PILOT'S MANUAL

for Heavy Lift systems equipped with
Herelink GCS

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Revision 1.2

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TERMINOLOGY AND NOMENCLATURE

Use of Procedural words

The concept of procedural word usage and intended meaning which has been adhered to in preparing this manual is as follows:

"**Shall**" has been used only when application of a procedure or direction is mandatory.

"**Should**" has been used only when application of a procedure or direction is recommended.

"**May**" and "**need not**" have been used only when application of a procedure or direction is optional.

"**Will**" has been used only to indicate futurity, never to indicate a mandatory or imminent procedure.

"**Warning**" is used when an operating procedure, practice, etc. which if not strictly observed could result in personal injury or loss of life.

"**Caution**" is used when an operating procedure, practice, etc. which if not strictly observed could result in damage to or destruction of equipment.

"**Note**" used when and operating procedure, condition, practice, etc. is essential to highlight.

GLOSSARY

Term	Meaning
AGL (Above Ground Level)	Refers to altitudes measured relative to ground level at the takeoff location.
AHRS	Attitude and Heading Reference System
Altitude	The height of the aircraft during flight, can be measured above ground level (AGL) or above mean sea level (AMSL).
AMSL (Above Mean Sea Level)	Refers to altitudes measured relative to sea level.
Autopilot	A control system comprised of multiple sensors such as GPS, compass, gyroscopes, etc. used to aid with flight control and navigation of an aircraft.
C2 (Command and Control Link)	The primary communication data link between the RPAS and the ground control station used to transfer flight controls, telemetry, video, etc.
CG (Center of Gravity)	A central point upon which the balance for all 3 axes converge to maintain stable and controllable flight behaviours.
CW	Clockwise
CCW	Counterclockwise
DGCS	DGroundControl Software running on the ground control station.
EKF	Extended Kalman Filter
EOP	Emergency Operating Procedure
exFAT	File allocation Table 64 bit used on data storage devices up to 2 TB.
FAT16	File allocation Table 16 bit used on data storage devices up to 2GB.
FAT32	File allocation Table 32 bit used on data storage devices 4 to 32GB.
FIC	Flight Information Centre

FPV	First Person View
GCS	Ground Control Station
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HHC	Handheld Controller
LiPo	Lithium Polymer
LiHV	Lithium Polymer High Voltage
MAVLink	Micro Air Vehicle Link is a communications protocol for small, unmanned vehicles.
NOTAM	Notice to Airmen
PCB	Printed Circuit Board
PIC	Pilot in Command
Pitch	Motion around the UAV's Y axis
QA	Quick Attach
ROI	Region of Interest
Roll	Motion around the UAV's X axis
RPAS	Remotely piloted aircraft system. May be used synonymously with UAV
RTL	Return To Launch
SDS	Safety Data Sheet
SOP	Standard Operating Procedure
UAV	Unmanned Airial Vehicle. May be used synonymously with RPAS
VO	Visual Observer
X axis	An imaginary line that protrudes out the nose of the UAV
Yaw	Motion around UAV's Z axis.
Y axis	An imaginary line that protrudes out the right side of the UAV
Z axis	An imaginary line that protrudes out the bottom of the UAV

1. GCS USE

1.1. HERELINK-SPECIFIC FEATURES

1.1.1. Overview

Draganfly systems may optionally be equipped with a Herelink controller. The Herelink is a small handheld controller that is a fully integrated tablet and radio system.

1.1.2. Charging

To charge the Ground Station, connect a USB to micro-USB cable to the USB port on the charger and to the micro-USB port located on the bottom of the radio controller.

When charging, the charging indicator LED will turn red, and when charging is complete, the indicator will turn green.

Charge with 5V 2A.

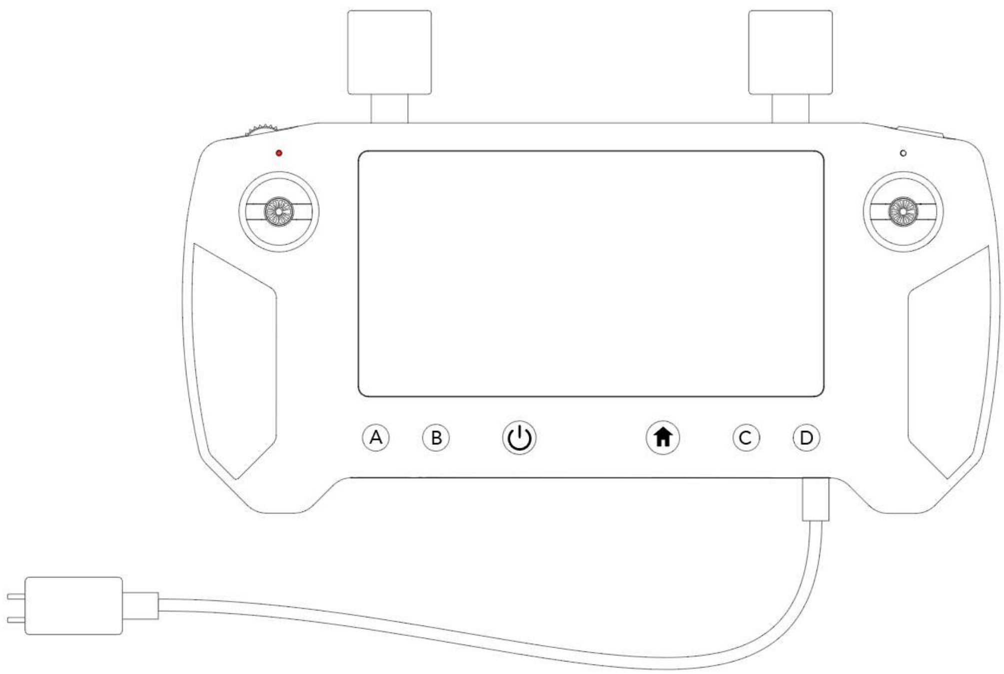


Figure 1: Herelink Controller Charging

1.1.3. Controls

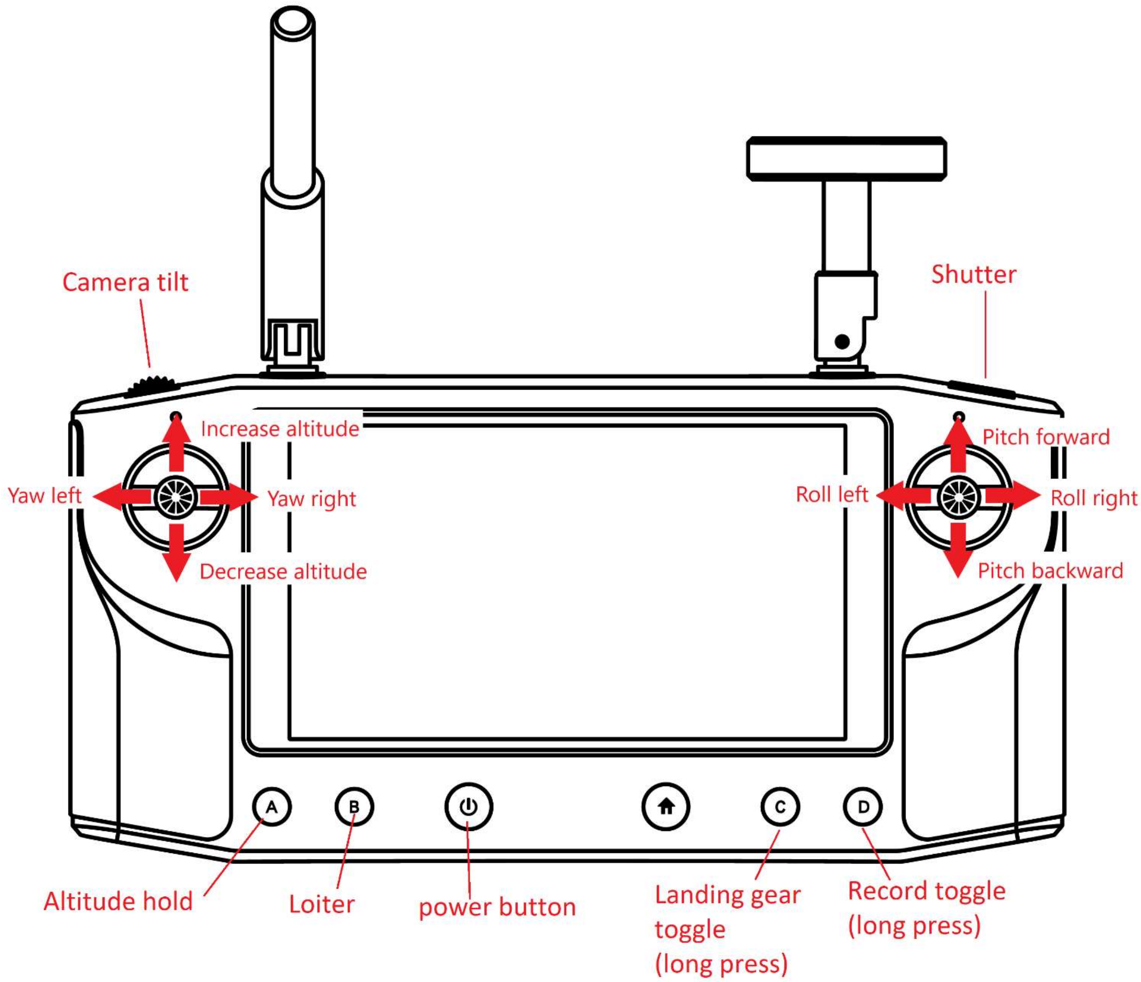


Figure 2: Herelink Controller Explained

The power button turns the Remote Controller on and off. Hold the power button for 5 seconds to turn on. Press the power button and select power off on the popup menu to turn off.

The camera tilt control is a scroll wheel. Pull to the left to tilt up, push to the right to tilt down.

The Right stick is the control to move the vehicle in the desired direction and position. Letting the stick return to the center will cause the vehicle to stop. The movement of the vehicle will always be controlled in relation to the forward direction of the aircraft.

The Left stick is the control that controls the vertical position of the vehicle as well as its pointing orientation. The left stick is also used to Arm the vehicle in manual mode. Arming requires the left stick to be put into the lower right position and held for 3 seconds. The propellers will begin spinning when armed.

When the vehicle has landed, disarming the vehicle requires the left stick to be put into the lower left position and held for 3 seconds.

Button A selects altitude hold mode; button B selects Loiter mode.

1.2. GCS COMMON CONTROLS

All Draganfly GCS options feature a common set of manual operating controls.

The primary flight controls are the two joysticks on either side of the controller. The left stick vertical motion controls the altitude of the aircraft while the horizontal motion controls the yaw (or heading) of the aircraft. The right stick vertical motion controls the pitch motion (front and back) of the aircraft while the horizontal motion controls the roll motion (left and right) of the aircraft. **The behavior of the right stick is different depending on what flight mode is selected.**

Flight mode is selected by either moving a toggle switch or pressing a button. The two options configured are altitude hold and loiter. These are suitable for manual flight using the joystick controls.

In both Alt-Hold and Loiter flight modes the yaw (left stick horizontal) controls vehicle heading, and the throttle (left stick vertical) controls vertical climb and descend rate of the vehicle. In Alt-Hold mode the Pitch/Roll stick controls the attitude angle of the vehicle and thus the horizontal position and velocity. In Alt-Hold mode the vehicle will not maintain position unless controlled by the operator. In Loiter mode the pitch/roll stick controls the velocity of the vehicle, and the vehicle will maintain position when the stick is centered. When in automated flight mode, this mode can be interrupted to revert to manual mode by toggling the Alt-Hold / Loiter switch. For example, if flying a mission in auto mode, the mission can be aborted by changing to altitude hold or Loiter mode. It may be necessary to toggle the switch twice or press two different flight mode buttons depending on what the last state of the controls was.

Depending on the quality of the GPS lock it may or may not be possible to use Loiter mode. It is rare that loiter mode is not available unless flying indoors or in a location where significant GPS interference is present. A warning will be issued in the DGCS software if loiter mode is not available.

Depending on the quality of the GPS lock it may or may not be possible to takeoff in Loiter mode. This is common. If this occurs it is usually possible to take off in Alt-Hold mode and then engage loiter mode. It is also often possible to simply wait for a better lock to allow takeoff in Loiter mode. The optimum Hdop is 1.7 or smaller values.

1.3. GCS TABLET APP

The ground control base station runs a software program called DGroundControl to interact with the aircraft, plan flights and view the video down link. To launch this software, tap the icon DGroundControl on the home page of the tablet.

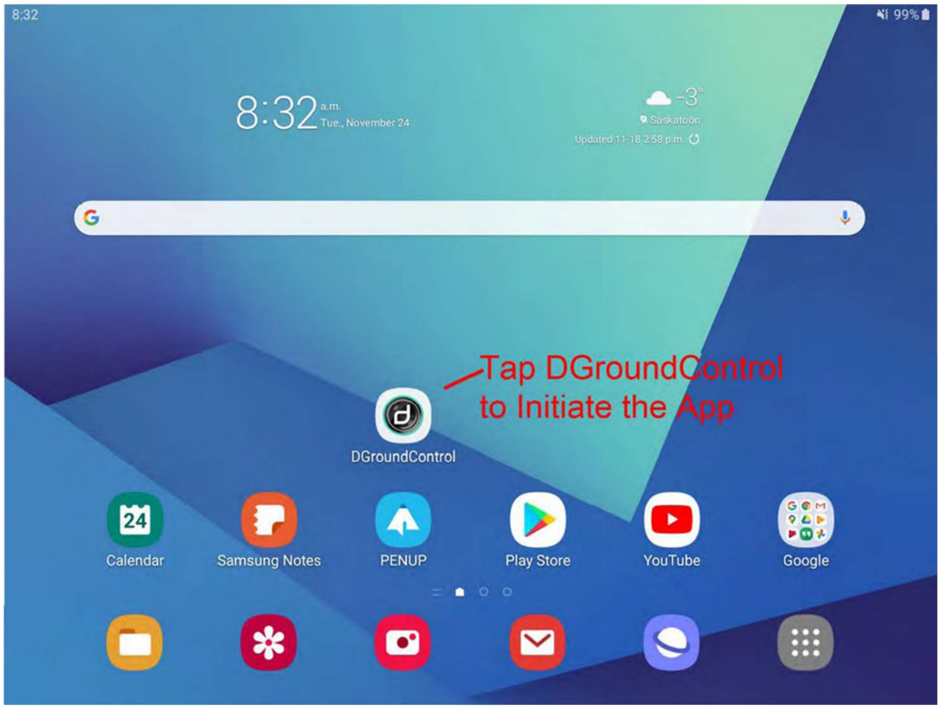


Figure 3: DGCS Tablet App

Your aircraft will normally automatically connect to the ground control station. Within DGroundControl you will see the status "Disconnected" at the top left corner of the software as shown below. Once a connection is established between the DGroundControl and the aircraft, you can see ARDUPILOT on the top right corner when the telemetry is connected to the aircraft.

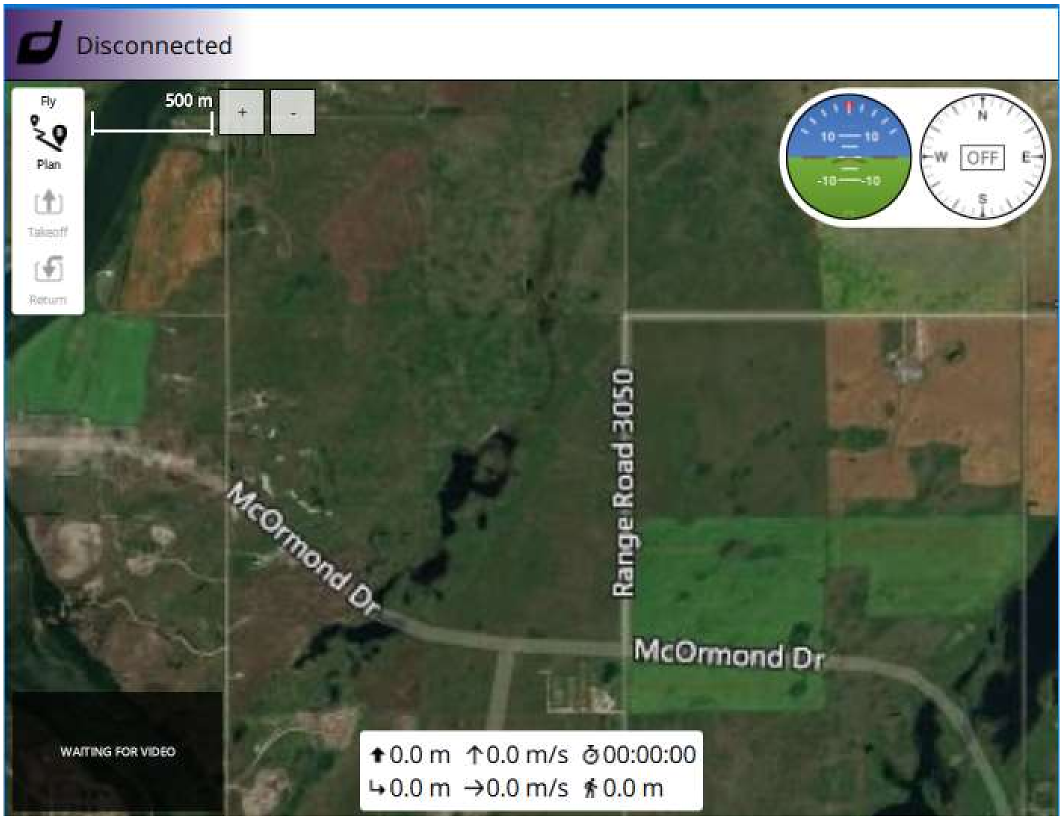


Figure 4: DGCS App Main Screen

If a connection does not automatically start or you are reconnecting (after a reboot, etc), then follow these steps.

Tap the "*d*" icon at the top left of DGroundControl which pops up the below dialog box.

Figure 5: DGCS Menu

Tap on 'Application Settings'

Tap the *Comm Links* icon and then select the pre-configured connection and tap the "*Connect*" button at the bottom of the screen as shown below.

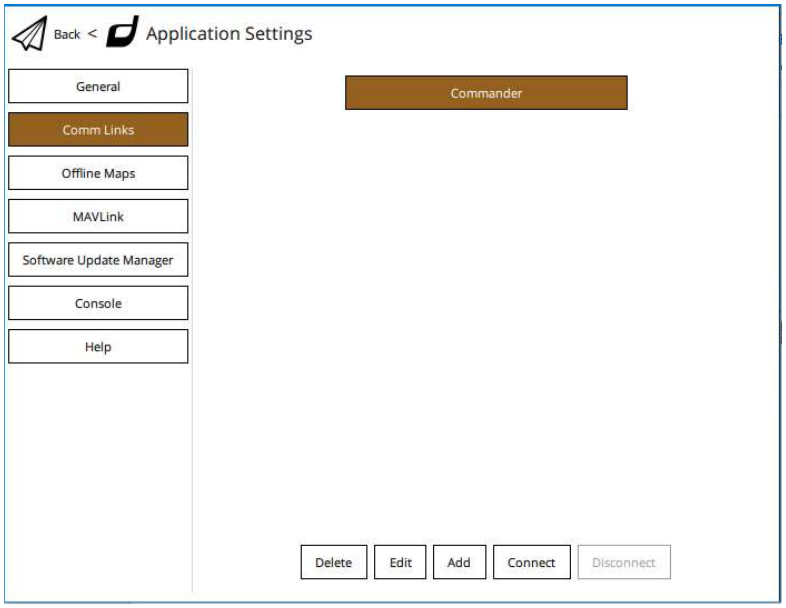


Figure 6: DGCS Application Settings

This next step is completed at the factory however, if this is a new tablet or installation of DGCS is may be necessary to add the connection manually.

