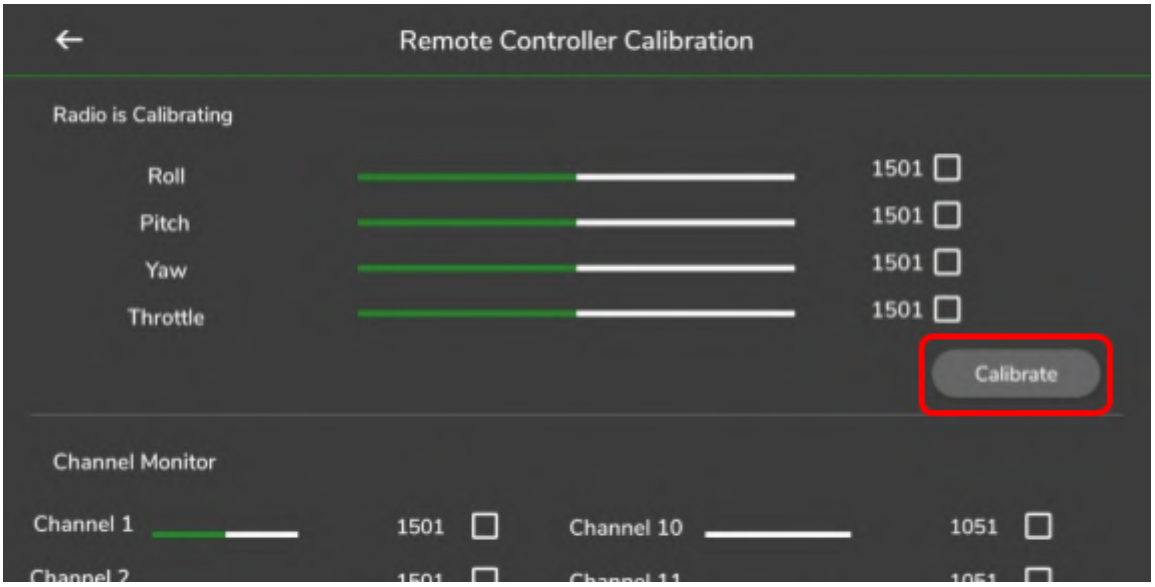
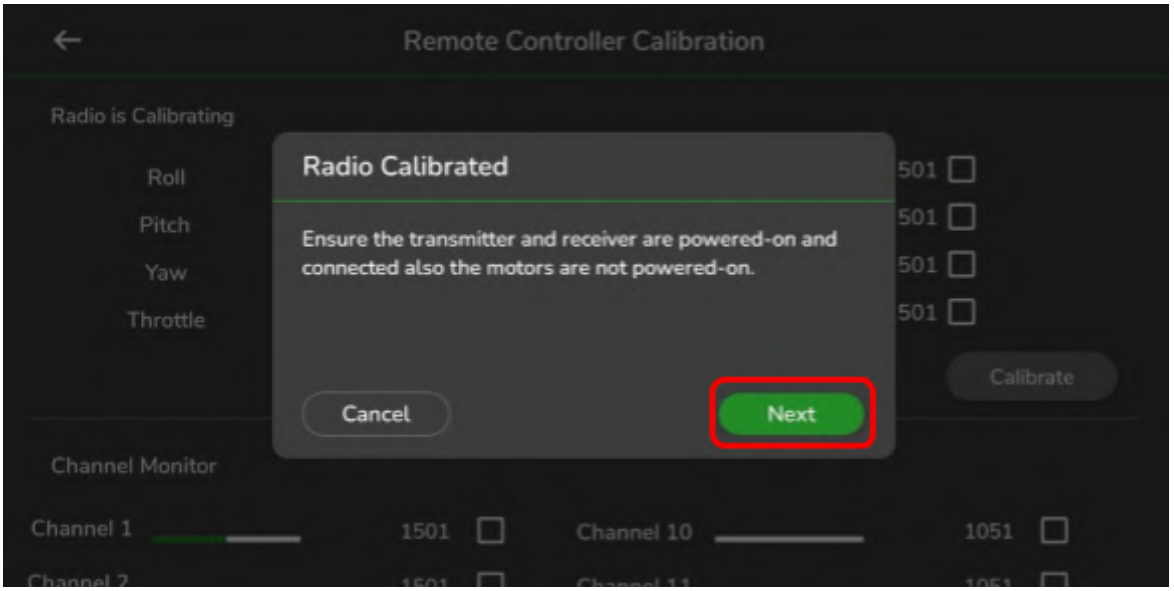
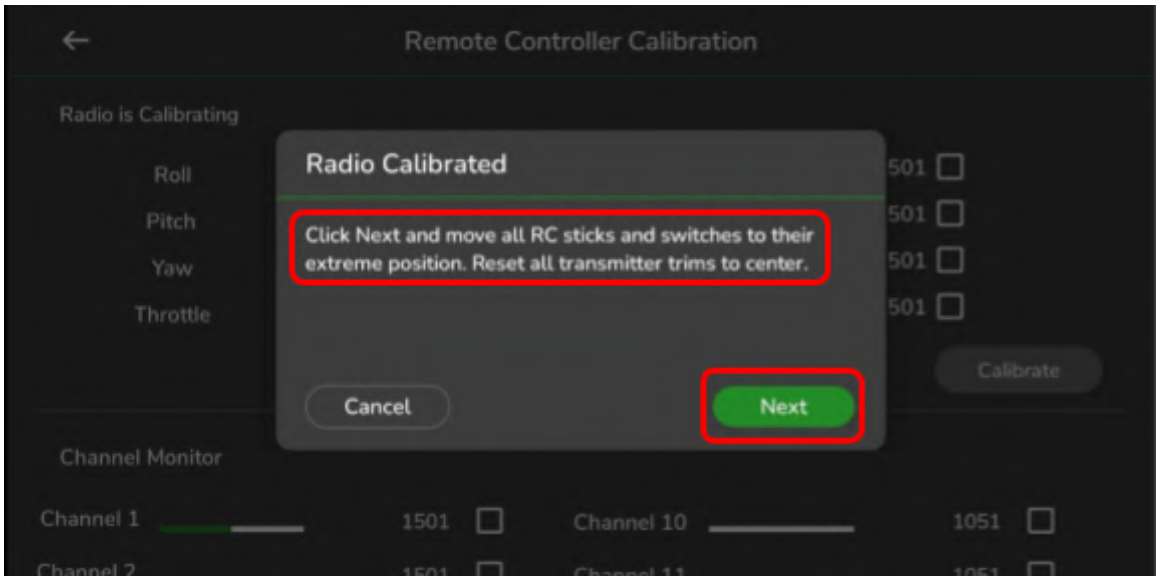


Figure 24: Remote Controller Calibration Start

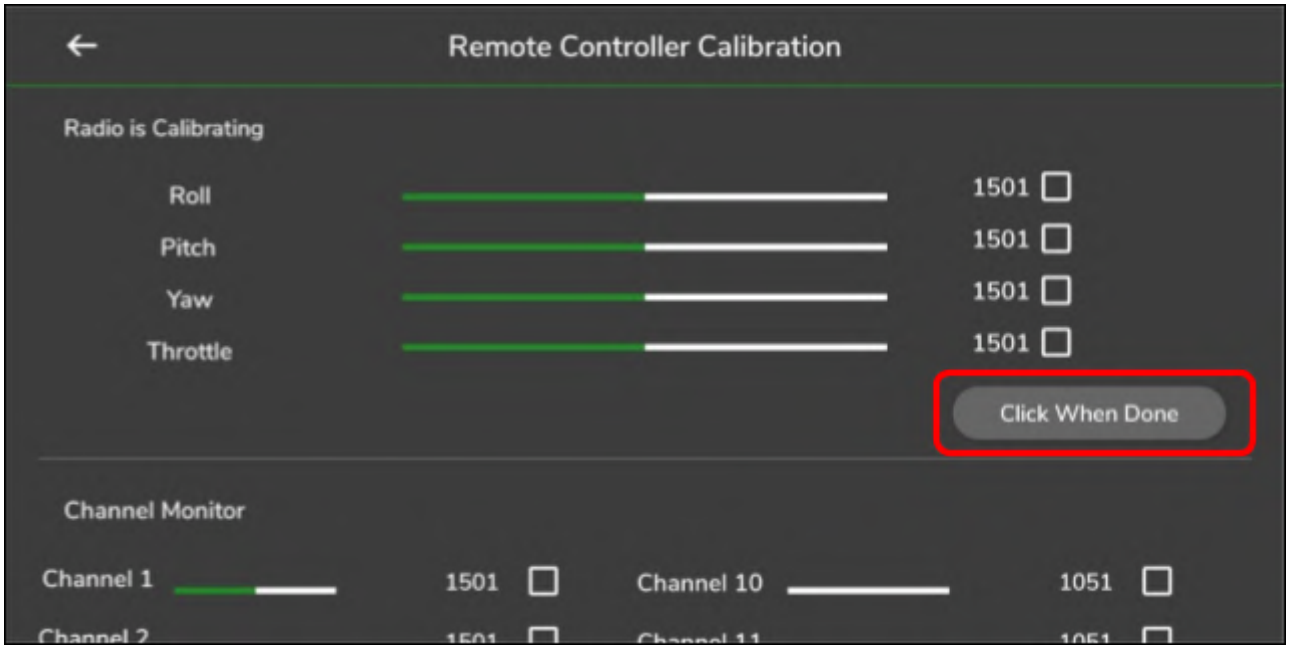
- Ensure all receivers are powered and connected, then click "**Next**" to continue.



- Again, Click on **Next** button and then move all RC control sticks to their extreme positions.



- Then cross check the all-throttle sticks are positioned at centers and the respective PWM values are 1551. Click on the "**Click When Done**" option once done.



- Then you will get a popup showing successful RC calibration and Number of channels detected. Make sure that the respective Min/Max PWM values are 1551 and 1951, respectively. If not, do the process again. Click on **OK** to finish the process.

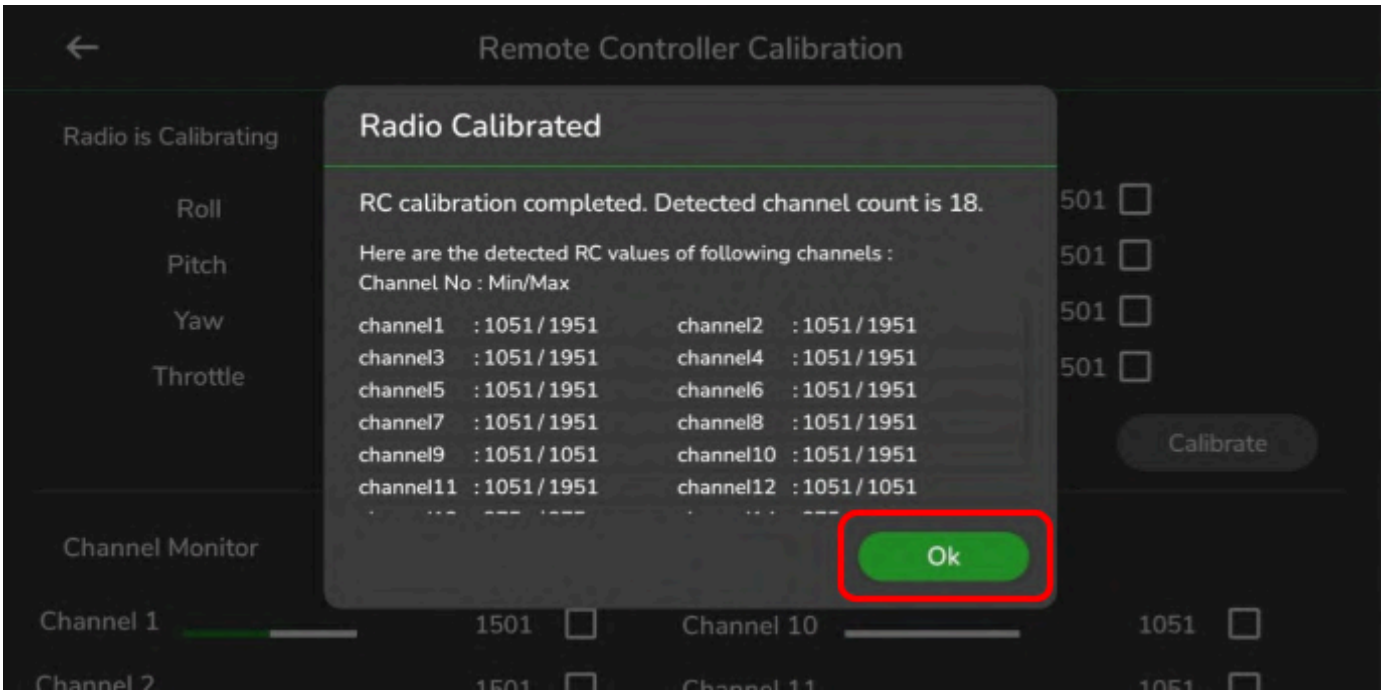


Figure 25: Remote Controller Calibration Complete

9. Preparing Drone for Flight

To start the SprayCoptor drone, follow these steps:

- Complete the preflight checklist. (Refer to Annexure 1).
- Connect the GCS to a drone.
- After the parameters are ready, you will see the "Hardware Safety Switch" pop-up on the data screen of the GCS.
- Press and hold the hardware safety switch on the side of the drone until a long beep comes out from FC and ESC will stop beeping. The hardware safety switch will turn on a solid red light.
- The double flashing yellow lights status LED will change to double flashing green lights on the GPS module.
- Your vehicle is now ready to fly.

