



Vesper UAS
Vision GCS

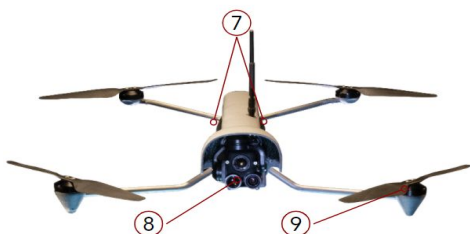
Operator's Manual
v1.8

CONTENTS	PAGE
I. SYSTEM COMPONENTS & CONTROLS	4
II. SAFETY	5
A. FAILSAFE TRIGGERS	
B. EMERGENCY PROCEDURES	
C. LOW BATTERY	
D. LOSS OF GPS	
E. RC LOSS	
F. FAILSAFE LANDING LOCATION	
III. ENVIRONMENTAL CONDITIONS	9
IV. SETUP	10
A. UNPACKING AND POWERING	
B. PAIRING	
C. PRE-FLIGHT CHECKLIST	
V. MANUAL FLIGHT	12
A. TAKEOFF	
B. LAND	
C. RETURN TO LAUNCH LOCATION (RTL)	
D. DEFAULT CONTROLS	
VI. AUTOMATED FLIGHT	14
A. PREPARING A VESPER FLIGHT PLAN	
B. FLYING A MISSION FLIGHT PLAN	
C. RETURNING VESPER AFTER FLIGHT	
D. CREATING NEW FILE	
E. LOADING A FILE	
F. SAVING CURRENT FILE	
VII. CAMERA CONTROL	28
A. TAKE PHOTOS	
B. SWITCH CAMERA MODES	
C. SWITCH SENSORS	
D. CAMERA PITCH CONTROL	
E. ZOOM CONTROL	
F. RECORD VIDEO	
VIII. POST FLIGHT	32
A. VESPER POST-FLIGHT INSPECTION	
B. BATTERY USAGE AND CHARGING	
C. TRANSFERRING PHOTOS AND VIDEOS	
IX. VISION GROUND CONTROL STATION	36

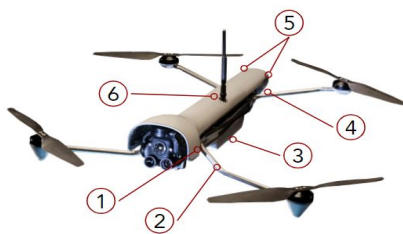
	A. GCS SETUP	
	B. POWERING ON AND OFF	
	C. PAIRING	
	1. INITIAL PAIRING	
	2. RE-PAIRING OR CHANGING BANDWIDTH	
	3. CONNECTING	
	D. USER INTERFACE	
	1. VESPER STATUS ICONS	
	E. ASSIGNING CONTROL BINDINGS	
	F. GCS ANTENNAS	
X.	VESPER HARDWARE	59
	A. ROTOR SETS	
	B. TAKEOFF AND LANDING OPTIONS	
	C. FIELD CASE	
	D. TRANSPORTATION CASES	
XI.	MAINTENANCE	66
	A. VISION GCS MAINTENANCE	
	B. CLEANING & CARE ACCESSORY CASE	
	C. CLEANING	
	D. VESPER CLEANING & CARE	
	E. REPLACING/REMOVING GIMBAL	
	F. REPLACING PROPELLERS	
XII.	TROUBLESHOOTING	71
	A. PAIRING	
	B. CONNECTING	
	C. PRE-FLIGHT	
	D. FLIGHT	
	E. RESTARTING QGC	

I. SYSTEM COMPONENTS & CONTROLS

VESPER



1. Rotor arm joint
2. Rotor arm
3. Battery
4. Tailboard assembly
5. Status LED windows



6. Radio antenna
7. Battery touch points
8. Gimbal
9. Rotor set

VISION GROUND CONTROL SYSTEM (VISION GCS)



1. Altitude/Yaw Joystick
2. Gimbal Pitch Joystick
3. Pitch/Roll Joystick
4. Return to Home
5. Camera Control
6. Flight Data Display
7. Camera Stream/Map
8. Map/Camera Stream PiP
9. QGC Settings
10. Vesper Battery Level
11. Power
12. Brightness +/-



15. User-definable Button
16. Cooling inlets (do not block)
17. USB-C (charging, data, HDMI)
18. Take photo
19. EO/IR video stream select
20. Camera Zoom In/Out
21. Pairing Icon

II. SAFETY

- Read Vesper & Vision GCS Manual to completion before operating Vesper.
- Always ensure Vesper is at least 20 feet away from people before takeoff.
- Be mindful of where your hands and other body parts are, especially when Vesper is powered on.
- Only launch Vesper from the operator's hand using the Safety Rotor Set. Never attempt to launch from, or land to, the operator's hand with the Recon Rotor Set.
- When using the Recon Rotor Set, keep Vesper at least 20 away from personnel. Never attempt to touch Vesper while it is in flight or while the propellers are in motion.
- While manually operating Vesper, only fly where you can see. Vesper does not have lateral obstacle avoidance; therefore, it is the operator's responsibility to prevent collisions. Exercise extreme caution when flying in a direction where the camera doesn't provide clear visibility.
- Plan takeoff and landing to protect people and Vesper. Designate a launch and landing spot at a location clear of obstacles and people.
- Before using the Return To Home (RTH) feature, ensure settings are adjusted for an appropriate return altitude over terrain.
- Follow all pre- and post-flight operational guidelines and storage procedures described in this manual.

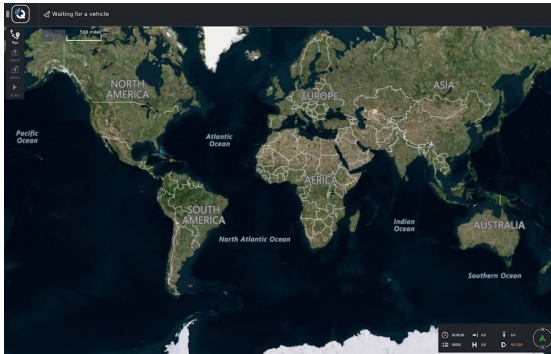
IMPORTANT:

**WHEN VESPER IS CONFIGURED WITH THE RECON ROTOR SET,
NEVER HOLD VESPER BY HAND WHILE PROPELLERS ARE IN MOTION.**

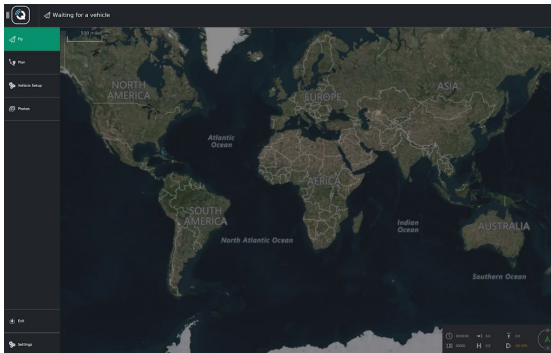
FAILSAFE TRIGGERS & EMERGENCY PROCEDURES

To program safe behavior for various scenarios:

- Click on the “Q” Ground Control logo on the top left-hand side



- Navigate to the Vehicle Setup menu  at the top of the screen



- Select the Safety option  Safety

The sections below detail how to program for specific situations:

LOW BATTERY

Vesper will automatically land and shut off once the battery level reaches 5%. The GCS will give multiple visual pop-up warnings in advance of the automatic landing. The operator can override the final 5% automatic landing with stick inputs, but should be aware that doing so risks loss of the aircraft. The low battery preset limits can be modified in the Safety options.

Low Battery Failsafe Trigger

Failsafe Action:

Return mode

Battery Warn Level:

15

%

Battery Failsafe Level:

7

%

Battery Emergency Level:

5

%

Warning

Return mode

Land mode

Return mode at critically low level, Land mode at current position if reaching dangerously low levels

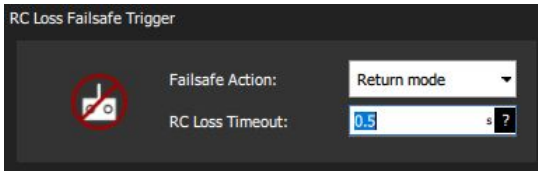
By clicking the Failsafe Action dropdown menu, the operator can define low battery behavior. In this menu, the operator can choose at what % battery level to send a warning notification, and enter the failsafe setting or emergency setting.

LOSS OF GPS

Vesper can maintain position using visual inertial odometry (VIO) and optical flow in the event of GPS loss as long as scene illumination is greater than 10 - 50 lux (depending on surface texture). If Vesper is unable to maintain position and has lost the control link, it will land in a level orientation. VIO will drift by approximately 7 meters for every 100 meters of travel.

RADIO CONTROL (RC) LOSS

Radio Control (RC) Loss means Vesper has lost connection to the Ground Control Station (GCS). In Q → Vehicle Setup → Safety, the operator can preemptively choose what actions Vesper will take should this scenario occur. By clicking the Failsafe Action dropdown menu, the operator can designate the best option for Vesper and determine how many seconds of data link loss will lead to time out.



FAILSAFE LANDING LOCATION

By default, Vesper will return to its launch position when facing a critical condition, such as low battery or GPS loss. To modify these settings, select the Failsafe Trigger settings in Q → Vehicle Setup → Safety.

III. ENVIRONMENTAL CONDITIONS

RANGE OF USE:

- Optimal flight conditions = open areas devoid of obstacles, crowds, power lines, trees, and bodies of water.
- To be field serviceable and to minimize dirt ingress, Vesper's motors are partially sealed. Nonetheless, avoid contact with debris, sand and dirt whenever possible.
- Vesper is safe to fly in heavy rain; however, Vesper should never be submerged in water.
- To minimize radio link and GPS interference, avoid high levels of electromagnetism such as power lines and electrical substations.
- When operating Vesper in cold conditions, store Vesper's battery close to your body to maximize performance.
- Vesper uses a magnetometer for vehicle heading. Do not take off from any magnetic or steel structures.
- Vesper maximum operating temperature is lower on the ground than in the air, as Vesper uses forced convection from the propellers for cooling.

Temperature Operating Conditions are as follows:

Vesper Operating Conditions	Minimum	Maximum
Temperature Limits - Flight	-32° F	113° F
Temperature Limits - Ground Operation	-32° F	95° F
Temperature Limits - Storage	14° F	122° F
Wind	0 mph	40 mph (65 kph)
Range from Vision GCS	0 mi	1.55 mi (2.5 km)

IV. SETUP

IMPORTANT:
READ SAFETY INSTRUCTIONS & ENTIRE MANUAL BEFORE FLYING VESPER

UNPACKING AND POWERING

1. Remove Vesper from the field case and fully unfold all four arms.
2. Power on Vesper by grabbing battery on left and right sides; a beep, followed by a series of tones and illuminated tail LEDs indicate success.
3. Turquoise LED light will turn green or blue once unit is fully booted, as follows:

Pulse Pattern \ Color	Turquoise	Blue	Green
Blinking	Booting...	No GPS, unarmed	GPS, unarmed
Solid	Booting...	No GPS, armed for takeoff	GPS, armed for takeoff

4. Power on the Vision GCS by pressing the Power button and unfolding both antennas.
5. If Vesper has not yet been paired with Vision GCS, connect Vesper to Vision GCS by following the pairing instructions below.
6. If Vesper has been paired previously with Vision GCS, telemetry and video should appear after approximately 85 seconds.

7. Once connection is established, place Vesper at chosen launch location.

PAIRING

1. Power up Vesper and wait for the turquoise LED to switch to blue or green, indicating that boot is complete.
2. Pick up Vesper by the battery and flip Vesper upside down 3-4 times (flip from top to bottom and back) to initiate pairing.
3. Vesper will beep with 1 middle and 2 high tones when it enters pairing mode.
4. Tap the pair vehicle icon on Vision GCS to open pairing manager.
5. Choose "Pair a Vehicle."
6. After 30-45 seconds, confirmation will appear. To switch to high power mode press "confirm."
7. Move Vesper 10 feet or more away from Vision GCS. Telemetry and video should start within 60 seconds.

PRE-FLIGHT CHECKLIST

1. Inspect propellers for loose screws and damage, replace as needed.
2. Inspect lenses for dirt, and clean as needed.
3. Ensure no people are within 20 feet of Vesper's takeoff location.
4. Confirm battery capacity >20%.
5. Confirm that Vesper tail LEDs are pulsing green, indicating GPS lock.

