Julian Dale

THE PARROT DISCO MODIFIED

Flight manual for conversion and operation

Version 1.4. 2021-02

MODIFICATIONS

- Load arduplane firmware on aircraft to allow flight planning capability
- Install downward facing RGB camera for mapping
- Setup PS4 wireless remote controller for manual flight
- Define parameters and mission planning protocols under QGroundcontrol environment
- Provide data process to import images into Pix4D for analysis.

Although the Parrot disco is a very capable, easy to fly and inexpensive aircraft, it lacks the ability to fly mapping missions under the parrot Freeflight app environment. To be fair this aircraft was never initially intended for this type of operation. Parrot did however provide the architecture to allow the disco to fly under the open source ardupilot firmware.

The origins of this project were to create a very low cost mapping aircraft with extended flight time. The intent was to send this out to field teams within the WCS (Wildlife Conservation Society) network to provide them with mapping and inspection capabilities in order to help their conservation efforts.

OVERVIEW

- Nylon X 3d printed battery and camera housing
- Remote power supply for Sony RX0 camera and dummy battery manufactured
- Custom Sony multi-terminal connector to trigger camera shutter with Seagull Map#X and remote power on/off switch
- Custom QGroundcontrol parameters and setting to use the PS4 controller and tuned for the increased aircraft weight

CONTENTS

1. INSTALL PS4 CONTROLLER

DualShock 4 Bluetooth Pairing Settings

Step 1:

- To pair the DS4 with a computer, first put the controller into pairing mode by press and HOLDING the PlayStation button and Share button at the same time for 3 seconds. Hold these buttons until the light bar starts rapidly flashing.

Step 2:

- If your Operating System is Windows 7 then you have to right click on the Bluetooth Icon on the bottom right tray. If you are using Windows 8 or higher, open Bluetooth Settings by clicking on the Speech Bubble icon in the Task Bar on the bottom right corner.
- This will launch Action Center, click on Bluetooth and wait for the Wireless Controller to Appear.
- Click on it and type 0000 for typing the Pair Code.

That's it, the controller is now connected wirelessly. In case you find issue with detecting the Wireless Controller after turning on Bluetooth, troubleshoot your PC Bluetooth adapter by updating drivers.

USB Connection

- The controller can also be connected directly to the PC with a USB to USB micro cable. This plugs into the charge port on the front of the controller.

2. CONNECTING DISCO

Power up Disco

1. Install battery as shown.
2. Connect main battery lead (Yellow XT60 connector)
3. Press power button once (Pitot tube). Aircraft will start up. Wait for the long tone
4. **Press power button 3 times** in quick succession. This will boot the Disco into Arduplane and it will play a short tune as it boots up.

WiFi connection

1. Use a long range USB WiFI modem such as the Alfa Long-Range Dual-Band AC1200 Wireless USB 3.0 Wi-Fi Adapter w/2x 5dBi External Antennas. You may need to download the latest driver for the Alfa USB WiFi modem here https://www.alfa.com.tw/download/all/1.htm

2. Connect USB WiFi modem to the computer

3. Go to computer device manager and **disable** the computers inbuilt network adaptor or turn off the internal WiFi. *ensure you are only connecting to the aircraft using the long range WiFi modem and not your computers internal WiFi*

3. Connect to Disco WiFi from the computers network connection using the USB modem. Disco should appear as a DISCO-xxxxx as a WiFi connection **It is **highly advised** to disable all "connect automatically" options for your other WiFi connections. You do not want the aircraft to disconnect mid flight and have your computer connect to another network.**

4. Open QGroundcontrol. The Disco should connect automatically after a few seconds. If you encounter any issues. Shut down QGroundcontrol, ensure the disco is booted into Arduplane (three button presses on the pitot), the WiFi is connected to the aircraft then restart the app.

3. CONFIGURING QGROUNDCONTROL

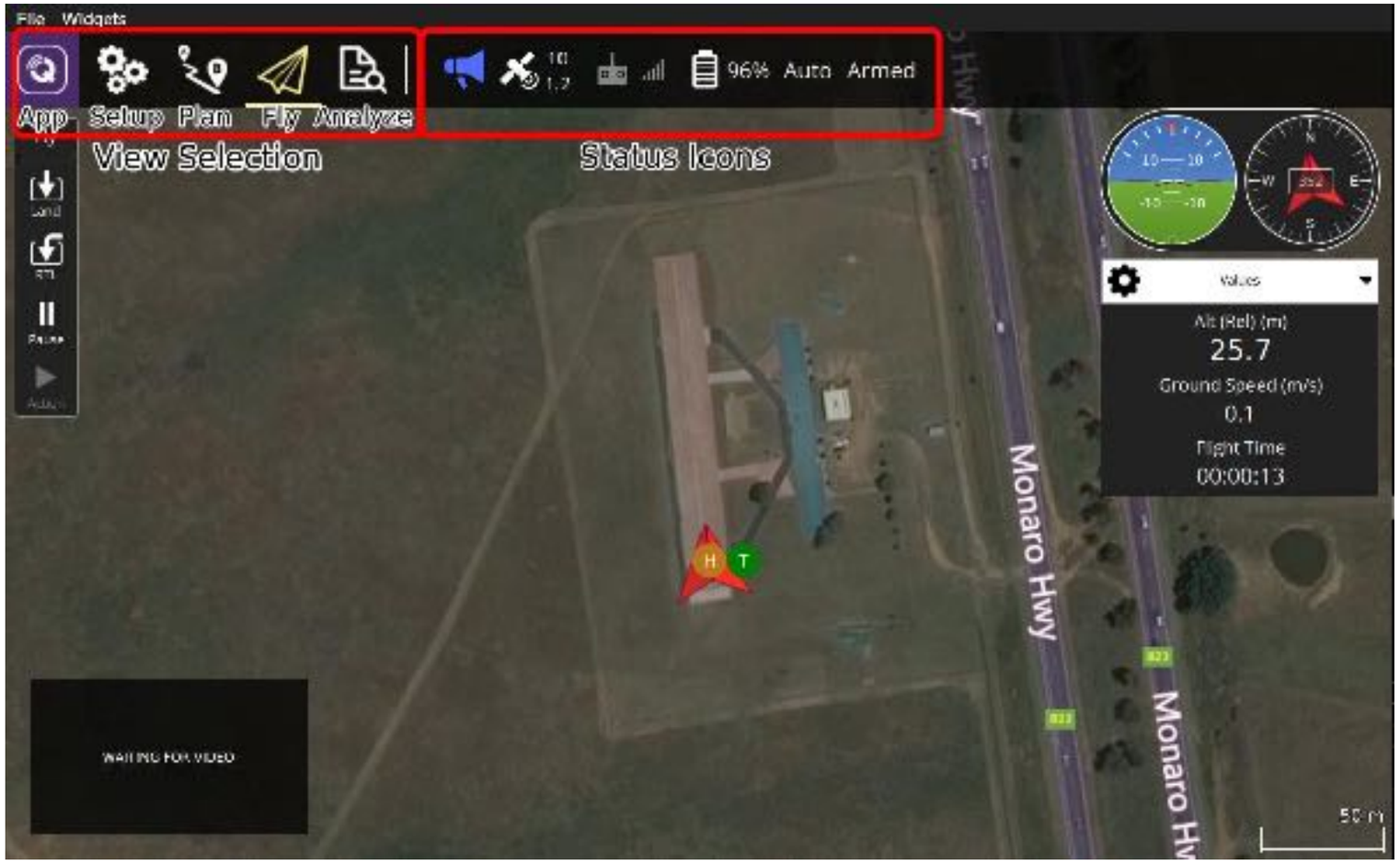
Getting QGroundControl up and running is quick and easy:

1. Download and install the application. **Current stable** version tested with the modified **Disco is V4.0.10**. Other versions many not function properly. You can go the the GitHub site to download previous versions. The link is on the downloads page for qGroungcontrol.

2. Start QGroundControl.

3. Attach your vehicle to the ground station device via USB, through a telemetry radio, or over WiFi. QGroundControl should detect your vehicle and connect to it automatically.