9.1. LED and Buzzer Status Meanings

The Status LED on the GPS module will display different flashing colors and patterns. Each color and flashing pattern have specific meanings along with a specific buzzer sound pattern.

Table 2: Status LED and Buzzer Sound Pattern Meanings

Sr. No.	Color Flashing Pattern	Sound Pattern	Meaning
1	Flashing Red and Blue	Initializing Tune	Initializing gyroscopes. Hold the vehicle still and level while it initializes the sensors.
2	Flashing Blue	-	Disarmed, no GPS lock found. Autopilot loiter and return-to-launch modes require GPS lock.
3	Solid Blue	Arming Tune	Armed with no GPS lock.
4	Flashing Green	-	Disarmed (ready to arm), GPS lock acquired. Quick double tone when disarming from the armed state.
5	Fast Flashing Green	-	Same as above but GPS is using SBAS (so should have better position estimate).
6	Solid Green	Arming Tune	Armed, GPS lock acquired. Ready to fly!
7	Double Flashing Yellow	Arming Fail Tune	Failing pre-arm checks (system refuses to arm). Resolve Prearm error.
8	Single Flashing Yellow	-	Radio Failsafe Activated
9	Flashing Yellow	Battery Failsafe Tune	Battery Failsafe Activated
10	Flashing Yellow and Blue	GPS Failsafe Tune	GPS glitch or GPS failsafe activated
11	Flashing Red and Yellow	EKF Failsafe Tune	EKF or Inertial Nav failure
12	-	Lost Copter Tune	UAS is Lost

9.2. Flying Modes

9.2.1. Loiter (Manual) Flight Mode

In this mode, the pilot should fly the drone manually by giving the controls from Remote controller. Loiter mode is suitable for returning to the central control. IMU, GPS, magnetic compass and barometers participate in the flight. The Loiter mode can be switched to the control mode according to the GPS signal. Loiter mode requires GPS to be connected with a minimum of 13 satellites to work properly. If the GPS signal is good, the Status LED on GPS flashes green color.

Only Loiter mode allows to arm the UAS, make sure current mode is Loiter before arming.

9.2.2. Waypoint Mission (Auto) Mode

In this mode, the pilot should plan the mission before the flight so that the drone completes the mission automatically without the commands of the pilot.

The Auto mode directs the UAV to adhere to the waypoint mission plan that has been loaded into the autopilot system. It's essential to pre-plan the mission using the Ground Control Station (GCS) before selecting Auto mode. While the mission is in progress, the pilot retains manual control only over the UAV's heading. Prior to triggering Auto mode, it is crucial to verify the drone's location. In case the need arises, the autonomous mission can be paused at any moment by toggling the flight mode switch on the Remote Controller (RC). If the user wishes to assume manual control during an Auto mission, they can switch to "Loiter" mode, at which point the UAV will transition from Auto to Loiter mode within the GCS interface.

9.2.3. RTL (Return to Launch) Mode

In this mode, the drone comes to its launch location. This can be given by the pilot or this mode activates automatically in any of the following cases for the safety of men and machinery.

- Battery is low.
- Spraying Mission Complete/Tank Empty
- GCS shut off abruptly
- Connection to GCS is lost.
- Fence Breach
- Geofence Breach
- RC Signal loss for more than 5 seconds

Operating Instructions:

The RTL mode can be triggered by the mode switch toggling to the right. When the remote control CH5 Right mode switch is set to the one-push return position or the flight control enters the out-of-control protection, if the UAS is more than 2 meters away from the return point, it will automatically rise to the set altitude (RTL Altitude of 20 meter is set in firmware). After reaching the return point, the UAS will first hover in the air for about 5 seconds and then land slowly. At this time, the flight status of the UAS can be controlled by the remote-control joystick (but the throttle stick does not work), making it easier for the aircraft to find a more suitable landing point. After the aircraft has fully landed, the aircraft will automatically disarmed.

Precautions:

The premise of automatic return is that the return point of the aircraft has been recorded. If you need to use the automatic return, please unlock it after the GPS search is completed. Please refer to the appendix LED three-color light for status and meaning. When the aircraft is close to people, it is

recommended not to switch to the auto return mode to avoid accidents. Make sure that the Altitude of the UAS while returning is sufficient or more than the obstacles in its path to home.

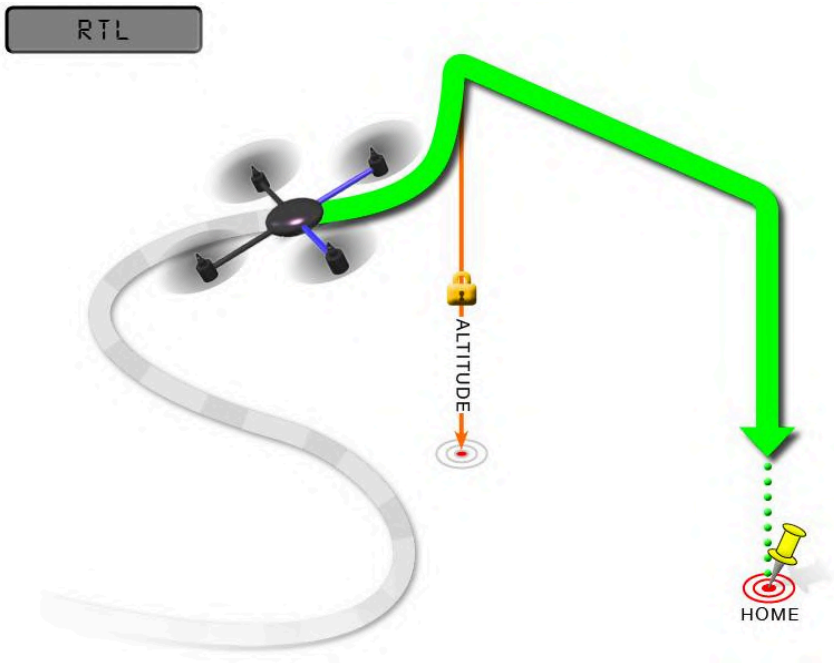


Figure 26: Return To Launch (RTL) Mode

9.2.4. Brake Flight Mode

In case of panic or any eventuality, Brake mode can be activated by switching the mode switch to left so that no command is received from the GCS and the drone freezes at the position where it is flying. In the meantime, an expert pilot can deactivate the mode and take control and land the UAS safely if there are any problems with flight.

Figure 27: Flight Mode control switch on GCS

10. Mission Plan/Project Creation

- Connect the GCS (Ground Control Station) and drone successfully. Make sure that the GCS and the drone are within range and can communicate with each other. Also, ensure that both the GCS and drone are properly configured and calibrated for the mission.
- To plan a mission, follow the below steps. These steps are necessary to create a new project and define the project details before planning the mission. Click on the “Home” Icon present on the interface as shown in below image.

- Click on the Project '+' symbol present on the dashboard near the project to create a new project. The '+' symbol is usually located in the top right corner of the dashboard. Clicking on this symbol will open a new window where you can create a new project.

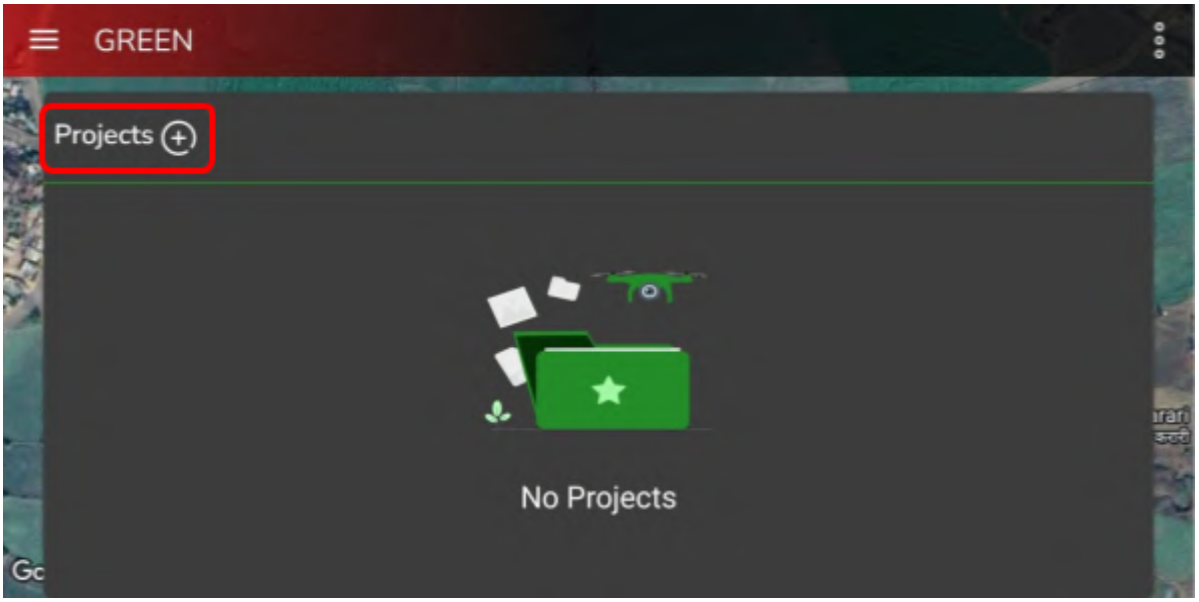
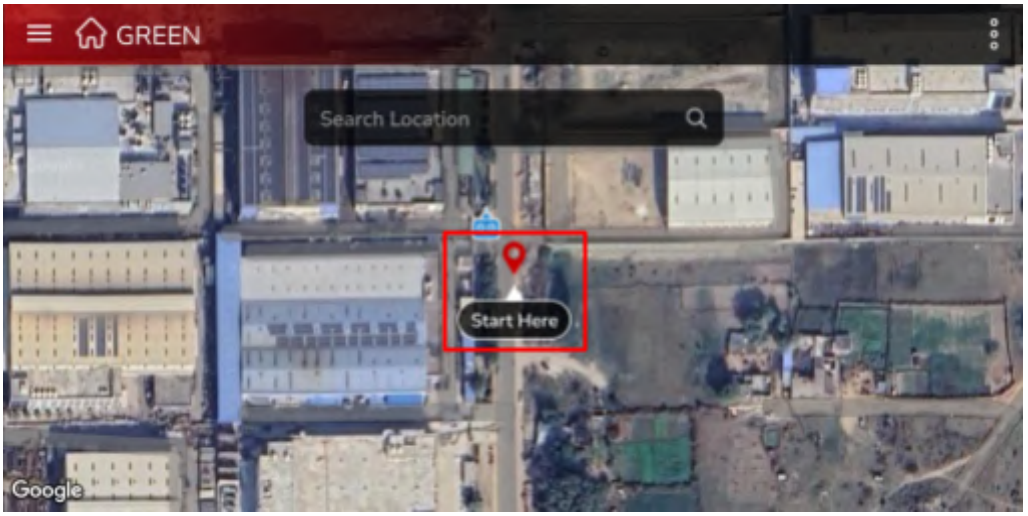
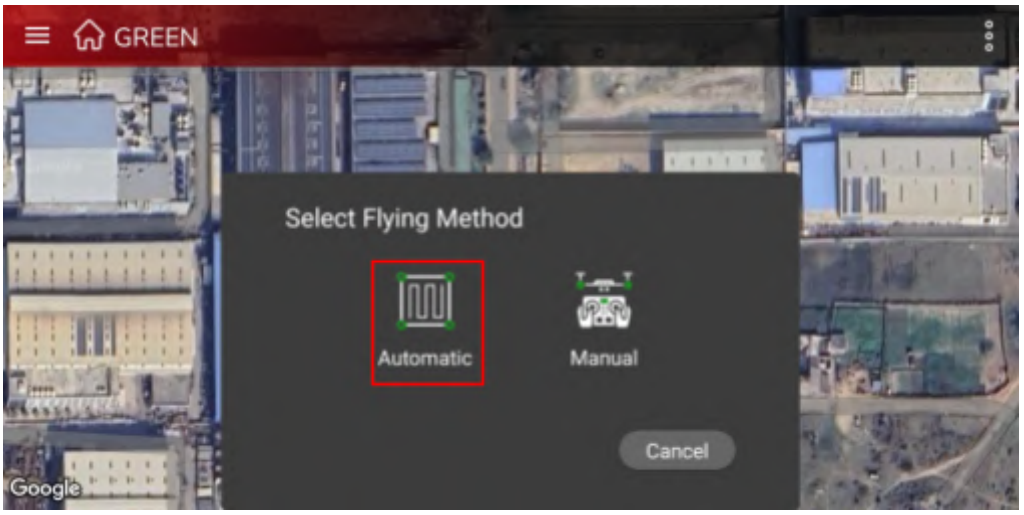