V. MANUAL FLIGHT

Manual Mode allows the operator to have full control over Vesper's path, using Vision GCS to direct all movement. You should only use Manual Mode if you are an experienced operator. When in Manual Mode ensure you are aware of your surroundings at all times, and whenever possible use the camera to view the flight direction.

TAKEOFF

1. Once ready, select "Takeoff" on the Vision GCS screen. Use the lateral slider to confirm Vesper takeoff.
2. Vesper will hover at a preset height and maintain position automatically.

LAND

1. Ensure no people are within a 20 foot perimeter around the landing area.
2. To land Vesper at its current location, press the Land button . A prompt will appear at the bottom of the screen to confirm.



3. Once the command is confirmed, Vesper will descend and land.

RETURN TO LAUNCH LOCATION (RTL)

Command Vesper to return to the launch location by pressing the RTL button on Vision GCS. Vesper will respond by first ascending to 200 feet above takeoff altitude, or up to a cone extending up at 45° from the takeoff site, whichever is lower. Then Vesper will traverse until it is directly above the takeoff point. When above the RTL location, Vesper will descend quickly, and then will hover for 15 seconds once 10 feet above the ground, before descending the final 10 feet slowly. Once Vesper lands it will power off.



FLIGHT CONTROLS

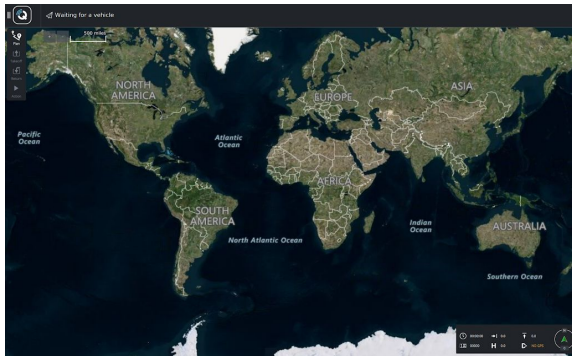


VI. AUTOMATED FLIGHT

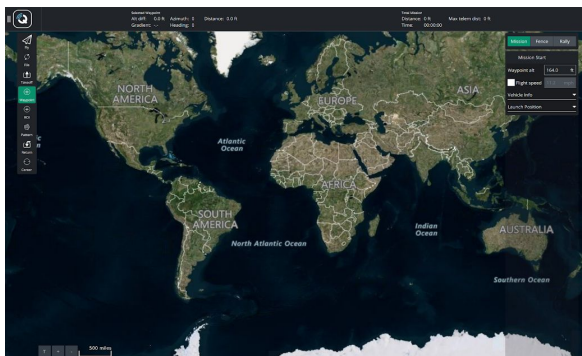
Automated flight modes allow the operator to create a flight plan and have Vesper fly the entire route autonomously. Use-cases for Automated Flight Mode include: (a) rapidly flying to a predetermined location, (b) creating a photo dataset for 3D models, (c) creating a photo dataset for orthomosaics, and (d) automated search grids.

PREPARING AN AUTOMATED FLIGHT PLAN

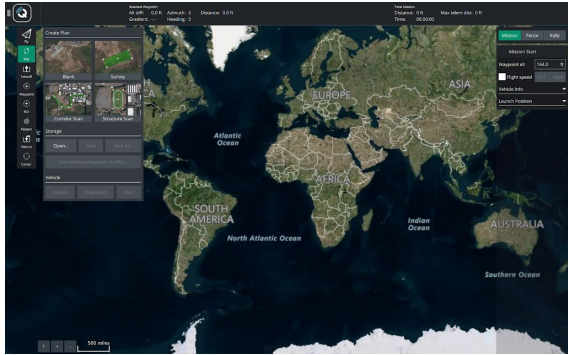
1. Select the Plan View icon  at the top of the screen.



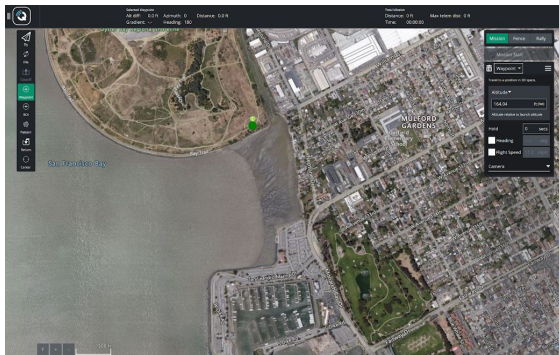
2. Select the Waypoint setting tool  in the upper left menu.



3. Select Mission Mode.

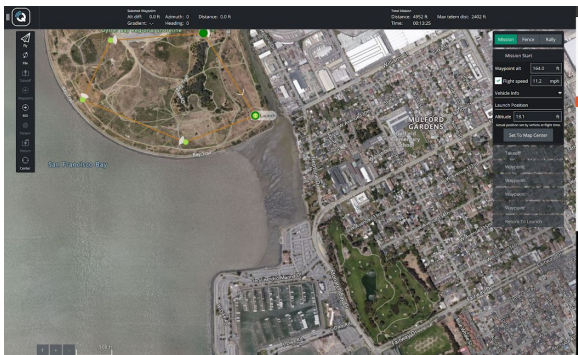


4. Add waypoints* by selecting areas on the map.



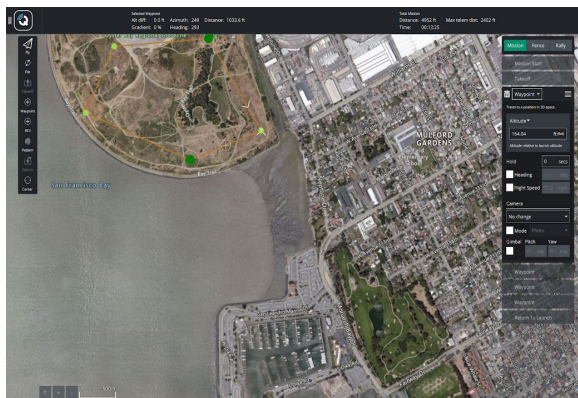
***Note:** A waypoint is a point in three-dimensional space that the drone flies to as part of a mission. Each mission consists of a series of coordinated waypoints. The operator can choose just one, or set multiple, waypoint(s).

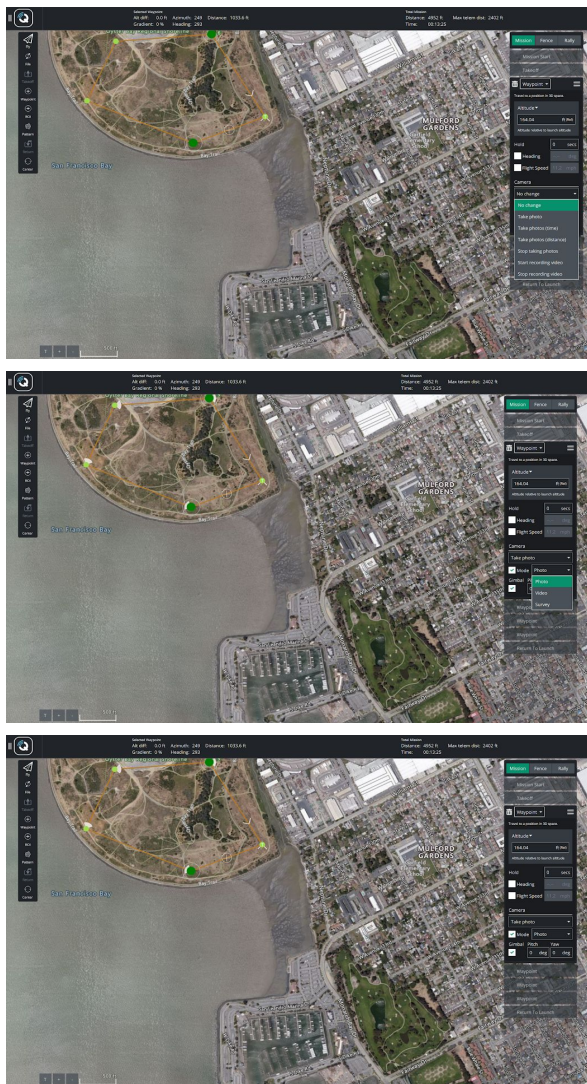
IMPORTANT: Set the first waypoint as close to the mission starting position as possible- this waypoint can mark the takeoff point.



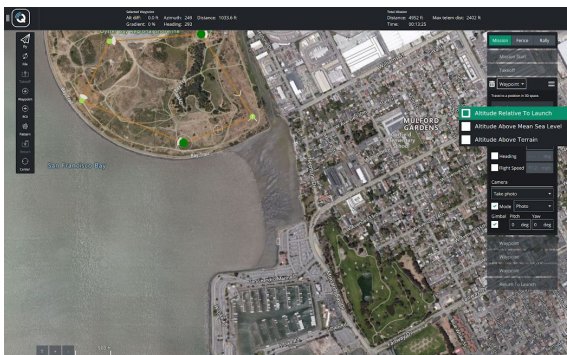
After plotting the route, the operator can set specific directions for Vesper at each waypoint, such as altitude, flight speed and camera.

5. To automatically take photos on a mission, set directions for the camera at each waypoint. Select the desired photo setting: one photo, multiple photos over time, or photo(s) specified by distance. Specify options for setting the gimbal pitch and yaw.





6. Set specific altitude directions for Vesper at each waypoint, as desired. By default, the altitude is set relative to home. The operator can change the altitude to be relative to sea level or relative to terrain.



4
Waypoint

Travel to a position in 3D space.

Altitude
10.00 m (Rel)

Altitude relative to home altitude

Hold 0 secs

Flight Speed 5.0 m/s

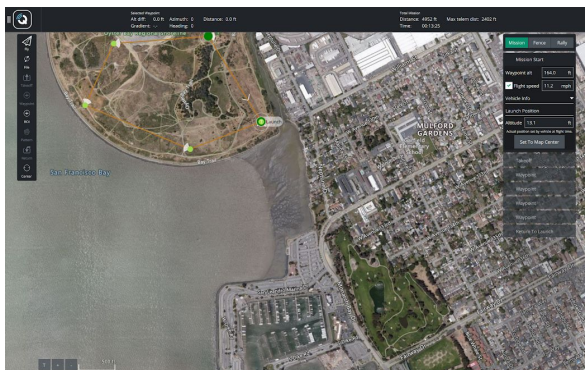
Camera
No change

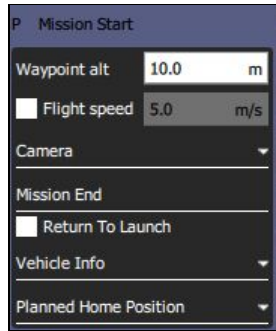
Mode Photo

Pitch 0 deg

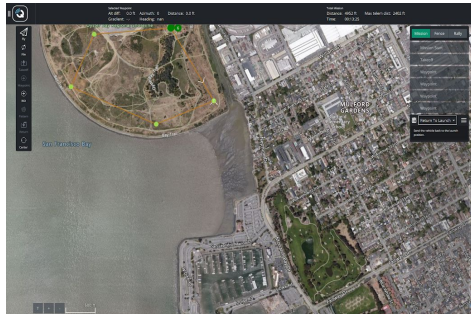
Yaw 0 deg

7. Set the flight speed from the Mission Start position.
 - Operator **MUST** check the box next to “flight speed” and set the flight speed, otherwise Vesper will not proceed to the first waypoint upon takeoff.

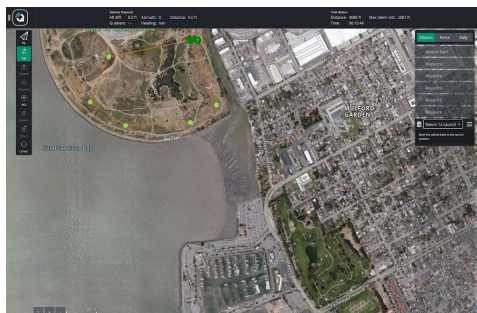


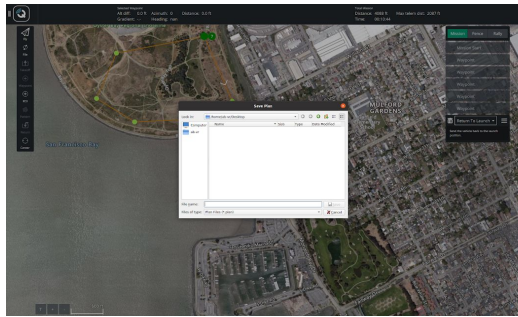


8. From the mission sidebar, the operator may choose “Return to Launch” to automatically direct Vesper to return to the mission starting position.



