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Lynx VTOL

User Manual

Last Updated: 19 May 2020

A PDF version of this manual is available here.

GENERAL INFORMATION

READ THIS USER MANUAL CAREFULLY BEFORE USING LYNX VTOL.

Applicable Regulations

Unmanned Aircraft are subject to regulations enforced by civil aviation authorities. Regulations may vary depending on the country where you intend to operate your product. ANY USE OF SWIFT RADIOPLANES LLC PRODUCTS IN BREACH OF THE LAW OF THE COUNTRY WHERE YOU OPERATE THE PRODUCT IS UNDER YOUR SOLE RESPONSIBILITY. INFORM YOURSELF BEFORE USING THE PRODUCT. SOME COUNTRIES MAY HAVE LAWS THAT LIMIT THE USE OF UNMANNED AIRCRAFT TO LINE-OF-SIGHT OPERATIONS AND/OR PROHIBIT THE USE OF UNMANNED AIRCRAFT AT ALL OR IN SPECIFIC AREAS/AIRSPACE.

Limited Warranty and Service Agreement

The limited warranty and service agreement can be found at srp.aero/policy

Limitation of Liability

SWIFT RADIOPLANES SHALL NOT BE LIABLE FOR SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS OR PRODUCTION OR COMMERCIAL LOSS IN ANY WAY, REGARDLESS OF WHETHER SUCH CLAIM IS BASED IN CONTRACT, WARRANTY, TORT, NEGLIGENCE, STRICT LIABILITY OR ANY OTHER THEORY OF LIABILITY, EVEN IF SWIFT RADIOPLANES HAS BEEN ADVISED OF SUCH DAMAGES. Further, in no event shall the liability of Swift Radioplanes exceed the individual price of the Product on which liability is asserted. As Swift Radioplanes has no control over use, setup, final assembly, modification or misuse, no liability shall be assumed nor accepted for any resulting damage or injury. By the act of use, setup or assembly, the User accepts all resulting liability. If you as the Purchaser or the User are not prepared to accept the liability associated with the use of the Product, Purchaser is advised to return the Product immediately in new and unused condition to the place of purchase.

Copyright

Address

SRP Aero

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Prescott Arizona 86301

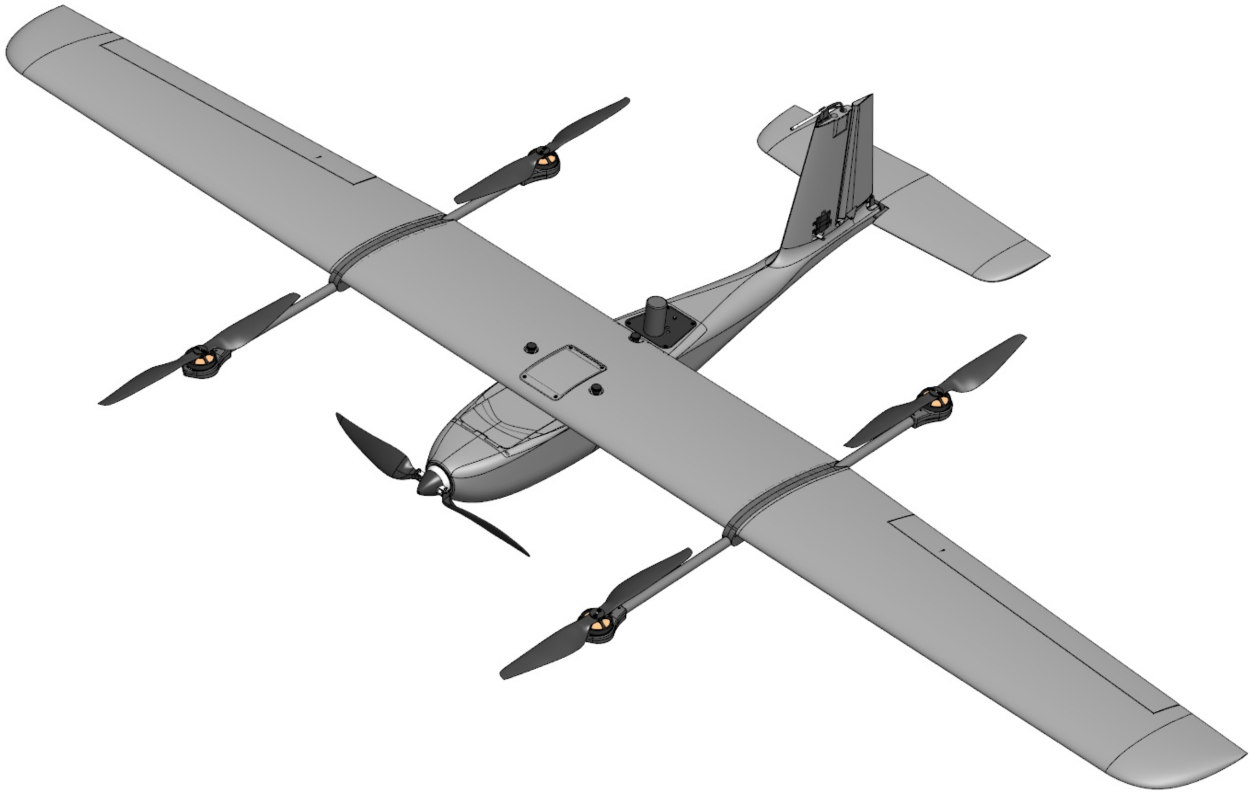
United States of America

Technical Support

If you have questions regarding Lynx VTOL or accompanying software please visit srp.aero/lynx-vtol or contact support@srp.aero.

Welcome

Congratulations on your purchase of the Lynx VTOL. Lynx VTOL is a vertical takeoff and landing fixed-wing unmanned aircraft for precision aerial mapping. Lynx VTOL blends the ease-of-use and flexibility of a multirotor with the endurance and speed of an airplane.



This revision of the manual refers to version 0.6.0 of Swift GCS software. Check the software version included in your package and consult the Swift GCS release notes for potential changes included in more recent versions of the software.

Package Contents

The standard Lynx VTOL utilizes an SKB 3i-4213-12 rugged transport case and contains the following items:

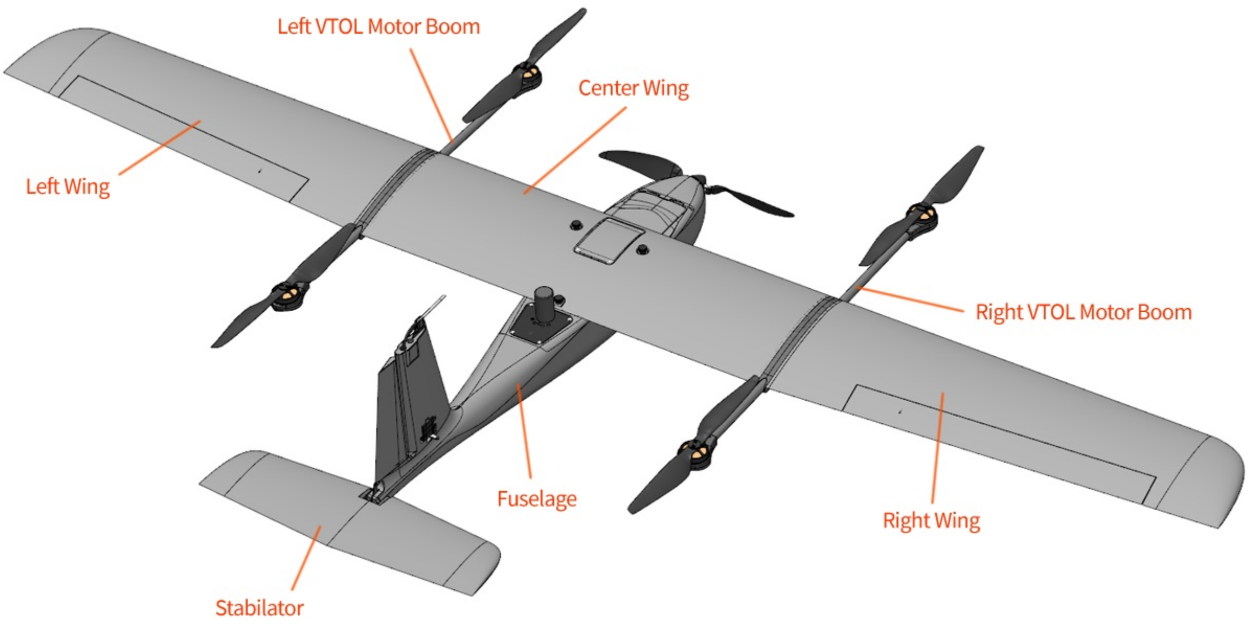
- Main body fuselage with integrated autopilot
- Center wing
- Left wing
- Right wing
- Stabilator (horizontal tail)
- Left VTOL motor boom
- Right VTOL motor boom
- 4x Lithium Ion battery packs (main battery)
- 2x Lithium Polymer battery packs (VTOL battery)
- Battery charger (for main and VTOL batteries)
- Tool bag
- Tool kit
    - Philips screwdriver
    - Flathead screwdriver
    - Crescent wrench
    - 2.5mm hex key
    - Pitot tube cover

  - Lens brush (optional with payload)
- Spares kit
  - 4x pitot tube clips
  - 2x tail clips
  - 2x wing clips
  - 2x 4-40 x 1/2" screws (for pitot and wing clips)
  - 8x front wing thumbscrews
  - 4x rear wing thumbscrews
  - 4x motor boom thumbscrews
  - 1x pair folding propellers
- Micro SD card adapter
- USB micro cable
- USB-C cable
- Ground telemetry radio with antennas
- RC controller (optional)
- Gamepad (optional)
- Payload (optional)
- GNSS base station (optional)
- GeoTagz license and dongle (only with PPK option)

Depending on your order, your package may also include other items, such as additional payloads. Please verify you packing list upon delivery. Contact support@srp.aero immediately if anything is missing.

Hardware Features

The Lynx VTOL airframe consists of the following components.



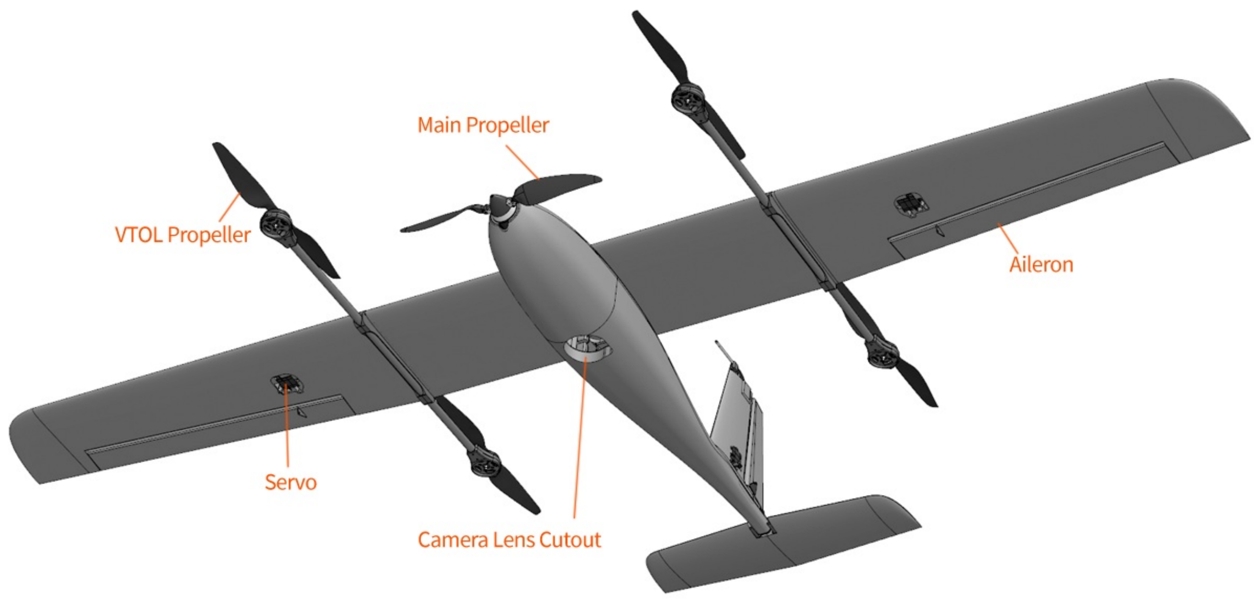
Fuselage: The Lynx VTOL fuselage is the main body of the airframe and contains the majority of electronics, including the autopilot and payload.

Left/Right Wing: The wings provide lift for the aircraft when in forward flight. Each contains a servo actuator and aileron for controlling the how the aircraft turns in flight. The wings are detachable from the center wing.

Center Wing: The center wing connects to the top side of the fuselage and joins the entire wing and VTOL motor booms together. It also houses electronics for controlling the VTOL motors.

Left/Right VTOL Motor Boom: The vertical takeoff and landing (VTOL) booms connect to the center wing and contain two vertical thrust motors each.

Stabilator: The stabilator is a movable tail surface for controlling climbs, descents, and aircraft pitch in flight.



Main Propeller: Used to generate thrust when flying as an airplane.

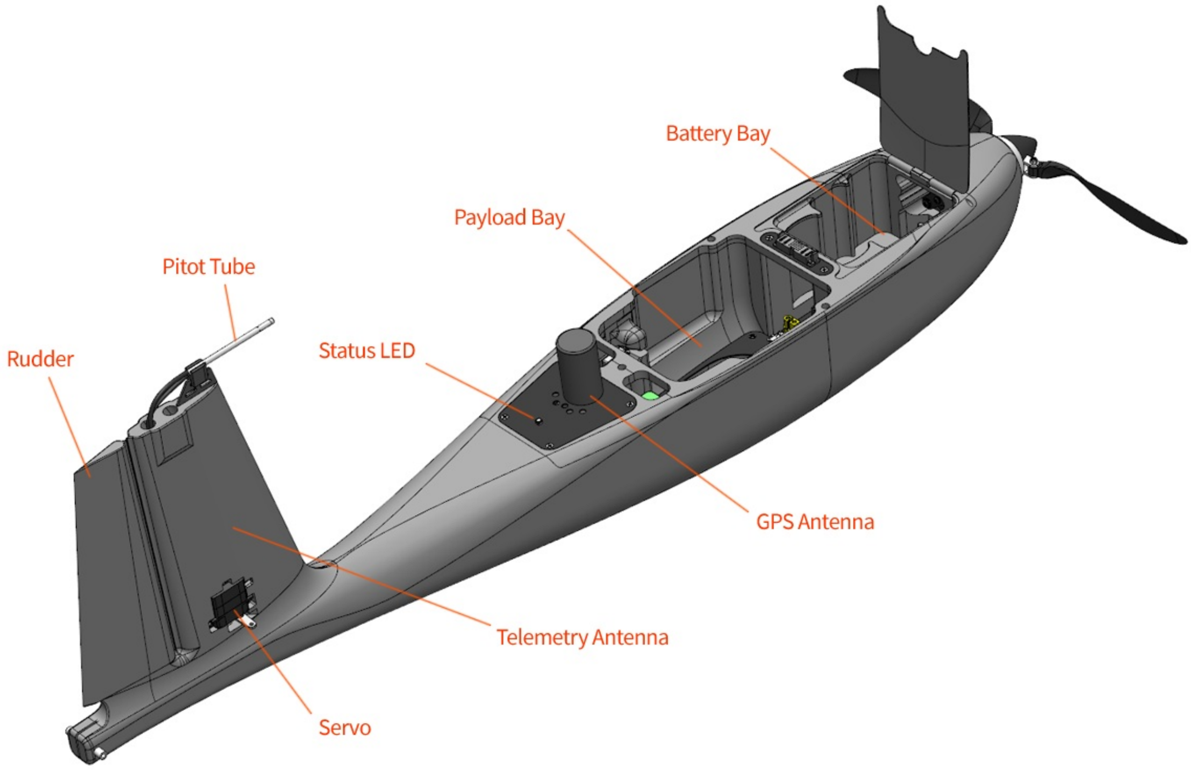
> **Warning:** Rotating propeller(s) may cause serious injury or death. When attached to the motor the propeller spins at high speeds and is capable of cutting. Always keep clear of propellers when the aircraft is armed, taking-off, or landing, and whenever possible while the aircraft is powered-on.

VTOL Propeller: Used to generate thrust for vertical takeoffs and landings.

Camera Lens Cutout: Lynx VTOL features downward facing camera payloads for aerial mapping.

Aileron: An aileron is a hinged flight control surface that turns the aircraft in flight.

Servo: A servo is an electric device that moves a flight control surface. Lynx VTOL has four servos. The servos located in each wing move the ailerons.



Battery Bay: Lynx VTOL is an electric aircraft. The main and VTOL batteries are installed within the battery bay.

> **Caution:** Proper care of your battery is essential. Please read the battery charging instructions.

Payload Bay: Swappable cameras are housed within the payload bay.

GPS Antenna: Lynx VTOL features a multi-constellation, multi-band (L1/L2) GPS antenna used for determining aircraft position, altitude, and geo-tagging images.

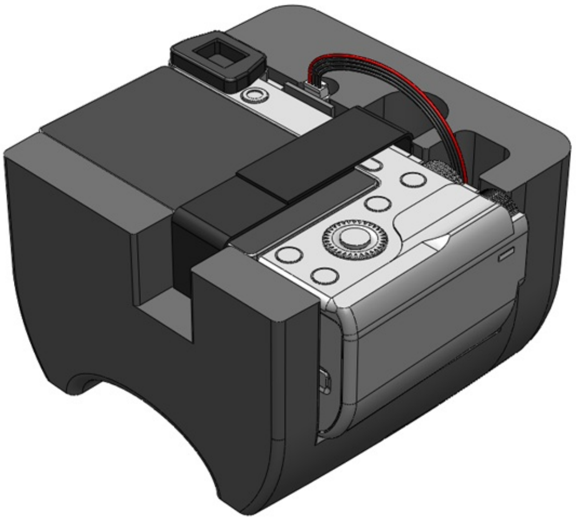
Status LED: This colored LED indicates the status of the autopilot.

Telemetry Antenna: Used by the aircraft to communicate with Swift GCS via the ground telemetry radio. The antenna is located within the rudder.

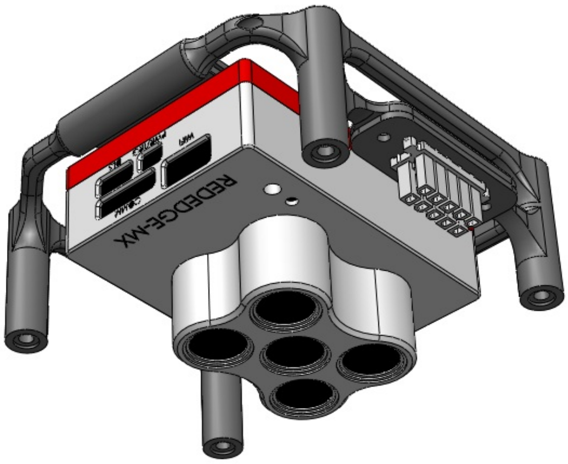
Pitot Tube: The pitot tube combined with the airspeed sensor provide Lynx VTOL with airspeed and wind information. It must be kept clean and clear of obstructions to function properly.

Servo: The fuselage contains two servos. One controls the rudder, the other controls the stabilator.

Rudder: The rudder is a hinged flight control surface used to coordinate turns.



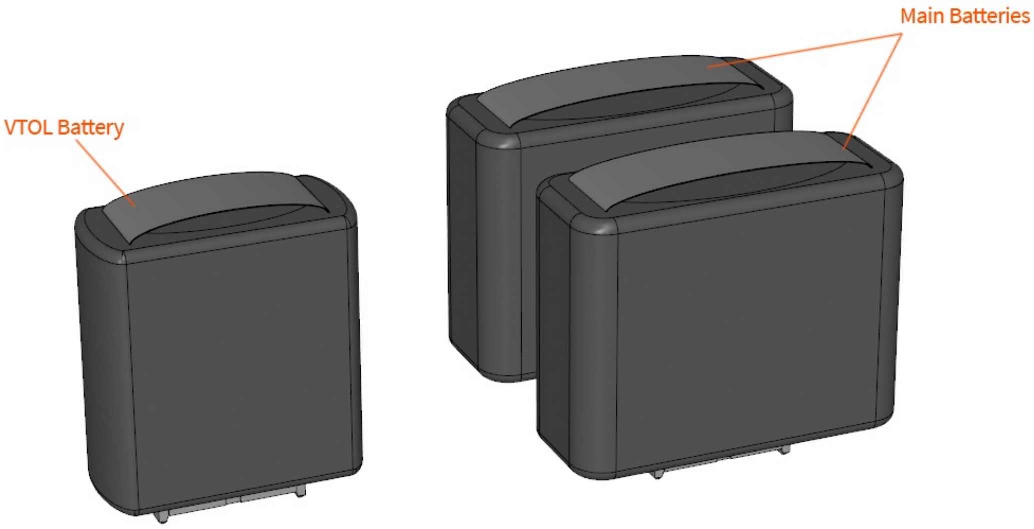
Mapping Payload



Multispectral Mapping Payload

Standard Mapping Payload: RGB mapping payload with high resolution and large Sony sensor.

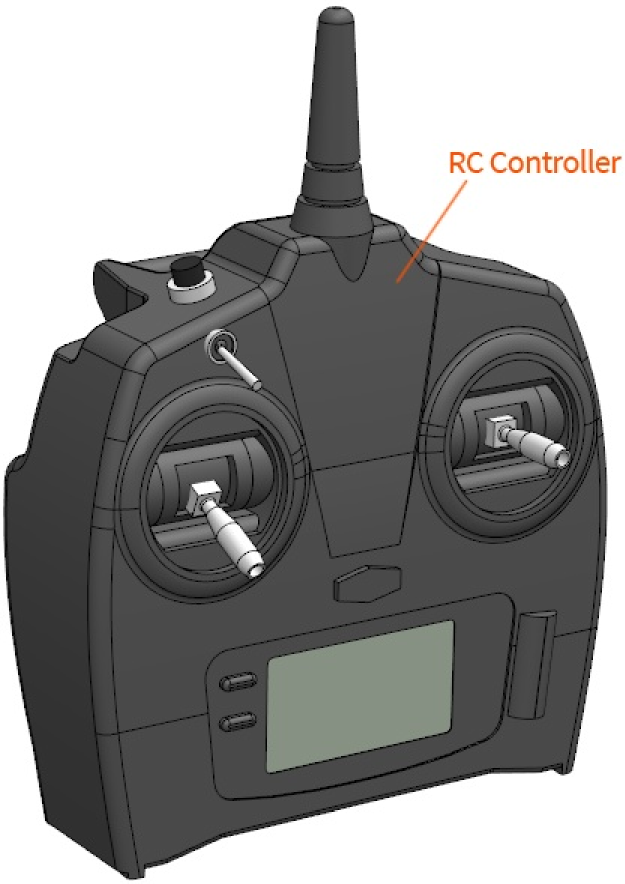
Multispectral Mapping Payload: 5-band multispectral payload with downwelling light sensor.



Main Batteries: Lynx VTOL uses one pair of main batteries. That main battery is split into two packs to comply with air cargo and airline restrictions. The two main batteries are connected in series and power the avionics and fixed-wing equipment.

VTOL Battery: Lynx VTOL uses a single high-discharge battery dedicated to the VTOL motors and is only used during takeoff and landing.

Telemetry Radio: The telemetry radio communicates with the aircraft on the ground and in flight.



RC **Controller:** The RC controller enables the safety pilot to optionally fly the aircraft in assisted modes.

Software Features

The standard Lynx VTOL package includes one Swift GCS license which is good for two activations. This allows you to install Swift GCS on two computers. A typical setup is to have one install on your office computer and the other on your field laptop or tablet.

Swift GCS

Swift GCS is how you interact with Lynx VTOL. It features a sleek and simple touch screen interface that is ideally suited for field tablets, and requires minimal computing hardware to run. New users are guided through the flying process via the built-in checklist and preflight steps. Survey planning is fully integrated with intuitive controls and drag-and-drop waypoints. Once airborne, you can use Swift GCS to track aircraft position, monitor status, and send commands as desired through the radio.

ArduPilot

Lynx VTOL uses ArduPilot, an open source autopilot for flying unmanned aircraft. ArduPilot is distributed under a GPLv3 license and the source code is available here.

GeoTagZ

GeoTagZ preforms PPK corrections and photo tagging for PPK enabled Lynx VTOL systems. If the aircraft is not PPK enabled GeoTagZ is not needed or provided.

Getting Started

Installing SwiftGCS

Requirements

Please consult the table below for the system requirements for running the GCS.

	Minimum	Recommended
Operating System	Microsoft Windows, Linux	Microsoft Windows, Linux
Processor	x86, dual core, 1.5GHz or faster	x86 quad core, 2.0 GHz or faster
Memory	2 GB	4 GB
Screen	1024x720 or better	1280x720 or better
Graphics Card	OpenGL 2.1 with 128 MB or more of memory	OpenGL 3.3 with 2 GB of memory
Software	Java 8 JRE or newer	Java 8 JRE or newer
Connectivity	1x USB port capable of providing 5 watts	1x USB port capable of providing 5 watts, integrated GPS

Installation

1. The most recent version of the GCS can be downloaded below:
   - Windows
   - Linux
   - Linux x64
2. Run the included installer after downloading.
   - Driver installs are only needed on Windows, and are only needed the first time the GCS is installed. They can be safely ignored on future updates.
3. Launch the newly installed GCS.
4. The GCS will prompt you for a Mapbox token. If you do not already have a Mapbox token sign up for an account here. After signing up for Mapbox, you can find your access token on the Accounts page.

   > Mapbox is used to provide map data to the GCS. The free tier of mapbox covers all normal use case of the GCS.

5. The GCS will then prompt you to select the units used when displaying information from the aircraft and while planning. Units can be changed at anytime, but will require a restart to have an effect.
6. You will then be prompted to select the aircraft type you are flying from the list. With Lynx VTOL simply select the `Lynx VTOL` entry from the list.
7. The GCS will then prompt you for a license key, a license key will be provided to you with the purchase of a Lynx VTOL, and will remain valid for all new releases of the GCS for one year from purchase. You must be connected to the internet to activate a license key.

   > If you do not have, or cannot find your license key please contact support@srp.aero.

License Requirements A license key is required to upload more than 15 mission items to the aircraft. The GCS may be used with this limitation for evaluation purposes.

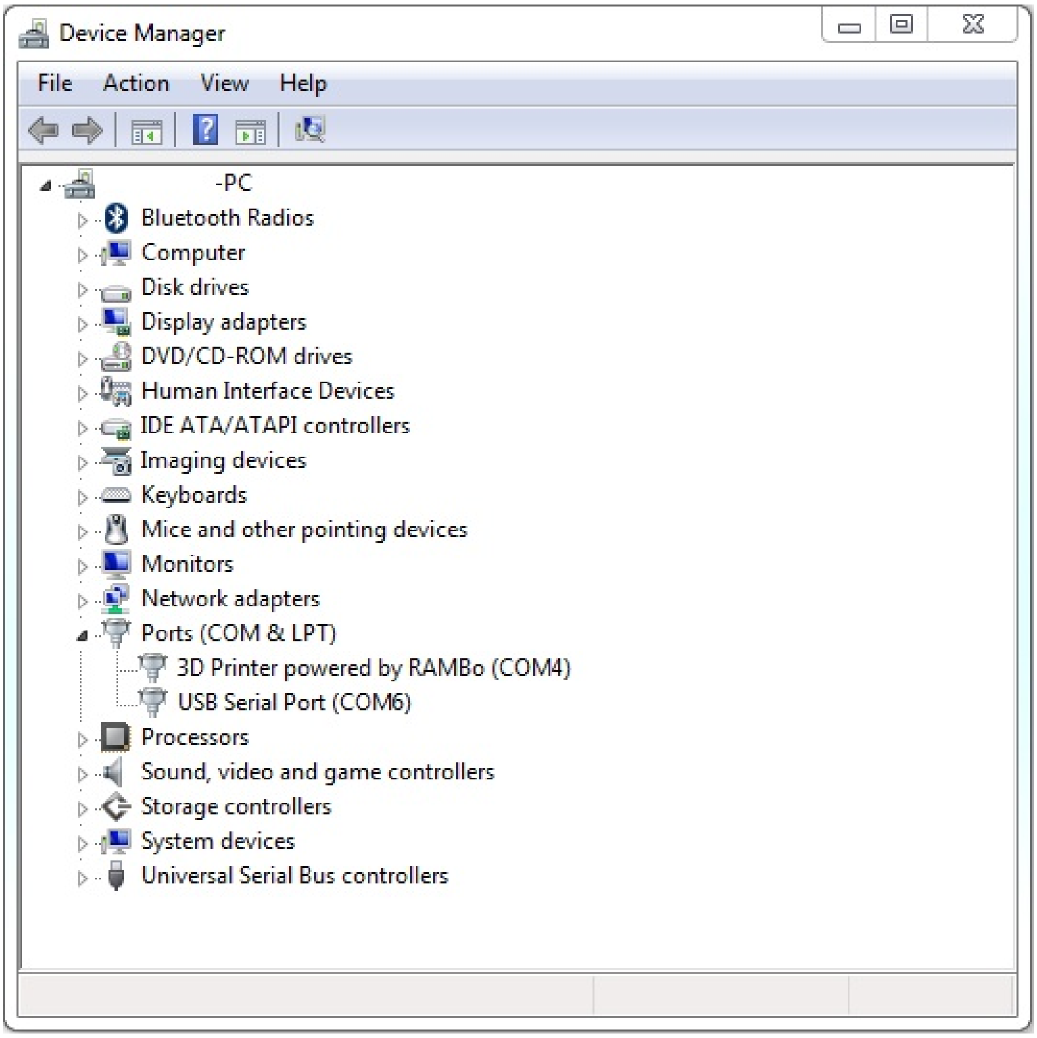
8. The GCS is now ready to be used. There are several things that you may wish to change however.
   - The GCS defaults to a touchscreen friendly mode. If you are using it on a desktop, or with a mouse you may wish to turn off the UI scaling. If so select the Settings Tab, then select the GCS entry and uncheck Optimize for touchscreen
   - By default the GCS will report errors/crashes automatically which is used to help improve future versions. You can opt out of this behavior by selecting the Settings Tab, then select the GCS entry and uncheck Report anonymous usage and errors.

Windows Telemetry Driver Configuration:

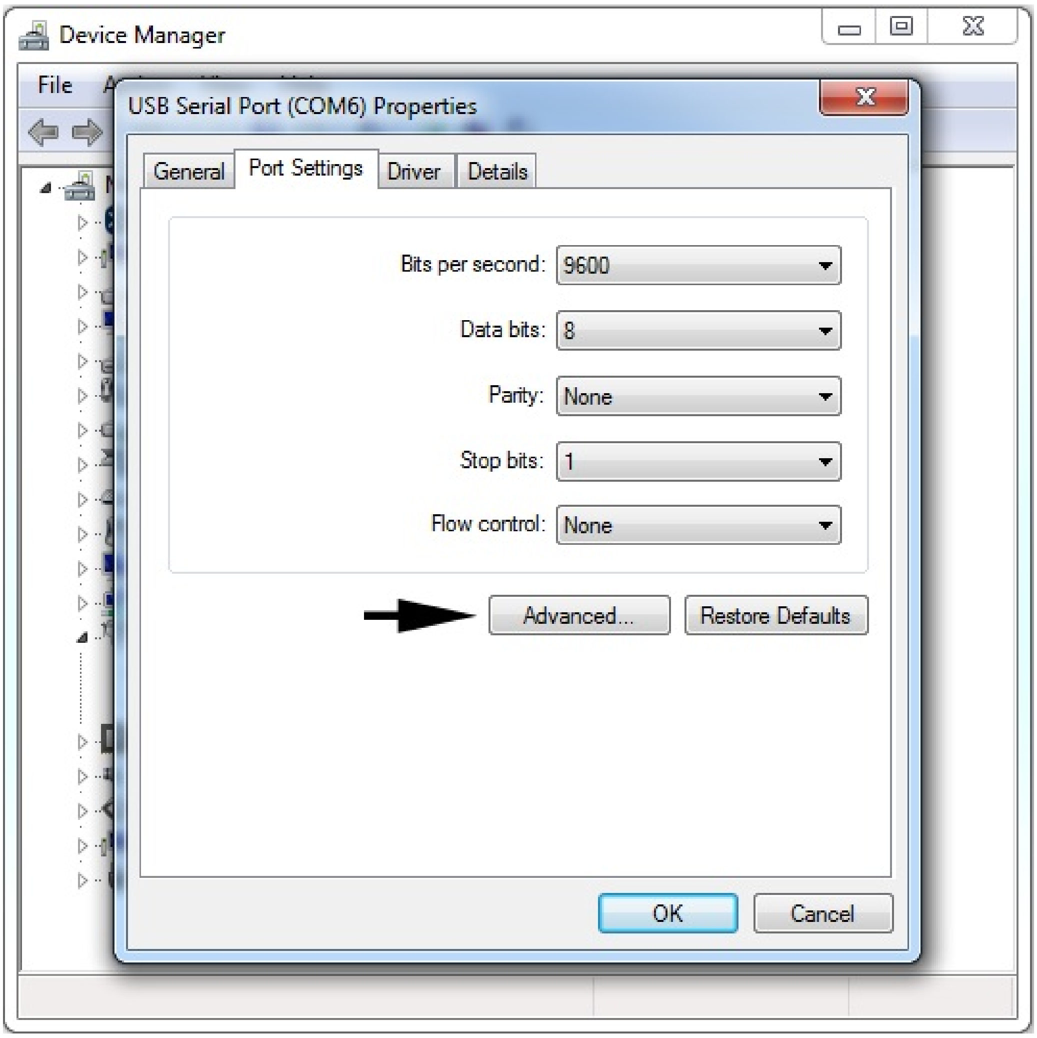
The default settings with the telemetry radio can cause Windows to mistake the radio as a mouse. The following procedure will correct that.

1. Connect the telemetry radio to the computer with the aircraft powered off.
2. Launch the computers Device Manager. Expand the Ports entry and select the USB Serial Port entry that corresponds to your telemetry radio.

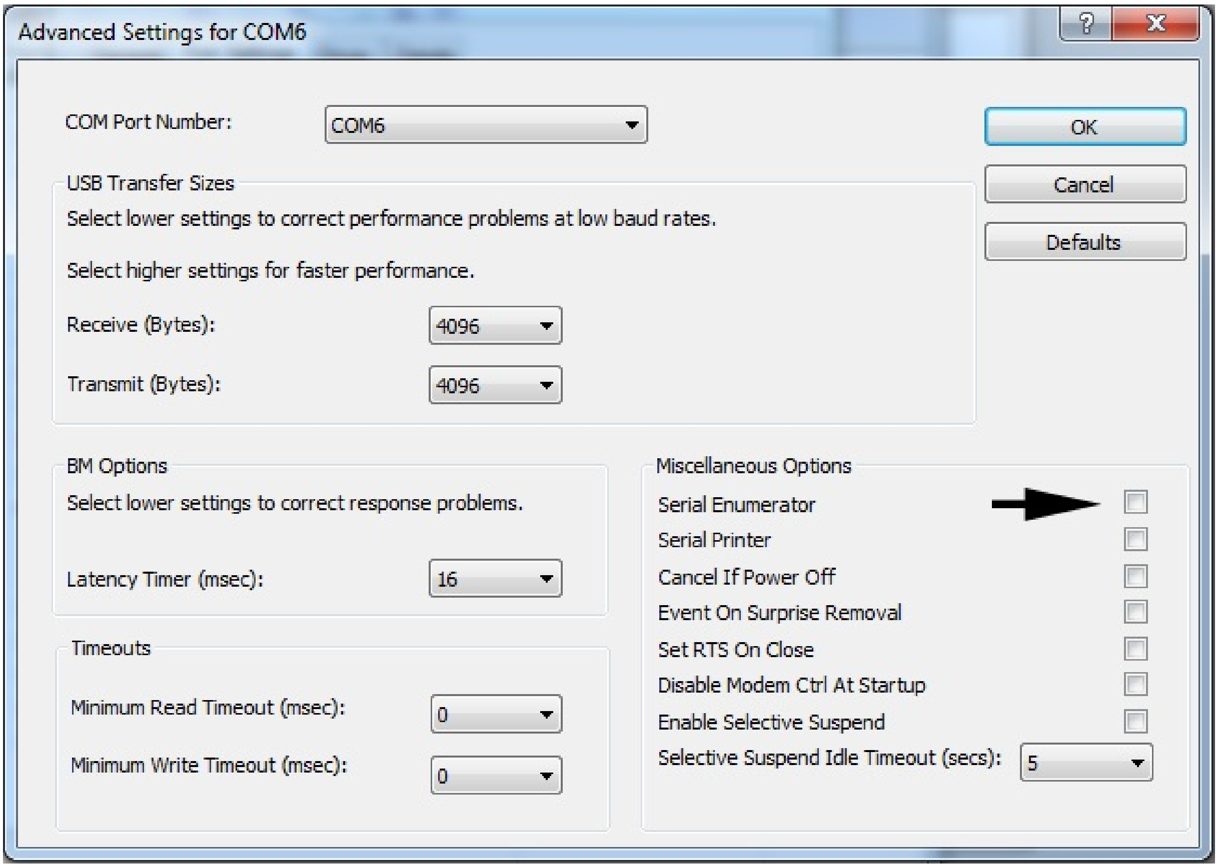
   If you have multiple entries for USB Serial Port you can find the correct one by unplugging the radio from the computer, note what devices are currently available then plug the radio back in. The new entry will be your telemetry radio.



3. Right click on the USB Serial Port and select properties.



4. Swap to the Port Settings tab and select Advance



5. Uncheck the Serial Enumerator option and select OK.

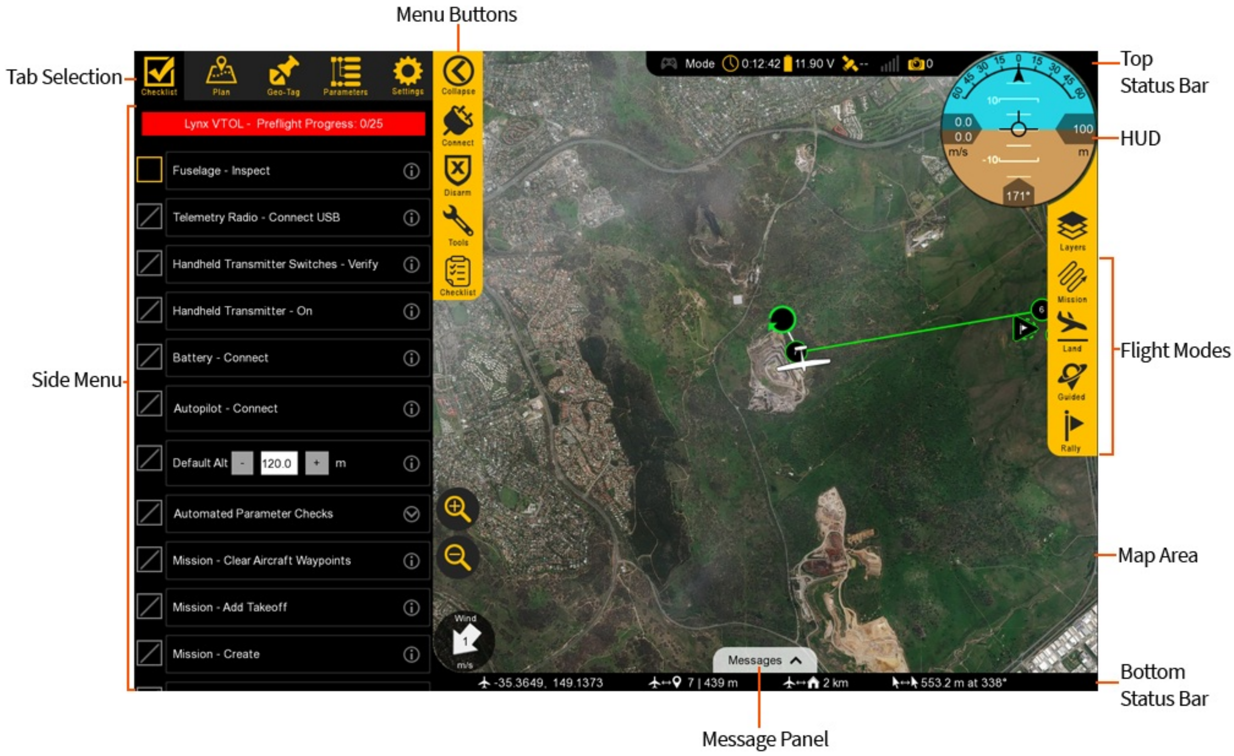
Installing GeoTagZ

1. Download the most recent version of GeoTagZ and the manual here.
2. Follow the instructions in the manual to install and configure GeoTagZ.

Swift GCS Overview

Lynx VTOL is an autonomous unmanned aircraft (drone) and capable of performing a mission from takeoff to landing without any intervention. It is highly advised that you still monitor the aircraft during the entire flight. The GCS receives live updates regarding the aircraft through the telemetry radio. You may change flight modes or intervene with the mission while flying. Uploading a new mission(s) or modifying an existing mission in flight is also possible.

The GCS is comprised of the following distinct sections.



Tab Selection

Used to select which tab you are on, each with a particular function. There are five tabs: Checklist, Plan, Geo-Tag, Parameters, and Settings.

- **Checklist:** The Checklist tab is used to perform a preflight on your Lynx VTOL prior to every takeoff.
- **Plan:** The Plan tab is used add waypoints, survey grids, actions, or rally points to your mission. The Plan tab is utilized during the preflight process but can also be used to modify a mission in flight.
- **Geo-Tag:** The Geo-Tag menu is used to geo-reference images for mapping applications that do not require high accuracy. For post-processed kinematics (PPK) tagging, the standalone GeoTagz software is used. Geotagz is included with Lynx VTOL with the PPK option.
- **Parameters:** The Parameters Tab is an used to modify and update parameters on the autopilot. Parameters are only to be changed if instructed to do so by SRP Aero support.
- **Settings:** The Settings tab is used to configure GCS, equipment, and autopilot settings. The settings tab is also used to update firmware and license keys.

Side Menu

The side menu corresponds to what tab you are on.

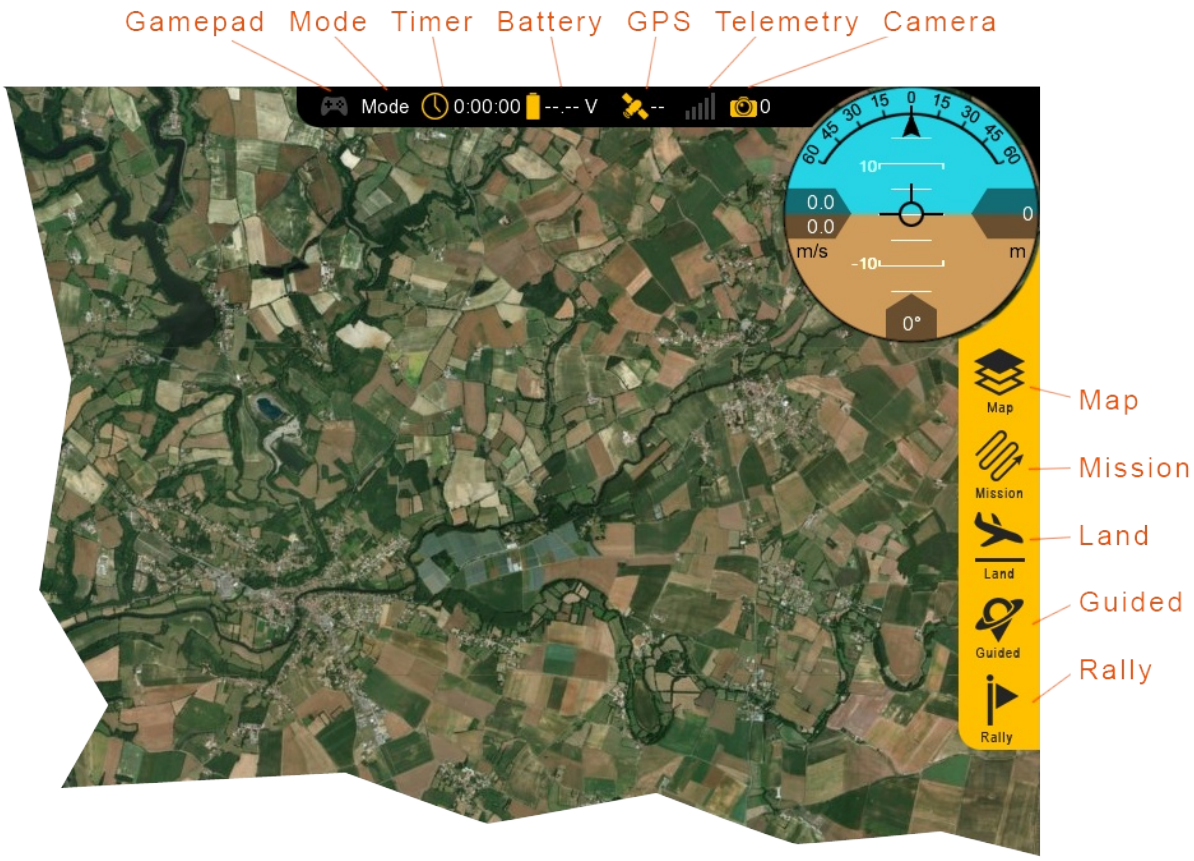
Menu Buttons

Each menu has unique buttons that change depending on which tab you are on. The very top button is used to collapse or expand the entire side menu. This can be useful when you are flying as it increases the overall map area.

Top Status Bar

Displays important aircraft information.

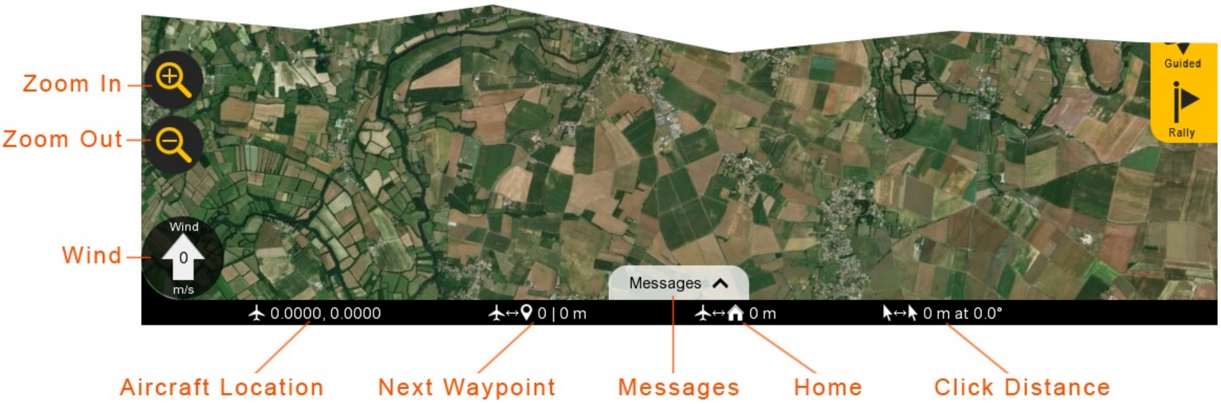
- **Gamepad:** Indicates if a gamepad is connected to Swift GCS. This connection may be USB or Bluetooth. Swift GCS only recognizes XBox controllers. Note, this functionality is not fully supported at this time.
- **Mode:** Displays the current flight mode.
- **Timer:** Displays the current flight in Hours:Minutes:Seconds. The timer automatically starts on takeoff and stops when the aircraft lands and disarms. The aircraft must be restarted (turned off and on) to reset the timer.
- **Battery:** Displays the main battery voltage. Click on the battery icon to expand this menu. The VTOL battery voltage is displayed in the expanded menu.
- **GPS:** Displays the GPS and GNSS satellite count.
- **Telemetry:** Displays the telemetry radio's signal strength.
- **Camera:** The camera icon displays photo count for cameras equipped with feedback. Feedback is essential for PPK tagging but is also helpful to see if and when the camera is taking photos.



Flight Modes

Used to change modes and aircraft location.

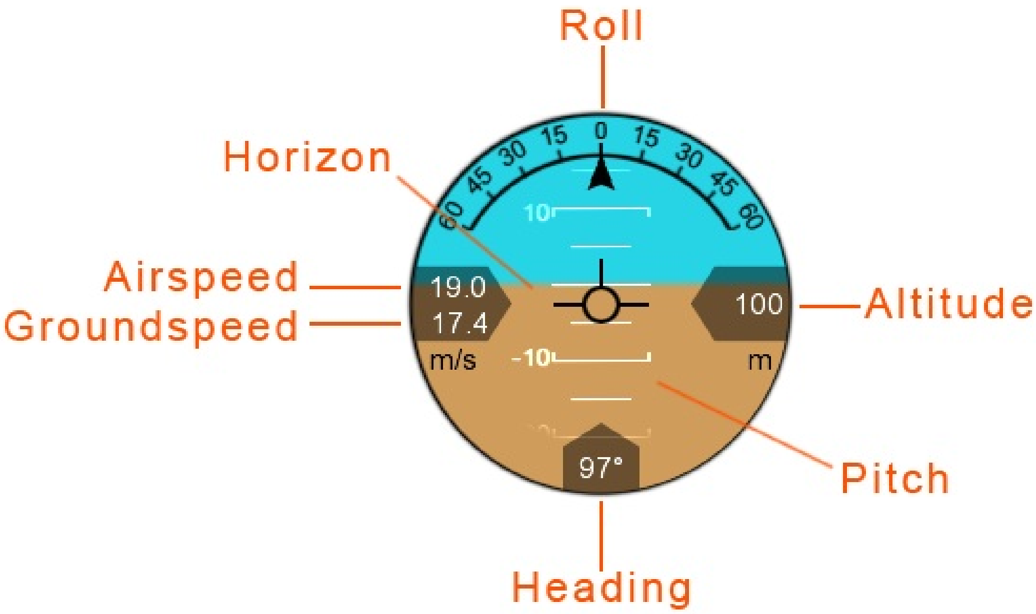
- **Map:** The Map menu is used to configure how the aircraft icon and waypoints are displayed on the map. Under this menu is also where you can toggle the terrain view and load KML overlays.
- **Mission:** In the mission menu, you can change the flight mode to Auto, restart the mission, or select an individual item in your mission to fly to.
- **Land:** Select land to begin your planned landing or to execute an emergency landing.
- **Guided:** The Guided flight mode is a 'fly here' mode. In Guided, you choose a spot on the map that the aircraft flies to and circles.
- **Rally:** The Rally flight mode is automatically used when the aircraft completes its mission or a failsafe activates. You can also select the Rally flight mode. In this flight mode, the aircraft will navigate to the nearest Rally point and circle.



Bottom Status Bar

Displays aircraft location and waypoint information.

- **Zoom in/Out:** Zooms the map area in or out. On touchscreen devices, you can also use ‘pinch-zoom’.
- **Wind:** Displays the wind velocity and direction that the wind is blowing.
- **Aircraft Location:** Current aircraft location coordinates shown in decimal degrees format.
- **Next Waypoint:** Displays the next waypoint number in your mission and the distance to that waypoint from the aircraft.
- **Messages:** The message panel displays warnings and notifications from the GCS and autopilot. A new warning will automatically expand the message panel if it was collapsed.
- **Home:** Shows the distance from the aircraft to home. If you have a tablet with built-in GPS, this can be toggled to show the distance from the aircraft to your location.
- **Click Distance:** Click distance shows the distance between your last two mouse clicks. This is a quick and useful tool for planning purposes such as determining how far away something is on the map.



HUD

The Heads-Up Display (HUD) displays aircraft information and attitude against a horizon line.

- **Roll:** The aircraft's roll in degrees (bank angle).
- **Altitude:** The aircraft's altitude above the ground. The unit is displayed below the altitude reading.
- **Pitch:** The aircraft's pitch in degrees.
- **Heading:** The aircraft's magnetic heading.
- **Horizon:** The aircraft's attitude is shown against an artificial horizon.
- **Ground Speed:** The speed of the aircraft relative to the ground. The unit for both ground and airspeed is displayed below.

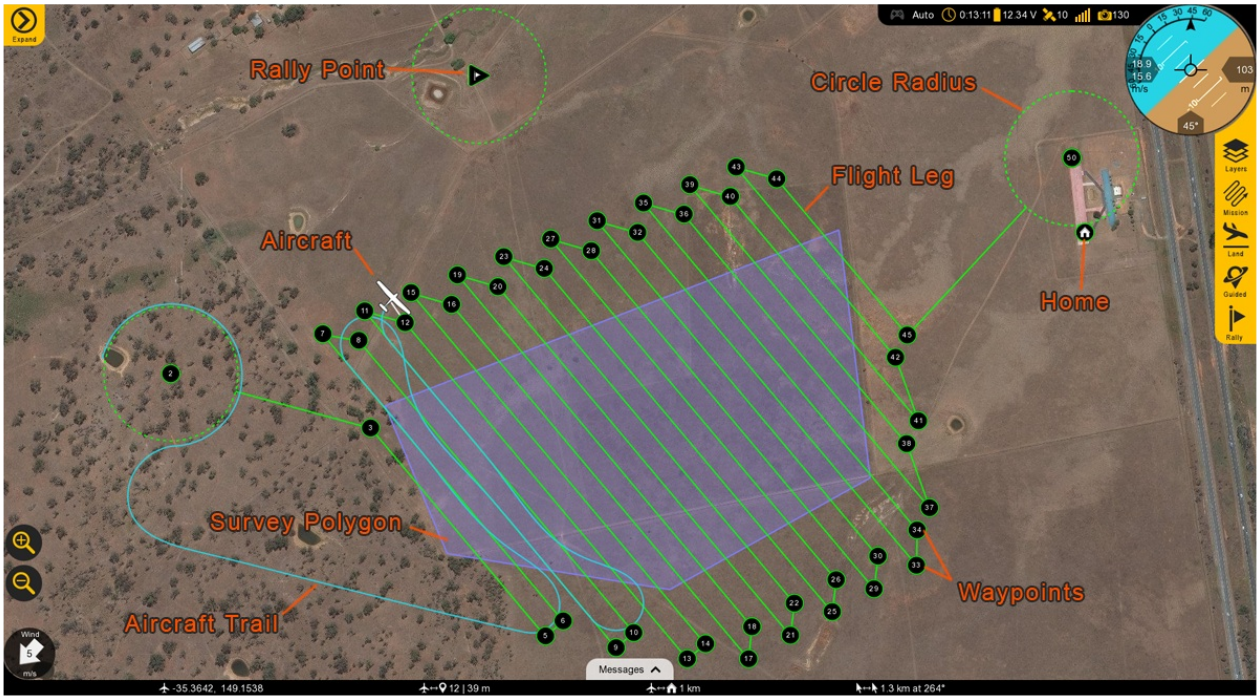
  > Ground speed is affected by wind.

- **Airspeed:** The speed of the aircraft relative to the air through which it is moving.

  > Airspeed is not affected by wind and should remain relatively constant in straight and level flight. Climbs or descents may have an affect.

Map Area

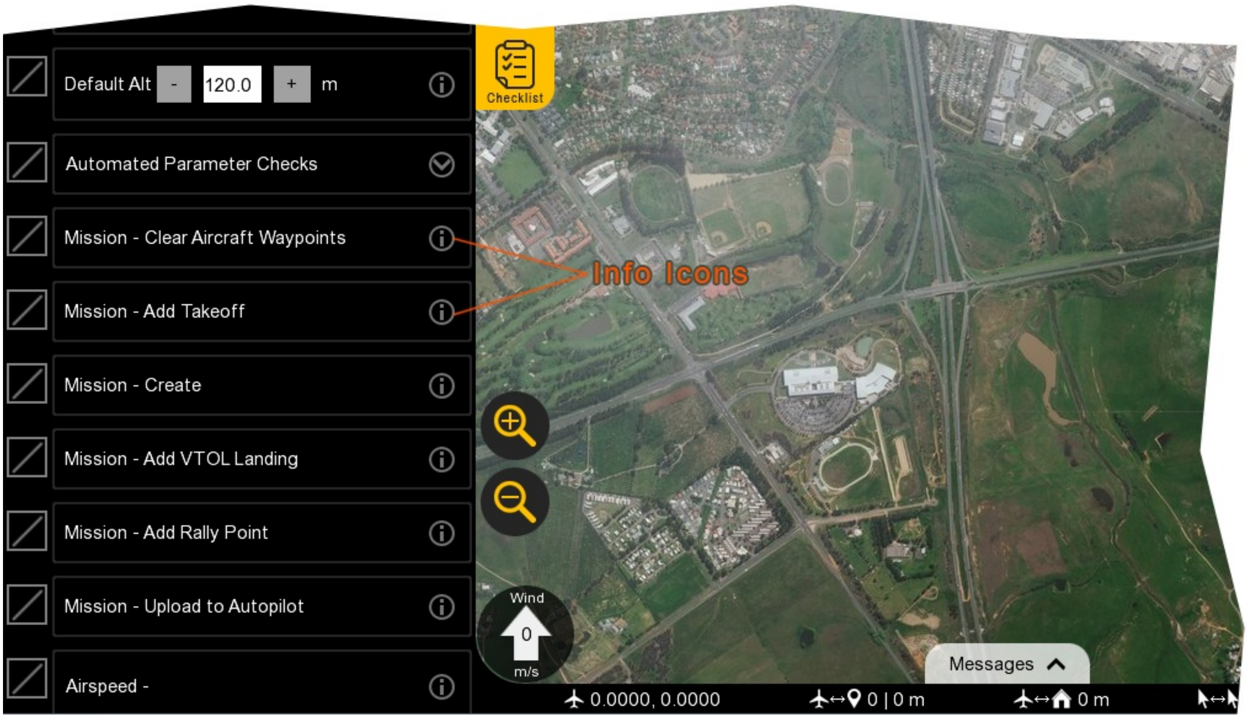
The Map displays the background satellite imagery with the position of aircraft flying over it. Currently there are two sources of map imagery: Mapbox and ESRI. The map area is also where your mission items and polygons will be shown.



- **Rally Point:** The Rally icon shows the location of your planned Rally points. The icon is a flag within a triangle.
- **Flight Leg:** The flight legs connect each waypoint in sequence. They are an approximate indication of how the aircraft will fly from one waypoint to the next. They do no account for the turning radius of the aircraft. It is normal to observe small deviations from the flight legs in windy conditions.
- **Circle Radius:** A dashed line will appear around certain waypoints that have a radius. Examples include the landing pattern and loiters.
- **Home:** Displays the home location. Home is your takeoff location.
- **Waypoints:** Displays the location of your planned waypoints. Each waypoint is numbered. Waypoints are used to fly to a location in the sky. The aircraft will fly through or near the waypoint and then proceed to the next item in your mission. Waypoints are automatically generated when creating a survey.
- **Survey Polygon:** A survey polygon displays the area on the ground that you are mapping. Survey polygons are created from the `Plan` tab ⇨ `Survey`. You can draw a new region or load a KML or KMZ (Google Earth format). Flight legs will extend past the polygon area to account for the extra space that the aircraft needs to turn around. Viewing the polygon can be toggled on/off from the `Map` button ⇨ `Survey`. Multiple survey areas can be planned into your mission.
- **Aircraft Trail:** The aircraft trail shows the history of the aircraft's flight path. At a certain length, the trail will automatically begin to disappear. The trail can also be clear manually from the `Map` button ⇨ `Clear Aircraft Trail`.
- **Aircraft:** Displays the aircraft location and heading.

Preflight

Swift GCS features a built-in preflight checklist for getting Lynx VTOL ready for flight. The built-in steps replace the traditional paper checklist. Some of the steps are automated, while other steps require you to interact with the aircraft or GCS.



There is an info icon next to each step of the preflight within the GCS. Click on the info icon to reveal additional information pertaining to each step.

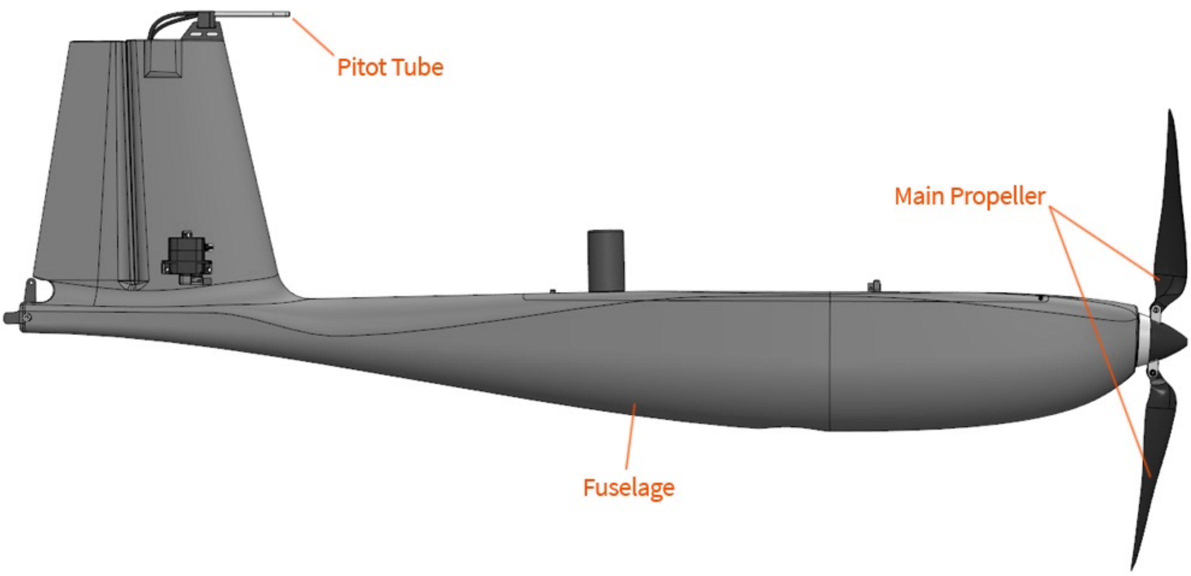
Tip: We recommend that you perform your first flight in a large obstacle-free area and limit the length of the mission in order to familiarize yourself with the Lynx VTOL in flight.

Before each flight, you should be aware of the weather conditions. Lynx VTOL is a small drone that cannot fly in heavy rain or strong wind conditions. In case of doubt, make sure to check a weather bulletin including wind estimations in the flight area. Note that wind is often stronger at higher altitudes and that the wind perceived at the surface is not always a good reference to estimate the wind at flight altitude. Cloud velocity or tall tree movements can help you to estimate the wind speed once you are out in the field. Weather forecasts may use various units to measure wind speed.