Figure 28: Adding New Auto Mission Project

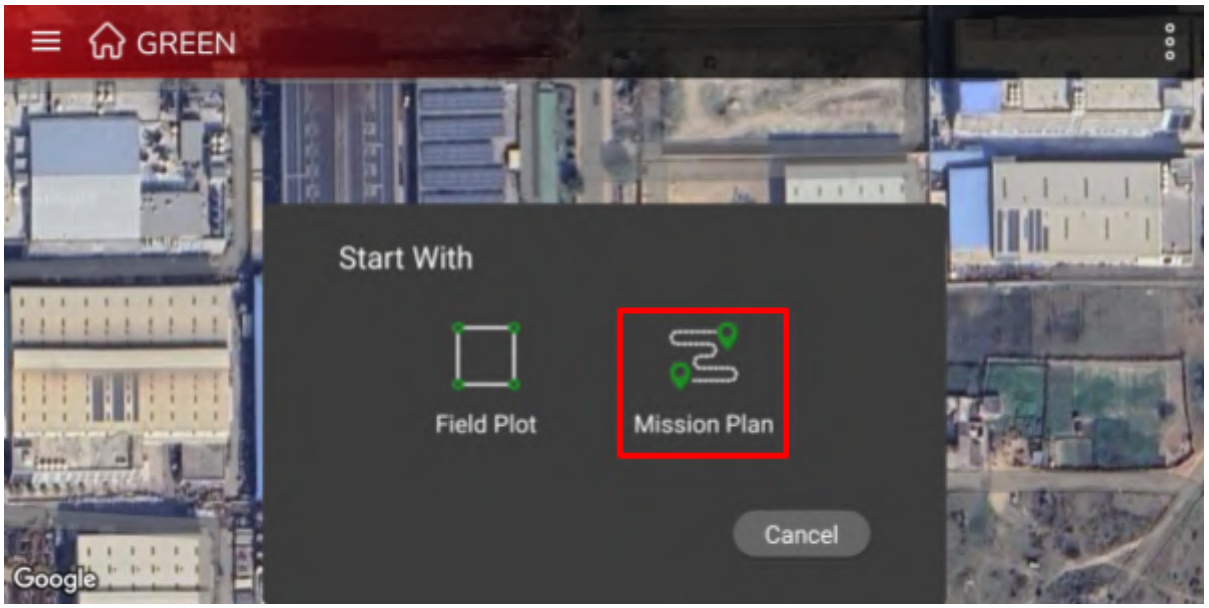
- Click on **Start Here** Icon to get started with field plot creation.

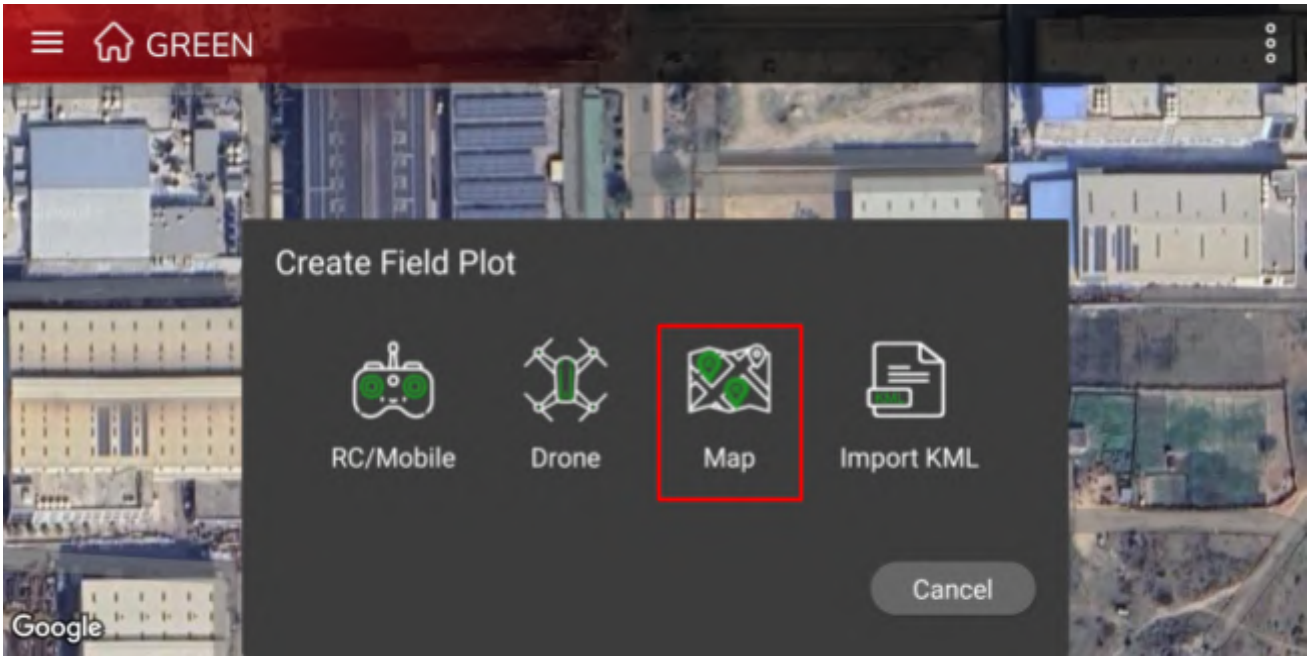


- Then in the Flying Method Window, select the **Automatic** option as shown in below image.



- Once you select Automatic Flying Method, then it will show Automatic Plan creation methods. Select the appropriate method. It is recommended to select the "**Map**" option as shown below.

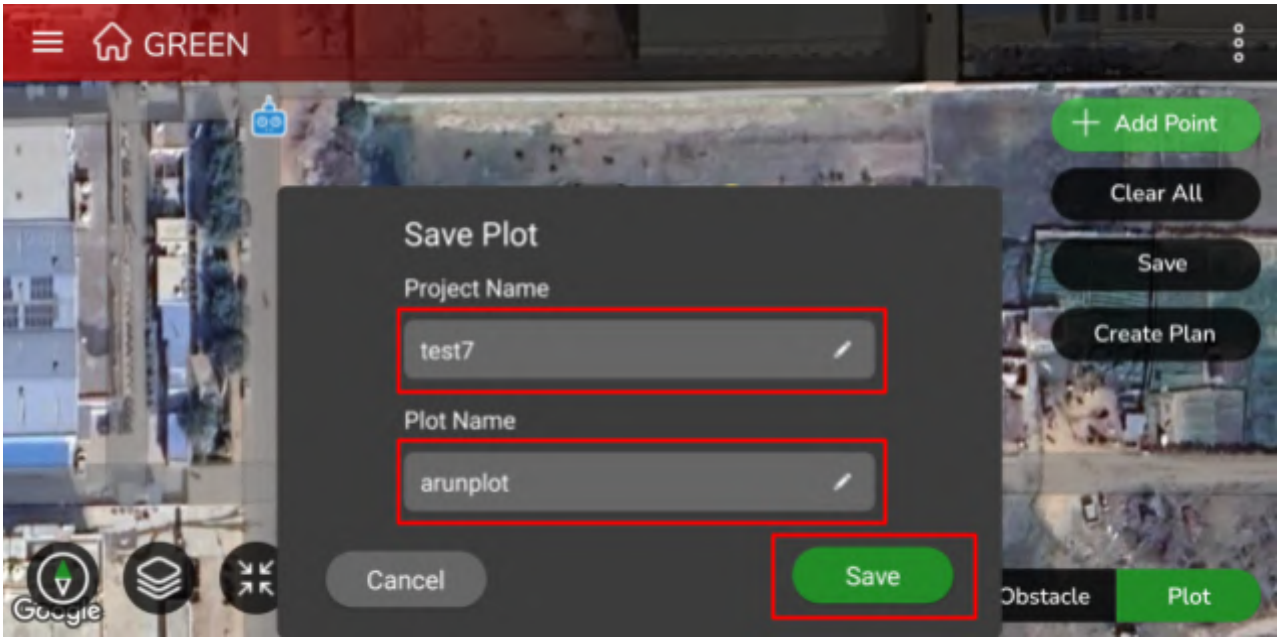




- After selecting the Map option, a "+" icon is available on the interface, which we will use to set our boundary points.

- To set points, move the map and align the boundary point location with the "+" icon and click on the "**Add Point**" button to save the boundary point. Likewise add all the boundary points and create an enclosed area. Minimum 3 points need to be added to create a plan.
- Cross check the boundary points whether they are covering the entire field or not. You can clear the added point by clicking the Clear All button. Once all the boundary points are added, Click on the "**Save**" option to save the plan.

- For Project Name, enter any alphabet with up to 50 characters. The project name should be short and descriptive, representing the overall purpose of the project.
- For Plan Name, define a proper plan name of up to ten characters, such as Field01. The plan name should be short and descriptive, representing the specific plan for the mission

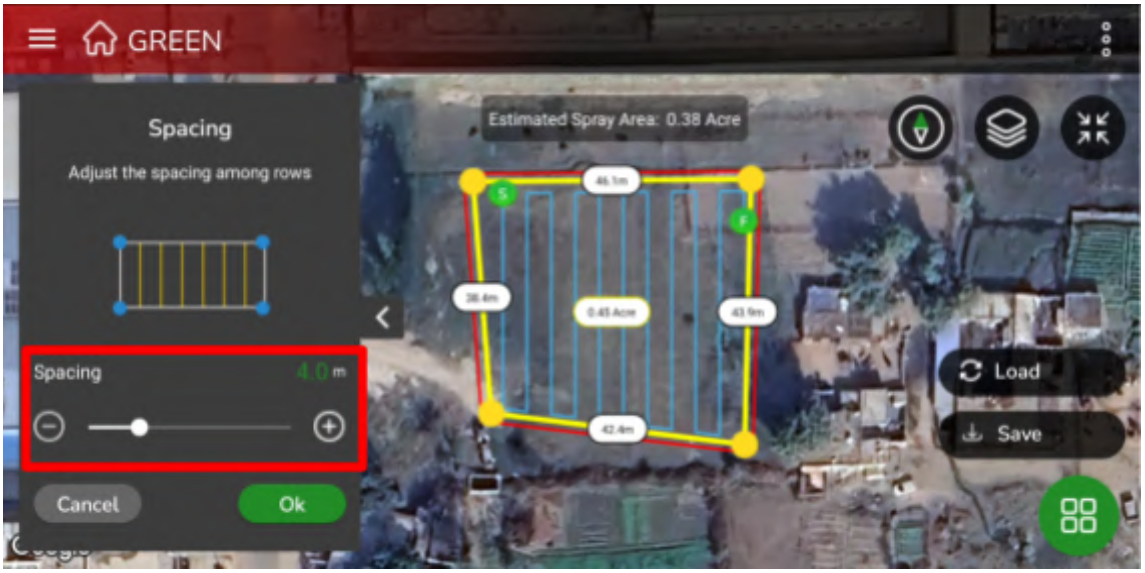


- Click on the "**Save**" button to save the project details. This will create a new project with the specified project details.
- The new project will be created and listed on the dashboard. You can now use this project to plan your mission successfully.