That's it! If the vehicle is ready to fly, QGroundControl should display Fly View as shown below (otherwise it will open Setup View).



A good way to become familiar with *QGroundControl* is to start experimenting:

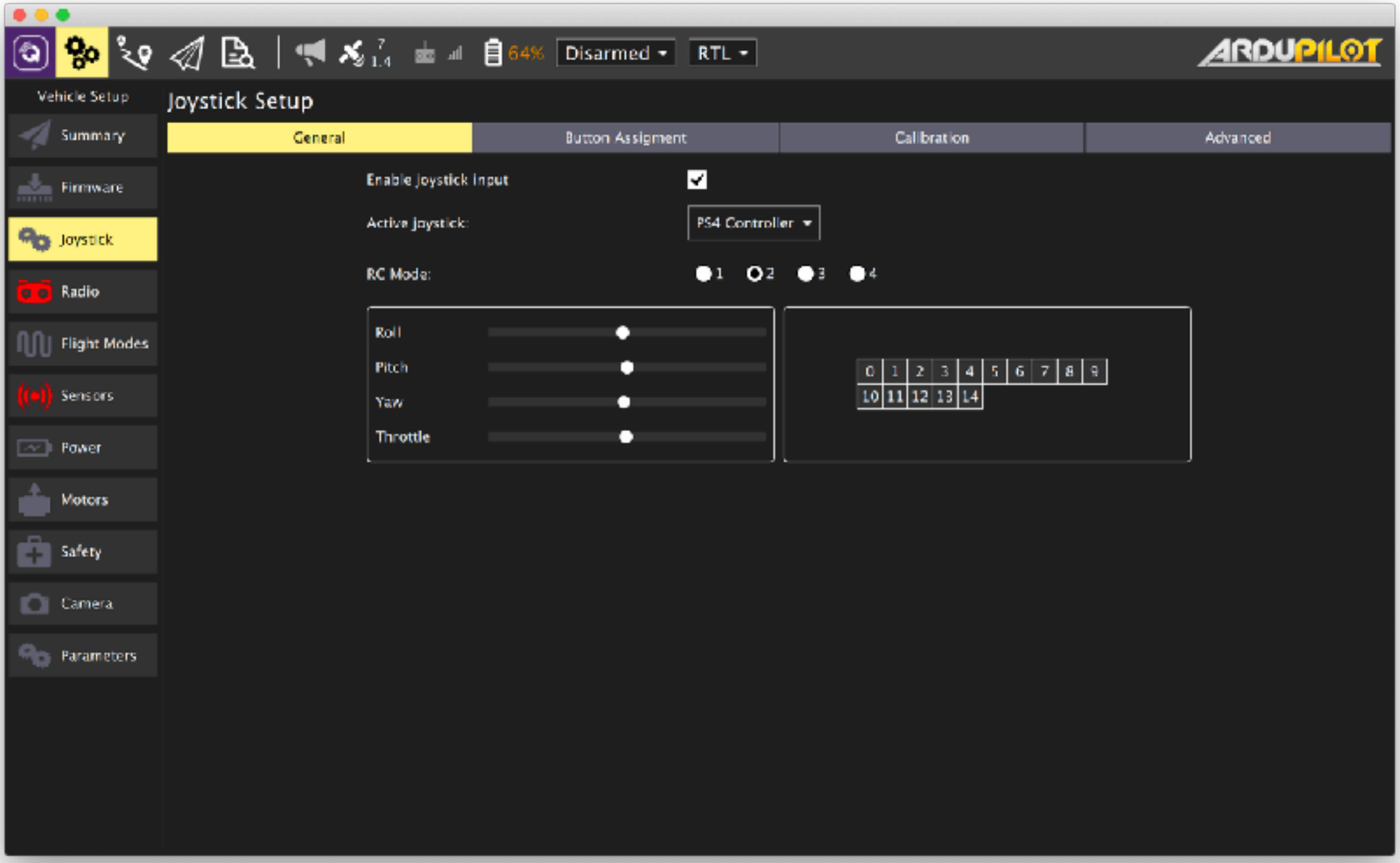
- Use the toolbar to switch between the main views:
  - Settings: Configure the *QGroundControl* application.
  - Setup: Configure and tune your vehicle.
  - Plan: Create autonomous missions.
  - Fly: Monitor your vehicle(s) while flying.
- Click the *Status icons* on the toolbar to find out the status of the connected vehicle.

While the UI is fairly intuitive, this documentation can also be referenced to find out more.

Controller calibration

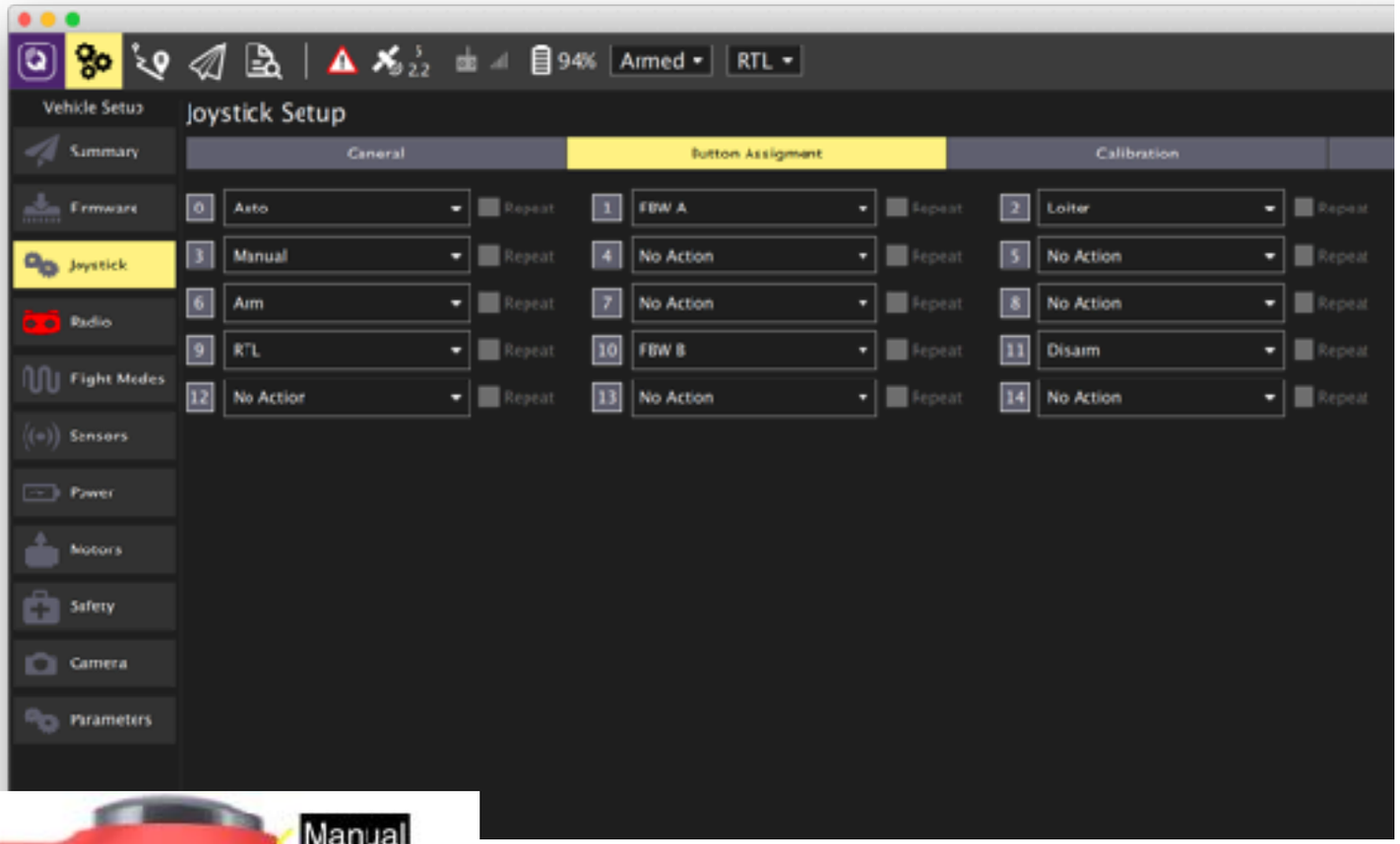
To configure a joystick:

1. Start *QGroundControl* and connect to a vehicle.
2. Connect the Joystick or Gamepad to a USB port or bluetooth.
3. Select the **Gear** icon (Vehicle Setup) in the top toolbar and then **Joystick** in the sidebar. The screen below will appear.
4. Make sure your joystick is selected in the **Active joystick** dropdown.
5. Press the **Calibrate** button and then follow the on-screen instructions to calibrate/move the sticks.
6. Test the buttons and sticks work as intended by pressing them, and viewing the result in the Axis/Button monitor.
7. Select the flight modes/vehicle functions activated by each joystick button. A maximum of 16 joystick *button actions* can be set.
8. Check the **Enable joystick input** checkbox to begin sending joystick commands to the vehicle.