- Press the "Add" button.
- Give the connection a name.
- Set Type to UDP.
- Set port to 24041.
- Enter the IP address of the aircraft in the text box next to the "Add Server" button. Add :24042 to the end of the IP address. In this example the full string is "192.168.XXX.XXX:24042" without the quotes. **Your IP address will be different, and is provided at the time of purchase**
- Press the "Add Server" button.

- The connection should appear as below:

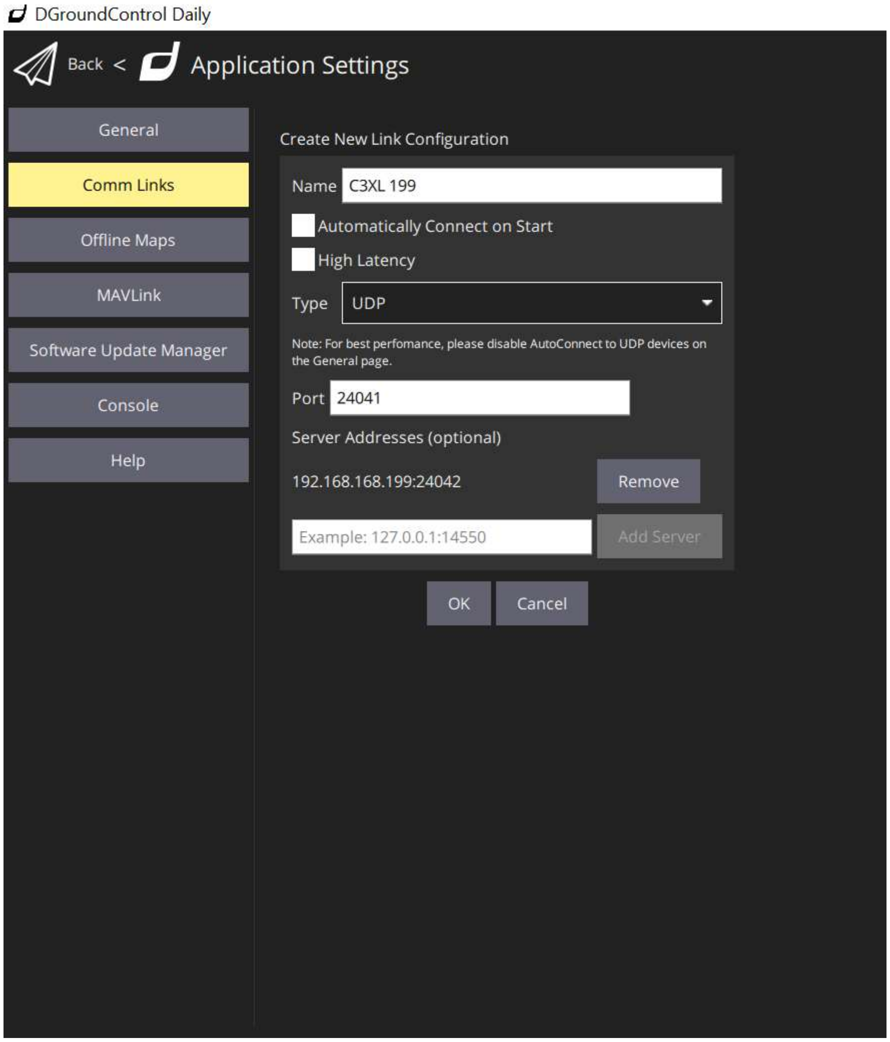


Figure 7: Adding a link to DGCS

- Selected "Automatically Connect on Start" if you want this connection to automatically run when DGCS is launched (recommended).
- Press Ok.

Tap the Fly icon (paper airplane) back button at the top menu bar. This will take you back to the flight screen as shown below.

The status on the top left corner will change to 'Ready to Fly.' The Red Arrow will appear when the telemetry is connected and the vehicle has a valid GPS lock, Also the status icons on the top bar will appear. The red arrow shows the direction the aircraft is pointing.

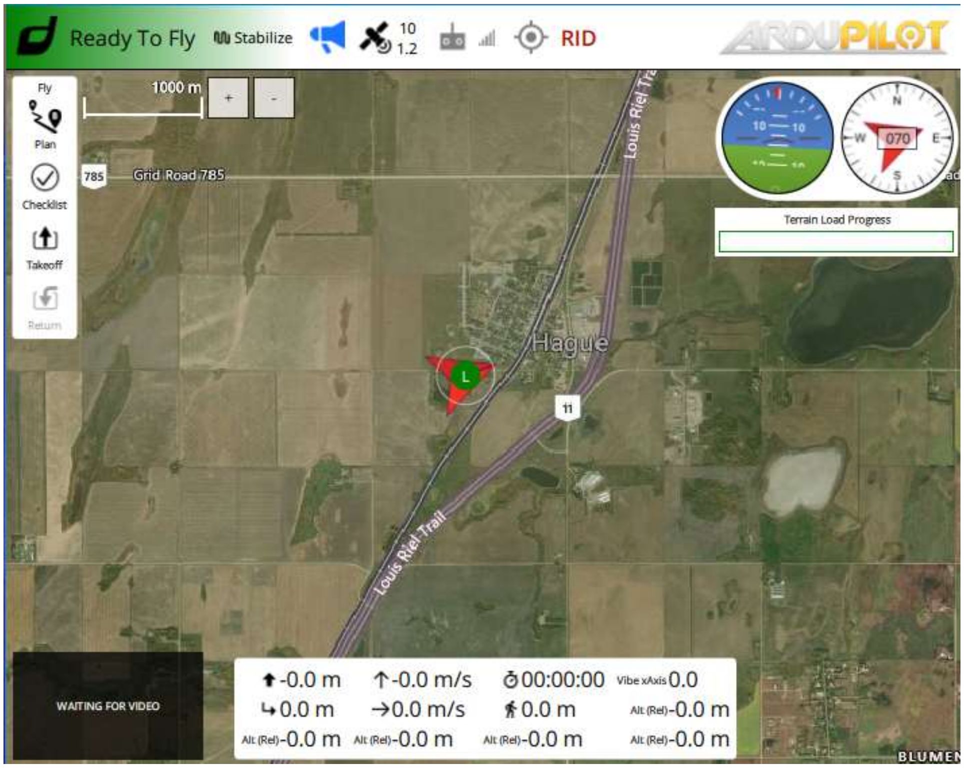


Figure 8: DGCS Ready To Fly

Automated flight is setup using the GCS Tablet. The DGroundControl app allows the operator to choose the type of automated flight and to set up the parameters of the flight. The flight location and flight plan can be preprogrammed before arriving at the data collection site. It is desirable to do this in the office where the internet is available to download the map information. If the internet is not available at the collection site, it is best to download the offline map of the location prior to heading out to the collection site. DGroundControl app is a variant of the QGroundControl app with modifications to support the aircraft and its payloads. The manual for QGroundControl can be accessed at https://docs.qgroundcontrol.com/master/en/ for more information and additional functions.

1.3.1. Main Toolbar and View Change Ribbon

The main toolbar is available in the 'Fly' view mode when DGroundControl is connected to a vehicle providing high level status information for the connected vehicle. There is a vertical ribbon on the top left corner which can be used to switch the view between 'Fly View' and 'Plan View.'

1.3.2. View-Select Icons on the Change View Ribbon

The following icons are used to switch between the main *Views*. These are available on the vertical ribbon at the top left corner and are displayed even if no vehicle is connected.

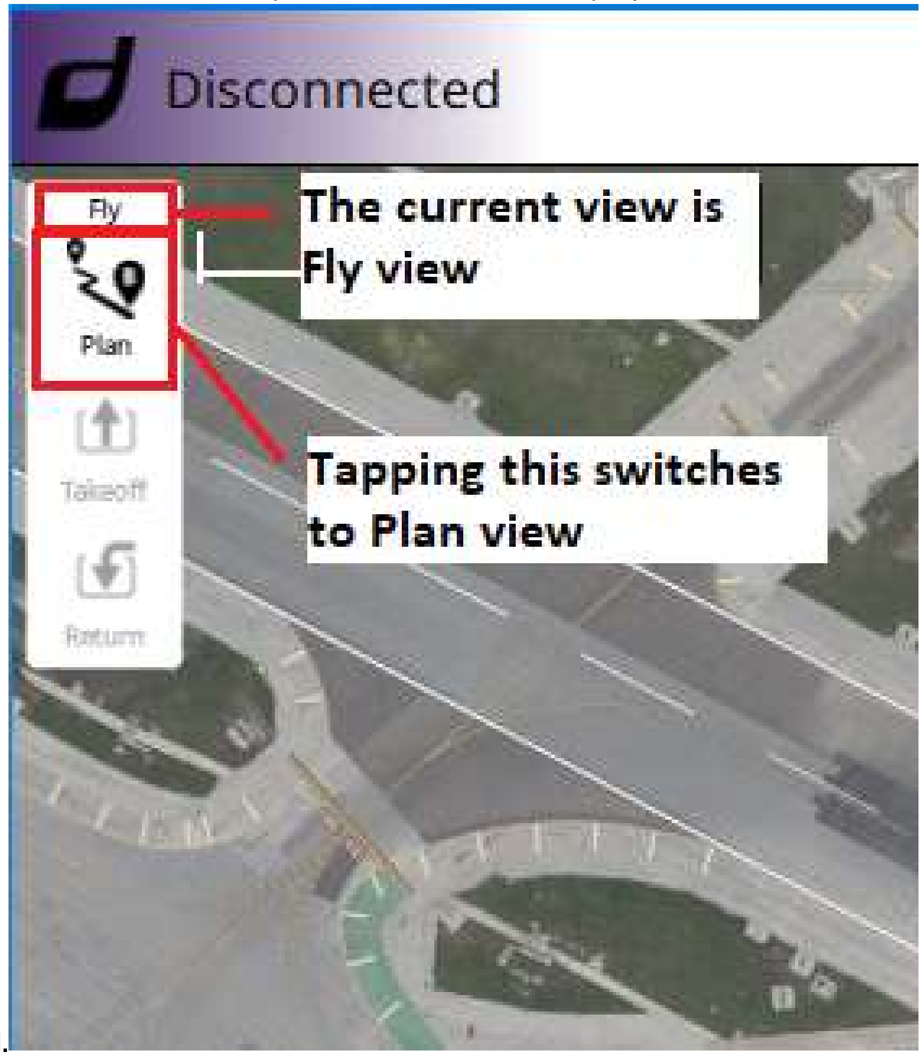


Figure 9: DGCS Disconnected

The current view is shown on the top of the ribbon. It is the Fly view in the example above. This view allows the user to monitor the vehicle(s) including streaming video.

The user can switch to the view shown below that (Plan view in the example above). In the above case, tapping on the 'Plan' icon switches the current view to the plan view and the ribbon changes as shown below. The plan view enables creating automated missions.

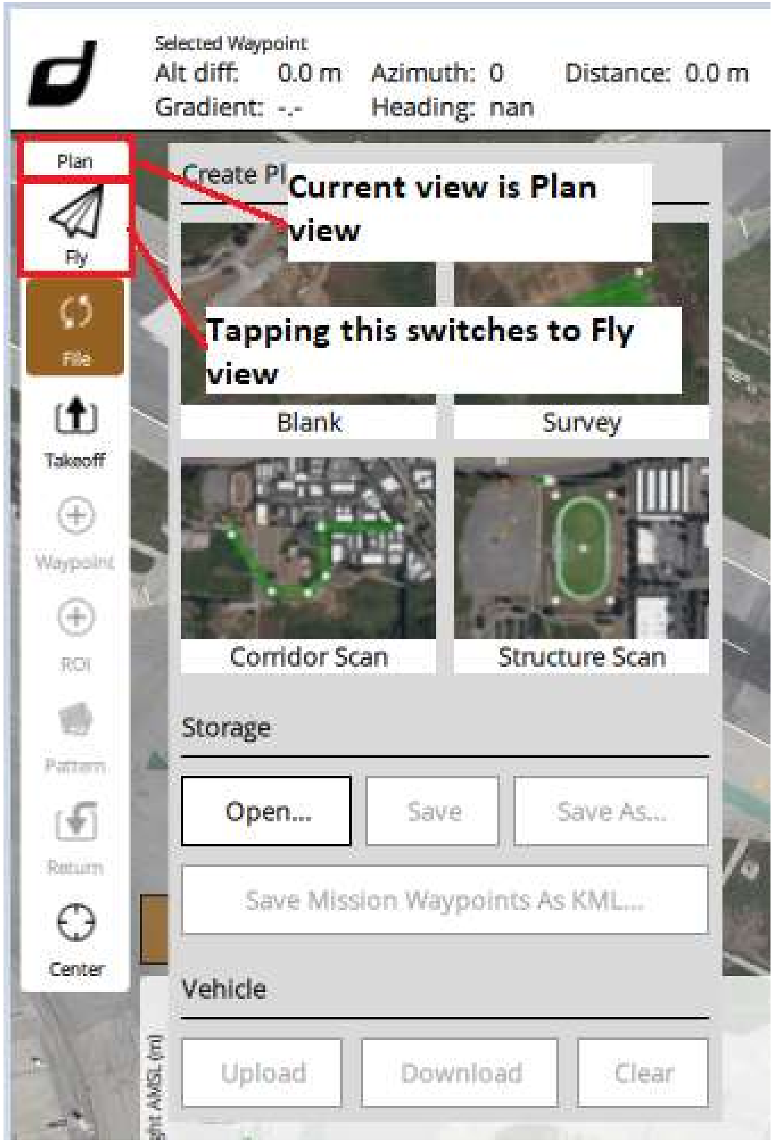


Figure 10: DGCS Plan View

1.3.3. Status Icons on the Status Tool Bar

Status icons are displayed when *DGroundControl* is connected to a vehicle and is in 'Fly View.' These show the high-level status of the vehicle and can be clicked to see more detailed information.

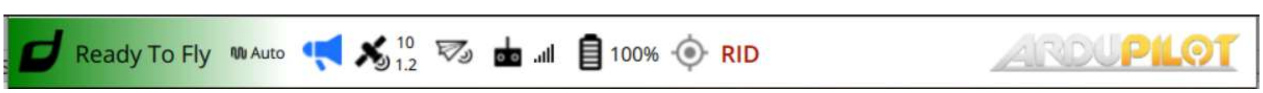
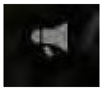


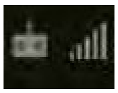
Figure 11: DGCS Status Icons

 Vehicle Messages

Click to show a dropdown of messages from the vehicle. This will change to a Yield sign if there are critical messages.

GPS Status

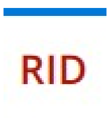
Shows you satellite count (top) and current Hdop (bottom). Hdop values above 1.7 will allow for takeoff in loiter mode.

 *RC RSSI*

RS signal strength information.

 *ROI*

Indicates whether Region of Interest is in effect in the current flight.

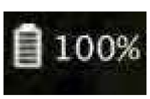


RID

Indicates remote ID information about the flight. Tap on this icon to view and edit broadcast information related to remote ID

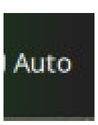
 Telemetry RSSI

Telemetry signal strength information.



Battery

Remaining battery percent.



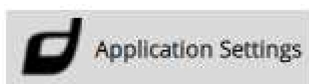
Flight Mode

Current flight mode. Click to change flight mode.

1.3.4. Tools to Configure the Application and Setup the Vehicle.

Tap the below icon on the top left corner of the application window.

This pops up the tool selection dialog box below.



Configure the *DGroundControl* application.

Configure and tune your vehicle.

Invokes a set of tools for analysis.

1.3.5. Fly View

The Fly View is used to command and monitor the vehicle when flying. You can use it to:

Control missions: start and continue.

Guide the vehicle to arm/disarm/emergency stop, takeoff/land, change altitude, go to, or orbit a particular location, and return/RTL.

Switch between a map view and a video view (if available)

Display video, mission, telemetry, and other information for the current vehicle, and also switch between connected vehicles.

Figure 12: DGCS Fly View

1.3.6. UI Overview

The screenshot above shows the main elements of the fly view:

Map: Displays the positions of all connected vehicles and the mission for the current vehicle.

You can drag the map to move it around (the map automatically re-centres after a certain amount of time).

Once flying, you can click on the map to set a Go to or Orbit at location.

Status Toolbar: Key status information for sensors (GPS, battery, RC control), and vehicle state (Flight mode, Armed/Disarmed status) and remote Id information.

Select the sensor indicators to view more detail.

Tap the *Flight mode* text (e.g., "Stabilize") to select a new mode. Not every mode may be available.

Tap the flight status text (i.e., 'Ready To Fly' or 'Flying') next to the "*d*" icon on the flight status tool bar when DGCS is connected to the vehicle. And tap on the Arm or Disarm button to toggle the armed state. If flying you can Tap this text to Emergency Stop, this will make the vehicle immediately stop flying. The confirmation slider must be used to finalize this action.

Tap on the RID icon to view/set remote Id information.

Fly tools: You can use these to:

Toggle between takeoff/land.

Return to launch position (also known as RTL or Return).

Enable the pre-flight checklist (tool option disabled by default).

Instrument Panel: A widget that displays vehicle information like telemetry, vibration etc. This can be configured to show many other values by pressing the "pencil" icon that appears when you hover over it.

Video/Switcher: Toggle between video or map in a window.

o Tap the element to switch *Video* and *Map* to foreground.

DGroundControl supports RTP and RTSP video streaming over your vehicles UDP connection. The video stream is automatically configured by most payloads.

A Telemetry Overlay is automatically generated as a subtitle file.

Confirmation Slider: Context sensitive slider to confirm requested actions. Slide to start operation.

Tap X to cancel. If you are not using the automated flight planning features tap the X to cancel and the box will disappear.

There are a number of other elements that are not displayed by default/are only displayed in certain conditions. For example, the pre-flight checklist tool button is only displayed if the appropriate setting is enabled.

1.3.7. Instrument Panel

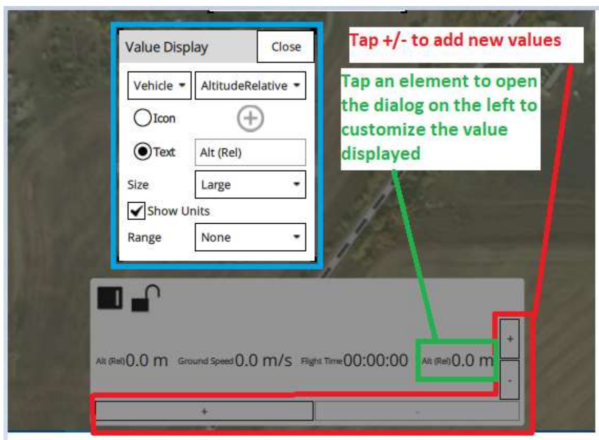
The instrument panel is a that displays information about the current vehicle, like telemetry, vibration information etc.