9. Once waypoint(s) and additional directions are set, the operator can save the flight plan for future use by pressing the File  button in the Plan menu.

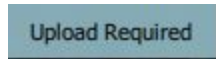




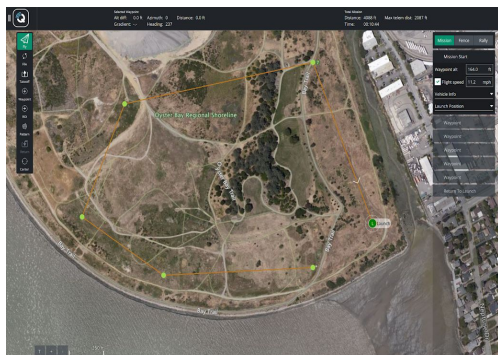
10. The operator can see the Total Mission distance, time, and max range in the top information bar of QGC. The details are based on the chosen settings and directions and update in real time in response to the mission settings.



11. When Vesper is ready to be sent on its flight path, press Upload Required in the upper right corner



12. After upload to Vesper is complete, switch to Fly view by pressing the icon in the upper left



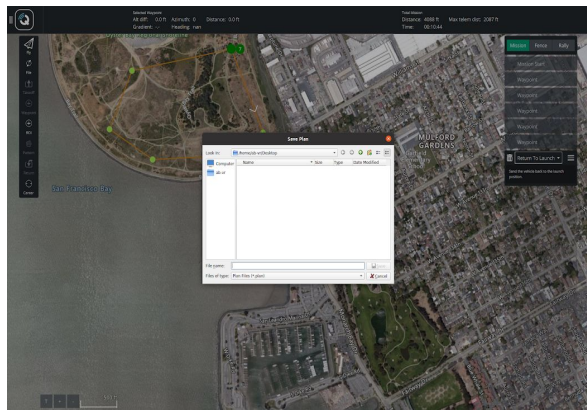
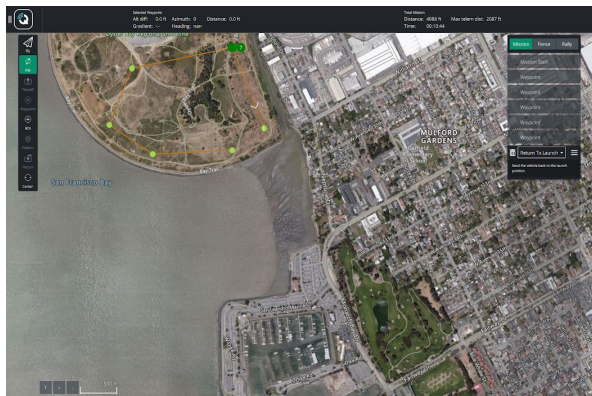
13. From the Fly view, begin the mission. To do so, follow the *Flying a Mission Flight Path* instructions (below).

USING FLIGHT PLAN FILES

Flight Plans that have been created and saved, or loaded onto the GCS, are located in the Plan view under the File icon.

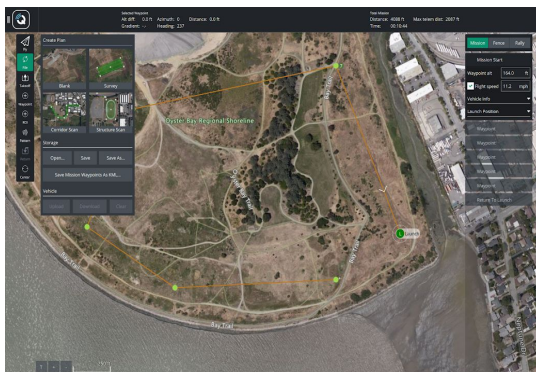


Note: Flight Plan files are saved as “.plan” files.

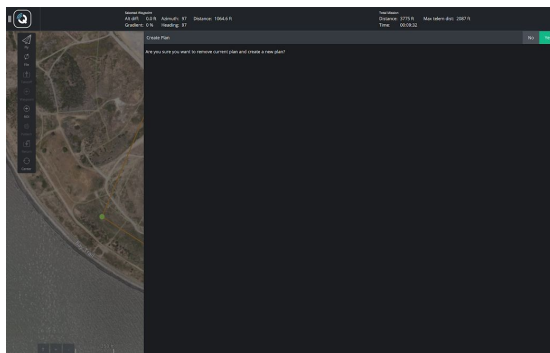


CREATING A NEW FLIGHT PLAN FILE:

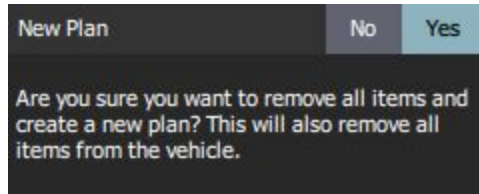
1. Under the File menu, select “New File” to create a new Flight Plan.



2. If there is already a Flight Plan open, a prompt will appear on the right side of the screen to ensure you want to remove any preselected commands. Select “Yes” to clear commands.

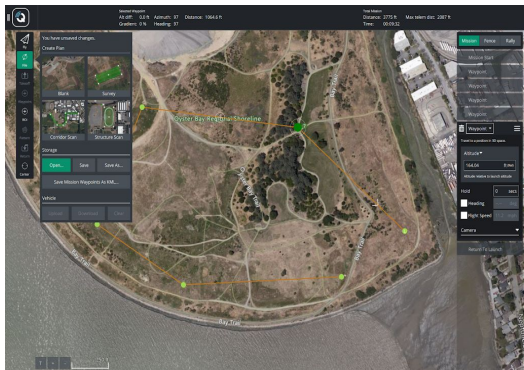


3. The operator can then program a new Flight Plan.

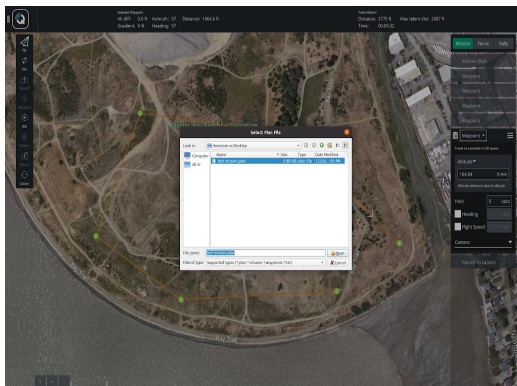


LOADING A FLIGHT PLAN FILE:

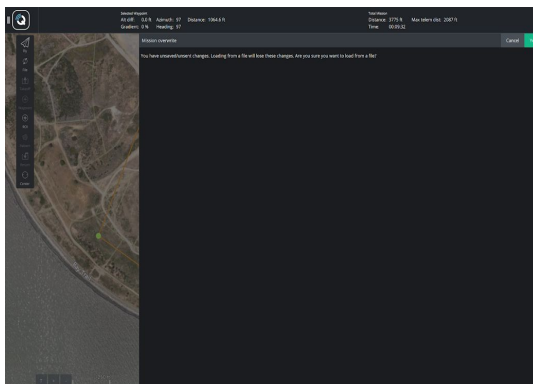
1. Under the File menu, select “Open...”



2. A prompt will appear to open a Flight Plan file from storage.

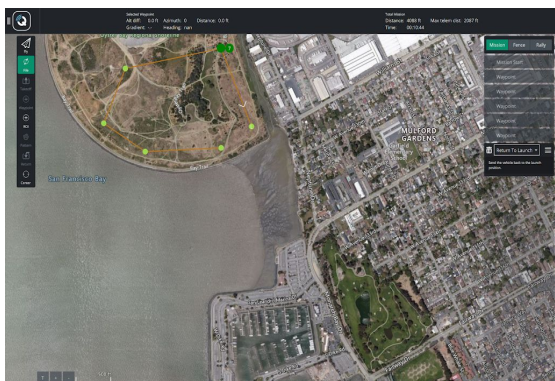


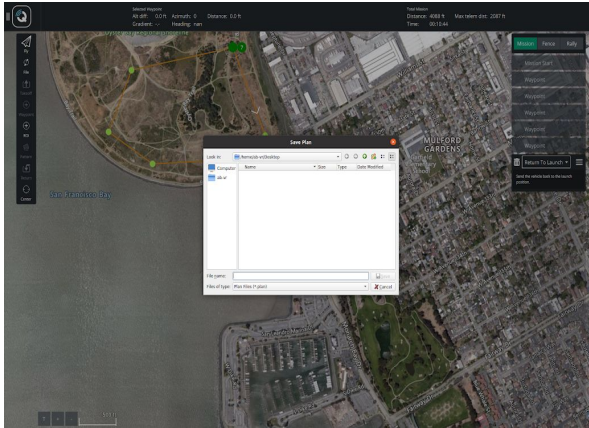
3. If a Flight Plan is already open, a prompt will appear on the right side of the screen to ensure the operator wants to clear the existing file in order to open a new file.



SAVING A FLIGHT PLAN FILE:

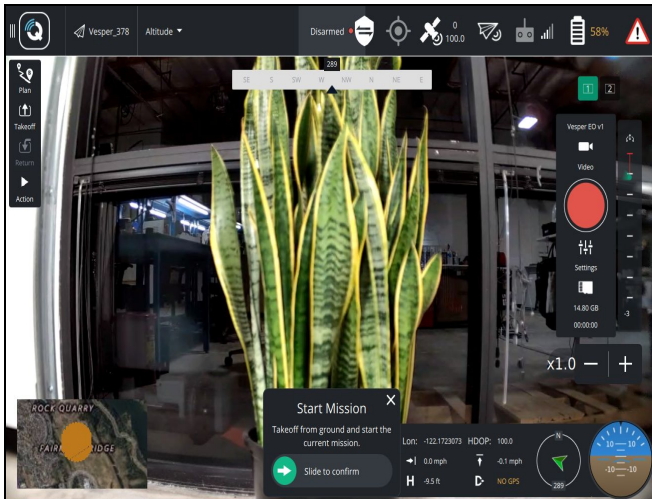
1. Go to the File menu and select "Save" or "Save as":
 - a. "Save" will write over the current file;
 - b. "Save As" will allow the operator to create a copy of the file and to designate a new name for the file.





FLYING A MISSION FLIGHT PLAN

1. Once a flight path has been programmed and uploaded from the Plan view, navigate to the Fly view.
2. A prompt to Start Mission will pop up at the bottom of the screen. Slide the blue arrow to confirm.



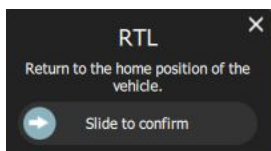
3. The Ground Control Station (GCS) will display Vesper on the map:
 - The red arrow indicates Vesper's location.
 - The line indicates where Vesper has traveled.
4. If desired, the operator can make Vesper pause (suspended in the air) in its current location by using the control sticks on the GCS or by simply pressing the Pause button on the Fly  menu.



RETURNING VESPER AFTER FLIGHT

- If Vesper was set to “Return to Launch” upon ending the mission, Vesper will fly directly to that point, rather than retrace the plotted course.
- If “Return to Launch” was not set when the flight plan was created, Vesper will stay at the last waypoint until instructed to return to its launch location.
- The operator can initiate “Return to Launch” by following these direction:

1. Press the RTL button  in the Fly menu.
2. The GCS display will receive a prompt at the bottom of the screen.
3. Swipe “Slide to confirm.”



4. Vesper will then ascend and fly directly to the Mission Start location.
- Vesper will default to a 60 meter altitude for “Return to Launch” to ensure obstacle- and detection-avoidance. This pre-set altitude can be changed in Settings.