7
1.4
64%
Disarmed
RTL
ARDUPILOT
Vehicle Setup
Summary
Firmware
Joystick
Radio
Flight Modes
Sensors
Power
Motors
Safety
Camera
Parameters
Joystick Setup
General
Button Assigment
Calibration
Advanced
Enable joystick input
Active Joystick:
PS4 Controller
RC Mode:
1
2
3
4
Roll
Pitch
Yaw
Throttle
0 1 2 3 4 5 6 7 8 9
10 11 12 13 14

The following button actions should be set up.

- **Auto** = Start mission loaded
- **FBW A** = Fly By Wire A (stabilised but no altitude hold function. Direct control over throttle)
- **FBW B** = Fly By Wire B (stabilised with altitude hold function. Throttle will control min/max airspeed set)



- **Loiter** = Will put aircraft into an orbit and maintain altitude

- **Manual** = Full manual control. **NOT RECOMMENDED FOR FLIGHT**. Use this mode only to verify flight controls on the ground.

- **Arm** = Arm the motor ready for takeoff

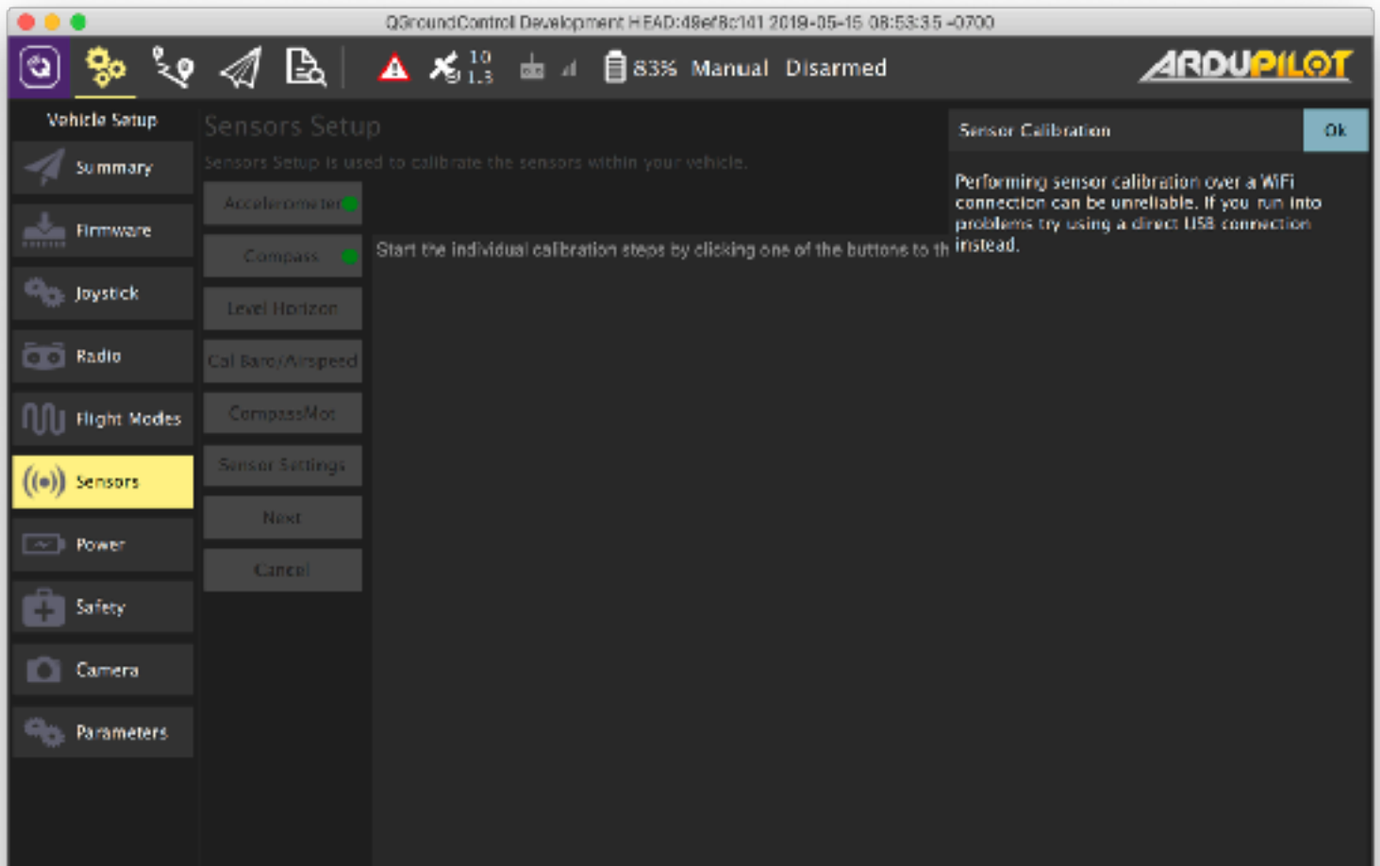
- **Disarm** = Disarm the motor

- **RTL** = Return to Launch. Aircraft will return to the home position and orbit.

Sensor calibration

Perform the following calibrations as instructed

- Accelerometer
- Compass - Note. Ensure the battery cowling **is fitted** during compass calibration.
- Level Horizon = Using the level bubble measure on your phone. Sit the phone on the autopilot and lift the nose up by 3deg by placing something under the airframe. Ensure the wings are horizontal. When the aircraft is in the correct position and is completely still, hit the “level horizon” button
- Cal Baro/Airspeed = Cover the pitot tube with your had so it measure the static air pressure and is not influenced by the wind.



4. CAMERA SETUP

Camera settings

Install the micro SD card.

Plug in the Sony Multi connector to the camera.

With the camera connected to the main flight battery, press the button below the camera to turn the camera on

A **new or unformatted SD card** will require a database to be set up before use. Power up the camera and hit “enter” at the image database creation prompt.

It is important to set the following camera parameters

1. Aspect ratio = 4:3
2. Manual shutter speed = 1/1250 is a good default speed
3. ISO = Auto
4. Focus = Wide
5. Set the camera time to GMT
6. Ensure the SD card has enough space

Camera Parameters		
	Width	Height
Sensor Size	13.2mm	8.8mm
Image px	4272	3200
Focal length	7.7mm	


DISP
Quality/Image Size 1/7
Quality Fine
Image Size L: 14M
Aspect Ratio 4:3
High ISO NR Normal
Color Space sRGB
MENU
Fn


Shoot Mode/Drive 2/7
Shoot Mode Manual Exposure
Drive Mode Single Shooting
Bracket Settings
Recall
Memory
MENU
Fn


AF 3/7
Focus Mode Single-shot AF
Focus Area Wide
button Lock-on AF Off
AF Area Auto Clear Off
NEAR Mode in PF Off
Set Focus
MENU
Fn


Exposure 4/7
Shutter Speed 1/1250
Exposure Comp. ±0.0
ISO ISO AUTO
ISO AUTO Min. SS Standard
Metering Mode Multi
AEL w/ shutter Auto
MENU
Fn