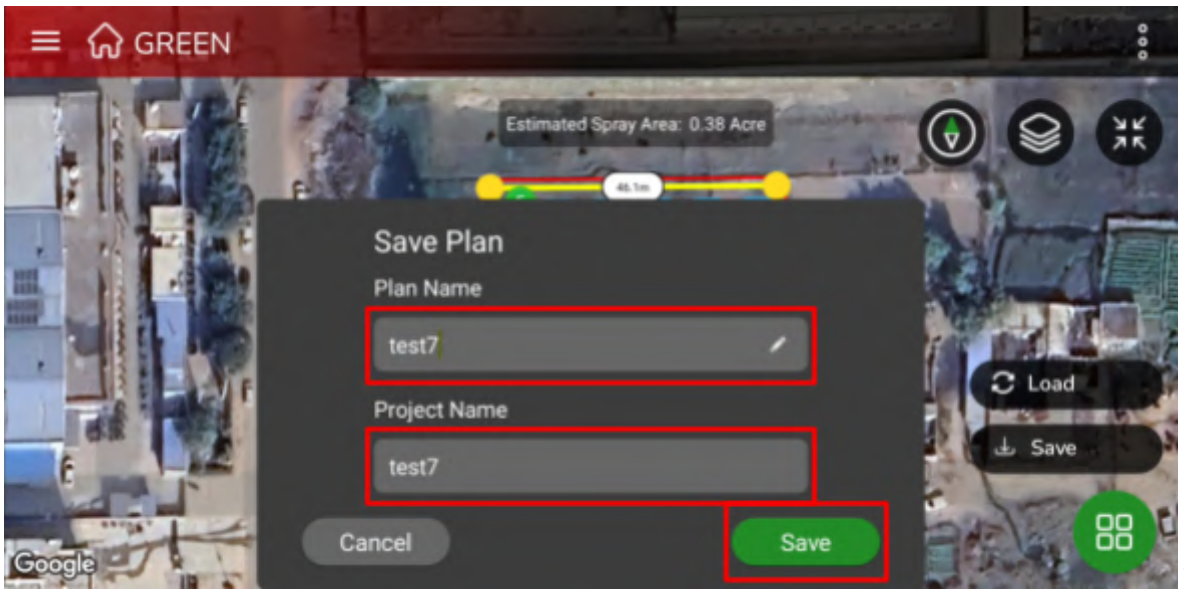
- You can now start planning your mission by defining the mission requirements such as Pump Spray rate, Spray Altitude, Forward Speed and Fence boundary which is the distance from entered boundary UAS tries to maintain, which ensures the UAS is always within the plan boundary created.

- To change the spacing between the two gridlines, click on the more options button as shown and click on Spacing Option.

- It is recommended to keep 4 m of spacing for plan, as it is the effective spray width of UAS and covers all the effective area. Click on **Ok**, after setting the desired spacing value.



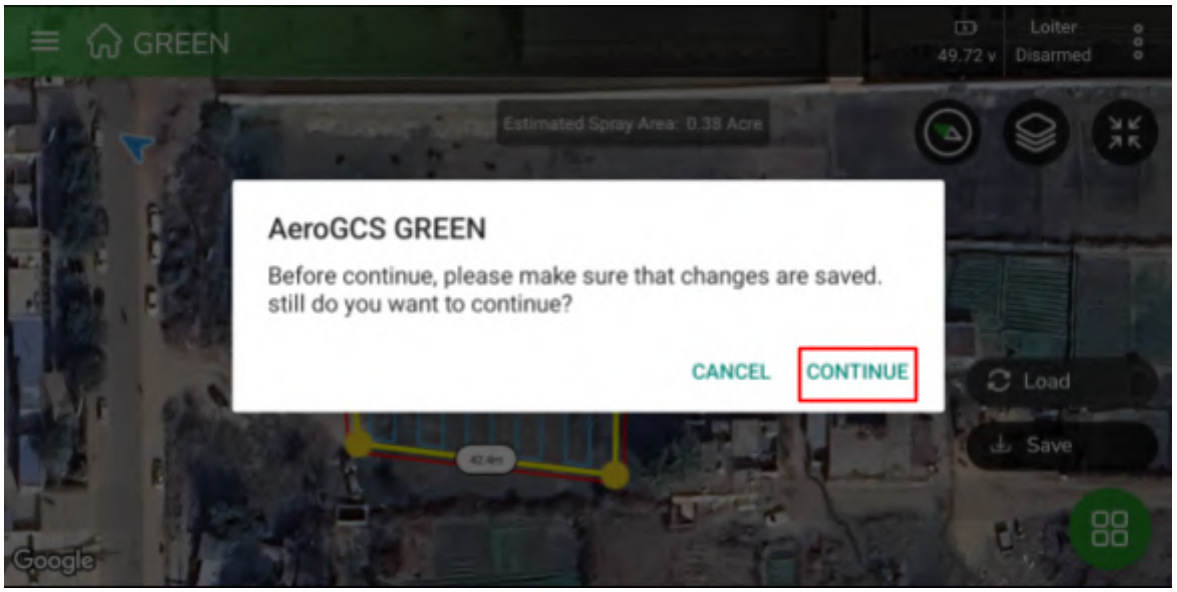
- Make sure the plan parameters are as per requirement, then Click on **Save** button to save the plan. Give the plan a name and Click on **Save** button. You will get a Plan Successfully saved message.



,

Connect the drone and click on the **'LOAD'** button.

- After the plan is successfully saved, Click on Load button to load the upload the plan on Flight Controller. You will get a popup asking if the final plan is saved, click on "**CONTINUE**" to proceed.



- Once you click on Continue, the plan will be uploaded to Flight Controller. Click on **Done** to start with the Auto Mission.

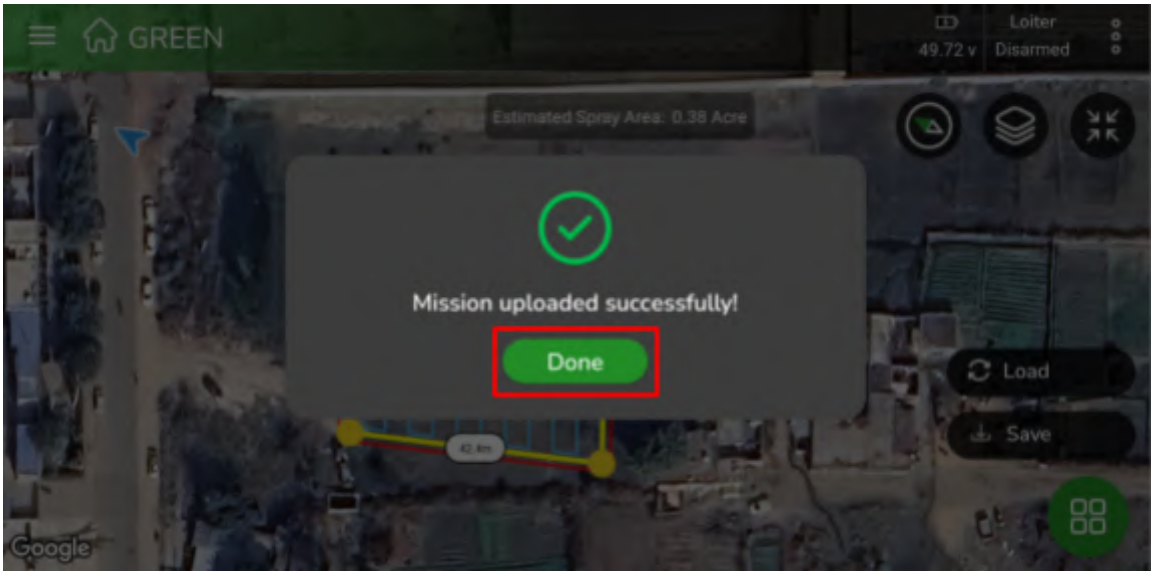


Figure 29: Uploading the Auto Plan Successful

- The plan is now visible on the interface. To execute the auto plan, Take the drone manually, take it to 5-meter altitude, then Trigger the Auto Mode by Pressing "**A**" switch on the Remote Controller. Then UAS will start following defined waypoints. Always keep an eye on the drone and make sure it is flying as intended. If some problems happen with UAS, take manual control by changing Flight mode to Loiter.

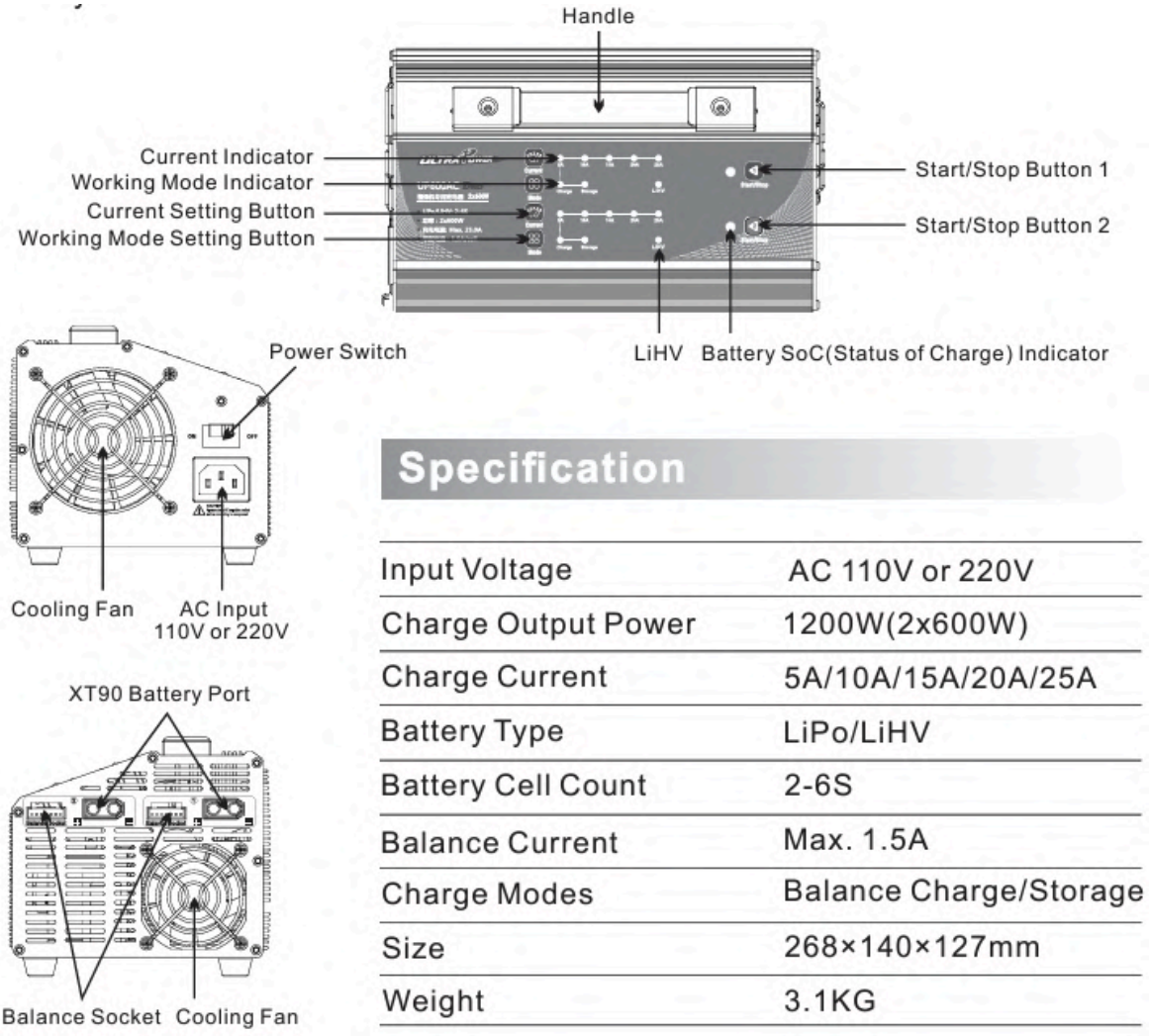
- In the above image, "**S**" point in the plan denotes the start of the mission and "**F**" denotes the end of the plan. If, before completing the plan pesticides in the tank gets over, it will automatically trigger the RTL mode, once landed, remove the battery connections, refill the pesticides, rest the UAS for 5 min. Again, continue the same mission.
    - The **right mission plan** is essential in achieving the following objectives: Optimize the flight path to reduce fuel/battery consumption by choosing the shortest paths.
    - A **flight path is a predefined** set of longitudes, latitudes, and elevations (waypoints) that a drone uses to navigate autonomously.