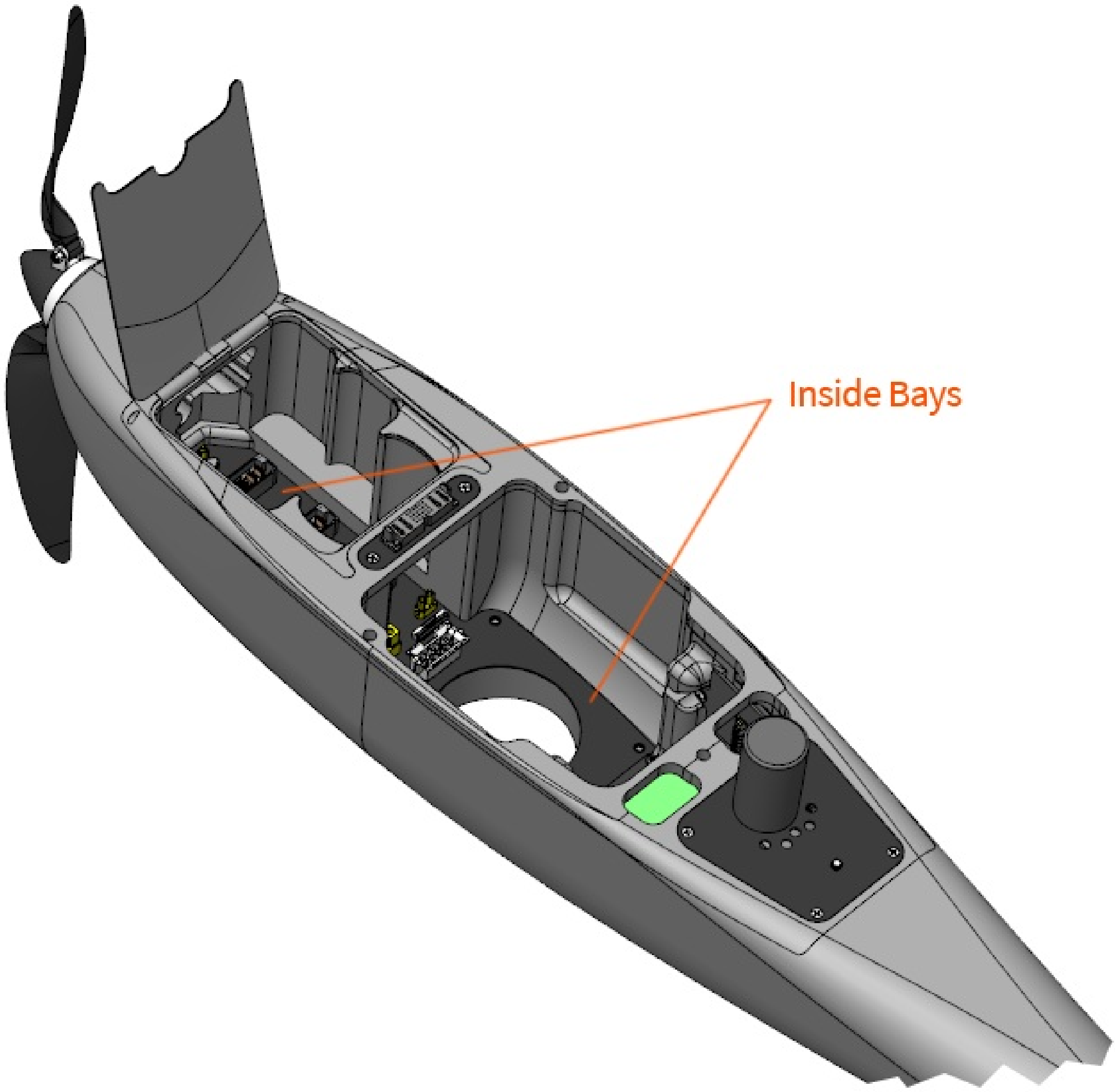
Warning: Lynx VTOL's simple design means it can be ready for flight in minutes. You must, however, perform the following preflights steps before every flight to ensure that the aircraft is prepared for flight. Failure to preform a preflight step can result in a crash and loss of the aircraft.

Aircraft - Inspect

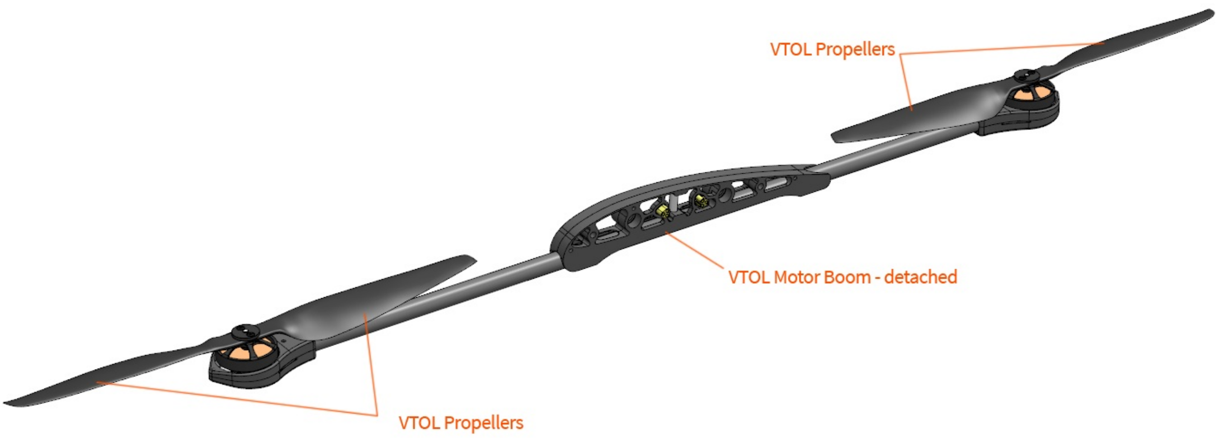
Visually inspect the aircraft for damage or wear.



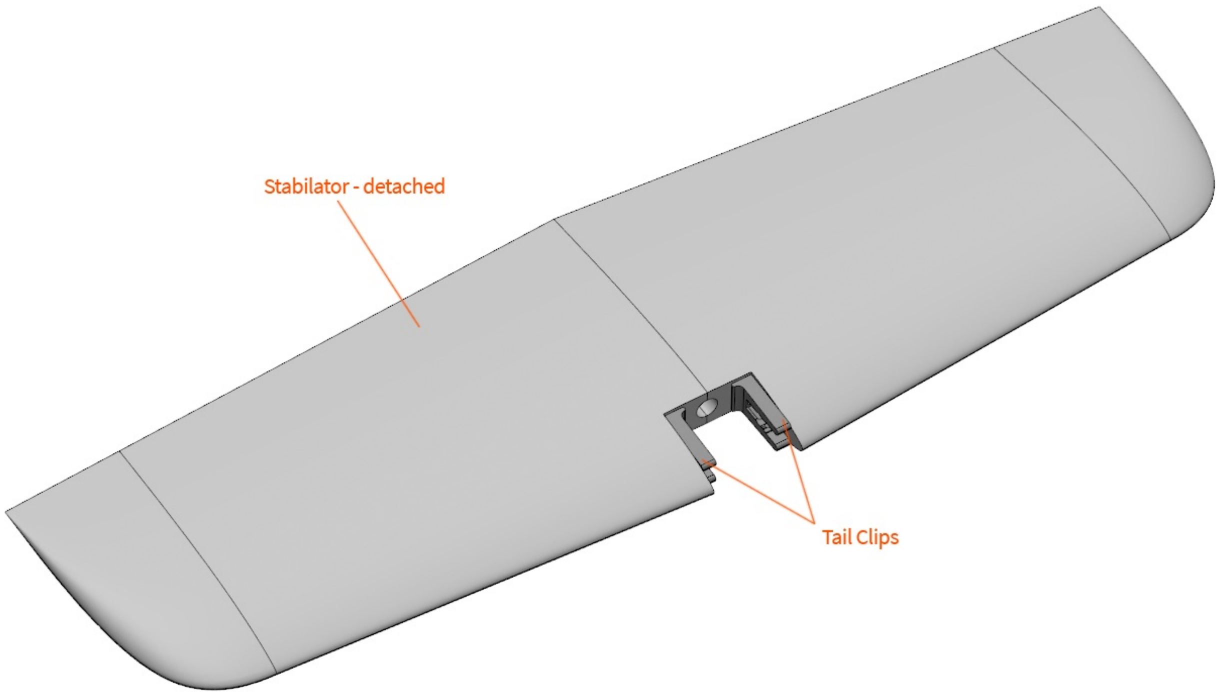
- **Fuselage:** Inspect the fuselage for cracks or other damage.
- **Pitot Tube:** Check that the pitot tube is attached to the fuselage and that the tube is free of obstructions. Check the hoses behind the pitot tube for kinks or damage.
- **Main Propeller:** Fold the propeller blades outward after removing the fuselage from the transport case. Inspect the propeller blades for chips or other damage.



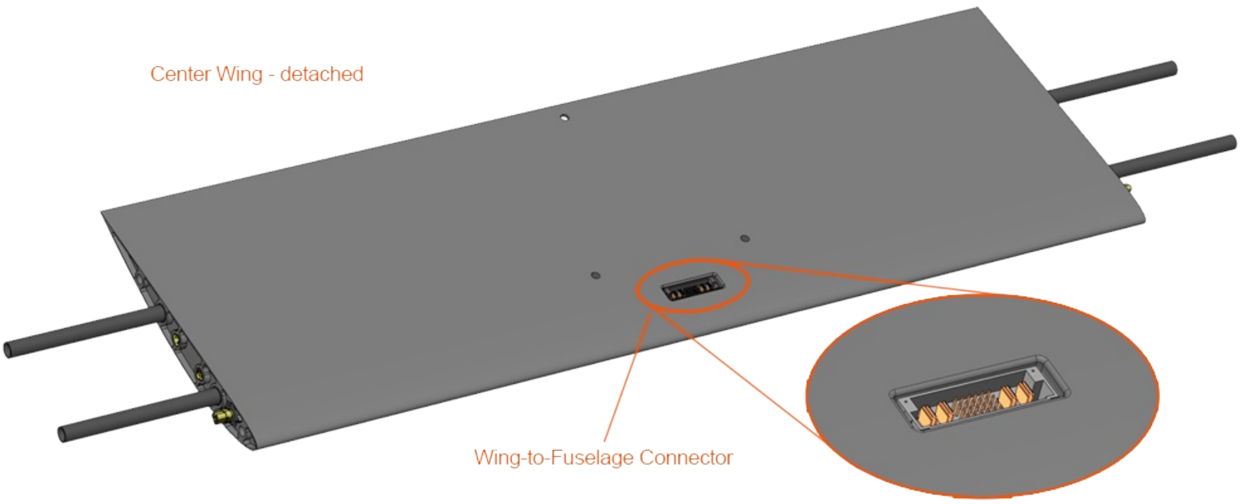
- **Inside Bays:** Ensure the inside of the fuselage, especially within the battery connectors, is free of dust and debris.



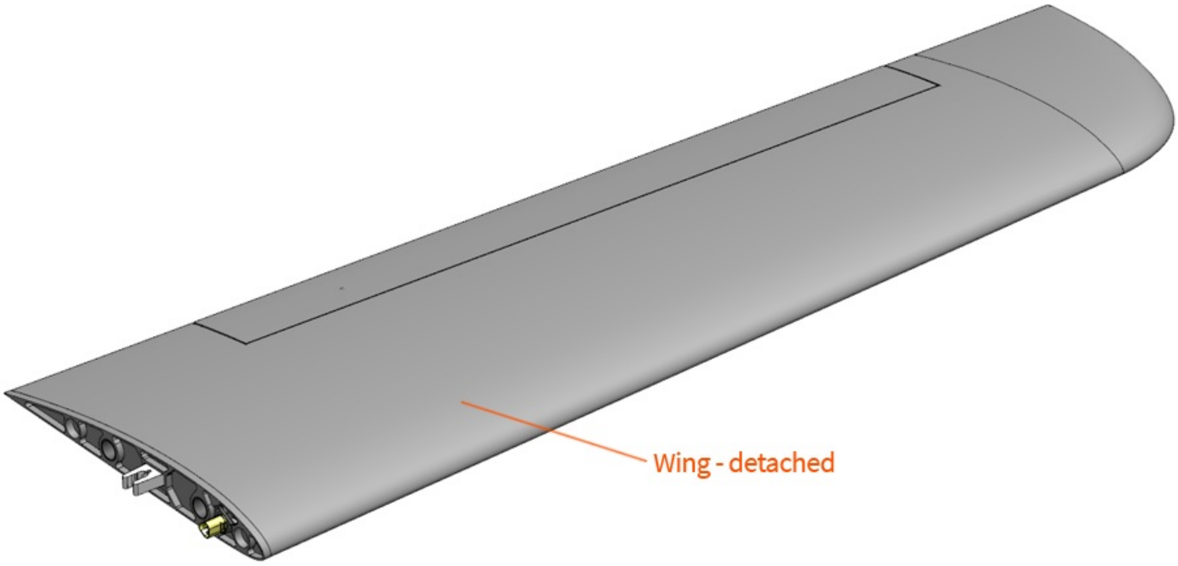
- **VTOL Propellers:** Inspect the propeller blades for chips or other damage.



- **Stabilator:** Inspect the stabilator for cracks or other damage.
- **Tail Clips:** Inspect the tail clips for cracks and ensure that they are securely fastened.



- **Center Wing:** Inspect the center wing for cracks or other damage. Inspect the wing-to-fuselage connector for bent or damaged pins.



- **Wings:** Inspect the wings for cracks or other damage.

Telemetry Radio - Connect USB

Connect the telemetry radio USB to your GCS computer.

> The standard Lynx VTOL telemetry radio frequency uses 915 MHz. The antennas should be spaced apart 90 degrees from each other for best reception.

RC Controller - Verify and Turn On

Verify the RC controller switches are in the correct position and then turn it on.

- **Throttle:** Ensure that the left stick is down, into the zero throttle position.
- **Mode Switch:** Ensure that the mode switch is down, into the manual position.
- **On/Off:** Turn the RC controller on after both throttle and the mode switch are in the correct positions.

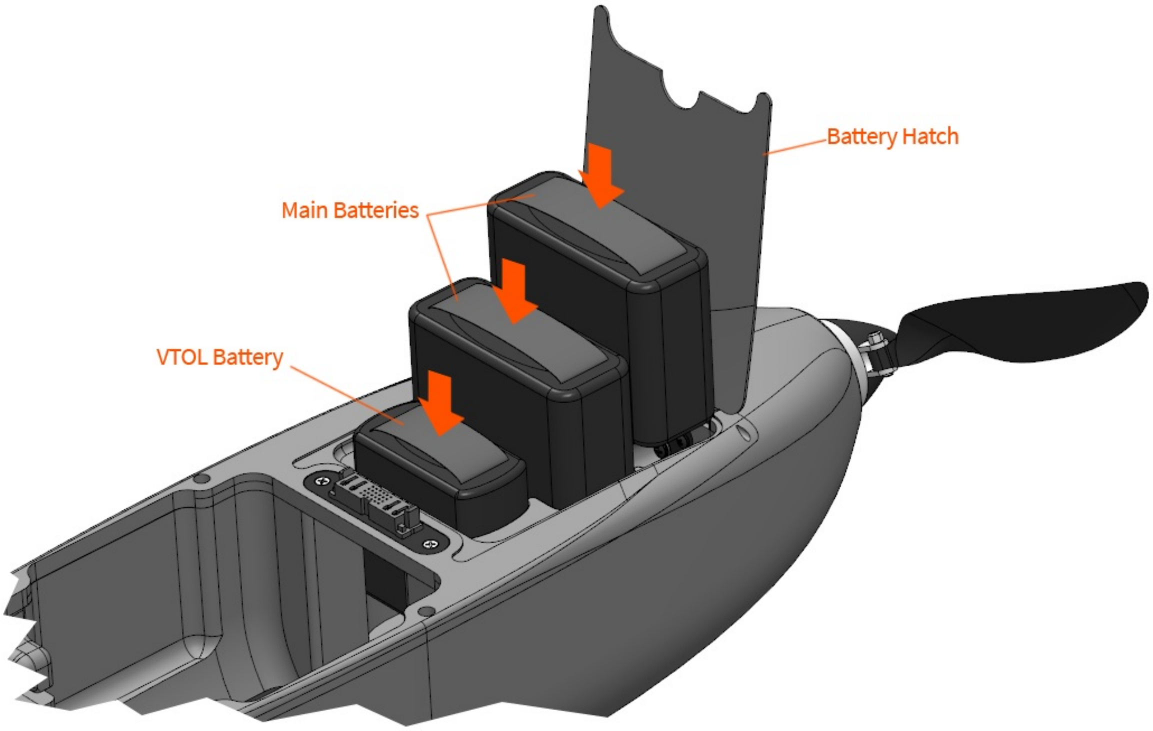
The position of the other RC switches is inconsequential.

When powered-on, the RC controller's screen will display the Lynx VTOL tail number, controller's battery, and stopwatch. Ensure the tail number displayed matches your aircraft, and that the controller is charged.

The standard Lynx VTOL RC controller frequency uses 2.4GHz.

Battery - Connect

Place the fuselage on flat ground. Insert fully-charged batteries into the battery bay and press downward. The battery is fully seated when you cannot press it down any further. The order in which the batteries are installed does not matter. The aircraft will energize after the second main battery is installed. Once all three batteries are connected, close the hatch.

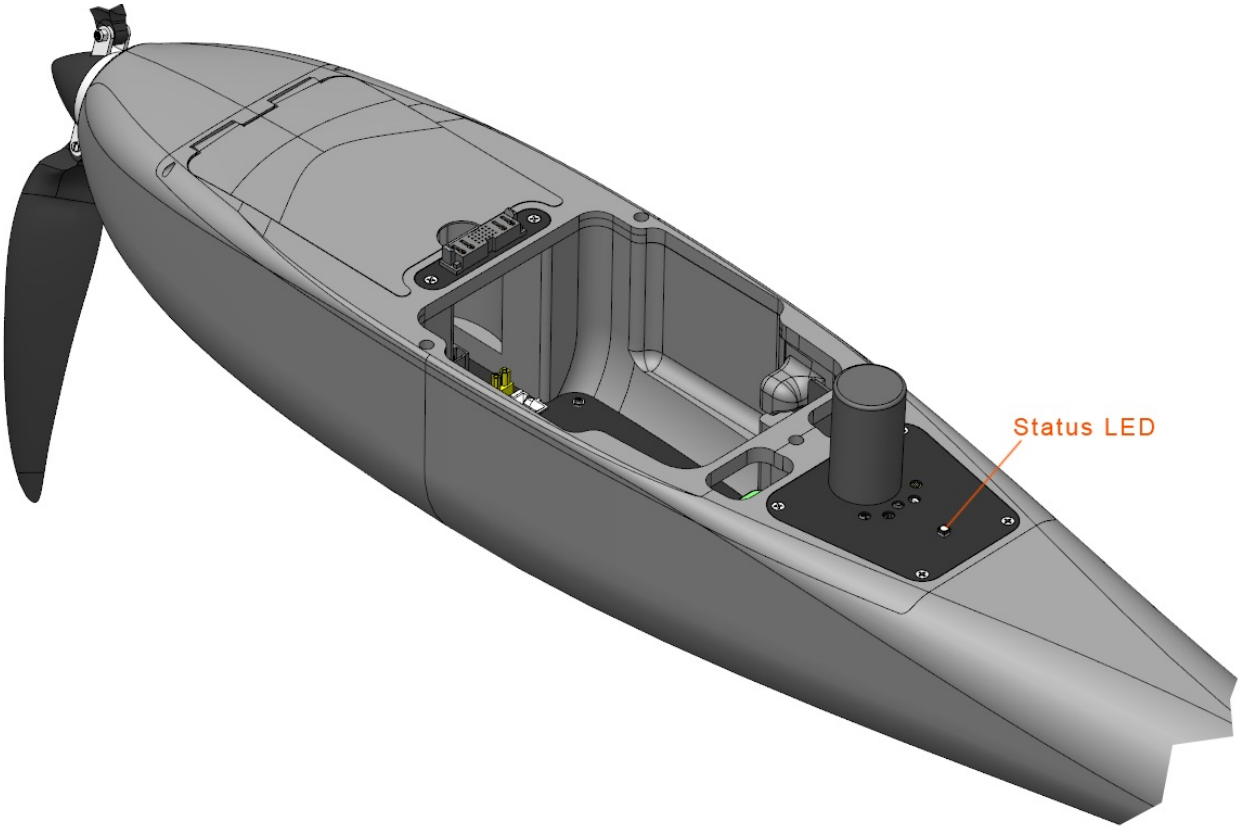


- **Main Batteries:** The two main batteries are connected in series and power the avionics and fixed-wing equipment.
- **VTOL Battery:** The VTOL battery is dedicated to the VTOL motors and is only used during vertical flight modes (such as takeoff and landing).

Warning: The main motor is now energized. Always keep clear of propellers when the aircraft is armed, taking-off, or landing, and whenever possible while the aircraft is powered-on.

Caution: The battery connectors are keyed and only fit one way. Forcing the battery into the wrong orientation may damage the battery, the connector, and/or the aircraft.

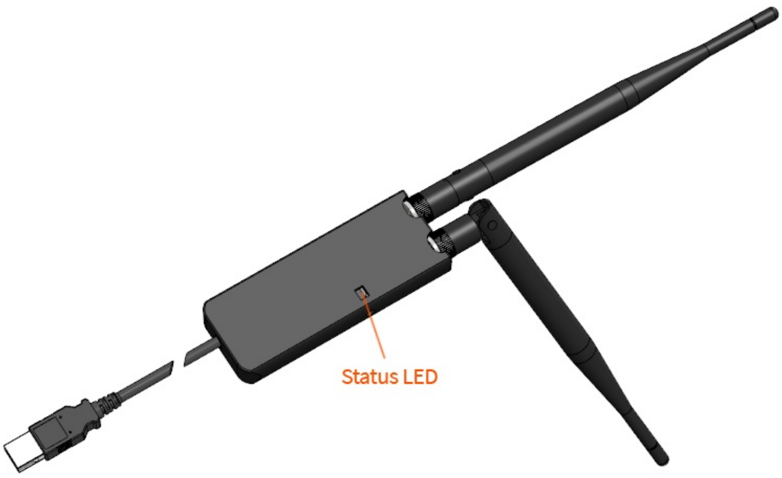
Caution: Only connect the batteries when you are ready for start-up. Do not leave the battery connected for extended periods of time when the aircraft is on the ground, as this may discharge the batteries and cause equipment within the fuselage to overheat in direct sunlight.



As soon as the aircraft is power-on, the autopilot and its sensors will begin to initialize. Avoid moving the aircraft during these first few seconds. The status LED will blink blue and red. Once initialized, the status LED will change to blinking yellow. See the Status LED Meanings section for more details on the status LED.

Autopilot - Connect

Wait until the telemetry radio's status LED displays solid green/blinking red before proceeding. Press the `Connect` button on the Checklist tab and use `Auto Detect` to automatically detect the correct radio to use.

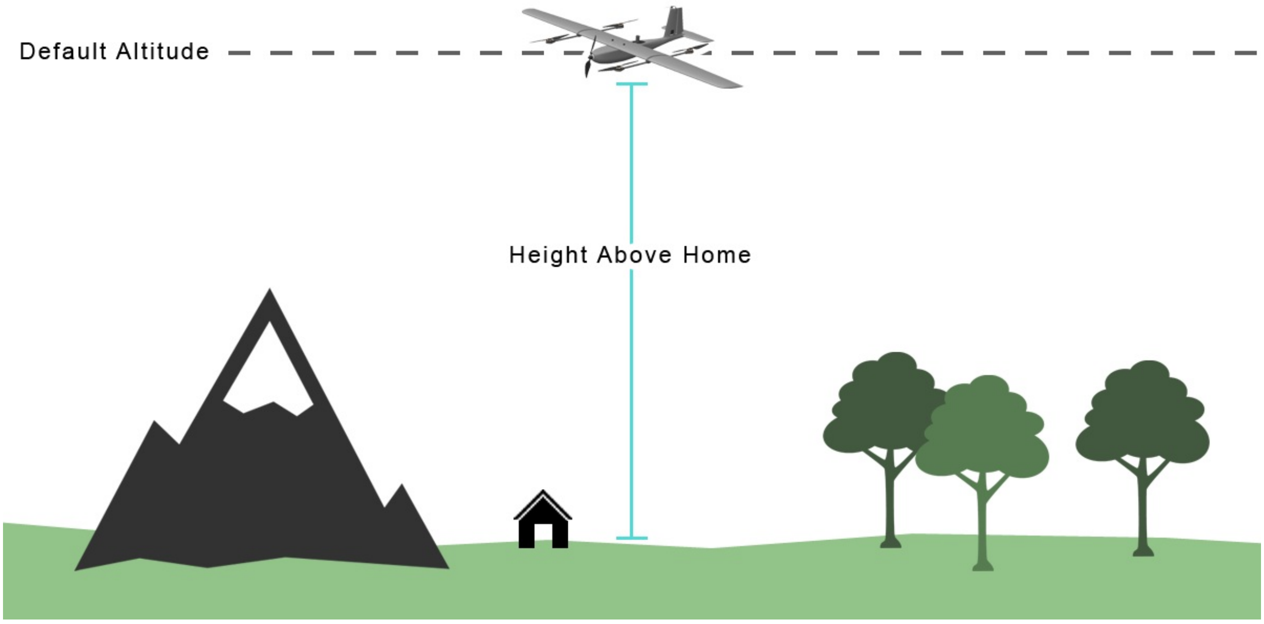


If bluetooth is enabled, Auto Detect may fail to connect and get stuck trying to wake up remote serial devices. In this case the correct serial port should be selected from the menu.

The GCS will automatically check if a firmware update is available upon connecting. If an update is available the GCS will open a dialog which states that a firmware update is available. Please follow the insturctions in Firmware Update for instructions on how to update the firmware.

Default Altitude - Set

The default altitude sets your mission altitude. The altitude is referenced as a height above ground from where the aircraft takes off from. That location is known as home. Mission items will default to this altitude when planning a flight, except for takeoff and landing transition. Individual mission items can be modified on the Plan Tab if they need to be higher or lower than the default altitude. At this time, Lynx VTOL does not support terrain following.



Choosing the appropriate flight altitude for your mission is critical and dependent upon imagery resolution requirements, ground coverage vs. time, terrain, obstacles, other air traffic, and local regulations.

Caution: Changing the default altitude does not affect any mission items that have already been planned. Items that have already been planned must be individually edited or cleared.

Automated Parameter Checks

The GCS will automatically check that the autopilot parameters are correctly configured.

Caution: If any parameters fail the check please contact support@srp.aero. Do not fly.

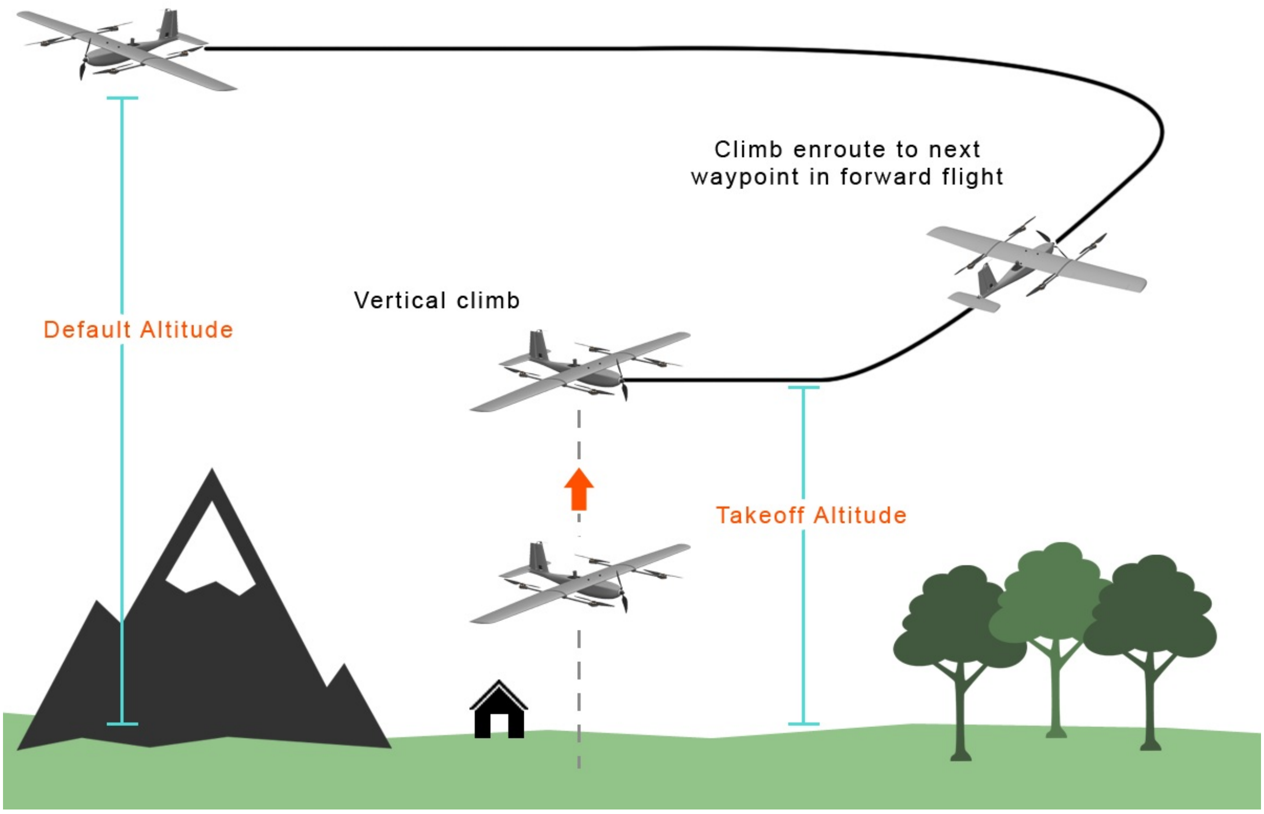
Mission - Clear

The existing mission on the aircraft must be cleared before a new flight. Do this from the Plan Tab by selecting `Clear` ⇨ `Clear mission on the aircraft`.

In order to clear a mission on the aircraft, the aircraft must not be in the Auto mode.

Mission - Add Takeoff

From the Plan tab, select `Add` ⇨ `Takeoff` to insert a takeoff at the start of the mission. The default takeoff altitude is 30 meters above home. The aircraft will climb vertically to this altitude and then transition to forward flight and proceed to the remainder of the mission, climbing enroute as needed. The takeoff direction, or heading, is determined by the wind. The aircraft will automatically weathervane to face the wind during the vertical climb and transition.



Caution: Lynx VTOL has a limited battery capacity for the VTOL motors. If the takeoff altitude is too high, the aircraft battery may be depleted and ultimately cause a crash. Restrict takeoff altitudes to 45 meters or less.

Caution: If flying with a GCS other than Swift GCS, please see Flying with an different GCS. Failure to plan the takeoff correctly can result in failsafes not working correctly and may result in a crash.

Mission - Create

Create or load a mission from the Plan Tab.

Refer to the Mission Planning section for help with creating a survey grid.

Mission - Add Landing

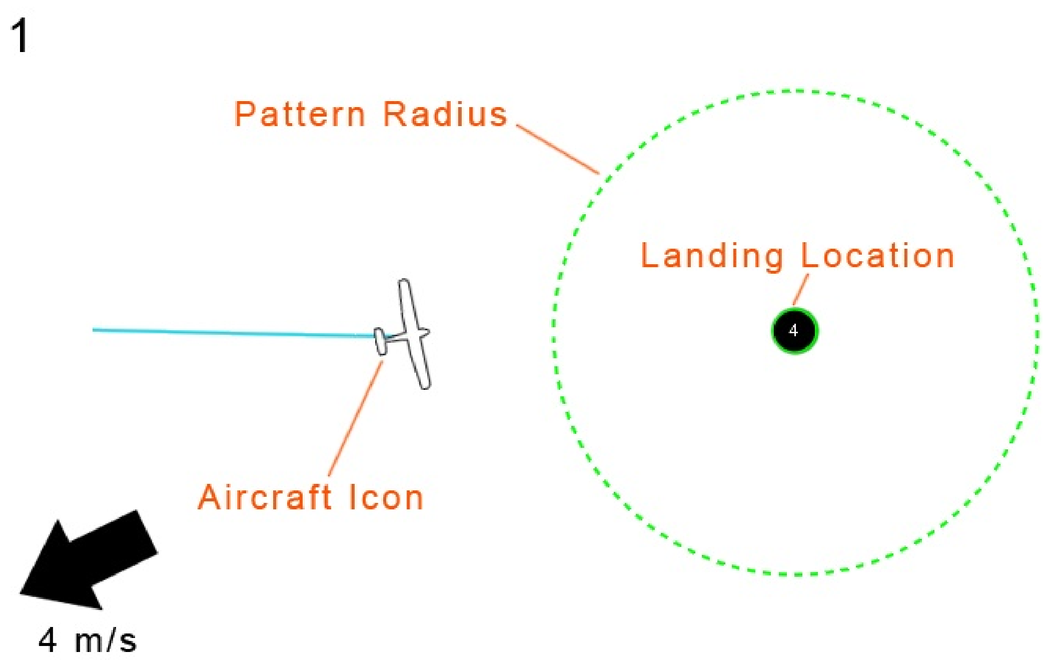
From the Plan tab, select `Add` ⇨ `Landing` to insert an autonomous landing into the mission. The default transition altitude is 30 meters above home.

There are several ways to plan where the aircraft lands. The location can be selected by clicking on the map, by using the aircraft's position (this option is only available during the preflight), or by using a computer that has a built-in GPS. Using the aircraft's position will result in the best landing accuracy.

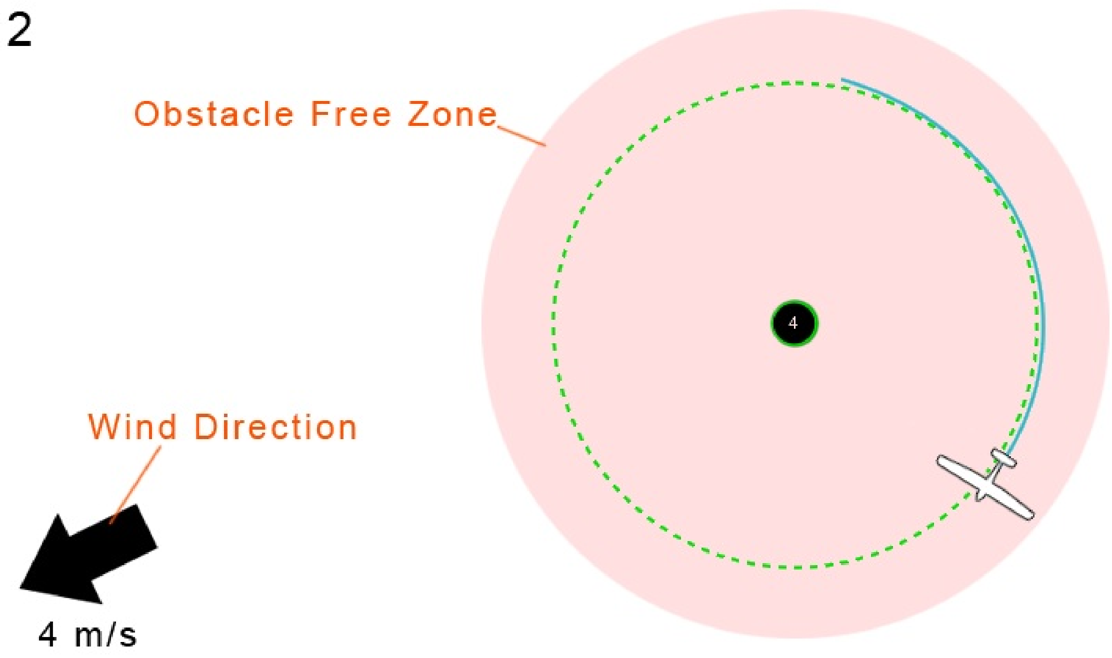
You will see your landing waypoint on the map with a dashed line around it. The dashed line represents the radius of the landing pattern. It is important to keep this radius away from obstacles that are near or higher than your transition altitude when planning the location.

The landing pattern is automatically generated. The heading is affected by the wind direction. Similar to a takeoff, the aircraft will fly into a headwind for the transition and weathervane during the vertical descent.

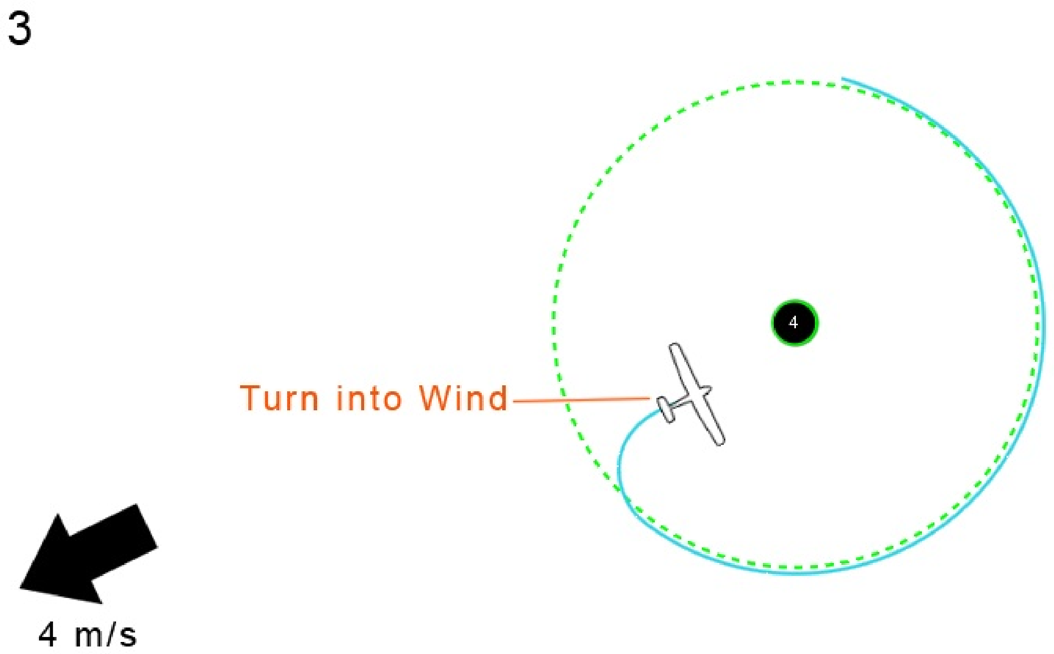
The pattern is divided into four distinct phases: 1. Approach, 2. Pattern, 3. Heading, 4. Transition



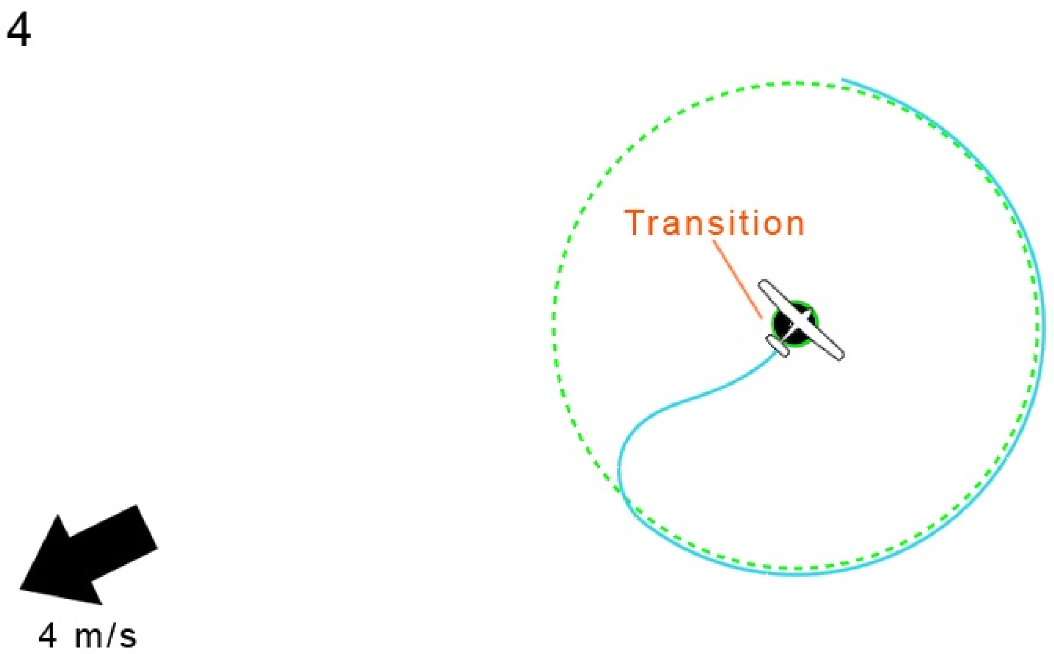
Approach: In the approach stage, the aircraft will fly to the landing location from its previous waypoint. The altitude of this approach leg will be the same as your default altitude unless you have configured the landing differently from the Plan Tab. If your previous waypoint was lower than the approach altitude, the aircraft will climb during the approach and vice versa. This must be considered with regards to terrain and obstacles.



Pattern: Once near the landing location, the aircraft will enter a 150 meter radius circle and descend to the planned transition altitude. The default transition altitude is 30 meters. The area within the landing circle must be free of obstacles near or above the transition altitude.

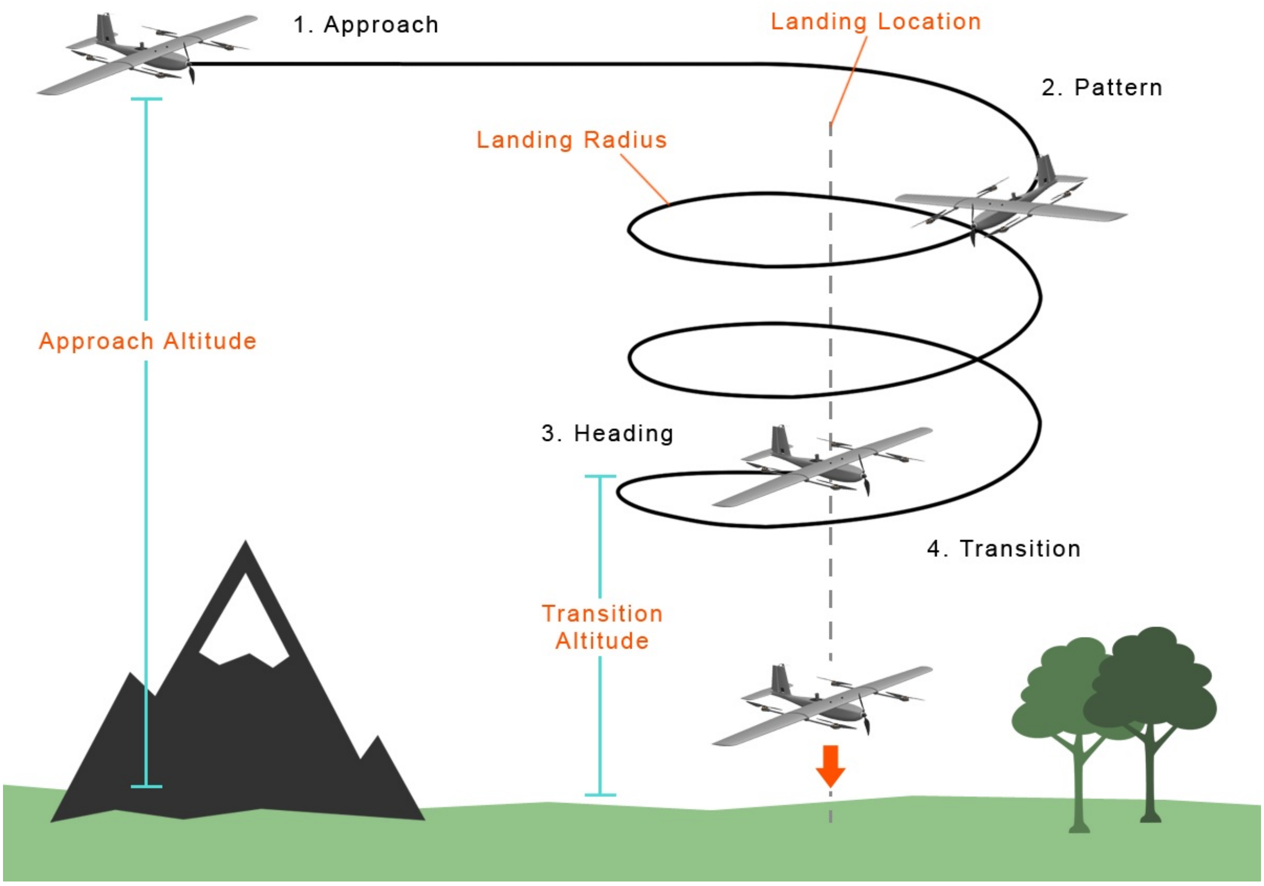


Heading: Upon reaching the transition altitude, the aircraft will pick a heading that is into the wind. Once the path has been selected, the aircraft will turn into the wind and fly towards the landing location.



Transition: The aircraft will automatically transition from forward flight into a hover just before the landing location. Lynx VTOL will then descend vertically over the landing spot. Upon reaching the ground, the aircraft will automatically disarm and stop spinning the motors after a short delay.

Landing procedure, seen from the side.



Caution: Lynx VTOL has a limited battery capacity for the VTOL motors. If the landing transition altitude is too high, the aircraft battery may be depleted and ultimately cause a crash. Restrict landings to 45 meters or below.

Caution: With an autonomous landing, the GCS operator has no direct input on the landing once the aircraft has transitioned.

Caution: If flying with a GCS other than Swift GCS, please see Flying with an different GCS. Failure to plan the landing correctly can result in failsafes not working correctly and may result in a crash.

Mission - Add Rally Point

From the Plan tab, select `Add` ⇨ `Rally` to insert rally points into the mission. Multiple rally points can be added.

Rally points are used to control where the aircraft will go in the event of certain failsafes. When the aircraft wants to fly to a rally point, it will select the nearest one. The aircraft will circle around this point until the operator changes the flight mode, or a more critical failsafe activates.

Rally points should be planned in safe locations, free of obstacles, and within radio range of the operator. Multiple rally points can be staggered throughout an area for large missions, especially if the operator is mobile.

For more information about rally points please see the section describing the rally mode.

Caution: If there are no rally points within 5 kilometers of the aircraft during a failsafe or if you choose the flight mode rally, the aircraft will fly to home and circle, descending enroute to an altitude of 100 meters.

Mission - Upload to Autopilot

From the `Plan` tab, select `Upload`. This will upload the entire mission to the autopilot.

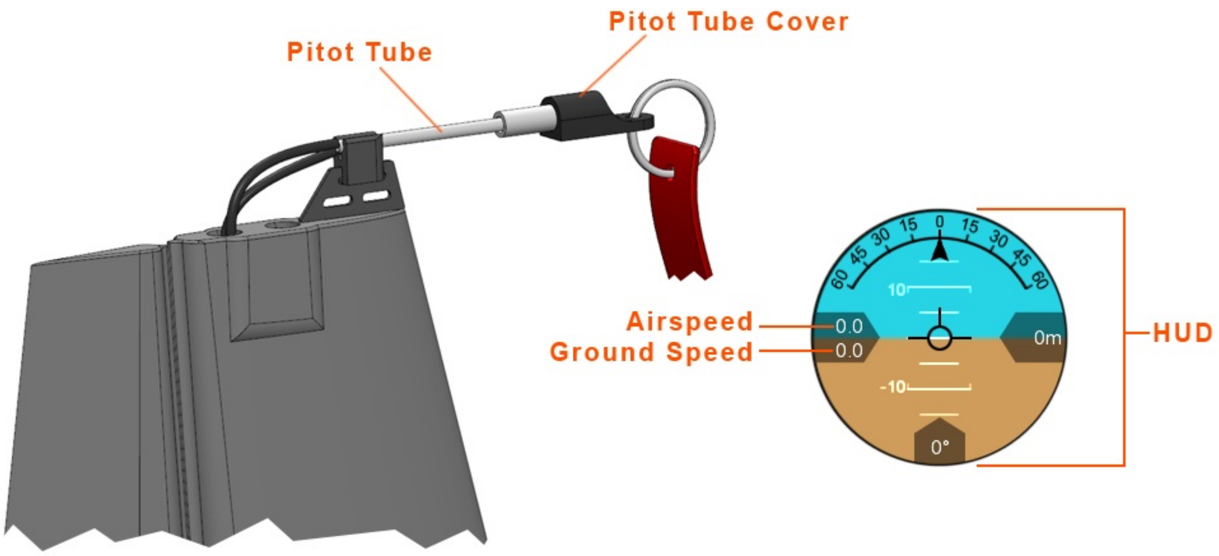
Autopilot Warmup - Wait

The autopilot has an internal heater to hold the IMU at a specific temperature which improves the accuracy of the sensors. Please wait for the IMU to reach the required temperature before proceeding.

Airspeed - Calibrate

This step will walk you through calibrating your airspeed sensor. First shield the pitot tube from any wind with the provided pitot tube cover. Next, press the `Calibrate` button on the Checklist Tab. Remove the pitot tube cover to test the airspeed sensor. To test, tap and hold the tip of the pitot tube with your fingertip while watching the airspeed reading on the Heads-Up Display (HUD). The reading should exceed 6 m/s. If you cannot exceed 6 m/s, gently blow into the front opening of the pitot tube from a distance of around 5 cm.

At rest, the displayed airspeed should be close to zero, but it may drift up to 2 m/s.



Payload - Check

Check that your payload is configured correctly. See the Payload section here for more information.

Lynx VTOL may be flown safely without any payload.

The max payload weight is 500 grams.

Camera - Synchronize

The sync step is only required if doing a photomapping mission. If no survey grid was planned, then the step will automatically be shown as complete.

This sync process is not required if doing a PPK flight, however it is still recommended, as it provides a fallback geotagging option.

This step is used to check that the camera triggering circuit is working, and to create a marker in the autopilot log that is used for tagging.

Step 1: Press the `Sync` button to begin the process.

Step 2: The GCS will prompt you to ensure that the camera is installed and connected to the aircraft. Press `Yes` button to proceed.

Step 3: The GCS will prompt the aircraft to take a photo, at which point you should hear the camera trigger. If a photo was taken then select `Yes` button to continue. If no photo, select `No` and double check the connection to the camera, the camera settings, camera storage, and camera power.

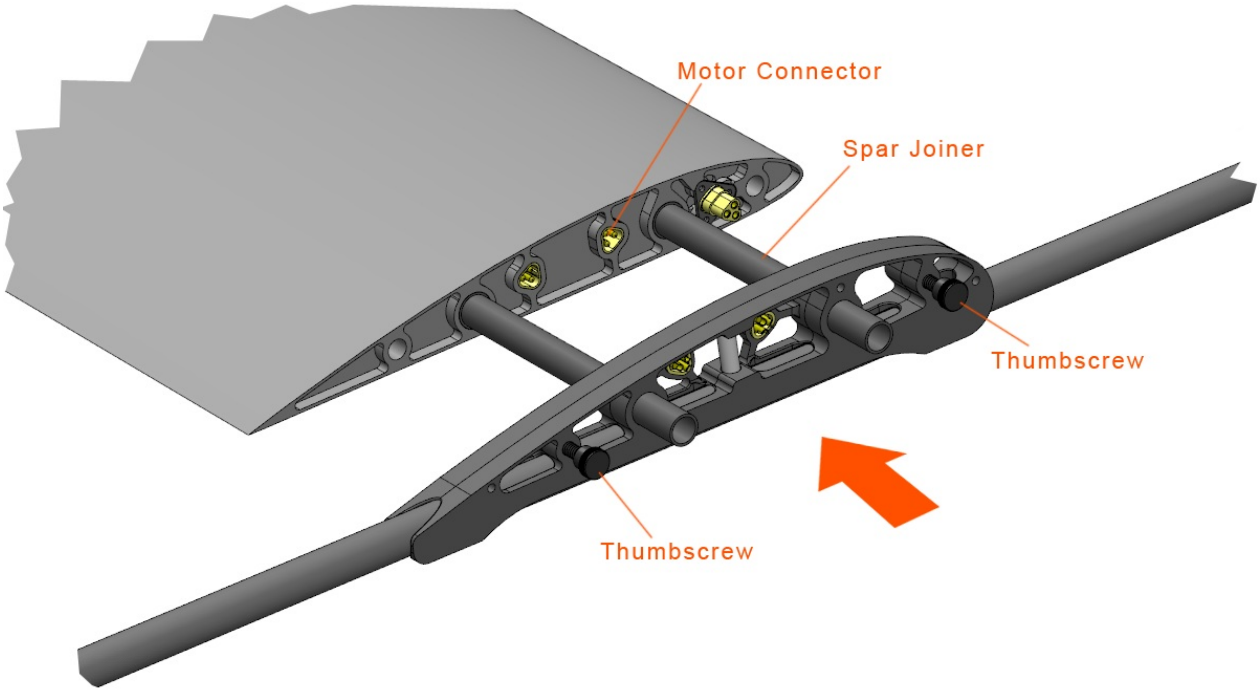
Step 4: You are now ready to take the sync photo. This is a photo you will need to find during the geotagging process, so ensure that the camera is pointing at an object you can recognize later. When ready, press the `Take sync photo` button.

Tip: Taking a photo of your hand or shoe is fairly easy to do and makes a distinctive photo for the tagging process.

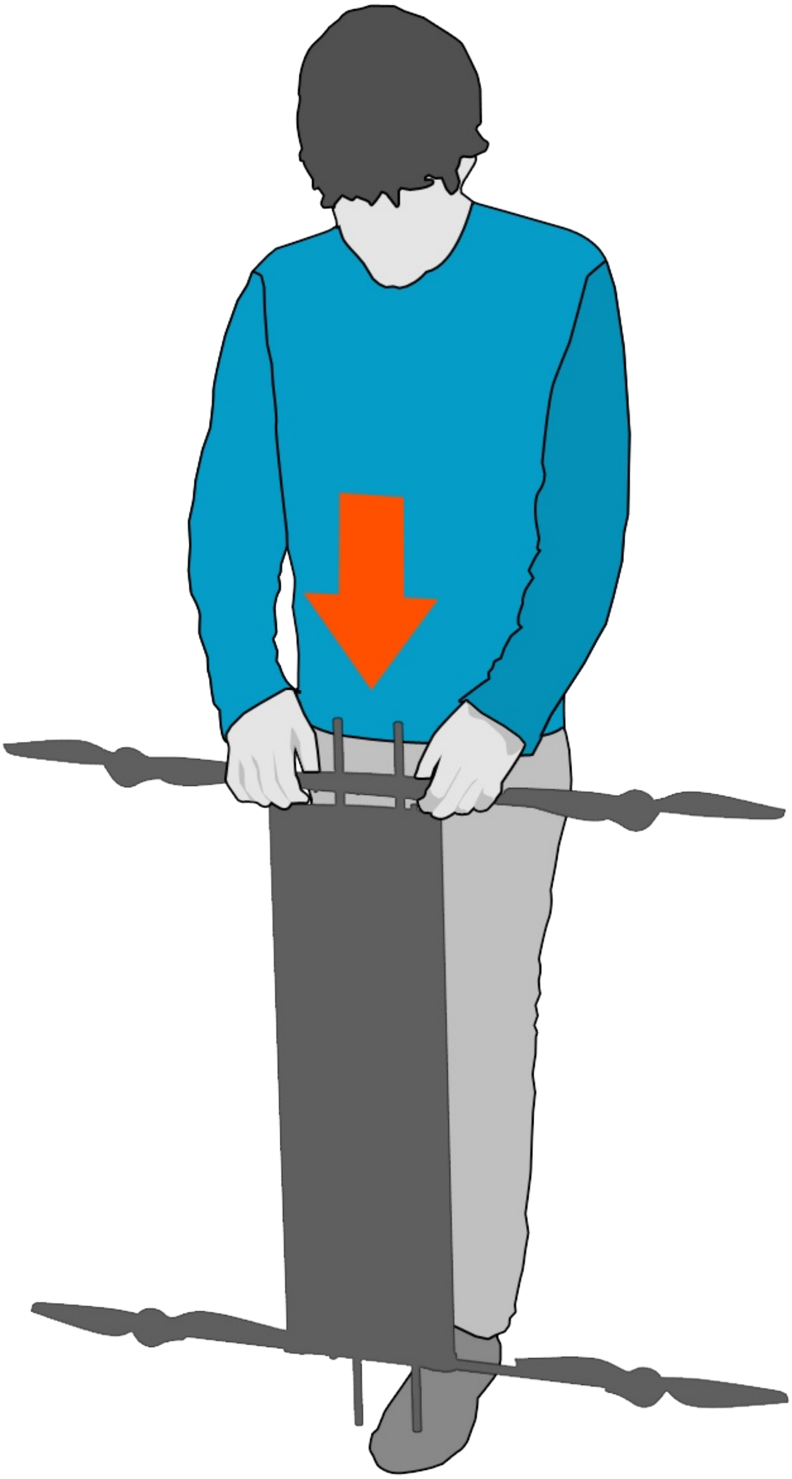
Step 5: Select `Yes` to continue if the sync photo was successfully taken. If this failed then there is something unreliable with the connection to the camera, and you should inspect all the connections and settings before restarting the process.

Aircraft - Assemble

This step will walk you through assembling your Lynx VTOL

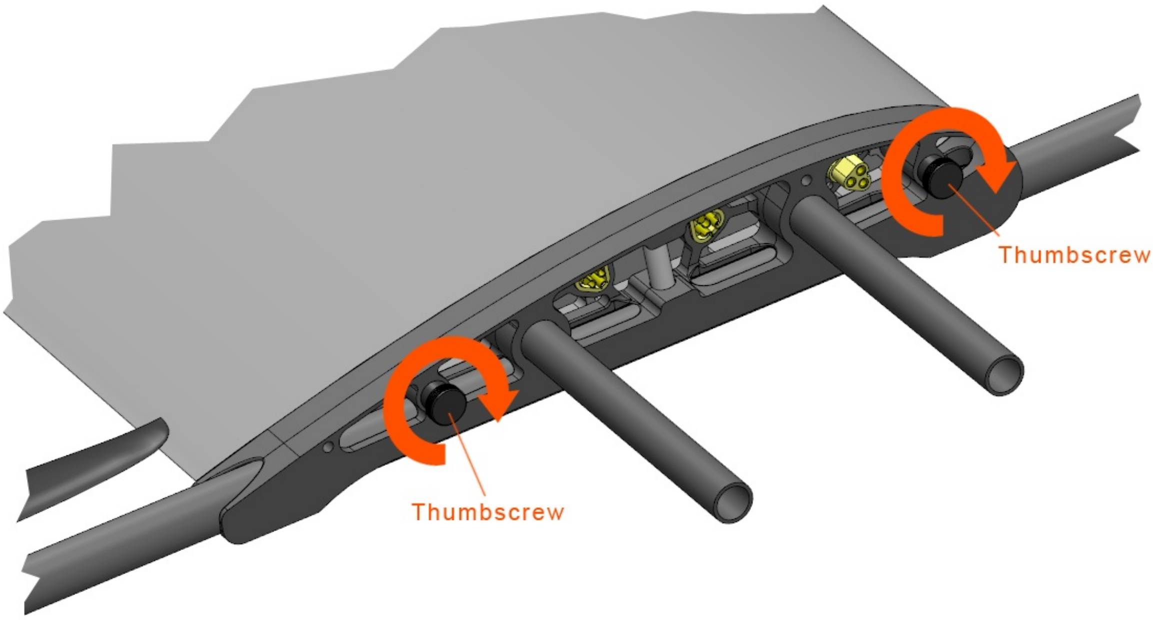


Step 1: Attach one of the motor booms to the center wing by sliding it against the spar joiners. Loosen the motor boom thumbscrews such that they do not stick out on the side facing the center wing. Keep sliding the motor boom against the center wing until flush. The motor connectors should now be fully seated.

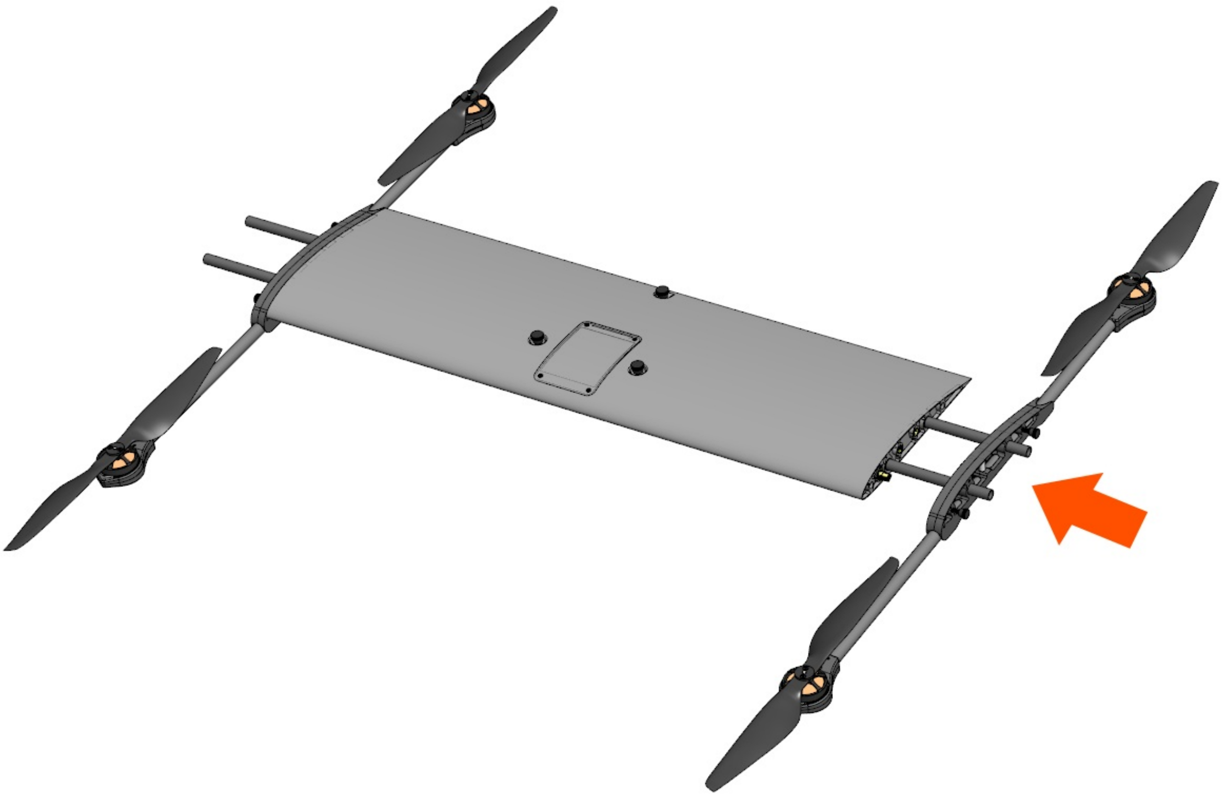


Tip: Place one end of the center wing against your shoe such that the wing is standing vertically. Align the motor boom with the spar joiner and press down.