Color/WB/Img. Processing 5/7
White Balance Auto
DRO/Auto HDR D-Range Opt.
Creative Style Standard
Picture Effect Off
Picture Profile Off
MENU
Fn


Focus Assist 6/7
Focus Magnif. Time No Limit
MF Assist On
Peaking Level Off
Peaking Color White
MENU
Fn


Face Detection/Shoot Assist 7/7
Face Detection Off
Face Registration
MENU
Fn

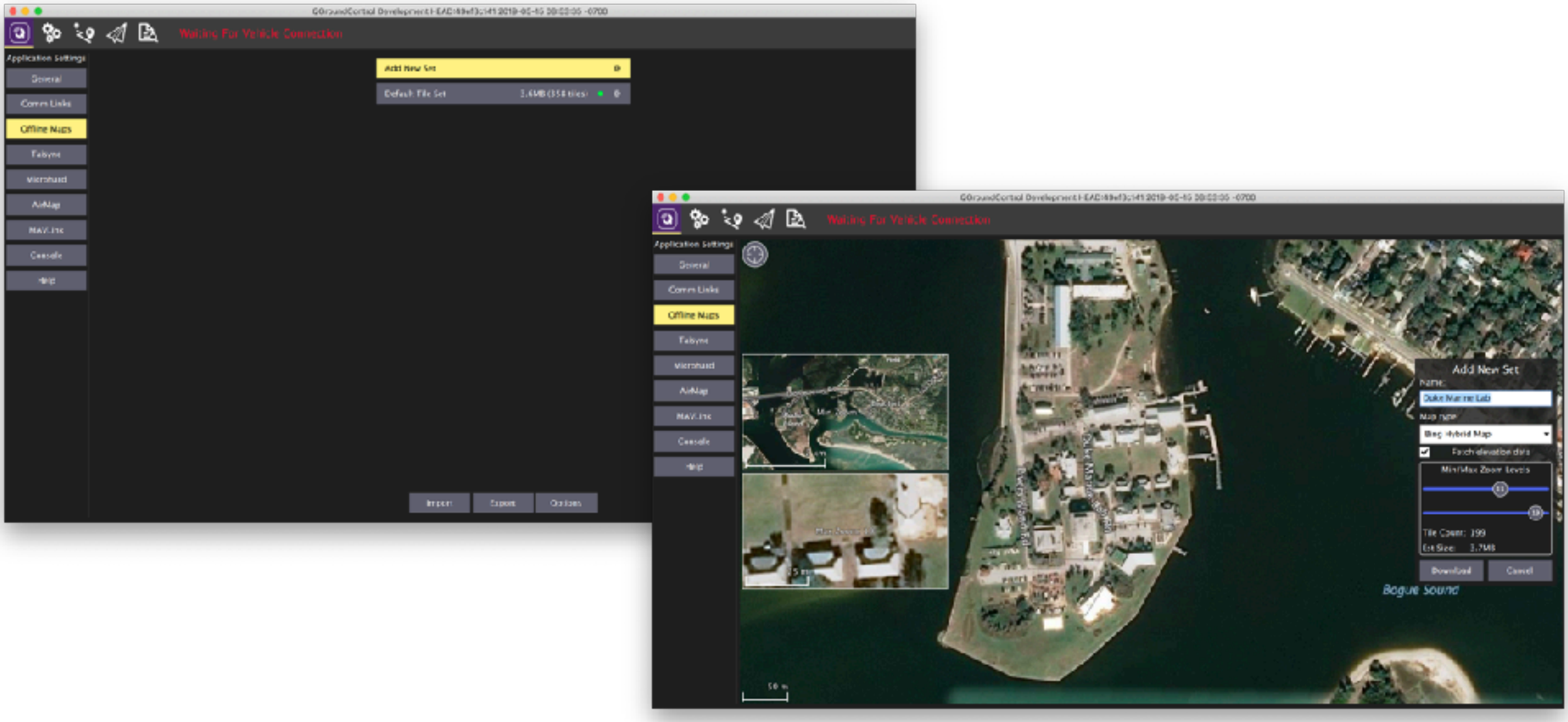

Setup1
1/6
Monitor Brightness
Manual
Gamma Disp. Assist
Off
Volume Settings
7
Tile Menu
Off
Pwr Save Start Time
30 Min
Auto Pwr OFF Temp.
Standard
MENU
Fn


Setup3
3/6
USB Connection
Auto
USB LUN Setting
Multi
USB Power Supply
Off
PC Remote Settings
Language
English
Date/Time Setup
MENU
Fn

5. FLIGHT PLANNING

1. Download base maps

If you are working in areas where you have no internet connection, you can download the base maps prior to departing. Go to **Application Settings** and click **Offline Maps**. Click **Add New Set**. Here you can create a file name, map area to download and zoom level required. Once selected click **Download** to store this map locally on your computer



2.Planning a Survey

1. Home position will be set automatically at the position the Disco is powered up.

2. Click on **Takeoff** and move the waypoint close to the takeoff location and at an altitude where it will clear all obstacles.

3. The takeoff parameters will automatically be set in position1 of the mission list. Set the **altitude** to a sufficient height to clear all obstacles at takeoff. Set the **takeoff pitch** angle to **25deg**

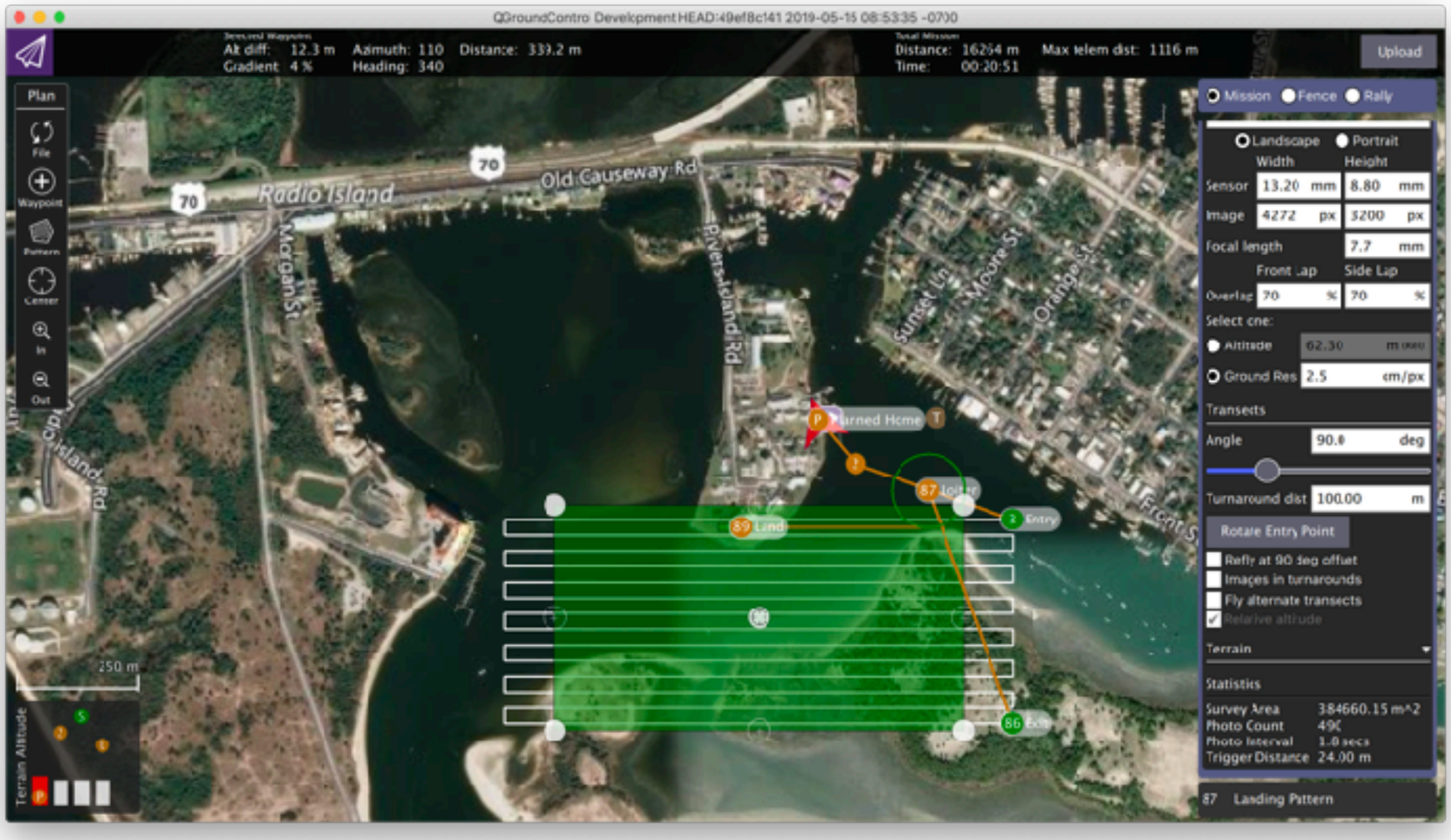
4. Set a waypoint close to the takeoff and in a position where the aircraft has a good entry to the first survey waypoint. You may need to adjust the **current set survey speed if the winds are strong**. To change this you need to click the “gear” icon and then select the parameters tab. In the search window type “trim_arspd_cm” **Set speed to 1500cm/s for light winds. 1700cm/s for moderate and 1900cm/s for strong winds ~18mph.** This will be the survey flight speed used during the flight.