11. Battery and battery chargers

11.1. Battery

Figure 30: 25000 mAh Battery

11.2. Battery charger



Specification

Input Voltage	AC 110V or 220V
Charge Output Power	1200W(2x600W)
Charge Current	5A/10A/15A/20A/25A
Battery Type	LiPo/LiHV
Battery Cell Count	2-6S
Balance Current	Max. 1.5A
Charge Modes	Balance Charge/Storage
Size	268×140×127mm
Weight	3.1KG

Figure 31: Battery Charger Specifications

- **Current Button**
  - This button allows you to change the charging/discharging current.
- **Parameter control buttons:**

- **Stop/Setting button**: Press once to stop the charging process, and long-press to access settings.
- **Work mode set button**: These buttons allow you to switch between charging and discharging modes.
- **Start button**: Press once to select any configuration, and long-press to start the charging process.

- **AC Input Port**
  - Connect the 110 V or 220 V power input cable to this port.
- **Battery Port**
  Connect the XT90 connector of battery to this XT90 battery port
- **Balance Port**
  - Connect the balance charging cable of the battery to the balance port on the device.

For more details refer to the Battery Charger Manual provided in the flight box.

11.3. Battery Charger Setup Procedure

- Switch on the charger from the AC supply plug and from Back side of the charger.

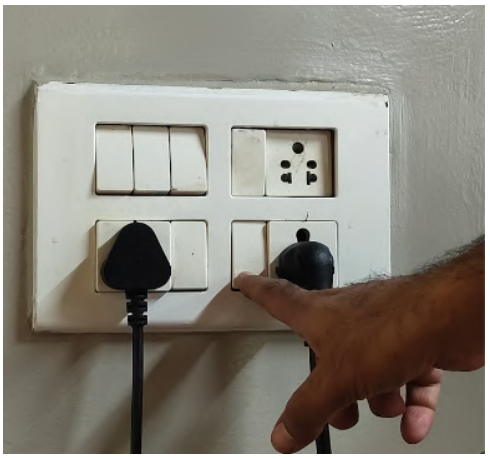


Figure 32: Connecting plug to the power supply

- Connect the battery balance connector to the balance port in the charger in the following manner.

Figure 33: Connecting balance connector to the balance port

- Connect the main battery cable to the battery port of the charger.

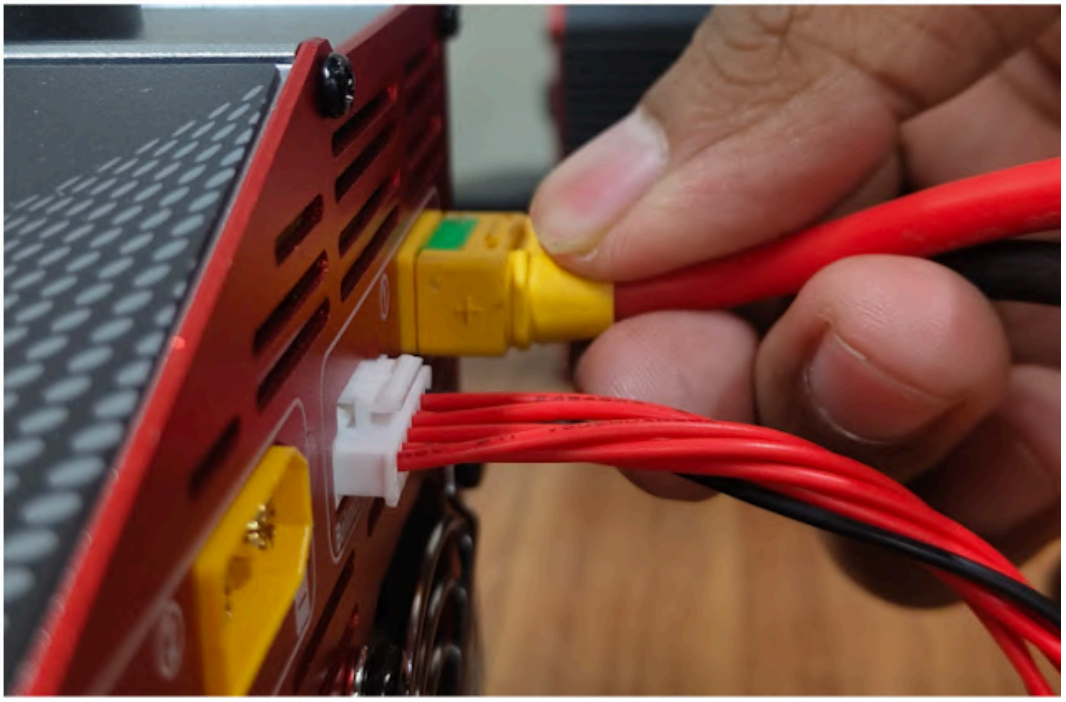


Figure 34: Connecting main battery cable to battery port

Select the battery type to Li-Po in Balance charge mode and charging rate to 10 Amps.

NOTE- IN MASTER SLAVE MODE THE SETTING APPLIED IN MASTER PORT AUTOMATICALLY APPLIES TO SLAVE PORT.

Figure 35: Selecting the charge type and charging rate

- Press Start button after cross checking the inputs. The charger will make a sound once it starts charging.

Figure 36: Pressing start button on the charger

- Press Stop to end the charging once it is done or for emergency stop of charging.

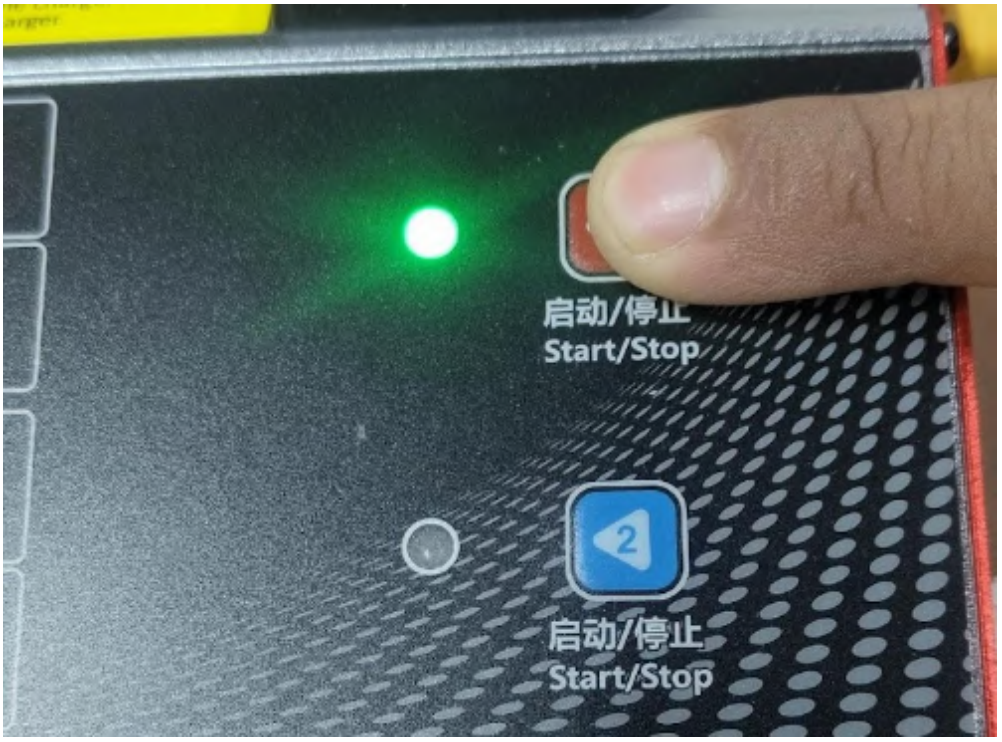


Figure 37:. Pressing stop button on the charger

After charging is complete, disconnect the battery from the charger and turn off the charger.

Figure 38: Battery Charging

11.4. Sop for Battery Storage and Charging

11.4.1. Battery Storage and Transport

- When not in use, store the batteries in a battery storage box to protect them from damage.
- Store the battery packs in a room with a low temperature, ideally below 25 degrees Celsius.
- Be aware that damaging a cell in a pack can permanently damage the entire pack and potentially cause a fire.
- Store fired batteries in a cool and dry chamber to prevent the risk of smoke or flames.
- Ensure that fire extinguishers are readily available during storage, transportation, and loading.
- Store the battery pack at its nominal voltage of 3.7 V (22.2 V across the pack) to increase its lifespan and reduce volatility.
- Avoid placing batteries in pockets or near conductive metals where they can short circuit.
- Do not store, transport, or carry the battery in a way that it may come into contact with sharp or metallic objects.
- Avoid storing Solid State batteries in extreme temperatures below 0°C or above 50°C.
- Always store Solid State packs in safe, non-flammable containers and away from combustible materials.
- Refrain from bulk-storage of Solid State batteries in non-laboratory areas such as offices.
- Store Solid State batteries partially charged as they maintain their performance level over time. Cycling is not necessary unless stored for more than 3-6 months, ideally.
- Conduct visual inspections of battery storage areas at least once a week.

11.5. Safe Battery Storage

- Avoid placing the battery close to liquids and do not store it in a humid environment to prevent moisture damage to the battery.
- Keep the battery away from open flames, heaters, or other fire sources, as it can pose a fire hazard.
- Store the battery in a location that is inaccessible to children to prevent accidental handling or misuse.
- Ensure that the battery has enough storage space and is not squeezed between other batteries or objects, as it can cause damage or deformation.
- Store the battery in a cool and dry place with a temperature of around 25 degrees Celsius, as extreme temperatures can affect battery performance and lifespan.
- For batteries that will not be used for an extended period, control the storage voltage to be between 3.7 V to 3.85 V to prevent over-discharge or overcharge, which can damage the battery.
- Regularly check the status of the battery storage box at least once every two weeks for any signs of damage, leakage, or other abnormalities. If any issues are detected, take appropriate action, such as replacing damaged battery storage boxes.
- Perform a full charging and discharging cycle on the battery at least once every two months to maintain battery stability and prevent capacity loss due to prolonged storage.
- Store the battery in a well-ventilated area to ensure proper airflow and prevent the accumulation of gas

or fumes that may be released by the battery during storage.

- Avoid storing the battery in direct sunlight or in excessively humid or damp conditions, as it can affect battery performance and potentially cause safety hazards.
- Use appropriate storage containers or cases specifically designed for batteries to prevent physical damage, short-circuiting, or exposure to foreign objects that may cause damage.
- Follow manufacturer recommendations for battery storage duration and conditions, as different battery types and brands may have specific requirements.
- If you are unsure about the proper storage procedure for a particular battery, refer to the manufacturer's instructions or seek professional guidance to ensure safe and optimal storage practices.

11.6. Precautions To Take While Charging The Battery

11.6.1. Before Charging and Discharging

- Before charging, carefully inspect the surface of the battery for any signs of damage, such as dents, cracks, or corrosion. Do not charge a battery with a damaged surface.
- Check if the battery is swollen or bulging, which may indicate a potential internal issue. Do not charge a swollen battery as it can be dangerous.
- Look for any signs of leakage, such as fluid or stains, on the battery. If the battery has leaked, do not charge it as it may pose a risk of damage or injury.
- Check the voltage of each cell in the battery to ensure they are within the normal range, typically around 3.3 volts. If any single cell has a voltage lower than the normal range or if the voltage among cells is unbalanced, it may indicate a quality issue with the battery, and it should not be charged.
- Double-check that the positive and negative poles of the battery plug are correctly aligned before connecting it to a charger. Never short circuit the battery, as it can cause damage or even result in a fire or explosion.
- Ensure that the lithium battery charger you are using is in good condition, free from any visible damage or defects. A faulty charger can potentially damage the battery or pose a safety risk during charging.
- Follow the manufacturer's instructions and recommendations for charging the specific type and model of battery you have. Different batteries may have different charging requirements, so it is important to adhere to the guidelines provided by the manufacturer.
- Charge the battery in a well-ventilated area, away from flammable materials and out of the reach of children or pets. Avoid leaving the battery unattended while charging.
- Use a charger that is specifically designed for lithium batteries and has the appropriate voltage and current ratings. Using an incompatible charger can damage the battery or pose a safety risk.
- Monitor the battery during charging for any unusual signs, such as excessive heat, smoke, or a strong odor. If any abnormalities are detected, immediately stop charging and disconnect the battery from the charger.
- Once the battery is fully charged, disconnect it from the charger and store it in a cool, dry place away from direct sunlight or extreme temperatures. Avoid overcharging the battery, as it can shorten its lifespan or cause damage.