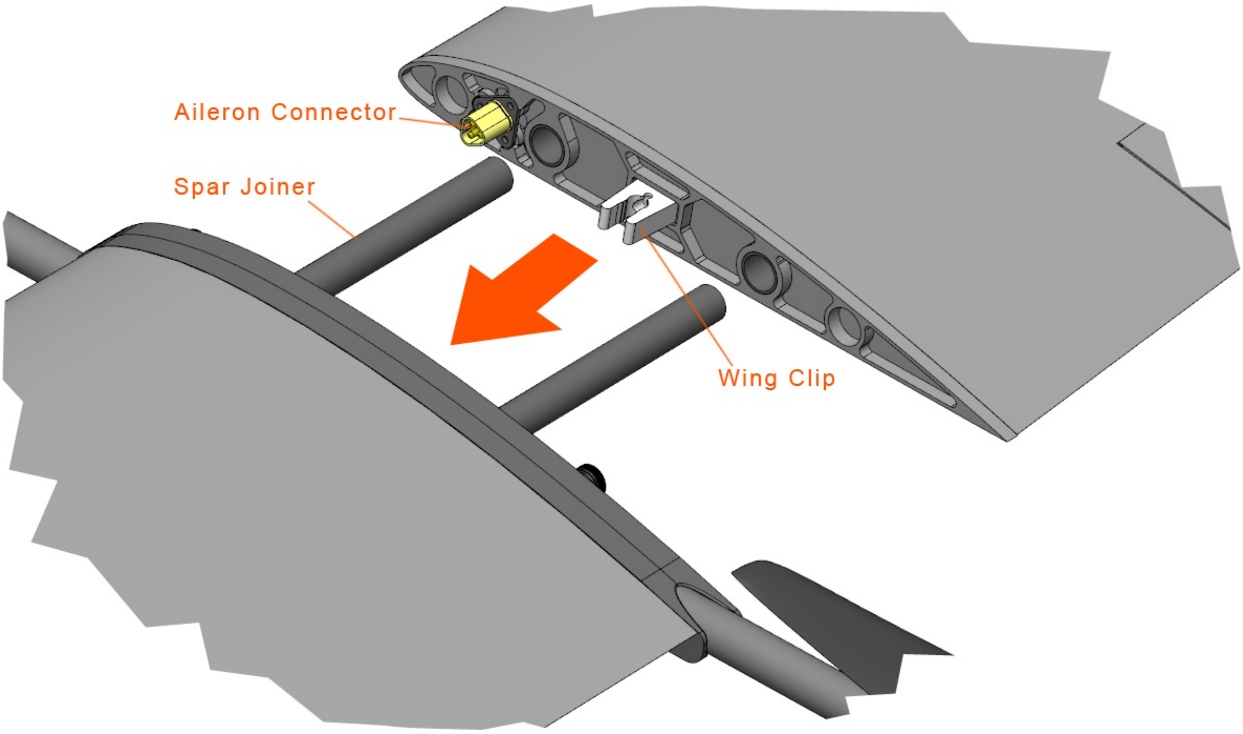
Caution: Do not force the motor boom if the connectors do not align. Instead, wiggle the motor boom until the connectors align.



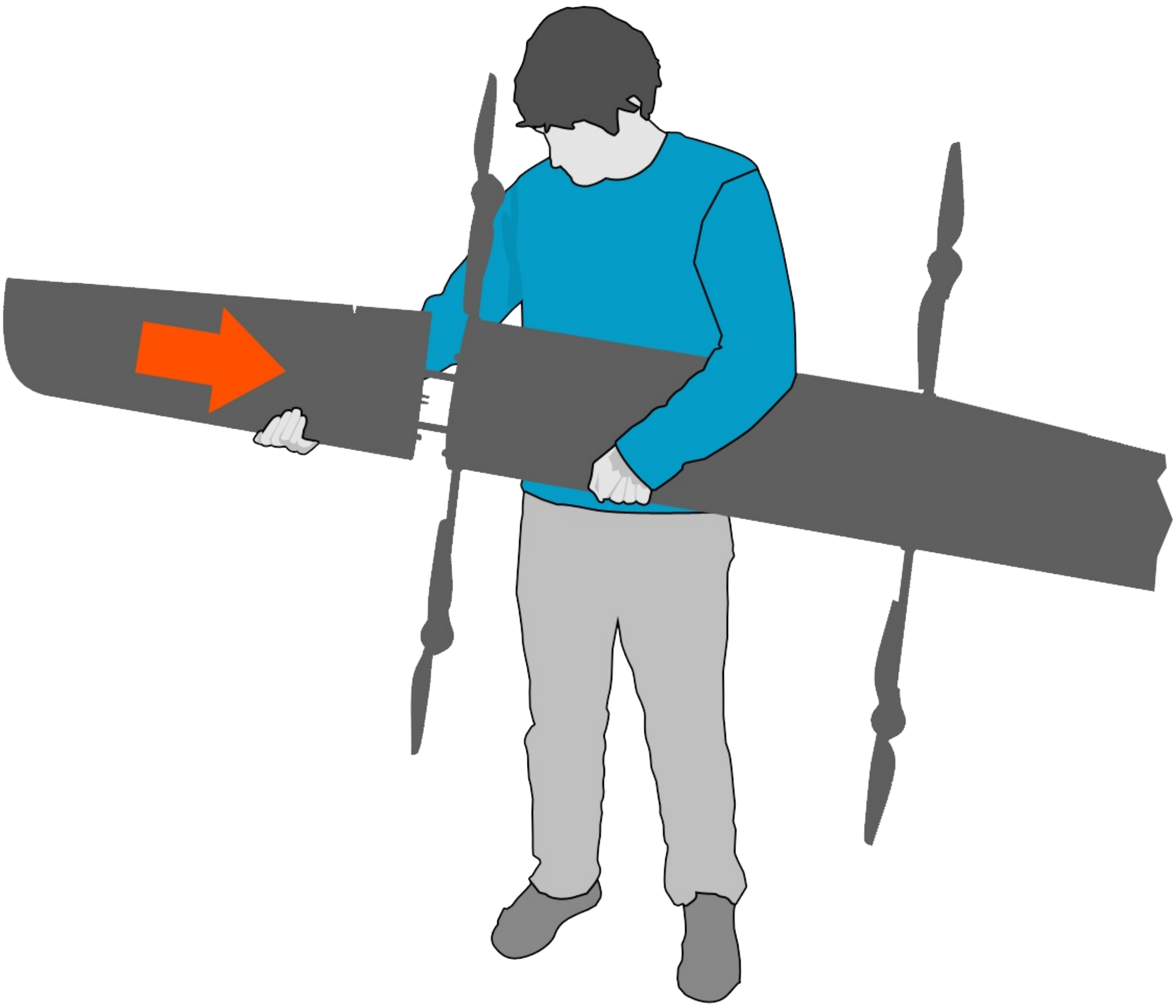
Step 2: Tighten the 2x motor boom thumbscrews to secure it against the center wing.



Step 3: Attach the other motor boom using the same process.

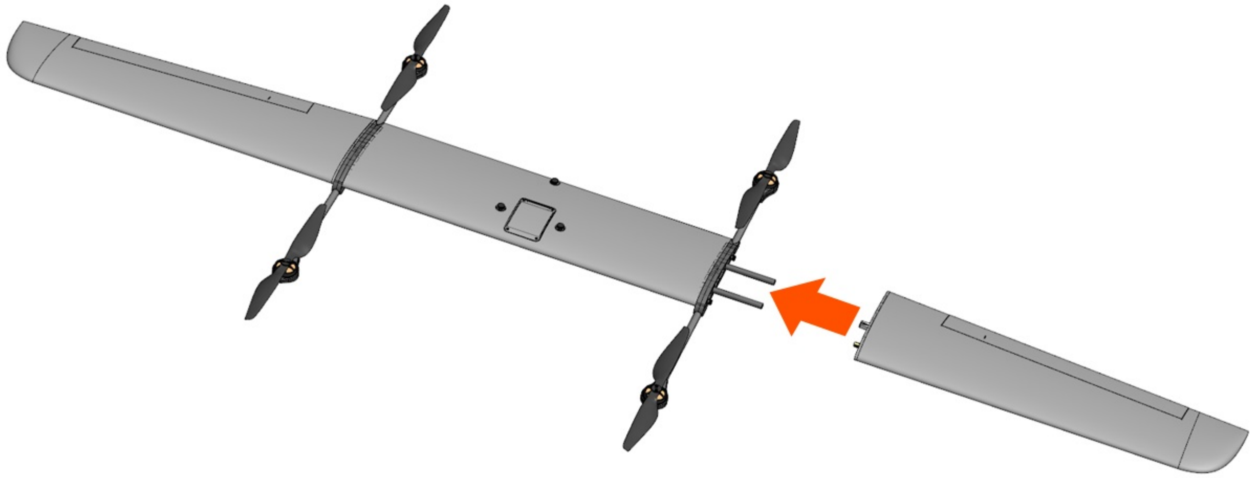


Step 4: Attach one of the wings to the center wing by sliding it against the spar joiners. Keep sliding the wing against the center wing until the wing clip engages. The wing should now be nearly flush with the motor boom.

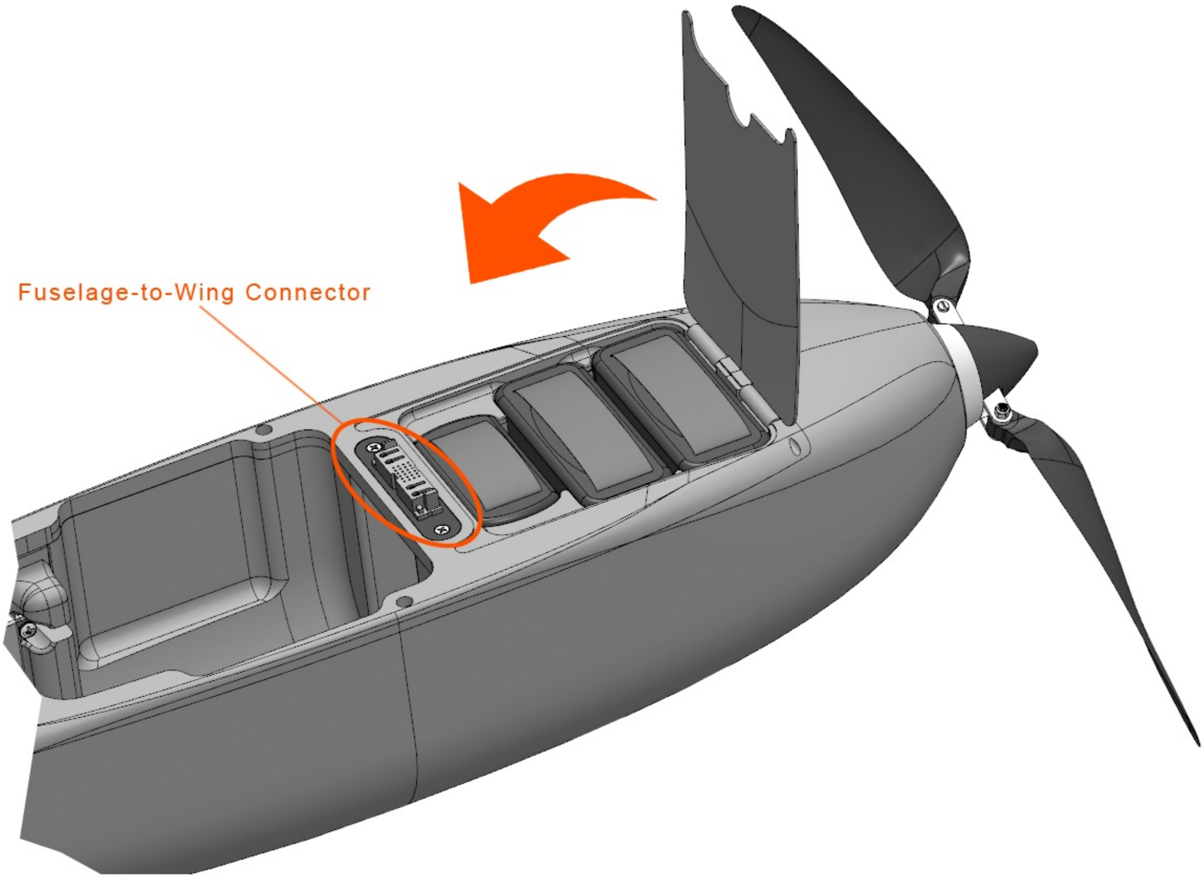


Hold the center wing horizontally and flat against your stomach. Point the leading edge (front) of the wing down. Holding the center wing with one hand, and grasp the leading edge of a wing with your other hand. Line-up the spar joiners and slide the wing together.

Caution: Do not force the wing if the aileron connectors do not align. Instead, wiggle the wing until the connectors align.

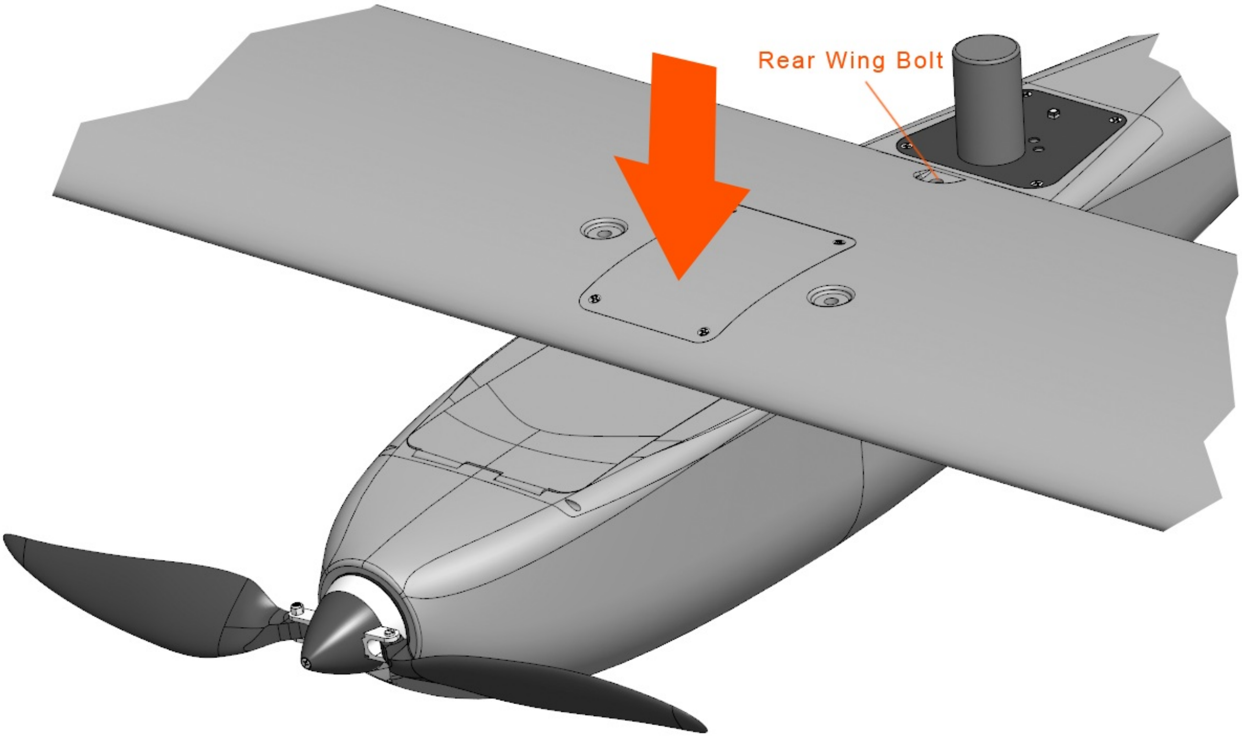


Step 5: Attach the other wing using the same process.



Step 6: Ensure the battery hatch is closed and flush with top of the fuselage.

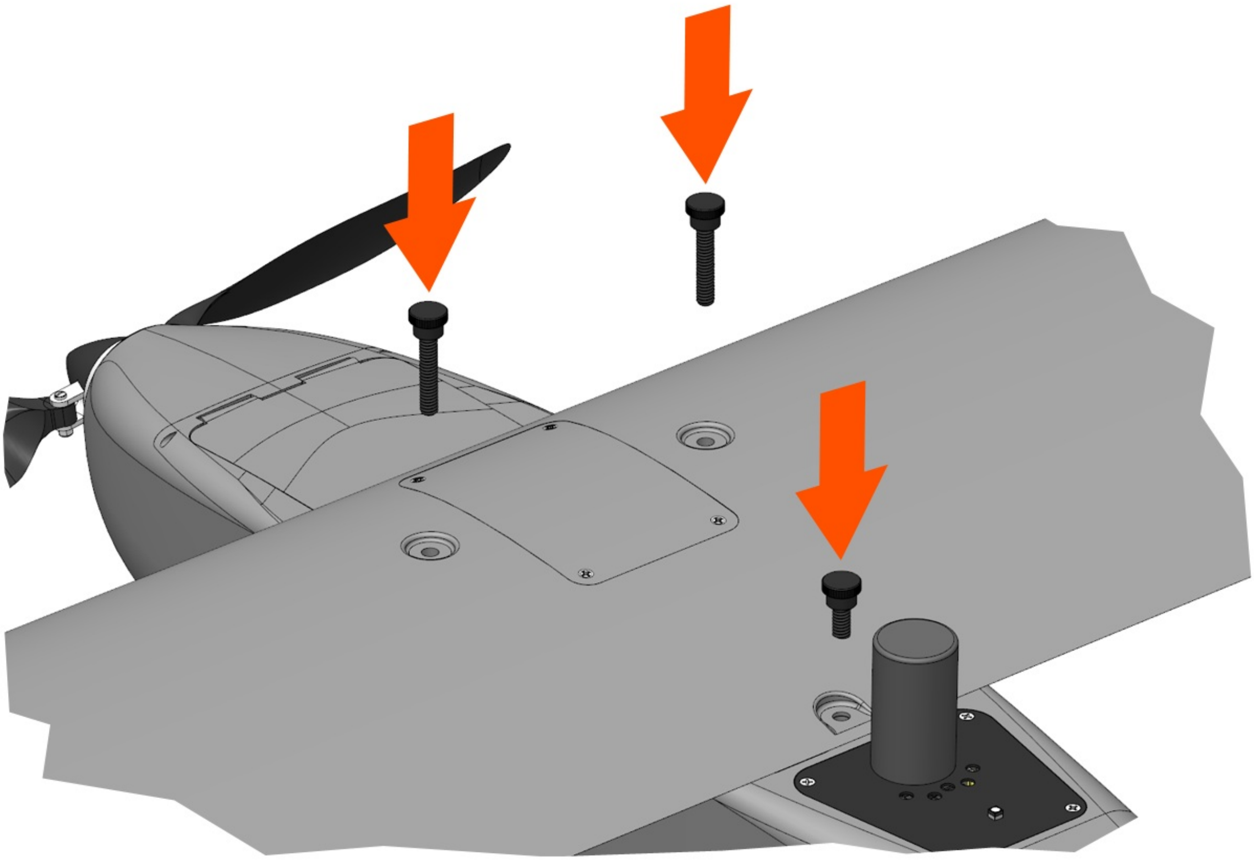
Caution: If the battery hatch is not properly aligned with the fuselage, it may interfere with mating the fuselage-to-wing connector.



Step 7: Attach the entire wing to the fuselage. Place the wing atop the fuselage. The wing should be centered and aligned with the fuselage-to-wing connector. Use the rear wing bolt slot to visually center the wing and align it to the bolt threads. Once aligned, gently press down on the wing until the fuselage-to-wing connector is fully seated. The VTOL motors will audibly beep when the connector is seated.

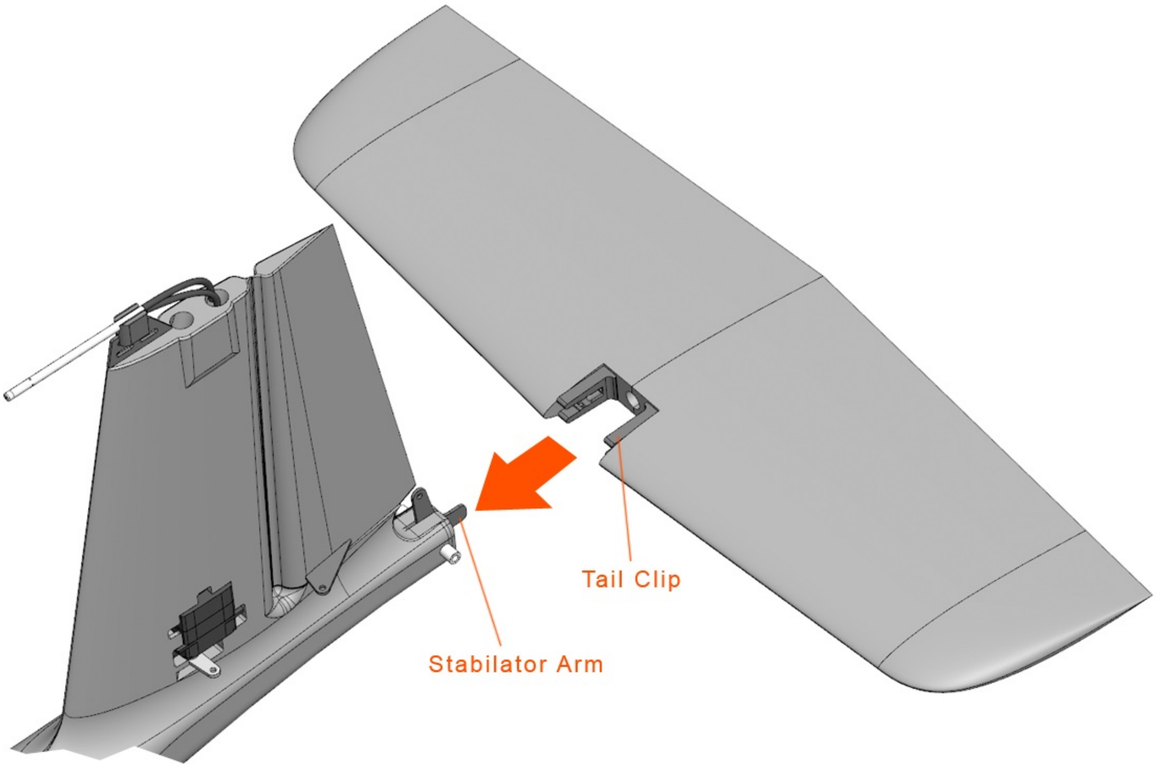
Caution: Do not force the wing downward onto the fuselage if the connector does not align. Doing so may damage the connector's electrical contacts.

Warning: The VTOL motors are now energized. Always keep clear of propellers when the aircraft is armed, taking-off, or landing, and whenever possible while the aircraft is powered-on.



Step 8: Secure the wing to the fuselage by inserting and finger-tightening the wing thumbscrews.

There are three wing thumbscrews. The two in the front are longer than the rear one.



Step 9: Attach the stabilator to the fuselage by lining up the stabilator arm and tail clips. Press the stabilator against the fuselage until it clips into place.

Compass - Check

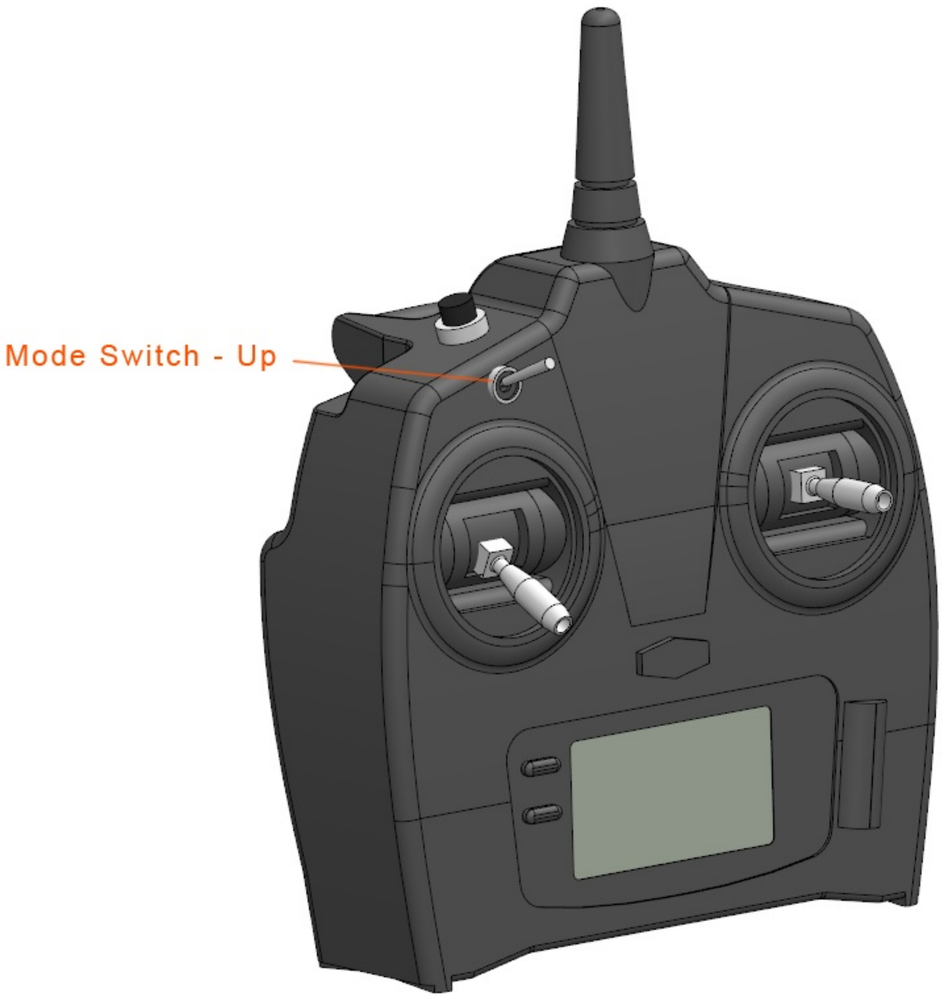
Check that the compass is behaving correctly by pointing the aircraft at a known object and then verify that the map shows the aircraft pointed at the same object. Rotate the aircraft in 90 degree increments and check that the map and aircraft continue to agree. No warnings should be triggered while performing this check.

> **Caution:** If the heading is off from where the aircraft is actually pointing by 10 degrees or more, you may need to perform a compass calibration. Please see the calibration section for more information.

> Changing the aircrafts payload may change the required compass calibration. Please see the calibration section for more information.

Mode - Auto

Using the RC controller, change the current flight mode to auto by moving the mode switch all the way up. Swift GCS will display the current flight mode at the top.



Initial Waypoint - Set

This step verifies that the initial mission item is set to a takeoff.

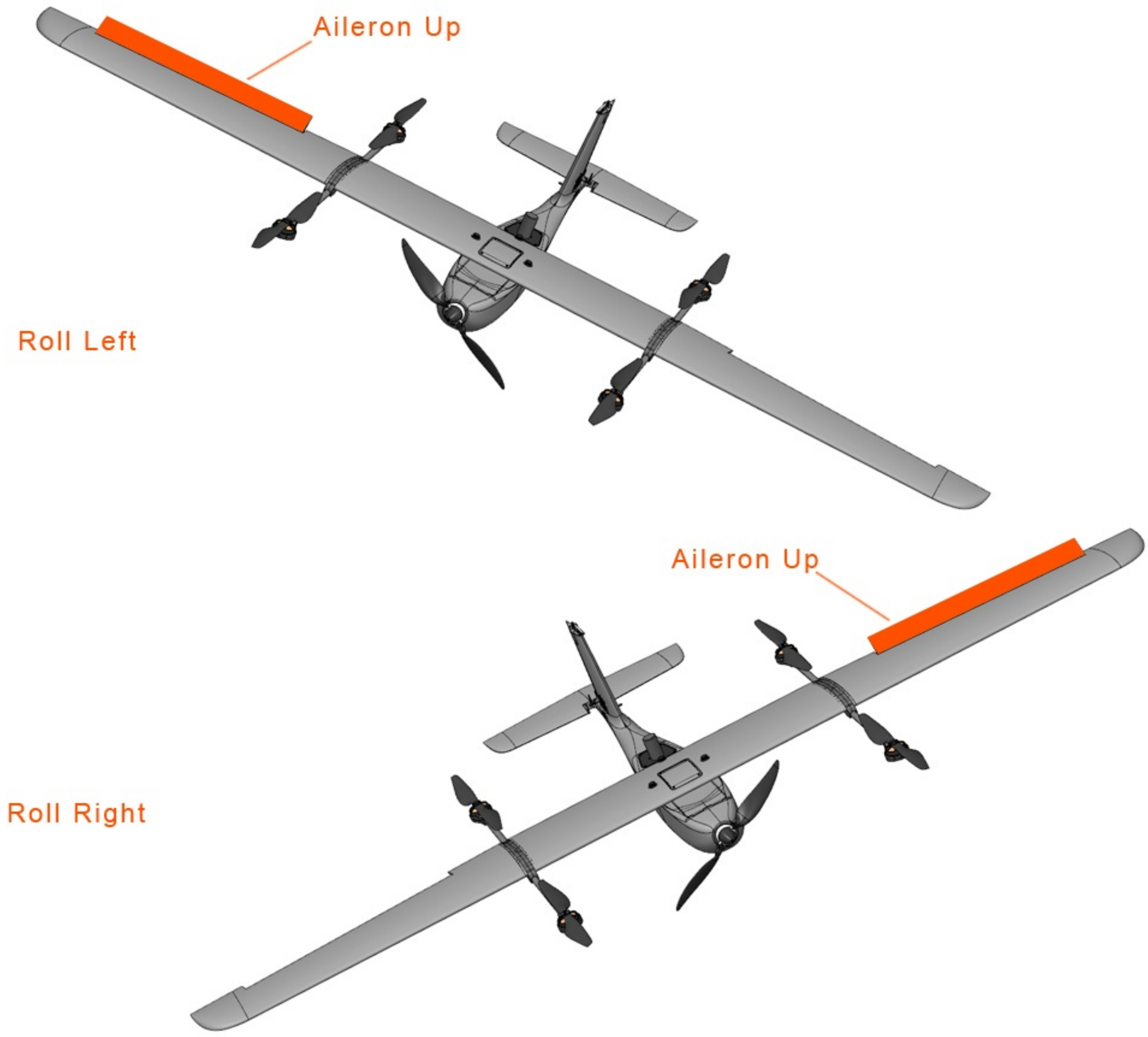
Control Surfaces - Enable

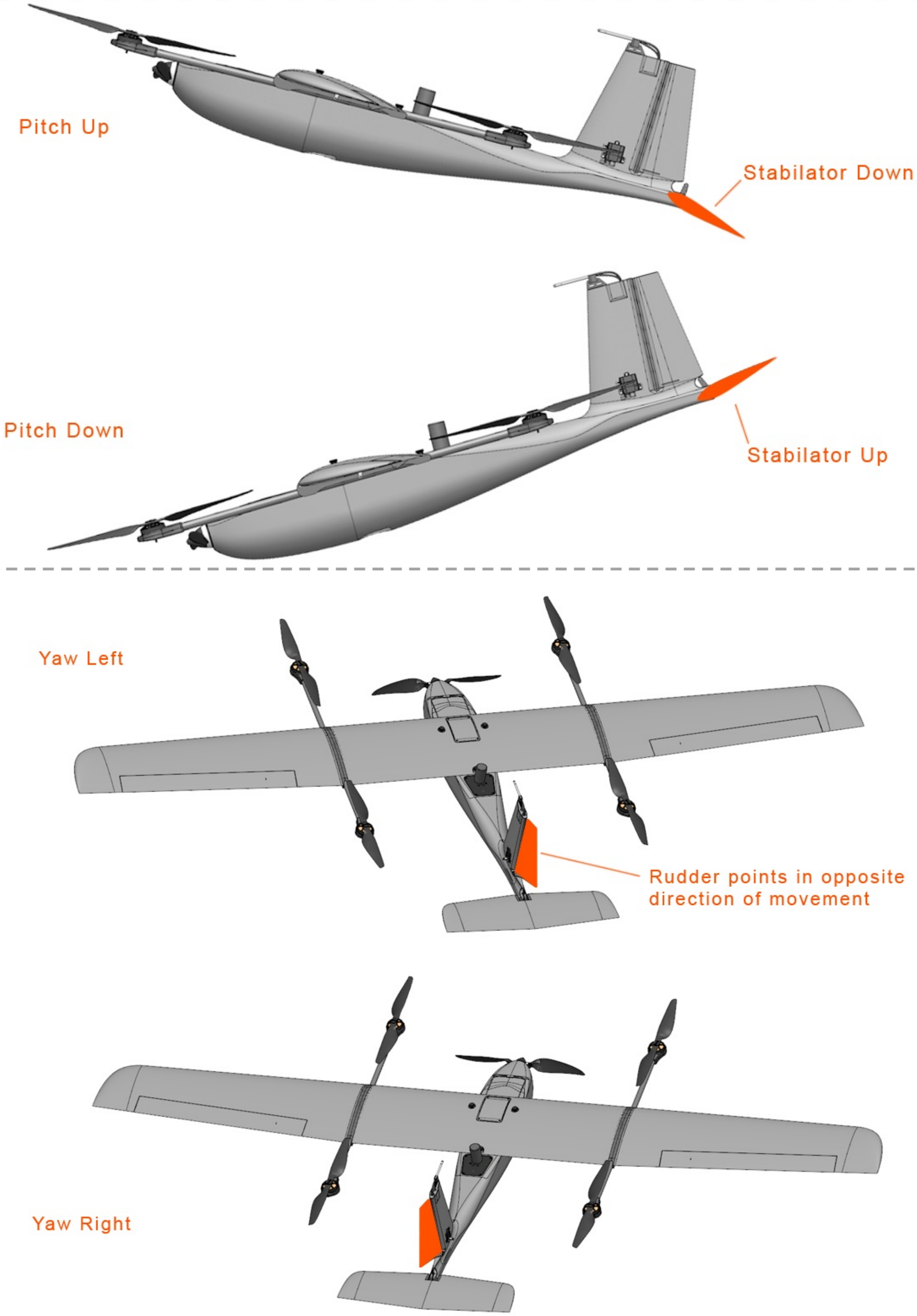
This enables the aileron, rudder, and stabilator flight control surfaces to move.

> Throttle will still be disabled.

Control Surfaces - Check

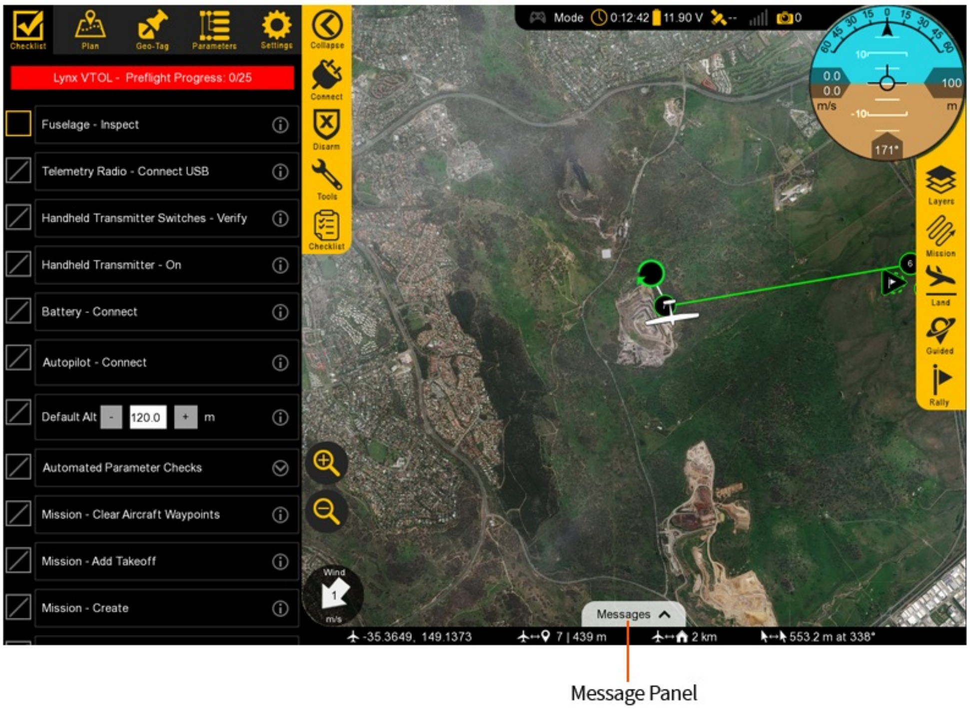
Move the aircraft to test that the autopilot is responding correctly to attitude upsets. Do this by observing how the flight control surfaces react to rotations in all three axes: pitch, roll, and yaw (heading). The control surfaces should oppose the movement in each direction. For example, when the aircraft is rolled, the ailerons should be trying to return the aircraft to level.





No Warnings - Verify

Ensure that there are no warnings before takeoff. All warnings must be resolved.



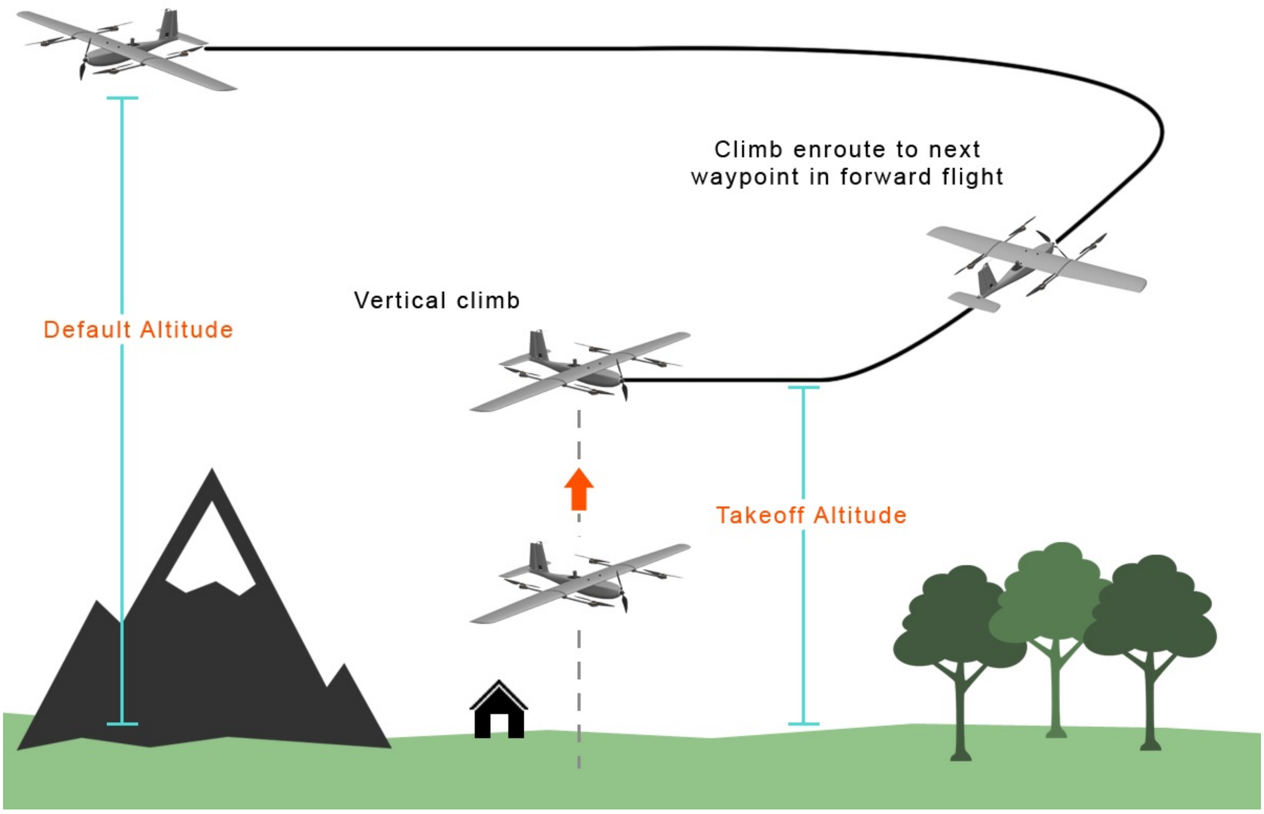
The message panel in Swift GCS displays warnings and notifications from the GCS and autopilot. A new warning will automatically expand the message panel if it was collapsed.

Takeoff - Ready?

Double check the wind direction and velocity. Do not takeoff if the wind speed exceeds the Lynx VTOL system limitation of 10 m/s. Ensure that the aircraft is pointing into the wind. The takeoff area should be clear of bystanders and obstacles. Notify everyone participating in the flight that the aircraft is about to takeoff.

Aircraft - Takeoff

This step arms the aircraft and then immediately commands a takeoff. Lynx VTOL will spin the VTOL motors and climb vertically to your takeoff altitude, by default 30 meters. During the ascent, Lynx VTOL will try point its nose into the wind, or weathervane, to assist the takeoff. Upon reaching your takeoff altitude, the aircraft will transition to forward flight and climb enroute to the next item in your mission.

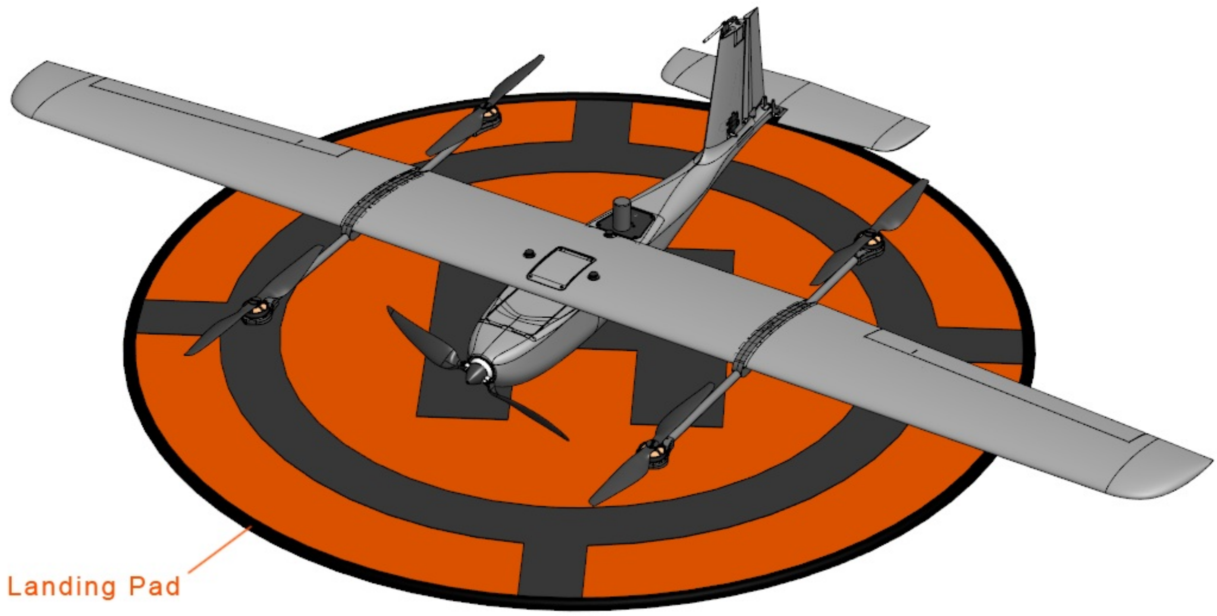


Caution: The operator has no direct input on takeoff once the aircraft has been armed. However, there are a number a situations that will cause the autopilot to automatically abort the takeoff.

Warning: Arming the aircraft allows the autopilot to spin propellers.

Arming finalizes your home location.

The aircraft must pass a series of automated pre-arm checks before arming is finalized. Failed pre-arm checks will be displayed in the warnings panel.

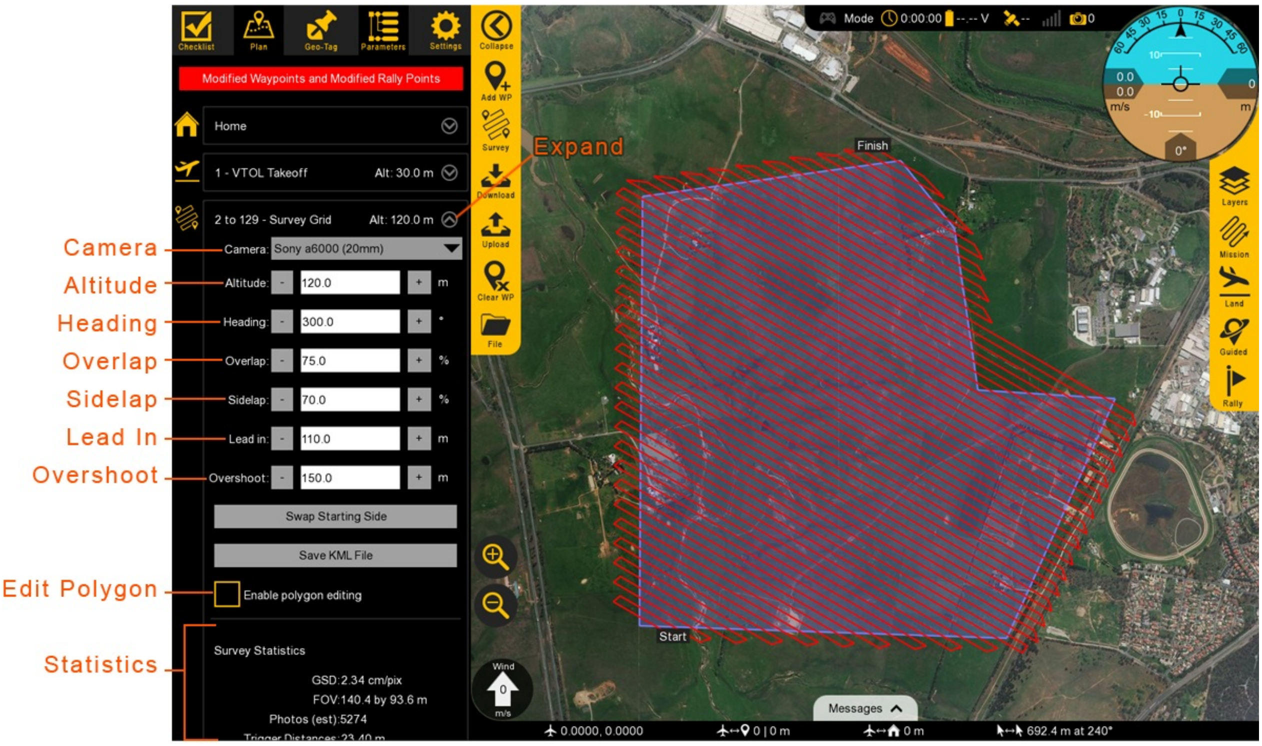


The thrust generated by the VTOL propellers on takeoff and landing can kick-up dust and loose debris. Use a landing pad or similar to reduce the amount of dust when flying from dusty environments.

Flying

Mission Planning

Survey



To create a mapping mission, a survey grid will need to be created in Swift GCS. Select the `Survey` button from the `Plan` tab to add one. You will be prompted to load a KML (or KMZ) file or to draw a new area by placing polygon points on the map. Polygons that you create in Swift GCS can be saved for future use. The survey grid makes all calculations based off the camera you selected from the list. Adjusting the flight altitude will allow you to change the ground sampling distance (GSD), or simply put, the imagery resolution.

Reaching the start of a survey will cause the camera to begin taking photos. The camera will continue to take photos until the last waypoint in the survey is reached. If you need to land before a survey is complete, the camera will continue taking photos until on the ground. This is fine, but those photos may need to be deleted before processing.

Settings for the survey mission can be modified by expanding the survey item in the list of mission items.

Camera

Expand to reveal the list of existing camera profiles. A custom camera profile can be added by going to the Settings Tab, then Camera.

Altitude

Altitude should be set based on the resolution requirements for your mission. It is critical to also account for safety factors such as surrounding terrain, air traffic, and local regulations. Flying higher will always increase your ground coverage vs. time but at the expense of reduced resolution.

Heading

Adjusting the heading control the direction of the flight legs. Flight legs should be perpendicular to the prevailing wind (crosswind). This will cause the aircraft to crab in flight but will result in a consistent ground speed from one flight leg to the next. A headwind/downwind scenario will cause the aircraft to have a slow ground speed one direction, and a high ground speed in the other direction. A high ground speed may cause motion blur in the imagery. Additionally, if the ground speed is high enough, the camera will be unable to take photos quickly enough which will result in missing photos.

You will be able to choose what side of the polygon the aircraft starts at with the `Swap Start` button. When possible , choose the starting position that will cause the aircraft to turn upwind. The result will be tighter turns between flight legs.

Overlap and Sidelap

Adjusting the overlap and sidelap percentages will control the number of photos that contribute to your mosaic for a given spot on the ground. Overlap controls the distance between photos along a flight leg. Sidelap controls the distance between photos from one leg to the next. The default numbers are 75% overlap and 70% sidelap. The starting numbers should be kept if you are uncertain of the settings, or if you are flying over hilly or forested areas. In areas of flat terrain, it is possible to safely lower these numbers. Doing so will allow you to cover more ground and reduce the amount of data to process. Never reduce the percentages below the minimum required for your imagery processing software.

Lead In and Overshoot

Lead in and overshoot are utilized to make sure that the aircraft is turning around outside the area of interest being mapped. The default values of 110 meters lead in and 150 meters overshoot are suitable for Lynx in most cases.

Statistics

Survey statistics will display information about your survey and polygon. The field of view (FOV) is the cameras footprint at the survey mission altitude. The photo estimation is the number of photos you can expect the camera to take during the survey; that number should be below what the camera’s SD card can store. Lines is the number of flight legs. Distance is linear distance of each flight leg, excluding turns. Time is the estimated duration to complete the survey. Note that the time estimate is based on a zero wind situation. High winds increase the time required to complete a mission because the aircraft’s ground speed is reduced overall. Area is the polygon’s area in square kilometers.

Editing a Polygon

To edit an existing polygon, select `Enable polygon editing` from within the survey grid item. The polygon corners will now show up as draggable points. Click to add an additional point, right-click to delete a point (tap and hold on touchscreen).

Modifying your Mission in Flight

You can upload a new mission while in flight, but doing so will not interrupt the current destination waypoint. Only the next waypoints will be affected by the new mission or if you restart the mission. For example, if you are flying to waypoint 4, and upload a new mission with 10 waypoints, the aircraft will continue to fly to the original waypoint 4 location and then travel to the new waypoint 5.

Changing Flight Modes

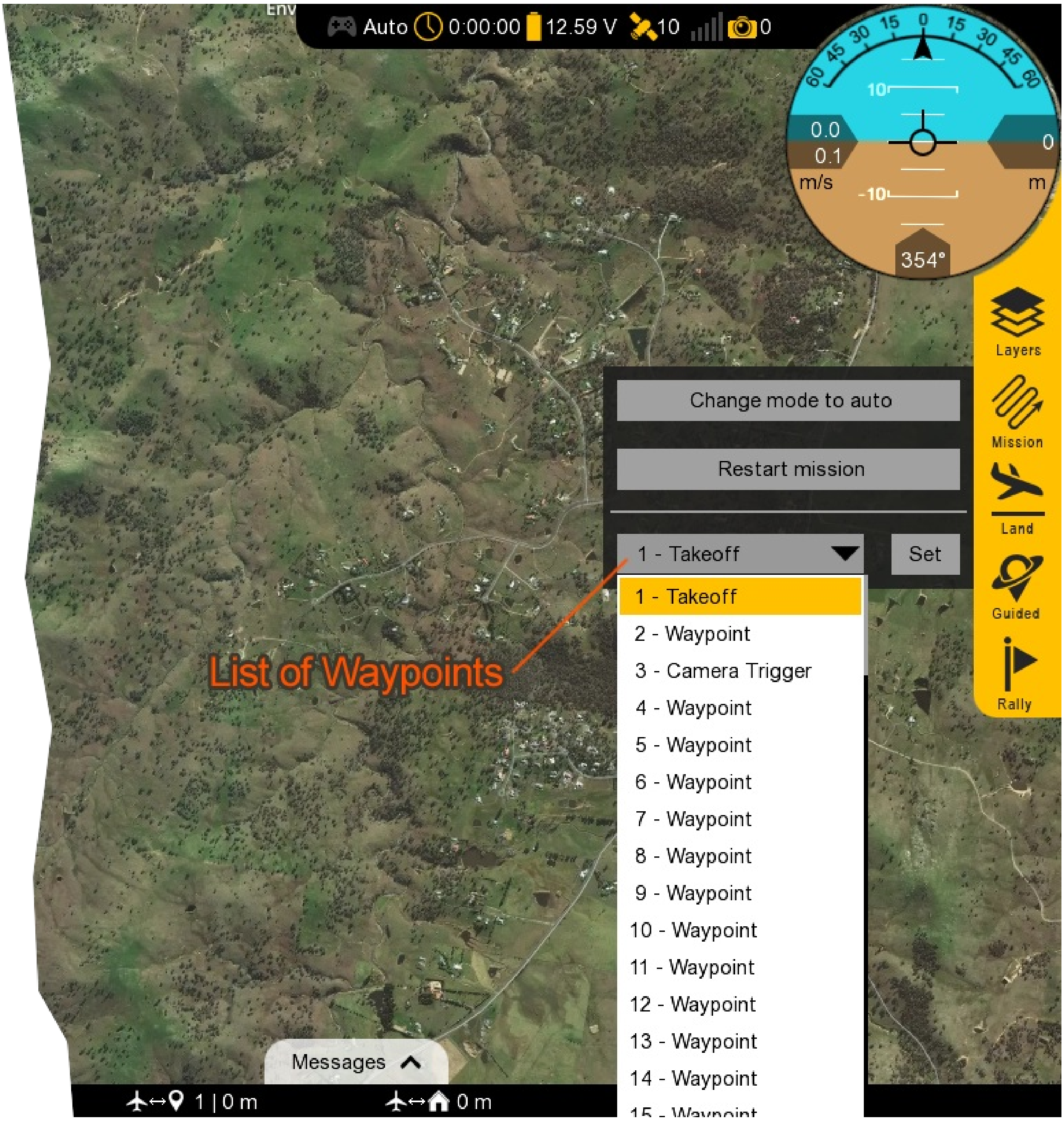
Changing flight modes can be done from either the RC controller or in Swift GCS. The RC controller has a three position switch that is dedicated to flight modes. Changing modes can be useful for a number of reasons such as modifying your mission, Safety Pilot intervention, or if you need to land early.

Whichever mode that was commanded last takes effect. For example, if the aircraft is in Auto but the Safety Pilot changes to Cruise, the aircraft will enter Cruise. If then, the GCS Operator changes back into Auto, the aircraft will enter Auto even though the mode switch on the RC controller is still in the middle position. If the Safety Pilot again requires Cruise, they must "bounce" the switch by briefly moving the switch to another mode and then back again. Never bounce the switch by moving it to Manual.

The current flight mode is displayed on the top status bar within Swift GCS.

Interrupting your Mission

If you need to interrupt your survey mission by changing out of Auto, the camera will stop taking pictures until Auto is resumed. When the mission is resumed, the aircraft will fly to the last waypoint it was trying to reach before changing modes. As such, you will most likely have to repeat the previous flight leg to ensure adequate image overlap. To do so, expand the list of waypoints under `Mission` and select the first waypoint of the line you want to refly.



Changing between Vertical and Forward Flight Modes

If the aircraft is in a vertical flight mode and is commanded into any forward flight mode (except manual), it will transition automatically to forward flight.

Warning: The aircraft will transition at whatever altitude and heading it is currently at. This can be extremely dangerous when close to the ground and must be avoided.

Caution: Changing from a vertical flight mode to manual will never perform a transition. Instead it will immediately shut off the VTOL motors. This will result in an immediate stall and loss of the aircraft. If the aircraft was accidentally put into Manual then simply change the mode back to the desired flight mode.

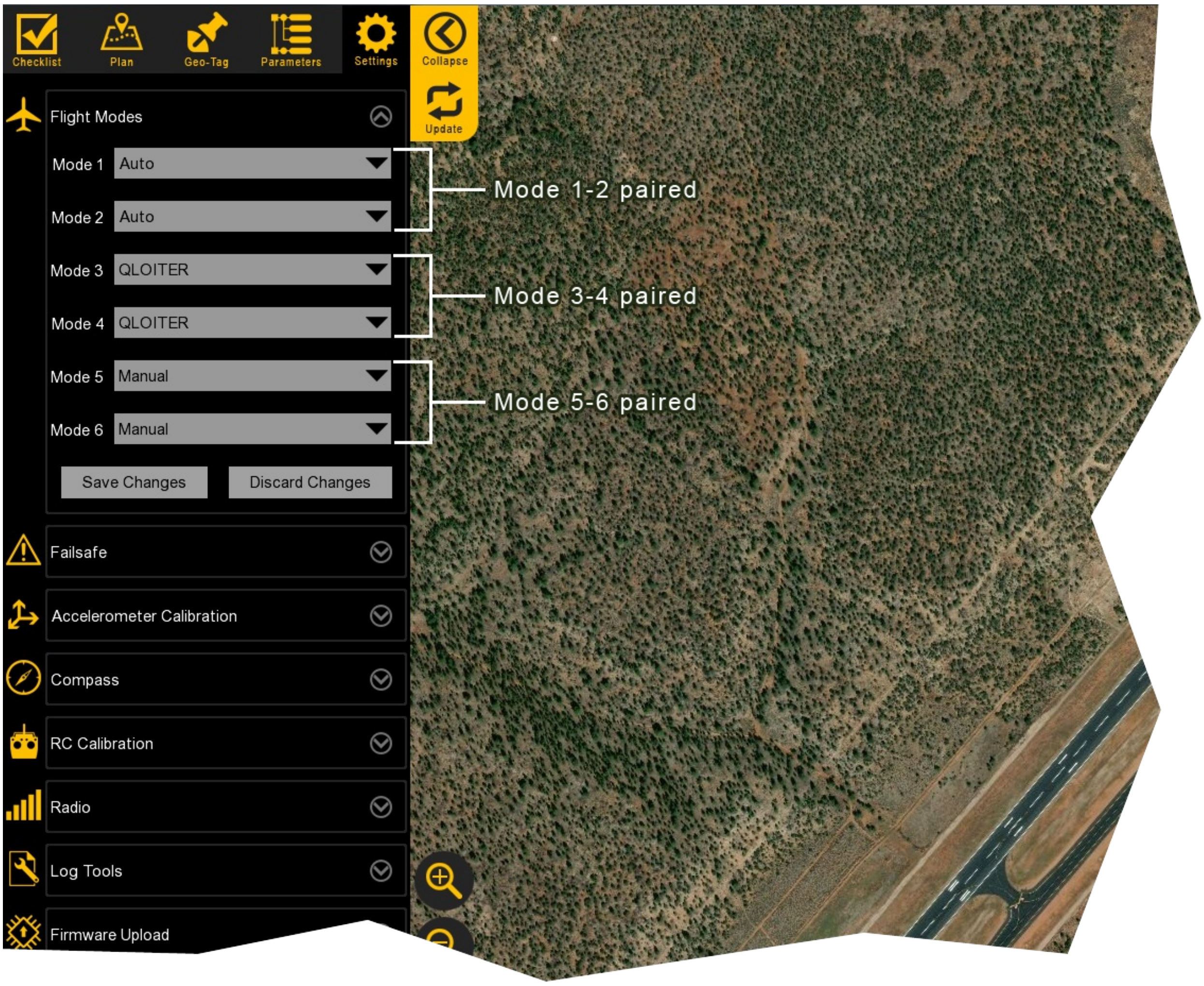
If the aircraft is in forward flight and is commanded into any vertical flight mode, the aircraft will transition to a hover and may climb or descend depending on the mode or RC controller stick position (if applicable).

The distance the aircraft will travel while transitioning to a hover depends upon the ground speed of the aircraft.