5. Set a **Survey** area up as desired. Additional grips around the polygon can be added by clicking on the + on the perimeter. Set the **camera** to the **Sony RX0**.

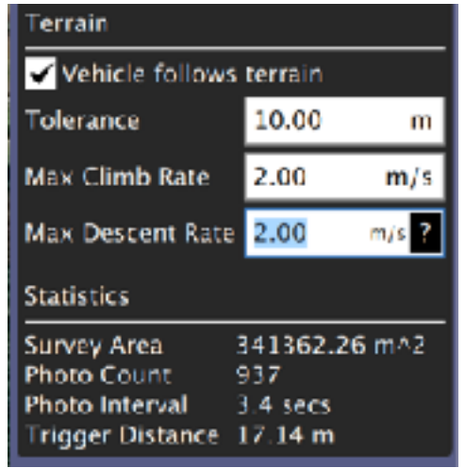
6. Select the desired GSD or Altitude , Overlap (70% is a safe default for mapping). Adjust the orientation as required for efficiency. In winds greatest than12mph it is advised to fly with a cross wind rather than a head and tail wind. For low altitudes, you may want to set the **Fly alternate transects** under the **options** so the aircraft isn’t making tight turns at the turnarounds. Set the **Turnaround distance** to **120m.** This allows enough distance to execute the turn and approach the start of the next transect.

7. Set the **landing position** on the desired landing position. You can physically move the aircraft to the desired landing spot and then set the centre of the green landing box on the aircraft icon for better accuracy. Remember to set move the landing loiter position so the glide slope approach line is into the wind and avoids **all obstacles**. The **Loiter Point Altitude** should be set to avoid all obstacles. The glide slope should be set to **10deg or less.** Lower glide slope angle will give higher landing accuracy in combination with the wind speed and wind direction relative to your approach direction.

8. **NOTE:** In the Windows version of QGroundcontrol you will need to un-check the “stop taking images” and “stop taking video” boxes at the bottom of the landing tab. The mission upload will fail otherwise.



9. If flying in areas with elevation changes, you can enable the **“Vehicle follows Terrain”** option in the **“Terrain”** section of the survey. This uses a course digital terrain model from the satellite imagery to adjust the waypoints to allow for changes in elevation.



NOTE: This will not account for tall trees, antenna or other tall obstacles. Ensure you have sufficient altitude during all aspects of the takeoff, survey and landing to account fo these obstacles or elevation changes.

10. Once all the settings have be configured and verified. Click **Upload**

11. Before flight, go to the **Safety** (Fig Safety) settings and ensure the **Return to Launch** altitude is set appropriately for the surrounding environment and will clear any obstacles if a RTL failsafe is triggered. Note: the altitude is in **CentiMeters**

12. Click on the gear icon under the Head Up Display (Fig. Values) to add additional information to the values panel.

13. Click the triangle (fig. Camera) to switch to camera and with camera turned on click “trigger camera” to test.

Fig. Safety

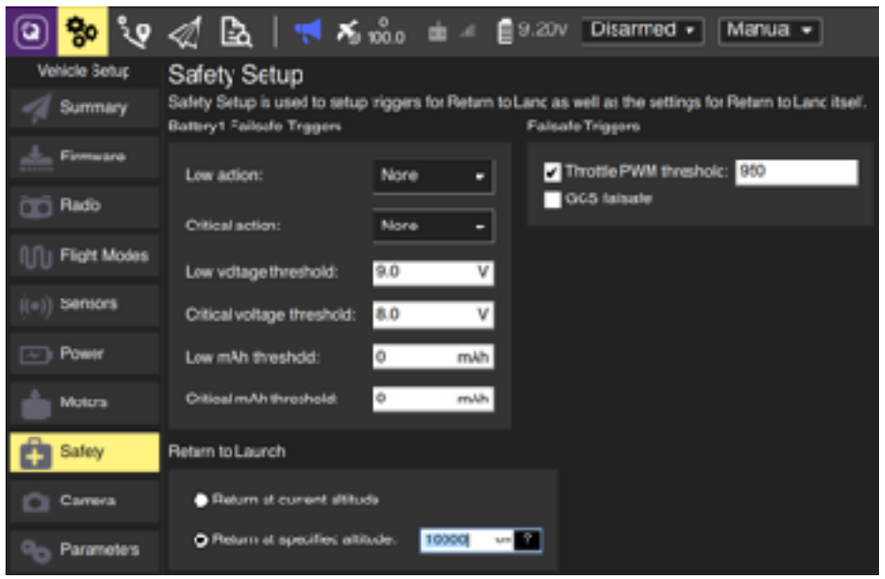


Fig. Values

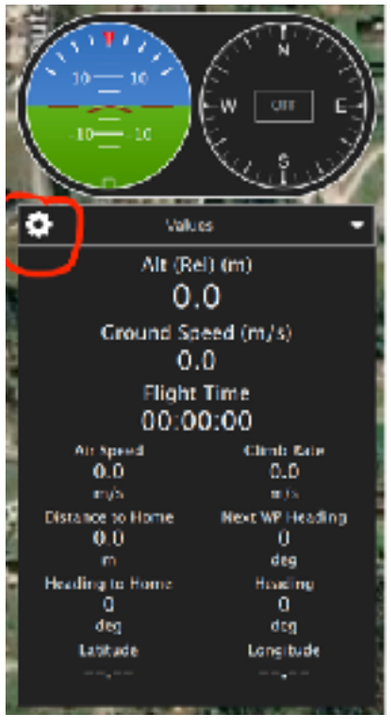


Fig. Camera

6. FLIGHT EXECUTION

1. Turn on the camera and check the lens is clean and there is an SD card installed

2. Perform the **PRE-Flight** check as per **appendix E. Checklists**

3. Go back to the flight page and verify the mission waypoints are displayed.

4. Check all telemetry data inc battery voltage, #GPS satellites. Check compass is stable and not drifting and artificial horizon corresponds to movement in vehicle attitude. Check airspeed sensor by blowing at the pitot tube front, gently.

5. Move the aircraft to the launch location and ensure the **aircraft is pointing into the wind and the direction you wish to takeoff**. This is **important** as this will be the direction that is set for the takeoff.

6. Using the Gamepad or clicking on the mode on the top of the screen, change the aircraft to manual mode. Move the joystick and verify the control surfaces are working and in the correct directions.

7. Slide the **ARM** button or select **AUTO** then **ARM** on the gamepad. The aircraft should beep and the aircraft mode should now show auto and armed.

8. Carefully pick up the aircraft. Hold each wing on the leading edge and keep arms and clothing clear of the propeller. Shake to wake up the aircraft. The motor will spool up to full throttle. Point the aircraft at a 30deg angle upward and into the wind. Take a step forward and push the aircraft up in this 30deg slope. Do not flick your wrists as this will cause the aircraft nose to go high and stall the aircraft.