VII. CAMERA CONTROL

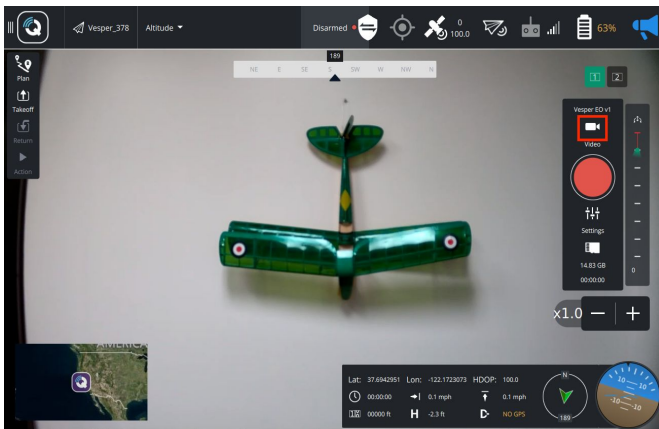
TAKE PHOTOS MANUALLY

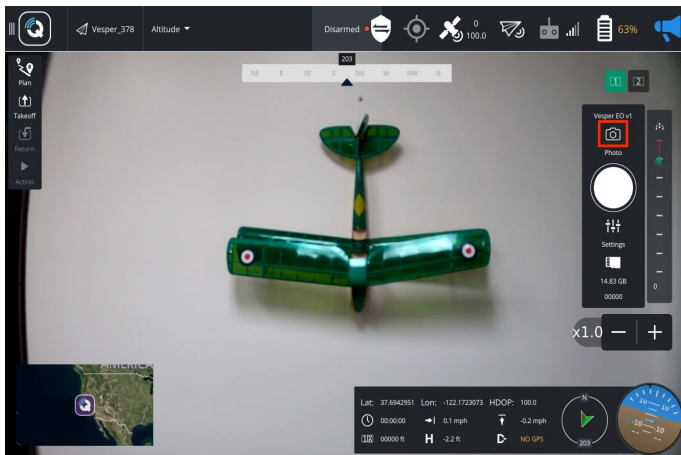
Note: see directions on Page 13 to automatically take photos on a mission.

To take photos manually, touch the camera trigger (big circle) on the screen. The on-screen indicator will spin while photo capture is processing.

SWITCH CAMERA MODES:

- Toggle the video/photo icon to switch camera control modes between video and photograph by tapping the icon outlined in red below.





SWITCH CAMERA SENSORS:

- Use button (19) on the GCS to toggle between Electro Optical (EO) and Thermal (LWIR) cameras.
- Alternatively,:
 - To select EO, tap the 1 Icon on the right edge of the screen, above the camera control; or
 - To select LWIR, tap the 2.
- Note: switching camera sensors may take up to 5 seconds.

CAMERA PITCH CONTROL:

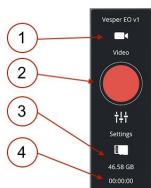
- Joystick (2) controls the camera pitch.
- Alternately, camera pitch can be controlled with the slider on the far right of the screen.

RECORD VIDEO:

- Select Video mode in the side-panel.
- Press the round red Start icon to start video recording.
- The icon will switch to a red square, indicating the camera is recording.
 - While recording, the elapsed recording time and available storage space are presented and updated periodically.

- To stop recording, press the square icon.

Camera controls for recording video:



1. Video/Photo control select
2. Record Start/Stop
3. Available storage space
4. Elapsed recording time

Note: EO video recording continues even when switching to IR view mode (in which case both EO and IR streams are saved and available post flight).

ZOOM CONTROL

- Six levels of zoom are available: 1X, 2X, 4X, 8X, 12X and 18X.
- Each press of the +/- icons  will change the zoom level ONE step. The indicator next to the +/- icons will read out the zoom level. You may also use the hardware buttons located on the top right of the GCS as shown below:



- Switching between zoom levels may take up to 2 seconds. Repeated presses are not required and may cause unintended zooming. Zoom will stabilize on what the indicator is set to within a few seconds.

- Zoom is achieved through a combination of optical and digital zoom. When capturing photos after zooming, photos are saved in the full resolution of the sensor and may appear less tightly zoomed than the view on the GCS.
- Zoom is only available on the optical cameras; the thermal camera does not have zoom.
- When switching to IR and back, the previously selected zoom level will be maintained.

VIII. POST FLIGHT

POWER DOWN

- Vesper will automatically shut off 5 minutes after the radio link is powered down.
- If the radio link to the GCS is active, Vesper will remain powered on until the battery is removed.

POST-FLIGHT INSPECTION

Inspection after every flight will help maintain Vesper and minimize safety risks. Specifically:

1. Inspect the propellers for loose screws and damage. Replace propellers if damage is discovered.
2. Inspect the lens for dirt/debris. Follow cleaning instructions, as necessary.
3. Keep batteries charged at full capacity whenever possible.

STORAGE

To insert Vesper into its field case:



1. Hold Vesper at the fuselage,
2. Gently press the rotor arms inwards towards the body.
 - Propellers should be parallel to the length of the fuselage.
3. Rear rotors tuck under the rotor set frame slightly and may need a stronger push.
4. Once rotors are collapsed, slide Vesper into the field case first, tail first

and with the antenna pointing up.

- The gimbal faces outward when Vesper is in the field case correctly.



TRANSFERRING VIDEOS

Videos (and photos) may be stored to SD card or on the internal flash memory:

- If an SD card is installed, videos and photos will automatically be stored to it.
- If an SD card is not installed, videos and photos will be stored on the internal flash memory and can be downloaded or transferred to an SD card as described below.

DOWNLOAD RECORDED VIDEO FILES:

1. Enable Vesper Wi-Fi Access Point.
 - a. Press and hold the zoom out (-) button on the GCS for over 5 seconds. When done, Vesper will enable operation as a WiFi AP and allow connection.
2. Connect to Vesper WiFi Network.
 - a. Open network preferences on your device.
 - b. Vesper WiFi will appear with SSID "VantageUAS".
 - c. Passphrase is "FlyVantage!!"

3. Access video downloads page.
 - a. Open a web browser on your device.
 - b. Navigate to "http://VantageUAS:5000" or alternatively "http://192.168.43.1:5000".
 - c. Note: if access is through a Vantage GCS, there is a preloaded bookmark to this location.
 - d. Upon loading, the Vesper download page will extract a few down-scaled frames and present them along with basic information for each video file. This process takes a few moments.

SELECT VIDEO FILE DOWNLOAD LOCATION

Below each file entry are buttons that enable:

1. Download of the video file to the client device; or
2. Copy of the video file to the on-board SD card (if installed).

BATTERY USAGE AND CHARGING

BATTERY OPTIONS:

Vesper is compatible with two types of batteries:

<u>Battery Type</u>	<u>Use & Compatibility</u>	<u>Description</u>
Stealth	• Light and quiet in flight • Compatible with Safety Rotor Set and Recon Rotor Set	Black plastic housing 4C 14.8 V/3000 mAh lithium-ion cells
Endurance	• Maximum endurance and speed • Compatible with Recon Rotor Set	Black Plastic housing 4C 14.8 V/4900 mAh lithium polymer cells

INSTALLING THE BATTERY:

1. Hold the battery in hand, touching both sides of the casing, with the magnets facing upward.
2. Verify a minimum of two green LEDs lit up, indicating the battery's life is at least 50%.
3. Attach the battery to the underside of Vesper's Fuselage:
 - Match up the battery lights with the camera end of the fuselage.
 - Once lined up the magnets will snap the battery in place.
4. Power verification tones will sound once the battery is successfully connected to Vesper's fuselage.

CHARGING THE BATTERY:

1. Assemble AC/DC adapter, AC cable, and red charge adapter.
2. Plug AC cord into an electrical outlet.
3. Attach the charge adapter to the battery.
4. Battery indicator light will pulse when charging begins.
5. All four indicator lights will turn off when charging is complete.
6. To confirm charge state, grasp the battery by its sides - all four LEDs should illuminate to indicate 100% charge.



IX. VISION GROUND CONTROL STATION

Vision Ground Control Station (GCS) controls Vesper while in flight. Vision GCS also programs flight paths, missions and functions.



1. Altitude/Yaw Joystick
2. Gimbal Pitch Joystick
3. Pitch/Roll Joystick
4. Return To Home
5. Camera Control
6. Flight Data Display
7. Camera Stream/Map
8. Map/Camera Stream PiP
9. QGC Settings
10. Vesper Batter Level
11. Power On/Off
12. Brightness +/-
13. Communication Antennas
14. User-definable Button
15. User-definable Button
16. Cooling Inlets (do not block)
17. USB-C (charging, data, HDMI)
18. Take Photo
19. EO/LWIR Video Stream Select
20. Camera Zoom In/Out
21. Pairing Icon

POWERING ON & OFF

1. Press the Power button once to turn Vision GCS on.
 - a. The Vantage Robotics logo will appear.
 - b. Then the login screen will appear.
2. Login using the on-screen keyboard to type in default password "Vantage1".
3. Press the Power button to power off.
 - a. A pop-up window will appear, asking for the operator to select Cancel, Restart, or Power Off.
4. Pair the GCS to Vesper by following the steps in the PAIRING section below.

PAIRING

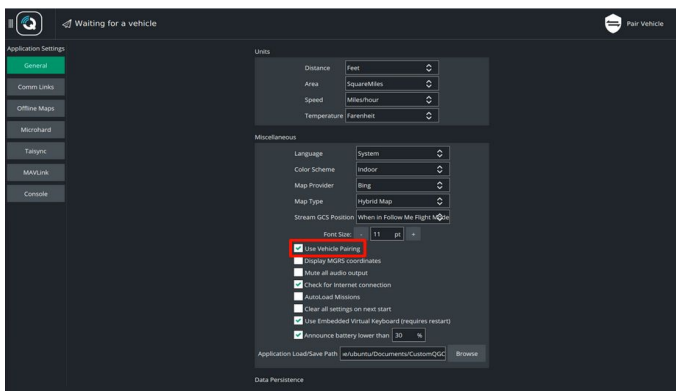
"Pairing" refers to the successful exchange of security keys between Vesper and Vision GCS. Pairing allows the hardware to communicate securely.

This process does not need to be repeated for subsequent flights if using the same Vesper & Vision GCS.

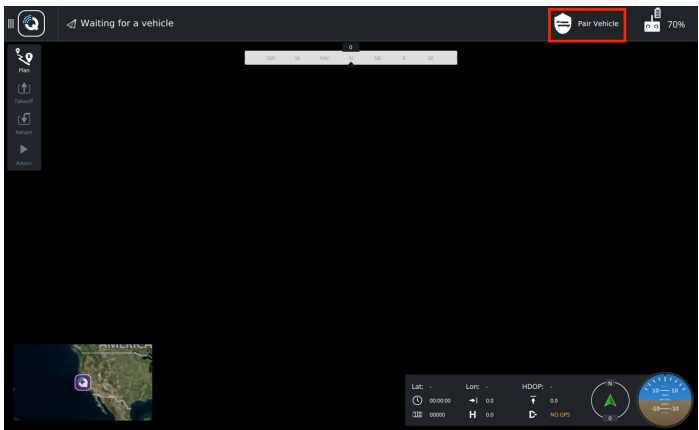
INITIAL PAIRING:

Pairing Vesper and Vision GCS:

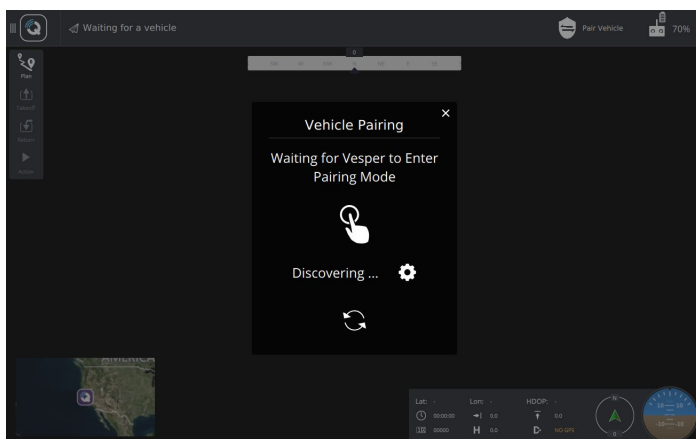
1. Power on Vesper and Vision GCS.
2. Ensure "Use Vehicle Pairing" is selected in the Settings → General tab.



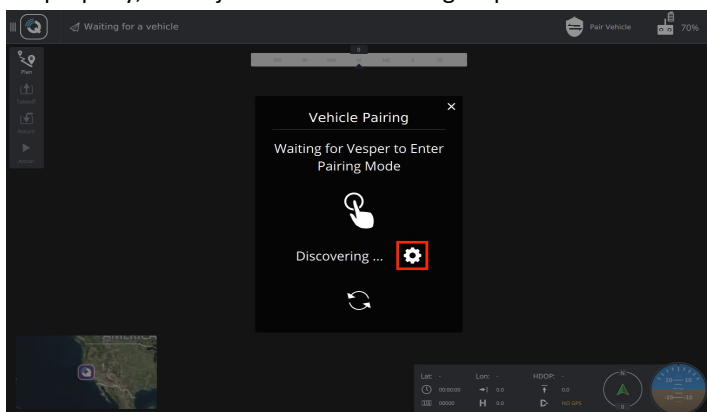
3. Click the PAIRING icon in the upper right of QGC.