11.6.2. During Charging and Discharging

- Use only chargers provided by the original equipment manufacturer (OEM) specifically designed for charging Solid State batteries. Do not use chargers meant for other types of batteries such as NICD or NIMH.
- Never leave the battery unattended while it is being charged to minimize the risk of overcharging, overheating, or other potential safety hazards.
- Avoid overcharging the battery. Make sure the voltage of each battery cell does not exceed 4.2 V when fully charged. Also, do not short circuit the battery, as it can cause damage or even fire.
- Charge the battery within the recommended temperature range of 0-45 degrees Celsius to ensure safe and efficient charging. Avoid charging in extreme temperatures that can damage the battery.
- Ensure that the charging table or platform used is heat resistant and can withstand high temperatures during the charging process to prevent any potential fire hazards.
- Place the battery on a concrete floor or in a flowerpot filled with sand during charging to

provide a stable and non-flammable surface, minimizing the risk of accidents.

- Avoid overheating the battery and its cells at any time, as it can lead to reduced performance, damage, or safety risks. If the temperature of the battery cell reaches 60 degrees Celsius, there is a potential hazard or risk of fire.
- Do not charge the battery directly on flammable materials such as paper, carpet, plastic, vinyl, leather, or wood, and do not charge it inside the device. Also, do not over-discharge the battery, as it can damage the battery, cause swelling, or reduce its lifespan. Make sure the voltage of each cell after discharge is not less than 3.3 V.
- Avoid contact with the electrolyte in the battery, as it can cause harm to eyes or skin. If accidental contact occurs, immediately wash with clean water, and seek medical attention if necessary.
- Do not disassemble or rewire the battery, and do not attempt to combine old battery cells or disassembled cells with another pack of batteries without proper equipment. Improper assembly can cause short circuits and result in burning or other hazards.
- Do not touch leaking batteries directly, as the electrolyte can be harmful. Handle with care and dispose of properly according to local regulations.
- Avoid assembling batteries privately and follow manufacturer guidelines for battery assembly. Improper assembly can result in safety risks, such as short circuits or fires.
- If the battery is involved in a collision during use, remove it and assess for any potential damage before continuing to use or charge it.
- Carefully inspect the battery and connector for any signs of damage, wear, or abnormality before charging or using it to ensure safe operation.
- ***After charging, make entries in the battery charging logbook.***

11.7. Procedure for Battery Disposal

Dispose of the battery by following local regulations for hazardous materials. The battery should be properly packaged, labeled, and transported to a certified disposal facility.

Precautions: Safety to be taken care of

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

Record-Keeping

- Records of the disposal should be kept for a minimum of five years.
- Any associated hazardous materials should be properly documented.
- Keep a record of the disposal, including the date and location.

This SOP outlines the steps to be taken for the safe and compliant disposal of the Battery of the drone that has reached its designated life of 300 Cycles. By following these procedures, the disposal process can be completed in a manner that is safe for personnel and the environment.

Once the battery life is over (300 cycles) or the battery gets damaged, it will be considered as battery waste. Collect such all the batteries and hand it over to SooryaUday Aerial Vehicles Private Limited.

11.8. Procedure for RC Charging

- Check blue lights on the RC power button.

Figure 39: Solid blue light on power button on RC

- Now connect the charging cable to the charging point of the RC and switch on the main power supply button.

Figure 40: Charging port on RC

- The charging indicator blue light, and the transmitter starts charging.
- When the charging indicator turns full, charging is finished as shown in the figure.

Battery Level LED definition ● ON ○ OFF

Bettery Level LED definition				
●	●	●	●	75%–100%
●	●	●	○	50%–75%
●	●	○	○	25%–50%
●	○	○	○	0%–25%

Figure 41: Charging Status Indicator

12. Drone Flying Checklist

A drone flight checklist is a list of items that a drone pilot should verify before each flight to ensure that the flight is conducted safely and without any issues. The checklist typically includes items such as the drone's battery level, the condition of the drone and its components, the location and weather conditions, and any other potential hazards or obstacles that may affect the flight.

12.1. Pre-Flight Checklist

- Turn on the ground control station (GCS) and ensure that it is fully charged.
- Connect the batteries to the drone and wait for the connection to establish. Make sure that the battery level is sufficient for the planned flight time.
- Calibrate the accelerometer and compass.
- Check the propeller configurations to ensure that they are correctly mounted and secured.
- Conduct a sanity check, including:
    - Ensuring that the battery voltage is fully charged.
    - Checking all mechanical and electronic connections, such as the drone arms and payload.
    - Verifying that all motors are running in the correct direction and at the same speed. Perform a motor test to confirm.
    - Checking that the GCS is fully charged and that the telemetry link between the drone and GCS is stable.
    - Balancing the tank and batteries to ensure that the drone is stable during flight.
- Check the weather conditions and adjust the flight plan accordingly. Avoid flying in windy or rainy conditions, as they may affect the stability and safety of the drone.
- Identify the location for battery charging and ensure that it is a safe and appropriate area for charging.
- Identify the location for take-off and landing. Check that the area is clear of obstructions and that there is enough space for the drone to take off and land safely.
- Identify the area for flying and check for any obstacles or hazards, such as trees or power lines. Make sure that the area is clear of people and animals.

12.2. In-flight checklist

- Take the altitude at the earliest possible opportunity but ensure that it is safe to do so and within the limits of your drone's capabilities.
- Keep the speed of the drone at a minimum of 5 m/s to ensure stability and control.
- Avoid jerky stops, as they may indicate a problem with the drone's accelerometer or compass. If any jerks are seen without manual command, land the drone immediately and redo the calibration. Conduct a flight test before resuming the flight.
- Fly the drone below the 6 m/s gust wind speed to ensure stability and control.

- Monitor the temperature of the motors after every flight. If the motors are too hot, rest the drone for 10 minutes to prevent overheating and damage.
- If the compass is getting heated, it will prompt for "compass not healthy" and "compass in-consistence error". Let the drone cool in some shade for 20-25 minutes before taking the next flight.
- Monitor the battery level during flight and ensure that the drone has enough power to return to the takeoff location or land safely.
- Monitor the telemetry data from the drone and ensure that the connection between the drone and the ground control station is stable.
- Avoid flying over people, animals, or restricted areas. Adhere to local laws and regulations.
- In case of emergency, activate the return-to-home function or land the drone immediately in a safe and clear area.

12.3. Post-flight checklist

- Rinse the tank thoroughly with water at least twice to remove any remaining pesticides or chemicals that may have been used during the flight. Use clean water to prevent residue buildup and potential damage to the tank.
- Remove the batteries from the drone to prevent any discharge or damage. Ensure that the batteries are safely stored in a cool, dry place and away from any flammable materials.
- Fold the arms of the drone and keep it in the box to protect it from any potential damage during transport or storage.
- Inspect the drone for any signs of damage, such as cracks or dents, and ensure that all components are securely fastened and in their correct positions.
- Check the drone's propellers for any signs of wear or damage. Replace any damaged propellers before the next flight.
- Inspect the drone's sensors, cameras, and other components for any signs of dirt, debris, or damage. Clean or repair, as necessary.
- Check the drone's telemetry data and ensure that all flight data has been safely downloaded to the ground control station or storage device.
- Log any relevant flight data or issues in a flight logbook for future reference or troubleshooting.

12.4. Routine checks/periodic checks

- Conduct a routine checkup after every 20 flights to ensure that the drone is in good working condition and prevent any potential issues.
- Check all the screws present on the base plate, propellers, landing gear, and other components to ensure they are securely fastened and tightened. Loose screws can lead to drone instability or component failure.
- Check the alignment of the landing gear, motor balancing, and tank balancing of the drone to ensure that the drone is properly balanced and stable during flight.
- Rinse the tank and the pipes properly to remove any remaining pesticides or chemicals that may have been used during the flight. Use clean water to prevent residue buildup and potential damage to the tank and pipes.
- Do the accelerometer calibration as explained in the drone's user manual to ensure accurate and stable flight performance.

- Do the compass calibration as explained in the drone's user manual to ensure the drone's compass is properly calibrated and accurate.
- Inspect the drone's propellers for any signs of wear or damage. Replace any damaged propellers before the next flight.
- Check the drone's sensors, cameras, and other components for any signs of dirt, debris, or damage. Clean or repair, as necessary.
- Check the drone's battery for any signs of damage or swelling. Replace any damaged or swollen batteries before the next flight.
- Check the weather forecast for the next flight to ensure that conditions are safe and favorable for flying.

12.5. Life of Critical Components and Their Replacement Procedure

Below is the list of critical components that are to be replaced before its designated limit of life.

Sr. No.	Component Description	Life Cycle (Hours)
1	Arm Joint	8000
2	Tank Connector	8000
3	Landing T Connectors	8000
4	Landing Gear Connector	8000
5	Propeller	500
6	Airframe	8000 Hours
7	Landing Gear	10000 Landings
8	Motor	500 Hours
9	Battery	300 Cycles

12.5.1. Landing Gear Connector

The obtained life of the Landing Gear Connector is **8000 hours.** After the duration of the assigned life of the component is completed, it should be replaced with a new component.

During the ongoing life period, the component should be continuously monitored for structural deformations or defects, such as cracks, creep, etc. Monitoring can be done by regular maintenance checks, pre-flight, in-flight & post flight inspection. If some anomaly is found, it should be replaced.

For replacement the user should contact the manufacturer (SooryaUday Aerial Vehicles Private Limited.).

12.5.2. Landing T Connector

As per FEA, the obtained life of the Landing T Connector is life has been limited to **8000 hours**. After the duration of assigned life of the component is completed, it should be replaced with a new component. During the ongoing life period, the component should be continuously monitored for structural deformations or defects, such as cracks, creep, etc. Monitoring can be done by regular maintenance checks, pre-flight, in-flight & post flight inspection. If some anomaly is found, it should be replaced.

For replacement the user should contact the manufacturer (SooryaUday Aerial Vehicles Private Limited). The manufacturer will inspect the component and will replace it with the new identical one.

12.5.3. Tank Connector

As per FEA, the obtained life of the Tank Connector is limited to **8000 hours.** After the duration of assigned life of the component is completed, it should be replaced with a new component. During the ongoing life period, the component should be continuously monitored for structural deformations or defects, such as cracks, creep, etc. Monitoring can be done by regular maintenance checks, pre-flight, in-flight & post flight inspection. If some anomaly is found, it should be replaced.

For replacement the user should contact the manufacturer (SooryaUday Aerial Vehicles Private Limited). The manufacturer will inspect the component and will replace it with the new identical one.

12.5.4. Arm Joint

As per FEA, the obtained life of the Arm Joint is limited to **8000 hours**. After the duration of assigned life of the component is completed, it should be replaced with a new component. During the ongoing life period, the component should be continuously monitored for structural deformations or defects, such as cracks, creep, etc.

Monitoring can be done by regular maintenance checks, pre-flight, in-flight & post flight inspection. If some anomaly is found, it should be replaced.

For replacement the user should contact the manufacturer (SooryaUday Aerial Vehicles Private Limited). The manufacturer will inspect the component and will replace it with the new identical one.

12.5.5. Propeller

As per OEM Test Report, the obtained life of the Propeller is limited to **500 hours**. After the duration of assigned life of the component is completed, it should be replaced with a new component. During the ongoing life period, the component should be continuously monitored for structural deformations or defects, such as cracks, creep, etc. Monitoring can be done by regular maintenance checks, pre-flight, in-flight & post flight inspection. If some anomaly is found, it should be replaced.