Configuring Modes on the RC Controller

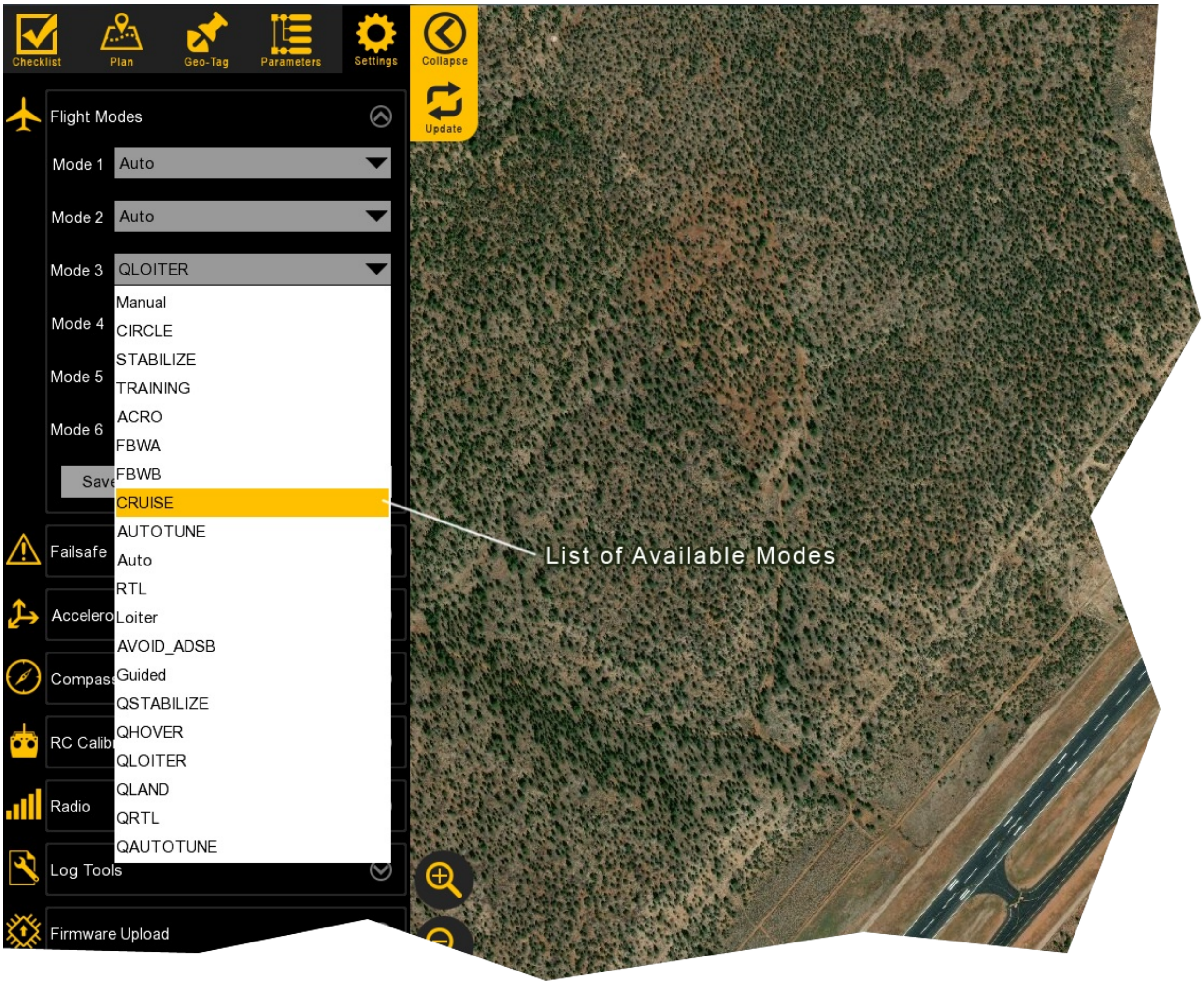
Not all modes listed below are available on the RC controller as standard. The standard configuration is Manual, QLoiter, and Auto. Manual and Auto must remain, but the middle position can be re-configured.

To re-configure the middle position, go to the Settings tab in Swift GCS and expand the Flight Modes menu. You will notice that modes 1-2, 3-4, and 5-6 are paired. The autopilot supports six positions for modes, but the RC controller switch only has three positions. As such, if you re-configure, mode 3 and 4 must match.



Expanding a mode reveals the list of options. You must save your changes for the new configuration to take effect.

Caution: Only select from modes described in the Lynx VTOL manual (Cruise, FBWB, QLoiter, QLand). Other modes are strictly reserved for testing.



Auto (Mission)

Auto is an autonomous flight mode that is used in both forward and vertical flight. Of all the modes available, Auto will be used the most. Following the preflight, your pre-planned mission will begin in Auto with an autonomous takeoff and end with an autonmous landing. You may intervene by changing flight modes as needed. Waypoints are flown through in sequence they are planned. However, in flight you can select specific waypoints to fly to within your mission using the `Mission` button in the GCS. The same `Mission` button is used to put the aircraft back into Auto if another flight mode was being used.

> **Applications:** flying your mission (surveys, waypoints, loiter, etc.), autonomous takeoff and landing.

Forward Flight Modes

Guided (Forward Flight Mode)

The Guided mode is used when you want the aircraft to fly to a specific point on the map without setting up a mission. Swift GCS supports a “point and click” feature where you can click a point on the map and the aircraft will fly to that location and circle. The aircraft will circle at this spot until one of the following occurs: the Guided location is moved, the flight mode is changed, or a failsafe is triggered.

To enter Guided, select the `Guided` button in Swift GCS. Click the map where you wish to fly. The GCS will prompt you to confirm the altitude and direction of rotation (CW or CCW). The Guided location on the map is moved by dragging the point on the map. Once in place, the altitude and direction can be adjusted by clicking on the `Guided` button.

> **Applications:** allows the GCS operator to intervene with a point and click interface, avoiding other air traffic, climb/descend at a specific location, holding pattern.

Rally (Forward Flight Mode)

The aircraft will automatically change modes to Rally if a failsafe activates, if you command Rally, or if a mission is completed without a landing planned. Once in Rally, the aircraft will fly to the nearest Rally point, within 5 kilometers, and circle there until commanded to perform some other action. If no Rally point is within 5 kilometers of the current aircraft position, the aircraft will fly "home" and circle at 100 meters. Home is where the aircraft was armed.

To manually enter Rally, select the `Rally` button in Swift GCS. The Rally point locations are chosen when you plan your mission.

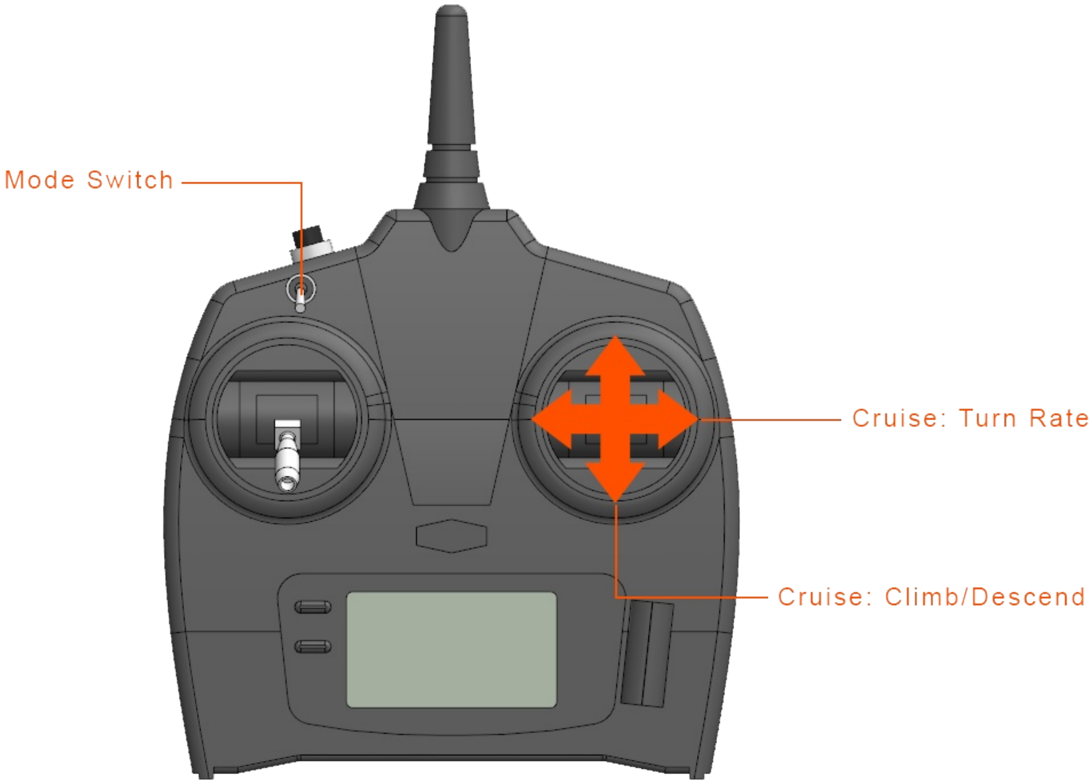
> **Applications:** failsafes, returning to a pre-planned location.

Cruise (Forward Flight Mode)

Cruise is a stabilized mode that allows the safety pilot to fly the aircraft in a gentle manner. The autopilot interprets the safety pilot's stick movements and translates them into a bank angle and climb rate which are both limited by the autopilot's parameters. For example, if you move the right stick on the RC controller all the way to the left, the aircraft will roll left to its limit of 45 degrees, and hold that bank angle. If you move the stick halfway, the aircraft will roll halfway to its limit, and so on. Moving the right stick forward/backward controls the rate of climb or descent and feels gentler compared to roll. The left stick is not used, and the aircraft will fly its normal airspeed regardless of stick position.

It is not possible to roll the aircraft past the roll limit, and it is not possible to pitch the aircraft beyond the pitch limit. Cruise is highly recommended over Manaul if the safety pilot needs to intervene during forward flight.

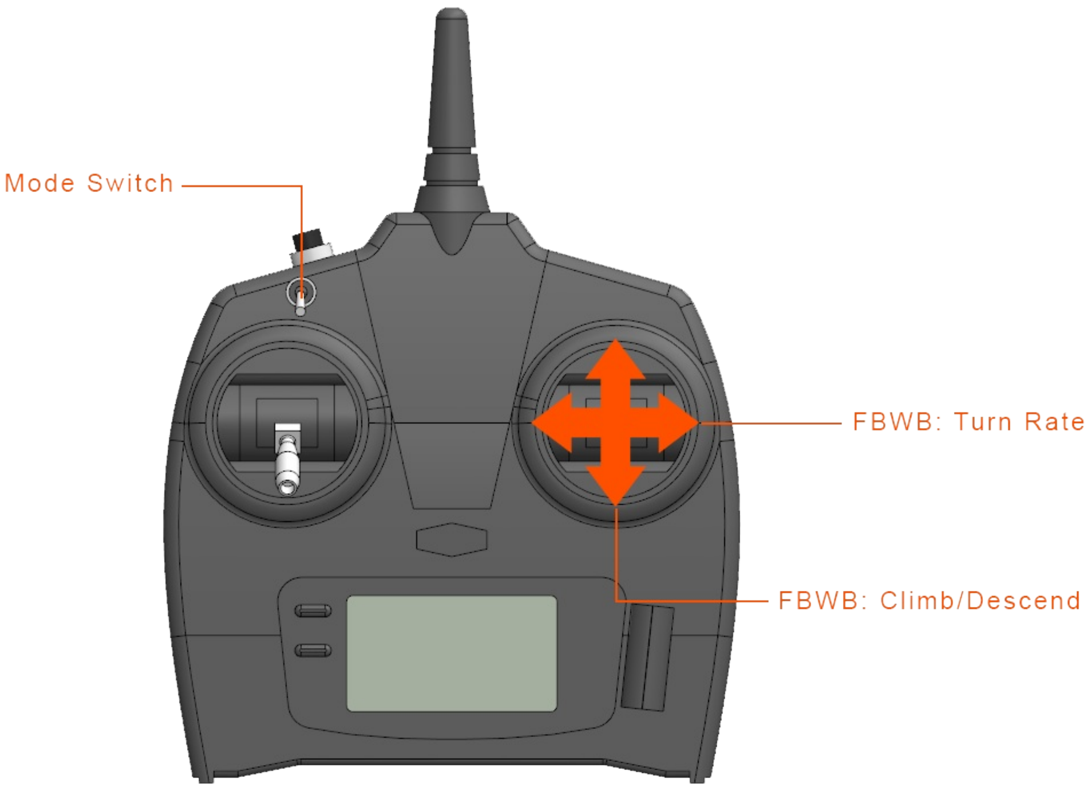
If the safety pilot has not touched the sticks within the last half second, the aircraft will roll level, hold its current altitude, and maintain its current ground course. The aircraft will crab to compensate for any crosswind, allowing the safety pilot to point the aircraft at a distant object and accurately track to that object. As such, Cruise requires GPS to maintain ground course.



Applications: allows the safety pilot to intervene within a defined flight envelope, flying a non-Auto landing pattern.

Fly-by-Wire "B" (Forward Flight Mode)

Fly-by-Wire B (FBWB) is another stabilized mode that allows the safety pilot to fly the aircraft in a gentle manner. FBWB is very similar to Cruise, except that it does not track ground course. The aircraft will fly level, but its course my drift depending on the wind. FBWB does not require GPS like Cruise does.

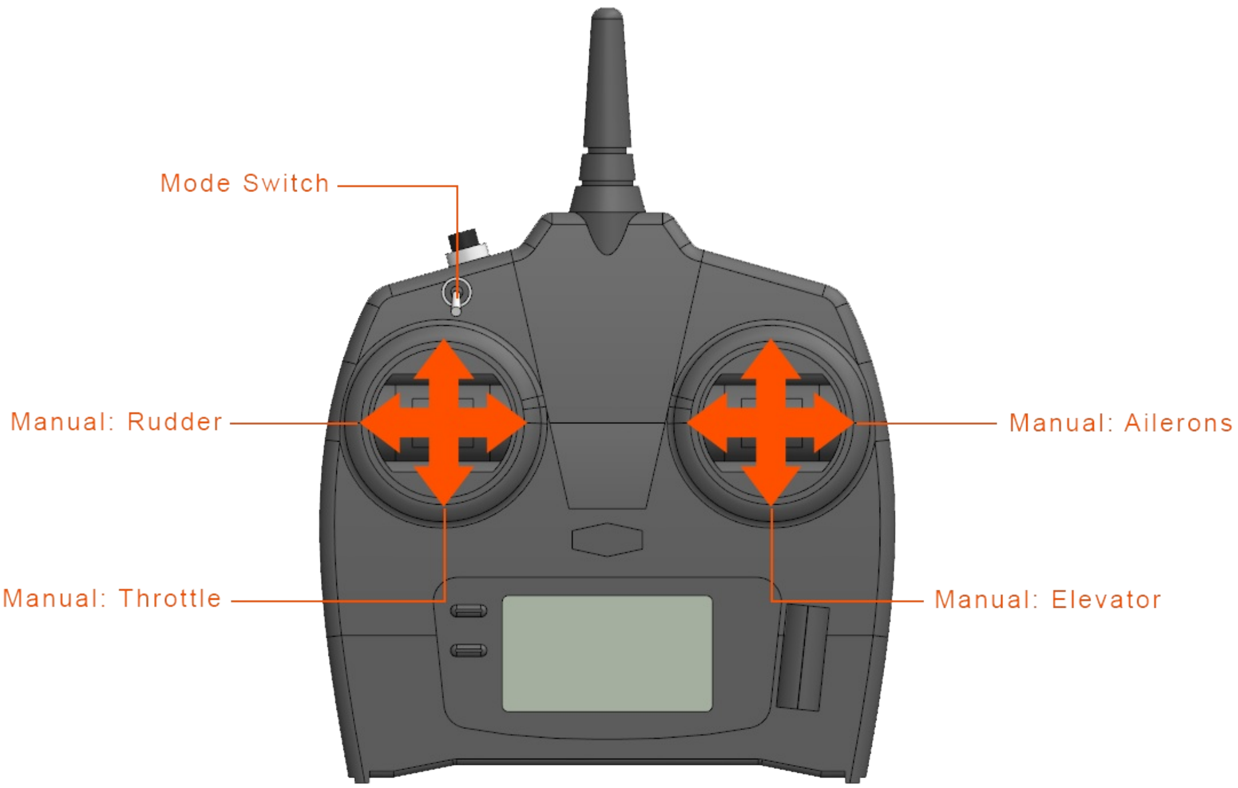


Applications: allows the safety pilot to intervene within a defined flight envelope, flying without GPS, flying a non-Auto landing pattern.

Caution: Although Cruise and FBWB are stabilized modes, neither will not stop you from flying the aircraft into the ground. Always be aware of your surroundings.

Manual (Forward Flight Mode)

The Manual flight mode gives the safety pilot full manual control of the aircraft. This bypasses all forms of autopilot stabilization. In this mode, the safety pilot is completely responsible for flying like an RC airplane. This gives the safety pilot the most control for an emergency scenario, allowing rapid alteration of the flight path, but requires expert skill. In Manual, the aircraft will feel extremely agile be very sensitive to your stick inputs. Do not use this mode if you are unprepared to fly the aircraft with zero autopilot stabilization. In most cases, Cruise or Fly-by-Wire is a better alternative if the safety pilot needs to intervene during forward flight.



Applications: allows the safety pilot to fly with complete authority in forward flight.

Warning: The safety pilot assumes all responsibility for the aircraft when flying in Manual, and must be aware that they can get the aircraft into a state in which the autopilot cannot recover from.

Forward Flight Mode Comparison

Forward Modes	Auto	Rally	Guided	Cruise	FBWB	Manual
Interface	GCS	GCS	GCS	Controller	Controller	Controller
Link	Telem	Telem	Telem	RC	RC	RC
Controlled by	Mission	Rally Point	Guided Point	Sticks	Sticks	Sticks
Autonomous	x	x	x			
Stabilized Pilot Inputs				x	x	
GPS Required	x	x	x	x		
Ground Track	x	x	x	x		

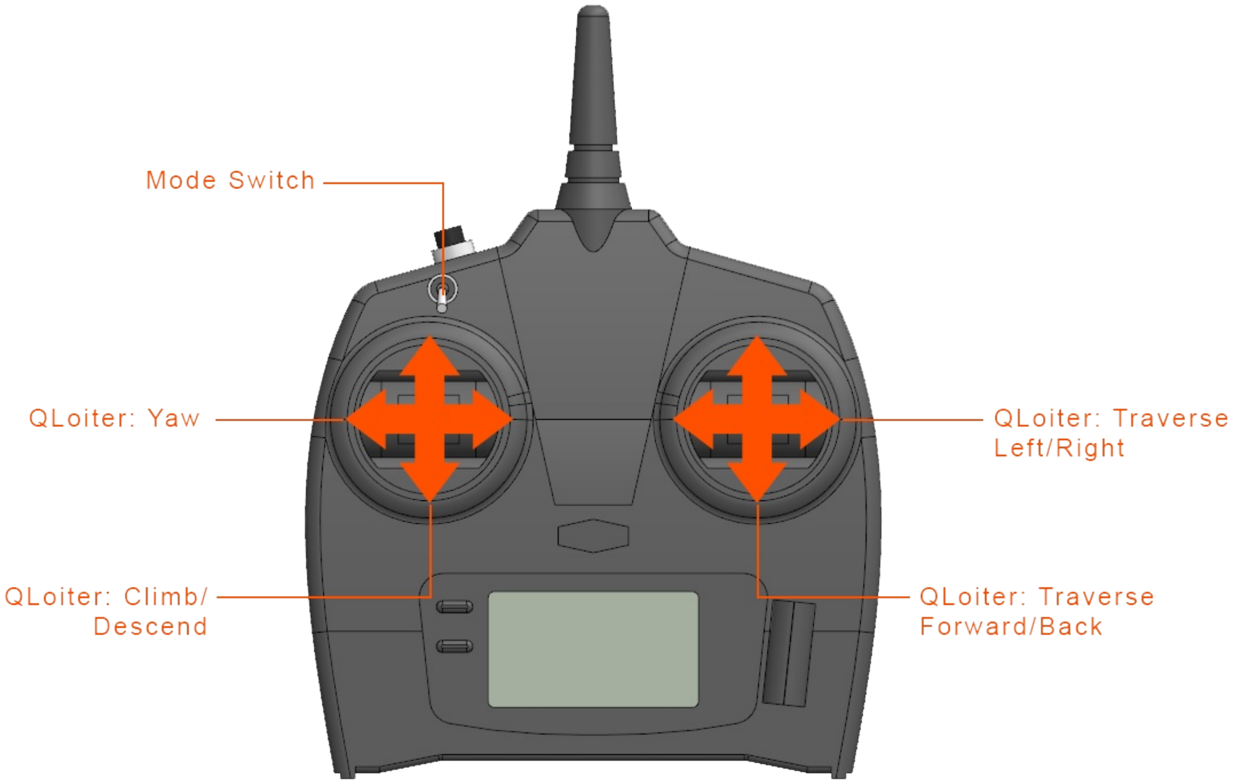
Vertical Flight Modes

Caution: Lynx VTOL has a limited battery capacity for vertical flight. Do not stay in vertical modes just to hover, use them only for takeoff or landing purposes.

QLoiter (Vertical Flight Mode)

QLoiter is a stabilized mode that allows the safety pilot to hover the aircraft in a gentle manner. In QLoiter, the aircraft will hold position and altitude with sticks centered. As such, it requires GPS. You can climb and descend vertically by moving the left stick up or down from the middle position. Rolling and pitching the aircraft with the right stick will cause the aircraft to traverse left/right and forwards/backwards respectively. Yaw is controlled by sideways movement of the left stick. It is not possible to roll the aircraft past the roll limit, and it is not possible to pitch the aircraft beyond the pitch limit. Weathervaning and forward assist are enabled in QLoiter.

If the aircraft is in forward flight when this mode is entered, it will transition to a hover.



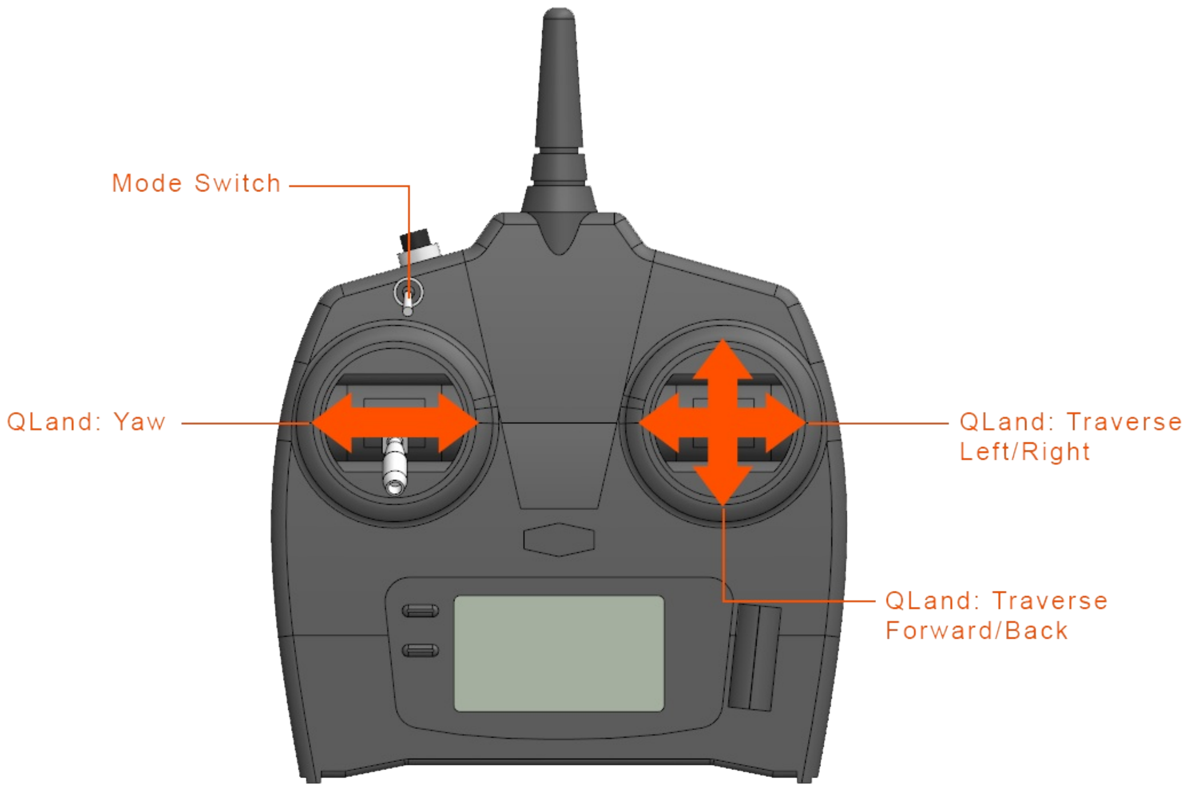
Applications: allows the safety pilot to intervene within a defined flight envelope if you have GPS, flying a non-Auto takeoff/landing.

QLand (Vertical Flight Mode)

QLand is an autonomous flight mode in which the aircraft will use the VTOL motors to descend straight down from its current position in the sky. As such, it requires GPS. The descent speed is the same as an autonomous landing. Stick nudging is enabled for QLand, whereby the safety pilot can adjust the position of the aircraft as it descends, but can not slow or stop the descent. The aircraft will continue to descend towards the ground and disarm once it has landed.

If the aircraft is in forward flight when this mode is entered, it will transition to a hover and descend.

You can enter QLand by selecting `Emergency Land` from the `Land` button within the GCS.

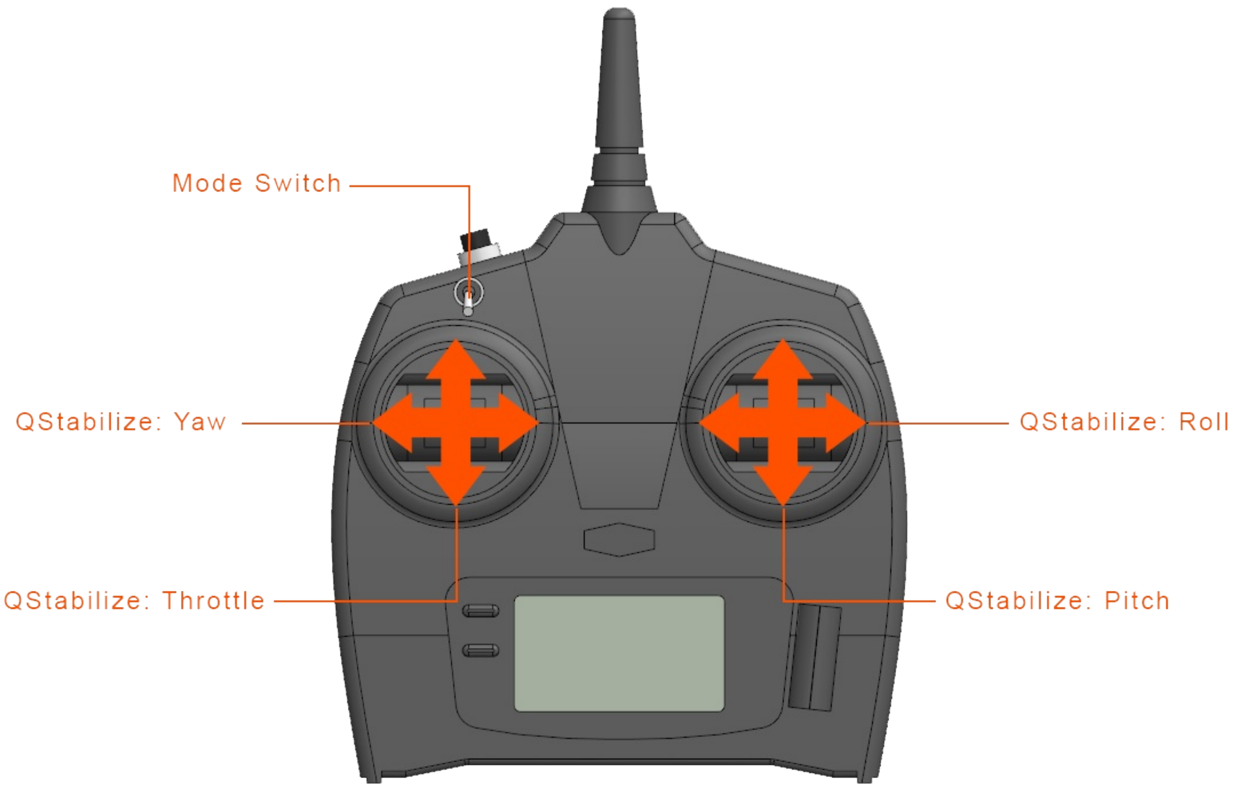


Applications: emergency landing.

QStabilize (Vertical Flight Mode)

QStabilize is a stabilized mode that allows the safety pilot to hover the aircraft in a more aggresive manner than QLoiter. QLoiter does not hold position or altitude. As such, it does not require GPS. It is not possible to roll the aircraft past the roll limit, and it is not possible to pitch the aircraft beyond the pitch limit. QLoiter is recommended over QStabilize if the safety pilot needs to intervene during vertical flight or manually transition from forward flight.

If the aircraft is in forward flight when this mode is entered, it will transition to a hover.



Applications: allows the safety pilot to intervene within a defined flight envelope if you lack GPS.

Vertical Flight Mode Comparison

Vertical Modes	Auto	QLand	QLoiter	QStabilize
Interface	GCS	Controller	Controller	Controller
Link	Telem	RC	RC	RC
Controlled by	Mission	Sticks	Sticks	Sticks
Autonomous	x	x		
GPS Required	x	x	x	
Stick Nudging		x		
Weathervaning	x	x	x	
Forward Assist	x	x	x	

Weathervaning and Forward Assist

With the exception of QStabilize, anytime the aircraft is in a vertical flight mode it will attempt to weathervane into the wind to reduce motor workload and increase wing lift.

Weathervaning will try to point the nose of the aircraft into the wind, but you should always point the aircraft into the wind prior to takeoff to increase performance.

The aircraft will also use the main motor, when 2 meters above the ground, to help maintain its position in higher winds. This is called forward assist and reduces the load on the vertical motors.

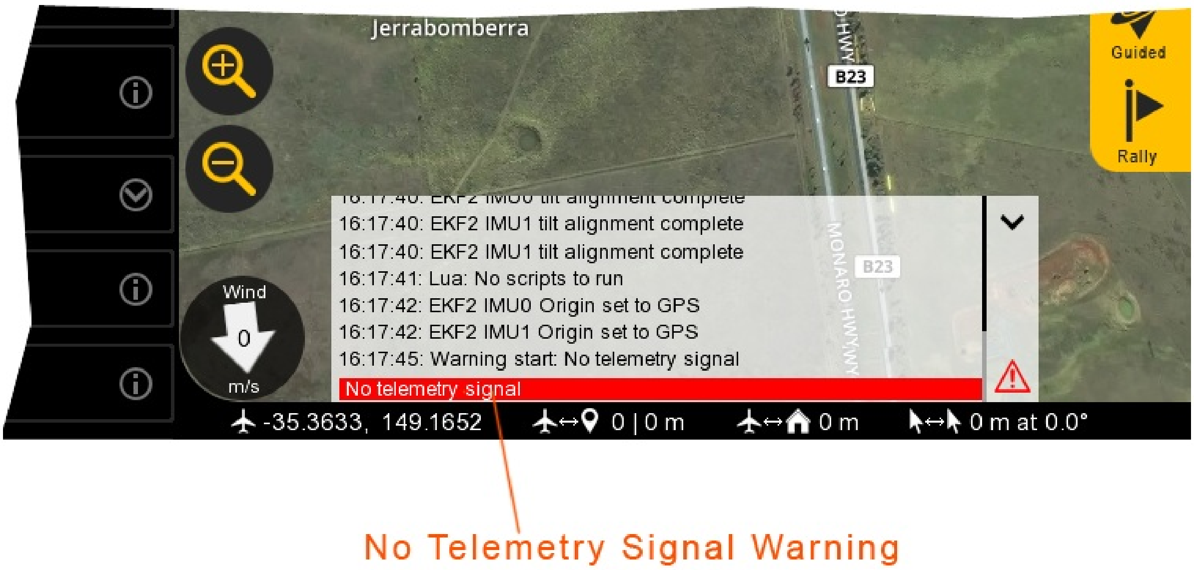
Data Links

The standard Lynx VTOL uses two radio links:

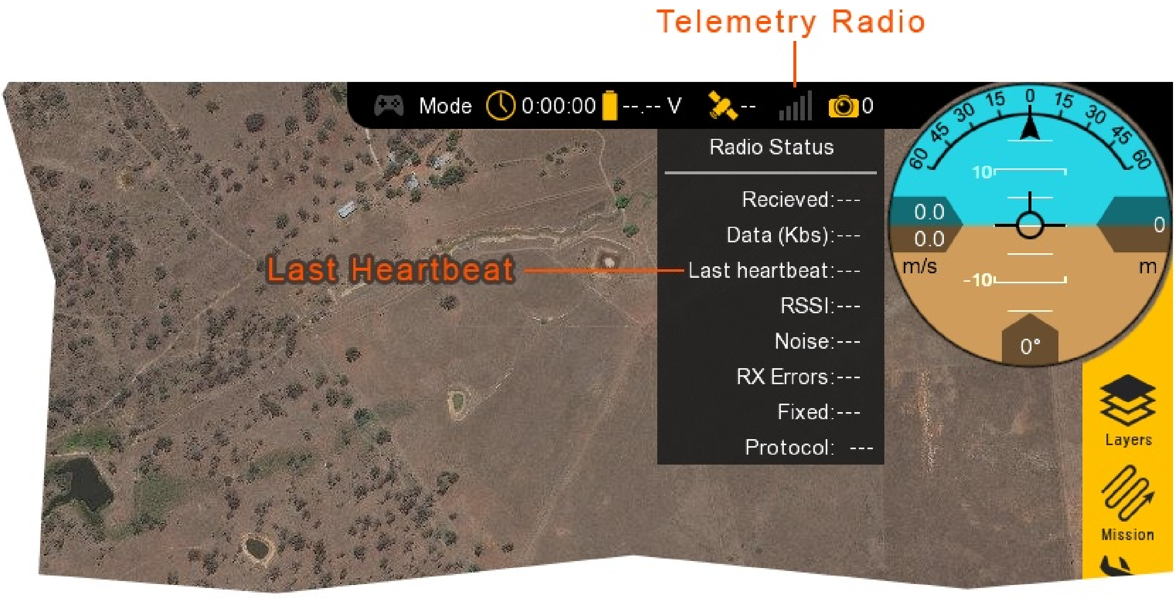
1. Telemetry, the uplink and downlink between the GCS and the aircraft through the telemetry radio.
2. RC, the uplink between the RC controller and aircraft.

Telemetry

You may occasionally lose the connection between Swift GCS and your aircraft while flying. If there is a loss in uplink or downlink communication, you will continue flying your mission and either regain link as the aircraft flies closer or trigger the telemetry failsafe. Your mission should be planned such that the aircraft regains link before the failsafe activates. The default failsafe timeout for the telemetry radio is 15 seconds. This means that 15 seconds after you lose link, the aircraft will change flight modes to Rally and fly to the nearest Rally point. The location of a rally point(s) should be close enough to where the ground telemetry radio is to ensure that your connection can be reestablished.



After one second of no telemetry link with the aircraft, the GCS will display a “No telemetry signal” warning in the message panel. If the failsafe timeout occurs, the GCS may additionally show the “Failsafe active” warning. You can determine how long you have been without link by noting the timestamp above the warning, next to “Warning start: No telemetry signal.”



If you lose link the telemetry link, the aircraft's position, HUD, and other flight information will stop updating. The flight timer and time since last radio heartbeat continue counting. When you regain link, everything will unfreeze and update to the aircraft's current position. The aircraft trail will draw a straight line from where you lost link to where you regained link.

Radio range can be affected by many external factors such as antenna height, antenna position, terrain, obstacles, and/or radio interference. A loose connection between the radio and antennas or the radio and computer (USB) will also negatively affect the link quality between you and the aircraft.

Use the following tips to improve the reliability of your connection in the field:

- Place the ground telemetry radio as high as possible (for example, on top of a car).
- Ensure that the antennas are spaced 90 degrees from each other and that one antenna is vertical.
- Ensure that your body (or other crew members) is not between the radio and the position of the aircraft in the sky.
- Avoid planning missions that exceed that exceed its range, typically 2 kilometers

Do not fly if you see a "High telemetry radio noise" warning during the preflight. This indicates that there may be a local source of radio interference that will greatly decrease range. Note, the absence of this warning during preflight does not mean that radio interference is not possible.

RC

You may occasionally lose the connection between the RC controller and your aircraft while flying. The lost link behavior for RC is identical to loss of telemetry. The aircraft will continue its mission until regaining link or change modes to Rally after the failsafe timeout. The default failsafe timeout for RC is 15 seconds.

After one second of no RC link with the aircraft, the GCS will display a "No RC input" warning in the message panel. If the failsafe timeout occurs, the GCS will additionally show the "Failsafe active" warning.

Use the following tips to improve the range of your connection in the field:

- Hold the RC controller such that it faces the aircraft.
- Ensure that your body (or other crew members) is not between the radio and the position of the aircraft in the sky.
- Disable any unneeded 2.4 GHz communication devices (or turn on airplane mode).

Failsafe Timeouts

The duration of the failsafe timeout for both telemetry and RC can be reconfigured in Swift GCS under the `Settings` tab ⇨ `Failsafe`. The longer the failsafe, the longer the aircraft will continue flying its mission before changing modes to Rally (unless link is regained first). Be aware that if you lose link with a long failsafe, you may be "in the dark" or unaware of what the aircraft is doing for a longer duration.

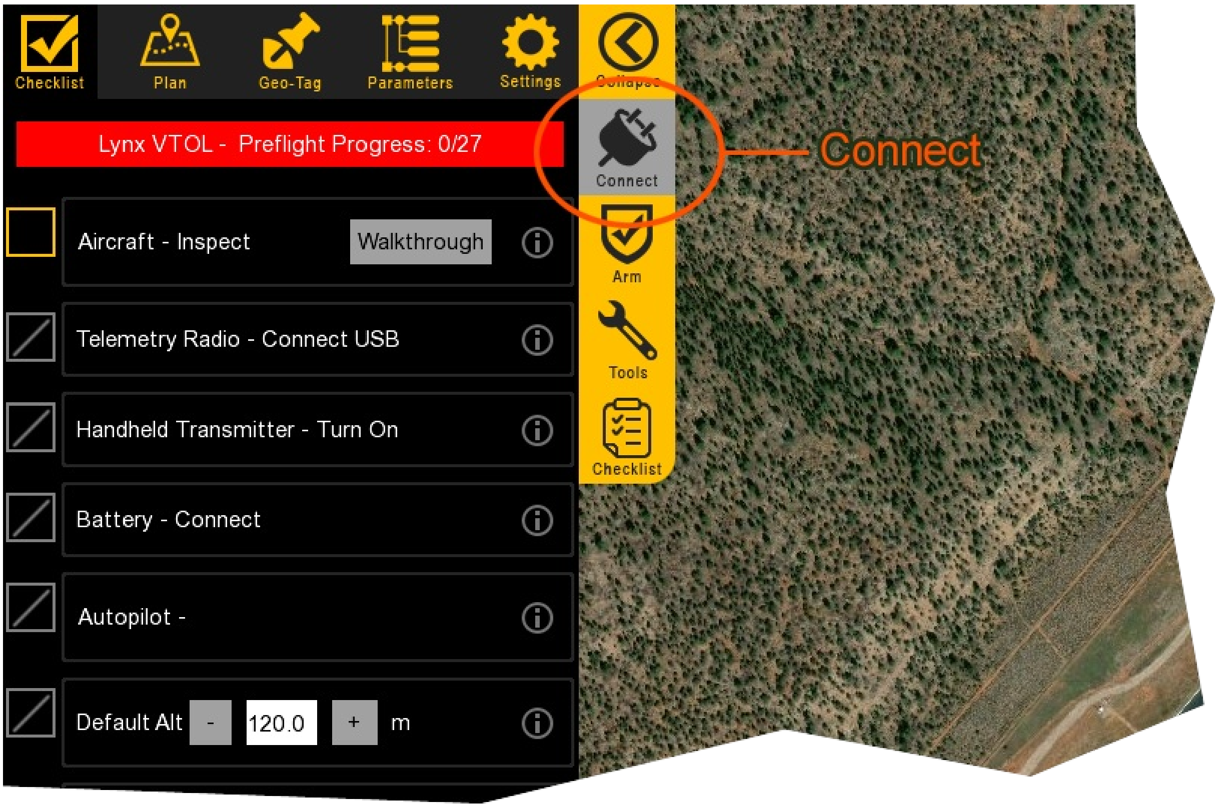
The RC failsafe can be disabled altogether if you are not using (turned-off) the RC controller. DO NOT disable the RC failsafe if you are using the RC controller.

> **Warning:** Disabling the RC failsafe when the RC controller is being used may result in a fly-away.

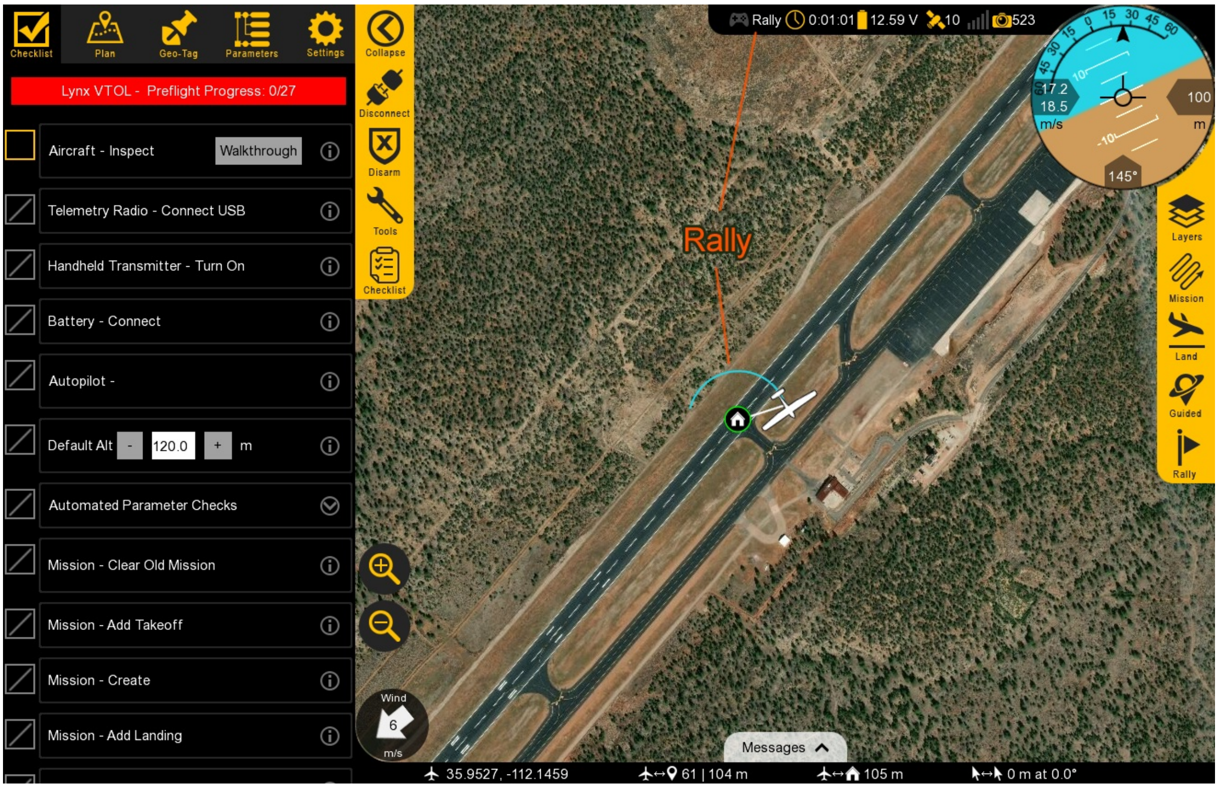
Reconnecting in Flight

The following procedure outlines how to reconnect to an aircraft already in flight following a GCS crash or computer issue.

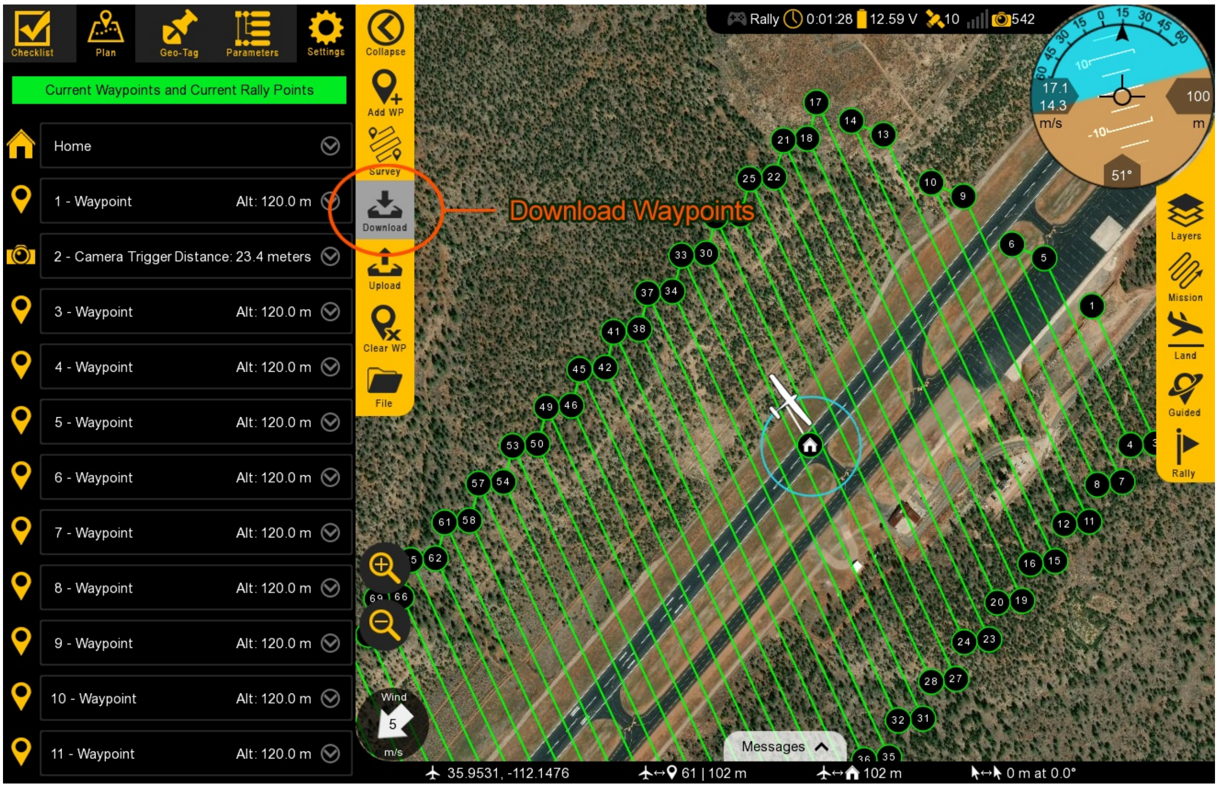
1. Reboot your computer and/or restart Swift GCS
2. Go to `Checklist Tab` ⇨ `Connect` ⇨ `Auto Detect` to reconnect to the aircraft



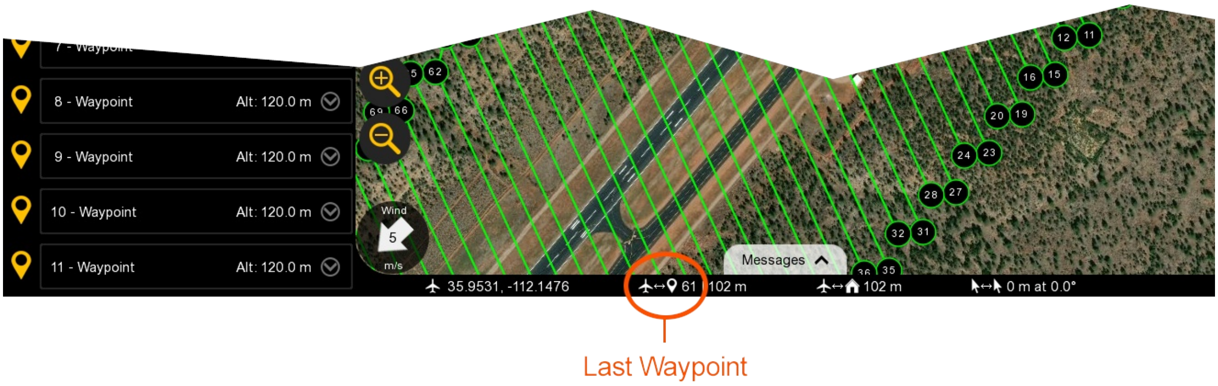
3. Assuming you have tripped your telemetry failsafe timeout, the aircraft will be circling a nearby Rally point



4. Go to `Plan Tab` ⇨ `Download` to visualize your waypoints.



5. Note the last waypoint the aircraft was going to prior to Rallying



6. Repeat the last flight leg to ensure adequate image overlap. To do so, expand the list of waypoints under `Mission` and select the waypoint preceding the waypoint mentioned in step 5.

Failsafes

The aircraft has several automatic failsafes which can trigger in flight. There are several actions that can be taken on a failsafe such as: change the flight mode to rally, jump to the planned landing in the mission, and emergency land in place.

> **Warning:** If a failsafe is active and the operator changes flight modes or target waypoint, they will override the failsafe action. This can be used to change what the vehicle is doing, but can result in cancelling a battery failsafe for example, which can lead to the loss of the aircraft.

Low battery

The main battery has been below 18.0V for 10 seconds. The aircraft will automatically fly the preplanned landing.

> **Caution:** Failure to include a landing in the planned mission will cause the aircraft to change mode to rally and not land, which can result in damage to the batteries.

Critical battery

The main battery has been below 15.0V for 10 seconds. The aircraft will automatically perform an emergency landing in place (QLand).

> **Caution:** The aircraft should always be landed before 16.2V as described in the system limits. Flying to the critical battery failsafe is not intended for normal use. It is intended to provide a last chance recovery, and the battery may have been damaged before this activates.

GCS (telemetry radio)

This is activated by a loss of communication between the GCS and aircraft (telemetry radio) for more than 15 seconds. The aircraft will automatically change modes to rallly.

> **Warning:** Operating the aircraft with the GCS failsafe disabled is unsafe as it can result in loss of control of the aircraft.

RC controller

This is activated by a loss of communication between the RC controller and aircraft for more than 15 seconds. The aircraft will automatically change modes to rally.

> **Warning:** Disabling the RC failsafe when the RC controller is being used may result in a fly-away.

Circular geofence

If the aircraft flies too far away from home then the circular fence will be triggered. The map will be shaded red for any region that would be considered to be too far away. The aircraft will repeatedly switch to Rally until the aircraft is back within the geofence. The radius can be changed in the `Settings` ⇨ `Failsafe`.

High altitude geofence

If the aircraft flies to high above home then the high altitude fence will be triggered. The aircraft will repeatedly switch to Rally until the aircraft is back within the geofence. The altitude can be changed in the `Settings` ⇨ `Failsafe`.

High wind during takeoff

This is activated by high winds, greater than 12 m/s, during takeoff. This indicates the aircraft is experiencing excessive winds and it is unsafe to continue flight. The aircraft will automatically perform an emergency landing in place (QLand), and the messages dialog will show “Failed to complete takeoff, excessive wind".

> **Caution:** Emergency land will land vertically wherever the aircraft currently is, this may not be the same as where the aircraft took off from.

Takeoff took too long

If the takeoff takes more than 45 seconds, the aircraft may consume too much VTOL battery capacity to safely continue the mission. It may have enough to finish the takeoff, but may not have enough remaining capacity to land. The aircraft will automatically perform an emergency landing in place (QLand), and the messages dialog will show “Failed to complete takeoff within time limit”

> **Caution:** Emergency land will land vertically wherever the aircraft currently is, this may not be the same as where the aircraft took off from.

Transition to forward flight failed

If the transition to forward flight takes more than 11 seconds the aircraft is not performing correctly. There may be a problem with the main motor or propeller. The aircraft will automatically perform an emergency landing in place (QLand), and the messages dialog will show “Transition failed, exceeded time limit"

> **Caution:** Emergency land will land vertically wherever the aircraft currently is, this may not be the same as where the aircraft took off from.

Low airspeed

The aircraft has experienced unusually low airspeed while in forward flight and is at risk of stalling. The aircraft automatically beings a transition to forward flight again, the VTOL motors will turn, the forward motor will go full throttle and the aircraft will maintain a level attitude till the transition is complete. If this transition takes to long the transition failsafe can activate.

Caution: If this failsafe activates repeatedly something is wrong with the forward propulsion. The aircraft should be brought back to the preplanned landing as this failsafe rapidly consumes the VTOL battery.

Swift GCS Warnings

Warning	Cause	Solution
Bad accelerometer health	Indicates that one or more of the accelerometers are unhealthy.	The operator should immediately begin the preplanned landing sequence.
Bad attitude reference (AHRS) health	Indicates an unhealthy estimation of the system's attitude. This is normal during the first part of the preflight and should resolve before takeoff.	The operator should intiate an emergency landing if this persists for more than 5 seconds.
Low battery	An aircraft is low, and the aircraft needs to be landed before it is exhausted.	If the main battery is low then the aircraft will automatically jump to the preplanned landing in the mission. If the VTOL battery is low then the aircraft will change modes to QLand, and land in place.
Bad airspeed health	The aircraft is unable to read the airspeed sensor.	The operator should immediately begin the preplanned landing sequence if this persists for more than 5 seconds. The aircraft may stall without an airspeed sensor and the operator should be ready to activate an Emergency Landing if this happens
Bad GPS Health	The aircraft has lost GPS fix, has insufficent GPS fix, or the GPS is reporting an error.	If this persists for more then five seconds the operator should land the vehicle using a combination of FBWB and QStabilize flight modes. QLand, QLoiter, and normal planned landings cannot be safely performed without GPS.
Bad gyroscope health	Indicates that one or more of the gyroscopes are unhealthy.	The operator should initiate an emergency landing
Logging Error	The autopilot is unable to log to its SD card.	If on the ground, first try restarting the aircraft. If the problem persists, power down the aircraft and reformat the SD card. If this happens during flight, you may safely continue flying, but no autopilot data for post-processing or logs for analysis will be available. If this data is needed, land as soon as practical
Bad magnetometer health	Indicates that one or more of the magnetometers are unhealthy.	The operator should immediately begin the preplanned landing sequence.
Bad barometer health	Indicates that one or more of the barometers are unhealthy.	The operator should immediately begin the preplanned landing sequence.
No RC input	Indicates that the aircraft is not receiving signal from the RC controller.	Use the GCS to bring the aircraft back within range if RC signal is required for flight. If the aircraft does not regain link within 15 seconds (by default) it will change flight modes to Rally
Failsafe active	Indicates that an automated failsafe, such as loss of RC, loss of GCS telemetry, or low battery is active.	Consult the list of failsafes to determine an appropriate action. Except for loss of GCS telemetry this will always be accompanied by another warning.
EKF: Compass variance	The main AHRS algorithm is rejecting compass data.	The operator should intiate an emergency landing if this persists for more than 15 seconds.
EKF: Position horizontal variance	The main AHRS algorithm is rejecting horizontal GPS data.	The operator should intiate an emergency landing if this persists for more than 15 seconds.
EKF: Position vertical variance	The main AHRS algorithm is rejecting vertical GPS data.	The operator should intiate an emergency landing if this persists for more than 15 seconds.

EKF: Velocity varaince	The main AHRS algorithm is rejecting GPS velocity data.	The operator should intiate an emergency landing if this persists for more than 15 seconds.
Excessive X vibration	The aircraft is suffering from an excessive amount of vibration. This could be from damage to the main motor or VTOL system.	The operator should initiate an emergency landing if this persists for more than 5 seconds.
Excessive Y vibration	The aircraft is suffering from an excessive amount of vibration. This could be from damage to the main motor or VTOL system.	The operator should initiate an emergency landing if this persists for more than 5 seconds.
Excessive Z vibration	The aircraft is suffering from an excessive amount of vibration. This could be from damage to the main motor or VTOL system.	The operator should initiate an emergency landing if this persists for more than 5 seconds.
High wind	The aircraft has detected that it has exceeded it's wind limit.	The operator should immediately begin the preplanned landing sequence.
No telemetry signal	The GCS has not recieved any data from the aircraft in the last second.	The aircraft will switch to flight mode Rally automatically after 15 seconds (by default) of not recieving data from the GCS and fly to the nearest rally point. See the failsafes section for more details.
High telemetry radio noise	The telemetry radio link to the aircraft is experiencing an excessive level of RF noise.	Do not takeoff with this warning active. If in flight move to improve the radio link and try and reduce noise, or begin the preplanned landing sequence.
High autopilot temperature	The autopilot is excessively warm.	If on the ground power off the system and let it cool before restarting the preflight. Avoid direct sunlight on the avionics while preflighting in warm ambient conditions. If in flight then begin the planned landing sequence if the warning does not clear within a minute.
Autopilot error	The autopilot has encountered an unexpected internal condition.	If in flight land immediately. Contact support and provide the log files from the flight so that this may be rectified for the future. The aircraft may be rebooted and flown again to clear the error.

Arming Errors

Error	Cause	Solution
PreArm: No SD card	The autopilot SD card is not installed.	Install the autopilot SD card and reboot.
Logging failed	The autopilot cannot write to the SD card.	Shut the aircraft off, remove the SD card and repair file system errors. If the error persists reformat (FAT32) the SD card.
PreArm: Gyros not Calibrated	The gyroscopes on the autopilot are not calibrated.	On the Checklist tab, select Tools and choose Gyroscope Calibration.
PreArm: 3D Accel calibration needed	The accelerometers need to be calibrated.	On the Settings tab select Accelerometer Calibration.
PreArm: Accels inconsistent	The accelerometers are not providing consistent readings.	If the autopilot has reached a temperature above 55C (click on the GPS icon in the top status bar to see the temperature) an accelerometer calibration is required. If the temperature is less than 55C, wait until the temperature has been above 55C for at least 10 seconds before attempting to arm again.
PreArm: GPS 1 failing configuration checks	The autopilot has been unable to fully configure the GPS. Further failure messages indicating the error will be	The aircraft will send an additional message explaining what is wrong with the GPS. This will usually be related to the GPS SD card.

checks	displayed following this.	
PreArm: Missing mission item: vtol land	A landing must have been planned before arming the aircraft.	Plan a landing in the mission tab and upload to the aircraft.
PreArm: Missing mission item: do land start	A DO_LAND_START must have been planned in the mission for failsafes to function.	If using Swift GCS simply plan a new landing point, with other GCS's insert a DO_LAND_START before the landing item.
PreArm: Missing mission item: vtol takeoff	A takeoff must have been planned before arming the aircraft.	Plan a takeoff in the mission tab and upload to the aircraft.
PreArm: No sufficently close rally point located	A rally point must be planned within 5 kilometers of the aircrafts position for failsafes to function.	Plan a rally point in the mission tab and upload to the aircraft.
PreArm: Internal errors	The autopilot has encountered an unexpected internal error.	Contact support and provide the log files. The aircraft must be restarted to clear this error.
PreArm: Battery 1 below minimum arming voltage	The main battery is below the required voltage to arm the aircraft.	Swap the main battery for a fresh battery.
PreArm: Battery 2 below minimum arming voltage	The VTOL battery is below the required voltage to arm the aircraft.	Swap the VTOL battery for a fresh battery.
PreArm: Battery 3 below minimum arming voltage	The main battery is below the required voltage to arm the aircraft.	Swap the main battery for a fresh battery.
PreArm: Battery 4 below minimum arming voltage	The servo regulator is below the required voltage to arm the aircraft.	Contact support, and do not attempt to fly the aircraft

Landing

Landing area - Clear

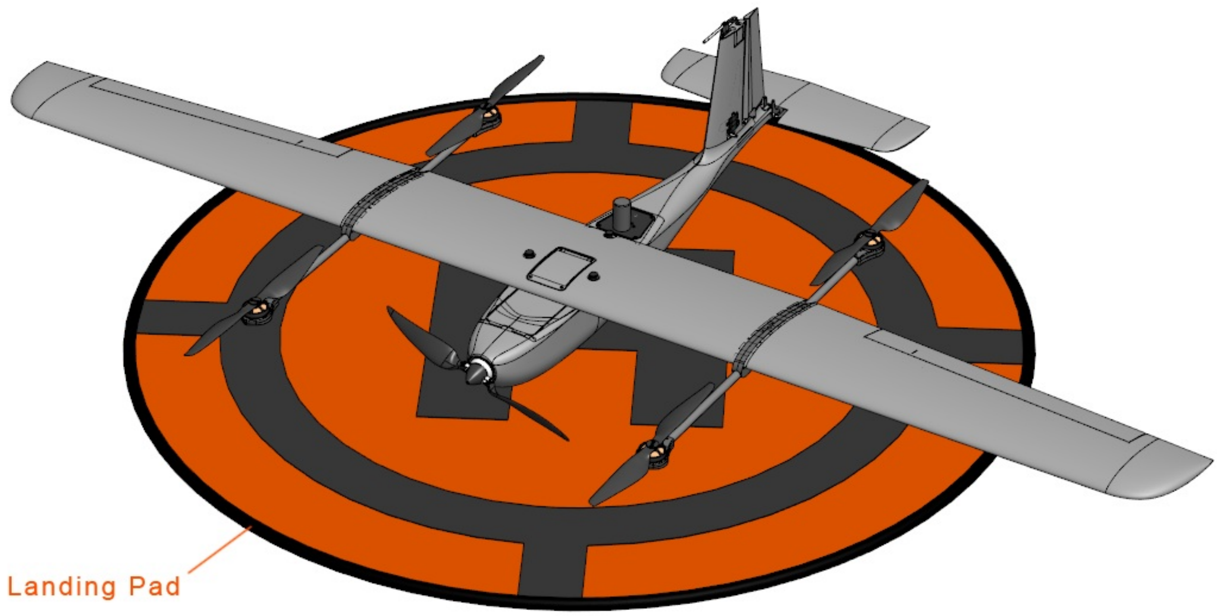
The landing area must be clear of obstacles and bystanders, including obstacles that are tall enough to interfere with the transition altitude, 30 m by default. Also ensure that everyone participating in the flight is aware that the aircraft will be approaching to land.

Landing - Start

Select the `Land` button ⇨ `Start landing sequence` from the Flight Modes section in Swift GCS.

The aircraft will now fly the landing pattern as described within the landing section of the preflight.

> Typical landing accuracy is a 2 meter radius. All factors negatively affecting GPS reception can reduce your landing accuracy. Flying in gusty wind conditions may also degrade accuracy



> Tip: The thrust generated by the VTOL propellers on takeoff and landing can kick-up dust and loose debris. Use a landing pad or similar to reduce the amount of dust when flying from dusty environments.

Once on the ground, the aircraft will continue to spin the motors at idle for a few seconds and then automatically disarm and disable the flight control surfaces.

If you change the flight mode to manual with the RC controller (or some other flight mode) after landing, but before the aircraft automatically disarms, then you will need manually disarm the aircraft from the GCS. The Disarm button is located on the Checklist Tab. Ensure that the GCS indicates that the vehicle is disarmed, and the aircrafts status LED is blinking before approaching the aircraft.

Your landing location should be located on flat ground. An angled landing surface can interfere will the aircraft's ability to sense when a landing is complete and may result in a roll-over. If, for any reason, the VTOL propellers do not stop spinning after the normal disarm time, you may change the flight mode to manual with the RC controller. Doing so will stop the motors from spinning, but you will have to disarm the aircraft from the GCS.

Landing - Complete?

Wait for the aircraft to complete the planned landing sequence.

Aircraft - Disarm

The aircraft will automatically disarm once the aircraft has landed, or you can manually disarm it.

Do not disarm the aircraft while flying. This will result in a crash.

Mode - Manual

Move the mode switch on the RC controller to manual.