The default widget displays vehicle telemetry - tap the pencil icon that appears when you hover over it and then click on an item to change to some other option. You can use the + / - icons on the panel to configure it to have new values.

1.3.8. Telemetry Information on the Instrument Panel

The instrument panel by default displays information like the altitude (relative to the home location) and the ground speed.

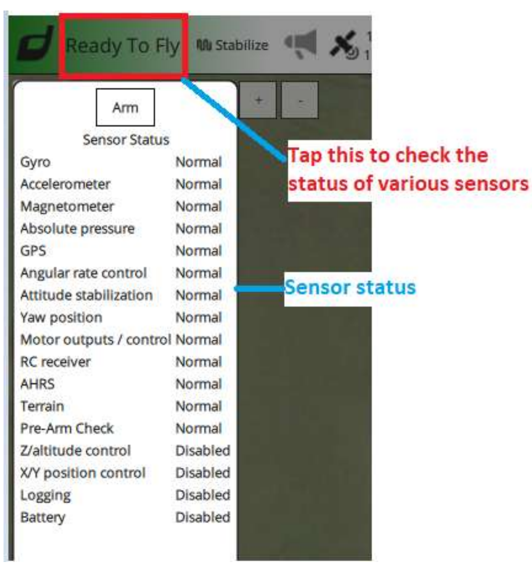
You can configure what information is displayed by tapping the small pencil icon that appears when you hover over the panel. Each value can be displayed in normal or "large" size.



You can add new elements and customize them to display various information like voltage, current, distance to home, etc.

1.3.9. Sensor Status

The status information of various sensors can be seen by tapping the flight status text next to the "*d*" icon on the flight status tool bar.



1.3.10. Camera

If a camera that supports the MAVLink Camera Protocol is connected to the vehicle, DGCS dynamically detects it and presents it as a camera widget on the right-hand side of the DGCS screen. You can configure and use other camera services that it makes available. For example, if your camera supports video mode you will be able to switch between still image capture and video mode and start/stop recording. It is also possible to send certain commands to the camera tapping the buttons made available on this widget. This widget and the commands being sent are all dynamically configured as per an XML file being downloaded from the aircraft. So, the GUI and the behavior is specific to the camera. See below for an example camera widget. It is also possible to minimize the widget by tapping on the top left corner.

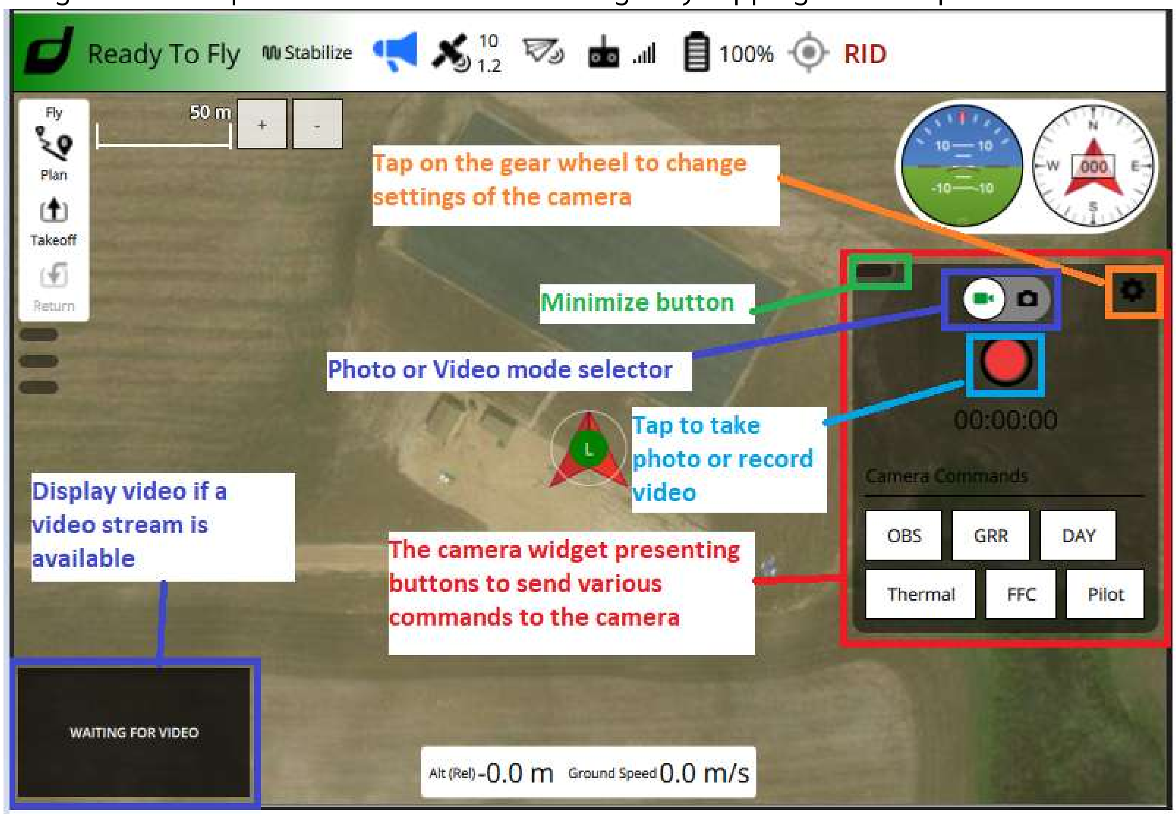


Figure 13: DGCS Camera Controls

Most of the settings that are displayed depend on the camera (they are defined in its MAVLink Camera Definition File. Refer to the specific payload manual for each camera for the optimal settings.

Advanced settings can be changed via the gear icon at the top right of the widget provided the camera has defined them.

1.3.11. Other Components on the Aircraft

If there are any other MAVLINK supported components on the aircraft like the winch, a controller widget for each of them is shown on the left-hand side of the FlyView screen. DGCS detects these components dynamically and a controller widget is displayed. This widget and the commands being sent when a button on the widget is pressed, are all dynamically configured as per an XML file being downloaded from the aircraft. So, the GUI and the behavior is specific to the component. See below for an example widget for a winch. It is also possible to minimize the widget by tapping on the top left corner. Advanced settings can be changed via the gear icon at the top right corner of the widget provided the component on the aircraft has defined them. The below screenshot shows only an example, and you may or may not see any component widget on your screen as it is specific to the payload.

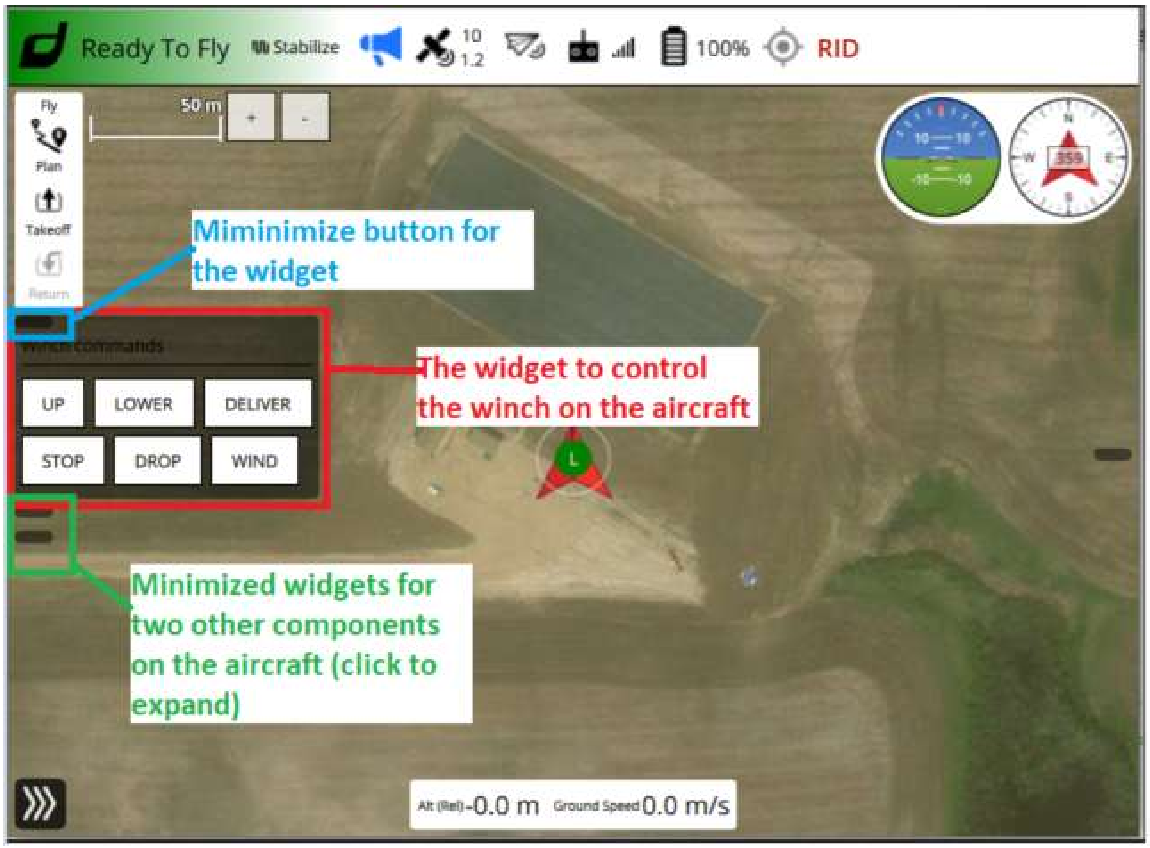


Figure 14: Component Control Widgets

1.3.12. Actions/Tasks

The following sections describe how to perform common operations/tasks in the Fly View.

> Many of the available options depend on both the vehicle type and its current state.

1.3.13. Pre-Flight Checklist

An automated pre-flight checklist can be used to run through standard checks to make sure that the vehicle is configured correctly, and it is safe to fly.

To use the checklist, first enable the tool by navigating to Application Settings > General > Fly View and selecting the **Use pre-flight checklist** checkbox. The tool will then be added to the *Flight Tools*. Tap it to open the checklist:

Figure 15: DGCS Pre-Flight Checklist

Once you have performed each test, select it on it in the UI to mark it as complete.

1.3.14. Arm

Generally, *DGroundControl* does not require you to arm the vehicle explicitly; this is done for you if you start a **mission or takeoff.**

Arming a vehicle starts the motors in preparation for takeoff.

To arm the vehicle, use the confirmation slider.

Vehicles usually disarm automatically if you do not take off after a few seconds.
As a safety feature it is required to hold the throttle control in the full down position if arming or starting a mission via the UI.

1.3.15. Disarm

Disarming the vehicle stops the motors (making the vehicle safe). To disarm the vehicle select **Disarm** in the Window as shown below when the vehicle is **landed.**

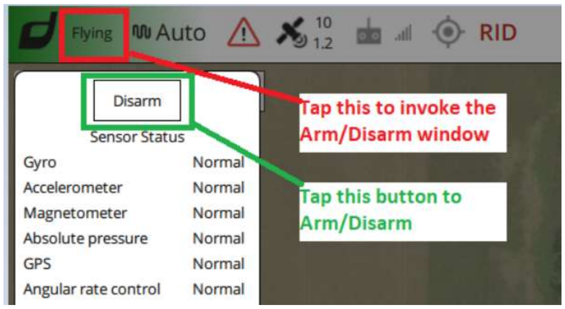


Figure 16: DGCS Disarm

1.3.16. Emergency Stop

Disarming the vehicle while it is flying is called an Emergency Stop

Emergency stop is effectively the same as disarming the vehicle while you are flying. Your vehicle will crash! To disarm the vehicle select **Disarm in** the window shown above when the vehicle is flying.

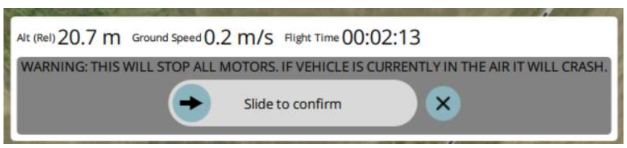


Figure 17: DGCS Confirmation

1.3.17. Takeoff

If you are starting a mission for the aircraft *DGroundControl* will automatically perform the takeoff step.

To takeoff (when landed):

Tap the ***Takeoff*** button in the *Fly Tools* (this will toggle to a **Land** button after taking off).

Optionally set the takeoff altitude in the right-side vertical slider.

Confirm takeoff using the slider.

1.4. MISSIONS

1.4.1. Start Mission

You can start a mission when the vehicle is landed (the start mission confirmation slider is often displayed by default).

To start a mission from landed:

Tap the **Action** button on the *Fly Tools*

Select the *Start Mission* action from the dialog.

Figure 18: DGCS Start Mission

(to display the confirmation slider)

When the confirmation slider appears, drag it to start the mission.

As a safety feature it is required to hold the throttle control in the full down position if arming or starting a mission via the UI.

1.4.2. Continue Mission

You can *continue* the mission from the *next* waypoint when you are flying (the *Continue Mission* confirmation slider is often displayed by default after you takeoff).

Continue and Resume mission are different! Continue is used to restart a mission that has been paused, or where you have taken off, so you've already missed a takeoff mission command. Resume mission is used when you've used a RTL or landed midway through a mission (e.g. for a battery change) and then wish to continue the next mission item (i.e. it takes you back to the beginning of the waypoint where you interrupted the mission, rather than continuing from your place in the mission).

You can continue the current mission.

Tap the **Action** button on the *Fly Tools*

Select the *Continue Mission* action from the dialog.

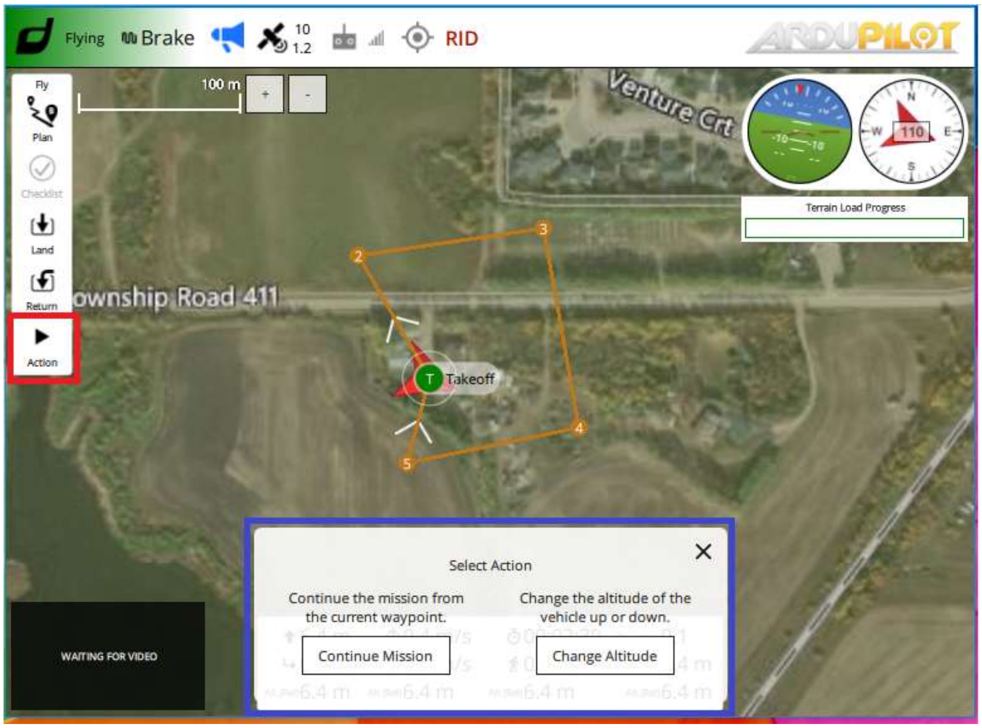
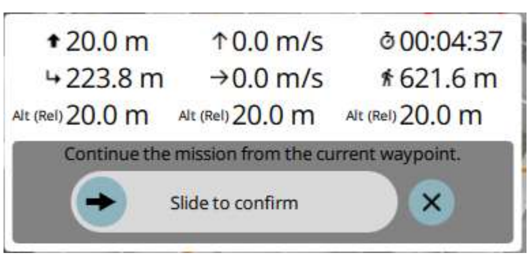


Figure 19: DGCS Continue Mission

Drag the confirmation slider to continue the mission.



1.4.3. Resume Mission

Resume Mission is used to resume a mission after performing an RTL/Return or Land from within a mission (in order, for example, to perform a battery change).

If you are performing a battery change, **do not** disconnect DGC from the vehicle after disconnecting the battery. After you insert the new battery *DGroundControl* will detect the vehicle again and automatically restore the connection.

After landing you will be prompted with a *Flight Plan complete* dialog, which gives you the option to remove the plan from the vehicle, leave it on the vehicle, or to resume the mission from the last waypoint that was traveled through.

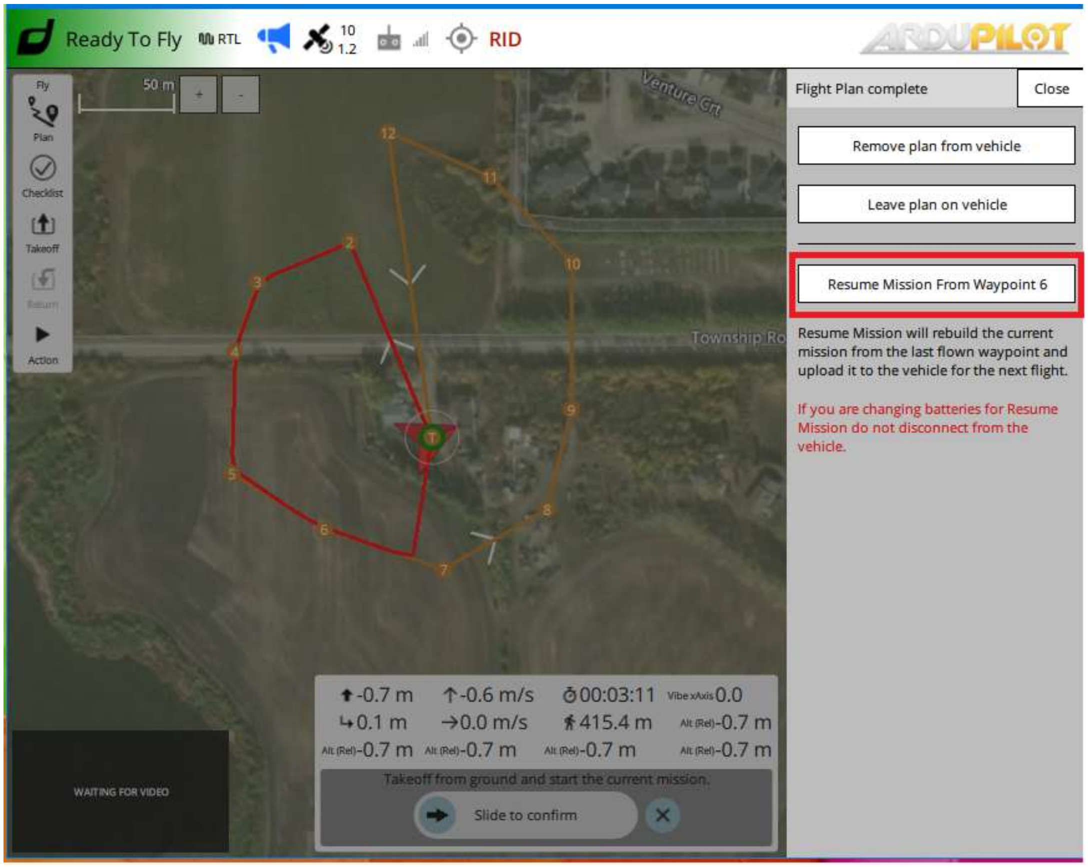


Figure 20: DGCS Resume Mission

If you select to resume the mission, then *QGroundControl* will rebuild the mission and upload it to the vehicle. Then use the *Start Mission* slider to continue the mission.