For replacement the user should contact the manufacturer (SooryaUday Aerial Vehicles Private Limited). The manufacturer will inspect the component and will replace it with the new identical one

12.6. Periodic Inspection Schedule for Primary Structural Elements

12.6.1. Inner Arm

- Check for any visible cracks, bends, or dents on the tube
- Inspect the surface for any signs of fractures losing nut bolts.
- Examine the connections between the Inner Arm and other components, such as motors and frame.

12.6.2. Outer Arm

- Check for any visible cracks, scratches, or dents on the carbon fiber tube
- Inspect the surface for any signs of delamination (separation of layers).
- Ensure there are no loose or protruding fibers.
- Examine the connections between the carbon fiber tube and other components, such as motors and frame.

12.6.3. Landing T Connector

- Check for any visible cracks, bends, or dents on the tube
- Inspect the surface for any signs of fractures losing nut bolts.
- Examine the connections between the Horizontal Landing Tube and other components, such as motors and frame.

12.6.4. Landing Gear Tube

- Check for any visible cracks, bends, or dents on the tube

- Inspect the surface for any signs of fractures losing nut bolts.
- Examine the connections between the Vertical Landing Tube, Horizontal Landing Tube and other components, such as motors and frame.

12.6.5. Landing Gear Connector

- Check for any visible cracks, bends, or dents on the tube
- Inspect the surface for any signs of fractures losing nut bolts.
- Examine the connections between the Vertical Landing Tube and other components, such as motors and frame.

PSE's and their Fasteners:

Sr. No.	PSE	No. of fasteners
1	Inner Arm	84
2	Outer Arm	6
3	Horizontal Landing Tube	4
4	Vertical Landing Tube	36
5	Central Hub	18
6	Landing T Connector	4
7	Landing Gear Connector	16

12.7. Flight Operating Limits

- ✔ Maximum Wind speed - Less than 6 m/s
- ✔ Ambient Temperature - Not more than 50°C
- ✔ Max Allowable Altitude - 40 m AGL
- ✔ Max Range – 1000 m
- ✔ Max Speed – 10 m/s
- ✔ Maximum Lean Angle - 30°
- ✔ Minimum satellites count for takeoff – 13
- ✔ Safe HDOP value – less than 1

12.8. Safe landing limits

- ✔ Minimum Landing area clear of obstructions – 25 feet
- ✔ Max Descend Speed - 2 m/s (Manual Mode)
- ✔ Max Ascend Speed – 1 m/s

12.9. Measures of Safe Operations

12.9.1. Warning

Users are explicitly forbidden from attempting to open the UAVs Top canopy. Any effort to access the Top canopy will result in tampering since the screws are secured with Loctite. In the event that a tamper mark is discovered, it will render the UAVs warranty null and VOID.

12.9.2. Tamper Proofing

"DO NOT OPEN" the Canopy of SprayCoptor UAS. A void sticker is employed to determine if any tampering has occurred. The critical hardware components of UAS are affixed with a unique hologram void sticker. If any tampering is detected in the casing of the system, it will result in the nullification of the UAVs warranty.

12.9.3. Motor LED Warnings

Flashing of LED	Meaning	Solution
Single short flash	Over-voltage	Replace the battery (Voltage below 63V)
2 short flash	Under-voltage	Replace the battery (Voltage higher 18V)
3 short flash	Over-current	• Check the motor for foreign objects and check the propeller,then power on again • Contact after-sales service
Single long flash	Throttle lost	• Check connection between signal line to the flight controller • Check whether the remote controller and flight controller are turned on • Check the resistance of the black and white wires, if there is a short circuit, contact the after-sales service
Single long flash + Single short flash	Throttle not reset to zero	This problem occurs during the rotation of the motor. Please check the aircraft battery and circuit. There is a short circuit on the circuit.
Single long flash + 2 Short flash	Mosfet overheated (Over 110℃)	Cool down the power system and power on again
Single long flash + 3 Short flashes	Capacitor overheated (Over 110℃)	Cool down the power system and power on again
Single long flash +4 Short flashes	Stall protection	• Restart after the throttle is reset to zero • Please check if there is any foreign matter in the motor, remove the foreign matter before starting
2 long flashes	ESC open-circuit	• Please check whether the motor circuit is intact • Contact after sales service
2 long flashes + Single short flash	ESC short-circuit	• Please check whether the motor is in good condition • Contact after sales service
2 long flashes + 2 Short flash	Motor short-circuit	• Please check whether the motor is in good condition • Contact after sales service
2 long flashes + 3 Short flash	Phase A operational amplifier is abnormal	• Re-power on to return to normal • Contact after sales service
2 long flashes + 4 Short flash	Phase B operational amplifier is abnormal	• Re-power on to return to normal • Contact after sales service
3 long flashes	Phase C operational amplifier is abnormal	• Re-power on to return to normal • Contact after sales service

- In case the motor LED gives any one of the above mentioned **flashing patterns**, this is the indication that the motor controller reached some of the warning state**, Land the UAS immediately.**

13. Emergency Flight Procedures Communication data link loss and Contingency Plans

13.1. Alerting mechanism – Visual and Aural signals

In case of C2 Data link Loss due to any malfunctions, Drone beeps the sound and Lights are made to flash continuously yellow on GPS showing Error (Data link Loss) by color code timing pattern.

When a data link is lost, the GCS connection status changes from Green to Red and Aural message comes "**Communication Link Lost, Drone Disconnected**" and UAS follows a predefined path to ensure a safe end of flight within the required area restrictions.

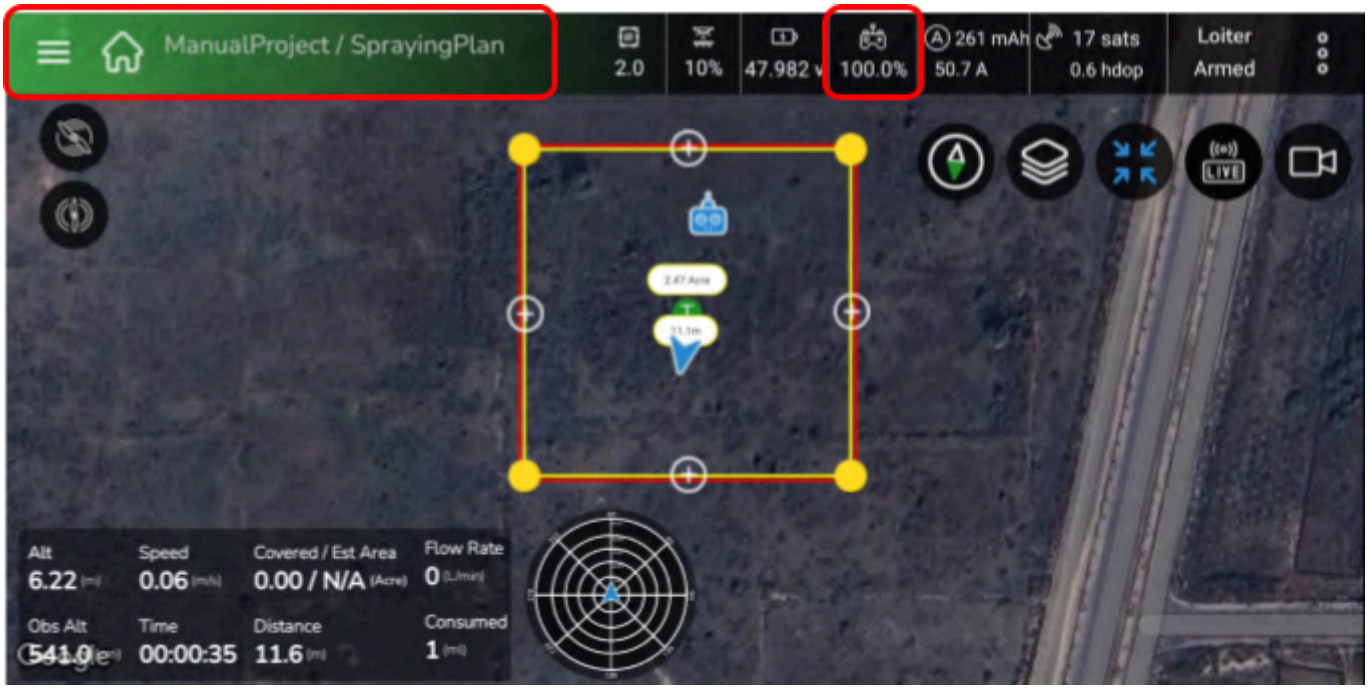


Figure 42: C2 Link Connection Status Before Connection Loss

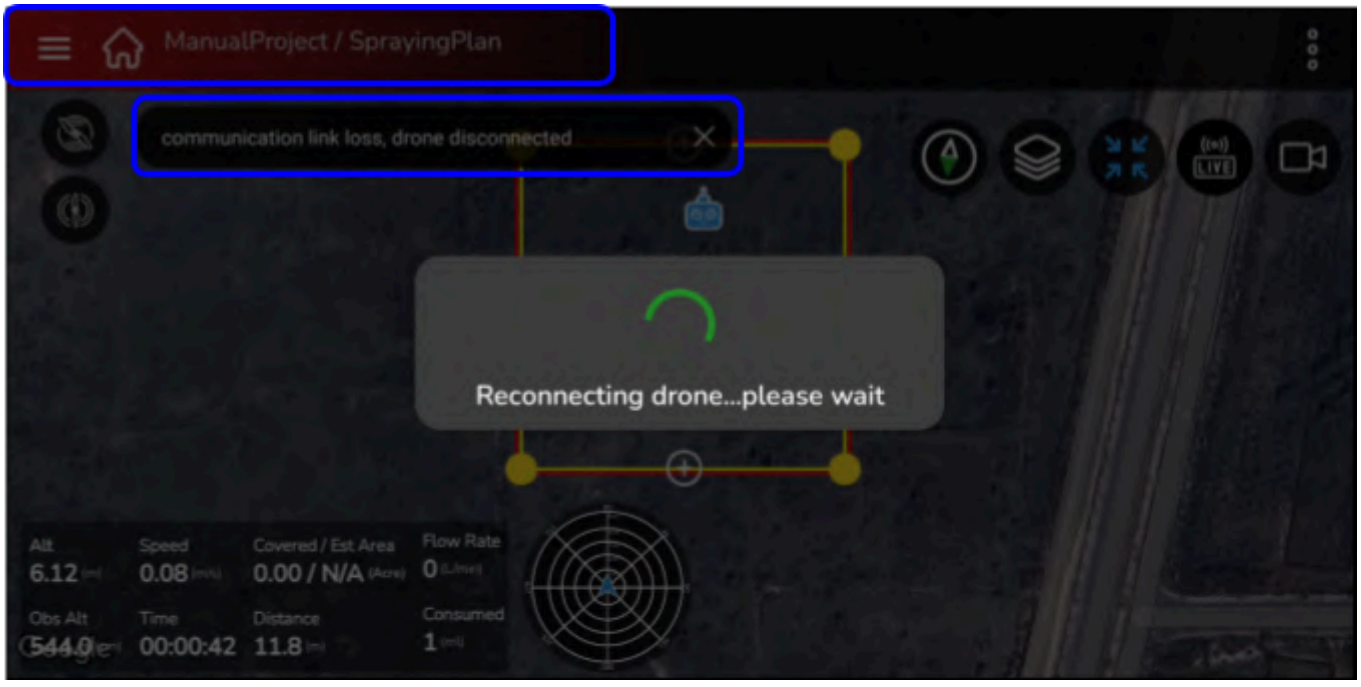


Figure 43: C2 Link Connection Status After Connection Loss

13.1.1. Contingency plan C2 Link loss

The Command & Control (C2) link between the control station and the UAV may face challenges like distance limitations, radio frequency interference, obstructions, and environmental factors. If the C2 link is lost, the flight controller will initiate the pre-programmed failsafe response, activating the Return to Launch (RTL) mode. In case of a C2 link loss, the **RTL mode will be triggered after 5 seconds** of connection loss.

In FAILSAFE mode, the UAV will initiate a direct return to the Home Position (Launch area). If the UAV is below the specified Return to Launch (RTL) Altitude, it will maintain its current position while ascending to the predetermined altitude. The pilot can manually trigger the RTL mode for any contingency, such as sudden weather changes during flight or difficulty in locating the UAV during flight, based on their flying expertise. Upon manual activation of RTL, the UAV will fly back to the home location at the RTL altitude specified in the Flight manual of SprayCoptor.