Wing - Remove

Unscrew the wing thumbscrews to remove the wing from the fuselage.

Payload - Shutdown

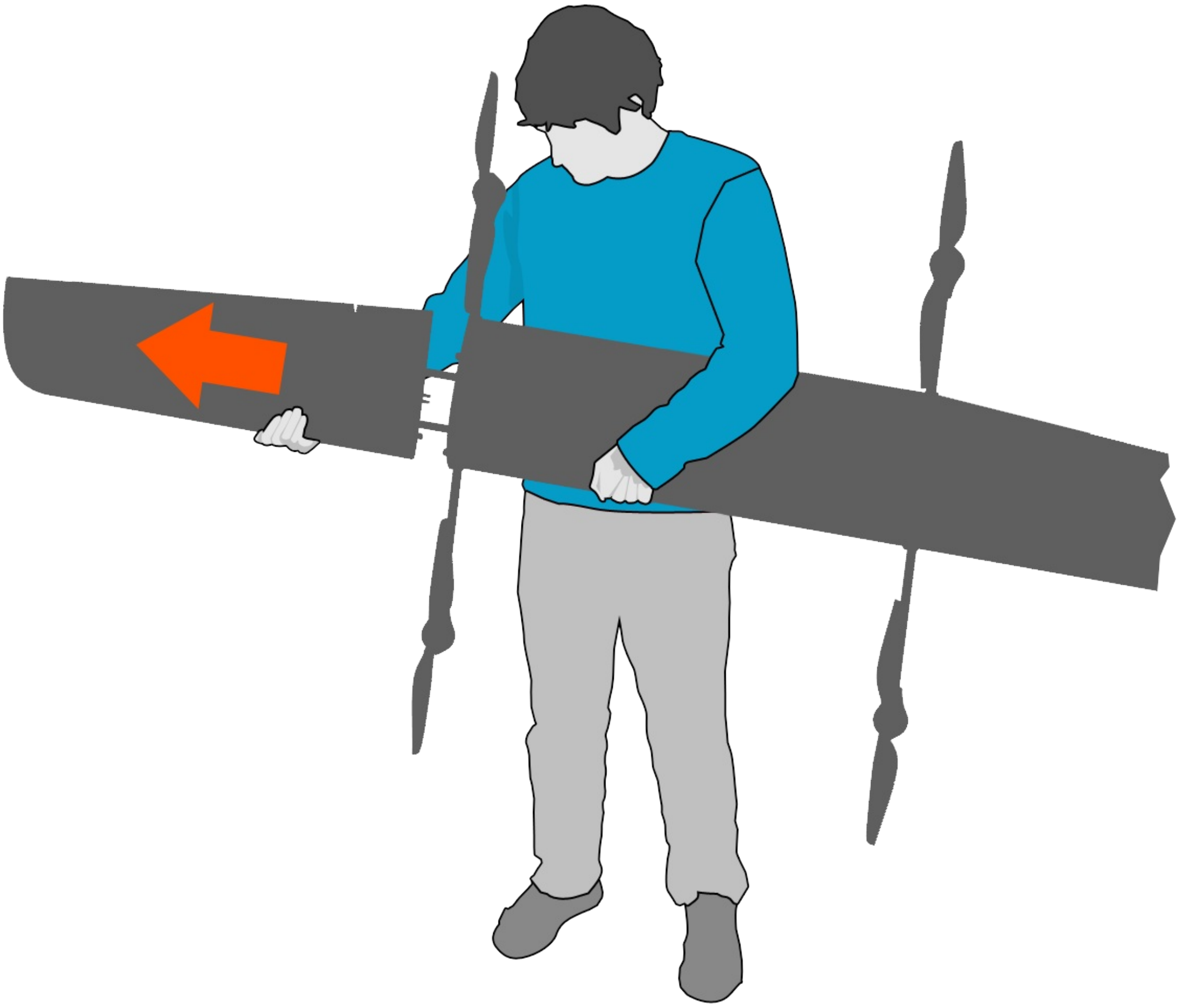
Perform any final steps with the payload as needed.

Aircraft - Shutdown

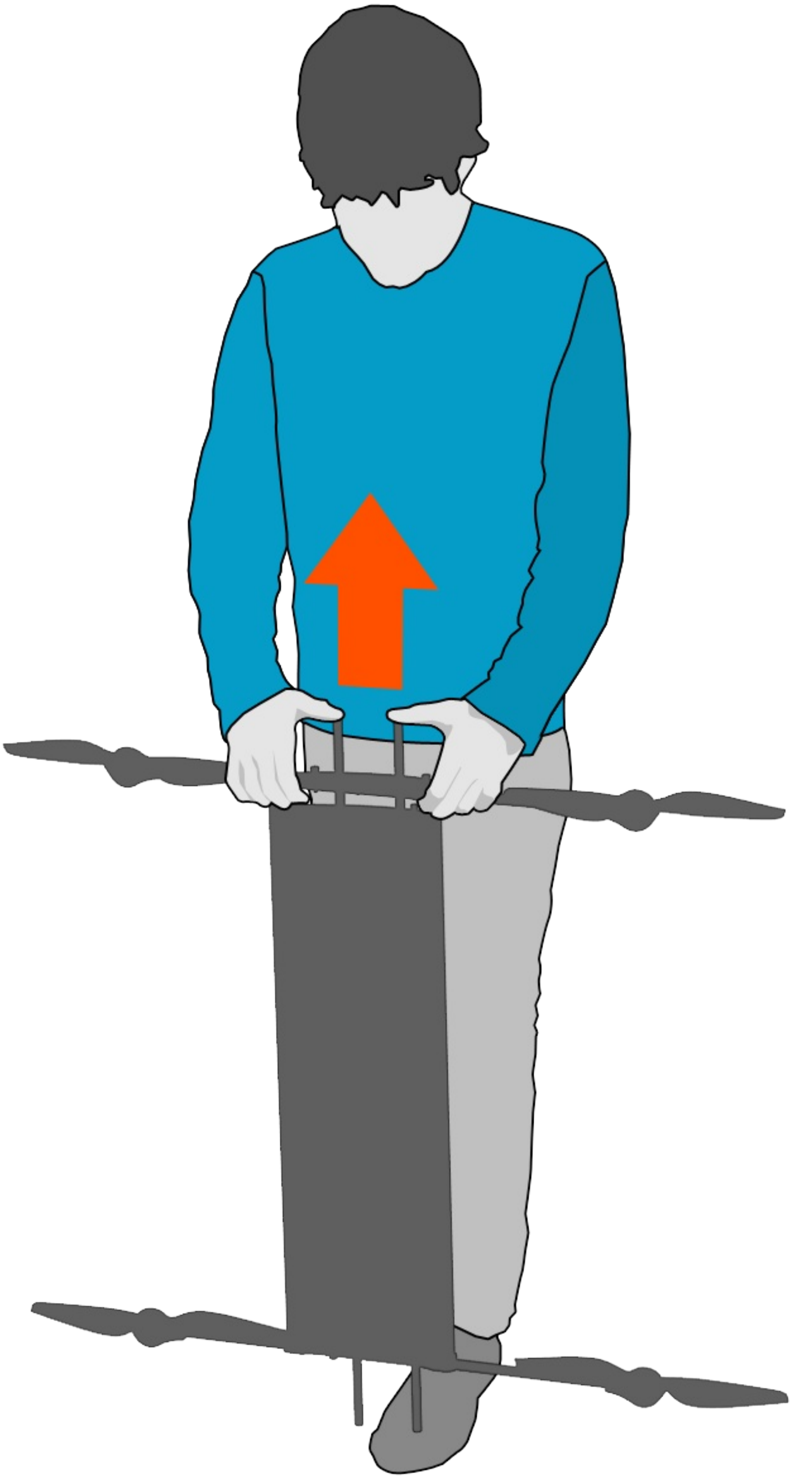
Shut the aircraft off by removing all batteries from the battery bay. Do not leave any batteries within the bay for storage.

Aircraft - Disassemble

Disassemble the aircraft.



Hold the center wing horizontally and flat against your stomach. Point the leading edge (front) of the wing down. Holding the center wing with one hand, and grasp the leading edge of a wing with your other hand. Gently rock the wing back and forth while pulling to disconnect each wing from the center section.

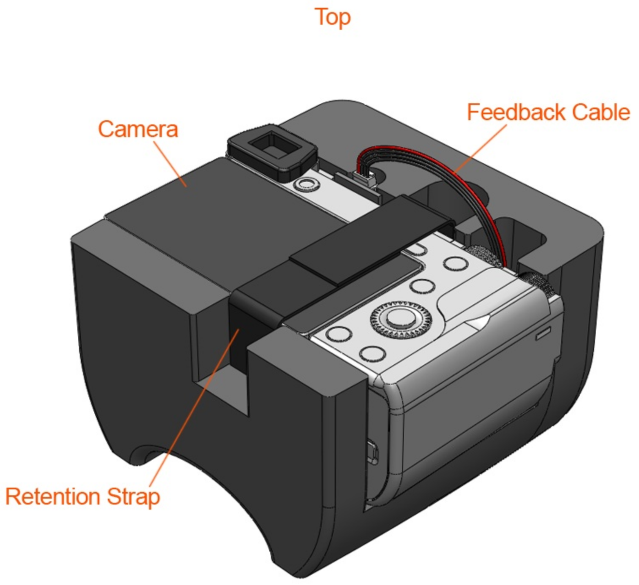


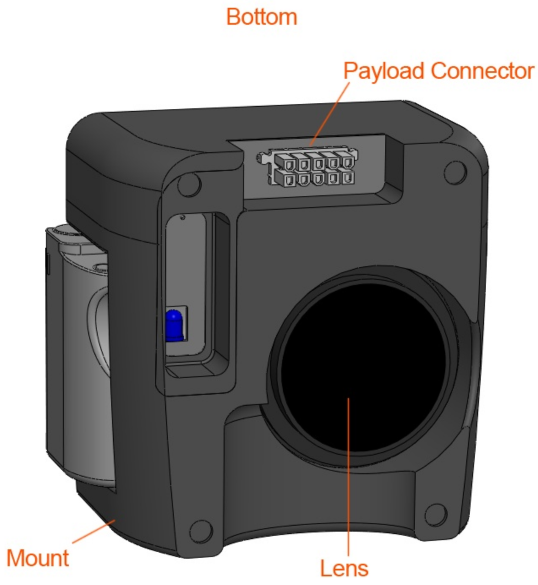
Place one end of the center wing against your shoe such that the wing is standing vertically. Loosen the 2x motor boom thumbscrews from the center wing. The thumbscrews do not need to be completely removed from the motor boom. They are held in place by the motor boom for convenience. Grab the motor boom with both hands and press against the spar joiners with your thumbs. Continue pressing to disconnect the motor connectors and slide the motor boom upward and off.

Payloads

Standard Mapping Payload

The Standard Mapping Payload uses the 24 MP (megapixel) Sony a6000 which features a large APS-C sensor and shutter feedback for optional PPK tagging. The camera sits in a ruggedized mount with an integrated payload connector and trigger board.



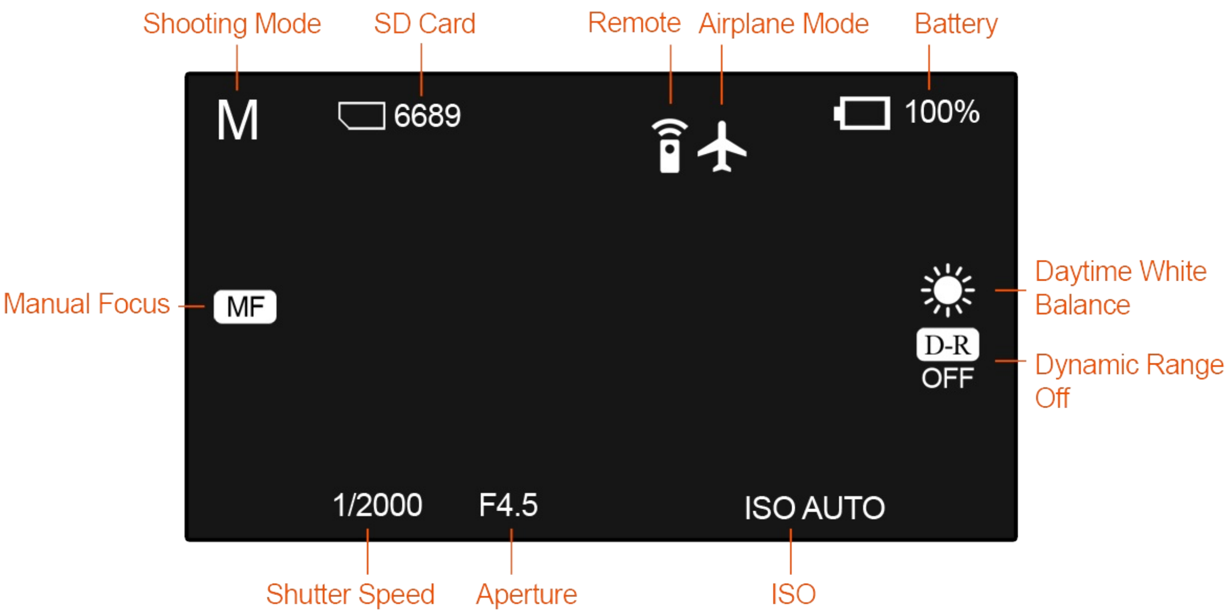


Technical Specifications

Sony a6000	Specs
Sensor	24 MP, APS-C, RGB
Lens	Interchangeable 20mm (as setup)
GSD at 90 m (~300 ft)	1.76 cm/px
GSD at 120 m (~400 ft)	2.34 cm/px
Coverage at 90 m (~300 ft)	3.3 km2, 815 acres (60% sidelap)
Coverage at 120 m (~400 ft)	4.5 km2, 1100 acres (60% sidelap)
PPK Capable	Yes
Weight	448 grams
Data	single images, point clouds, orthomosaics, 3D models

Image Settings

The camera settings in the table below should be verified before each flight. The camera should hold these settings unless there was an error or a problem shutting down after making changes.



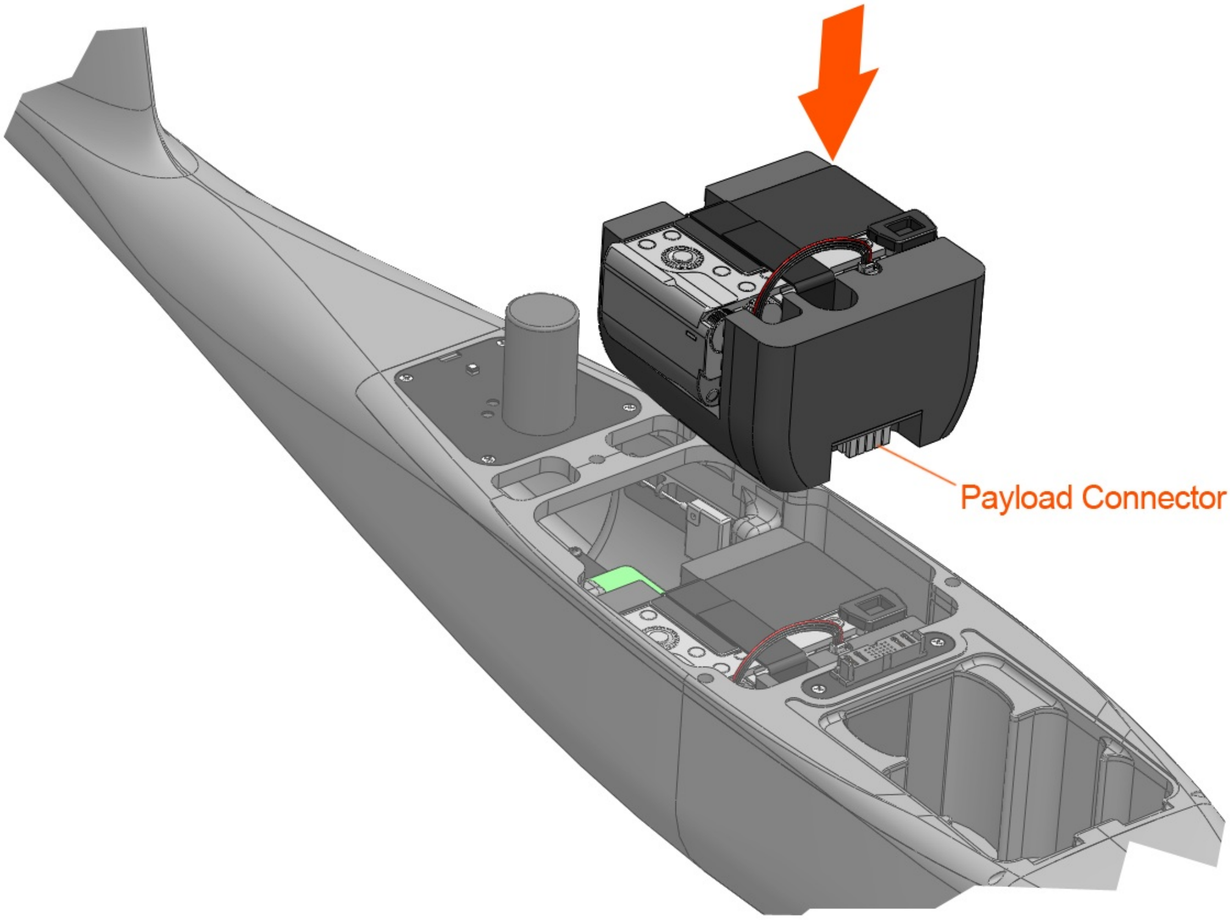
Setting	Value
Shooting Mode	Manual
SD Card	Empty
Remote Control	On
Airplane Mode	On
Battery	Full
White Balance	Daytime
Dynamic Range	Off
ISO Speed	Auto
Aperture	F4.5
Shutter Speed	1/2000
Focus	Manual
LCD Brightness	-2

Tip: Set and check the focus of the camera before turning the screen brightness down.

Installing the Camera

The compass on Lynx VTOL can be sensitive to payload changes and may require a compass calibration once your custom payload is installed within the payload bay. See the Calibration section for more information.

With the payload connector facing forward as shown, slide the mount (with or without camera attached) into the payload bay. If aligned correctly, the payload connector will fully seat and the top of the camera mount will be parallel with the top of the fuselage.

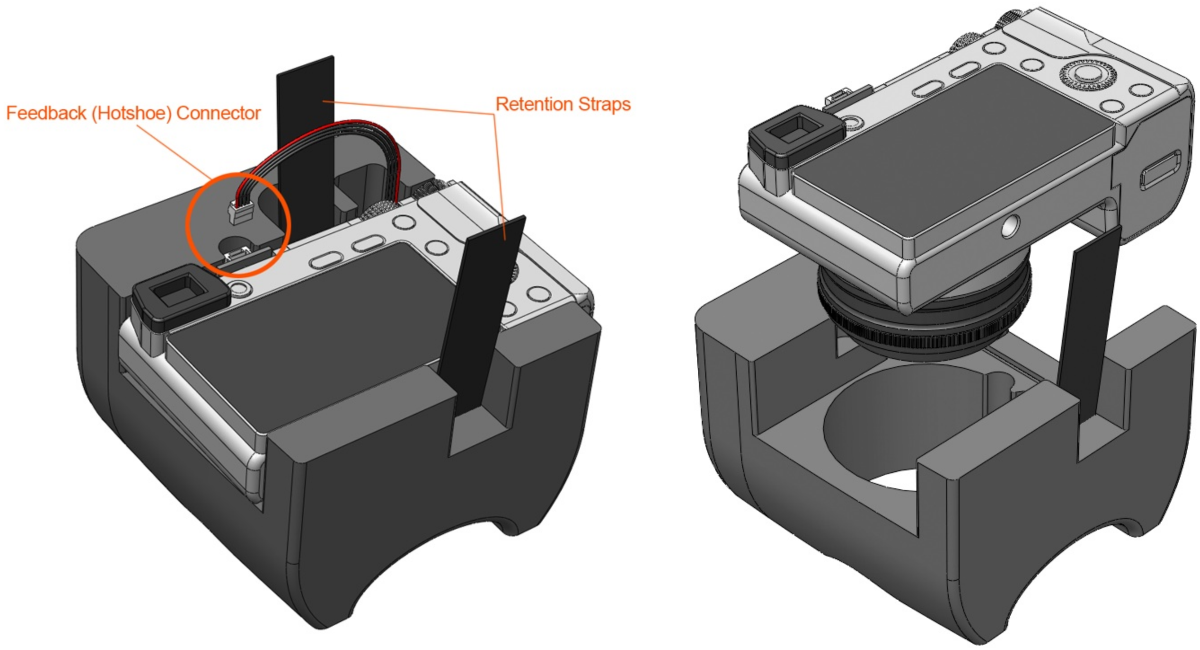


The payload connector is what is know as 'blind mating' which can account for some misalignment. However, do not force the connector into place. Doing so may damage the fuselage or camera mount.

Removing the Camera

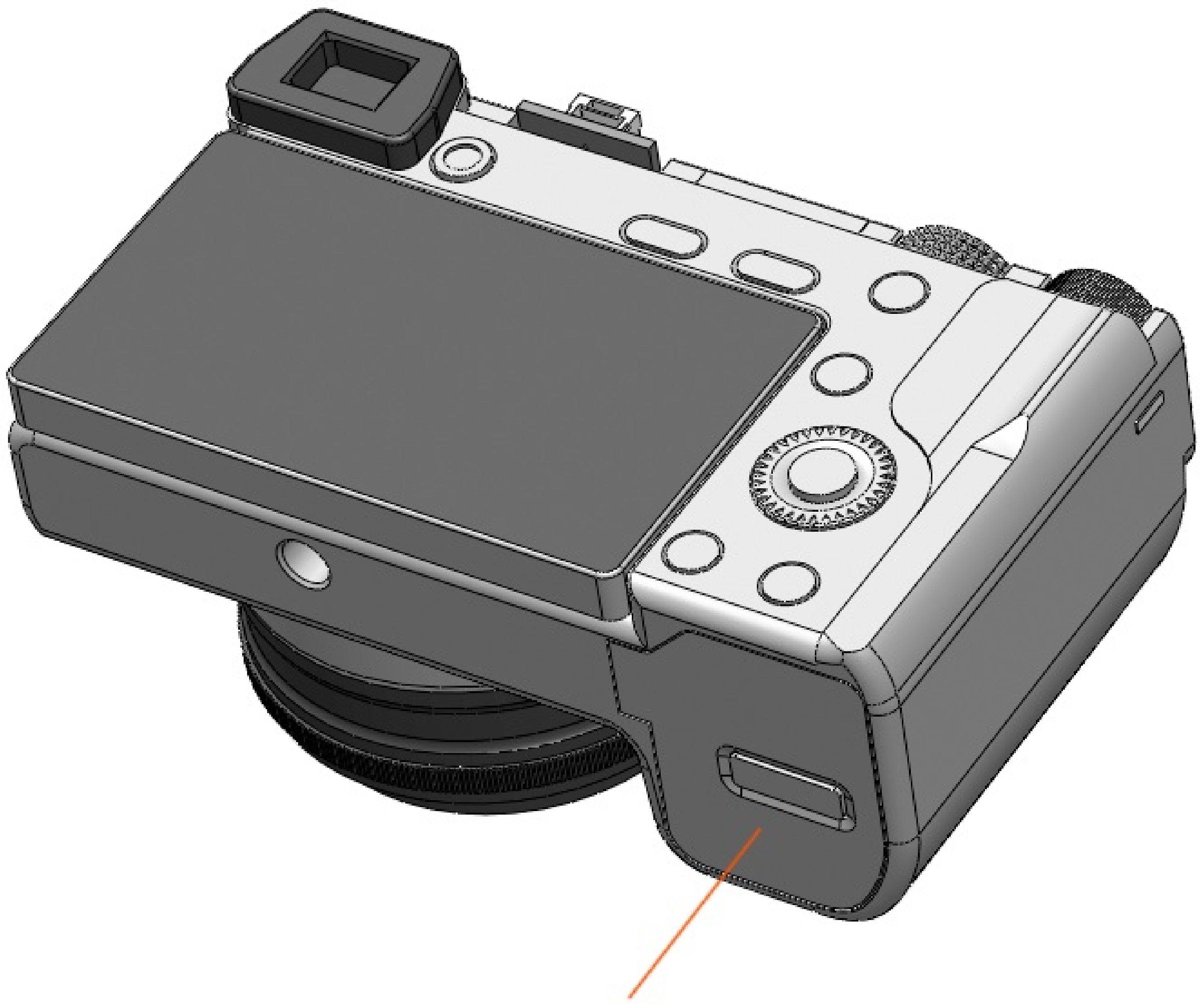
To remove the camera from the mount:

1. Disconnect the feedback connector from the hotshoe board
2. Undo the retention straps



SD Card and Battery

The camera's SD card and battery are located on the bottom of the camera behind a hinged door.



Providing your own Camera

Menu Configuration

The camera settings in the table below are set by SRP Aero if you purchase a payload with your Lynx VTOL. If you are providing your own camera, the following menu settings must be configured before flying. To begin, turn the camera on and enter the menu by pressing the MENU button. Change the settings as indicated below. When finished, turn the camera off using the ON/OFF switch to save your settings. Turning the camera off by ejecting the battery may not save the settings. The camera should hold these settings unless there was an error or a problem shutting down after making changes.

Menu	Page	Setting
Camera Icon	1	Image Size – L:24M
	1	Aspect Ratio – 3:2
	1	Quality – Fine
	2	Drive Mode – Single-Shooting
	2	Focus Mode – Manual Focus
	3	Focus Area – Wide (If using AF)

	3	AF drive speed – Fast (If using AF)
	3	Exposure Comp. - +/- 0
	4	ISO – ISO AUTO
	4	White Balance – Daylight
	4	DRO/Auto HDR – Off
	4	Creative Style – Standard
	4	Picture Effect – Off
Gear Icon	1	Zebra – Off
	1	Auto Review – Off
	2	Peaking Level – Off
	2	Live View Display – ON
	3	Zoom Setting – Optical zoom only
	3	FINDER/MONITOR – Monitor
	3	Release w/o Lens - Enable
	4	AEL w/ shutter – Auto
	5	Lens Comp. - all to Auto
	6	Custom Keys - all to "Not Set"
	6	Dial/Wheel Ev Comp – Off
	6	Dial/Wheel Lock – Lock
Wireless Icon	1	Airplane Mode - On
App Icon	n/a	n/a
Playback Icon	n/a	n/a
Briefcase Icon	1	Monitor Brightness - Manual
	2	PWR Save Start Time - 30 Min
	3	Remote Ctrl - On

Physical Modifications

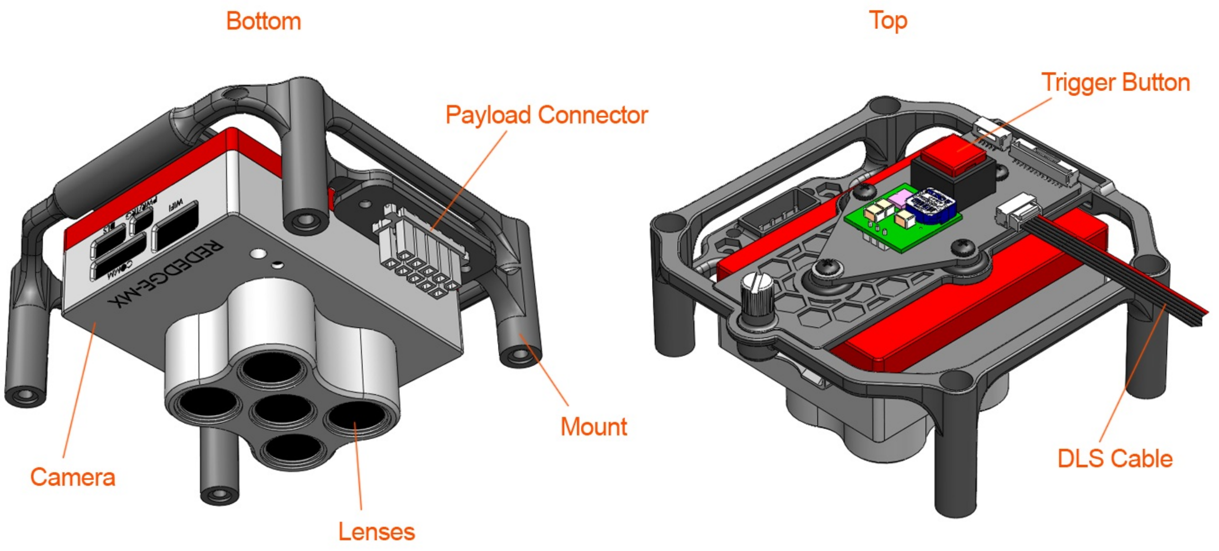
The lanyard anchor on the right side of the camera must be removed in order for your camera to fit properly within the payload bay. Use a Dremel cutoff wheel (or similar rotary tool) to remove most of the anchor. You may have to make multiple small cuts to minimize heat buildup and to prevent scratching the camera. Finish by grinding the anchor down with a sanding wheel. At a minimum, ensure the lens cover is installed when cutting. Dust-off the camera when finished.


right side lanyard anchor
must be removed
AVCHD
24.3 MEGAPIXELS
MENU
AEL
Fn
DISP
ISO
C2
SONY

Multispectral Mapping Payload

The Multispectral Mapping Payload uses the Micasense RedEdge-MX which features 5 bands and a downwelling light sensor (DLS). The camera sits in a hinged mount which allows easy acces to the camera's SD card when installed within the aircraft. Also included is a regulated power board with trigger and payload connector.

For more information, see the RedEdge-MX Manual by MicaSense which can be found here.

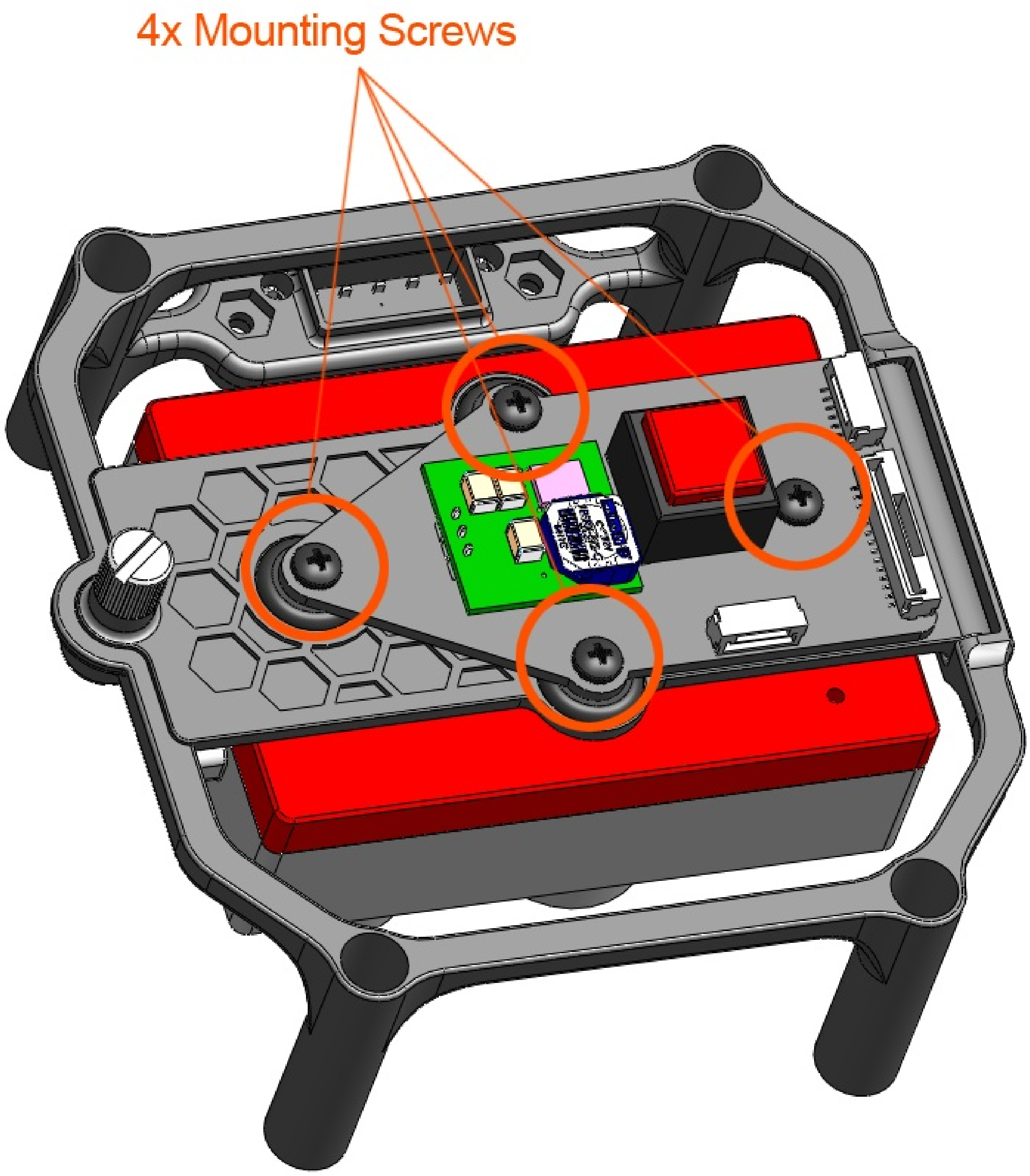


Technical Specifications

RedEdge-MX	Specs
Sensor	RGB, RE, NIR (narrowband)
Lens	5x fixed 5.5mm
GSD at 90 m (~300 ft)	6.14 cm/px
GSD at 120 m (~400 ft)	8.18 cm/px
Coverage at 90 m (~300 ft)	2.5 km2, 617 acres (60% sidelap)
Coverage at 120 m (~400 ft)	3.4 km2, 840 acres (60% sidelap)
PPK Capable	Yes
Weight	300 grams with DLS
Data	NDVI index map, Chlorophyll map, RGB, point clouds, orthomosaics, 3D models

Attaching the Camera to the Mount

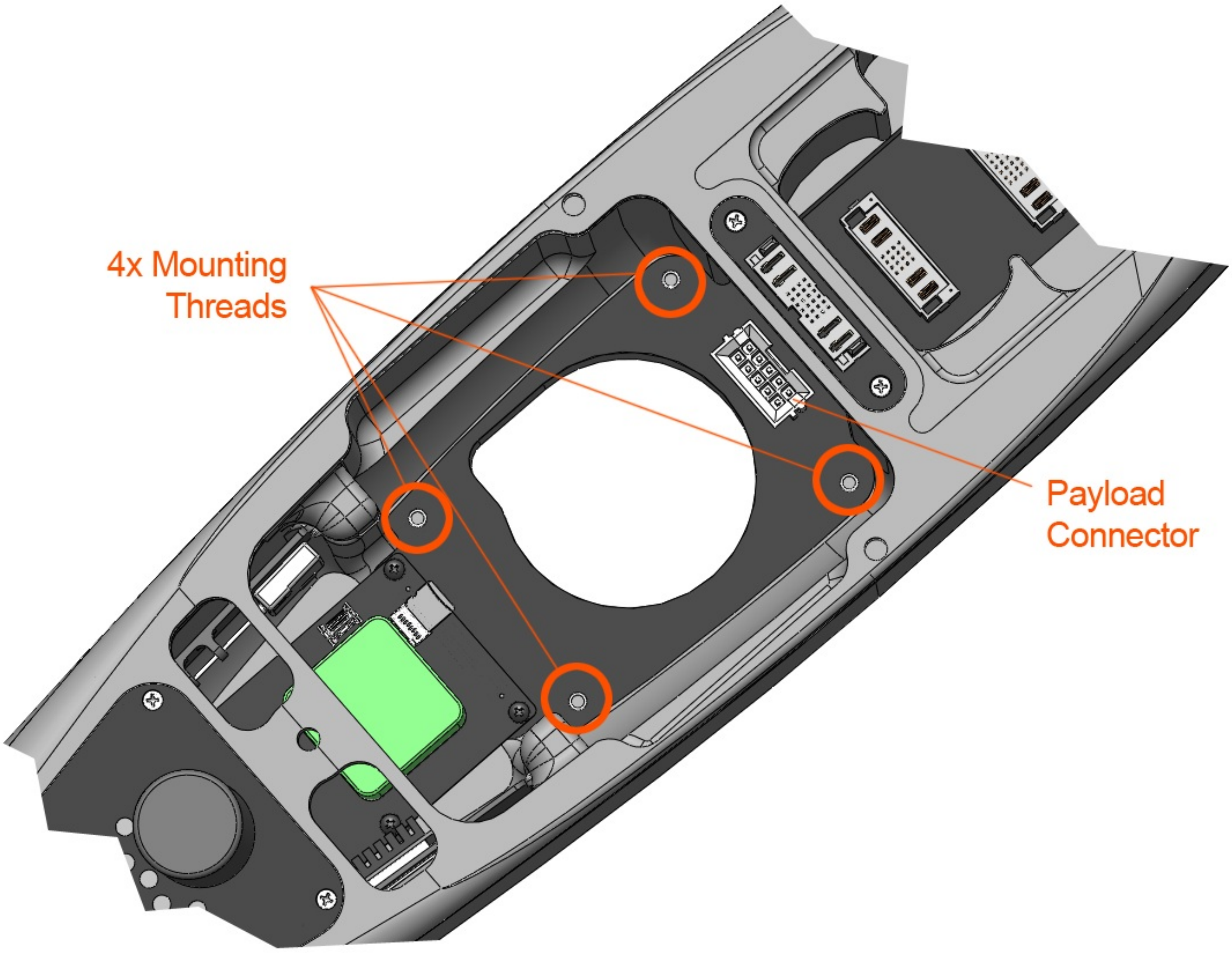
If you are providing your own camera, you will need to attach the camera to the mount using 4x M3 x 10mm screws (included).



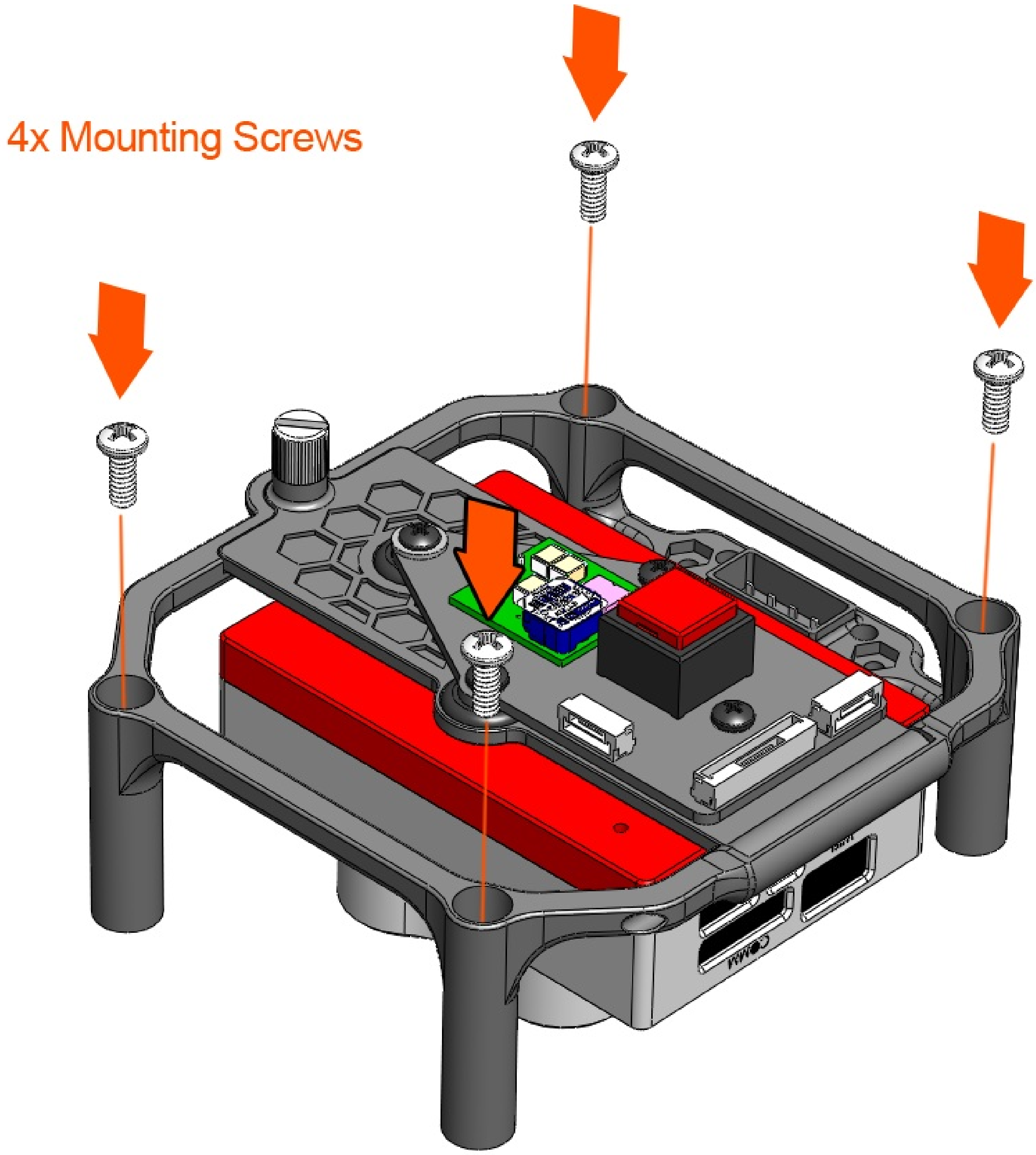
Installing the Camera

The compass on Lynx VTOL can be sensitive to payload changes and may require a compass calibration once your custom payload is installed within the payload bay. See the Calibration section for more information.

The camera mount is secured within the aircraft using 4x 6-32 x 3/8 inch screws (included) which fasten into the corresponding threads inside the payload bay.

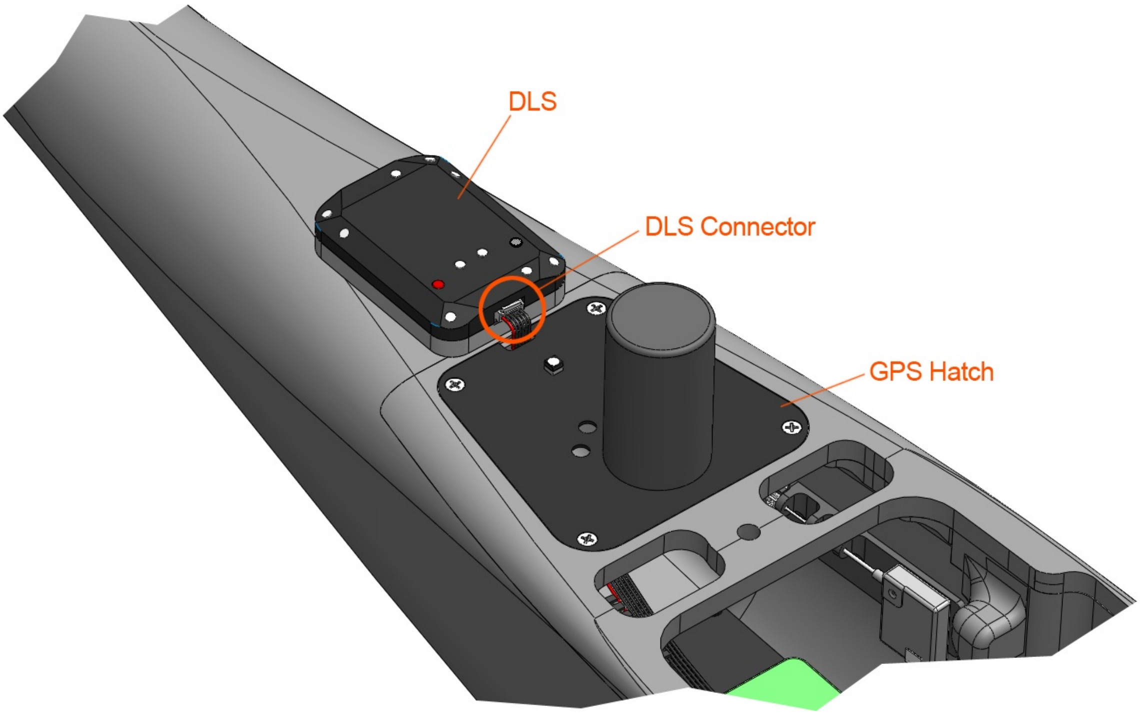


1. Insert the mount into the payload connector
2. Secure the mount to the payload bay using the 4x mounting screws



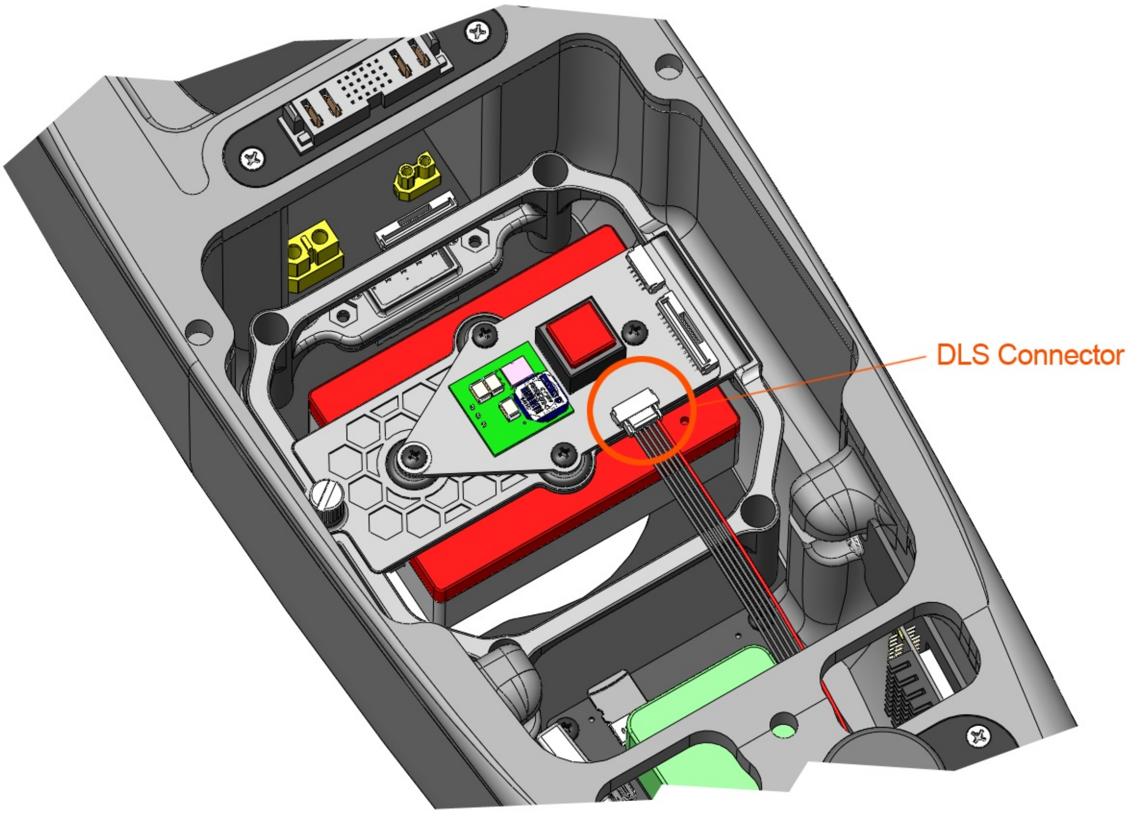
3. Tighten the screws (finger tight). The screwdriver included with the toolkit works, but you may find it easier to use one with a longer reach.

4. Attach the DLS to the top of fuselage just behind the GPS hatch as shown (connector must face forward) using doubled sided tape or adhesive-backed Velcro. Velcro will let you easily remove the DLS when not flying the multispectral payload.



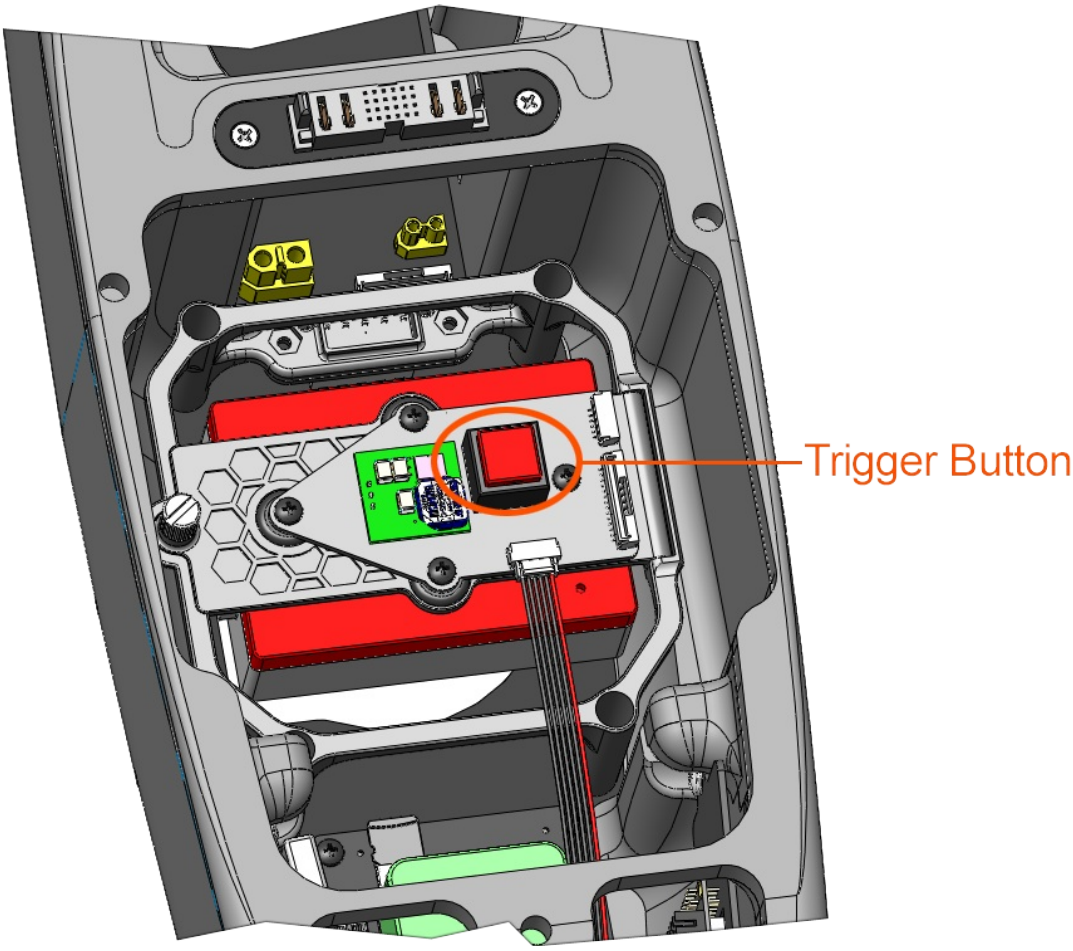
5. Attach DLS cable to the DLS

6. Attach other side of DLS cable to payload by routing the cable through the notch in the GPS hatch. You may need to undo the GPS hatch screws to route the DLS wire. On Lynx VTOL #079 and older, contact support@srp.aero.

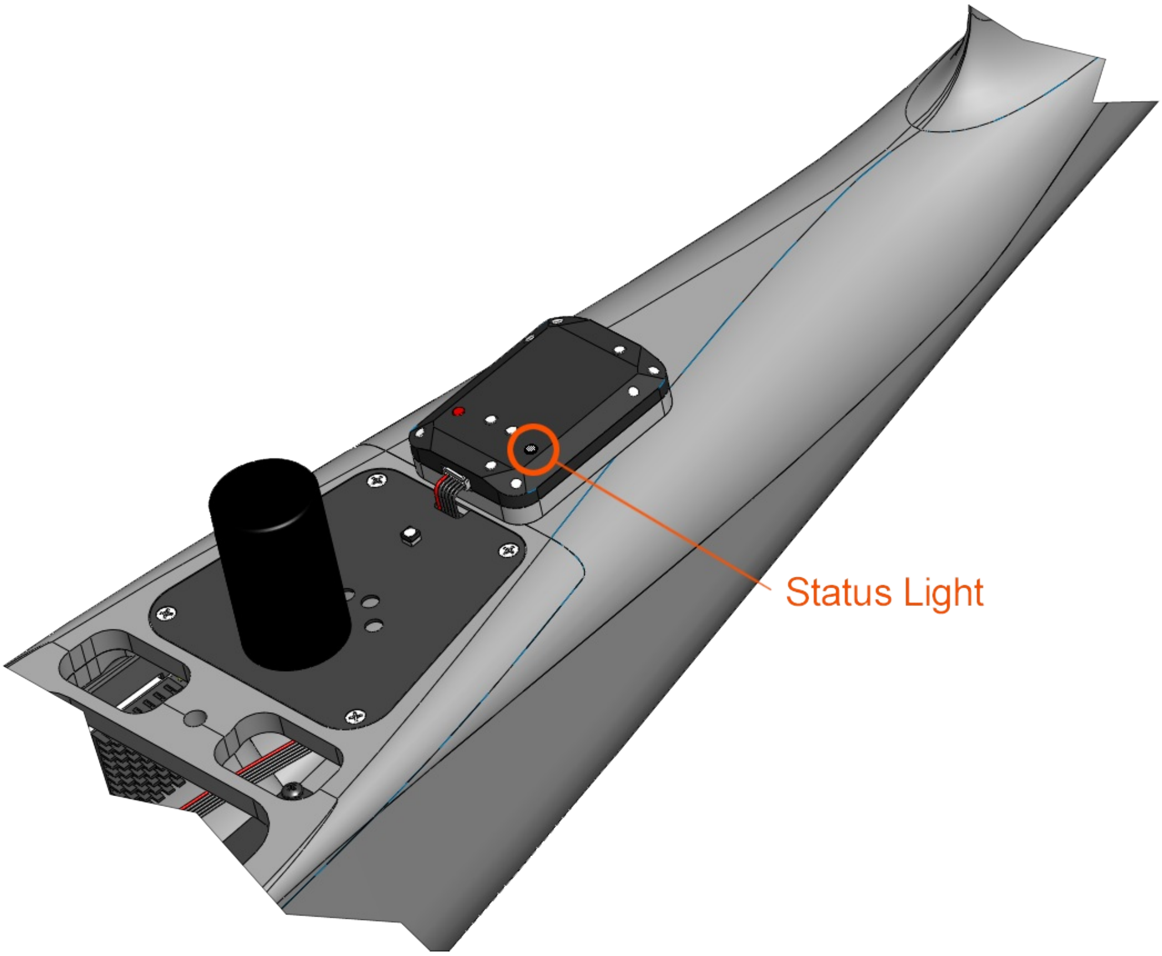


Triggering the Camera

The camera can be triggered manually with the trigger button to, for example, take a picture of the MicaSense calibration target.

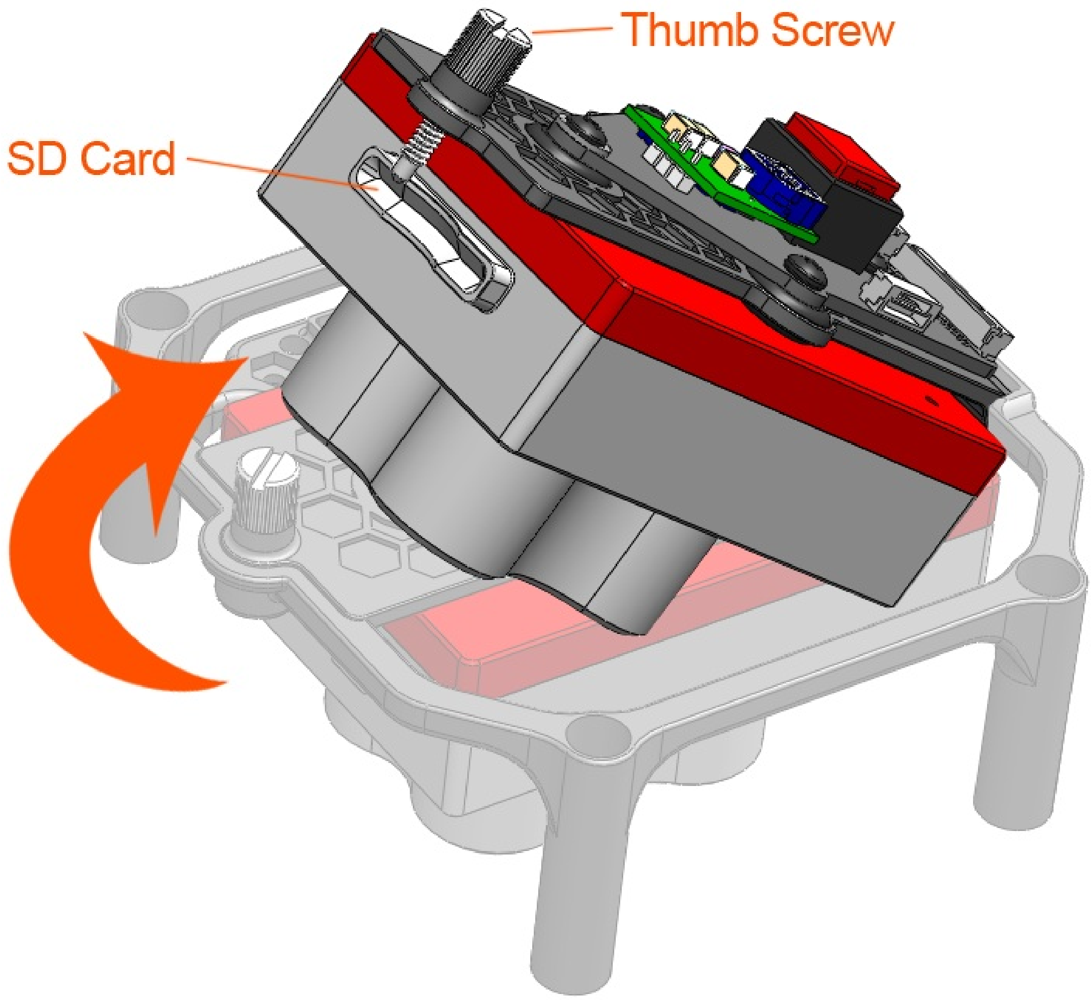


Whenever the camera takes an image, manually or from the autopilot, the status light on the DLS will flash blue. This is your only cue as to whether or not an image was taken during the payload check preflight step.



SD Card

The mount features a hinging mechanism that allows you to access the camera's SD card while the camera is installed within the aircraft. To access the SD card, simply loosen the thumbscrew and pivot the camera upward. Tighten the thumbscrew before flying or transport.



Removing the Camera

1. Disconnect the DLS cable from the camera mount.
2. Unscrew the four mounting screws holding the RedEdge-MX mount in place.
3. Pull the camera mount upward to disconnect the payload connector.
4. Remove the DLS and DLS cable.

The DLS should be removed when not flying the RedEdge-MX.

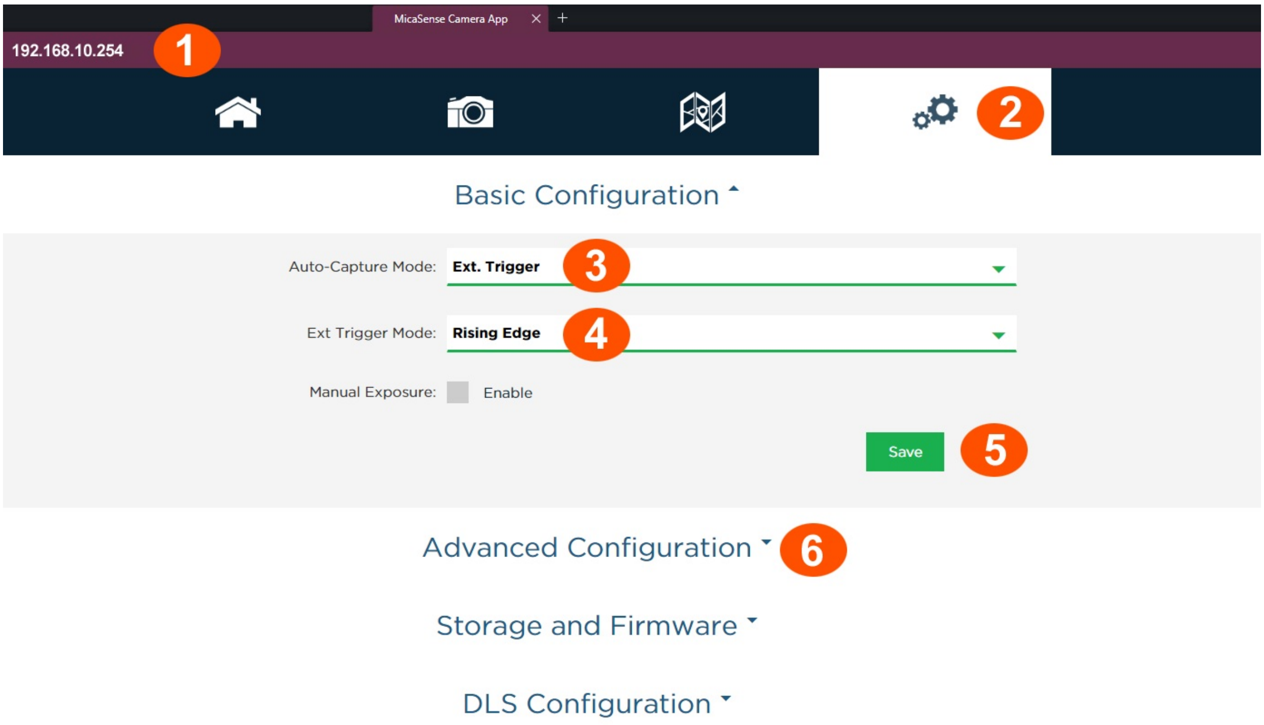
Geo-Tagging Multispectral Images

Multispectral imagery is automatically geo-tagged in flight using the autopilot's GPS and heading data. Additional processing is only required if PPK accuracy is required.