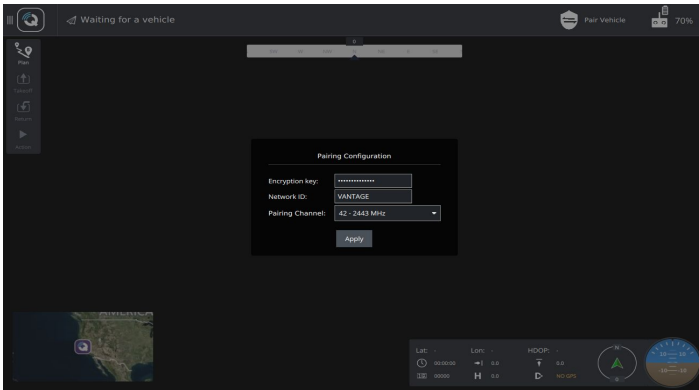


4. A Discovering indicator will appear.

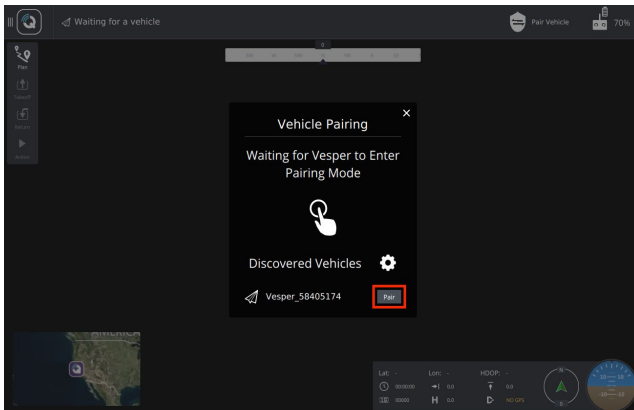


5. Tap the gear icon and ensure the pairing channel is set to 42 and the network ID is set to VANTAGE. These fields should already be set properly, this is just a troubleshooting step.

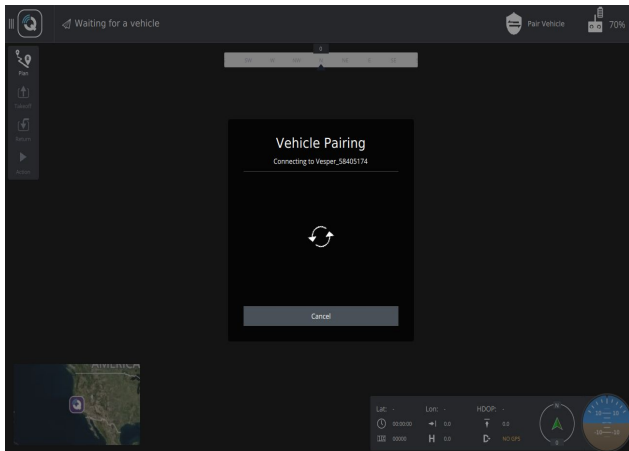
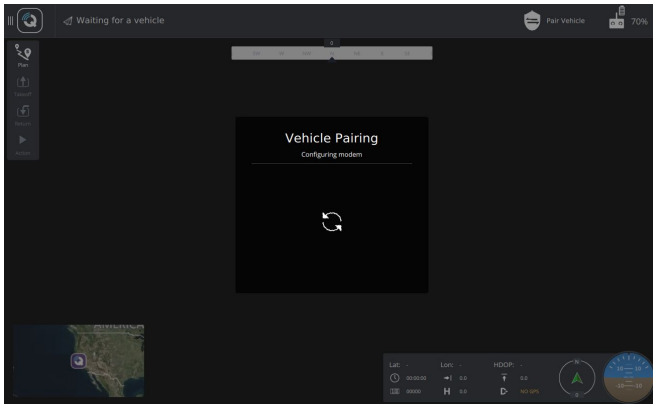




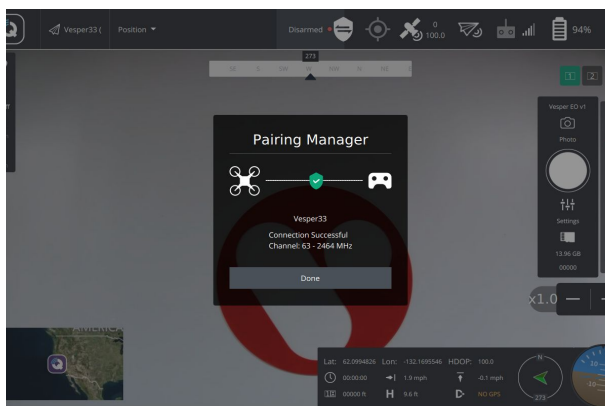
6. Flip Vesper, turning upside down, 3 times in a row consecutively. Vesper will play a tone to indicate that pairing mode has been triggered.
7. Once the Vesper is discovered, tap the Pair button to initiate the pairing process.



8. Move Vesper at least 15 ft. away from Vision GCS. After approximately 30 seconds, Vision GCS should connect. The pairing manager will show when it is configuring modems initially and then will show that it is connecting to Vesper.



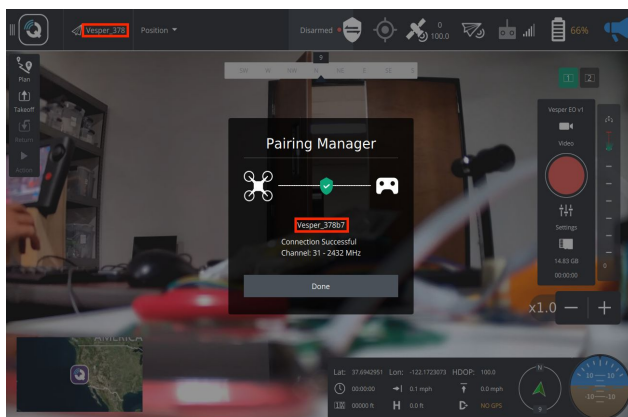
9. To double check the connection, open the Pairing Manager and view the list of connected UAS (vehicles).
 - The name listed should match the name of the currently connected UAS, indicated on the upper left of the UI.



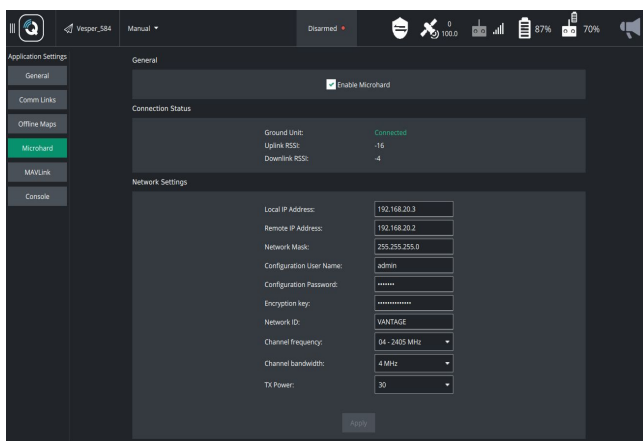
RE-PAIRING

The operator can re-pair Vesper and Vision GCS or change the bandwidth by following the below steps:

1. Tap Pairing Manager.
2. Tap Disconnect.
3. Tap "Pair Another."
4. Follow previous steps for pairing.



5. Change connection bandwidth, channel, and Tx Power in Settings -> Microhard.
 - a. The default bandwidth is 4MHz. Do not select a bandwidth lower than 4 MHz.
 - b. Connection channel can be changed to any available frequency other than the pairing channel (42). Note that there may be varying levels of interference on different channels.
 - c. If the configuration password or username is changed, the defaults are:
 - i. username: admin
 - ii. password: vantage
 - d. The pairing channel initial encryption key is: vantagevantage.
 - e. Do not modify the local and remote ip addresses.
 - f. The transmit power of Vesper's radio can be changed to any level from 7-30 dBm. Note that this will affect operating radio range directly.



CONNECTING:

Once pairing steps have been completed, the operator should proceed with the following steps to connect Vesper and Vision GCS:

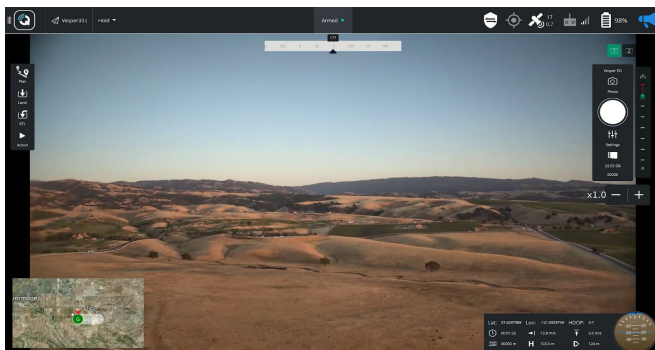
1. Power on Vesper and Vision GCS.
2. For 1.8 GHz units, ensure Vesper is at least 15 feet from Vision GCS (does not apply to 2.4GHz units).
3. Telemetry and video will appear in QGC after about 50 seconds - after Vesper emits startup tune.
4. If video does not appear after 60 seconds, see “Connecting with GCS” in the Troubleshooting section.

USER INTERFACE

VISION GCS VIEW MENU:

Vision GCS’ user interface has multiple modes, called “Views,” each in its own tab.

Views are displayed on the upper left navigation bar of the screen, whether or not Vesper is connected. To change views, the operator can tap each icon and access different features.



Settings – configure the application



Setup – configure and tune Vesper



Plan – create pre-planned (autonomous) missions



Fly – monitor Vesper while flying

VESPER STATUS ICONS:

Once Vesper is connected to Vision GCS, The Vesper status bar will show at the top of the screen.



Vesper status icons include:

- 
Vehicle messages – click to show a dropdown of messages.
 - If there is a critical message, icon will change to a **yield sign**

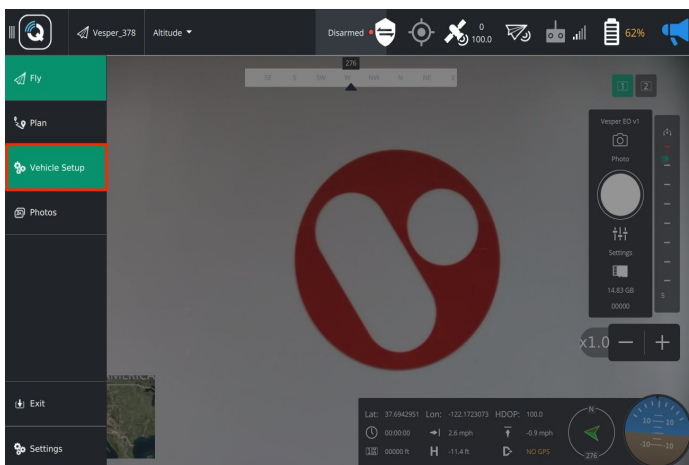
- 
GPS Status – satellite count, current Horizontal Dilution of Precision (HDOP) and other GPS information.
- 
Radio Connection Strength
- 
Vesper Power Level – displays battery life percentage.
 - Pressing this icon will tell you the voltage and accumulated consumption.

NOTE: The status bar is not displayed while in Plan mode.

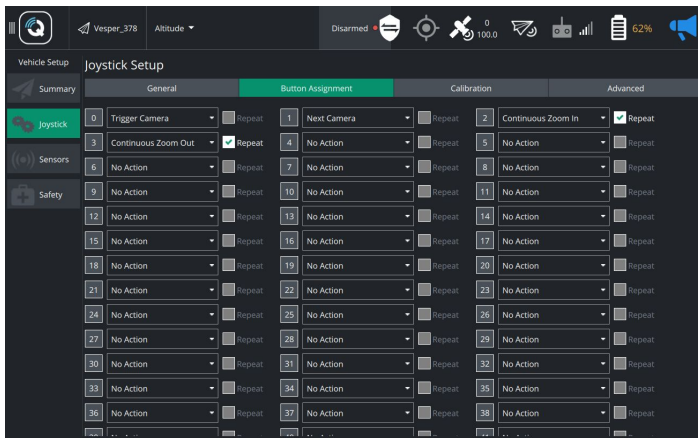
ASSIGNING CONTROL BINDINGS:

The operator can assign button controls by navigating to the Button Assignment tab in the Joystick menu under Vehicle Settings.

- Tap the 'Q' icon in the top left of QGC and go to the Vehicle Settings menu. This is only accessible when the GCS is connected to a Vesper.