The image below shows the mission that was rebuilt after the Return shown above.

Figure 21: DGCS Mission Rebuilt

A mission cannot simply resume from the last mission item that the vehicle executed, because there may be multiple items at the last waypoint that affect the next stage of the mission (e.g. speed commands or camera control commands). Instead D*GroundControl* rebuilds the mission, starting from the last mission item flown, and automatically prepending any relevant commands to the front of the mission.

1.4.4. Remove Mission Prompt After Landing

You will be prompted to remove the mission from the vehicle after the mission is complete and the vehicle lands and disarms. This is meant to prevent issues where stale missions are unknowingly left on a vehicle, potentially resulting in unexpected behavior.

1.4.5. Plan View

The *Plan View* is used to plan *automated missions* for your vehicle and upload them to the vehicle. Once the mission is planned and sent to the vehicle, you switch to the Fly View to fly the mission.

It is also useful to configure the Geofence and Rally Points if these are supported by the firmware.

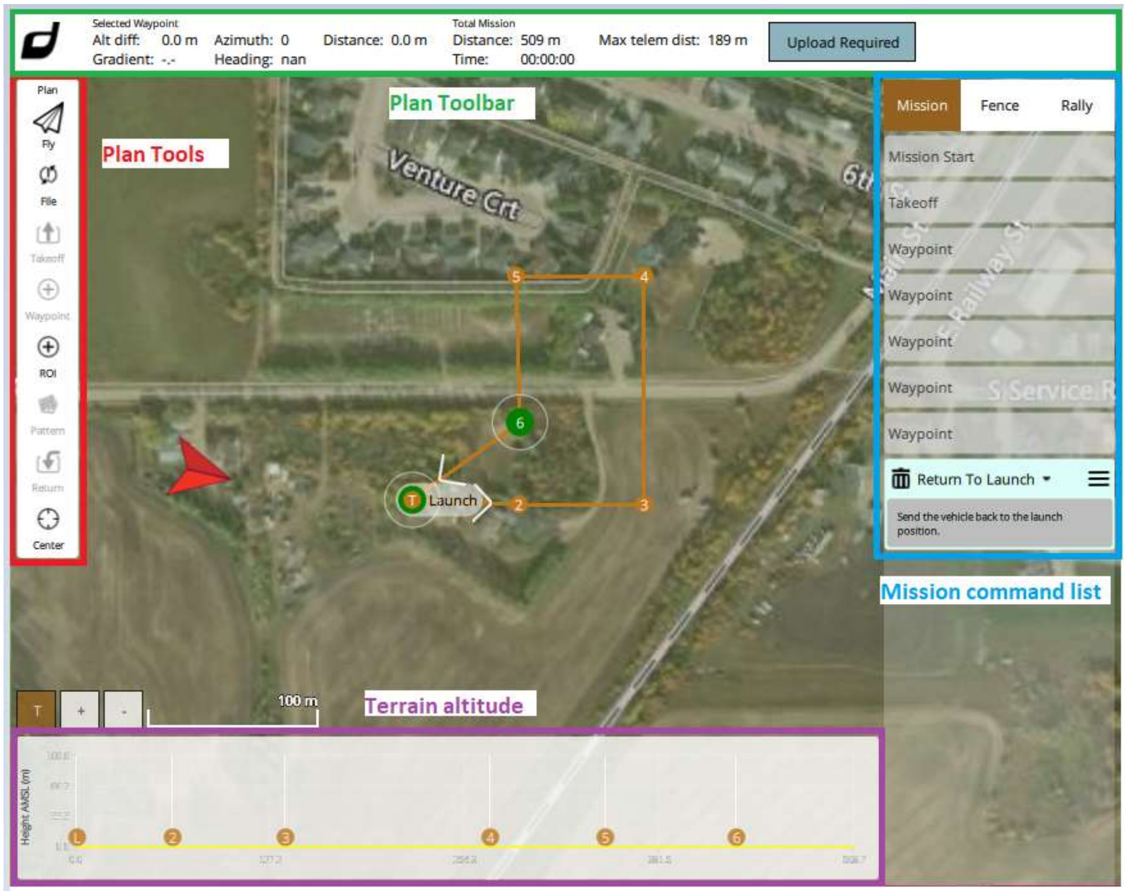


Figure 22: DGCS Plan View

1.4.6. UI Overview

The screenshot above shows a simple mission plan that starts with a takeoff at the Launch Position, flies through five waypoints, and then lands at the launch position.

The main elements of the UI are:

Map: Displays the numbered indicators for the current mission, including the Planned Home. Click on the indicators to select them (for editing) or drag them around to reposition them.

Plan Toolbar: Status information for the currently selected waypoint relative to the previous waypoint, as well as statistics for the entire mission (e.g., horizontal distance and time for mission).

- Max telem dist is the distance between the Planned Home and the furthest waypoint.
- When connected to a vehicle it also shows an **Upload** button, can be used to upload the plan to the vehicle.

Plan Tools: Used to create and manage missions.

Mission Command List/Overlay: Displays the current list of mission items (select items to edit).

Terrain Altitude Overlay: Shows the relative altitude of each mission command.

1.4.7. Planning a Mission

At a high level, the steps to create a mission are:

Change to *Plan View*.

Add waypoints or commands to the mission and edit as needed.

Upload the mission to the vehicle.

Change to *Fly View* and fly the mission.

The following sections explain some of the details in the view.

1.4.8. Launch Position

The *Launch Position* shown in *Plan View* is used to set the approximate start point when planning a mission (i.e., when a vehicle may not even be connected to a vehicle). DGC uses it to estimate mission times and to draw waypoint lines.

Figure 23: DGCS Launch Position

You should move/drag the planned home position to the location where you plan to takeoff. The altitude for the planned home position is set in the Mission Settings panel.

The Fly View displays the *actual* Launch position set by the vehicle firmware when it arms (this where the vehicle will return in Return/RTL mode).

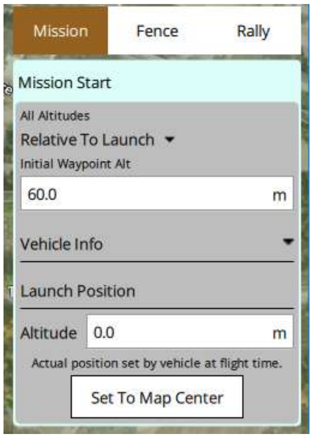


Figure 24: DGCS Mission Start

1.4.9. Plan Tools

The plan tools are used for adding individual waypoints, easing mission creation for complicated geometries, uploading/downloading/saving/restoring missions, and for navigating the map. The main tools are described below.

Center map, **Zoom In**, **Zoom Out** tools help users better view and navigate the *Plan view* map (they don't affect the mission commands sent to the vehicle).

1.4.10. Add Waypoints

Click on the **Add Waypoint** tool to activate it. While active, clicking on the map will add a new mission waypoint at the clicked location. The tool will stay active until you select it again. Once you have added a waypoint, you can select it and drag it around to change its position.

1.4.11. File (Sync)

The *File tools* are used to move missions between the ground station and vehicle, and to save/restore them from files. The tool displays an "!" to indicate that there are mission changes that you have not sent to the vehicle.

Before you fly a mission, you must upload it to the vehicle.

The *File tools* provide the following functionality:

Upload (Send to vehicle)

Download (Load from vehicle)

Save/Save as to File, including as KML file.

Load from File

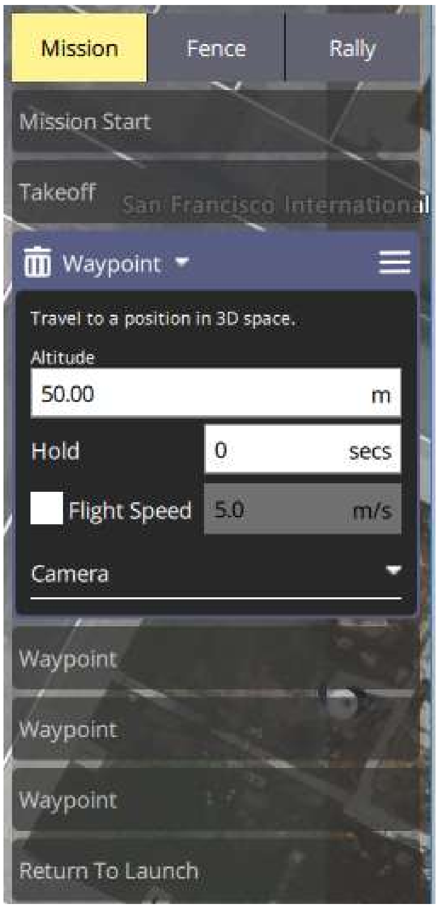
Remove All (removes all mission waypoints from *Plan view* and from vehicle)

1.4.12. Pattern

The *Pattern* tool simplifies the creation of missions for flying complex geometries, including surveys and structure scans.

1.4.13. Mission Command List

Mission commands for the current mission are listed on the right side of the view. At the top are a set of options to switch between editing the mission, GeoFence and rally points. Within the list you can select individual mission items to edit their values.



1.4.14. Mission Command Editors

Click on a mission command in the list to display its editor (in which you can set/change the command attributes).

You can change the **type** of the command by clicking on the command name (for example: *Waypoint*). This will display the *Select Mission Command* dialog shown below. By default, this just displays the "Basic Commands", but you can use the **Category** drop down menu to display more (e.g., choose **All commands** to see all the options).

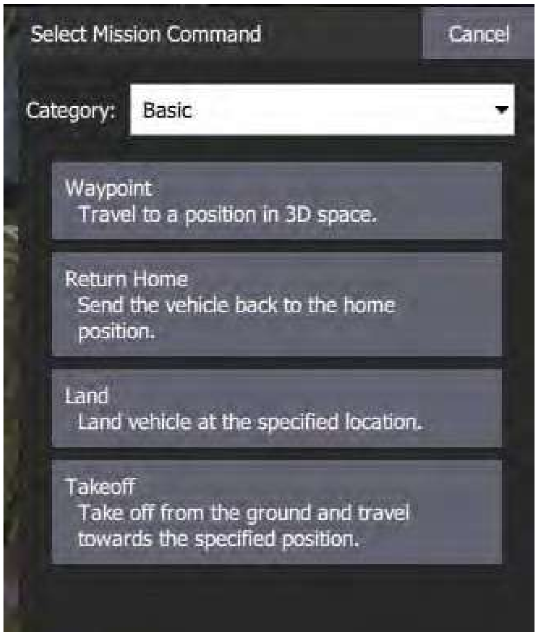


Figure 25: DGCS Mission Command Type

To the right of each command name is a menu that you can click to access additional options such as *edit position, move to previous position. To delete a way point you can use the bin icon on the top left corner of the mission item.*

The list of available commands will depend on firmware and vehicle type. Examples may include Waypoint, Start image capture, Jump to item (to repeat mission) and other commands.

1.4.15. Mission Settings

The *Mission Start* panel is the first item that appears in the mission command list. It may be used to specify a number of default settings that may affect the start or end of the mission.

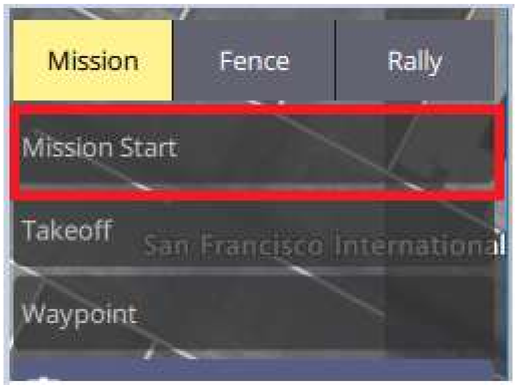


Figure 26: DGCS Mission Start

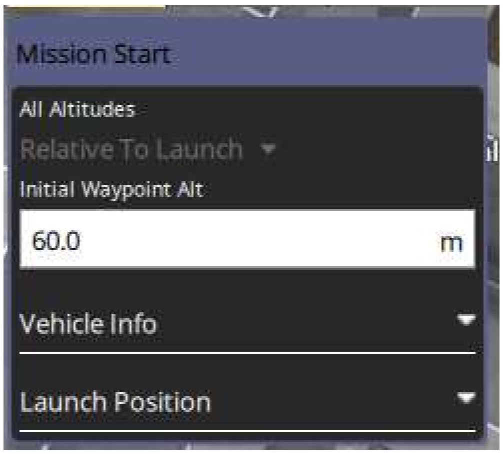


Figure 27: DGCS Mission Start Initial Waypoint

1.4.16. Mission Defaults

Initial Waypoint alt

Set the default altitude for the first mission item added to a plan (subsequent items take an initial altitude from the previous item). This can also be used to change the altitude of all items in a plan to the same value; you will be prompted if you change the value when there are items in a plan.

1.4.17. Launch Position

The [Launch Position] section allows you to simulate the vehicle's launch position while planning a mission. This allows you to view the waypoint trajectory for your vehicle from takeoff to mission completion.

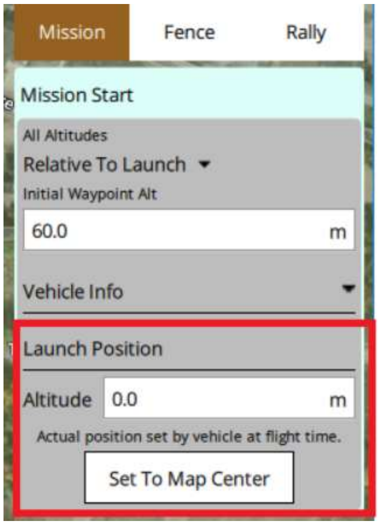


Figure 28: DGCS Launch Position

This is only the *Launch* position, and you should place it where you plan to start the vehicle from. It has no actual impact on flying the mission. The actual launch position of a vehicle is set by the vehicle itself when arming.

The section allows you to set the **Altitude** and **Set Home to Map Centre** (you can move it to another position by

dragging it on the map).

1.4.18. Vehicle Info

The appropriate mission commands for the vehicle depend on the firmware and vehicle type.

If you are planning a mission while you are *connected to a vehicle* the firmware and vehicle type will be determined from the vehicle. This section allows you to specify the vehicle firmware/type when not connected to a vehicle. Aircraft firmware is Ardupilot and not PX4 Pro.

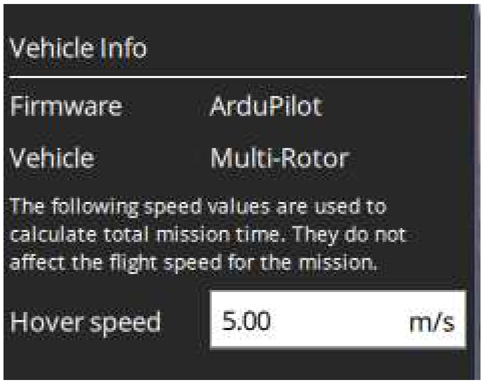


Figure 29: DGCS Vehicle Info

The additional value that can be specified when planning a mission is the hover speed. By specifying this value, total mission or survey times can be approximated even when not connected to a vehicle. Changing this value will not affect the speed at which the vehicle flies the mission.

1.4.19. Setting Properties for Each Waypoint

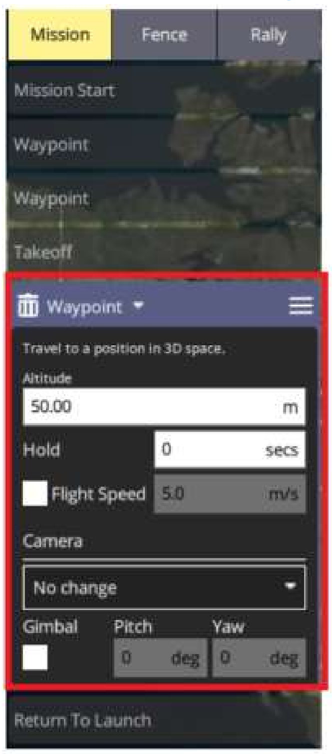


Figure 30: DGCS Waypoint Properties

1.4.20. Flight Speed

Set a flight speed for the mission that is different than the default mission speed. This will change the speed AFTER this waypoint has been reached.

Figure 31: DGCS Flight Speed

1.4.21. Camera

The camera section allows you to specify a camera action to take, control the gimbal.

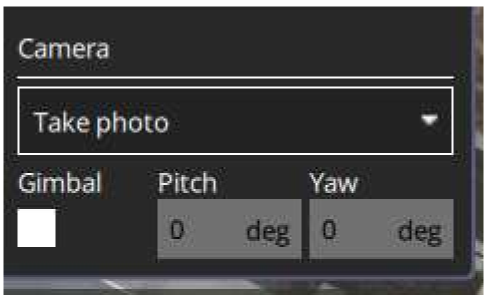


Figure 32: DGCS Camera Action

The available camera actions are:

- No change (continue current action)
- Take photos (time)
- Take photos (distance)
- Stop taking photos
- Start recording video
- Stop recording video

1.4.22. Mission End

Return to Launch after mission end.

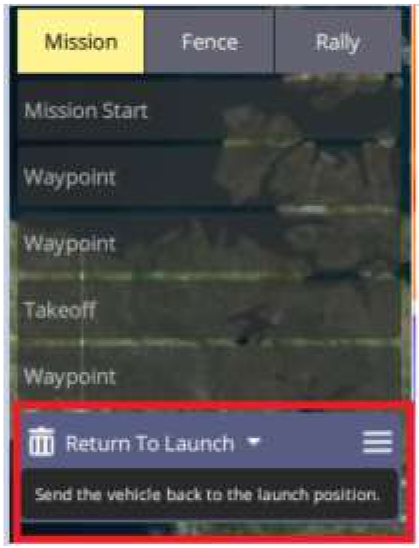


Figure 33: DGCS Mission End

1.4.23. Mission Planning Examples

1.4.23.1. BASIC WAYPOINT MISSION PLAN

A Basic Waypoint Mission Plan is a simple automated instruction for the aircraft to travel to specific positions on a map at a particular altitude and speed and then pause for a specific time and then continue to the next waypoint. Following the tapping of the *Plan view* Icon, the *Create Plan* popup box will appear. Select the *Blank* plan box to begin the waypoint mission plan.