To manually trigger RTL, the procedure outlined in the Flight manual of SprayCoptor must be followed. Once the RTL mode is activated, the UAV will continuously emit an aural signature through a beeping buzzer in a specific tone. Additionally, the Remote Controller (RC) will provide an AUDIO WARNING, indicating that RTL is armed and active.

Also, when the RTL is triggered, and in emergency conditions the pilot has provision to take loiter mode of UAV.

Action	Pilot	Observer/Spotter
Announce Emergency	Announce loss of control link to relevant authorities and personnel	Secure the area and establish a clear exclusion zone around the UAV's position.
Determine Cause	Investigate potential causes of link loss:	
RC Link Failure	Check for issues with the remote controller, power supply, or antenna.	
External Interference	Identify potential sources of interference, such as other radio signals or power lines.	
UAV Beyond Range	Verify the UAV's current distance from the controller and determine if it's exceeding range limits.	
First Aid & Fire Extinguisher	Stage first aid kit and fire extinguisher within the exclusion zone in case of an emergency landing.	Maintain situational awareness and prepare to assist the pilot if needed.

13.1.2. Automated Response – Return to Launch (RTL)

- RTL is Activated when data link is lost and in other contingencies like low voltage, low mAh, compass Variance (EKF Error) and heavy Vibrations Observed.
- The Return to home flight mode is used to fly a vehicle to safety on an unobstructed path to a safe destination, where it may either wait (hover or circle) or land.
- UAS use a home location return by default (and the following configuration):
    - Ascend to RTL altitude (20 meter by default)
    - Fly to the home position in a straight line and at constant altitude (if already above the return altitude it will return at its current altitude).
    - Hover over home location for 5 sec.

- Rapidly descend to the specified altitude. (10 meter by default)
- Land more or less immediately

- In return altitude, the vehicle will usually first ascend to a safe altitude before returning home, to avoid any obstacles between it and the destination.
- After reaching a home point altitude, the vehicle will slow or stop its initial descent from a higher return altitude.
- So, we can say the flight envelope of the RTL will always be ASCEND, CRUISE, LOITER, DESCENT and LAND.
- Always keep a hand on the Brake switch for stopping the RTL operation in case there are any obstructions while In RTL mode.

13.2. Low Power Situations

13.2.1. In case of MAH drop

We have set 10% Capacity of our battery as reserve. When the battery capacity is consumed beyond 22500 mAh, fail safe is triggered and RTL is activated.

13.2.2. In case of voltage drop

When the Voltage during operations falls below predetermined voltage 41.2 V, Failsafe is triggered, and RTL is activated.

And in case voltage is dropped to critical voltage of 39.5 V, it will trigger Land mode to avoid excessive battery discharge.

13.3. Loss of Propulsion System

In the event of propulsion failure occurring in one or more of the 6 brushless electric motors during flight, the pilot may encounter challenges in controlling the UAV. The severity of this situation can vary: In the best-case scenario, the failure might present itself as difficulty in precisely controlling the yaw of the UAV.

In the worst-case scenario, there may be a partial loss of attitude control. However, even in this situation, the pilot should still have some level of control over the UAV.

The behavior of the UAV in response to motor failure is influenced by the current All-Up Weight (AUW) of the UAV:

If the UAV is lightly loaded, the loss of propulsion will have a relatively minor impact on attitude control.

If the UAV is operating close to its Maximum Takeoff Weight (MTOW) as specified in the manual, it will become more challenging for the pilot to maneuver the UAV effectively.

If the UAV becomes uncontrollable due to motor failure, it is advisable to initiate an emergency landing. Upon landing, it's crucial to promptly power down the motors to prevent any further damage to the propulsion system. This action will help safeguard the UAV and facilitate subsequent repairs or maintenance.

Table 3: Actions to be Performed in Case of Propulsion System Loss

Actions to BE Performed By	
PILOT	**OBSERVER**
Decrease the UAV altitude as fast as possible, while directing towards the predetermined Emergency Area.	Move towards the emergency landing area with the first aid kit and fire extinguisher.
Take the most direct route to the emergency area but aim to avoid flying above populated areas.	Announce the emergency situation and make people in the area aware of the movements of the UAV as it is.

Land as quickly as possible, but pilots should begin with a slower descent than normal, to minimize the effect of lack of power.	Move away from the emergency area.

13.4. Fire Onboard

If there is an unanticipated loss or partial depletion of UAV battery power, the pilot should swiftly reduce the UAVs altitude while steering it towards the predetermined emergency landing area. opt for the most direct path to the emergency area, while being mindful to avoid flying over densely populated regions. Initiate an immediate forced landing, endeavoring to maintain the lowest possible ground speed for safety. It's important to note that, in the case of lithium battery fires, only a Class D Fire Extinguisher should be employed.

13.5. Flight Controller System Failure

Unforeseen anomalies may arise from inaccurate sensor data, weakened GPS signal reception, or compass irregularities. SprayCoptor UAS boasts redundancy in its critical systems. However, it is imperative that the Pilot in Command (PIC) does not persist with the flight once an error has been detected and reported. Potential system malfunctions encompass the Flight Controller IMU, GPS/compass, attitude telemetry, and stabilization components.

13.6. Sudden Change in Wind Conditions

An unexpected surge in wind strength can take a UAV pilot by surprise. Elevated wind levels will extend the flight duration and deplete the battery more rapidly. This is particularly crucial to bear in mind when the UAV is operating at a considerable distance downwind from the pilot.

If the UAV encounters difficulties in advancing against the wind, the pilot's strategy should involve descending to a lower altitude whenever possible. This allows the UAV to benefit from the reduced wind speeds closer to the ground.

It's important to exercise caution when flying downwind of substantial objects that can generate turbulent air or low-level wind shear. The SprayCoptor UAS is designed to safely operate within a maximum wind speed of 6 m/s.

13.7. Geofence Capability

- **The user can give the Geofence while creating the Auto plan for spraying. The User can give the fence up to 10 meters around the plan boundary.**
- A Geofence is a virtual boundary that defines where a vehicle can travel. Geofences can be used to prevent a vehicle flying out of range of the RC controller, or into unsafe or restricted airspace.
- The Geofence Failsafe defines a cylinder centered on the home position, with a specified maximum radius and altitude.
- This Feature Helps to Safeguard the drone to never breach predefined distance and height, which are recorded when Armed (By Default Drone Takes the Home Point from Where It Has been Flown).

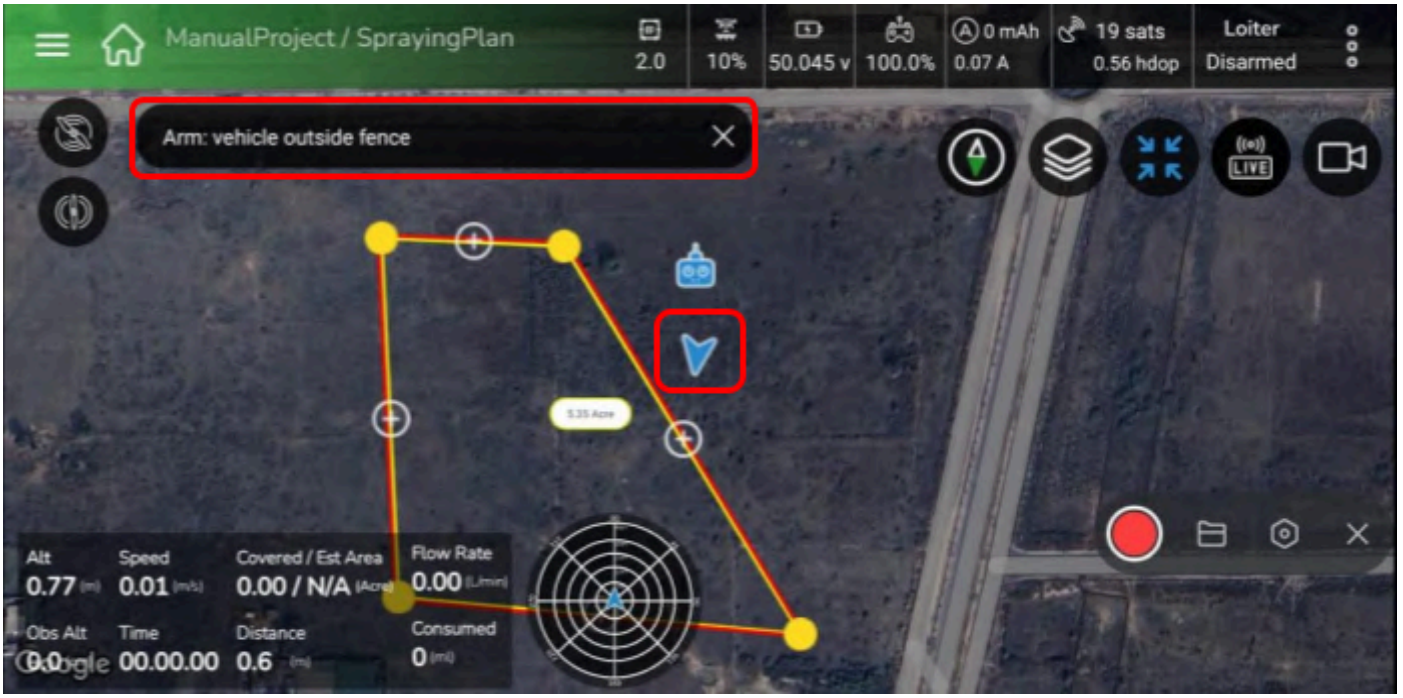


Figure 44: GCS Giving Warning on Arming the UAV outside the Fence

13.7.1. Actions to be performed during Geofence breach

- ✔ In general, the app is built in such a way that even if the way points are placed mistakenly outside the set geofence area, then the app will not save the mission plan/project unless until the waypoint comes inside the fence, this is a safety feature which is inbuilt
- ✔ Manual breach of geofence by the user leads to RTL action saying, “RTL Armed”, which can be seen on bottom corner of screen and command popup saying “Fence breached”

Figure 45: Fence Setup in GCS

Actions to be Taken:

- Once the geofence breach is detected by the on-board flight system, it is tuned to perform RTL.
- If you have better control over the drone while geofence is breached, take the drone inside the geofence manually by disabling RTL mode and switching to Loiter mode.

- Please make sure not to disturb the sequence of operations which are being performed during this activity.
- The drone tries to maintain the position inside the fence, in case it breaches the Geofence, then manually triggers RTL mode and lands the drone safely.

Table 4: Aural /Visual signals and its Relevance

Aural / Visual Signals	Relevance
Communication Link Loss, Drone Disconnected	This Signal by GCS means the datalink of the Transmitter and Receiver is lost. This could happen due to the faulty antenna of either transmitter or receiver. Check the connectivity of the Drone and the GCS.
Tank Empty	The liquid in the tank is finished during the operation
Battery Failsafe	The battery is drained to 41.2 V which is RTL voltage thus triggering RTL.
RTL	Return to Home (RTL) mode is triggered due to Low Battery, Empty Tank, Data link loss or Fence breach
Fence Breached	This warning is shown by the GCS to alert pilots that UAV has breached its Maximum range, altitude or fence defined by the pilot during the mission.

14. Certificate of Conformity

Date: DD/MM/YYYY

CoC Serial Number: CoC/SAV/MMYY/0000x

CERTIFICATE OF CONFORMITY

This is to certify that the Unmanned Aircraft System (UAS) described below has been manufactured in accordance with the specifications and standards set forth in the CERTIFICATION SCHEME FOR UNMANNED AIRCRAFT SYSTEMS (CSUAS Jan 2022) and Type Certificate No. _____ Dated _____ of the Directorate General of Civil Aviation (DGCA), Government of India.

Type Certificate Number:

UAS Model Name: SprayCoptor

Manufacturer Name: SooryaUday Aerial Vehicles Private Limited.

UAS Serial Number:

Date of Manufacturing:

UIN ID:

Name:

Designation: Director

Date:

***Note**: This Certificate of Conformity affirms that the mentioned Unmanned Aircraft System complies with the stipulated regulations and standards as per CSUAS 2022. The Type Certificate Number and UIN (If Associated), confirms the registration of this UAS with the DGCA. This certificate is signed by the authorized signatory of the manufacturing company as a declaration of adherence to the specified guidelines.*

Uppal's M6 plaza, 6E, 6th Street, Jasola, New Delhi, Delhi 110025