2. Tap on the Joystick menu and then navigate to the Button Assignment tab.

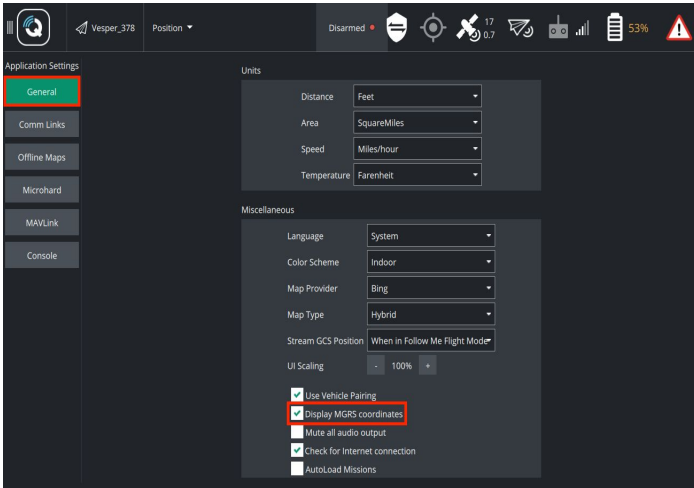


3. Press a physical button on the GCS and see which button lights up in green on the Button Assignments page.
4. Use the dropdown menu next to the selected button to assign a function.

DISPLAYING MGRS COORDINATES

INSTRUCTIONS FOR DISPLAYING MGRS COORDINATES:

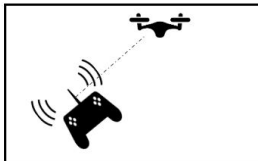
1. Navigate to the “General” tab in the Application Settings menu and select “Display MGRS coordinates.”



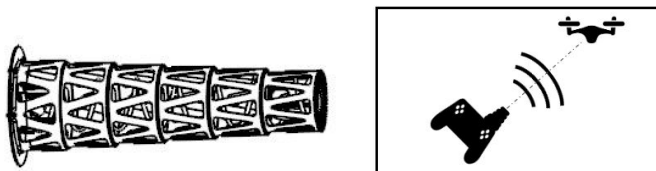
VISION GCS ANTENNAS

The GCS has two antennas, Omni Antenna and Directional Antenna, that can be attached for different use cases:

1. **The Omni Antenna** is a thin rod and strong at all ranges.
 - The Omni Antenna should be pointed sideways, flat sides towards Vesper for the most reliable signal.



2. **The Directional Antenna** is foldable, wide and cone-shaped and is best for long distance and non-line-of-sight flight.
- The Directional Antenna should be pointed directly towards Vesper for the most reliable signal.



The operator can deploy the antenna by rotating the inner ring counter-clockwise with the palm of a hand. To pack, reverse the process for deployment.

Note: the Directional Antenna should be handled with care.

- When opening the Directional Antenna, be sure to release it slowly.
- In storage, ensure the Directional Antenna is not in a position where it could be crushed.

GCS CHARGING

Vision GCS is charged through the USB Type C port on the bottom of the unit.

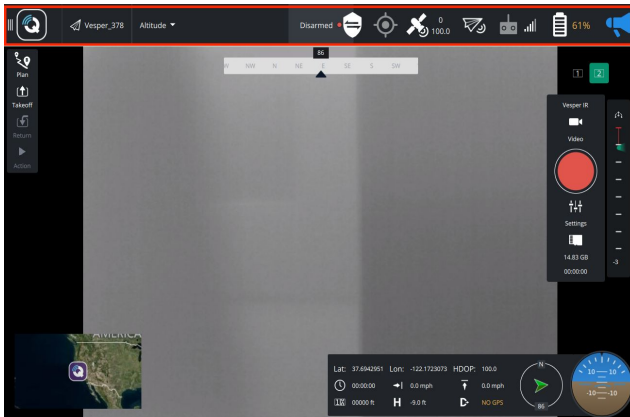
- Vision GCS charges at 45 Watts when turned off.
- Vision GCS charges 7.5 Watts when powered on.
- When the GCS is streaming video, it will charge very slowly.

IMPORTANT: only use the USB-C charger and cable provided.

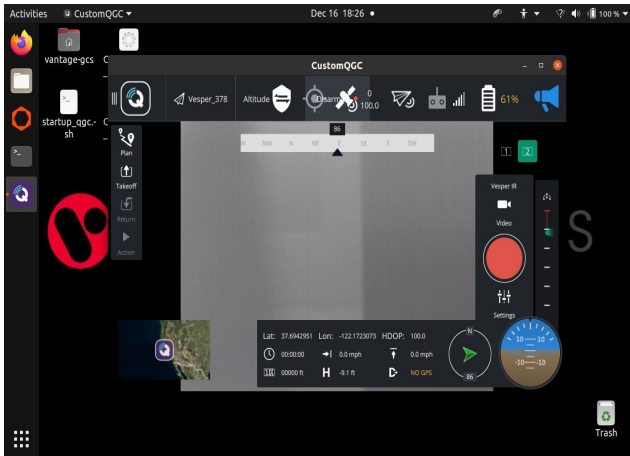


NAVIGATING UBUNTU

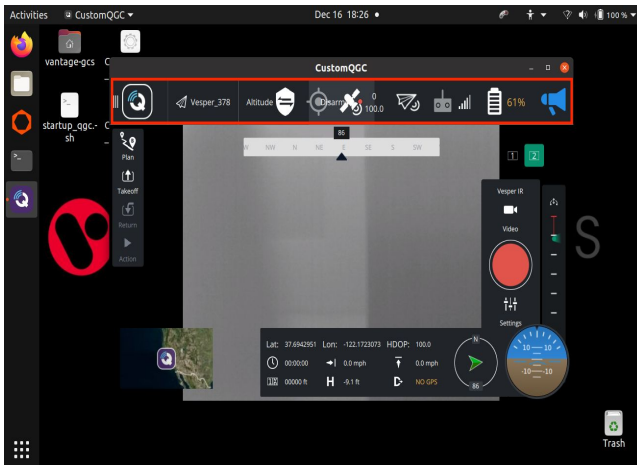
1. Triple tap the menu bar to exit fullscreen mode in QGC.



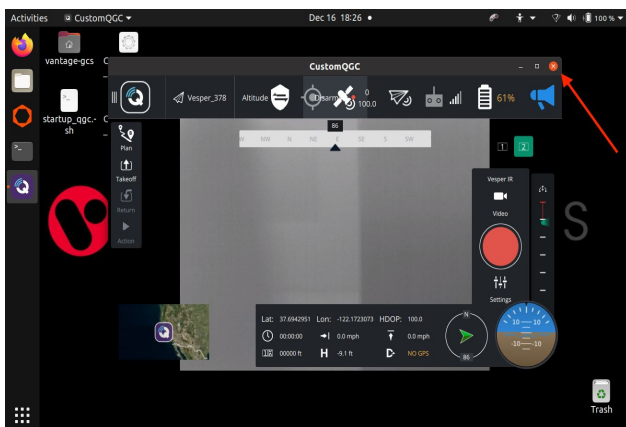
Note: screen below captures screen after fullscreen mode is exited.



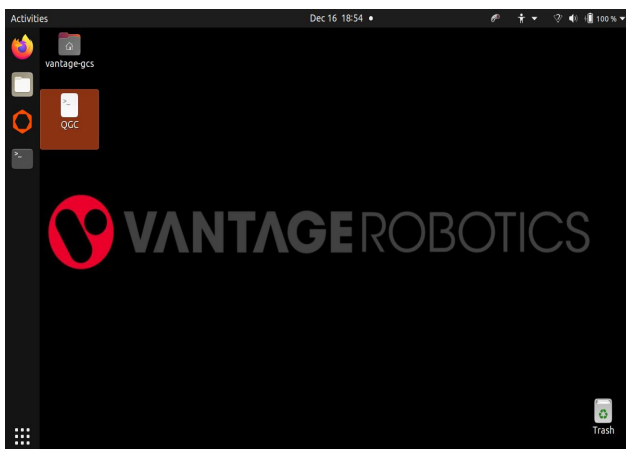
2. To go full screen double tap top menu bar.



3. To exit QGC when not in fullscreen mode, tap the red X icon in the top right corner of the window..

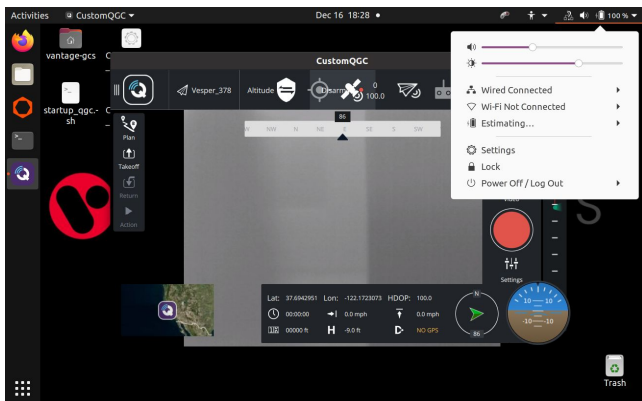


4. To re-open QGC, double tap the QGC file on the desktop as shown below.

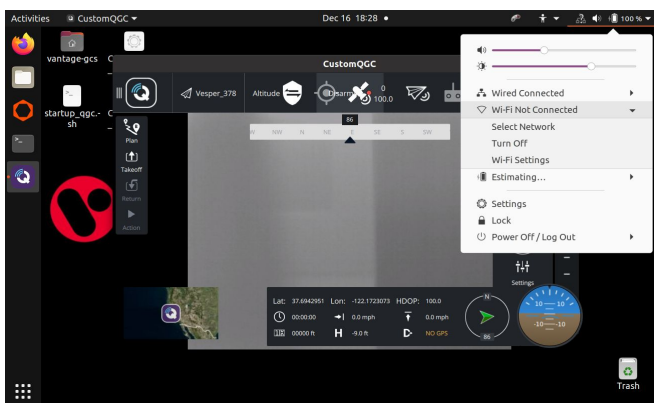


Connecting to a Wifi Network.

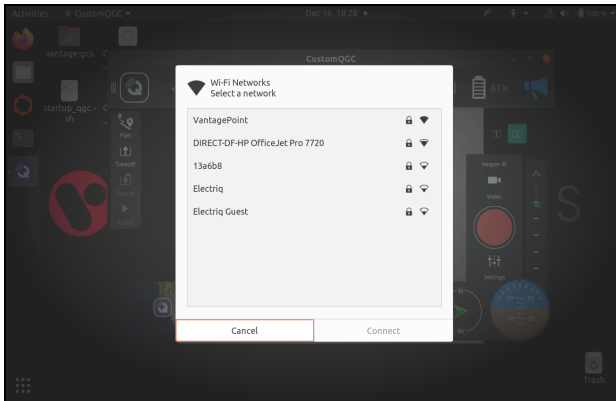
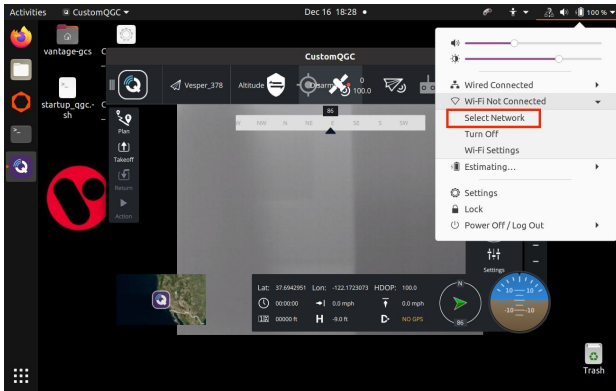
1. Exit fullscreen mode by following instructions on p.48.
2. Tap the menu bar in the top right to access the quick settings menu.



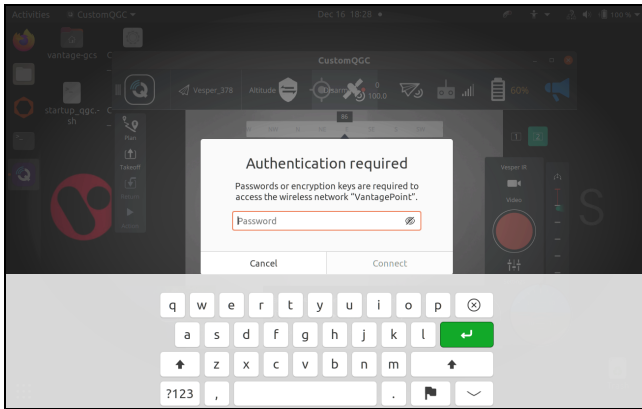
3. Tap the Wifi icon to access the wifi quick settings menu.