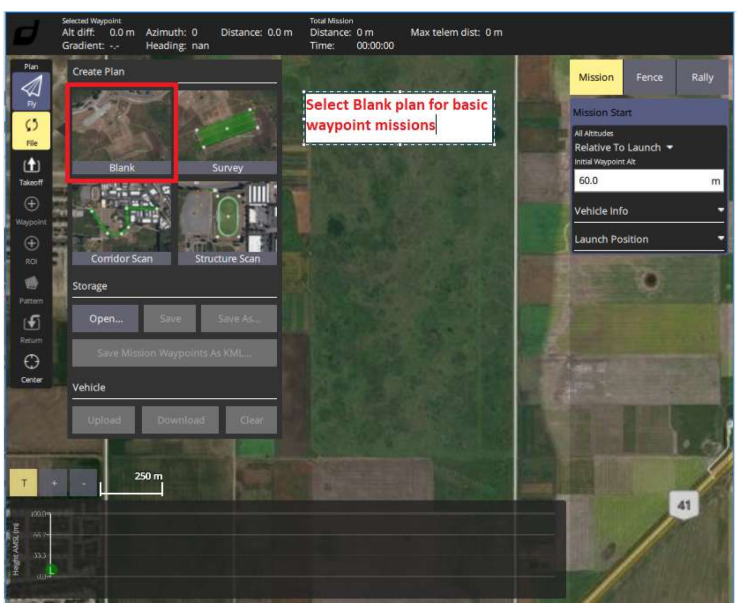


Figure 34: DGCS Create Plan

Tap the *Set To Map Center* box to place the *Launch* position on the map. Tap the *Takeoff* icon to add to the mission.

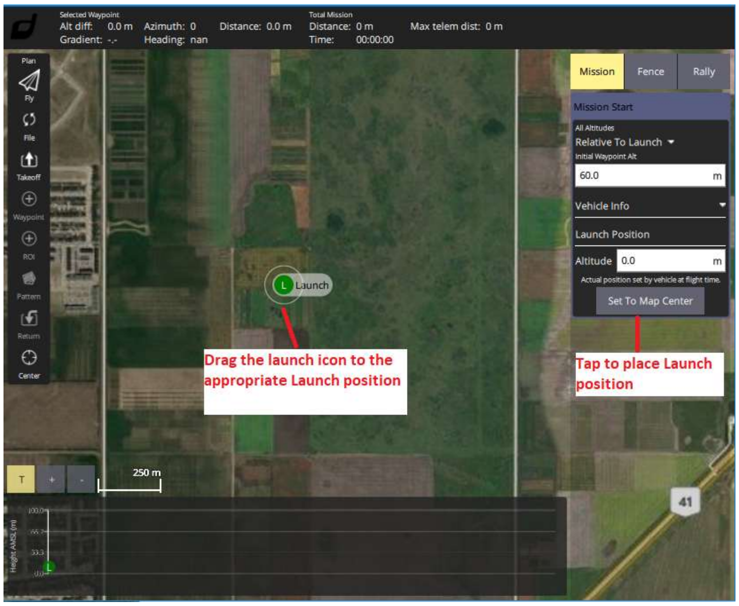


Figure 35: DGCS Place Launch Position

Tap the Takeoff icon to add the takeoff mission item. Tap the *Waypoint* icon from the *Plan tools* menu. Then tap the positions on the map to add waypoints to the map. Change the waypoint attributes as you create the waypoint or after all the waypoints are entered. The changes are altitude changes, speed changes and length of time to pause between waypoints and selecting camera functions. When complete, tap the *Return* icon to instruct the vehicle to return to the launch position. If a "Return to Launch" point is not added at the end of the mission, the vehicle will hover at the last waypoint.

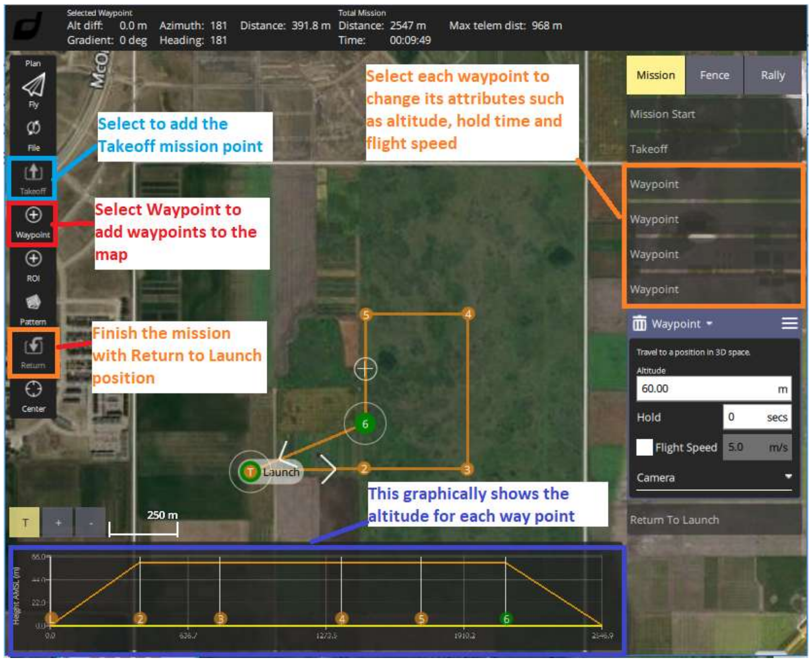


Figure 36: DGCS Mission Planning Window Labelled

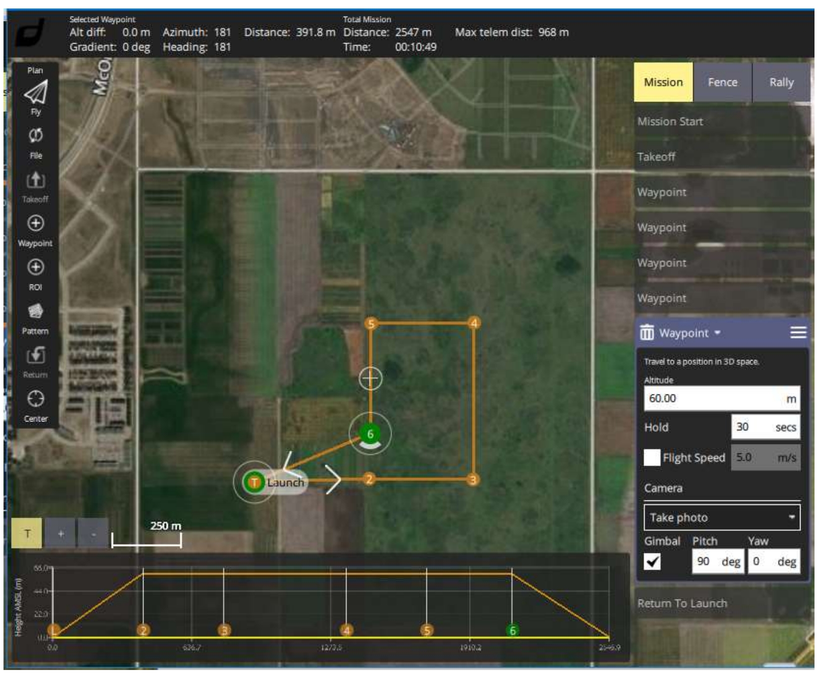


Figure 37: DGCS Mission Planning Window

When all the mission parameters are checked and corrected, upload the mission plan to the aircraft by tapping the *Upload Required* icon. When complete, tap the *Fly* (paper airplane) icon.

1.4.23.2. SURVEY MISSION PLAN

A Survey Mission Plan is a plan to capture a specific area with a camera, video camera, lidar or other sensors. This plan method automates the aircraft to fly grid pattern to capture data with the appropriate overlap to ensure quality data capture.

Tap the *Survey* icon to create a survey plan.

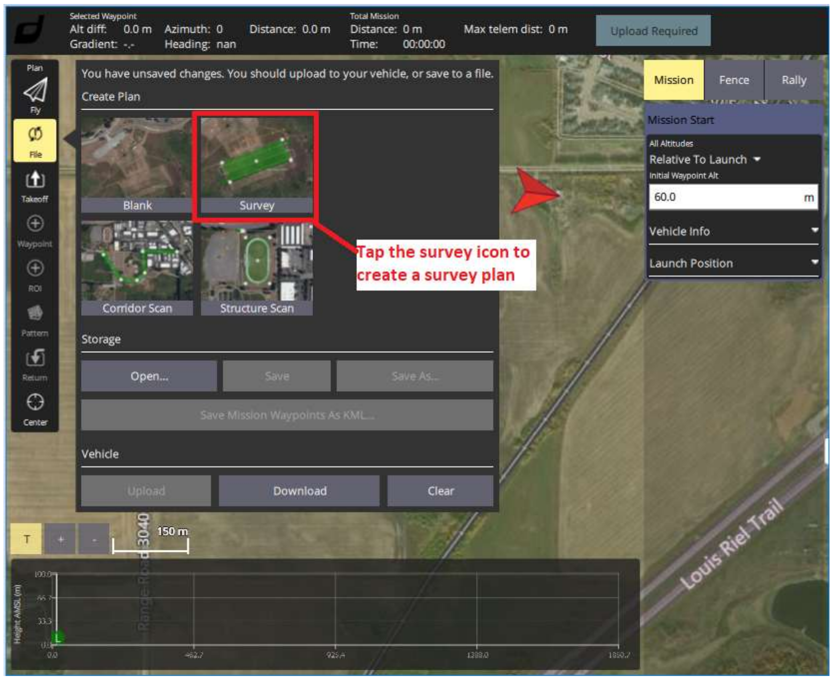


Figure 38: DGCS Mission Plan Survey

Drag the *Takeoff* point to the correct position on the map. Then tap the *Survey* box to configure plan type.

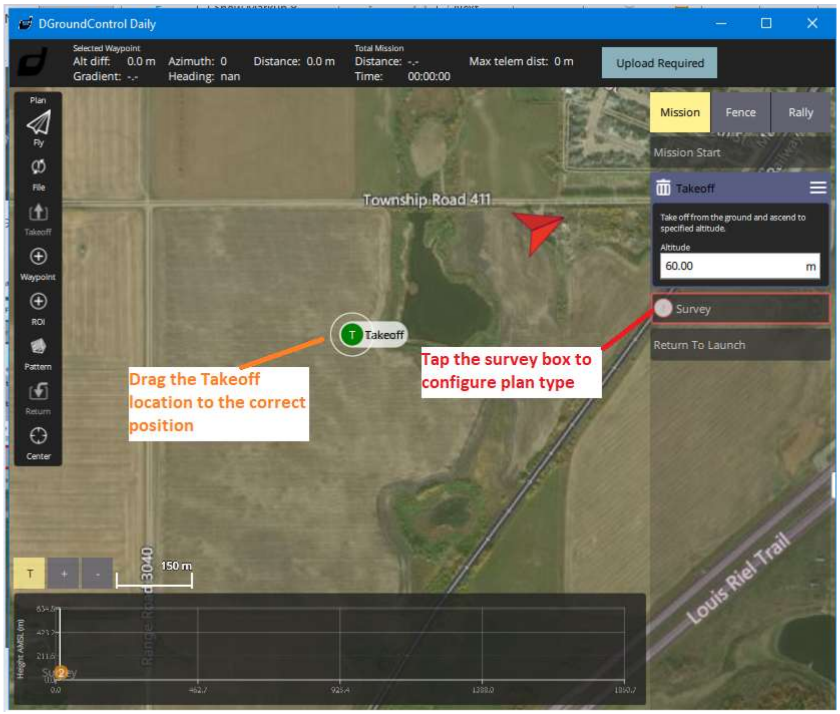


Figure 39: DGCS Takeoff Point

Choose the desired Polygon Tools shapes.

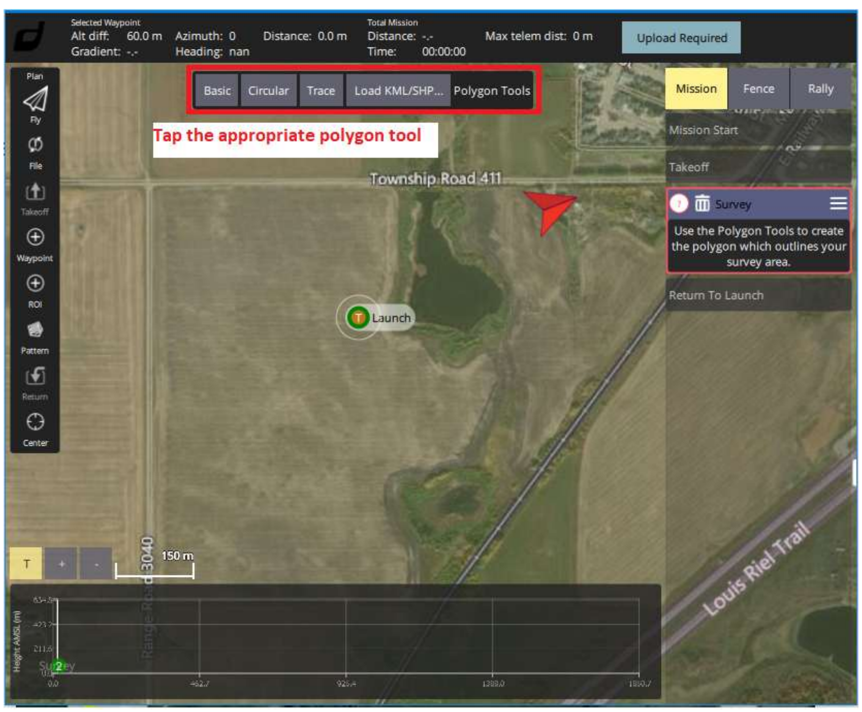


Figure 40: DGCS Polygon Tools

Basic is a four sided square or rectangle. Drag each corner to the correct position on the map.

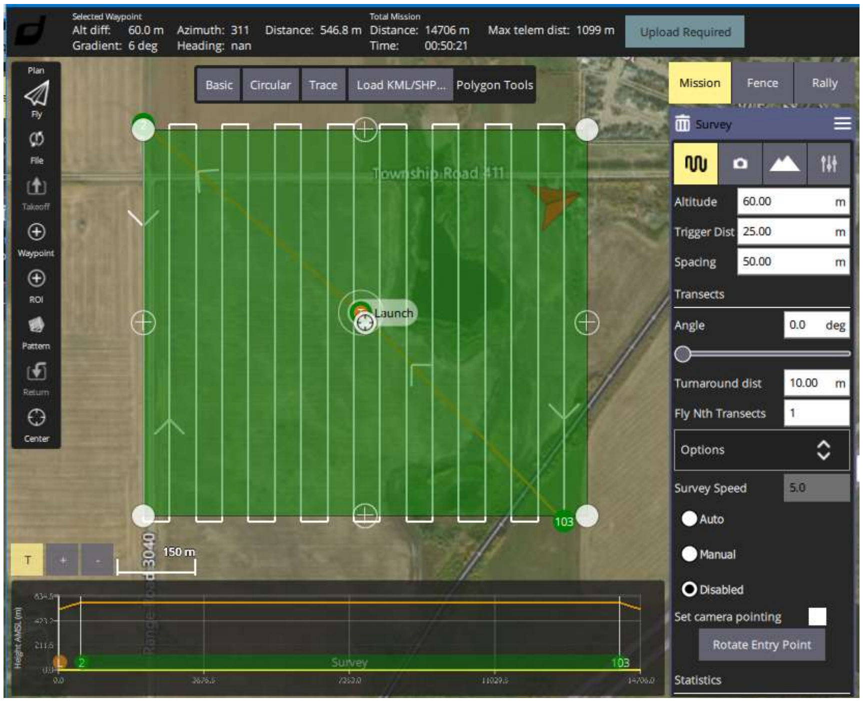


Figure 41: DGCS Rectangular Survey

A *Circular* survey creates a circular survey plan. Drag the white dot to change the diameter and drag the centre dot to change its position.

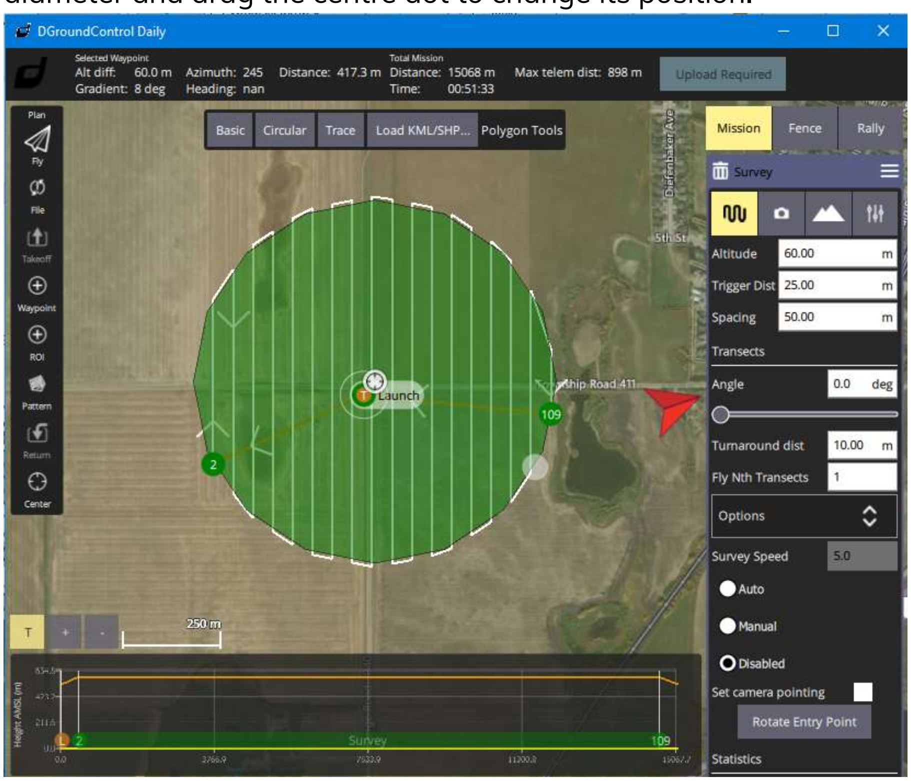


Figure 42: DGCS Circular Survey

Select the Trace tool to create a multipoint polygon. Begin tapping the boundary of the area needed to be scanned. When the polygon has been created, tap the *Done Tracing* box.

Figure 43: DGCS Polygon Survey

Now continue setting the flight attributes and camera settings.