9. The aircraft will climb to the takeoff altitude, then head for the first waypoint.

10. You can interrupt the mission at any time by clicking on the mode a the top of the screen and select a mode from the dropdown menu (Loiter, RTL (Return to Launch) and Auto are most common) . Alternatively you can change modes via the gamepad.

11. Carefully monitor the battery voltage and aircraft telemetry. Minimum battery voltage you should operate down to is **9.5v** . The aircraft **motor will shut down at 8.5v!!**

12. At any time during the flight you can increase the throttle to gain higher airspeed in the event of strong wind gusts if the aircraft is not making enough “speed over ground”

12. On the landing approach, if required you can input roll and throttle to adjust the landing of the aircraft in auto mode. Alternatively you can take full control in FBWA mode.This will allow you land and have direct control over the throttle. You can lower this for decent and pull all the way back to cut the motor. Once landed, click **DISARM** to stop the motor spooling up again when you release the throttle stick.

Stopping the Auto mission

If required you can pause, loiter or take manual control of the aircraft at any point. To continue on the mission or to re fly part of the mission, simply click on the desired **start waypoint**, confirm it and then go back to **“Auto”** mode

Modifying the Flight plan in flight

If required the flight plan can be modified while the aircraft is airborne.

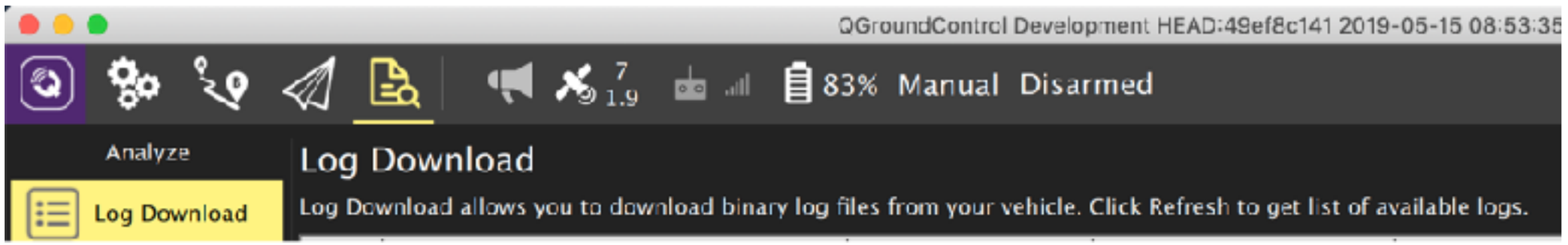
1. Put the aircraft in a “Loiter”

2. Make the changes to the flight plan in the “planning” tab and upload when satisfied.

3. Click on the desired start waypoint and “confirm”.

7. POST FLIGHT DATA MANAGEMENT

1. Disarm the aircraft and leave powered on.
2. Go to the **Analyse** tab and click **Refresh**
3. Select the last log from the folder. It should contain the date and time of the last flight. Create a folder on the computer with reference to the flight/location/time etc as desired.
4. **Download** the flight log to that folder.
5. Remove the SD card from the camera and **copy the images** from the flight to the same folder.
6. Backup the data on a separate hard drive.
7. Erase the images from the SD card when backup completed.
8. You can erase the logs stored on the autopilot to make it easier to associate the correct log with the images. Unfortunately the log files lose their date&time information when the aircraft is powered back up.
9. Ensure you **disconnect the battery** at the connector when **finished**. The switching regulator powering the Sony camera will continue to drain the battery if still connected and **may destroy the battery if over discharged**.



8. MAINTENANCE

It is important to perform Preflight inspections prior to each flight. This should pick up any faults and avoid having an in air incident.

We recommend a full aircraft inspection every 10 flight hours.

This should include

1. Close inspection of all wing connections and hinges
2. Airframe damage and skid plate secure. Check for delimitation in the airframe at the joints.
3. Pitot tube is clear
4. Servo operation through the full range of movement.
5. Motor rubber mounts are in good conditions and the bolts are snug
6. Propellers are free from damage and the mounting bolts are tight.
7. Motor spins freely and no contamination present.
8. Check all wiring for signs of chaffing or damage.

APPENDIX

A. INSTALL ARDUPLANE

The following information is for installing ArduPlane on the Disco for the first time.

Please Note: The current stable firmware version tested on this project is

Arduplane Disco FW = v 3.9.8.

Parrot Disco FW (installed through the Parrot Freeflight app) = v 1.7.1

For flight operations only! = QGround Control v 4.0.10

***** When uploading the parameters file it is critical you use QGroundcontrol v3.5.6 which was the last stable release before v 4+…. Using version 4+ will result in the parameters loading correctly and potentially some serious flight characteristics. We have not encountered any issues flying the aircraft under version QGroundControl v 4+ but strange behaviours when trying to load parameters under the later versions.****

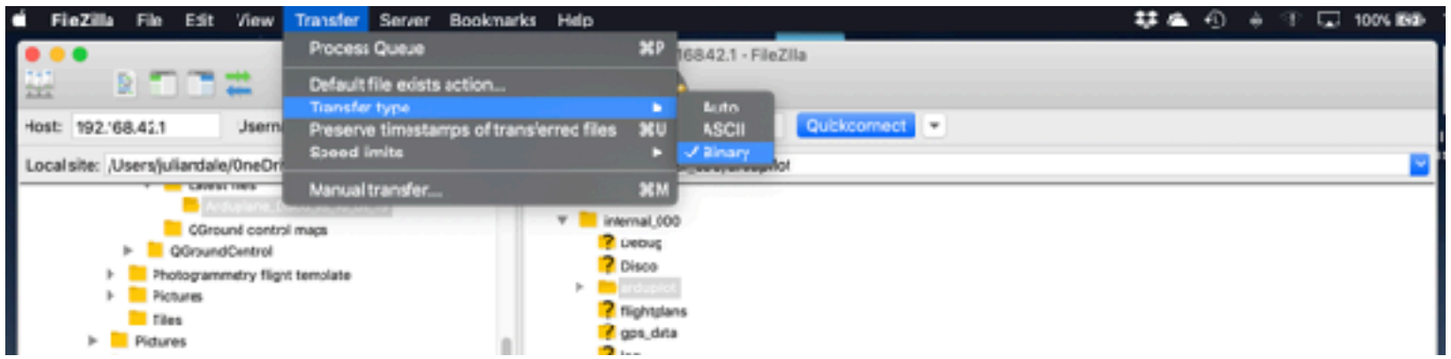
Build files, manuals and all the latest firmware and parameters can be found at

https://github.com/marrs-lab/WCS_ParrotDisco_Conversion

A. Installing ArduPlane

- Download FileZilla from https://filezilla-project.org

- Install and set transfer type to “binary”