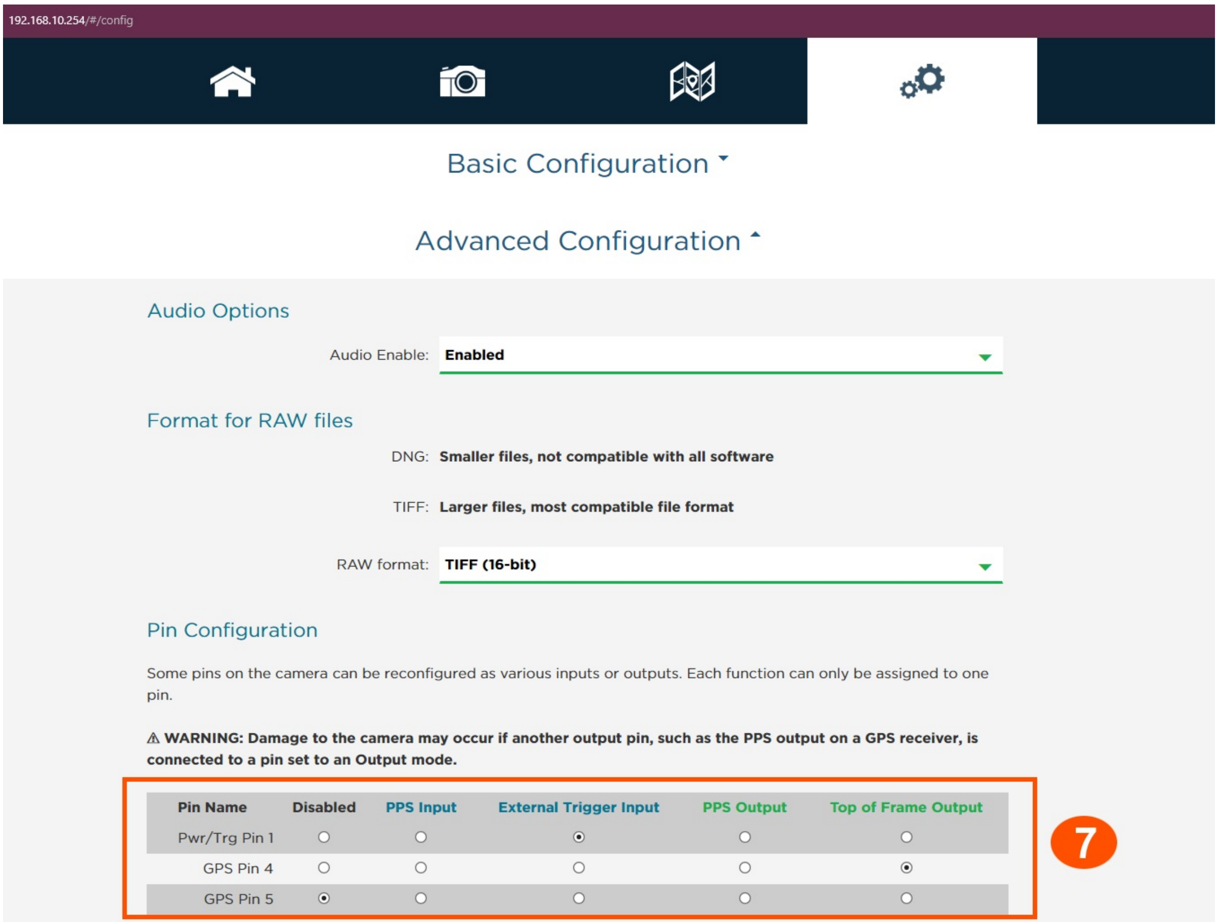
Providing your own Camera

Menu Configuration

The camera settings in the table below are set by SRP Aero if you purchase a payload with your Lynx VTOL. If you are providing your own camera, the following menu settings must be configured before flying.



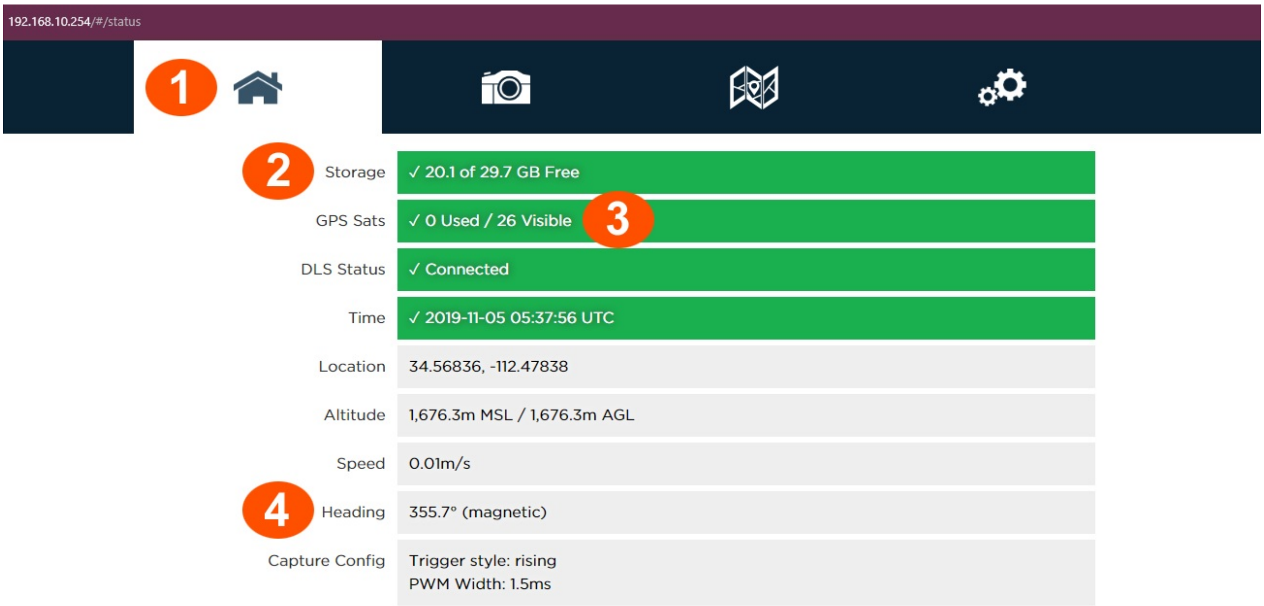
1. Power on the camera. Connect to the RedEdge-MX's WiFi with the password of *micasense*. Open a browser and type the default IP of 192.168.10.254 in the address bar to open the MicaSense Camera App.
2. Go to the settings tab.
3. Under 'Auto-Capture Mode' select 'Ext. Trigger'
4. Under 'Ext Trigger Mode' select 'Rising Edge'
5. Save
6. Expand 'Advanced Configuration'



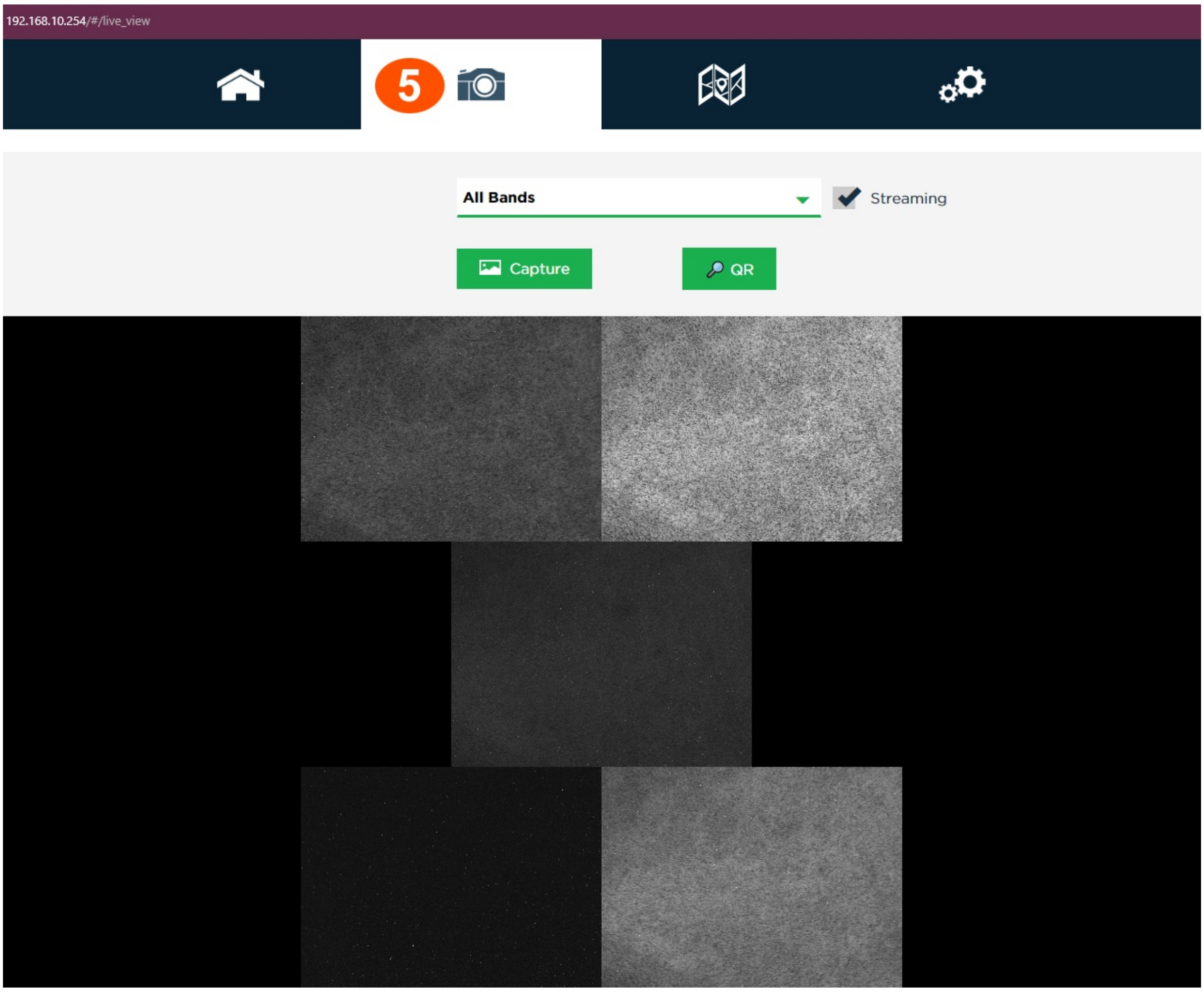
7. Set the 'Pin Configuration' to match the table shown
8. Scroll down and save your changes.

Camera Status

In the same MicaSense Camera App, you can monitor the camera's status and manually capture photos.



1. Go to the home tab.
2. Check that you have enough space on the SD card before flying.
3. Under 'GPS Sats' you will notice that 0 satellites are being used, this is because the camera is getting GPS data from the autopilot.
4. The heading shown is internal to the camera and can be ignored. The actual heading used for geo-tagging is provided by the autopilot.



5. On the camera tab, you can view the camera's field-of-view or manually capture photos.

Custom Payloads

Lynx VTOL has swappable payloads that enable you to effectively reconfigure your aircraft depending on your mission. The fact that the payloads are not permanent to the fuselage gives more advanced users the opportunity to create their own custom payloads when the standard options are not applicable. This can be common among universities and research organizations.

If you are developing a custom payload for Lynx VTOL, it must meet the following requirements:

- Fit within the volume of the payload bay.
- Must not exceed 500 grams (1.10 lbs) in weight.
- Must not exceed power requirements.
- Must not draw power from the VTOL battery.
- Must not cause interfere with the autopilot, sensors, the telemetry radio, or anything required for safe and reliable flight.

> The compass on Lynx VTOL can be sensitive to payload changes and may require a compass calibration once your custom payload is installed within the payload bay. See the Calibration section for more information.

> The power consumption of your custom payload may significantly affect flight endurance.

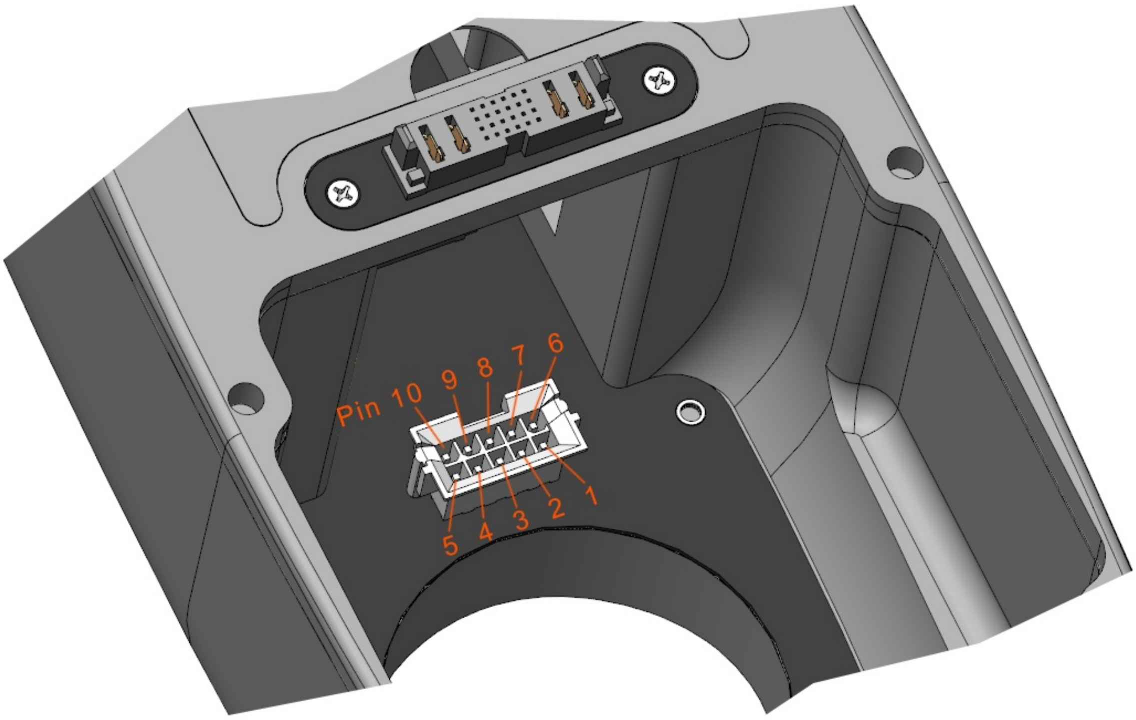
Pinout

Payload Bay Connector (fuselage side): Molex part# 0015-28-6102

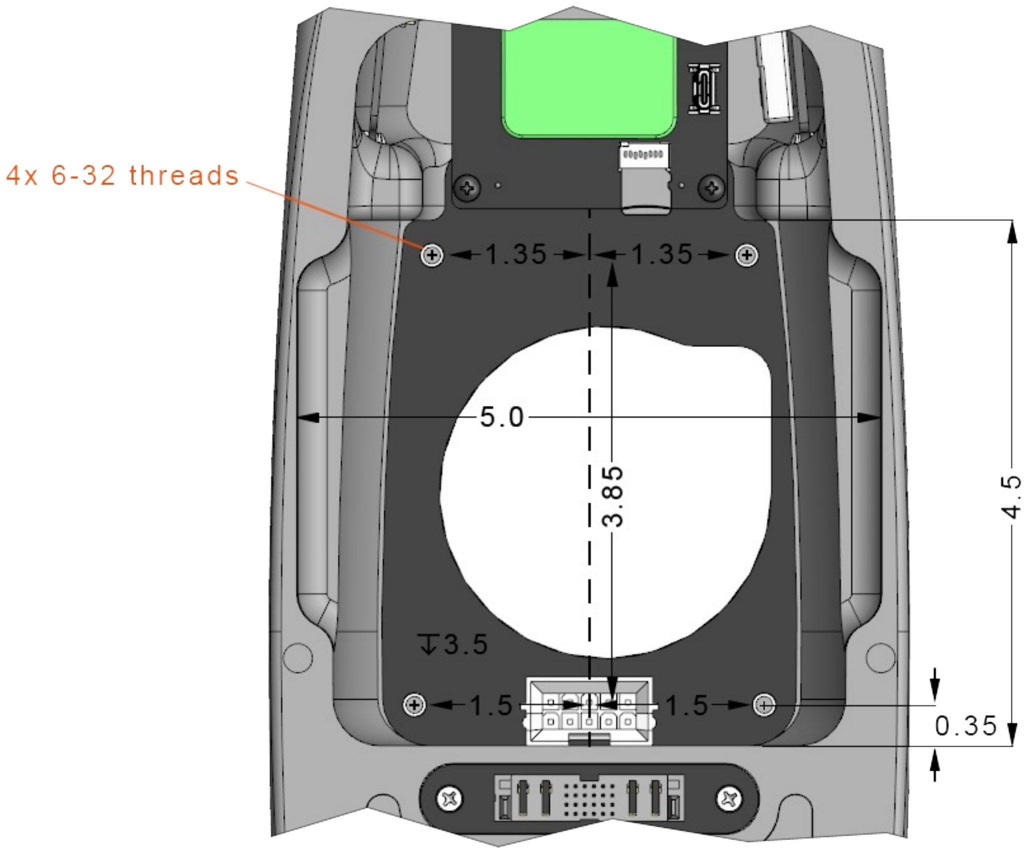
Payload Connector, Board Mount: Molex part# 0015-24-7103

Payload Connector, Wire: Molex part# 0039-01-2105

Pin	Signal	Signal Notes
1	VBatt (LiIon)	+15 to 25.2V at 3A
2	AutoPilot Power	+5.3V at 1A
3	Event (Aux 3)	0 to +3.3V at 10mA (also routes to GPS event input)
4	Trigger (Aux 6)	0 to +3.3V at 10mA
5	Serial2 Tx	0 to +3.3V at 5mA (57600 baud)
6	Serial2 Rx	0 to +3.3V at 5mA (57600 baud)
7	GPS Serial 2 Tx	0 to +3.3V at 5mA
8	GPS Serial 2 Rx	0 to +3.3V at 5mA
9	Ground	3A
10	Ground	3A



Mounting



Dimensions in inches

Standard Lynx VTOL payloads use a conformal foam block to mount sensors. Custom payloads should mount with a foam block or utilize the 4x 6-32 mounting threads within the payload bay. All mounting methods, though particularly a foam block, must leave an airflow channel that extends from camera lens cutout to the autopilot. Failure to do so may result in the autopilot overheating in flight.

Caution: When using the mounting threads, ensure that your mounting apparatus does not overly flex or scrape the underlying circuit board. Flexing or scraping the circuit board could sever an electrical trace.

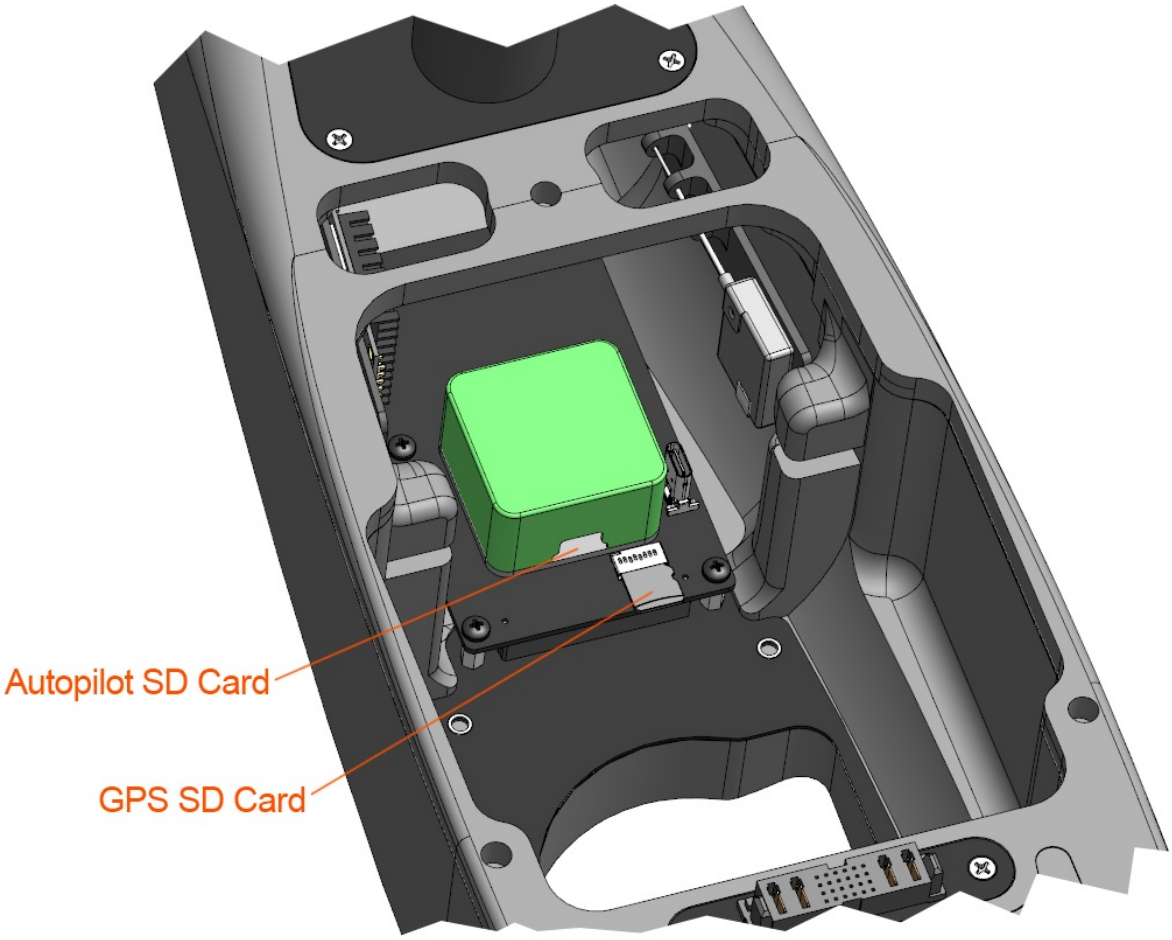
Contact support@srp.aero if having access to a payload bay CAD model would aid in your design.

Post-Processing

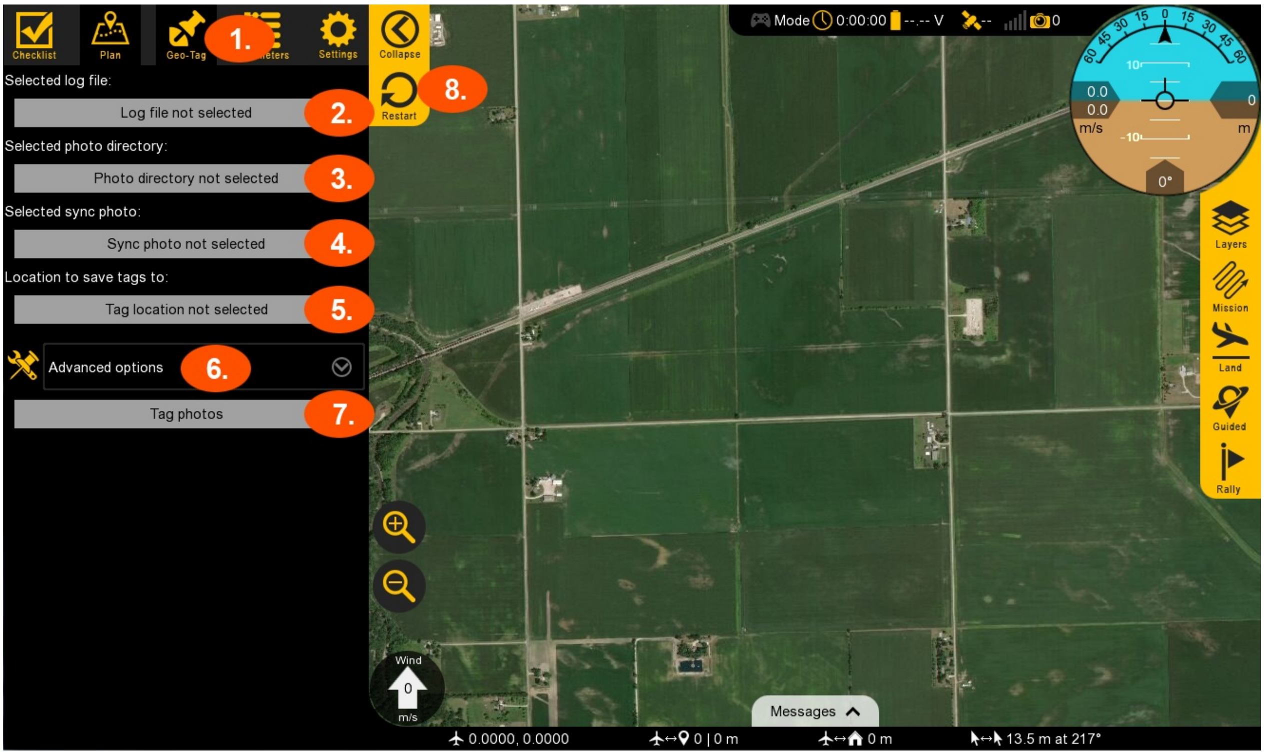
Geo-Tagging

The following workflow is the non-PPK method of geo-tagging images. While PPK achieves centimeter level postion data, normal geo-tagging results in much lower accuracy because there is no position refinement.

Start by removing the camera and camera mount from the payload bay (only required with Standard Mapping Payload). Once removed, both the autopilot and GPS micro SD cards are accessible. Either will work for geo-tagging position data, but only the autopilot log will tag with roll, pitch, and yaw data. The autopilot's micro SD card is flush with the front of the autopilot in a spring loaded housing. You will need to first push in with your fingernail to pop the card out. Insert the card into your GCS computer.



Geo-Tagging in Swift GCS



1. Open Swift GCS ⇨ `Geo-Tag`

2. Select log file. Select the log file that is being tagged. Tagging can use either the log file from the autopilot or the onboard GPS.

3. Select the folder containing your photos.

4. Select the photo that was used as the sync photo.

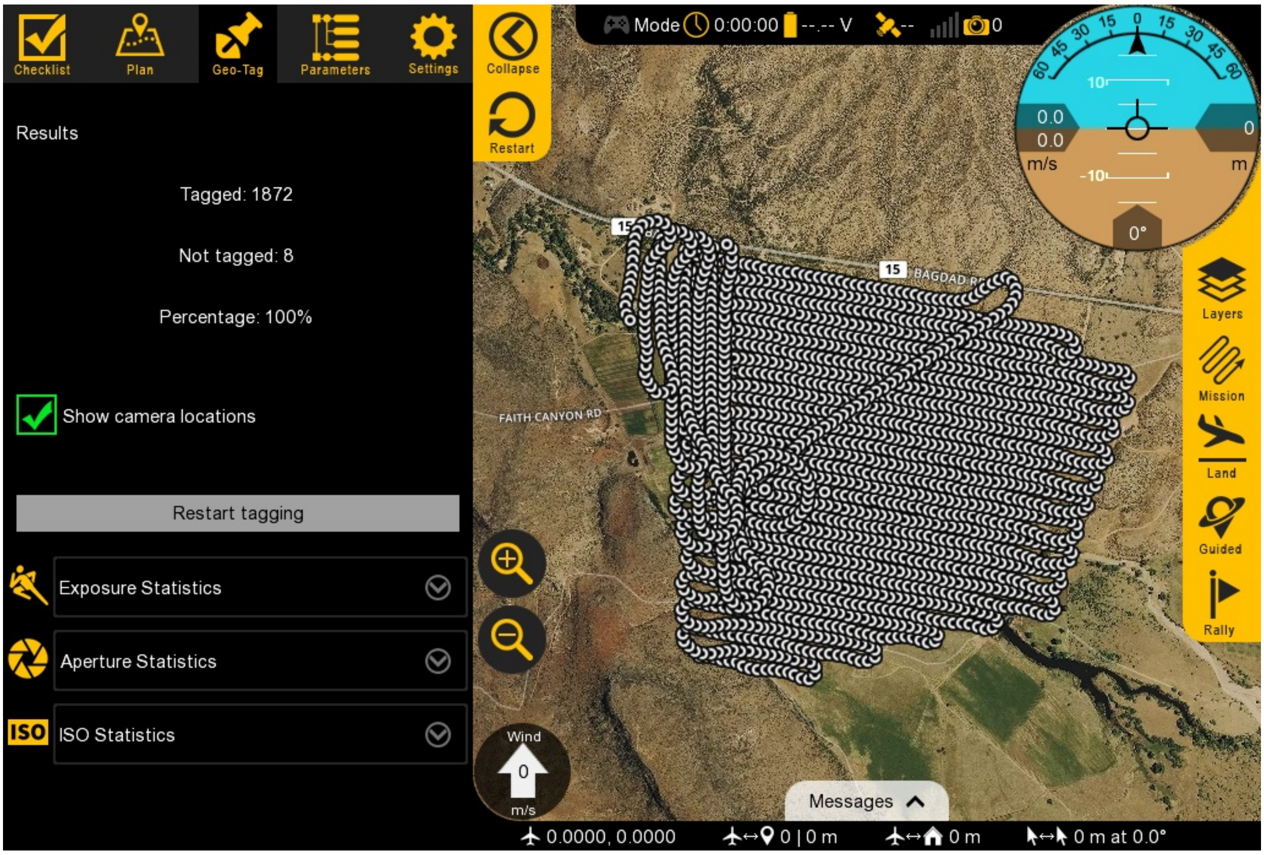
5. Select where the resultant tags (.csv) should be saved to.

6. If EXIF tags need to be written as well, this can be done by checking the box under `Advanced options`.

7. Select tag photos to begin the tagging process. Once complete the results will be shown.

8. Select to restart the tagging process as needed.

The results page will indicate how many photos were tagged. An icon will be drawn on the map for each tagged location. The statistics section will give a histogram of ISO, aperture, and shutter speed for your entire flight.



You can click on one of the map icons to see that specific image and more information.

Geo-Tagging Multispectral Images

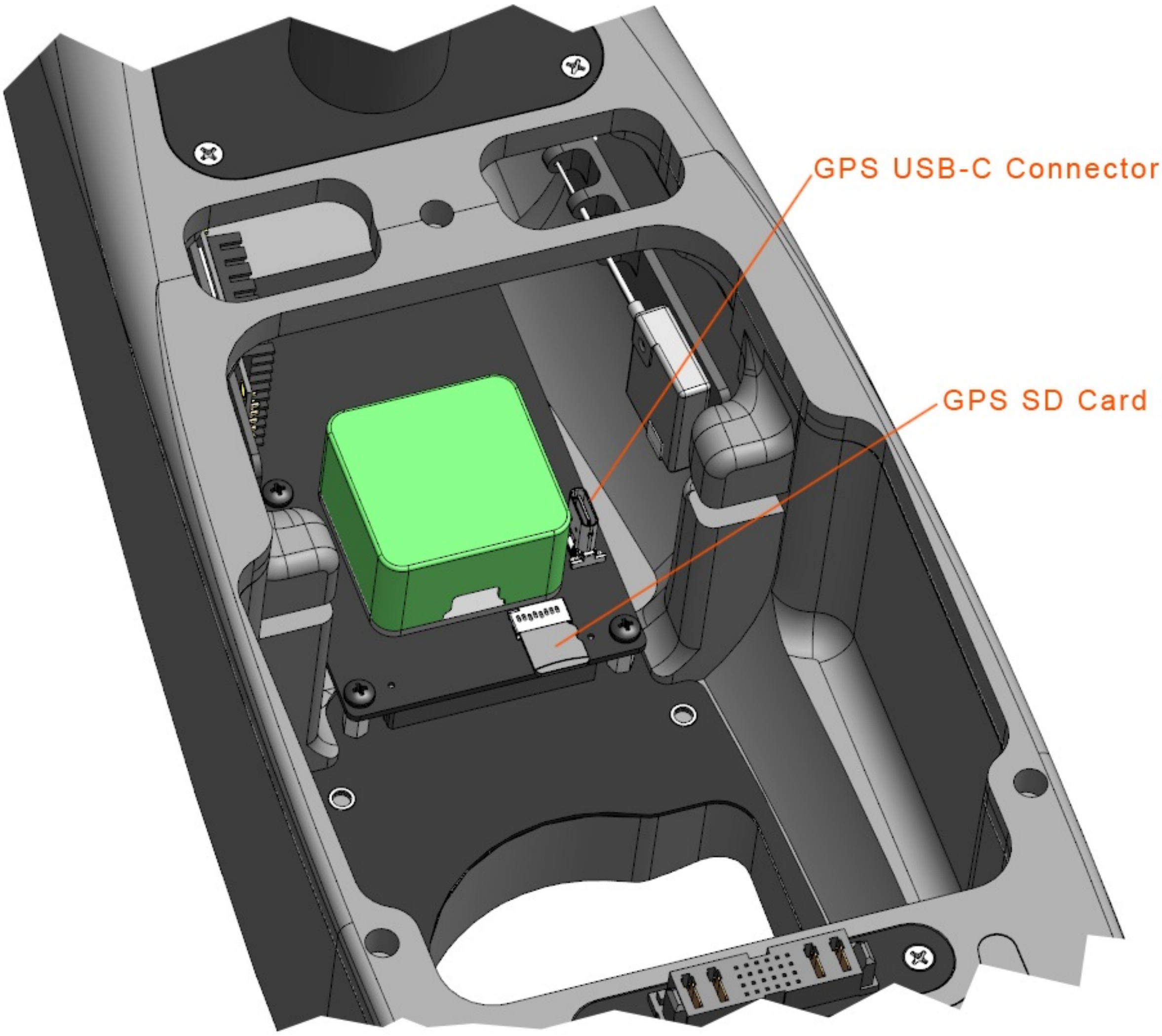
Multispectral data will already be tagged with the aircraft's position while flying. Additional processing is only required if PPK accuracy is required.

PPK Overview

Much of this information is from the GeoTagz Manual by Septentrio which can be found here.

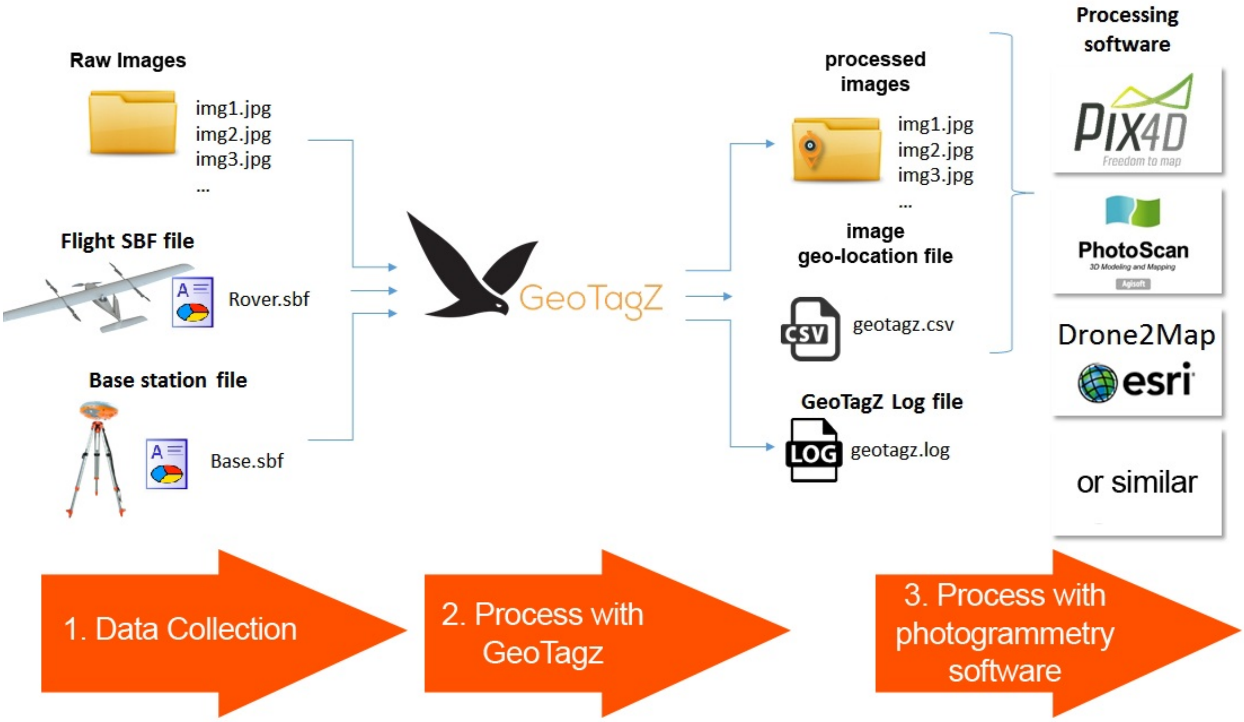
Using Septentrio's GeoTagZ in combination with Lynx VTOL PPK and the on-board AsteRx-m2 GNSS receiver, it is possible to obtain centimeter-level precision on the ground from aerial mapping. Compared to traditional survey methods, aerial mapping using Lynx VTOL PPK is significantly faster and cheaper. With GeoTagZ in your workflow, there is now no longer any need for Ground Control Points or a real-time data link to the UAS.

The on-board AsteRx-m2 receiver time-stamps camera shutter events to precisely identify the times when photographs were taken. These event markers along with the GNSS measurements are logged during the flight to the on-board SD card in Septentrio Binary Format (SBF).



After the flight, GeoTagZ combines SBF data from the aircraft with the data from a base station reference receiver on the ground, replacing the image positions with more precise cm-level PPK values.

The cm-level positions embedded in the EXIF data of the photographs or with the same position data in CSV format allows for seamless integration with image processing software (Pix4D, Metashape). This improves the quality of image stitching while removing the need for ground control points during data collection. Placing and measuring ground control points is always time consuming but in mines, ranges, and difficult terrain it can be far more cumbersome, dangerous or even impossible.



RTK vs. PPK

RTK positioning requires differential corrections from a base station with a pre-surveyed position before the flight. In most applications, these differential corrections are passed to the rover (the aircraft) receiver in real time necessitating a reliable communication link between Base and rover. For drone applications, this can be problematic. The equipment required for an additional communication link between the rover and base station can significantly add to the payload and power consumption of the aircraft. Furthermore, if your link is interrupted during flight, that portion of the flight will loose accurate correction data.

When everything is working well, the accuracy of RTK and PPK will be similar. However, if the rover GPS receiver experiences cycle slips, multi-path or data gaps, PPK becomse the more accurate option. With PPK there is also the benefit of being able to look at the entirety of the recorded data and run through it forward in time from the beginning to the end of the flight as well as backwards in time from the end of the flight. The ability to perform this forward and backward smoothing of the data is not possible with RTK, which is only calculated in real-time.

Required for Precision

For PPK image processing using GeoTagZ you will need:

- Lynx VTOL with PPK option
- Standard mapping payload (24MP)
- SBF data from the aircraft receiver containing GNSS measurements and camera shutter events
- Base station data in SBF or RINEX format. This can be downloaded from either a nearby reference network or from your own receiver, such as an Altus NR3 configured as a base station

GeoTagZ can then combine the GNSS measurement data from the aircraft and base receivers to reprocess the positioning. The images will then be automatically tagged with the new positions and can be easily imported to photogrammetry software.

GeoTagz Features

- GPS+GLO reprocessing for cm-level RTK precision
- GUI and command line versions offering identical functionality
- SBF input for the aircraft rover file
- SBF or RINEX input for the base station reference file

Supported Image Formats

GeoTagZ supports the following picture formats:

- JPG
- TIFF
- DNG

Package Contents

Lynx VTOL will include the following items in addition to the normal packing list:

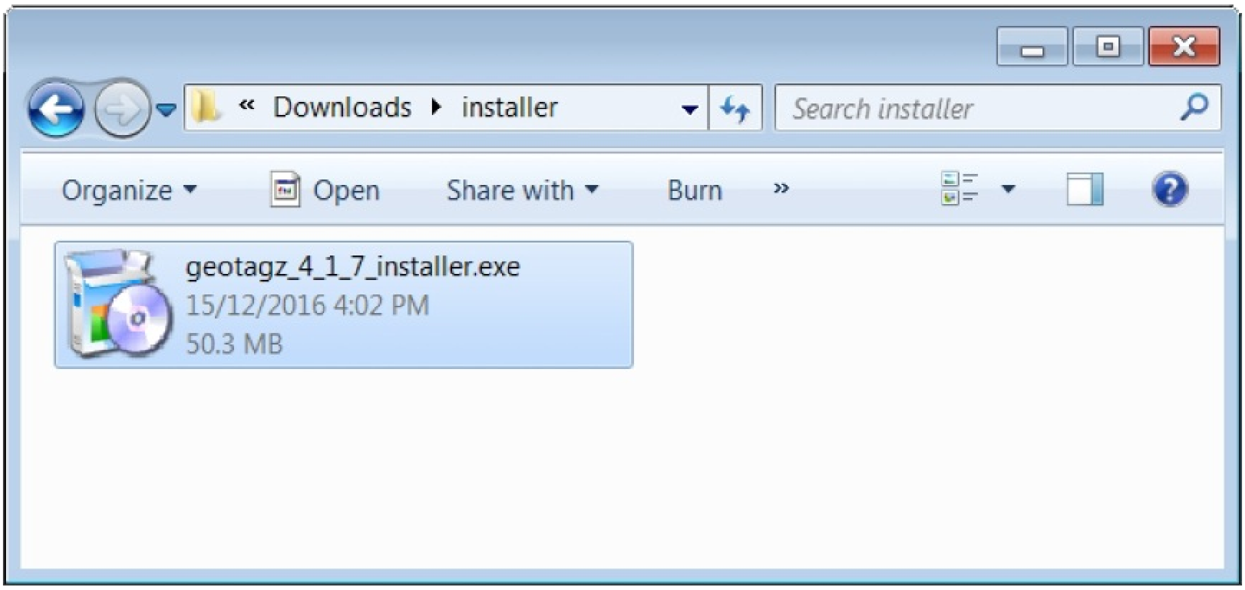
- USB dongle
- Permission license file for the USB dongle
- GeoTagZ installer
- GeoTagZ Software User Manual

Installing GeoTagZ

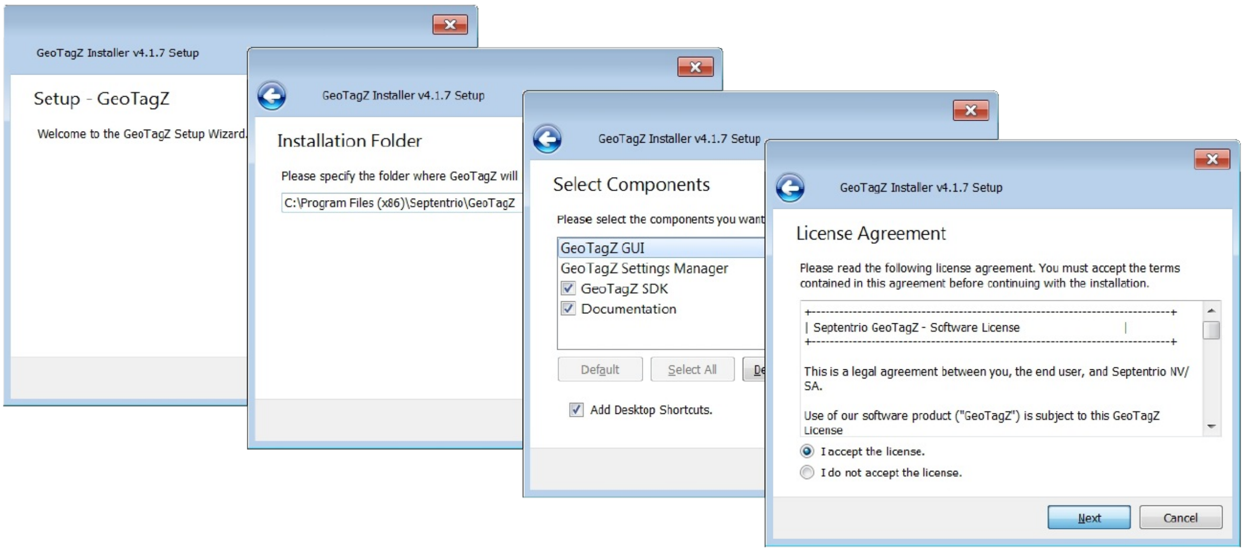
To install the GeoTagZ software on your PC you will need to have:

- A USB dongle and a license file (.bin) from Septentrio
- The GeoTagZ executable file

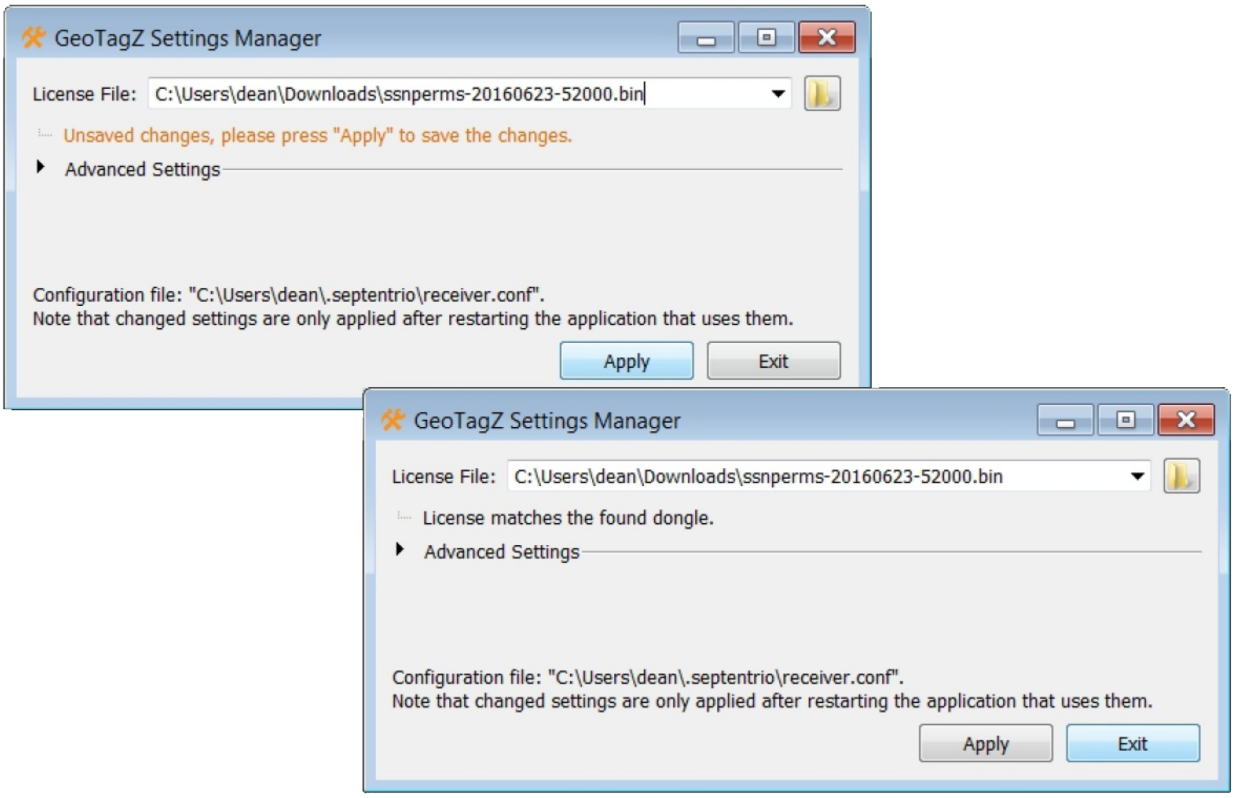
Download the GeoTagZ installer file and license file to your pc. Insert the GeoTagZ dongle into a USB connection on your PC then double click on the installer file to launch the installation procedure.



Follow the sequence of installation windows and select to ‘accept’ the GeoTagZ license agreement.

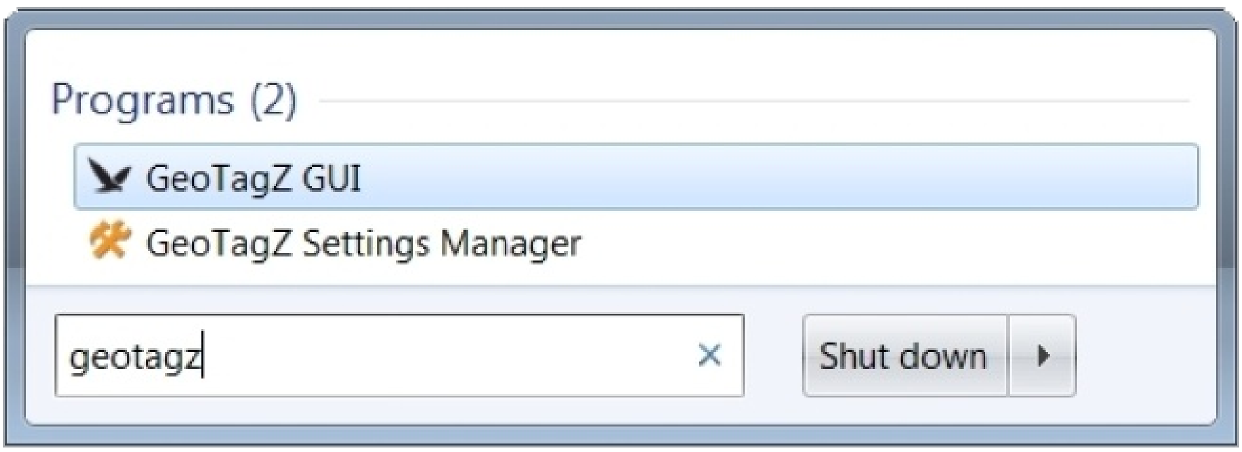


During installation, you will be prompted to input the location of the license file (.bin) for the GeoTagZ dongle. Select this file then click ‘Apply’. If the license file is the correct one for the connected dongle, the message, ‘License matches the found dongle’ will appear. You can then click ‘Exit’ to finish off the installation.



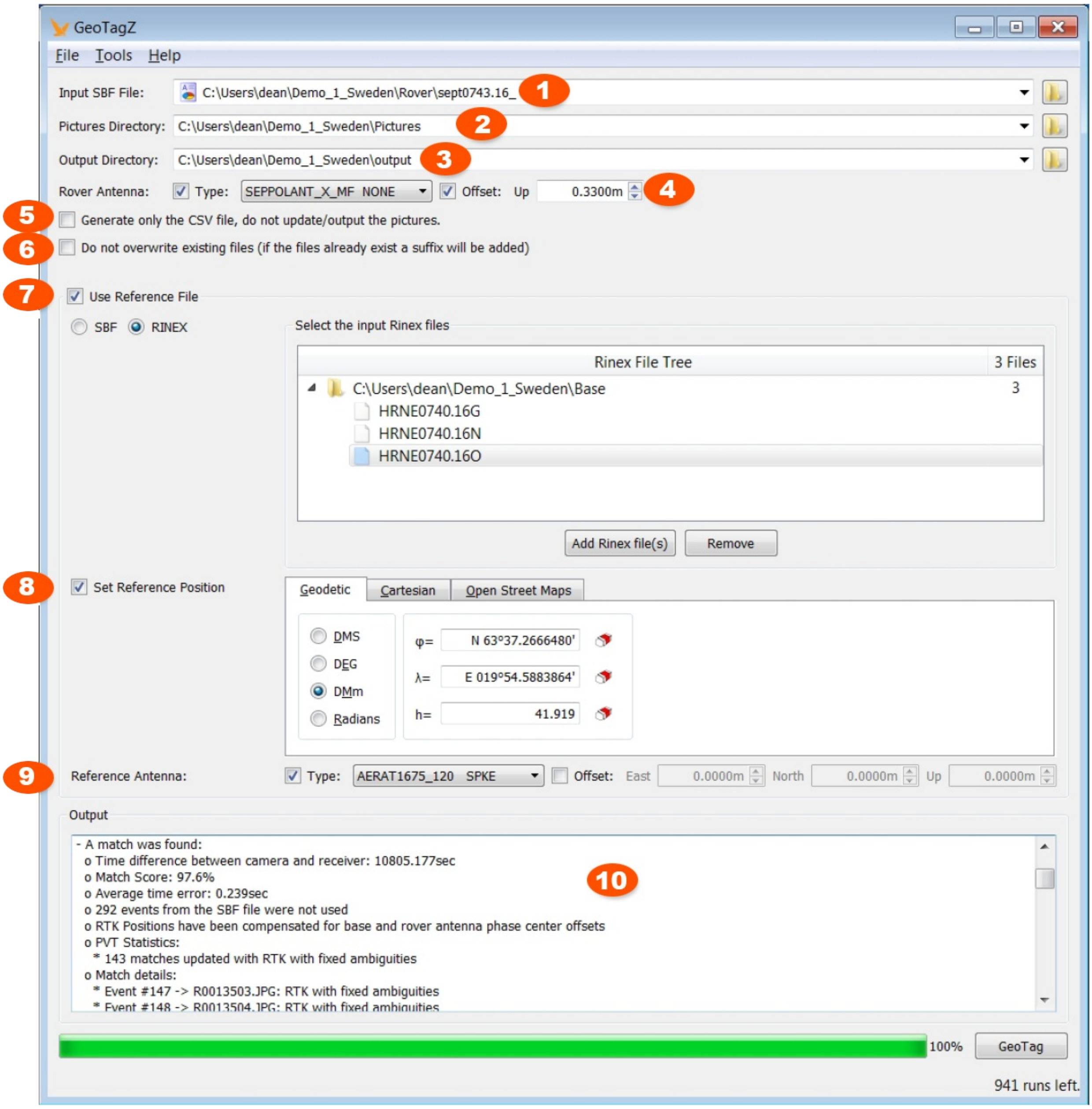
Launching GeoTagZ

- Insert the GeoTagZ dongle into one of the USB connectors on your PC
- Double click the ‘GeoTagZ GUI’ icon



Configuring GeoTagZ settings

You can select input files and configure all GeoTagZ settings on the GeoTagZ GUI as shown.



1. The Input SBF File is the rover file that was recorded by the AsteRx-m2 UAS on-board the aircraft.

2. The Pictures Directory is the location of the images taken during the flight.

3. The Output Directory is the location where the geotagged photographs and/or CSV photograph position file will be output.

4. Rover Antenna Type: used to select the type of antenna used by the rover receiver which allows GeoTagZ to take the phase center offset of the selected antenna into account. Offset: the Up Offset is the vertical distance between the antenna phase centre and the principle focus of the camera located within the aircraft. This setting can be ignored because often the photogrammetry software does a better job of estimating this and accounts for attitude changes in addition to a pure Up or Z offset.

5. Generate only the CSV file: checking this box will tell GeoTagZ to only write the photograph positions to a CSV file. The EXIF data in the photographs will not be updated.

6. Do not overwrite existing files: when this box is checked, the EXIF data in existing photographs will not be updated instead, the updated photographs will saved under a filename with an added suffix.

7. Use reference file: check this box to tell GeoTagZ to use the base station file given here as a reference for cm-level RTK positioning. The base station data can be either SBF or RINEX file formats.

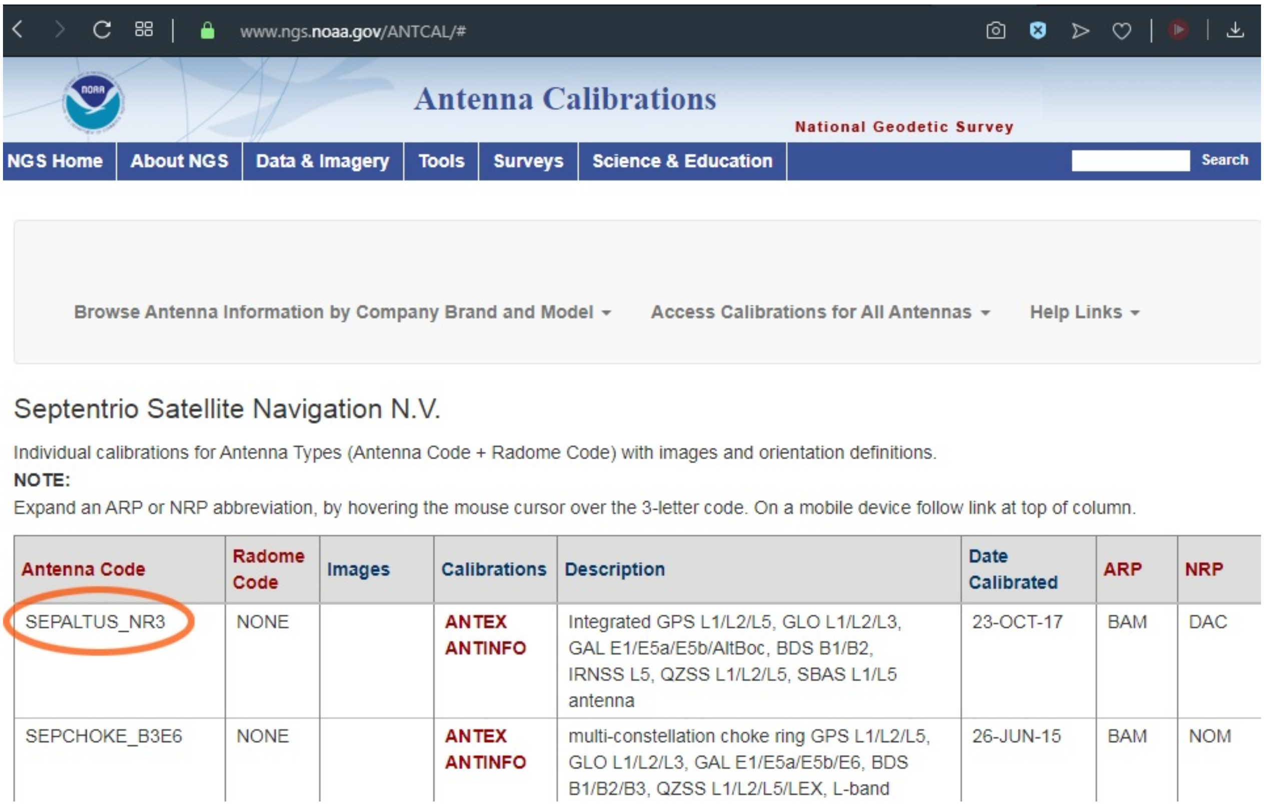
8. Set reference position: by checking this box you can manually insert the position of the base station. Please note that in this case, GeoTagZ will not use the offset in the RINEX file so any offset between the antenna reference point (ARP) and marker (see below) should be inserted manually in field 9. GeoTagZ will however still use the antenna type in the RINEX file.

When the 'Set reference position' box is not checked, GeoTagZ will:

- in the case of RINEX files, use the position in the RINEX header
- in the case of SBF files, the static position in the SBF file will be used or
- when not configured as static, a position similar to the real-time 'auto' setting will be used as the base station position. In this case, it is advisable to manually enter the base station position to ensure repeatability.

9. Reference Antenna Type: used to select the type of antenna used by the base station receiver which allows GeoTagZ to take the phase center offset of the selected antenna into account. By selecting Offset, the East, North and Up offset between the antenna reference point (ARP) and the position marker can be configured. When these boxes are not checked, GeoTagZ will use the antenna information contained in the selected reference file. The image below shows a schematic of the reference antenna setup.

The calibration file for the recommended Altus NR3 base station will be available in the next release of GeoTagz. In the meantime, the NGS (National Geodetic Society) provides specific calibrations for antenna types including Septentrio and other models. The Atlus NR3 file (ANTINFO) can be found here by searching 'SEPALTUS_NR3'.


www.ngs.noaa.gov/ANTCAL/#

Antenna Calibrations

National Geodetic Survey

NGS Home | About NGS | Data & Imagery | Tools | Surveys | Science & Education | Search

Browse Antenna Information by Company Brand and Model | Access Calibrations for All Antennas | Help Links

Septentrio Satellite Navigation N.V.

Individual calibrations for Antenna Types (Antenna Code + Radome Code) with images and orientation definitions.

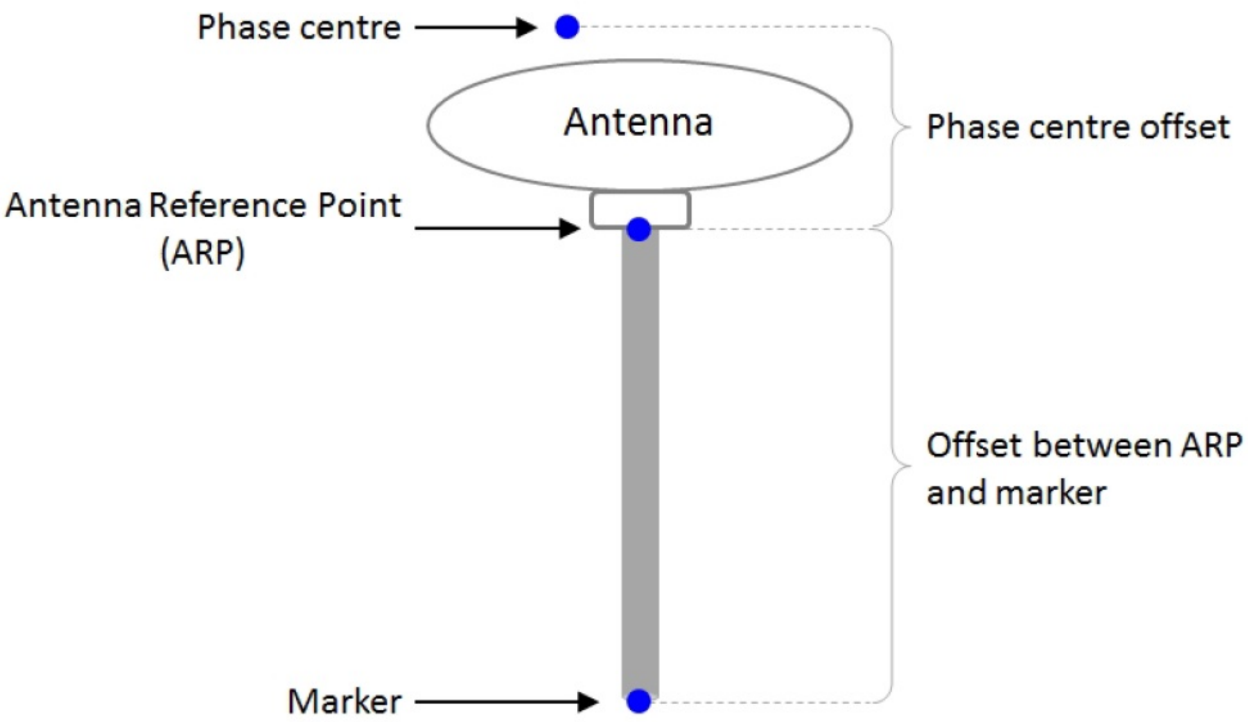
NOTE:

Expand an ARP or NRP abbreviation, by hovering the mouse cursor over the 3-letter code. On a mobile device follow link at top of column.