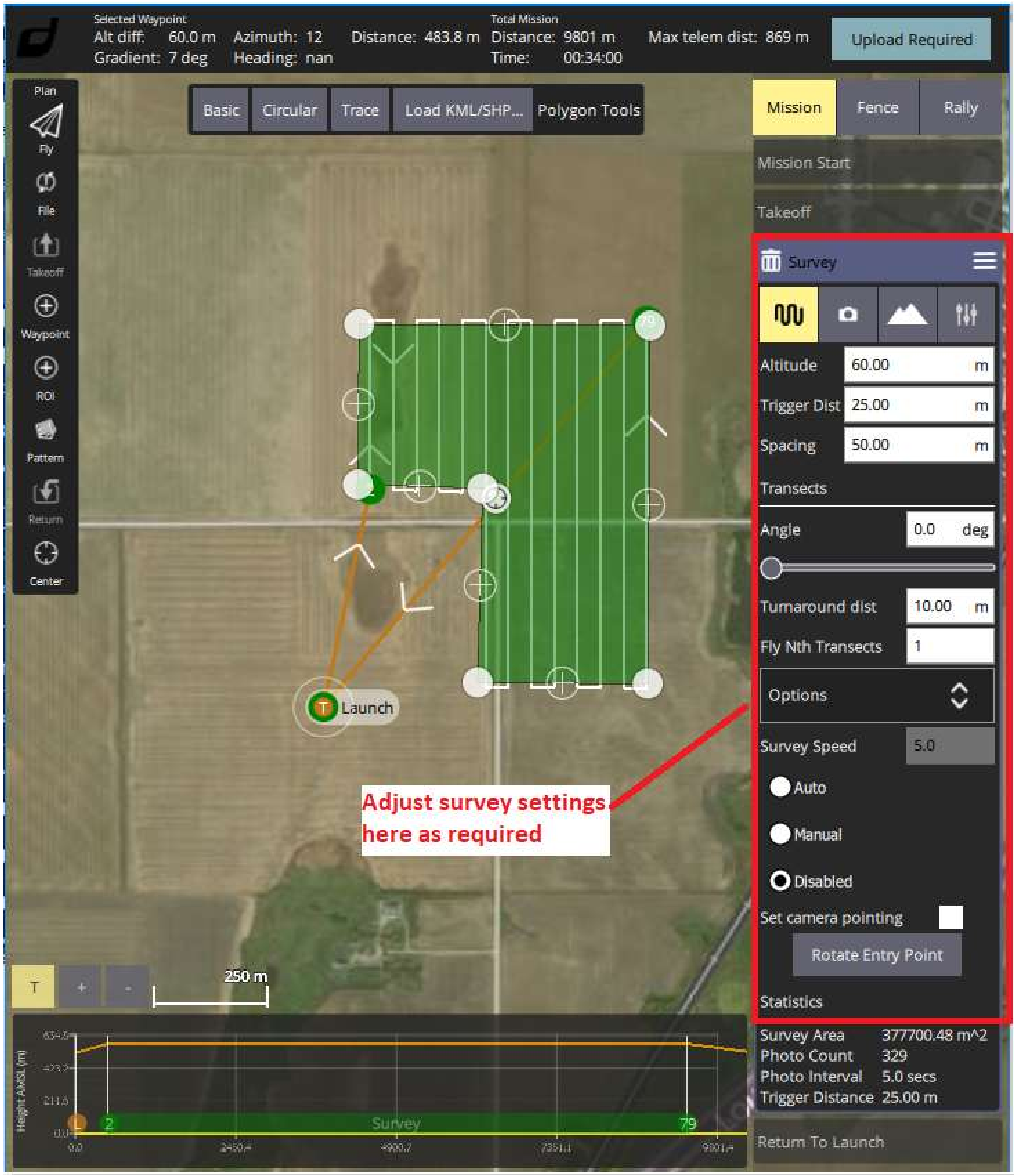


Figure 44: DGCS Survey Settings

Tap the *Camera* tab to change the selection of camera used. Choose the camera payload that has been preprogrammed into the DGroundControl app.

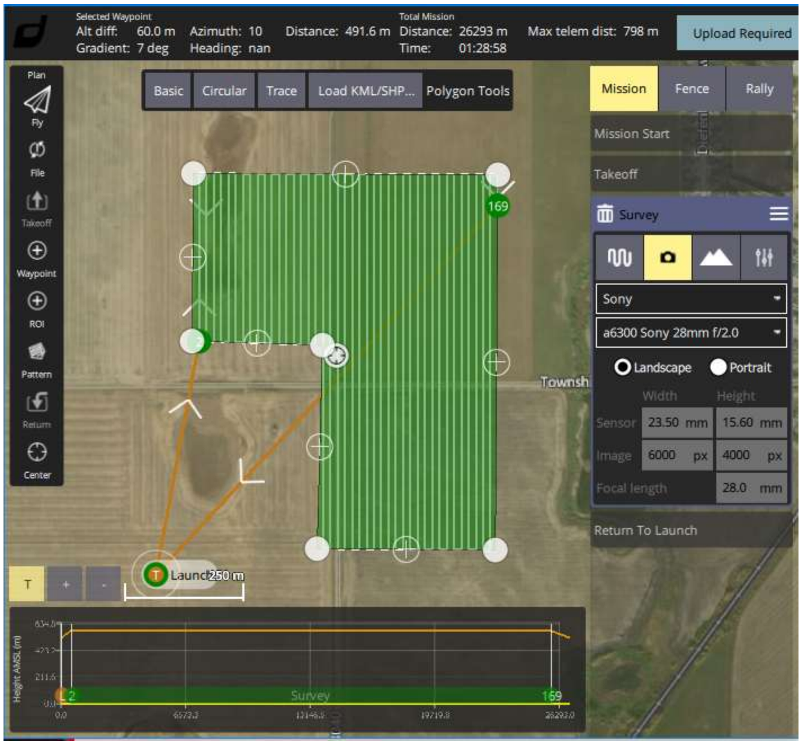


Figure 45: DGCS Survey Camera Settings

Now change the camera capture parameters under the *Grid* tab.

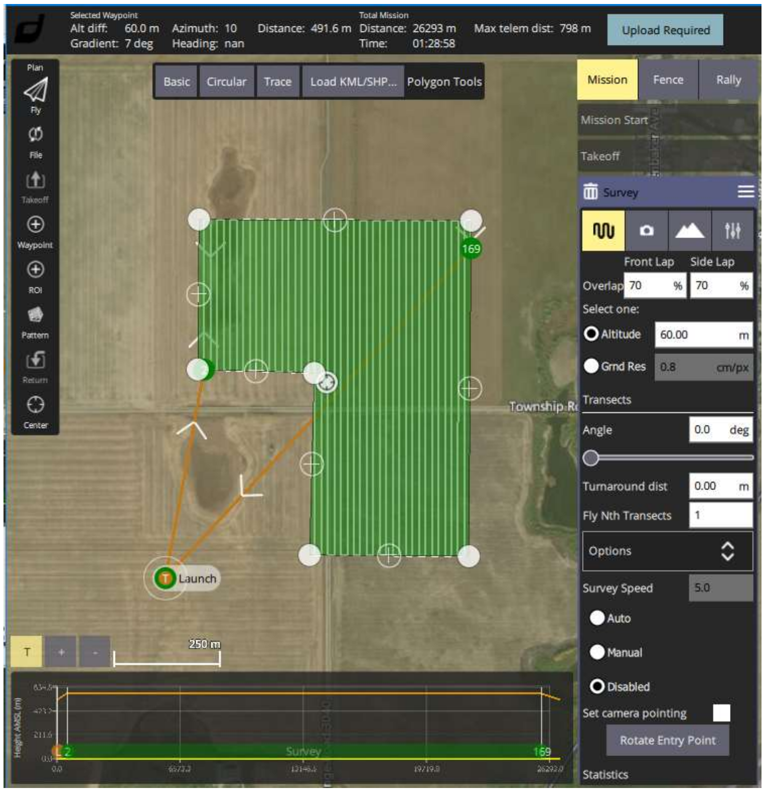


Figure 46: DGCS Grid Tab

1.4.24. Transects Settings for the Survey

Angle

Changing the angle changes the surveying direction of flight.

Turnaround distance

This specifies how far beyond the drawn survey grid the aircraft flies before turning around to follow the transect. This is usually set to 0 for multi-rotor aircraft.

Survey Speed

You have the option to specify a manual survey speed or an auto speed (Calculated automatically by DGCS) which would insert an explicit speed waypoint at the start of the survey entry point which gets reset at the survey exit point.

Set Camera pointing and Camera angle.

Checking this option and specifying an angle inserts a waypoint at the survey start to tilt the camera.

The *Upload Required* button must be tapped to program the vehicle before the *Fly* icon is tapped.

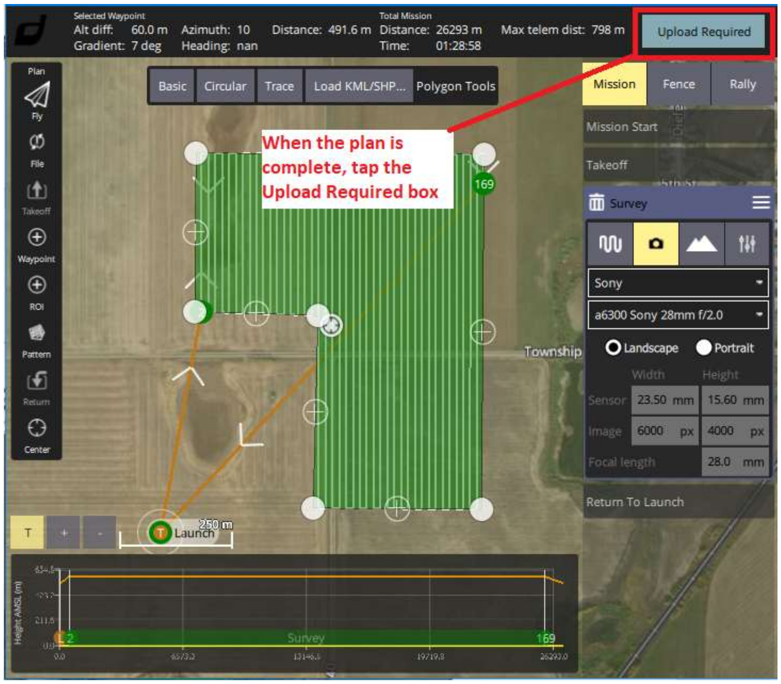


Figure 47: DGCS Upload Required

Tap the paper airplane icon on the top left corner to switch to fly view.

If all the conditions are met in the preflight checklist, The *Start Mission* can be initiated. Drag the *Slide to confirm* arrow and the Command will immediately take off and execute its preprogrammed mission.

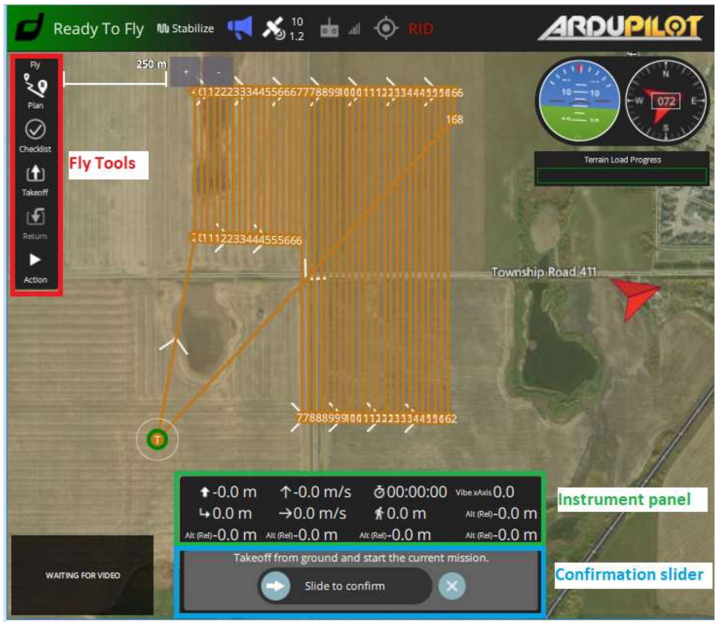


Figure 48: DGCS Start Mission

When the mission is completed, the aircraft will land and disarm.

1.4.25. Flying in Guided Mode

Flying the aircraft sending real time commands without having a planned mission is called a guided mode flight. To perform a guided mode flight,

Connect to the aircraft and make sure you are in the Fly view.

Wait until the flight status on the tool bar changes to 'Ready To Fly' as shown below.

Figure 49: DGCS Ready To Fly

Tap the flight mode text on the tool bar and select 'Guided' as shown below and wait until the flight status changes to 'Ready To Fly.'

Tap Takeoff as shown below and slide the conformation bar to confirm.

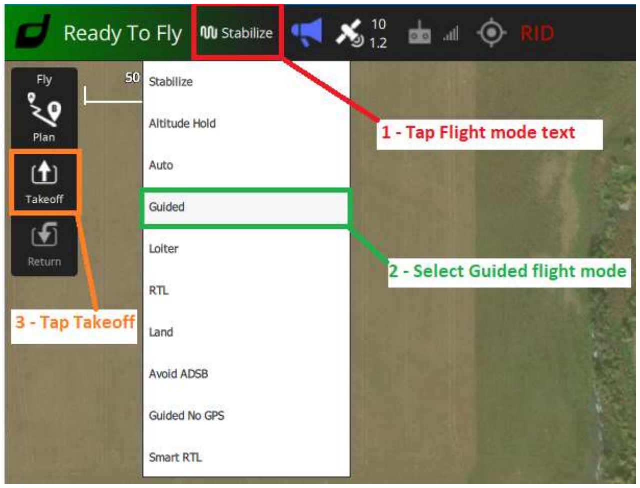


Figure 50: DGCS Takeoff

The aircraft takes off and ascends now and reaches a fixed altitude.

Now you can fly the aircraft to any position on the map. Click on the map where you want to fly and select 'go to location' as shown below. Then slide the confirmation bar to confirm.

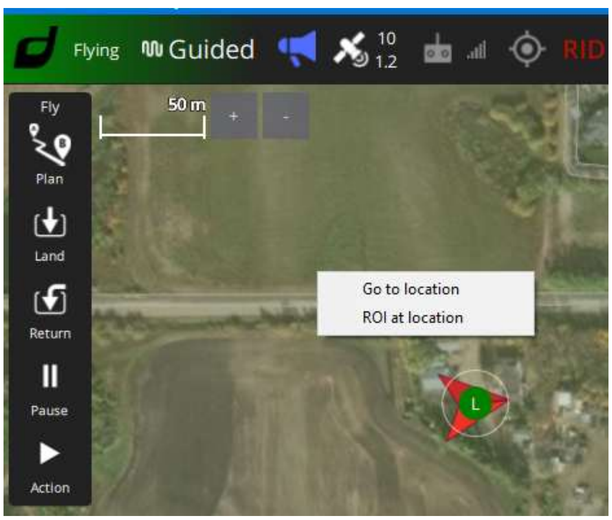


Figure 51: DGCS Go to Location

Once the aircraft reaches that location or during flight, you can click on another point on the map and repeat the previous step to fly to that location.

When you want to end the flight and bring the aircraft down, you can either tap the button Land to land the aircraft at the current position or tap the button Return to bring the aircraft to the original position and then land. You need to slide the confirmation bar to confirm either action.

1.4.26. Setting Region of Interest (ROI) for a Flight

During a flight it is possible to introduce a Region of Interest (ROI) in the form of a waypoint. This would make the nose of the aircraft point at the specified ROI point from that point. The nose would continue to point to the ROI point during the flight till an ROI cancellation way point is found.

1.4.27. Setting ROI for a Guided Flight

Start a guided flight as described in one of the previous sections.

When the aircraft is flying, click on a point on the map where you want to set the ROI and select 'ROI at location' as shown below and slide the confirmation bar.

Figure 52: DGCS ROI

The arrow starts pointing at the ROI location and the ROI button on the status bar turns green indicating ROI is enabled in the flight now. See below for a screenshot.

Figure 53: DGCS ROI Status

Now you can fly to another location by clicking on another point on the map and sliding the confirmation bar. The arrow would keep pointing at the ROI location during the flight as shown below.

Figure 54: DGCS ROI Orientation

Once the aircraft reaches the new point, navigate it to another point. When it is flying to that new location, click on ROI status indicator button on the fly toolbar and select 'Disable ROI' as shown below.

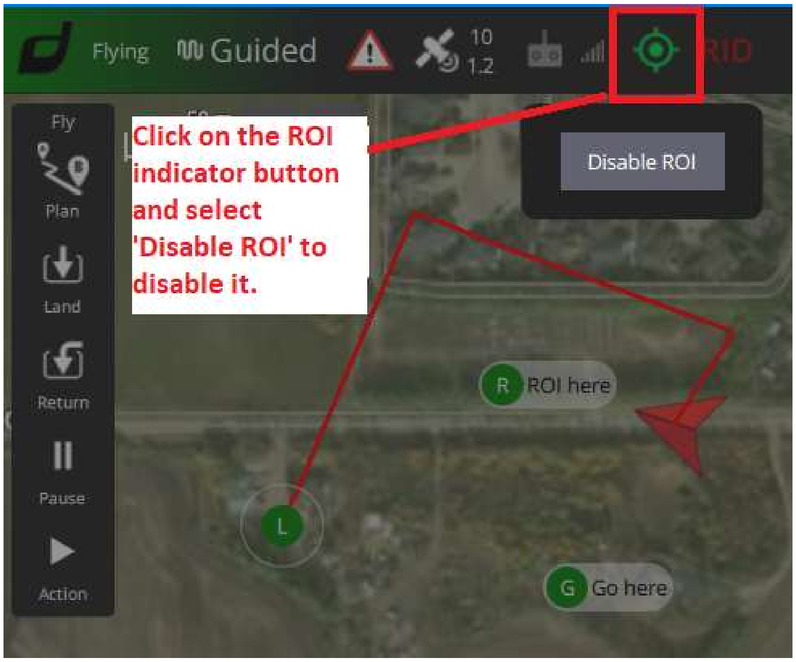


Figure 55: DGCS Disable ROI

Once disabled, The ROI point disappears from the map, the ROI indicator returns to its original color indicating it is disabled and the arrow starts pointing at the direction if flight from the ROI location as shown below and the aircraft continues to the next location as shown below.

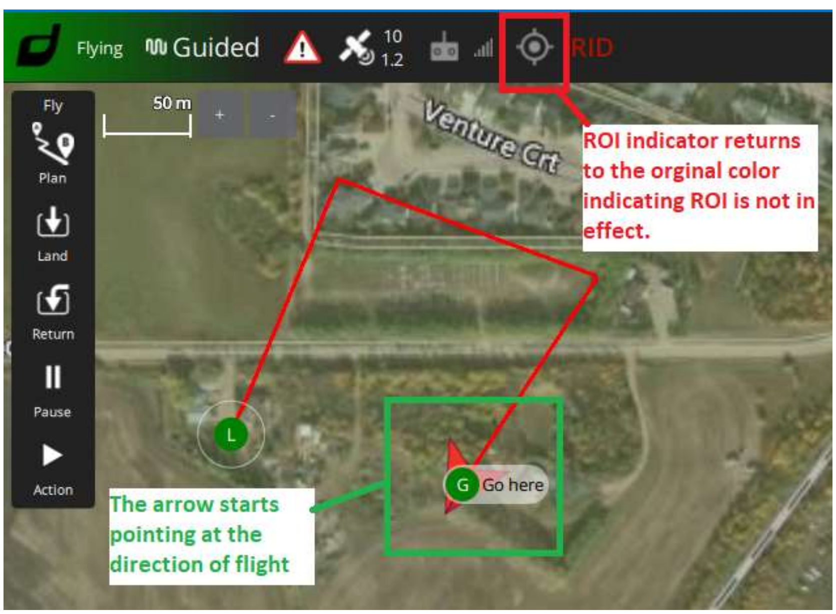


Figure 56: DGCS ROI Disabled

Now you can continue the guided flight as you want and land the aircraft as described in the guided flight mode in one of the previous sections.

1.4.28. Installing Software on the Aircraft via DGCS (This feature is still in development and subject to change)

DGCS provides the ability to update software on the aircraft. Make a connection to the aircraft and connect to it.