4. Tap select network to show all available wifi networks.

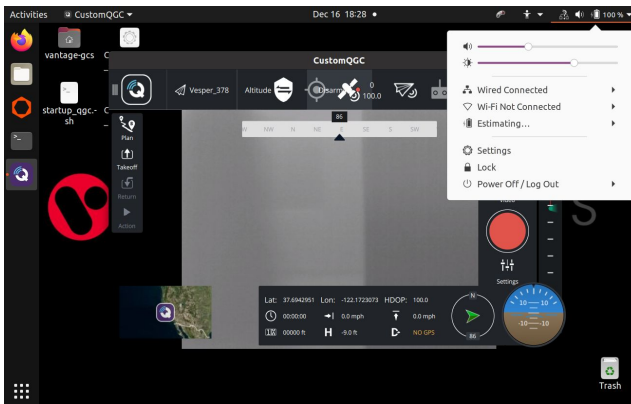


5. Select the network you would like to connect to and enter the passphrase using the on-screen keyboard. Tap 'Connect' when done.

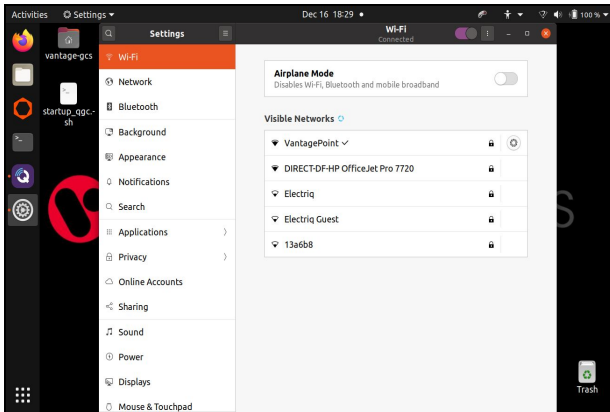


Accessing Ubuntu System Settings:

1. Tap the menu bar in the top right to access the quick settings menu.

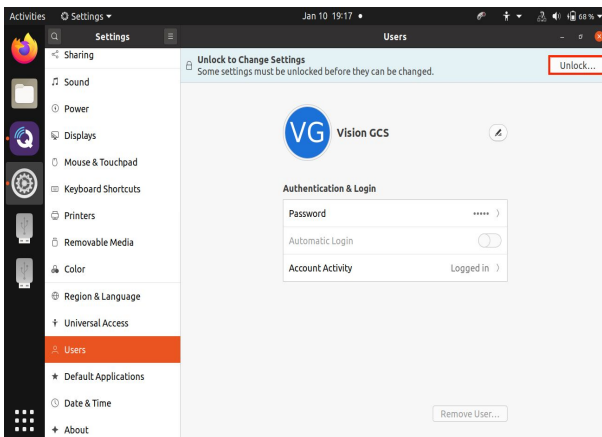


2. Tap Settings to access Ubuntu System settings. We recommend that you do not change anything here as it may affect system performance.

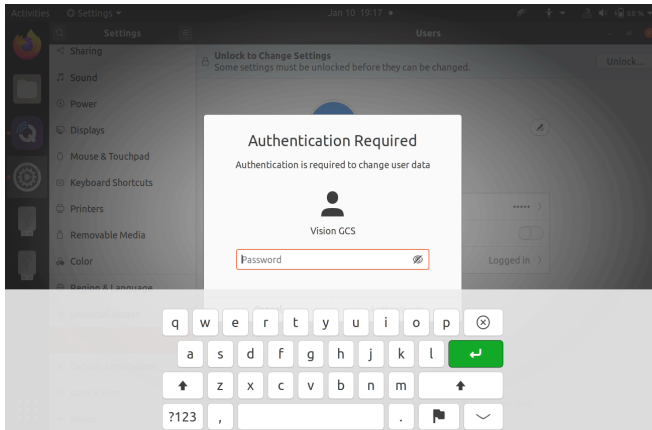


Disabling the lock screen:

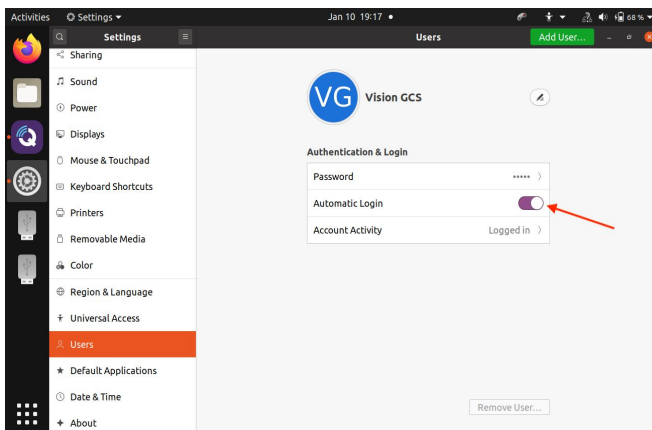
1. Access the settings menu as shown above
2. Select Users in the Sidebar



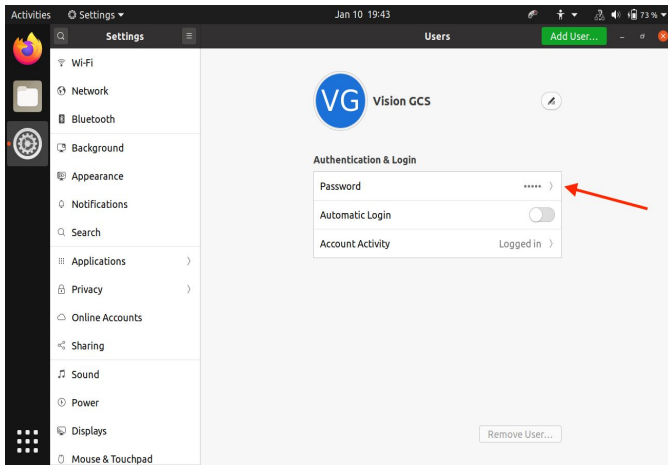
3. Tap Unlock in the top right corner of the screen. The authentication window will pop up. Enter the default password: Vantage1



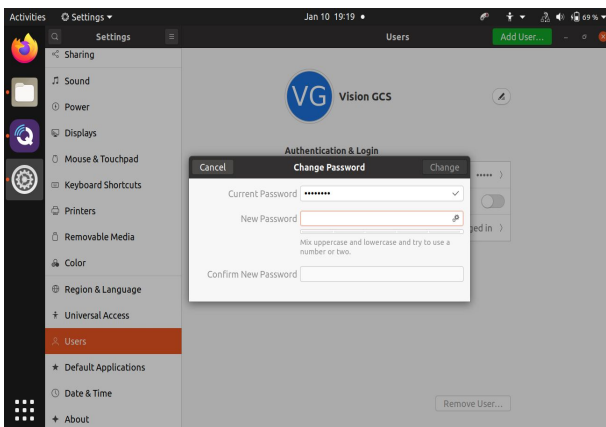
4. Toggle the Automatic Login switch to disable the lockscreen on boot.



5. You can change the GCS password by selecting the Password Menu.

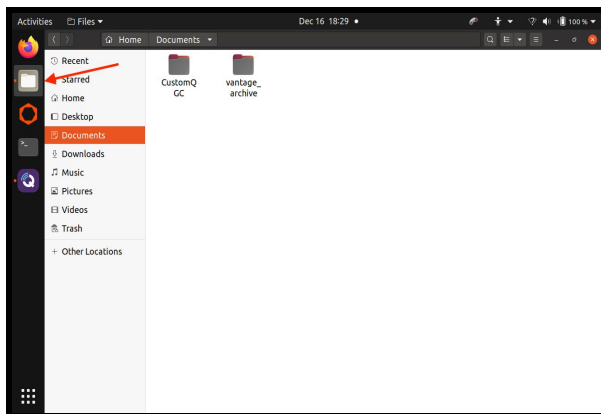


6. Enter the default password 'Vantage1' and then enter a new password. Tap Change to complete the change



Accessing files:

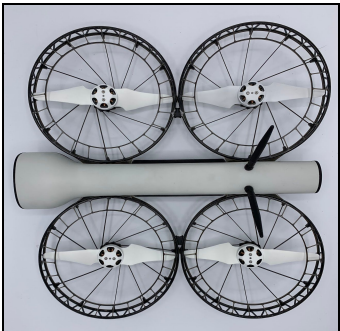
1. Exit full screen mode by following the instructions above.
2. Tap the Folder icon in the dock on the left side to open the file browser.



X. VESPER HARDWARE

ROTOR SETS

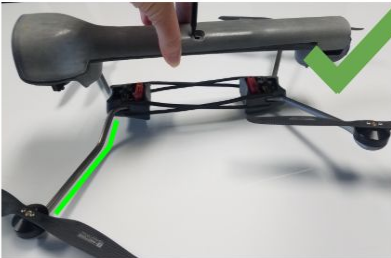
Vesper has two rotor set options: the Safety Rotor Set and the Recon Rotor Set.

<u>Name</u>	<u>Use</u>	<u>Description</u>
Safety Rotor Set	Use for: • Training, • Flights near or over people • indoors / in other confined spaces.	 6 inch shrouded plastic propellers
Recon Rotor Set	Use for: • Endurance • Stealth • Speed.	 8 inch open carbon propellers, titanium arms

Never attempt hand launching Vesper when using the Recon Rotor Set

INSTALLING THE RECON ROTOR SET:

1. Inspect the propellers for loose screws and damage.
2. Unfold the rotor arms so they are fully extended.
3. Confirm all magnets on Vesper's fuselage and rotor set are free of sand and other debris.
4. Orient the rotor set with the longer arms closest to the camera.
 - The longer bent arms should be on the front side of the fuselage (near the gimbal), and the shorter unbent arms should be on the rear end.
 - The polarity of the fuselage magnets will not allow the Recon Rotor Set to attach if aligned improperly (see picture below).
5. Attach the rotor set to the underside of Vesper's Fuselage by snapping magnets into place.
6. Confirm installation: when spun lightly with a finger, all four propellers should easily spin at least two full rotations.



TAKEOFF AND LANDING OPTIONS

Different takeoff and landing options can be used depending on the rotor set.

RECON ROTOR SET CONFIGURATION:

- **Ground Case Takeoff (use field case as a takeoff platform)**
 1. Place the case lid side down, with the lid open, on a flat/level surface.
 2. Place Vesper on top of the case, aligning the magnets on the bottom of the battery to the magnets on the case.
 3. Follow the standard takeoff procedure.
 4. The case may shift or be knocked over during takeoff, but Vesper will detach.



- **Hand Takeoff Using Case: (use in rough terrain/moving platform)**

1. Close the lid of the case.
2. Place the Vesper on top of the lid, aligning the magnets on the bottom of the battery to the magnets on the lid.
3. Instruct a co-operator to hold the case overhead while following these safety precautions:
 - a. Always hold the case from the bottom.
 - b. Always wear eye, head, and arm protection.
 - c. Look downwards as Vesper takes off.
 - d. As soon as Vesper has cleared the case, quickly exit the takeoff area without looking upwards.

CAUTION: the hand takeoff method is dangerous and should only be performed by experienced personnel who are trained and familiar with Vesper.



- **Ground Takeoff:**

1. When a flat surface is available Vesper can take off directly from the ground.
2. Always ensure blades have clearance to spin freely prior to takeoff.

Note: ground takeoff mode is less desirable than the alternatives, since it increases the chance of dust/dirt getting on the camera lens.

SAFETY ROTOR SET CONFIGURATION:

All Recon Rotor Set launch/landing options apply to the Safety Rotor Set. Additionally, due to the reduced risk of laceration from the blades, hand takeoff/landing is also possible with the Safety Rotor Set.

- **Hand Takeoff:**

1. Hold Vesper from above with one thumb and forefinger pressing against opposite sides of the battery.
2. Set feet in an active stance, so you are prepared to exit the fly area quickly.
3. When hands and feet are set, inform the operator you are ready for takeoff.
4. Once the blades are spinning, quickly remove your hand away from the propellers vicinity, and jog 20 feet away from launch location.

CAUTION: the hand takeoff method can be dangerous and should only be performed by experienced personnel.

- **Hand Landing:**

1. Push the Land button.
2. Grab Vesper from waist level. Adjust hand until it is securely holding the battery.
3. Once the co-operator or operator is securely holding the battery, lift Vesper upwards to shut off the propellers.