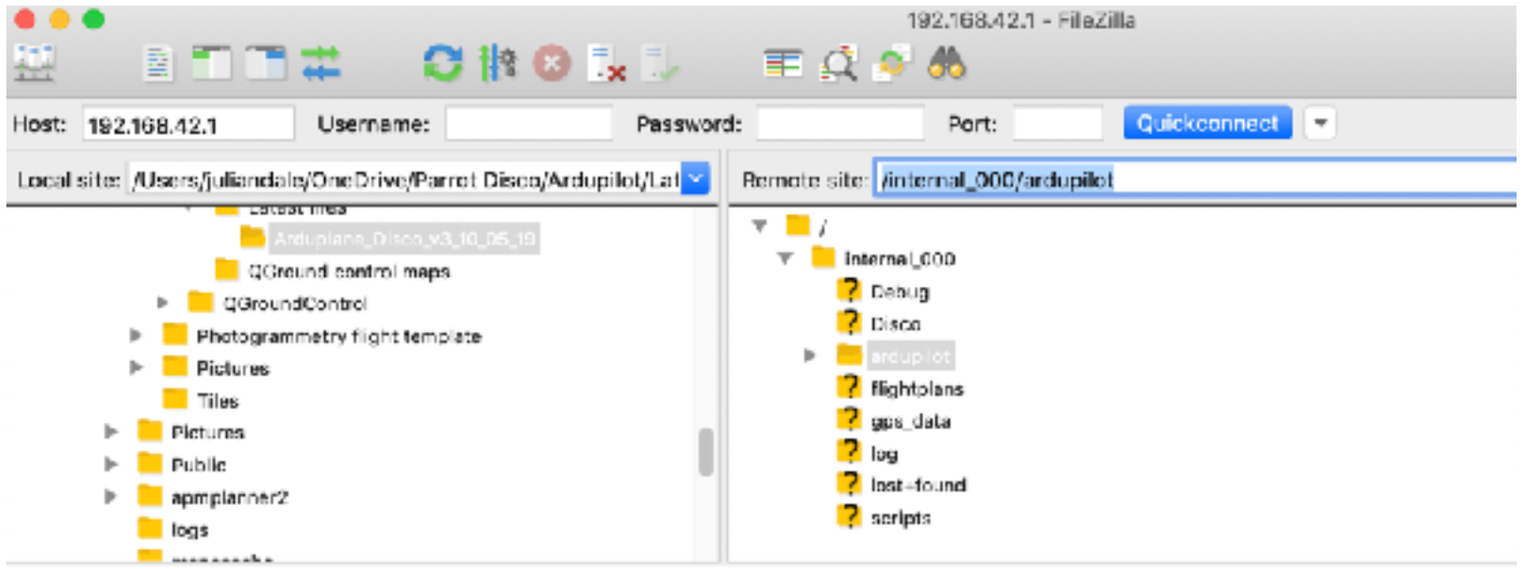


- Install battery in Disco and start by pressing on the pitot tube.

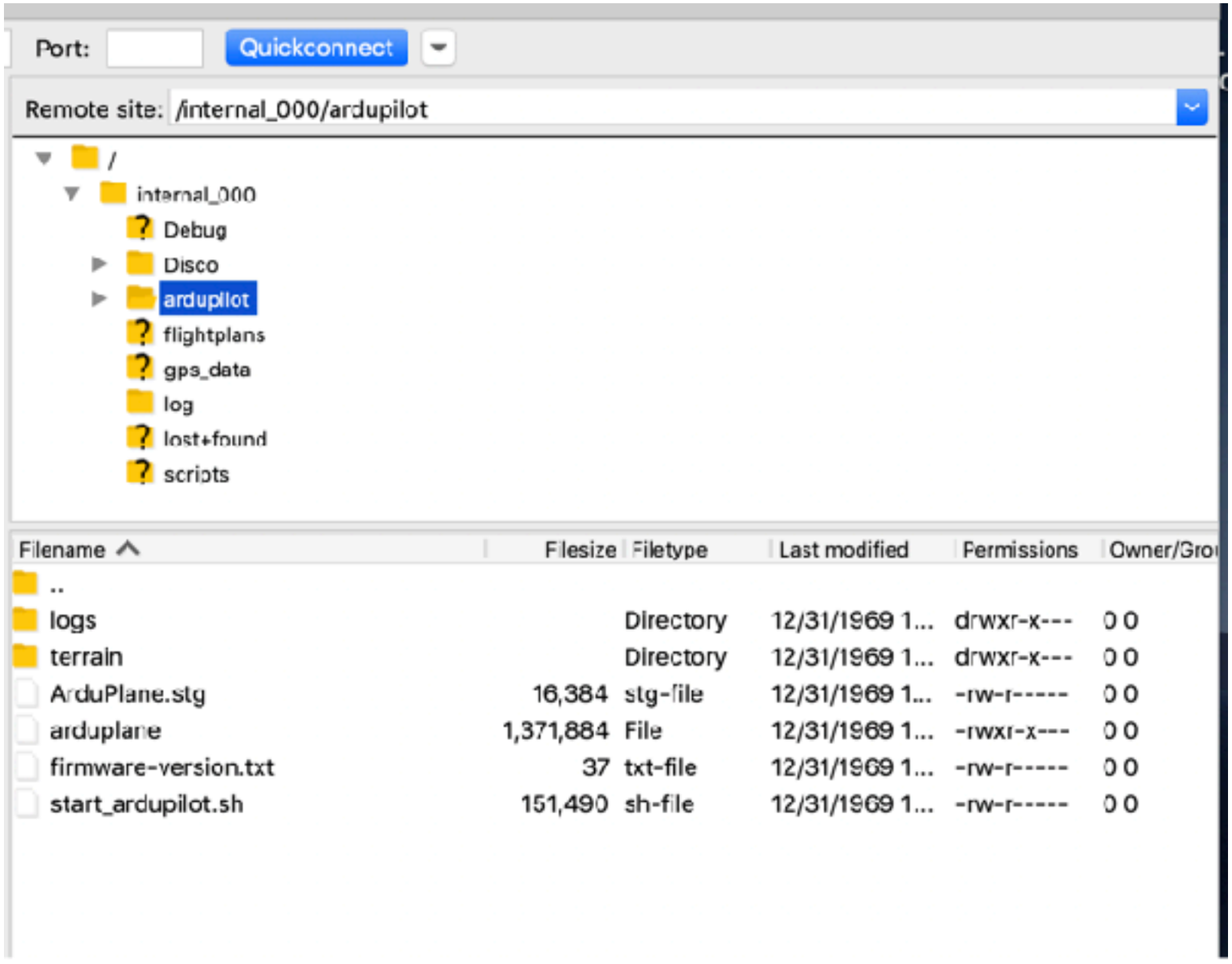
- After start up go to the computer wifi network and select “DISCO-xxxxxx” (the xxxxx will be the serial number of the Disco.

- Once connected, go back to Filezilla and enter 192.168.42.1 as the host: Click connect.

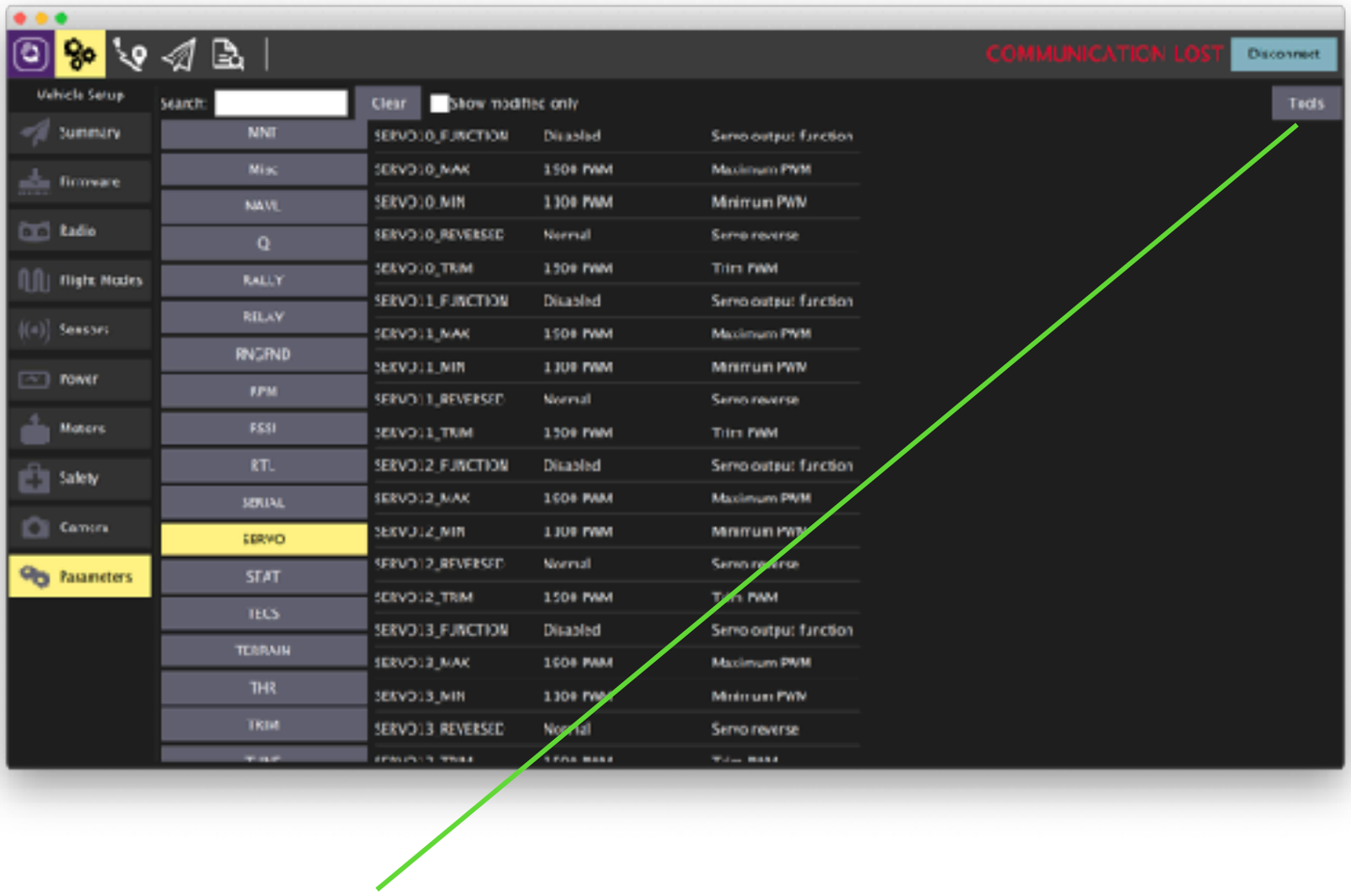
- Navigate to the /internal_000/ardupilot folder in the right hand window (remote site)