Open DGCS and go to application settings -> Software Update Manager

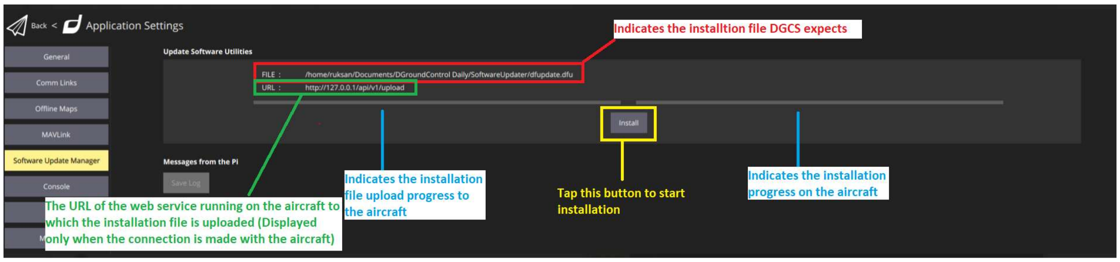


Figure 57: DGCS Software Update Manager

The software package file dfupdate.dfu which is used to install software on the vehicle should be copied to the path shown as the FILE in the 'Update Software Utilities' section.

1.4.28.1. ON WINDOWS

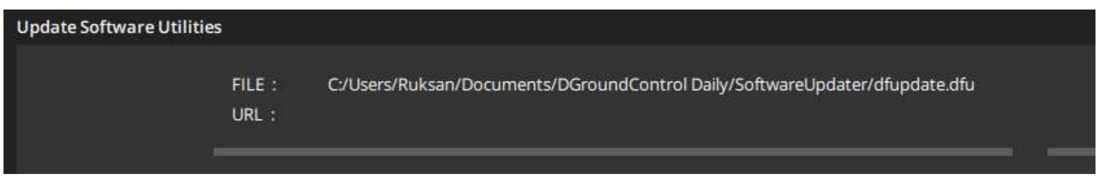


Figure 58: DGCS Software Update Windows

1.4.28.2. ON ANDROID

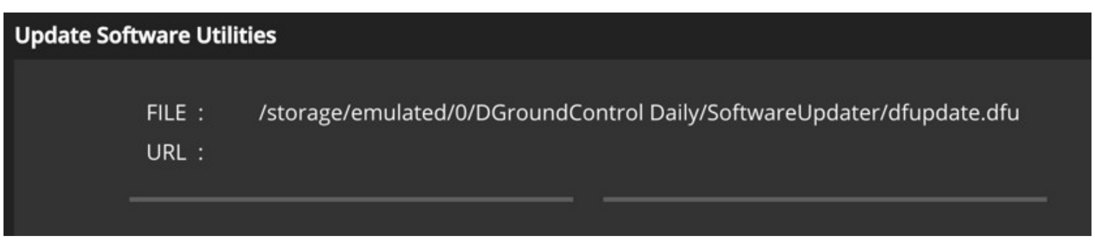


Figure 59: DGCS Software Update Android

The window should indicate the URL of the web service once a connection is established with the aircraft. Press the button 'Install' to start the installation and then confirm by sliding the confirmation bar. The upload should start, and you can see the progress of the upload on the first progress bar. Once the upload is finished, the installation on the vehicle starts and you can see the progress on the second progress bar. The messages received from the installer on the vehicle are shown under the section 'messages from the Pi.' You have the option to save the messages to a text file. Once the installation is completed successfully you can see the text 'Installation Successful' below the second progress bar.

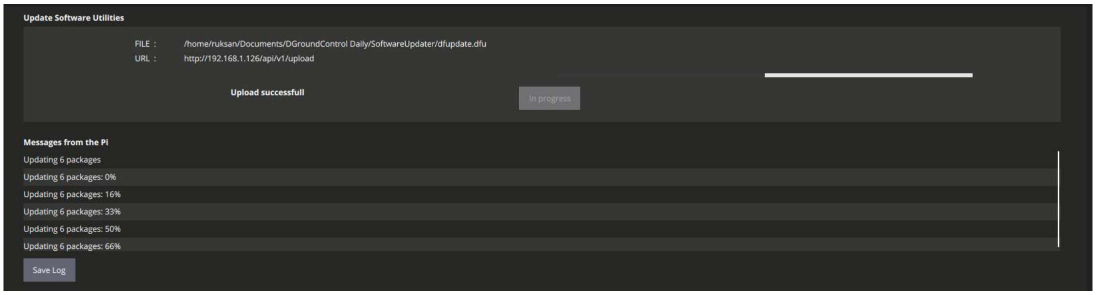


Figure 60: DGCS Software Update Messages

1.4.29. Installing DGCS on your Windows or Android Device

1.4.29.1. WINDOWS INSTALLATION

Obtain the DGroundControl-installer executable file from Draganfly and double click on it to start the installation.

Once the installation is complete run the application DGroundControl from the startup menu

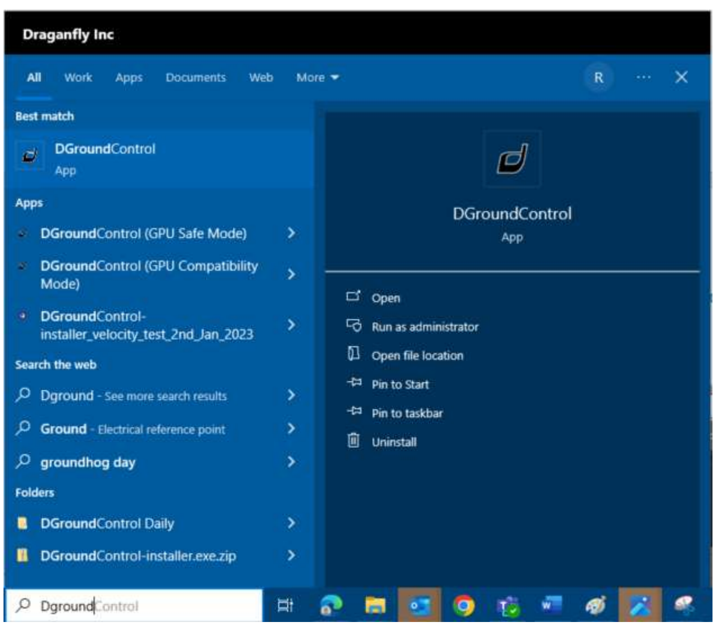


Figure 61: DGCS Application Windows

Select the below options when prompted in the next screen.

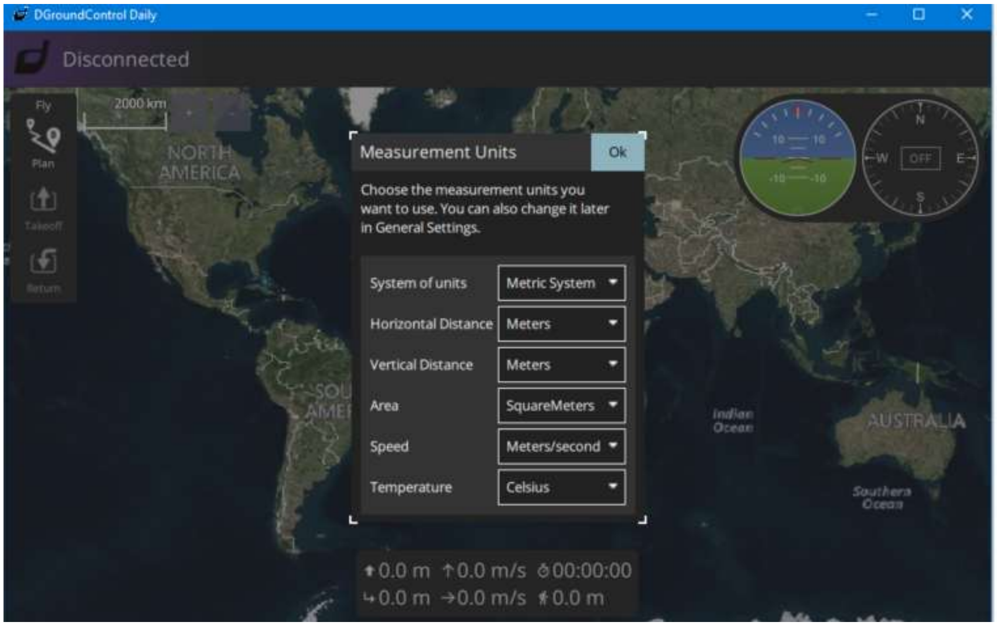


Figure 62: DGCS Windows Measurements Units

Press OK. Now select the options below as shown in the screen below. Make sure you select ArduPilot for the firmware and not PX4 or any other options and now hit OK.

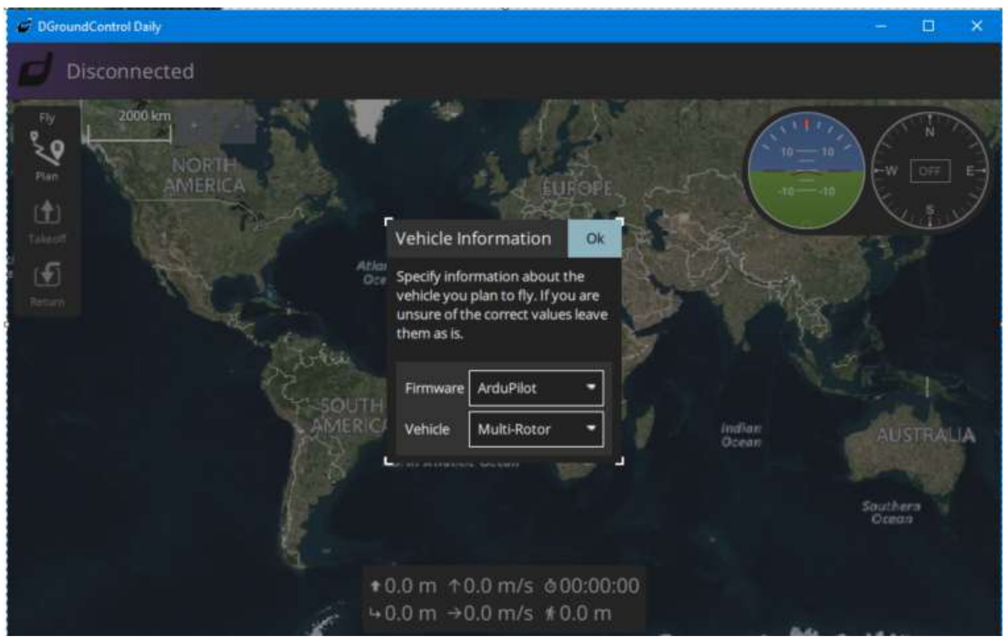


Figure 63: DGCS Windows Vehicle Information

1.4.29.2. ANDROID INSTALLATION

Obtain the DGroundControl .apk installation file from Draganfly and copy it to your device. Use a file browser app on the android device to locate the file. Double tap the file to begin installation.

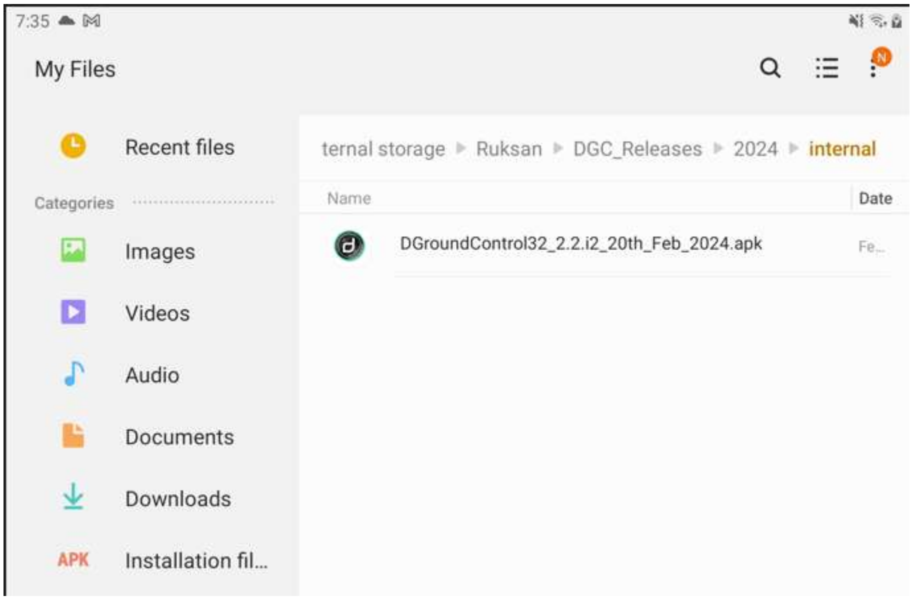


Figure 64: DGCS Android Installation

Once the installation is complete open the application by double clicking on the DGroundControl icon.

When the application starts it would ask for certain permissions like to access device location, to take pictures and record video and to access photos and media files on the device. Grant those permissions.

When the screen below appears select the options as shown

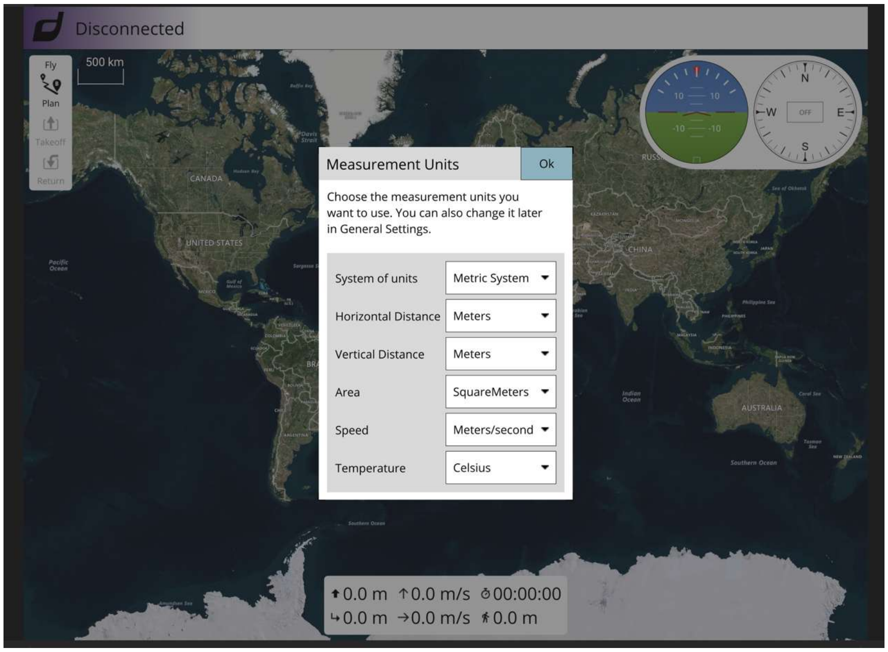


Figure 65: DGCS Android Measurement Units

And press OK. Select the firmware and the vehicle type as shown in the below screen. Make sure you select ArduPilot as the firmware and not PX4 or any other option.

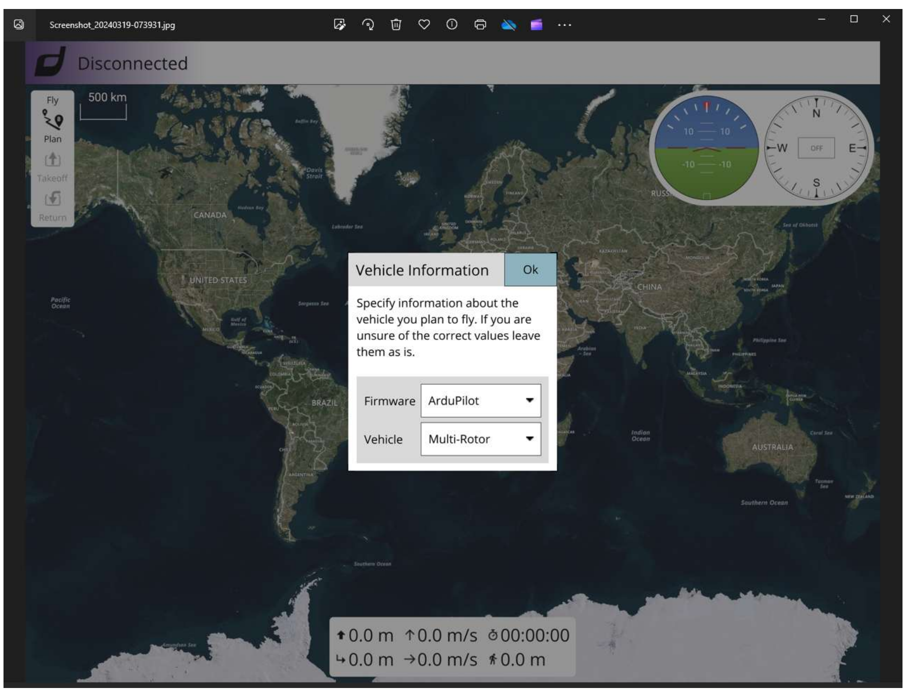


Figure 66: DGCS Android Vehicle Information

2. ALARMS AND MESSAGES

During operation, DGroundControl software (DGCS) will present several messages and alarms both audible and visual to provide informational data and alarms requiring action to the user.

Alarms are classified into six different severities as detailed below:

- *Informational:* provides engineering level information, can be ignored, no rectification needed

- *Low*: Does not represent a safety risk, but may indicate a potential performance degradation,
  These alarm should be address by flight crew but may resolve automatically.

- *Moderate*: May indicate a system problem if the message is persistent, should be resolved.
  Normally does not represent a safety risk.

- *Warning:* Indicates an anomaly has occurred, this may be transient, and the system may
  be able to automatically recover. Observe flight behaviour very carefully. Has potential to escalate to a safety risk if not monitored and actioned.

- *Critical:* A failure has occurred or is imminent. Flight operations shall be discontinued. Follow procedures for ***mission abort***. A safety risk exists if not immediately actioned.