Antenna Code	Radome Code	Images	Calibrations	Description	Date Calibrated	ARP	NRP
SEPALTUS_NR3	NONE		ANTEX ANTINFO	Integrated GPS L1/L2/L5, GLO L1/L2/L3, GAL E1/E5a/E5b/AltBoc, BDS B1/B2, IRNSS L5, QZSS L1/L2/L5, SBAS L1/L5 antenna	23-OCT-17	BAM	DAC
SEPCHOKE_B3E6	NONE		ANTEX ANTINFO	multi-constellation choke ring GPS L1/L2/L5, GLO L1/L2/L3, GAL E1/E5a/E5b/E6, BDS B1/B2/B3, QZSS L1/L2/L5/LEX, L-band	26-JUN-15	BAM	NOM

10. Output: this field contains the information written to the log file (geotagz.log). In this example, although there were an excess of events, GeoTagZ was still able to correctly assign the 143 photographs to their correct event. All the photographs were geotagged with the cm-level positioning.

Reference station antenna mounting.



Tagging Multispectral Images

Multispectral cameras present more of a challenge for PPK tagging because there are multiple images created for every trigger command; one for each band. In this case, the Multispectral Mapping Payload generates five monochromtic TIFFs. In order to use GeoTagZ, each band must be separated into its own folder before tagging. The band is indicated by the end of the file name ending in `_1` `_2` `_3` `_4` or `_5`. After the bands are in separate folders, run the normal PPK workflow for each folder seprately. The images can then be moved back into the same folder once tagged.

Did GeoTagZ processing work?

If all went well with GeoTagZ processing, you should see output messages similar to those shown in field 10.

GeoTagZ Troubleshooting

If something went during processing, GeoTagZ will report errors or warnings. The list below details some of the most common errors reported.

Not enough valid data to compute a Position-Velocity-Time (PVT) solution

This message indicates that the rover file did not contain the necessary data for GeoTagZ to be able to make position calculations.

This message will also appear if you have selected to use a reference file in field 7 but, the RINEX observation file is either missing or corrupt.

```
o PVT Statistics:
    * 143 matches updated with Stand-Alone PVT
  o Match details:
    * Event #147 -> R0013503.JPG: Stand-Alone PVT
    * Event #148 -> R0013504.JPG: Stand-Alone PVT
```

When GeoTagZ only reports standalone positions and fails to calculate an augmented GNSS position (DGNSS or RTK) for any of the images, this tends to indicate a problem with the base station reference data. If you are using an Altus NR3 base station, you may not have selected all the data blocks necessary for RTK post processing. If the manually entered position is a large distance from the correct base station distance then GeoTagZ may also not be able to calculate RTK positions.

No match found between the images and the events in the input SBF file

This error message means that GeoTagZ was unable to match up the times reported in the images with the shutter events in the rover (aircraft) SBF file. This may be due to excess events in the SBF file for example, from spurious pulses resulting from signal crosstalk. The problem may also be due to missing images which can happen if the camera fails to recognize trigger commands. In this event, you can end up with more shutter events than images which can cause problems for GeoTagZ during the matching stage. This problem can be avoided by using the feedback signal from the camera as an event signal input for the rover receiver.

RTK positions have not been compensated for base antenna phase center offsets.

This warning message means that the calculated positions have not been compensated for the phase center offset of the base station antenna because the antenna was not found in the GeoTagZ antenna library. When this happens, the phase center offset, as indicated in the antenna reference mounting, can be entered manually as an offset in field 9.

Images with anomalous time stamps

GeoTagZ is able to detect images with anomalous time stamps. When this happens, you will be prompted to select one of several proposed courses of action each of which is given a match score.

```
- Picture issues:
  o Error: Error: kabo.csv has an unsupported extension.
```

If there are files in the image directory that do not have standard file extensions, Geo- TagZ will list them under ’Picture issues’.

Base Station

A base station is a GPS receiver at an accurately-known fixed location which is used to derive correction information for nearby portable GPS receivers, in this case the portable receiver is in the aircraft. This correction data allows propagation and other effects to be corrected out of the position data obtained by the aircraft, which gives greatly increased location precision and accuracy over the results obtained by uncorrected GPS receivers.

The recommended base station is the Septentrio Altus NR3 as it is precise, easy-to-use, and not cost prohibitive. However, RINEX data from other base stations or reference networks can also be used, and thus are still compatible with GeoTagZ.

The following is a simple walkthrough for using the Altus NR3 as a base station. This is by no means an exhaustive explanation as GNSS position refinement techniques are relatively sophisticated. For more information and advanced settings, please see the Altus User Manual which can be found here.

Altus NR3 Base Station

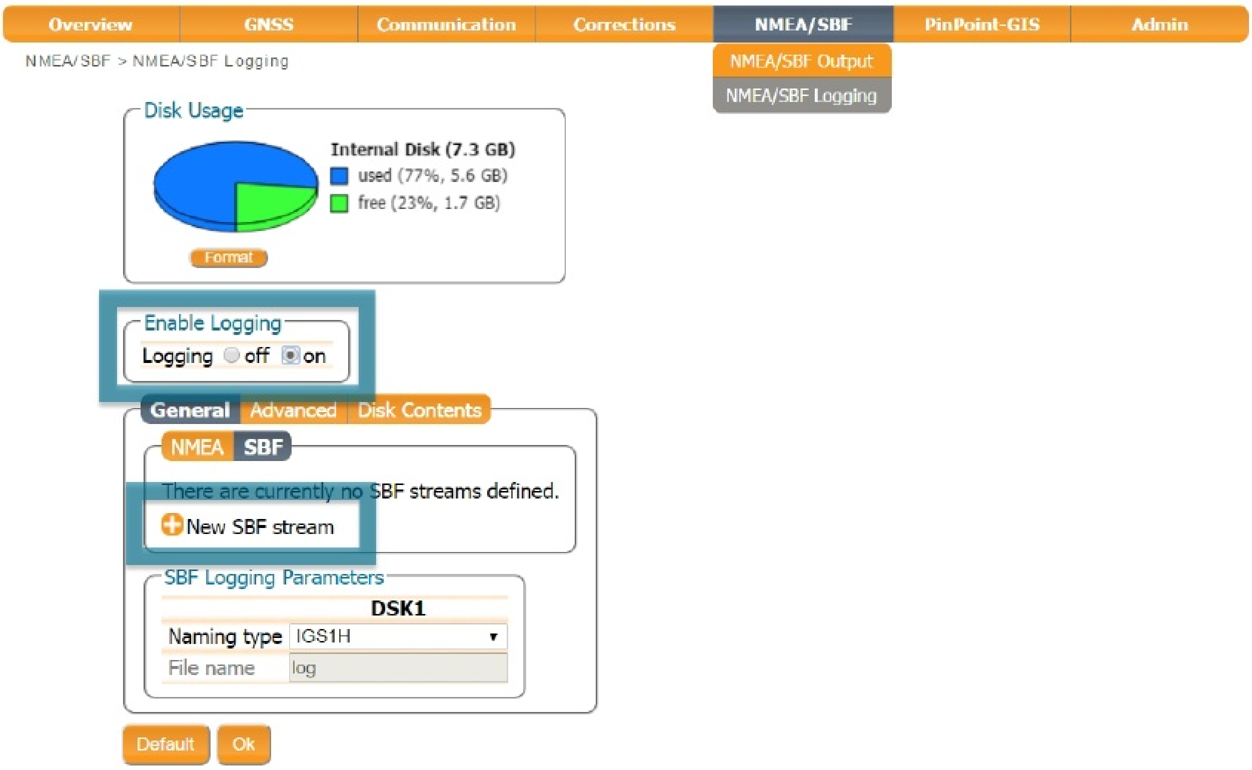
Configuring the Altus as a Base Station

Connecting to the Web Interface

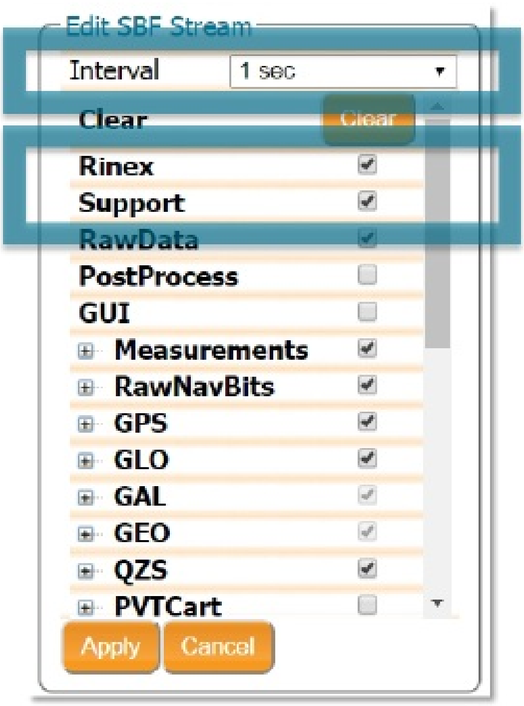
The base station makes a WiFi point. WiFi is turned on by default and will be available about 30 seconds after powering on. On your PC or mobile device, find the WiFi network and click Connect (there is no password). Open a browser and type 192.168.20.1 in the address bar.

Configuring Data Logging

On the `NMEA/SBF Tab` ⇨ `NMEA/SB Logging`



1. Enable Logging can be set to on or off. If 'on' is selected, the base will begin logging as soon as it is turned on. If 'no' is selected, the base will only log when you decide to begin logging by short-pressing the power button located on the Altus receiver.
2. Select `SBF` under `General` settings
3. Choose `New SBF stream`. A new window will open
4. Select to log data at 1 sec interval
5. Choose `Rinex` and `Support`. This option will automatically select the individual SBF blocks required for GeoTagZ processing.



Set the Base Station Position as Static

On the `GNSS Tab` ⇨ `Position Mode`

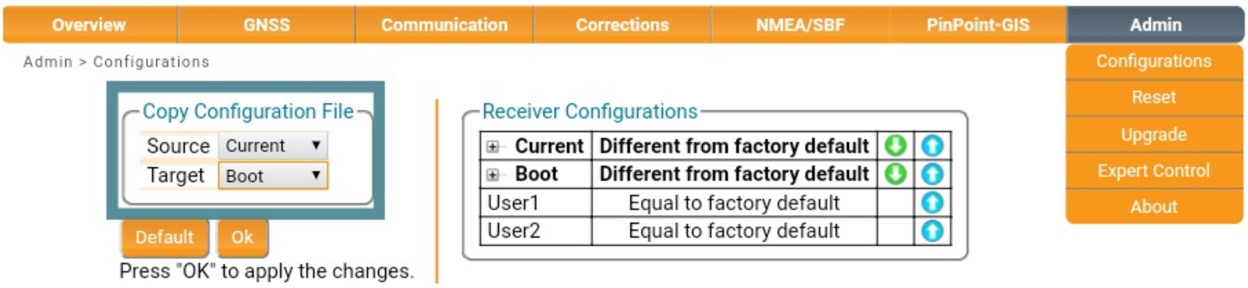
To work as a Base station, the position of the Altus NR3 should be configured as `static`. The ‘Static’ position mode should be selected as shown.

Copy Configuration

You will want to configure your base to power-on with your new settings everytime. To do this, go to the `Admin Tab` ⇨ `Configurations`

In the Copy Configuration File section:

1. Set 'Source' to `Current`
2. Set 'Target' to `Boot`
3. Press `OK` to apply changes

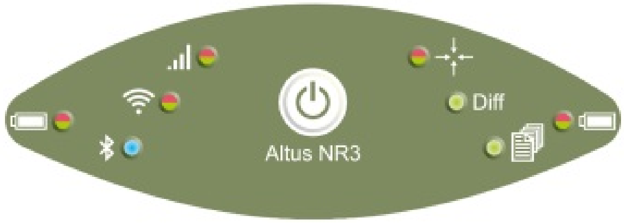


Using the Base Station

Logging Data

1. Assemble your tripod and base. The location of your setup does not really matter, but it should be at least roughly 10 meters away from any obstacles or building.
2. Turn on by pressing the power button.
3. Verify your base battery status.
4. To start logging, short press the power button (only applies if Enable Logging was set to 'no'). Logging is active when the page icon has a green light. For good results you should log for at least 61 minutes, or the entire duration of your flight, whichever is longer.
5. Connect to the WiFi to check how many satellites you have by opening the `GNSS Tab` ⇨ `Status`. In open sky, the Altus NR3 should track between 15 and 25 GPS and GLONASS satellites.
6. Fly.
7. Land and shutdown your aircraft.
8. To stop logging, short press the power button.
9. To turn off, press and hold the power button for 2 seconds.

LED Meanings



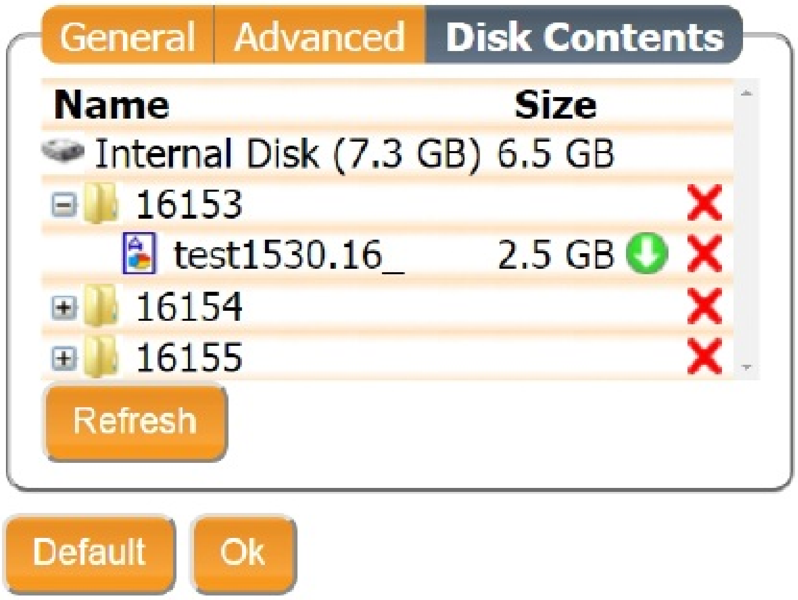
Altus NR3 Front Panel

The table below provides an overview of the LED indicators.

	Function	Indication
	Battery Power Level	Battery Power level (Green to Red) solidly lit = battery is in use, blinking = battery is not in use
	Bluetooth status	Bluetooth is off (not lit), Bluetooth is on and discoverable (blinking blue)[1], Bluetooth is connected to an external device (blue)
	WiFi On/Off	WiFi On (Green) or Off (not lit)
	Cellular Modem Status	The cellular modem is not in use (not lit), connecting (orange), connected (green) or there is an error in the connection (red)
	Position Mode	The reported position is RTK Fixed (green), Stand alone (red), any other mode (orange) or no position can be calculated (not lit)
Diff	Differential Corrections	Differential Corrections are being received (Green) or differential Corrections are not being received (not lit)
	Data Logging	Logging is disabled (not lit), active (green)

Downloading Data Files

1. Connect to the base WiFi
2. Under the `NMEA/SBF Tab` ⇨ `NMEA/SBF Logging`
3. Select `Disk Contents`
4. Find your most recent base file, or the one that correlates to your flight.
5. Select the `green arrow` to download.



Finding your Base Location

Your base station will estimate its location, but unfortunately that location is only accurate to 1-5 meters without a correction source. The following is a non-exhaustive list of correction sources or methods that you may use to determine your location, either before or after your flight. Some services require a fee or subscriptions; others are free.

- Shoot an RTK point for the base location
- Known location (survey monument)
- Static point for the base and correct via CORS
- Static for the base and correct with PPP (Precise Point Positioning)
- Use PPP in real time via satellite or modem

Workflow Example: Correcting a Static Point with PPP after your Flight

In this example, you will take your raw observations that you downloaded from your base and upload them to a free PPP correction service.

1. With you base setup nearby and at an unknow location, log for at least 61 minutes.
2. Covert your SBF file to RINEX using RxTools, or just output RINEX files. RxTools can be found here
3. Compress your RINEX files together as a zip or gzip.
4. Visit Natural Resources Canada's PPP website here
5. Create an account and sign in.
6. Upload your compressed RINEX file. Note, you must wait 24 hours after logging before submitting.
7. Choose 'Static Point' and set the geodetic frame to ITFR (International Terrestrial Reference Frame).
8. Waiting for results is variable and can take anywhere from 10 minutes to 24 hours depending on time of day and server backlog.
9. Results containing your base latitude, longitude, and altitude will be emailed to you.
10. Check 'Set Reference Position' in GeoTagZ and type in your base location.

Some known Reference Networks

RINEX data from CORS (Continuously Operating Reference Stations) can also be used for GeoTagz in lieu of your base station. Find a reference station with a baseline of 10km or less from your flight to ensure high position accuracy for PPK results. At distances greather than 10km, your accuracy will degrade, and you may be required to use your local base station.

Many countries operate CORS networks and make their RINEX data available for download. Where possible, use a base station that provides both GPS and Glonass data at a high recroding rate - ideally 1s. You can find a non-exhaustive list of some popular reference networks below. Some are free while others charge for service.

Reference Network	Coverage	Link
UREF	Europe	http://www.epncb.oma.be/_networkdata/stationlist.php
CORS	USA	http://geodesy.noaa.gov/CORS/
NGRS	Australia	http://www.ga.gov.au/ngrs/
RBMC	Brazil	http://www.ibge.gov.br/english/geociencias/geodesia/rbmc/rbmc.shtm
CACS	Canada	https://webapp.geod.nrcan.gc.ca/geod/data-donnees/cacs-scca.php?locale=en
RGP	France	http://rgp.ign.fr/
GREF	Germany	https://igs.bkg.bund.de/
FinnRef	Finland	http://euref-fin.fgi.fi/fgi/en/positioning-service
06-GPS	Holland	http://www.06-gps.nl/index.php/english
Flepos	Belgium (Flanders)	http://ntrip.flepos.be/
Walcor	Belgium (Wallonia)	http://gnss.wallonie.be/walcors.html
GPSBru	Belgium (Brussels)	http://www.ngi.be/agn/NL/NL0.shtm

Battery Charging

Charging

Proper care of your Lynx VTOL batteries is important to prevent damage to your aircraft and to maximize flight time. With a fully charged main battery, the Lynx VTOL will fly for about two hours. Frequent altitude changes, presence of wind, use of old batteries, temperature, payload power requirements, and your height above sea level can significantly reduce the flight endurance. Batteries perform better at medium or high air temperature and it is normal to observe shorter flight times in cold weather.

Lynx VTOL is powered by a pair of main batteries and a single dedicated battery for the vertical motors. The main batteries use Lithium Ion (LiIon) cells arranged as 9Ah 3S packs. In the aircraft, the main batteries are joined in series to create 9Ah 6S pack. A single LiIon cell can have a range between 4.2V (full) to 2.7V (empty) in its normal operating range. This means the main battery's voltage range (in the aircraft) is 25.2V to 16.2V.

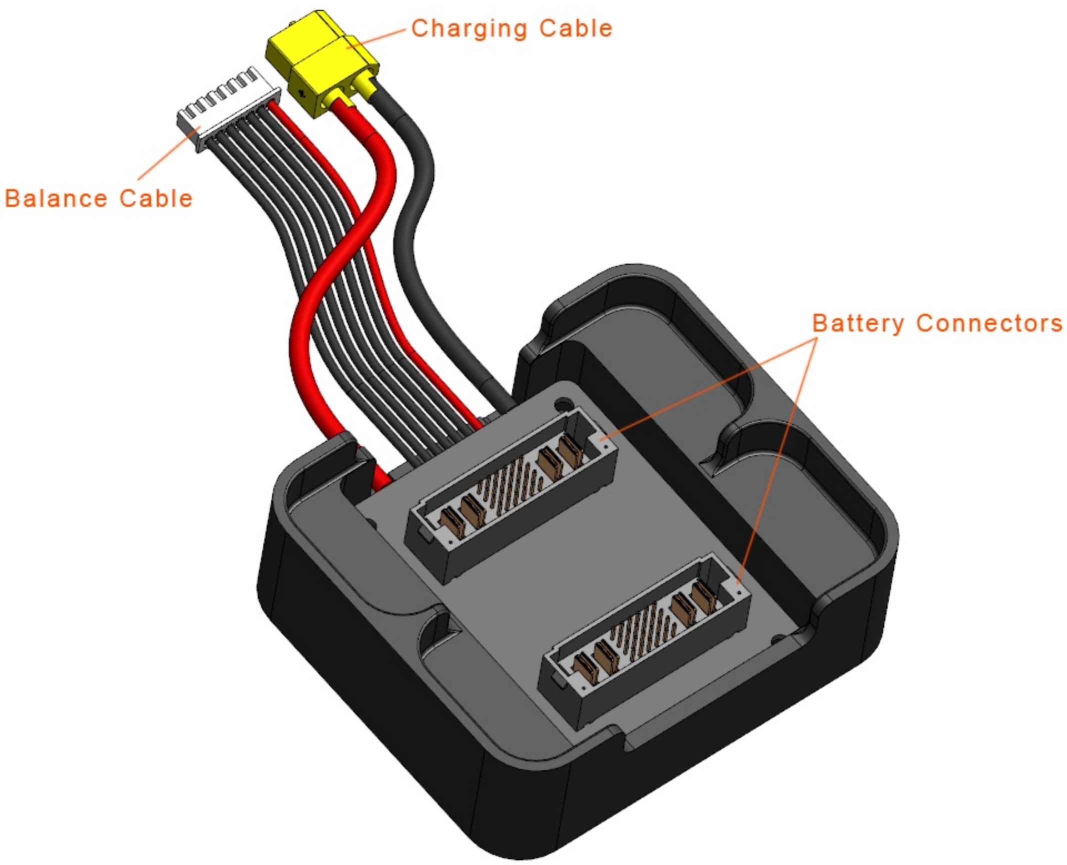
The VTOL battery is a high-discharge Lithium Polymer (LiPo) battery arranged as a 1.45Ah 6S pack. A single LiPo cell can have a range between 4.2V (full) to 3.3V (empty) in its normal operating range. This means the VTOL battery's voltage range is 25.2V to 19.8V.

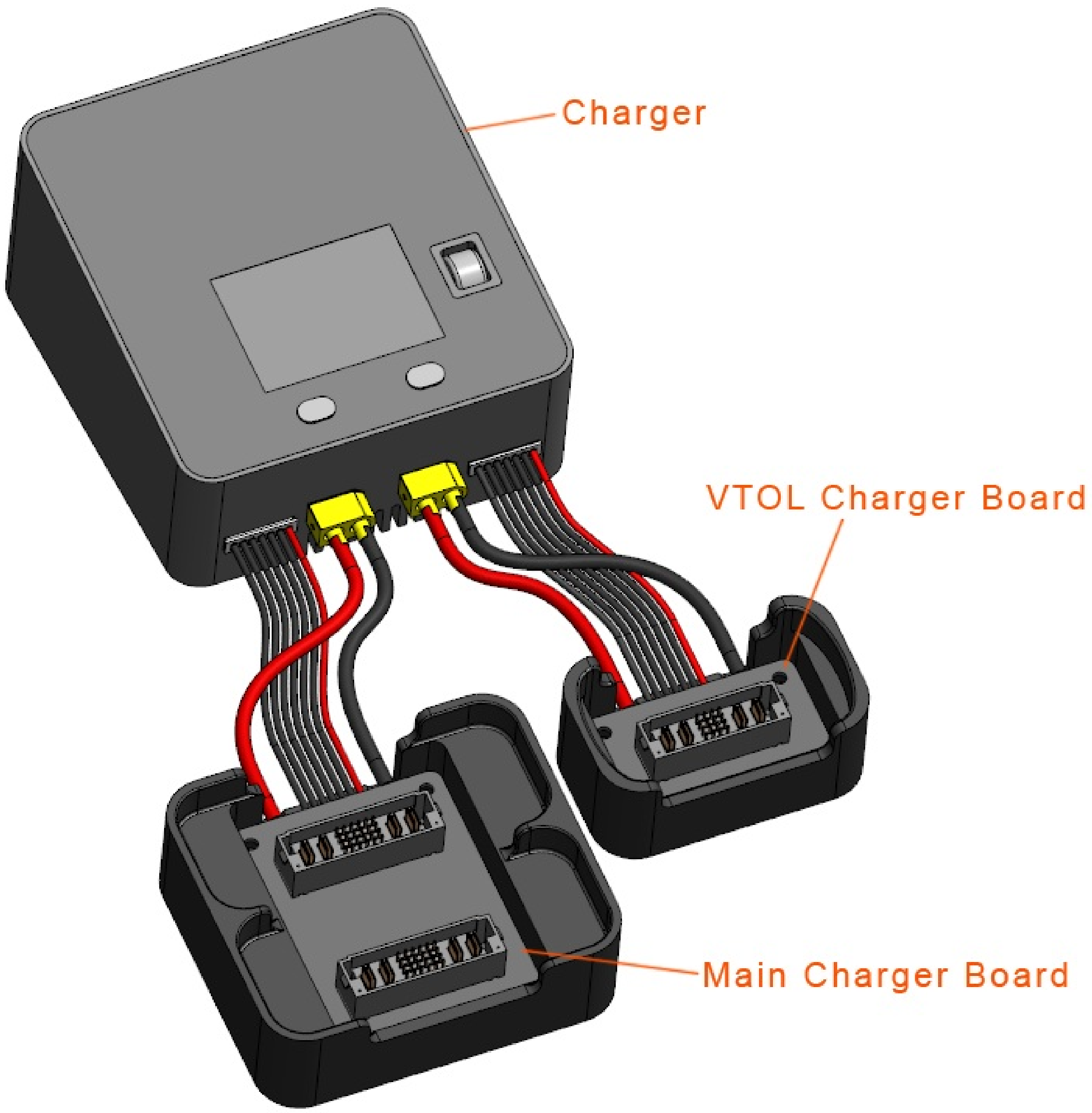
A well-balanced and healthy battery should have all cells within a very similar voltage.

Charging the main batteries can take up to two hours, depending on the charge level of the battery and the required cell balancing work. Charging the VTOL battery usually only takes an hour.

Charger Boards - Connect

Connect the battery charger boards to the charger.





Ensure that the balance cable and charging cable for each board are connected into the same channel on the charger.

Charger - Turn On

Connect the charger power cable to an AC outlet.

Battery - Install

Install the batteries into their respective charger boards. The dual charger board is used for the main battery pair. The single board is used for the VTOL battery.

Caution: The battery connectors are keyed and only fit one way. Forcing the battery into the wrong orientation may damage the battery, the connector, and/or the charger board.

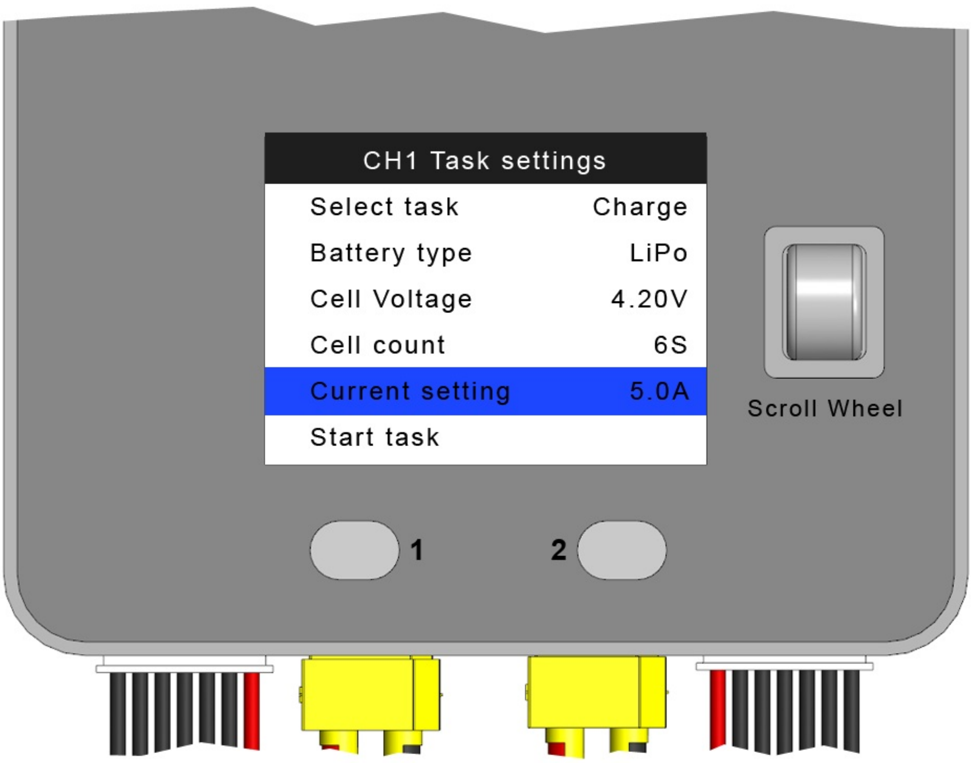
A warning of "To high balancer port voltage" may occur when the battery is connected. Wait for up to 15 seconds for this to clear automatically.

Channel - Select

Press the 1 button for the first charging channel.

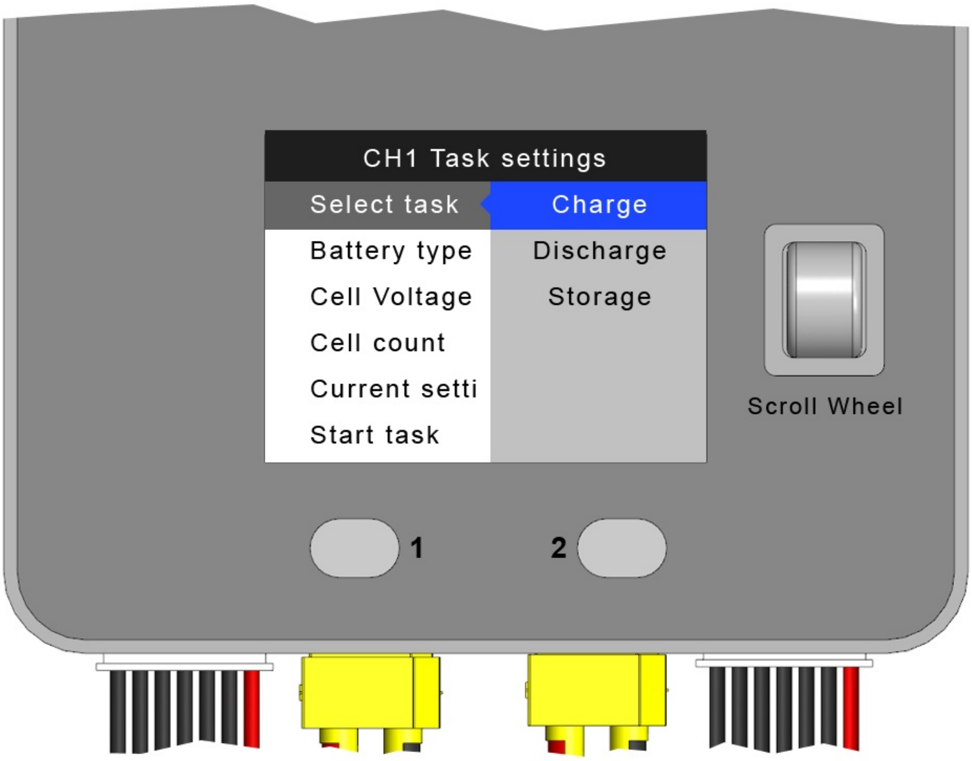
Menu - Open

Press down on the scroll wheel to open the menu for the selected channel.



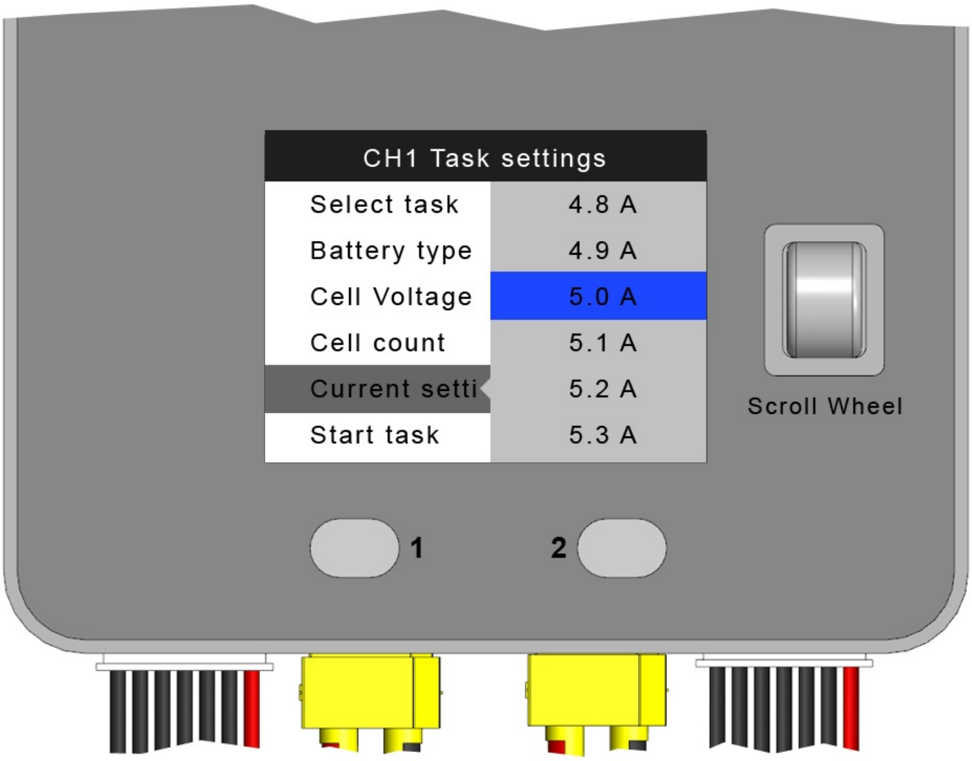
Charge Mode - Set

The charger needs to be running the charge task in order to charge the battery. This is done by scrolling to the “Select task” entry and pressing down on the scroll wheel. Then scroll and select "Charge".



Charge Current - Set

Set the appropriate charging current for the battery. This is done by scrolling to the “Current setting” entry and pressing down on the scroll wheel. Then scroll and select the correct charge current.



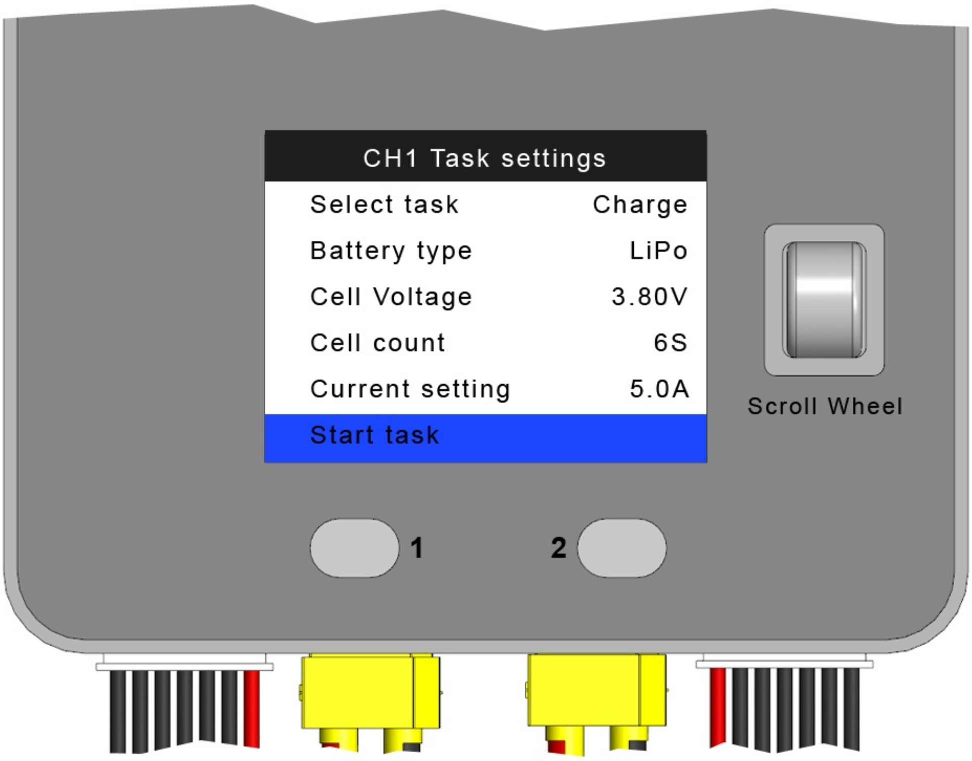
The charging current is printed on the battery charging board and can be found in the below table:

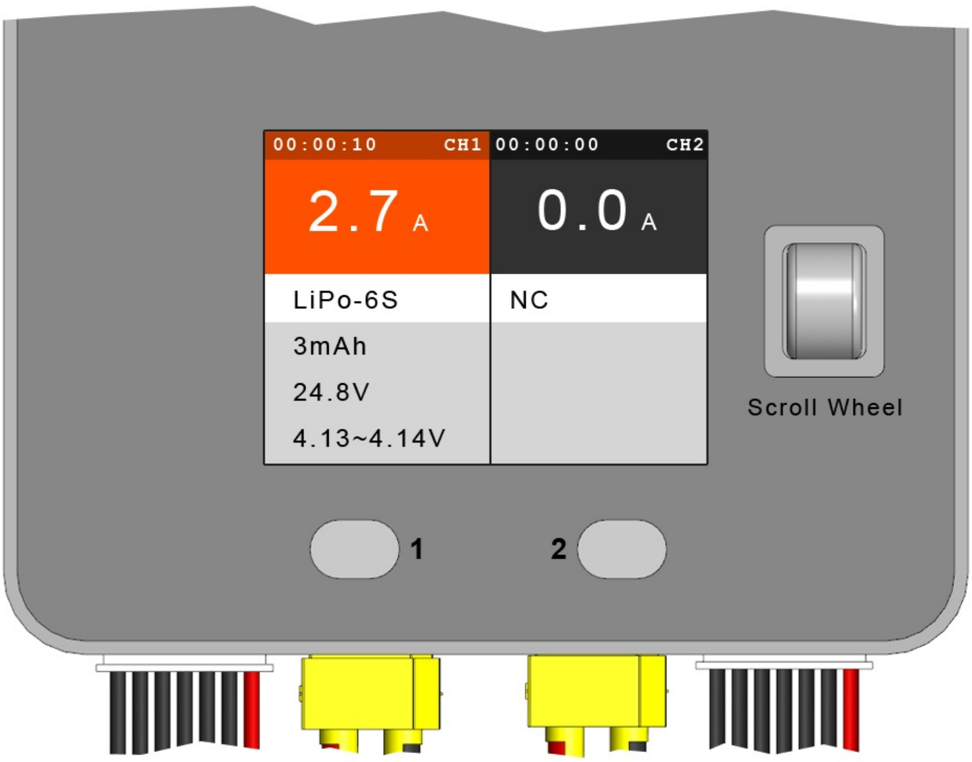
Battery	Charge Current
Main Battery (LiIon charger board)	5.0A
VTOL Battery (LiPo on charger board)	1.4A

Warning: Charging at a current higher than listed can damage the battery or cause a fire. A damaged battery will not fly as long as a healthy battery and pose a fire hazard. Do not exceed the listed charge current.

Charge - Start

Scroll down to the “Start task” menu entry and press down on the scroll wheel to start charging that battery.





Second Battery - Start

Repeat the same steps as above but select channel two instead.

> Warning: Never leave a battery charger unattended. A battery fire could happen if a defective or damaged battery is left unattended and overheats.

Charging - Complete

The charger will show an orange background while rapidly charging, a green background while balancing the cells, and a blue background when done. Wait until the battery has finished and displays a blue background. At this point, you may remove the finished battery from the charger board.

> It is important to let the charger finish balancing the battery. Using unbalanced batteries can damage the battery and/or aircraft.

Battery Storage

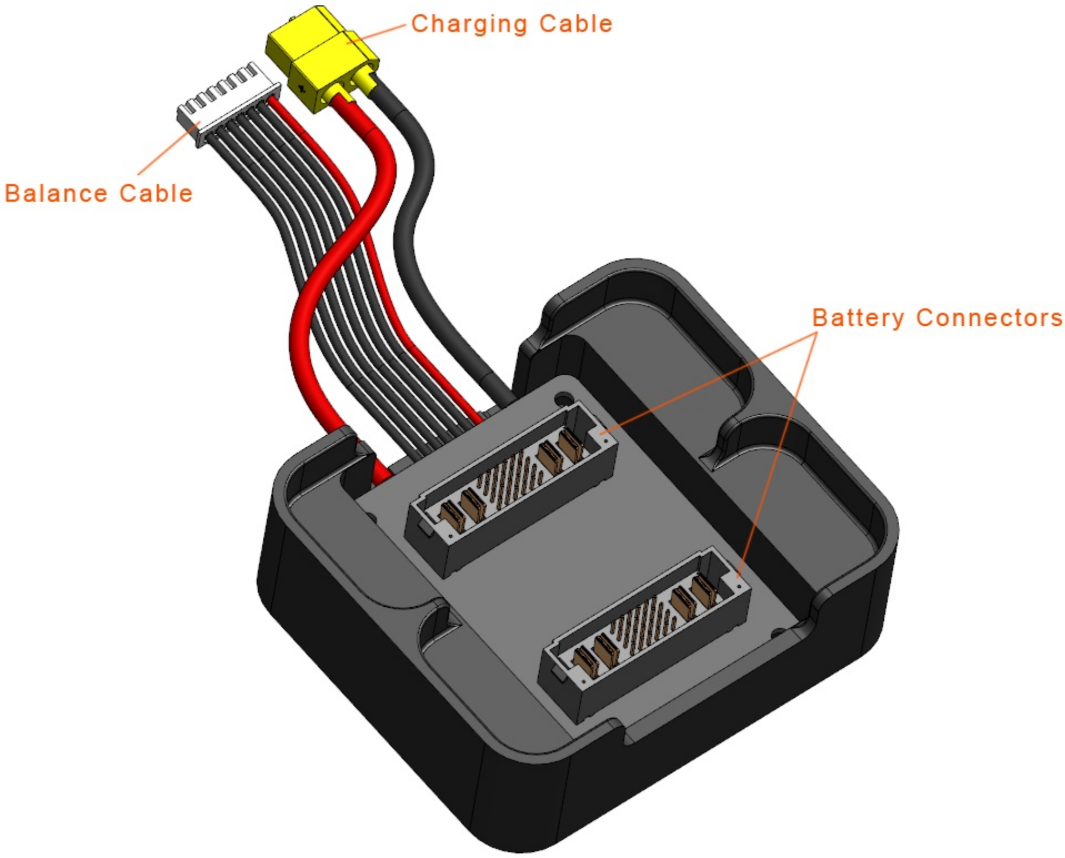
Batteries should not be stored fully charged, or discharged for longer than a week. Doing so can shorten their life span. If a battery will not be flown within that time period, it should be left at a storage charge instead.

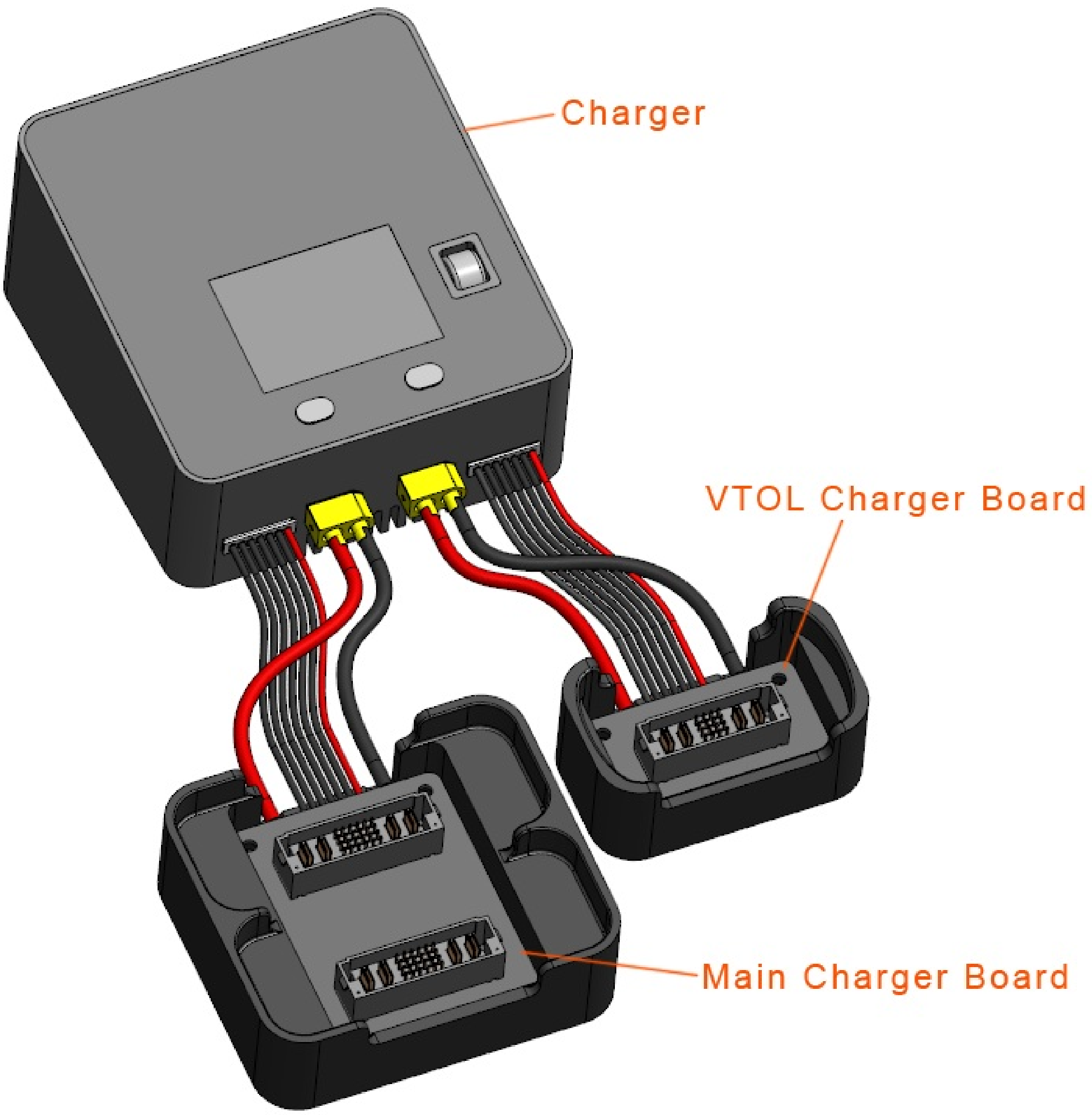
The battery charger will either charge or discharge the battery until the battery is approximately half full, this is considered the best way to store your batteries when not being used frequently.

Make sure to cycle your packs at least once per month if you are not flying the packs since leaving them on the shelf for a prolonged period of time can cause the packs to get severely out of balance, puff/swell or even go dead. The packs can be cycled by charging them, then running the storage function again.

Charger Boards - Connect

Connect the battery charger boards to the charger.





Ensure that the balance cable and charging cable for each board are connected into the same channel on the charger.

Charger - Turn On

Connect the charger power cable to an AC outlet.

Battery - Install

Install the batteries into their respective charger boards. The dual charger board is used for the main battery pair. The single board is used for the VTOL battery.

Caution: The battery connectors are keyed and only fit one way. Forcing the battery into the wrong orientation may damage the battery, the connector, and/or the charger board.

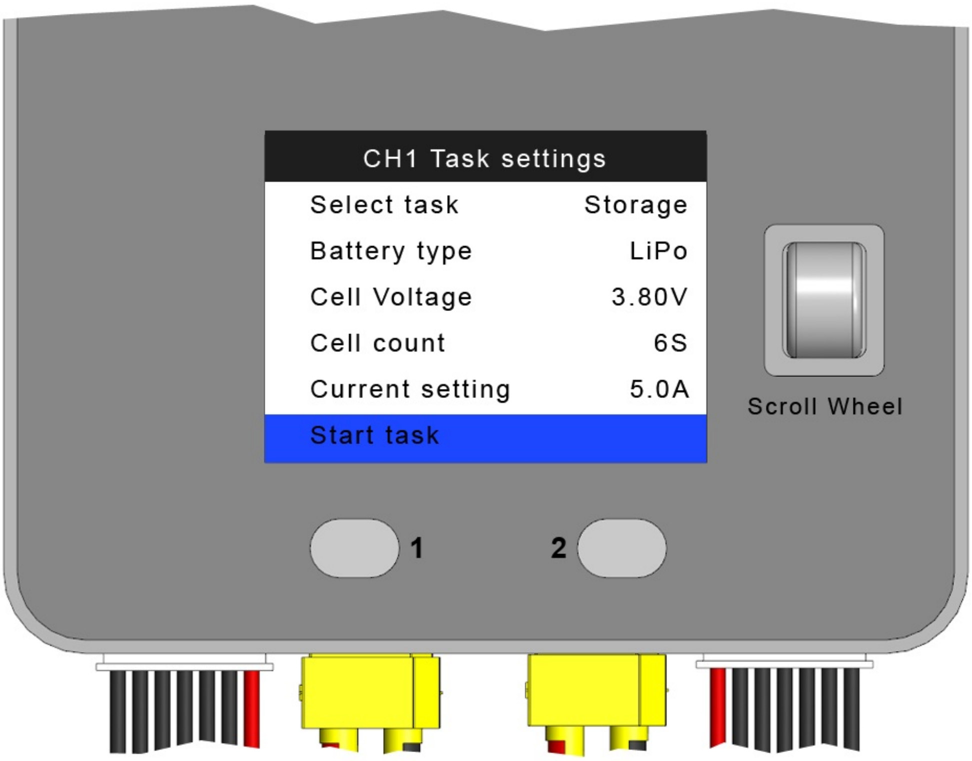
A warning of "To high balancer port voltage" may occur when the battery is connected. Wait for up to 15 seconds for this to clear automatically.

Channel - Select

Press the 1 button for the first charging channel.

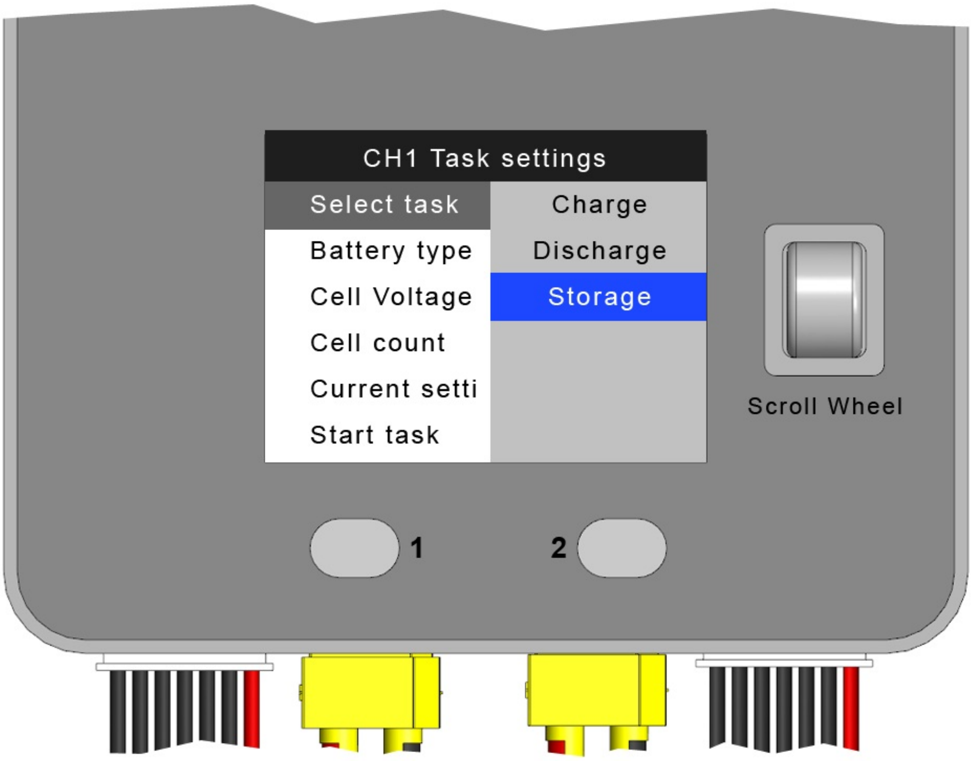
Menu - Open

Press down on the scroll wheel to open the menu for the selected channel.



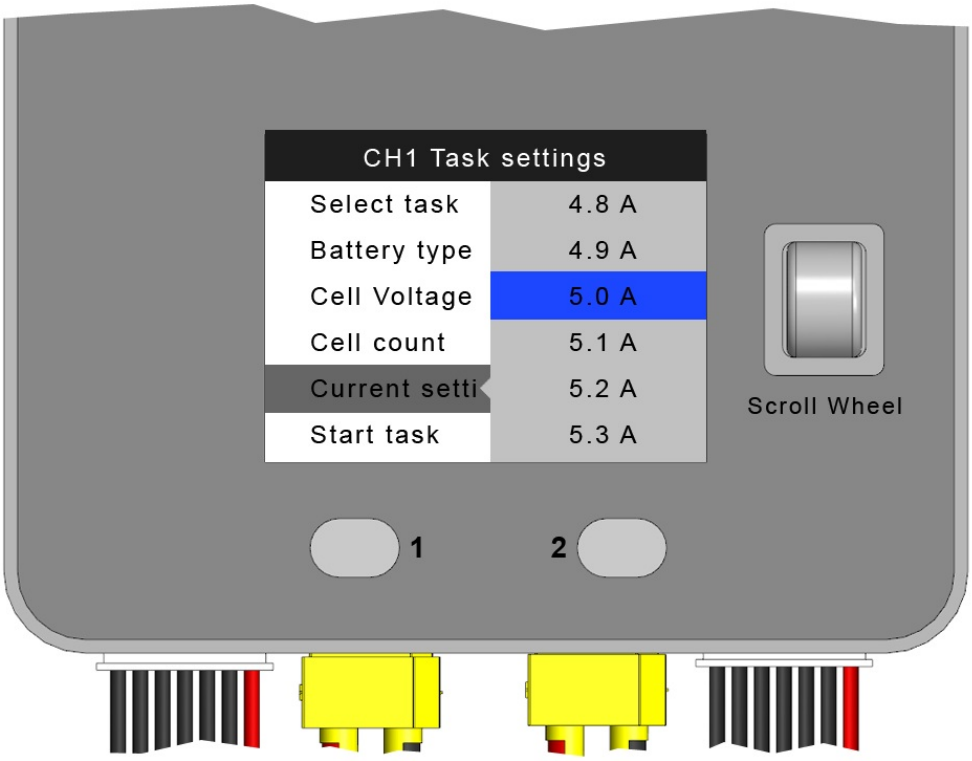
Storage Mode - Set

The charger needs to be running the storage task in order to put the battery into storage. This is done by scrolling to the "Select task" entry and pressing down on the scroll wheel. Then scroll and select "Storage".



Storage Current - Set

Set the appropriate charging current for the battery. This is done by scrolling to the “Current setting” entry and pressing down on the scroll wheel. Then scroll and select the correct storage current.



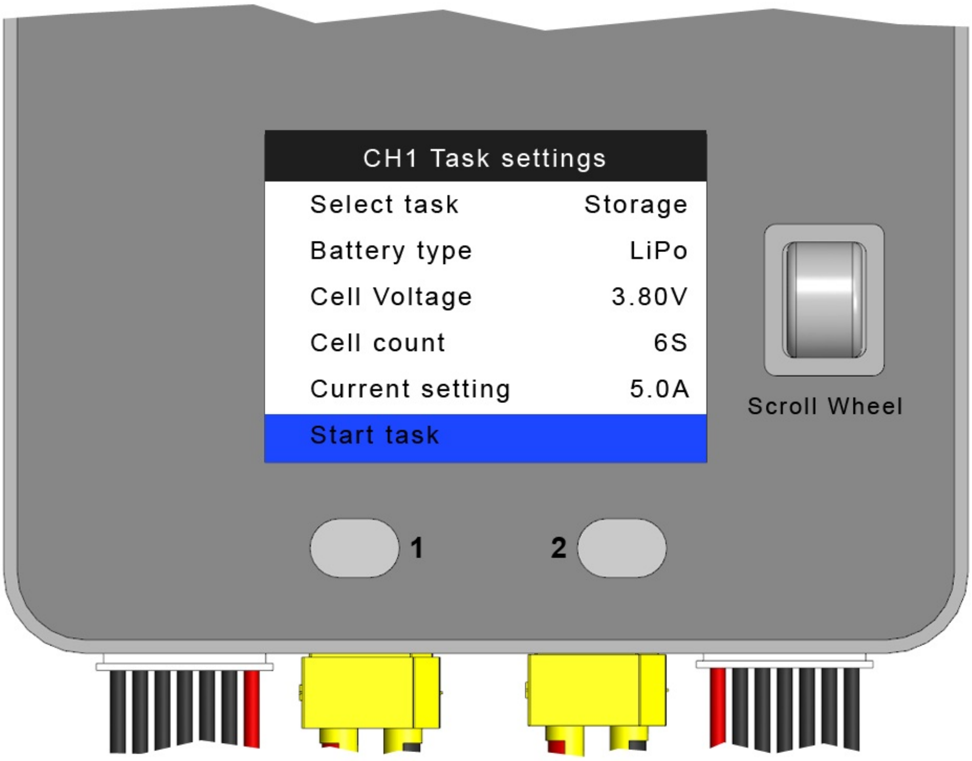
The storage current is printed on the battery charging board and can be found in the below table:

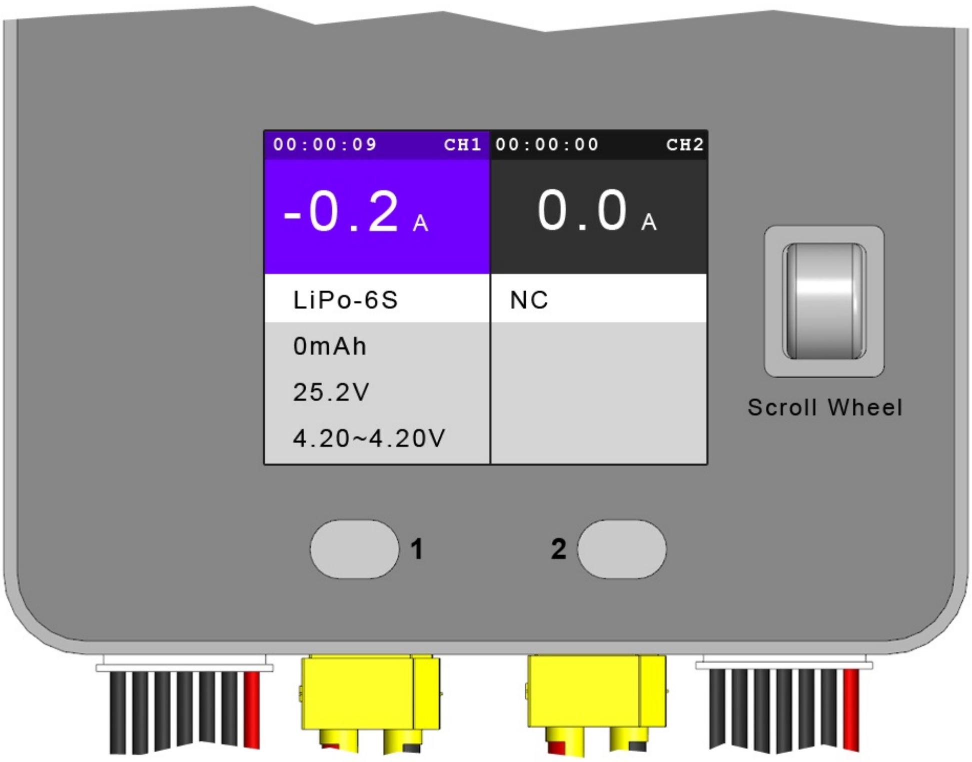
Battery	Storage Current
Main Battery (LiIon charger board)	5.0A
VTOL Battery (LiPo on charger board)	1.4A

Warning: Charging at a current higher than listed can damage the battery or cause a fire. A damaged battery will not fly as long as a healthy battery and pose a fire hazard.

Storage - Start

Scroll down to the “Start task” menu entry and press down on the scroll wheel to start the storage task for that battery.





Second Battery - Start

Repeat the same steps as above but select channel two instead.

> Warning: Never leave a battery charger unattended. A battery fire could happen if a defective or damaged battery is left unattended and overheats.

Storage - Complete

The charger will show a purple background while going to storage, and a blue background when done. Wait until the battery has finished and displays a blue background. At this point, you may remove the finished battery from the charger board.

> It is important to let the charger finish balancing the battery. Using unbalanced batteries can damage the battery and/or aircraft.

Maintenance and Repair

Tool Kit

Lynx VTOL maintenance and repairs are performed with simple hand tools included with each tool kit.

- **Pitot Tube Cover:** Used during the airspeed calibration preflight step to shield the pitot tube from wind.
- **Phillips Screwdriver:** Used for removing and tightening fasteners on Lynx VTOL.
- **Flathead Screwdriver:** Used for removing and tightening fasteners on Lynx VTOL.
- **Hex Key:** Only used for removing VTOL propellers.
- **Crescent Wrench:** The crescent wrench is an adjustable wrench used to apply grip when removing nuts and bolts/screws.
- **Lens Brush:** The lens brush is only included with camera payloads. It features a retractable brush and a pad for cleaning dust and smudges off the camera lens prior to takeoff.

Cleaning and Storage

Disconnect batteries before cleaning the aircraft. Use a damp cloth or compressed air to remove dirt and dust from the Lynx VTOL airframe. Use a vacuum or compressed air to remove dirt from the inside of the fuselage. Do not use solvents such as rubbing alcohol (isopropyl alcohol) or acetone as they can damage the paint and composite structure of the aircraft. Never submerge or pour water onto the Lynx VTOL airframe as this will damage sensors and electronics.

Caution: Do not blow compressed air directly into the pitot tube as this will rupture the airspeed sensor.