Note: if the co-operator grabs Vesper in flight, the operator will need to push the altitude control stick downwards until blades power off

CAMERA AND GIMBAL

Vesper’s modular gimbal is equipped with (a) a low light, wide angle navigation camera, (b) a zoom camera and (c) a thermal camera.



SENSOR SPECIFICATIONS:

	Lens Speed	Horizontal FOV	Resolution
Navigation	f1.0	63 degrees	3840x2160
Telephoto	f2.4	17 degrees	3840x2160
Thermal	f1.0	24 degrees	320x240

TRANSPORTING VESPER

Vision GCS, Vesper, and Vesper accessories have customized cases and bags for storing and transporting properly.

FIELD CASE:



- Store Vesper in the field case with the battery still attached by folding the Recon Rotor Set arms into the fuselage.
- The Field Case lid can act as a landing and takeoff point.
- The Field Case is waterproof to up to 3ft, crushproof up to 250 lbs, and resists drops up to 6 ft.

TRANSPORTATION CASES:

- Transportation cases are used to store bundles & long distance travel.
- The larger case stores two Vesper units in Field Cases, two batteries, two battery bags, one Safety Rotor Set and charging accessories.
- A second, smaller, transportation case stores Vision GCS.



XI. MAINTENANCE

CLEANING & CARE ACCESSORY CASE

The Vesper Cleaning & Care Accessory Case is a water resistant and contains:

- Set of four replacement propellers for the Recon Rotor Set and the Safety Rotor Set;
- Lens cleaning brush;uju
- 1.5mm hex wrench for gimbal replacement.



VESPER & VISION GCS CLEANING

STEPS FOR CLEANING PARTS & SUBASSEMBLIES:

1. Preparation:

- a. Remove all components from the Field Case.
- b. Disassemble fuselage, battery and rotor set.

2. Battery:

- a. Remove any metal debris stuck to magnets.
- b. Recharge batteries with charging dock after use.
Note: If a battery is cracked or otherwise unusable recycle it with other hazardous waste and replace it with a new battery.

3. **Rotor Set:**
 - a. Remove any metal debris stuck to magnets.
 - b. Inspect the propellers for loose screws and damage.
 - c. Confirm that all motors spin freely.
4. **Fuselage:**
 - a. Clean the underside of the fuselage.
 - b. Remove any metal debris stuck to magnets.
5. **Gimbal:**
 - a. If dirt or fingerprints are on the lens, gently wipe with the soft brush and lens cleaner provided in the cleaning kit.
 - **IMPORTANT:** Do not use fingers or hard material to wipe away particles blocking lenses.
6. **Vision GCS:**
 - a. Use a dry, soft, microfiber cleaning cloth.
 - b. If the casing becomes soiled it can be wiped down gently with soap and water.

STEPS FOR REASSEMBLY STORAGE:

1. After the battery is charged, attach battery to the fuselage.
2. Attach fuselage and battery to the rotor set forming a complete UAS.
3. Fold the rotor set arms and insert into the field case.

VESPER MAINTENANCE

REPLACING / REMOVING THE GIMBAL:

The gimbal can easily be removed/replaced in cases where a lens or the whole unit is damaged beyond repair.

1. Unscrew the two screws located directly behind the gimbal using the 1.5 mm allen head screwdriver provided, turning counter-clockwise.
2. Save the screws.
3. Gently remove the gimbal by pulling it away from the fuselage; set aside.
4. Place the new gimbal in the same position, and screw it into place using the same screws and screwdriver, turning clockwise.



REPLACING PROPELLERS:

- **Recon Rotor Set:**

1. Gently pull the propeller directly off of the motor.
2. Replace with a new propeller.
 - The new propeller will snap into place easily; listen for a click sound.
3. Spin the blades with one finger to check that the new propeller is attached correctly; propellers should easily rotate.

- **Safety Rotor Set:**

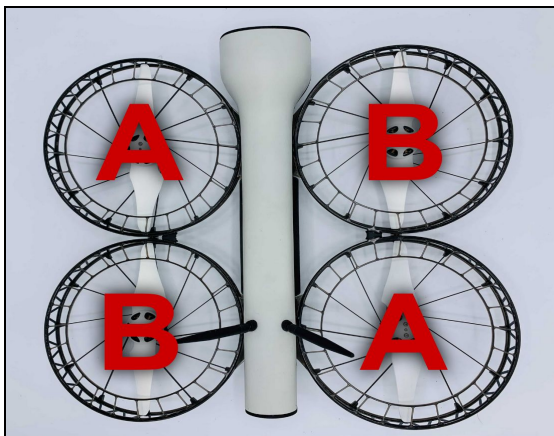
1. Remove the two screws attaching the propeller to the motor using a 1.5mm allen head screwdriver, turning screws counter-clockwise.



2. Set screws aside.
3. Ensure the new propeller is correct: for SRS → the white blades, and for RRS → the gray plastic blades.
4. Ensure the new propeller blades match the direction of the blade you are replacing.



5. The curves and direction of the slant must be the same as the previous blade used.
6. B blades move counter-clockwise & A blades clockwise
Note: When oriented as the picture below, the layout is:



7. Place the new propeller over the holes and attach with the screws. Torque the screws to snug plus a quarter turn.
8. Spin the blade with one finger to check that the new propeller is attached correctly. The propeller should easily make two full rotations.

XII. TROUBLESHOOTING

Common issues will be reported on the Vision GCS display as a warning/error message. For example, a lost or low link strength will result in a message displayed on the GCS, indicating that action should be taken.

Below is a list of common issues, how to identify them, and troubleshooting steps to resolve them.

To change notifications or failsafe settings refer to section: PROGRAM FAILSAFE TRIGGERS & EMERGENCY PROCEDURE.

PAIRING

Problem	Indicator	Response
Cannot get Vesper into pairing mode	No tone indicating successful pairing	1. Disconnect battery, wait a few seconds, then reconnect. 2. Repeat pairing instructions (see page 10).
Gimbal clacks back and forth when turning Vesper upside down to pair	Gimbal clacking	Wait a full 60 seconds from startup before flipping upside down.
Pairing process gets stuck on “Searching” screen	Searching screen shown for > 60 seconds	1. Confirm Vesper is on by checking the gimbal is active. 2. Confirm radio connections are plugged in. 3. Cancel pairing attempt on QGC and redo the process to put Vesper and GCQ into pairing mode and wait another 60 seconds.

		4. If not successful, cancel pairing and try again. 5. If not successful, power cycle Vesper and repeat instructions. 6. If not successful, power cycle Vision GCS and repeat again.
Pairing process gets stuck on switch to high power	High power transition screen shown for > 60 seconds	1. Confirm Vesper is on by checking the gimbal is active. 2. Confirm Vesper is at least 15 ft away from Vision GCS. 3. Restart pairing process and try again.

CONNECTING

Problem	Indicator	Operator Response
No telemetry or video appears after 60 seconds	No telemetry or video appears after 60 seconds	1. Confirm that Vesper is on by checking that gimbal is active. 2. Confirm that the radio is plugged in correctly. 3. If unsuccessful, power cycle Vesper and try 2x more times. 4. If unsuccessful, re-do the pairing process.
Telemetry appears but video does not appear	Telemetry is active, but video is not	1. Confirm that Vesper is at least 15 feet away from Vision GCS. 2. If unsuccessful, confirm that Vesper has a SD card inserted with at least 2 GB available. 3. If unsuccessful, power cycle Vesper and try again.
Connection quality is poor	Video comes and goes repeatedly, attitude updates in artificial horizon are not smooth	1. Confirm that Vesper is at least 15 ft away from Vision GCS. 2. If unsuccessful, confirm the antenna is correctly deployed. 3. If unsuccessful, confirm that Vesper has a SD card inserted with at least 2 GB available. 4. If unsuccessful, restart Vesper. 5. If unsuccessful, restart Vision GCS.

PRE-FLIGHT:

Problem	Indicator	Operator Response (P) / Cooperator Response (C)
Propeller(s) not rotating	Propeller does not freely make 2 rotations when spun with finger	1. (C) Check propellers for damage (i.e. cracks). 2. (C) Check for obstruction (dirt, sand, etc.) in the motor. 3. (C) Replace rotor set.
Launch conditions not met	Vision GCS feedback	1. (P) Click “!” in upper right on Vision GCS to learn more. 2. (C) If “Motor error”, confirm that props are clear and spin freely. 3. If props do not spin freely, replace the rotor set. 4. (P) If there is no clear corrective action, try again 3x times. 5. (C) Power cycle Vesper. 6. (P) Try again.
Image blurry	Image blurry	1. (C) Clean lenses by using brush to remove dust or water.
Magnetometer issue	Error message on Vision GCS or general failure to launch	1. (C)/(P) Move Vesper and Vision GCS away from any magnetic or metal objects. 2. (C)/(P) Use the Field Case Takeoff method. 3. (C) Power cycle Vesper and Vision GCS (UPCI).
Interface frozen	Unresponsive to commands after repeated	1. (P) Restart QGC. 2. (P) Restart Vision GCS. 3. (C) Restart Vesper.

	attempts	
Gimbal is not operating properly	Gimbal does not maintain level while rotating the fuselage	1. (C) Restart vesper while tilting/holding gimbal to the right (roll) of Vesper's flight direction for 25 sec. After being released the gimbal will auto calibrate and return to level position.
Warning upon connecting GCS to Vesper	Yellow warning indicator shows "One or more vehicle components require setup prior to flight"	1. (P) Tap X at the top right corner to disregard the pop-up.
SD Card show 0 GB Remaining	As indicated above camera button	1. (P) Power cycle and confirm the SD card on the underside of Vesper is inserted all the way. 2. (P) Follow instructions for removing video from the SD card, as the SD card may be full. 3. (P) Replace the SD card with one from another unit. 4. (P) Restart QGC.

FLIGHT

Problem	Indicator	Operator Response (P) / Cooperator Response (C)
Lost communication link	"No Video" shown, telemetry stops updating	1. (P) Confirm the antenna is pointing in the correct direction. 2. (P) Check antenna connections.
Lost video stream	"No Video" shown, telemetry continues to update	1. (C/P) Confirm the antenna is pointing in the correct direction. 2. (P) Wait 15 seconds. 3. (P) Switch to a different zoom level or sensor (EO/IR), and try 3x times. 4. (P) If there is no video feed after 60 seconds, try a higher altitude. 5. (P) If unsuccessful, return towards home until feed returns.
Operator cannot control gimbal pitch	Gimbal pitch not responsive	1. Restart QGC (see instructions below).
Drone does not command pitch in missions	Gimbal pitch does not change during missions	1. Turn off manual "Gimbal Pitch Control" option in camera settings.
Poor quality video stream	Video is pixelated or latency is high	1. (P) Climb to higher altitude if possible to regain line of sight. 2. (P) Confirm the antenna is pointed in the correct direction.
Lost GPS	Warning/error message on Vision GCS (low GPS strength)	1. (P) Maintain position manually, and fly to a lower altitude if possible to regain optical flow control.
Low Vesper battery	Message on Vision GCS of battery <8%	1. (P) Instruct Vesper to return to launch (RTL).

	and Vesper >1km away		
Downed Vesper (LoS, BLoS)	Unplanned landing or Vesper brought down	1. (P) Use the last known location on the map to locate Vesper. 2. (P)/(C) Go to the search location for Vesper recovery.	
Latency (command, data, or video)	Slow video feedback or response to commands	Early flight:	1. (P) Land. 2. (C) Power cycle. 3. (P)/(C) Restart flight mission.
		Mid flight:	1. (C) Adjust antenna. 2. (P) Move or increase altitude to re-establish LoS.
QGC/Vesper unresponsive to commands	Unresponsive to commands after repeated attempts	1. (P) Restart QGC. 2. (P) Restart Vision GCS. 3. (C) Detach and reattach radio power cable from Vision GCS.	

TAIL LED INDICATOR AND VEHICLE STATE REFERENCE

	Solid	Pulsing	Blinking
Blue	Armed No GPS	Ready No GPS	-
Green	Armed GPS	Ready GPS	-
Turquoise	Booting	-	-
Purple	Failsafe Mode (vehicle will RTL or land)	-	-
Amber	Low Battery	-	-
Red	-	-	Error, Critical Low Battery

RESTARTING QGC:

1. Tap the top of the QGC window three times to make the window smaller.
2. Tap the “Activities” button in the top left corner of the window.
3. Select the image of the QGC interface, and click the upper right arrow to quit.
4. Select the option to exit from the popup window when returning to the app.
5. Open activities → Files → Desktop.
6. Double tap VantageQGC.ApplImage.