- Navigate to the files provided* in the left hand file browser and copy the files provided into the /ardupilot folder.
- You should have the following files in the /ardupilot folder (the ArduPlane.stg file and logs+terrain folders will populate as we configure the Disco in QGroundcontrol)
    - arduplane
    - Firmware-version.txt
    - start_ardupilot.sh



B. Installing Parameters file



- Open **QGroundControl v 3.5.6** and connect to the aircraft wifi
- Click on the Gear icon and then Parameters.
- Click the Tools button and select “Load from file”
- Load the .prams file dowloaded from the https://github.com/marrs-lab/WCS_ParrotDisco_Conversion
- Restart the aircraft and check the parameters.

C. Camera specifications

D. Airframe Modifications

E. Checklists

Modified Disco Pre-flight checklist Checklist

Disco test flight (2019-07-13 12:00:00)

		Passed	Not-passed	Not-applicable
1	Check airframe for signs of damage	○	○	○
2	Check aircraft motors are mounted securely and check props for cracks and tightness	○	○	○
3	Check area of operation for obstructions, people, and property	○	○	○
4	Check payload is installed, connected, and secure	○	○	○
5	Check pitot tube is clear	○	○	○
6	Check wings are installed securely	○	○	○
7	Check wings and alerions are in good condition and hinge mechanism are not damaged	○	○	○
8	Check battery condition and install	○	○	○
9	Lens clean	○	○	○
10	SD card/memory installed with sufficient space available	○	○	○
11	Power up aircraft	○	○	○
12	Boot into Arduplane (press power switch 3 times)	○	○	○
13	Connect modem	○	○	○
14	Check AV Health. Battery	○	○	○
15	Check AV Health. GPS satellites	○	○	○
16	Check GCS battery level	○	○	○
17	Verify fail-safes settings are appropriate for mission	○	○	○
18	Upload flight plan to aircraft	○	○	○

Notes:

Full Name: _____

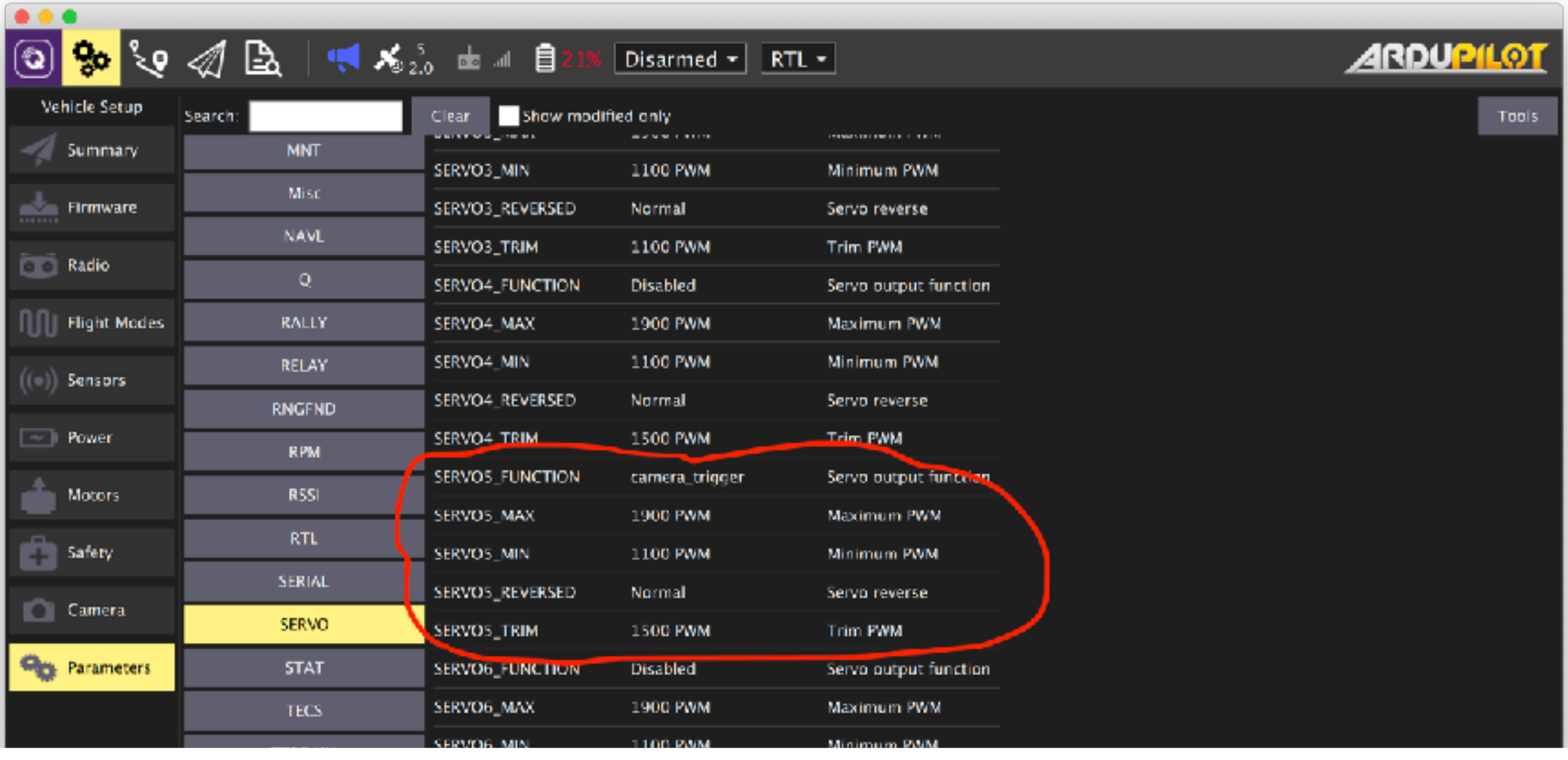
Phone: _____

Email: _____

F. Notes

Servo rail pin numbers in the list below are from left to right when looking at the C.H.U.C.K from the back, so pin1 on the servo rail is closest to the first ‘C’ in ‘C.H.U.C.K’ on the case.

- channel 1 : servo rail pin 1
- channel 2 : servo rail pin 6
- channel 3 : I2C ESC motor output
- channel 4 : servo rail pin 2
- channel 5 : servo rail pin 5
- channel 6 : servo rail pin 3
- channel 7 : servo rail pin 4



Camera Trigger