Flying from a Dusty Environment

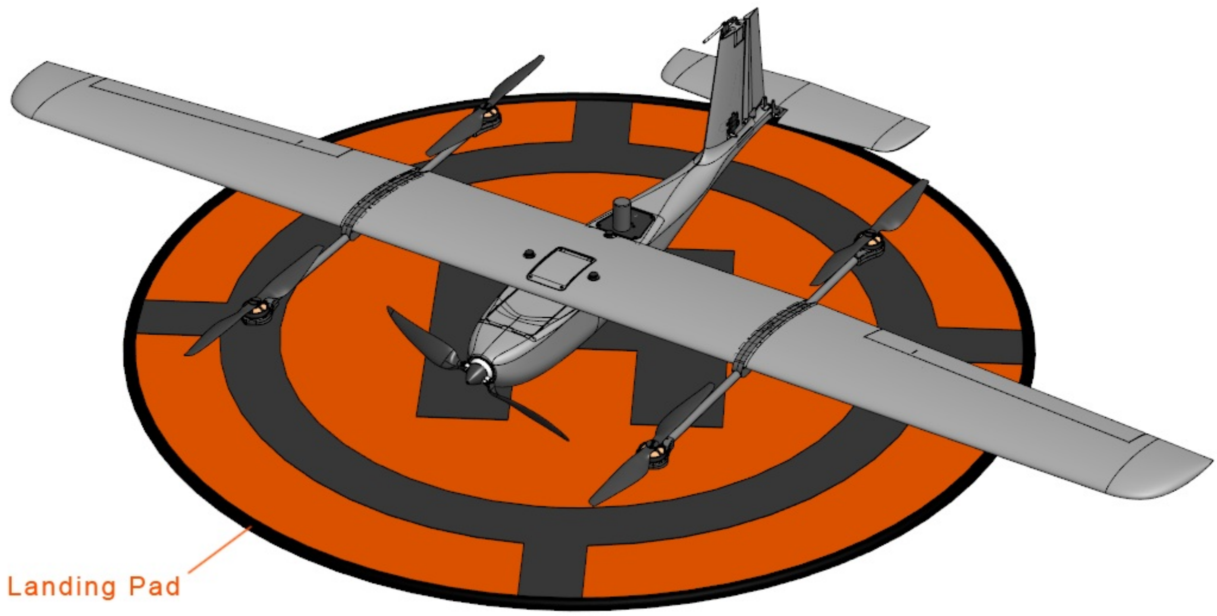
In dusty environments, motor thrust will kick-up significant dust during takeoff and landing. The aircraft should be cleaned after each flight if dust has visibly accumulated. Ensure the main and VTOL propellers are wiped clean in addition.

Check that each VTOL motor spins freely by hand. A motor that grinds, clicks, or is difficult to turn usually indicates that ferrous (iron) dust, gravel, or sand is stuck to the motor's magnets. Since the dust is likely attracted to magnets, the dust can be tricky to remove. First try a combination of compressed air and vacuuming. Blow air directly through the motor from the top by aiming at the magnets and windings. This is the highly preferred method as no disassembly is required. However, if the dust cannot be removed with compressed air/vacuum, and it is obstructing the motor from freely spinning, the motor will need to be disassembled to wipe away the dust.

See VTOL Motor Disassembly for more info

Dust Mitigation

Use of a large landing pad is an effective way to reduce dust accumulation on the aircraft during takeoff and landing. An eight foot (2.5 meter) diameter pad or larger is recommended for landing accuracy. A landing pad should be considered essential when flying from dirt roads, dry environments, sandy areas, etc.



Tip: We use the eight foot pad from Hoodman at https://www.hoodmanusa.com.

Battery Storage

Batteries should not be stored fully charged, or discharged for longer than a week. Doing so can shorten their life span. If a battery will not be flown within that time period, it should be left at a storage charge instead.

The battery charger will either charge or discharge the battery until the battery is approximately half full, this is considered the best way to store your batteries when not being used frequently.

Make sure to cycle your packs at least once per month if you are not flying the packs since leaving them on the shelf for a prolonged period of time can cause the packs to get severely out of balance, puff/swell or even go dead. The packs can be cycled by charging them, then running the storage function again.

See Battery Storage for more info

Aircraft Storage

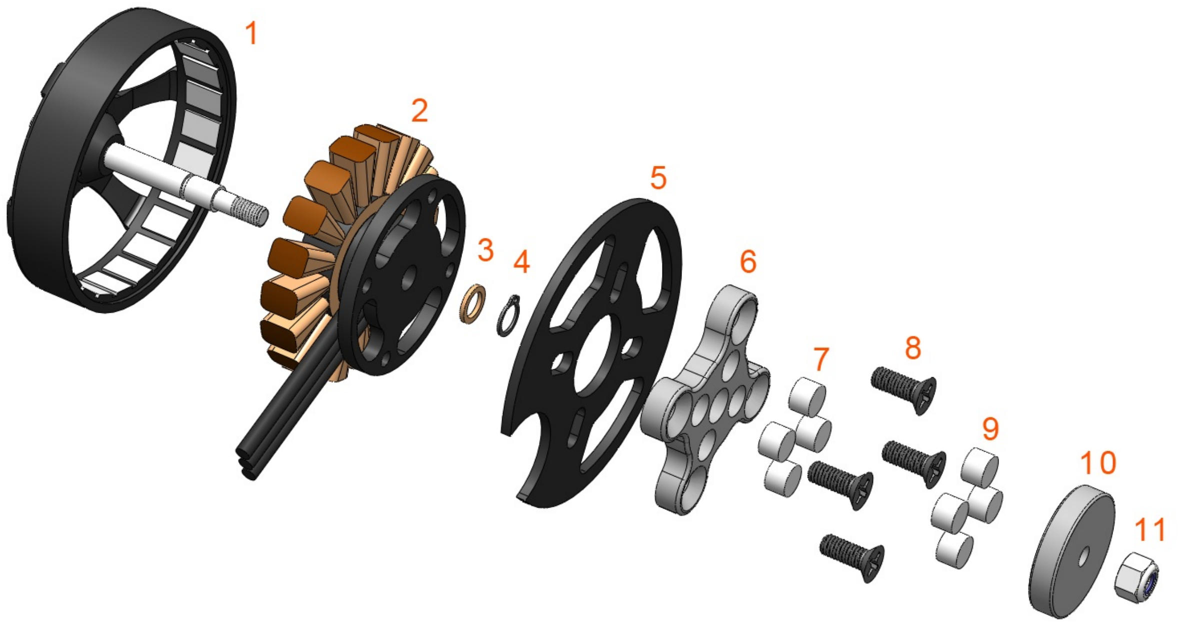
Store the aircraft in its transport case at room temperature.

Cleaning a VTOL Motor

In dusty environments, motor thrust will kick-up significant dust during takeoff and landing. The aircraft should be cleaned after each flight if dust has visibly accumulated. Ensure the main and VTOL propellers are wiped clean in addition.

Check that each VTOL motor spins freely by hand. A motor that grinds, clicks, or is difficult to turn usually indicates that ferrous (iron) dust, gravel, or sand is stuck to the motor's magnets. Since the dust is likely attracted to magnets, the dust can be tricky to remove. First try a combination of compressed air and vacuuming. Blow air directly through the motor from the top by aiming at the magnets and windings. This is the highly preferred method as no disassembly is required. However, if the dust cannot be removed with compressed air/vacuum, and it is obstructing the motor from freely spinning, the motor needs to be disassembled to wipe away the dust.

VTOL Motor Exploded View



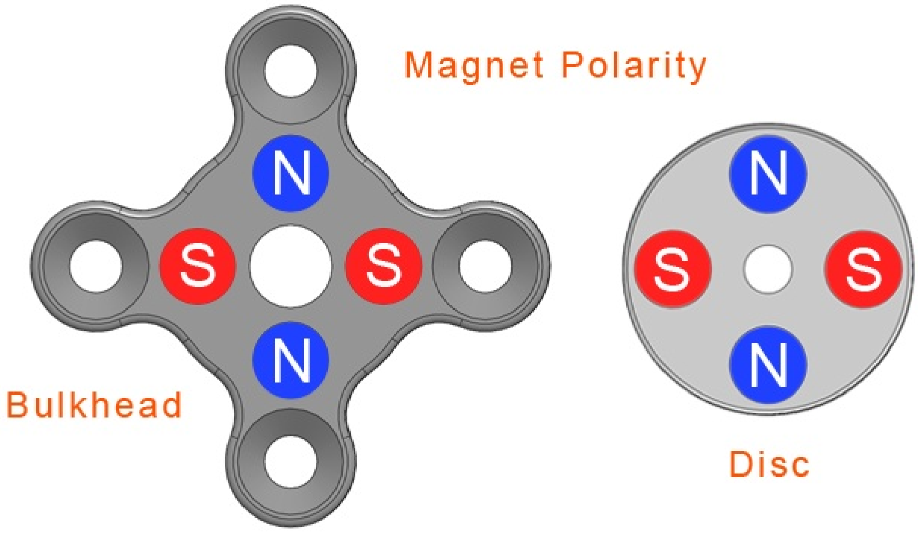
Item	Description
1	VTOL motor rotor
2	VTOL motor stator
3	Copper bushing
4	Snap ring (C clip)
5	Motor boom bulkhead
6	Magnet aligner bulkhead
7	Bulkhead magnets x4, glued
8	Motor screws, M3, x4
9	Disc magnets, x4, glued
10	Magnet aligner disc
11	Locknut, M3

Tools Needed: Phillips screwdriver, torque wrench, snap ring pliers, 5.5 mm socket or small crescent wrench, blue thread locker (medium strength). Fast thin CA glue and toothpick as required.

Disassembly

Reference the VTOL Motor Exploded View above.

1. Disconnect the batteries from the aircraft.
2. Unscrew the locknut (11) with crescent wrench or 5.5 mm socket.
3. Remove magnet aligner disc (10) by rotating the disc 90 degrees, this will cause the magnets to push against each other.
4. Inspect the magnet aligner disc (10) and magnet aligner bulkhead (8) for any dust attracted to the magnets (7,9) and clean as necessary. Also check for loose magnets.
5. If any magnets are loose: Loose magnets are fixed by applying a drop of fast thin CA glue to the top of the magnet. Spread the glue to the edges of the magnet with the tip of a toothpick or similar to allow the glue to seep in around the magnet. Allow glue to dry. The magnets must be arranged with alternating polarity in order to align the propeller. See the following diagram.



6. Unscrew the four motor screws (8) with Phillips screwdriver.
7. Remove magnet aligner bulkhead (6).
8. Slide the motor up until the motor shaft is clear of the motor boom bulkhead (5). The motor can not be completely removed as it is attached by its wires.
9. Gently remove the snap ring (4) from its groove using snap ring pliers. If the ring is damaged from disassembly, it must be replaced.
10. Slide the copper bushing (3) off the shaft.
11. Grasp the base of the motor stator (2) with one hand, and the motor rotor (1) with the other, and pull the two apart. You will feel a strong resistance from the motors when pulling.

With the motor disassebled, remove any and all dust that is causing the motor to grind. This can be accomplished with the help of compressed air and vacuuming, or by wiping away the dust with cotton swabs or paper towels. For stubborn dust, try using a piece of tape to remove it from the magnets. Larger gravel pieces can be removed with tweezers.

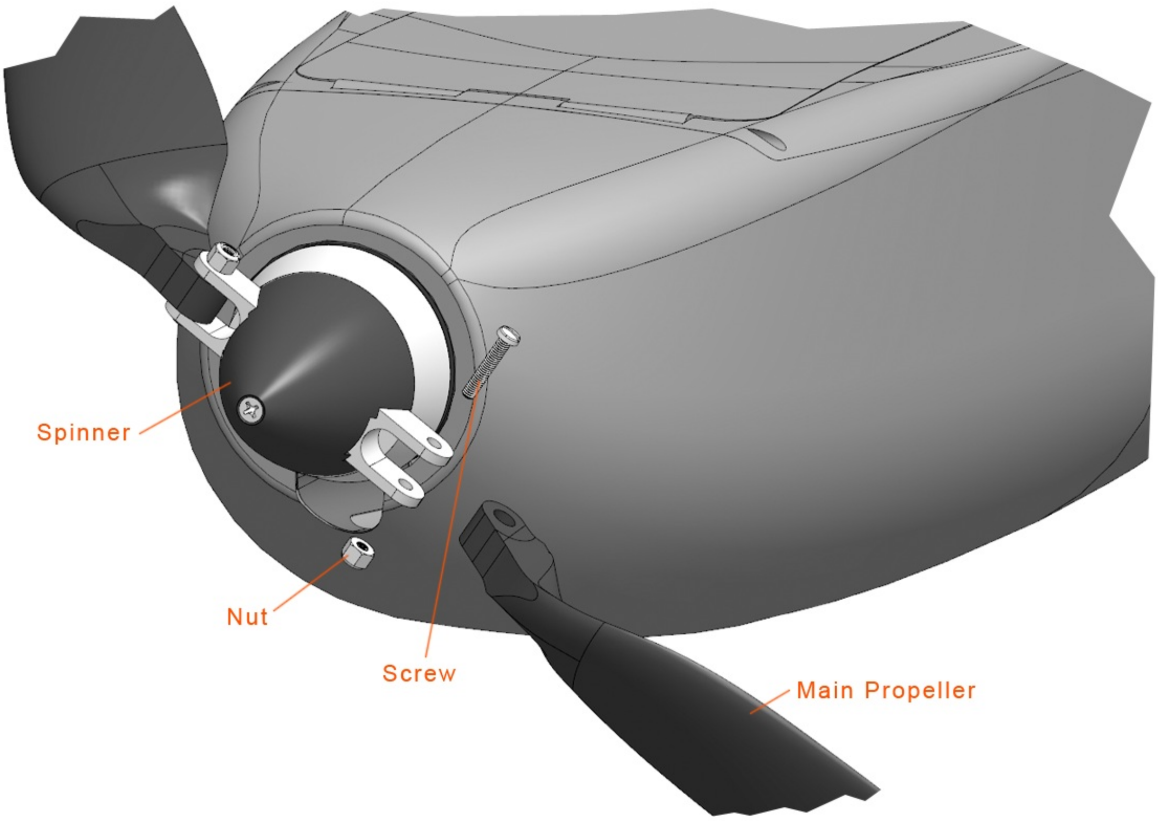
Assembly

Reference the VTOL Motor Exploded View above.

1. Disconnect the batteries from the aircraft.
2. Carefully slide the motor rotor (1) and motor stator (2) back together by lining up the motor shaft with the stator. The motor will want to snap back together due to the magnets. Avoid this by holding onto the motor and slowly letting the two halves come together.
3. Slide the copper bushing (3) back onto the shaft.
4. Install the snap ring (4) back into its groove using snap ring pliers. Ensure the copper bushing (3) is between the motor and snap ring (4). There should be no vertical play in the motor.
5. Slide the motor shaft back through the motor boom bulkhead (5).

6. Place the magnet aligner bulkhead (6) around the motor shaft and line-up the screw holes with the motor.
7. Apply blue thread locker to the four motor screws (8) and screw the motor down using a cross pattern. Incrementally finger-tighten each screw and then torque to 7-9 in/lbs (0.8-0.1 Nm).
8. Slide the magnet aligner disc (10) onto the motor shaft.
9. Thread the locknut (11) onto the shaft until it just comes into contact with the manget aligner disc (10).
10. Align the propeller to be parallel to the motor boom and then tighten the locknut (11) a 1/16 turn. Overtightening the locknut will cause the magnet aligner disc to get jammed on the motor shaft. It may take a few tries to get the propeller properly aligned. To retry, simply loosen the locknut, realign the propeller, and repeat the process.

Replacing the Main Propeller



A main propeller blade may need to be replaced if it is chipped, cracked, or damaged in any way. A damaged blade will cause a buffeting noise and high vibration. A vibration warning may be triggered in flight depending on the extent of damage. The propeller blades do not need to be replaced as pairs. If one blade is damaged and the other is not, you may replace just the individual blade.

Lynx VTOL uses a aero-naut CAM carbon 15x10 propeller for the main propeller.

Tools Needed: crescent wrench, flathead screwdriver

To replace a blade:

1. Disconnect the batteries from the aircraft.
2. Remove the screw and locknut holding the damaged blade to the spinner.
3. Replace the damaged propeller blade with a new one and ensure the new blade faces the correct way (text forward).
4. Reinstall the new blade with the same screw and lock nut. Tighten the screw down finger tight. The new blades should not flop back and forth, yet hold its position with a small amount of friction.

   Warning: Installing a propeller blade on backwards will cause extremely high vibration and will not effectively product thrust. This may damage the motor, motor mount, and/or aircraft.

Replacing a VTOL Propeller

A VTOL propeller blade may need to be replaced if it is chipped, cracked, or damaged in any way. A damaged blade will cause a buffeting noise and high vibration. A vibration warning may be triggered in flight depending on the extent of damage.

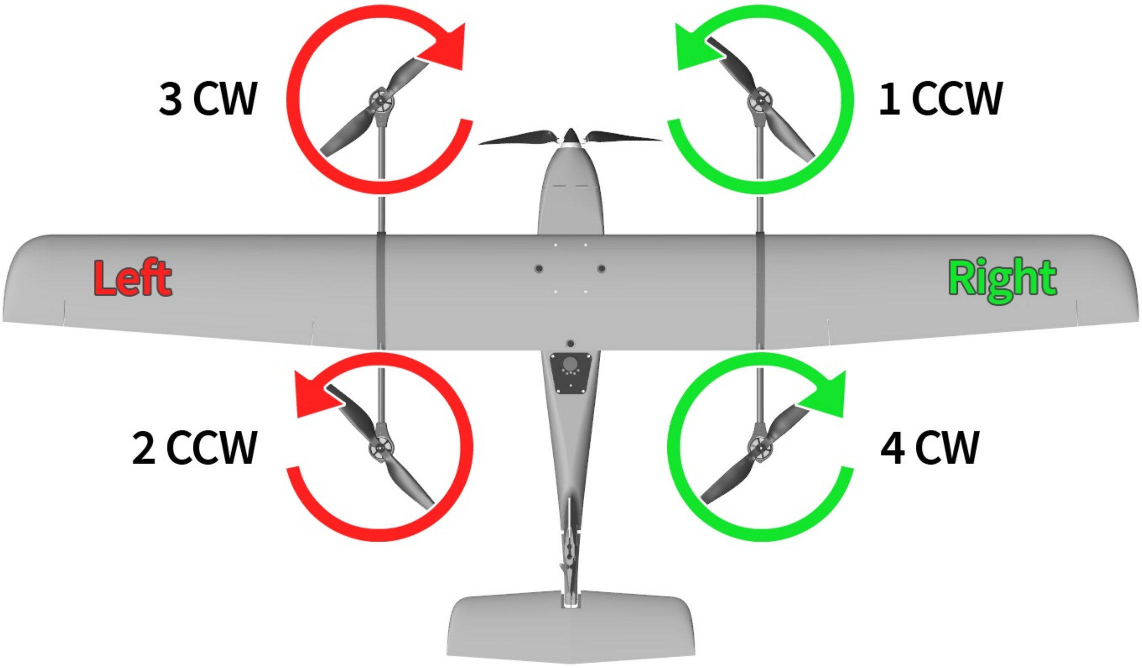
Lynx VTOL has four vertical lift motors. Each motor is numbered. The motor number corresponds to the direction the propeller spins, clockwise or counter clockwise. The motor and spin directions are physically labelled on each motor boom.

Lynx VTOL uses a T-Motor 15x5 carbon fiber propeller for the VTOL propellers.

Tools Needed: 2.5 mm hex key, blue thread locker (medium strength)

To replace a propeller:

1. Disconnect the batteries from the aircraft.
2. Note the propeller orientation and find a matching one. The VTOL propellers can be either clockwise (CW) or counter clockwise (CCW) rotation. The propellers have a label on them that indicates the rotation direction. Use the table below to select the correct propeller.



Label	Direction	Motor
15x5L	CW	3, 4
15x5R	CCW	1, 2

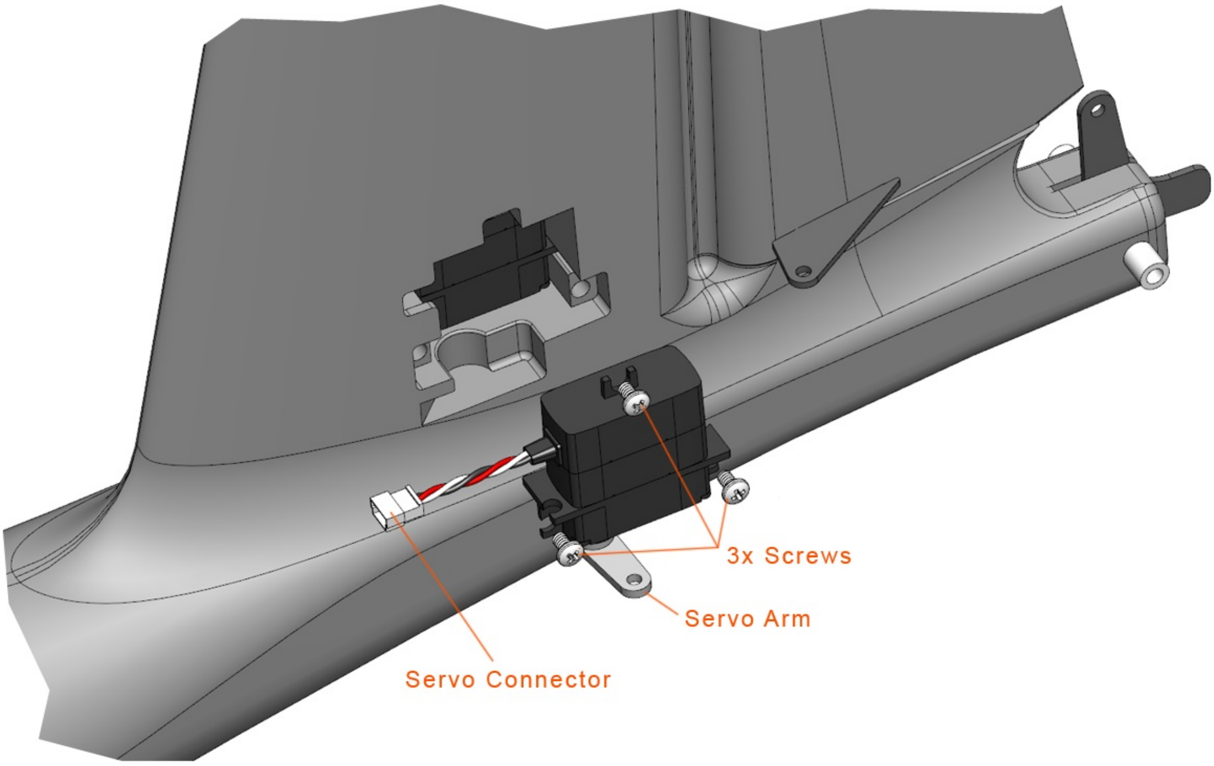
1. Remove the two screws holding the propeller to the motor.
2. Discard the damaged propeller, but keep the two screws, cover, and copper bushing. The bushing may be stuck in the propeller and therefore needs to be pushed out.
3. Insert the bushing around the motor shaft and place the new propeller around the bushing. Ensure you have the correct propeller and that it faces the correct way.

   Caution: Always install the propeller with the logo and text facing up.

4. Reinstall the propeller with the same two screws and cover. Apply a drop of thread locker to each screw and loosely tighten each. With both screws in place, tighten them down finger tight.

   Warning: Installing the wrong propeller or installing a propeller on backwards will cause extremely high vibration and will not effectively product thrust. This may damage the motor, motor mount, and/or aircraft. A backwards VTOL propeller will cause the aircraft to tip over on takeoff.

Replacing a Servo



Servos need to be replaced every 100 flight hours or if damaged in any way. The same process is used for all Lynx VTOL servos.

Servos must be replaced with a set of calibrated servos from SRP, failure to do so may result in a crash.

Tools Needed: crescent wrench, philips screwdriver

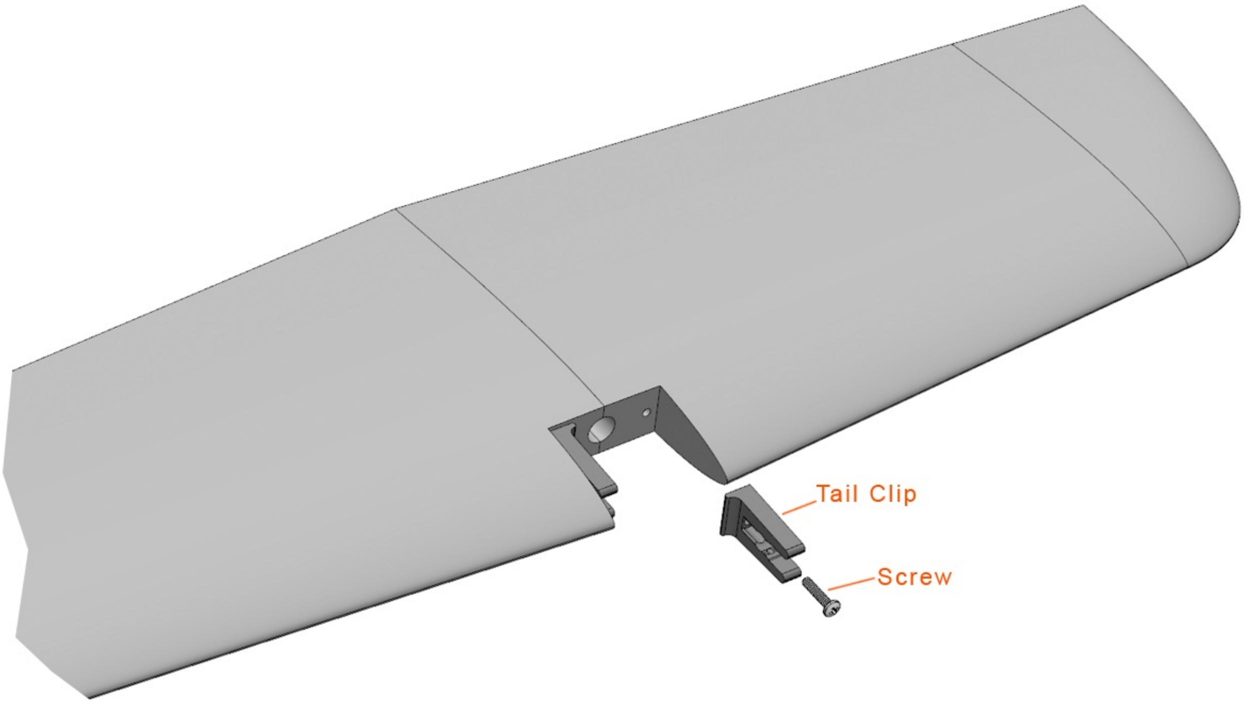
To replace a servo:

1. Disconnect the batteries from the aircraft.
2. Disconnect the servo linkage from the servo arm. This may be either a clevis device or ball joint and screw.
3. Once disconnected from the servo, do not spin the clevis, ball joint, or control rod. Doing so will change the linkage length and may affect flight control surfaces. A piece of tape may need to be place onto the clevis device to stop it from spinning.
4. Loosen the three screws holding the servo down.
5. Remove the servo by pinching the servo arm.
6. Carefully disconnect the servo connector. Try to avoid pulling from the wires. Instead, pull apart from the connector housing.
7. Reconnect the appropriate replacement servo.
8. Install the replacement servo back into place taking care not to pinch the servo wire.
9. Tighten the three screws finger tight.

10. Reattach the servo linkage to the servo arm.

> Replacement servos are calibrated such they should be drop-in replacements. When the aircraft is on, the flight control surface deflection should be very close to the original. Each servo is calibrated differently for each flight control surface. For example, you can only use a left aileron servo to replace a left aileron servo, and so on.

Replacing a Tail Clip



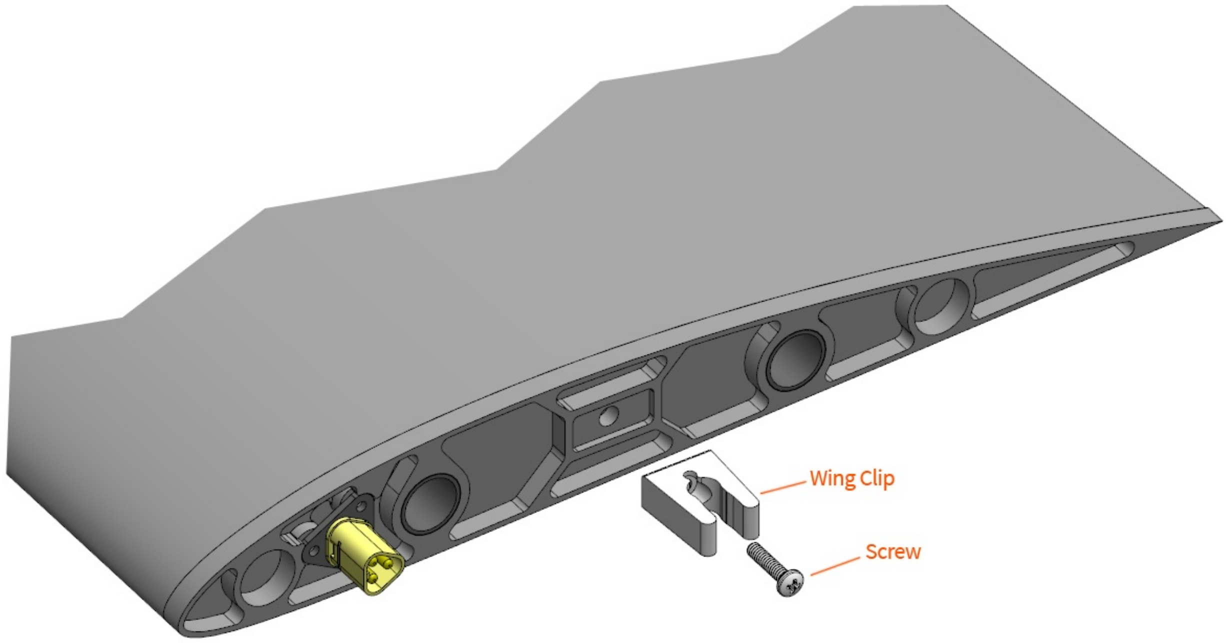
You may need to replace a tail clip as they wear over time or if one is damaged in any way. A worn tail clip will feel loose when attached to the fuselage.

Tools Needed: philips screwdriver

To replace a tail clip:

1. Loosen the screw holding the tail clip in place
2. Discard the old tail clip
3. Install the new tail clip using the same screw. Tighten the screw down to finger tight.

Replacing a Wing Clip



You may need to replace a wing clip as they wear over time or if one is damaged in any way. A worn wing clip will feel loose when attach a wing to the center wing.

Tools Needed: philips screwdriver

To replace a wing clip:

1. Loosen the screw holding the wing clip in place
2. Discard the old wing clip
3. Install the new wing clip using the same screw. Tighten the screw down finger tight

Firmware Update

An update for the aircraft firmware will be periodically shipped with a new build of SwiftGCS. Whenever the GCS connects to the aircraft, the GCS will automatically check if the aircraft is running the expected firmware version. If the aircraft is not running the expected firmware, a dialog will prompt the user that the firmware should be updated.

> The GCS will not stop you from flying with the incorrect firmware. Firmware updates are strongly recommended however as they can fix errors in the flight code, add new features and improve the performance of the aircraft.

A short list of what changed in the aircraft firmware is available from the Swift GCS changelog.

Updating Firmware

1. Follow the aircraft preflight through the Autopilot - Connect step.

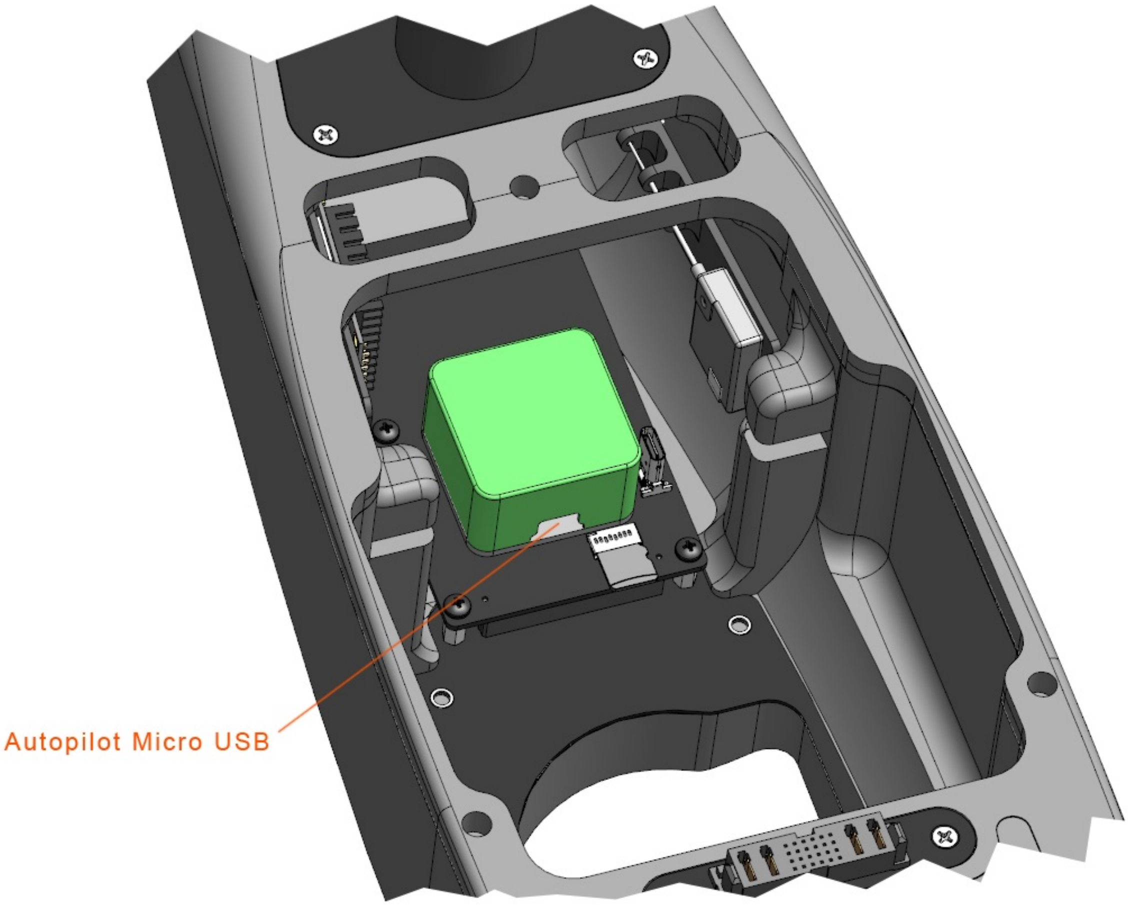
   > Tip: While not required the firmware update is more reliable when the main batteries are installed in the aircraft.

2. On the Settings tab, go to the Firmware Upload section and expand the item.
3. Select `Upload Firmware`. This will open a dialog box that walks you through the upload process.

   > The micro USB cable must not be connected to the autopilot before proceeding.

4. Press the `Upload` button to begin scanning for the autopilot.

5. Plug in the micro USB cable to the autopilot.



6. The GCS will detect the autopilot, erase the old firmware, and upload new firmware.

> Under certain rare scenarios the computer can develop a problem communicating over the USB cable. If no progress is made during the firmware upload for more then 30 seconds, unplug the USB cable and go back to step 4 to restart the firmware upload.

7. When the firmware upload has been completed, a dialog box will open and the autopilot will automatically reboot. Press the `Close` button to proceed.
8. The GCS will then prompt if you would like to automatically update any new parameter values. Select `Update Parameters` to automatically scan for and connect to the autopilot.

> This step relies upon the `Auto Detect` method of connecting working. If this is not available then please contact support for an alternate way to update the parameter values.

9. Once the GCS finds the autopilot, it will download and then upload a new set of parameters.
10. When the process has been completed a dialog will open. Select `Close` to finish the process.
11. The aircraft should be power cycled before attempting to fly.

Calibration

Compass Calibration

A compass calibration may be required if the compass check preflight step is failing. This may be due to changing payloads, where you are flying from, or a compass error.

Before starting a compass calibration, make sure that the aircraft is **disarmed** and that the batteries, payload, and the wing are installed in the aircraft. The payload should be powered-on. Avoid calibrating near a magnetic source such as large metal objects, vehicles, magnets, high power transmission lines, etc.

To start, go to `Settings Tab` ⇨ `Compass` in Swift GCS. Select `Start Calibration` to begin the process. The GCS will now show a progress bar next to each compass.

Pickup the aircraft and rotate the aircraft about each axis. As you do so the progress bar will slowly move until complete. The process typically takes less than a minute. If the aircraft observes a magnetic anomaly, or gets inconsistent data during the calibration, the calibration will automatically restart. Once a valid calibration has been obtained, the aircraft will need to be restarted before proceeding. Set the aircraft on the ground, remove the wings, and disconnect and reconnect all three batteries.

Accelerometer Calibration

An accelerometer calibration may be required if the aircraft is refusing to arm due to an accelerometer error.

To start, go to `Settings Tab` ⇨ `Accelerometer Calibration` and select `Start Accelerometer Calibration`. The GCS will walk you through all the required steps. After the calibration is complete the aircraft must be restarted by disconnecting and reconnecting the batteries.

Service Bulletins

Service Bulletin 002 - VTOL LiPo Battery Lifespan

Date: 14 May 2020

Affected Aircraft: Lynx VTOL 068+

Background

We are attempting to quantify the estimated lifespan of the VTOL lithium polymer battery. This only applies to the VTOL (smaller) battery. The main batteries are unaffected.

Increased voltage sag under load (takeoff) has been noticed by a Lynx VTOL user. As the battery voltage sags, the aircraft cannot generate enough thrust to complete a takeoff. In this specific case, the aircraft automatically aborted the takeoff due to triggering the takeoff abort timeout and landed.

We had also noticed a similar issue with some of the original VTOL batteries in Autumn 2019. Those particular batteries were used for testing Lynx VTOL prototypes. The battery supplier was contacted, but ultimately proved not very helpful and ascribed the issue to either a bad batch, abuse from flight testing, or poor storage habits.

They provided the following storage guidelines:

```
When not using your LiPo battery pack, store it at 60-70% of the pack’s rated
capacity at room temperature.  Make sure to cycle your packs at least once per
month since leaving them on the shelf for a prolonged period of time can cause
the packs to get severely out of balance, puff/swell or even go dead.
High-discharge batteries require such specific care
```

It was not the response we wanted, but chose to proceed with same cell type given that it had only happened to our early batch. Unfortunately, due to the second occurrence, we are now asking the supplier to perform additional load testing in an attempt to help ascertain the issue.

We do not believe, given the battery’s advertised ratings, that Lynx VTOL is abusing the battery on takeoff or landing. Furthermore, flight testing was performed that far exceeded the demands of normal operations and showed that both temperature and capacity requirements were acceptable.

All batteries, especially lithium polymer, have relatively short lifespans. However, we now think that these batteries simply have a shorter lifespan than what we anticipated.

Recommended Action

- Store battery at 60-70% capacity using the charger’s storage function
- Store battery at room temperature
- Cycle battery at least once per month if not flying regularly. Do so by charging and then using the storage function.
- After use, wait at least 30 minutes before charging
- Avoid car charging near a running engine due to excessive heat
- Avoid charging the battery in temperatures below 10C or above 50C
- Rotate what batteries are used for flying (label them if needed, example A, B, etc.)
- Replace after 40 flights or one year, whichever comes first

It is unclear how much degradation is due to flying, storage, or frequency of use. At this time, the safe thing to do is limit the batteries to 40 flights, or one year, whichever comes first. We are not satisfied with a battery that is limited to 40 flights. Alternative batteries are now being evaluated. Unfortunately the selection is narrow due to the space requirement for the VTOL battery. We want the replacement battery to be backwards-compatible and fit within your existing aircraft.

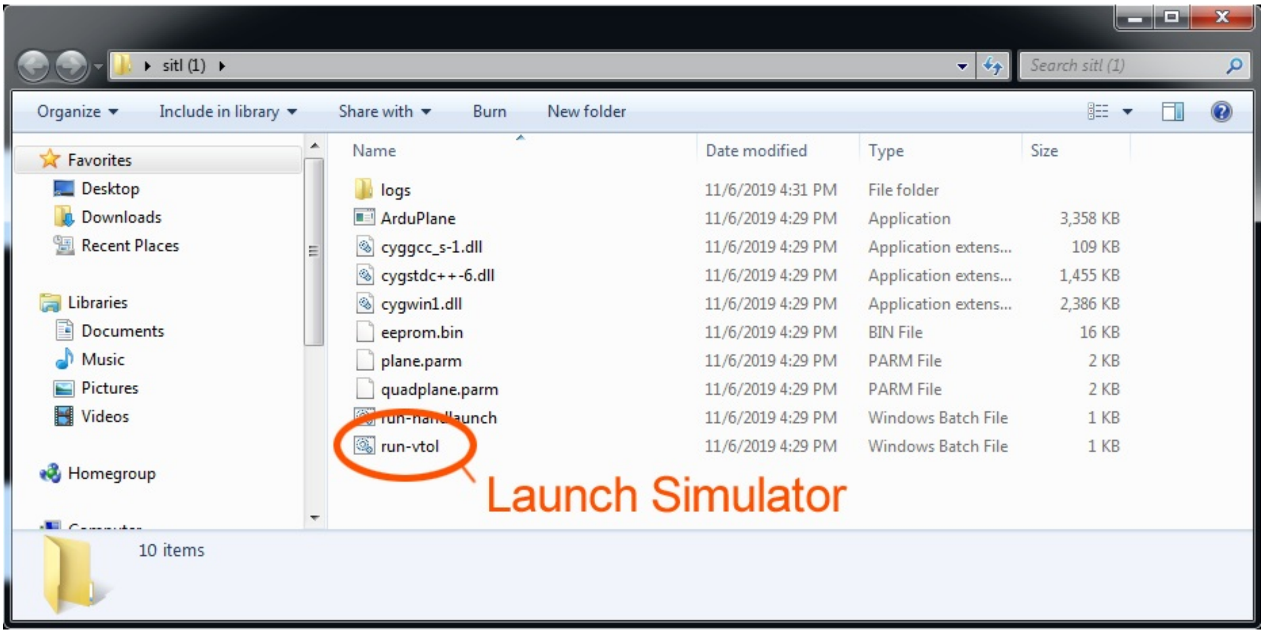
In addition, a VTOL battery failsafe will be implemented in a coming Swift GCS update that will help mitigate unacceptable low voltages during takeoff and cause the aircraft to land in place.

Appendixes

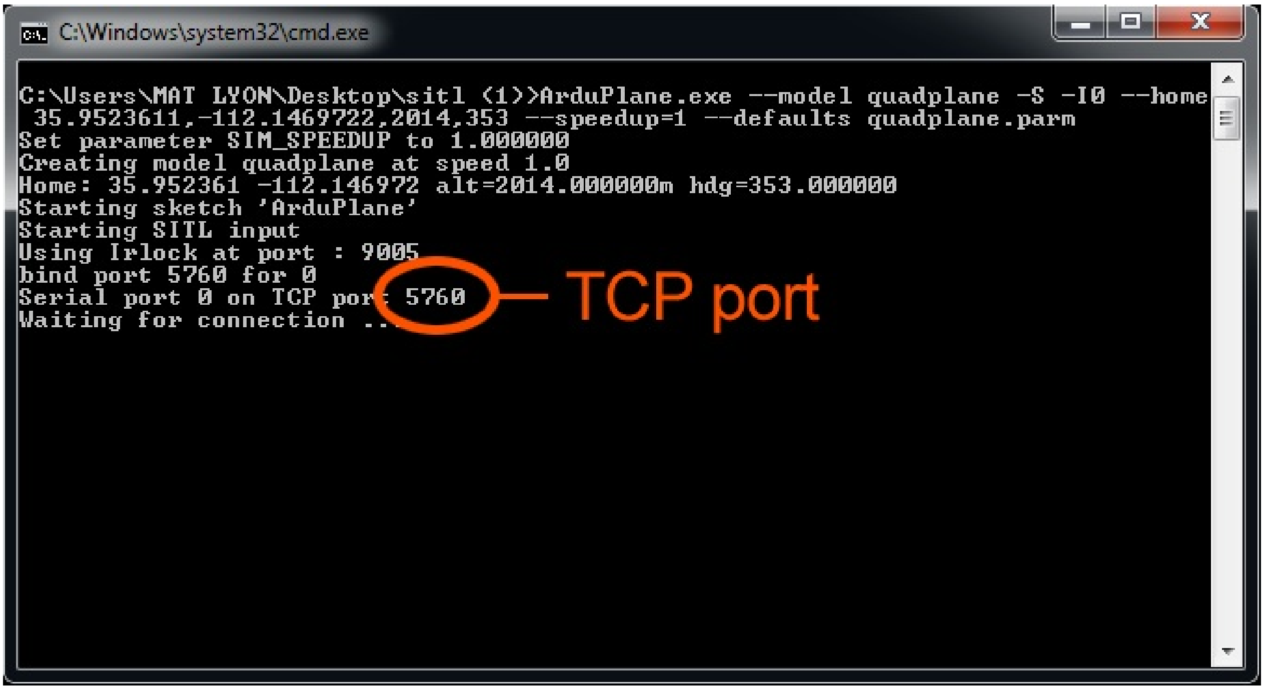
Simulator

Lynx VTOL features a simulator for training and Swift GCS familiarization. The simulator is useful for providing a high level simulation of the aircraft and the mission, however the exact tuning and response of the simulated aircraft is different than the actual Lynx VTOL. Additionally items such as the wind estimator may not work well during simulation.

Download the simulator here. Extract and open the folder. Located and run "run-vtol"



This will launch the simulator command prompt window. Note the TCP port.



Run Swift GCS. Go to `Checklist Tab` ⇨ `Connect`. Select `Advanced Options` ⇨ `TCP` ⇨ `Connect`. Use the local IP address of 127.0.0.1 and the port listed in the simulator window.

Once connected, you will need to:

1. Plan a mission
2. Set the flight mode to Auto using `Mission` ⇨ `Change mode to auto` on the right-hand side of the GCS
3. Go to `Checklist Tab` ⇨ `Arm`

Once armed, the aircraft will takeoff vertically and transition to forward flight.

Flying with a different GCS

If flying without Swift GCS, there are several complexities which must be taken into account when planning the mission.

Caution: Mission planning these waypoints is critical to flight safety, if there is confusion about planning these items please contact support@srp.aero.

Caution: Flying without Swift GCS removes many of its safety checks and requires the operator to perform and track the preflight carefully. Swift Radioplanes, LLC (SRP Aero) is not responsible for any incidents that result from incorrect planning, preflight, or flight operations.

Takeoff

A takeoff must be planned relative to home in order to ensure the aircraft transitions at the correct altitude. The following fields of the mission item must be planned as specified below.

Field	Required Value
command	MAV_CMD_NAV_VTOL_TAKEOFF
frame	MAV_FRAME_GLOBAL_RELATIVE_ALT
x	0
y	0
z	Altitude above home to takeoff to in meters

Landing

A VTOL landing consists of a number of waypoints. If these are not all planned as specified then the aircraft may be unable to perform failsafes, or may encounter terrain obstructions while flying the landing. The waypoints must be planned as specified below.

Field	Required Value
command	MAV_CMD_DO_LAND_START
x	Landing latitude in degrees * 10^7
y	Landing longitude in degrees * 10^7

Field	Required Value
command	MAV_CMD_NAV_LOITER_TIME
param1	1
x	Landing latitude in degrees * 10^7
y	Landing longitude in degrees * 10^7
z	Approach altitude in meters (can be relative or global height according to the frame field)

Field	Required Value
command	MAV_CMD_NAV_LOITER_TO_ALT
x	Landing latitude in degrees * 10^7
y	Landing longitude in degrees * 10^7
z	Approach altitude in meters (can be relative or global height according to the frame field)

Field	Required Value
command	MAV_CMD_NAV_VTOL_LAND
frame	MAV_FRAME_GLOBAL_RELATIVE_ALT
x	Landing latitude in degrees * 10^7
y	Landing longitude in degrees * 10^7
z	Transition altitude (above home) in meters

Status LED

Color	Meaning
Green	The aircraft is disarmed, and the flight surfaces are disabled
Yellow	The aircraft is disarmed, and flight surfaces are enabled
Red	The aircraft is armed

Warning: Do not handle the aircraft while it is armed as propellers may spin at any time.

Blink Speed	Meaning
Slow	Aircraft is passing arming checks
Fast	Aircraft is failing the arming checks

Getting Logs

If you have an incident with the aircraft please provide all the relevant log files. These logs are needed to assess what went wrong, and providing them allows support to resolve problems quickly.

Swift GCS Logs

Swift GCS automatically keeps two forms of logs. An internal log, and a telemetry log (TLOG). Both logs should be provided together to support. The logs can be found in the following locations:

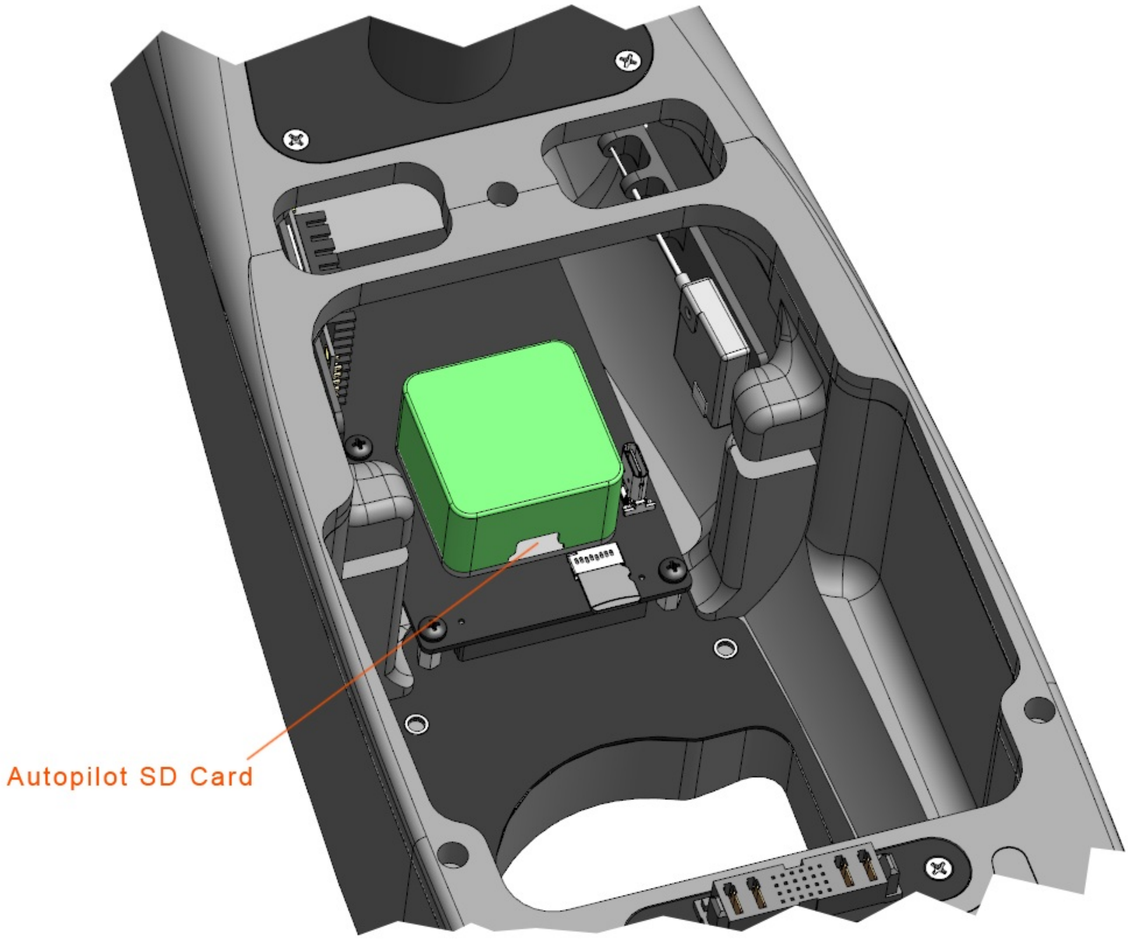
Operating System	Log Directory
Windows	%userprofile%/.swiftgcs/logs
Linux	~/.swiftgcs/logs

> In SwiftGCS 0.7.0 and newer there is a `View Logs` button that can be found in `Settings` tab ⇨ `GCS` which will open the file browser to the folder where logs can be found.

The GCS log will be named by the date with a .log extension. The TLOG will have a longer time stamp, and there is a new file every time the GCS connects to an aircraft. If you are unsure which log file is correct, sending multiple log files is fine.

Autopilot Logs

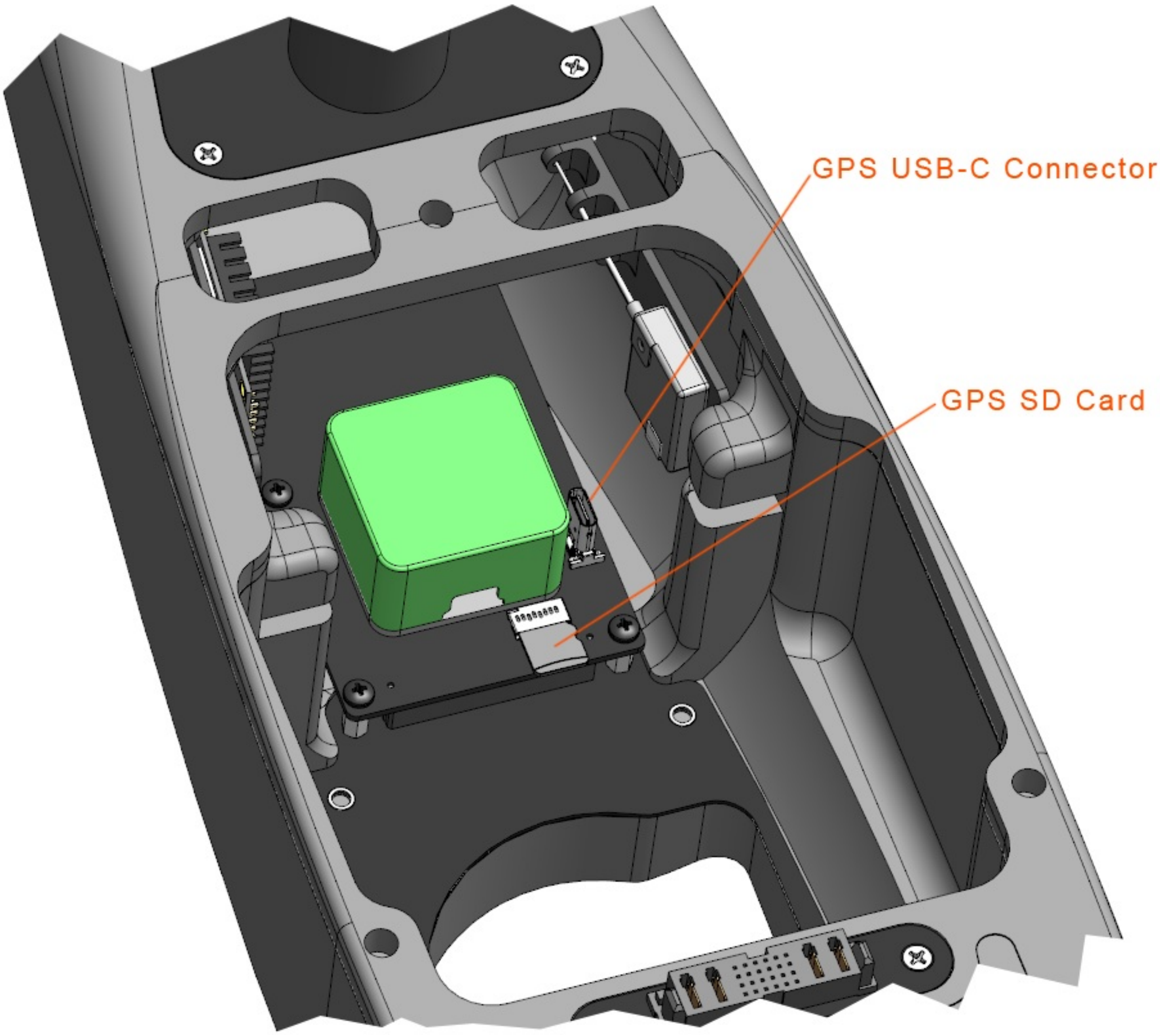
The autopilot automatically records and stores many parameters of the flight. This log file is essential for determining what the autopilot was doing and why. These logs can be found on the micro SD card in the autopilot.



To download the autopilot log, simply remove the SD card from the autopilot, open it on any computer to find the APM/LOGS folder. This folder will contain the log files from the autopilot. Typically, the log you would be looking for is the most recent log file, which will be the highest number. If not you can try looking at the size and date created to determine which one you need, or LASTLOG.TXT to find the number of the most recent log file. Copy the .bin file from the micro SD card and send to support@srp.aero. Do not forget to reinsert the micro SD card back into the autopilot.

GPS Logs

The GPS saves logs to an internal SD card. These can be needed for both incident review, or PPK tagging. These logs can be found on the GPS SD card, or can be pulled over the GPS USB-C connector.


GPS USB-C Connector
GPS SD Card

Performance and System Limitations

General

Wingspan	2.3m
Propulsion	Electric
Max Payload	0.5 kg
Maximum Gross Takeoff Weight	4.5 kg
Center of Gravity Limits	-7.1 to -8.3 cm (center wing leading edge datum)

Performance

Cruise Speed	17 m/s
Never Exceed Speed (Vne)	20 m/s
Stall Speed	13 m/s
Endurance	Up to 120 min (with Sony a6000 payload)
Range	Line-of-sight (LOS)

Takeoff and Landing

Takeoff Method	Vertical Takeoff
Minimum Takeoff Height	10 m + height to clear highest obstacle
Maximum Takeoff Height	45 m
Landing Method	Vertical Landing
Minimum Landing Height	10 m + height to clear highest obstacle
Maximum Landing Height	45 m
Landing Accuracy	2 m

Electrical

Main Battery Fully Charged	25.2 volts (4.2v per cell)
Main Battery Low Voltage	16.2 volts (2.7v per cell)
Main Battery Charge Limit	5 Amps
Main Battery Discharge Limit	10 Amps continous, 30 Amps burst
Main Battery Emergency Voltage	15.0 volts (2.5v per cell)
VTOL Battery Fully Charged	25.2 volts (4.2v per cell)
VTOL Battery Low Voltage	19.8 volts (3.3v per cell)
VTOL Battery Charge Limit	1.4 Amps

VTOL Battery Discharge Limit	29 Amps continous, 50 Amps burst
VTOL Battery Emergency Voltage	19.0 volts (3.16v per cell)
VTOL Battery Flight Limit	40
RC controller Frequency	2.4 GHz
Telemetry Frequency	915 MHz

GNSS

Hardware	Septentrio AsteRx-m2
Constellation	GPS, GLONASS, Galileo, BeiDou, SBAS, QZSS
Frequency	L1/L2
PPK Option	Yes

Environmental

Wind Limitation	10 m/s (20 knots)
Ambient Temperature Range	-10 to 40C
Precipitation	None

Prohibited Maneuvers

- Takeoff or landing with any tailwind
- Flight into known icing conditions
- Flight into visible moisture (rain, snow, fog, clouds, mist, etc.)
- Flight beyond safety pilot's visual line-of-sight (LOS)
- Flight beyond telemetry link

Changes

Date	Change
2020-06-02	Update cleaning and storage section, add 'Cleaning a VTOL Motor' section for removing ferrous dust
2020-05-20	Update the low battery warning description
2020-05-20	Simplify the flight mode tables
2020-05-19	Add SB-002, and update VTOL battery storage information
2020-05-19	Update references to the Layers button to be the Map button
2020-05-19	Added battery prearm errors
2020-05-19	Add internal errors to the list of warnings
2019-11-18	Fix errors with spare hardware included
2019-11-12	Add high temperature warning
2019-11-12	Add geofence failsafes
2019-11-12	Update the LED meanings for SwiftGCS 0.8.0 release
2019-11-12	Remove the check of the staibaltor arm
2019-11-08	Add instructions for reconnecting while in flight
2019-11-08	Add instructions on how to use the simulator
2019-11-08	Add instructions for reconnecting while in flight
2019-11-05	Add standard and multispectral payloads
2019-11-05	Add the tagging procedures for normal and PPK tagging
2019-11-05	Split the flight modes page into a seperate page describing the modes, and one on how to change the modes
2019-09-04	Fix custom payload listing a fuse on the autopilot power line
2019-09-04	Fix incorrect dimensions shown on custom payload page
2019-08-14	Update warnings pages to handle GPS loss better
2019-08-08	Document the View Logs button for SwiftGCS 0.7.0 and newer
2019-08-08	Add this changelog
2019-08-08	Add links to the appropriate replacement propellers
2019-08-07	Update the camera settings description and image
2019-08-07	Fixed the status LED color list not indicating what solid blue meant
2019-08-05	A number of small grammar improvements
2019-08-05	Improved the photos for assembly, the flight modes, and labelled the transition and approach altitudes on the landing images
2019-08-05	Improved the GCS overview page, and changed where it was in the navigation bar
2019-08-05	Significant overhaul of the flight modes descriptions, added other flight modes people may use
2019-07-01	Update battery charging information, and add documention on how to properly store the batteries
2019-06-11	Point out on the preflight that the GCS will automatically check if the vehicle firmware should be updated on initial connection

2019-06-11	Add instructions on how to do a firmware update
2019-06-11	Fix incorrect numbering and indentation on the propeller maintenance pages
2019-06-11	Update the package contents to match currently shipping systems
2019-05-20	Fixed an incorrect part number being listed for payload connector in custom payloads
2019-05-06	Update the photos of the case, and the VTOL propeller replacement images
2019-05-05	Fix some spelling errors
2019-02-11	Fix some spelling errors
2019-02-11	Ensure the landing checklist matches the GCS landing checklist

GCS

Ground Control Station. This is the computer system that is connected to the aircraft via a telemetry link, and allows the operator to control the aircraft.

GPS

Global Position System. A US based GNSS system that provides geo-spatial positioning. Typically used interchangably with GNSS.

GNSS

Global Navigation Satellite System. A system that uses satellites to provide autonomous geo-spatial positioning. Typically used interchangably with GPS.

IMU

Inertial Measurement Unit. This measures the vehicles orientation, and velocity.

LOS

Line Of Sight. This refers to a straight line along which you have unobstructed vision.

PPK

Post Processed Kinematic. This is a technique used with GPS data to greatly improve the accuracy of logged GPS data.

RC

Remote Control. This refers to the RC controller that allows the safety pilot to manually fly the aircraft, as well as select flight modes.

TLOG

Telemetry Log. A log file of the telemetry data sent and recieved from the aircraft.

VTOL

Vertical Take Off and Landing. An aircraft that can hover, takeoff and land vertically.

Weathervane

When in vertical flight the aircraft slowly turns the nose into the wind. This reduces the work the vertical motors have to do.