- *Emergency Procedure:* A failure has occurred, and a safety risk is present. The aircraft is in an
  emergency state. Follow appropriate **Emergency Operating Procedures.**

Alarms and messages will be displayed in three different formats:

- Message Log: Discrete window which records and when opened displays a history of
  all messages and alarms on the current cycle of DGCS

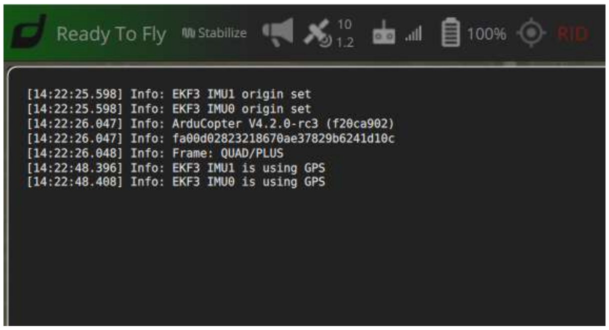


Figure 67: Discrete Window Messages

- **Heads Up Messages:** Will be displayed in a grey semi-transparent box at the center of the DGCS screen

Figure 68: Heads Up Messages

- **Pop Up Alert Messages:** Will display in a bold yellow bounding box at the top of the DGCS screen

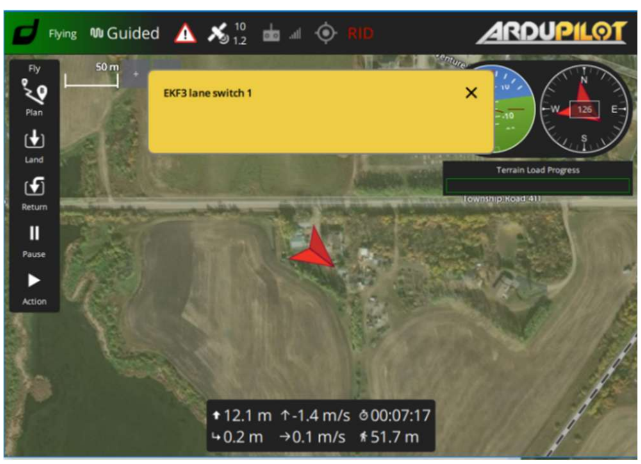


Figure 69: Popup Messages

Message	Severity	Display Method
No ap_message for mavlink id(xxx)	Informational	Message Log
Triggered when the aircraft electronics request a message type from the autopilot that does not exist.		
Resolution: No action needed, can be ignored.		
AP: PreArm: Throttle (RC3) is not neutral	Low	Popup Alert
Triggered if the PIC attempts to arm the aircraft without the throttle control stick in the lowest position. This commonly occurs if attempting to execute an automated takeoff in Auto or Guided flight mode prior to arming the aircraft. Aircraft will not be able to arm and takeoff until this alarm is cleared.		
Resolution: follow best practice and launch procedures to arm aircraft prior to initiating automated takeoff ***Note:** if the alarm persists despite following correct procedures a calibration error may exist,* *please contact Draganfly technical support.*		
FFT: self-test failed: wanted XX had YY	Low	Popup Alert
Triggered if the flight controller detects too high of a vibration present on initialization. This can be caused by cooling fans running on startup. Aircraft will not be able to arm and takeoff until this alarm is cleared		
Resolution: power cycle aircraft.	***Note:** this has been corrected with updated software, please check with Draganfly technical support for software updates.*	
	Low	Popup Alert

DGroundControl Daily was unable to retrieve a full set of parameters from the vehicle.		
This will be presented if there was a minor hiccup or communication glitch on start-up that prevent a data packet from being received by DGroundControl.		
Resolution: disconnect and reconnect the communication link within DGCS or close and re-launch DGCS. ***Note:*** *If this message persists there may be a wiring fault, please contact Draganfly technical support*		
PreArm: Heater Temp Low XX<40	Low	Heads Up
The flight controller has an internal heater and must reach an operator temperature of 40C before flight. Aircraft will not be able to arm and takeoff until this alarm is cleared		
Resolution: no action needed, wait for internal temperature to reach 40C. This may take several minutes in cold operation environments. Consider keeping aircraft in a warm vehicle until ready to fly.		
ODID Lost Operator Location	Low	Popup Alert
Will be presented in the event that the GCS is not reporting a valid GPS location. This message is common on startup and will often resolve itself after a few seconds. The aircraft will not be able to arm and takeoff until this alarm is cleared.		
Resolution: if the alarm does not automatically resolve, follow instruction for how to set the GCS for a fixed position. Check that location services are enabled on device. Set RID to fixed location.		
ODID Lost Transmitter	Moderate	Popup Alert
Indicates that the flight controller is not communicating with the integrated Remote ID module onboard the aircraft. This typically indicate a wiring fault, aircraft settings fault, or module failure. The aircraft will not be able to arm and takeoff until this alarm is cleared.		

Resolution: power cycle the aircraft, if the alarm persists contact Draganfly technical support		
OpenDroneID: Operator Location Must Be Set	Low	Popup Alert
Will be presented in the event that the GCS is not reporting a valid GPS location. This message is common on startup and will often resolve itself after a few seconds. The aircraft will not be able to arm and takeoff until this alarm is cleared.		
Resolution: if the alarm does not automatically resolve, follow instruction for how to set the GCS for a fixed position. Check that location services are enabled on device. Set RID to fixed location.		
PreArm: 3d Accel Calibration Needed	Low	Popup Alert
Will be presented on startup if an accelerometer calibration is required. The aircraft will not be able to arm or takeoff until this alarm is resolved.		
Resolution: perform an accelerometer calibration followed by a compass calibration		
PreArm: Compass Not Calibrated	Low	Popup Alert
Will be presented on startup if the compass requires calibration either due to poor or missing calibration data. The aircraft will not be able to arm to takeoff until this alarm is resolved.		
Resolution: perform a compass calibration		
PreArm: Battery *X* low-capacity failsafe	Low	Popup Alert
Presented on start up if one or both of the flight batteries are at too low of a state of charge for flight. The aircraft will not be able to arm or takeoff until this alarm is resolved		
Resolution: fully charge flight batteries		
PreArm: GPS Glitching	Low	Popup Alert

Indicates erroneous or poor data from the GPS system, typically is present when GPS lock has not yet been acquired or if there is a physical obstruction present		
Resolution: wait for GPS lock acquisition, moving aircraft to a location with clear view of sky may help		
PreArm: Gyros Inconsistent	Low	Popup Alert
Indicates that the aircraft was moving during startup and initialization or there was a significant temperature change since startup. The aircraft will not arm or takeoff until this alarm is resolved.		
Resolution: Allow the aircraft to sit stationary to perform initialization. Power cycle may be needed.		
Prearm: Rangefinder 1: No Data	Moderate	Popup Alert and Heads Up
May be presented on startup or arming attempt in the event that the terrain range finder is erroneous or missing. This may indicate that something is too close to the sensor. The terrain sensor normally expects to be above the ground by the length of the landing gear, if there is something closer (i.e. grass, transport case, etc.) this error may be issued. This may also indicate a wiring fault or component failure.		
Resolution: Ensure ranger finder sensor is plugged in. Ensure there is nothing too close to the sensor. If there is no obstruction to be removed, power cycle the aircraft, if the problem persists, please contact Draganfly Technical Support.		
Prearm: Logging Failed	Low	Popup Alert and Heads Up
Triggered if the Cube flight controller is not able to start recording a log file. The most common cause of this is a missing or corrupt micro-SD card in the Cube flight controller. This message will appear upon attempting to arm the aircraft, arming and takeoff will not be possible until resolved.		
Resolution: Power off the aircraft and ensure a valid micro-SD card is presently installed in the Cube flight controller.		
Potential Thrust Loss *(On Takeoff)*	Moderate	Popup Alert

This message is presented if the commanded control for one or more motors has reached a saturation at full power even if briefly. If presented during takeoff this generally is caused due to the aircraft not being level during takeoff command or operating in high winds.		
Resolution: often not indicative of an issue, monitor flight performance, if this message persists during flight follow *Potential Thrust Loss* emergency procedure and any additional emergency procedures as required.		
Potential Thrust Loss (*During Flight)*	Critical	Popup Alert
This message is presented if the commanded control for one or more motors has reached a saturation at full power even if briefly. If this alarm is presented during flight this often indicates an issue with one or more of the propulsion system components, or exceeding flight envelope or operating limits. Failure to immediately action this alarm may result in system failure and crash		
Resolution: immediately follow emergency procedures for *Potential Thrust Loss.* Contact Draganfly Technical support to identify and resolve the cause of the alarm		
EKF3 IMU*X* MAG*X* ground mag anomaly, yaw realigned.	Warning	Popup Alert
Most often will occur shortly after takeoff and may indicate that the flight control has recognized a significant change in the magnetic field and has applied a compensation for this. This may be caused by a poor compass calibration, large metal object in the area or a geomagnetic anomaly. This does not necessarily indicate a system issue or safety issue.		
Resolution: carefully monitor flight behaviour and reported heading. If heading or bearing telemetry drifts, aircraft exhibits "toilet bowling" behaviour or the alarm persists follow emergency procedures for *Failure or loss of magnetometer data*		
PreArm: Radio failsafe (*On Ground)*	Low	Heads Up / Popup Alert
Will be presented in the event that the aircraft does not have a connection to the RC controller. This can be caused by a procedural error or a system fault. The aircraft will not be able to arm or takeoff until resolved.		
Resolution: Verify the HHC and GCS are powered on. If the problem persists, contact Draganfly Technical support.		

PreArm: Radio failsafe on (*During Flight)*	Emergency	Popup Alert
Will be presented in the event that the aircraft does not have a connection to the RC controller. The aircraft will enter a fail safe emergency flight mode.		
Resolution: follow emergency procedures for *12.16 Loss of C2 Link*		
GPS Glitch or Compass Error	Warning	Popup Alert
Indicates a problem with the compass or GPS system, this may be transient. The aircraft will not be able to reliably operate in automated flight modes (ie, Loiter, Guided, Auto, RTL) that relay on GPS data until this alarm is resolved.		
Resolution: PIC shall regain manual flight control in Attitude flight mode and assess the cause of the alarm. If the alarm has cleared flight the flight may be resumed, if the alarm persists, follow emergency procedures for *12.14 Failure or Degradation of GNSS Signal*		
EKF Failsafe	Emergency	Popup Alert
This alarm will be present accompanying the aircraft entering a fail safe emergency landing mode. This indicates a critical failure on one or more component of the EKF, the most typical cause is the loss of GPS signal.		
Resolution: follow emergency procedures for *12.18 Erratic or Degraded Flight Performance*		
EKF3 IMUX Emergency Yaw Reset	Critical	Popup Alert
An erroneous heading condition has been detected by the flight controller, this will often be accompanied by "toilet bowling" flight behaviour or divergence from intended position.		
Resolution: If flight behaviour is good, flight ops can be continued however carefully monitor flight behaviour, if toilet bowling or poor flight performance is observed follow procedures for *12.13 Failure or Loss of Magnetometer Data*		
No GPS Lock for Vehicle	Low	Heads Up

The aircraft has not yet acquired a GPS lock, automated flight modes using GPS will not be permitted until the alarm has resolved.		
Resolution: wait for GPS lock acquisition, moving aircraft to a location with clear view of sky may help		
EKF Yaw Inconsistent by XX Deg	Low	Popup Alert
Indicates that there is a discrepancy between the sensor data being used to calculate yaw values and in turn heading.		
Resolution: perform compass calibration.		
Terrain: Clamping Offset	Moderate	Popup Alert
This alarm may appear upon arming the aircraft and indicates a discrepancy between the report GPS elevation and the estimated terrain elevation at the takeoff location of at least 15m. This can lead to errors with altitude control if operating an automated mission using terrain based altitude control.		
Resolution: If operating using relative altitude control based on Barometric pressure no action is needed. If operating with terrain-based altitude control review and edit the flight plan, re-upload, power cycle.		
Error binding UDP port: The bound address is already in use	Informational	Popup Alert
This message willy only be presented when using the aircraft equipped with a Herelink radio system. This message will *always* appear on startup and is tied to an internal system process within the Herelink handheld controller. This does not impact operation and is strictly informational		
Resolution: Tap the "Ok" button and proceed as normal.		
PreArm: Need Position Estimate	Low	Heads Up
This alarm may appear upon when attempting to arm the aircraft. This will be presented if the flight controller is not yet fully initialized. During startup the aircraft expects to be stationary as this is required to auto calibrate and initialize all internal sensors. If the		

aircraft is moving or subject to vibration this initialization process can take longer than usual and the above message will be presented.		
Resolution: This alarm messae will automatically clear itself after initialization has occurred. Allow the aircraft to sit stationary.		
DGround Control Daily was unable to retrieve the full set of parameters from vehicle	Low	Popup Alert
This alarm message appears on startup if DGround Control software was not able to download the full settings and parameter file from the aircraft during initialization. This message is rare but can occur for a few different reasons, such as there is a slight disruption to the communication link causing a dropped packet during connection, the aircraft has a flight plan loaded with invalid commands, power is cycled on the aircraft rapidly. This does not impact flight performance but can prevent certain user interface buttons and features from appearing.		
Resolution: This will not correct itself, power cycle the aircraft, basestation, hand held controller, and DGround Control. Please allow all devices to be off for 5 seconds before powering back on.		

3. FIRST FLIGHTS AND JOYSTICK CONTROLS

We strongly encourage you to complete a Draganfly certified flight training session however if this is not practical for you, we do also offer video conference calls to act as a system and operations overview to help with system familiarity.

Please perform your first few flights without a payload and in a controlled, safe environment. Please only move onto operational flight once you are comfortable operating the aircraft with the joysticks and are familiar with all flight behaviours. For your first few flights we recommend low windspeed, short duration, and that you keep your flights at low altitude, with slow and gentle control inputs to establish comfort with the system, please follow all SOP's and EOP' for all flights.

While there are different variants of handheld controller available the following flight controls and actions are universal across all aircraft and HHC variants.

Prior to flight, please ensure that the aircraft is connected to the GCS and DGround Control is giving a status indicator of Ready to Fly.

3.1. 7.1 ARMING AND DISARMING

For our first flight we need to get all motors running or "armed" this is done using the left-hand joystick. Hold the left-hand joystick in the throttle full down and yaw full right position for 2 seconds. The aircraft should emit a tone, the motors will begin running and DGCS should give an audio message indicated "Armed".

To Disarm the motors, also use the left-hand joystick to hold the throttle in the full down position and yaw in the full left position for 3 seconds. The motors should stop running and DGCS should give an audio message indicated "Disarmed".

Before flight we recommend performing this arm and disarm action a few times with propellers removed to get comfortable with these movements.

3.2. 7.2 TAKEOFF

With all of the motors running increase the left-hand joystick, throttle control to increase the motor speed and initiate a takeoff. We recommend advancing to throttle control to approximately 50% of its overall travel and hold it there until the aircraft has reached its desired altitude. For the first few takeoffs climb to approximately 5-10 feet above ground level. Gently reduce the throttle control back to neutral to maintain a static altitude.

3.3. 7.3 Flight Controls

Pitch and roll movement are affected by the right-hand joystick, forward and back corresponds to pitch forward and back, while left and right corresponds to roll left and right. The left control stick adjusts climb rate and yaw. Forward and back control climb and descend while left and right controls yaw rotation left and right. Use very small and gentle control inputs on pitch, roll and yaw to maintain a stable position and gradually provide control inputs to maneuver the aircraft through horizontal flight. Note that while in Attitude flight mode the aircraft will be very responsive to control inputs and will NOT automatically hold position, it will drift with wind. To hold position, toggle the aircraft to Loiter mode.

3.4. 7.4 Landing and Disarm

One of the most important aspects of landing is that you maintain a stable hover with no horizontal movement at touch down. Use the pitch and roll controls to maintain a stable position, alternatively Loiter flight mode will maintain a stable position for you. Gently reduce the throttle control to slowly descend, as the landing gear are within a couple inches of touching the ground pull the throttle control to the lowest position and hold it. Once on the ground hold the left-hand stick in the throttle full down and yaw full left position for 3 seconds to disarm the motors.

> ***Caution:*** *When landing and pulling back the throttle control be very careful to pull this control stick straight back. If any yaw control input is given this will cause the aircraft to begin spinning or rotating and can result in a tip over on landing causing damages to the aircraft.*

4. Standard Operating Procedures (SOP's)

The following standard operating procedures shall be considered the manufacturers best practice guidelines and should be adhered to for all flight operations. The below SOP's may reference additional processes that are detailed in appendices or additional chapters throughout this manual. Please read and understand the full manual prior to operations.

Caution: Failure to adhere to any of the following procedures may result in damage or destruction of equipment and property as well as personal injury or death.

4.1. Flight Planning

- Complete *Site Survey*
- Complete and save automated flight plan with DGCS if conducting an automated flight operation.
- Brief Flight Crew
- Complete *Preflight Checklist*

4.2. INITIALIZATION

- Complete Flight planning
- Install desired payload to aircraft.
- Power on ground control station including HHC.
- Place aircraft at the desired takeoff location on a level and stable surface and power on
- Power on payload if not automatically powered.
- Launch DGCS flight management software.
- Allow aircraft to connect to GCS, if needed perform manual connection process
- Verify reported heading in DGCS is correct to the true heading of the aircraft
- Move aircraft in pitch/roll and verify correct response on AHRS artificial horizon display in DGCS
- Complete *Pre-Takeoff checklist*

4.3. TAKEOFF/LAUNCH – PIC MANUAL

- PIC, verify desired flight mode is selected.
- PIC announce "Arming."
- PIC arm aircraft using HHC flight control.
- PIC verify all motors are running and allow 3 seconds for spool up.
- PIC announce "takeoff."
- PIC input flight controls for takeoff/launch using HHC.
- PIC to maintain a stable position and attitude using flight controls.
- Allow aircraft to hover in stable position, PIC manipulate pitch, roll, and yaw controls and verify correct response.
- Conduct flight operations as intended.

4.4. TAKEOFF/LAUNCH – AUTOMATED MISSION

- PIC, verify desired flight mode is selected.
- PIC announce "Arming."
- PIC arm aircraft using HHC flight control.
- PIC verify all motors are running and allow 3 seconds for spool up.
- PIC announce "takeoff."
- PIC input commands for mission execution within DGCS
- PIC be prepared to toggle flight mode and assume manual control of the aircraft.
- PIC monitor aircraft for stable and expected flight performance throughout flight.

4.5. COMMANDED RETURN TO LAUNCH (RTL)

- PIC and VO shall access the flight path back to the launch location and ensure it is clear of obstacles.
- PIC and VO shall inspect the launch location and verify it is free of obstacles and personnel.
- PIC shall tap the DGCS icon for return to launch.
- PIC shall announce "Return to Launch."

- PIC shall drag the action confirmation slider in DGCS to execute the return to launch action.
- PIC and observer will continue to monitor airspace and verify the aircraft maintains a stable and safe path back to launch.
- PIC shall remain ready to resume manual flight control by toggling the flight mode.
- Upon reaching the launch location the aircraft will pause for 3 seconds then begin descent
- PIC and VO shall inspect the launch/landing location and verify it has remained free of obstacles and personnel.
- PIC shall announce landing.
- Aircraft will continue it decent until touch down and will then automatically disarm and stop motors.
- Wait for “Disarmed” messaged from DGCS and verify propellers have stopped.
- After confirming motor stop PIC announce “Clear” to indicate the aircraft can be approached safely.

4.6. LANDING/RECOVERY

- Navigate to target landing location.
- PIC shall announce “landing.”
- PIC shall input controls through HHC to maneuver the aircraft for landing.
- As the aircraft passed below 5m AGL pause slightly to verify landing gear automatically extends
- Continue decent at slow controlled rate.
- Control horizontal movement to a velocity of less than 0.2m/s
- Upon touch down fully reduce throttle stick and perform motor disarm control inputs
- Wait for “Disarmed” messaged from DGCS and verify propellers have stopped.
- After confirming motor stop PIC announce “Clear” to indicate the aircraft can be approached safely.

4.7. SHUT DOWN

- Perform shut down of payload as per the payload operations guide.
- Power off payload
- Power off aircraft
- Remove both flight batteries.
- Close DGCS flight management software
- Power off GCS and HHC
- Remove payload.
- Complete *Post Flight Checklist*

4.8. COMPASS CALIBRATION

The magnetometer, more commonly known as a compass is responsible for providing heading information to the aircrafts flight controller. This data is needed for stable and controlled flight. Occasionally the compass will need to be calibrated to ensure optimum performance. Calibrations should be completed in the following scenarios:

- DGCS flight management software is giving an alarm or message indicating the compass needs calibration
- The flight location is more than 500km away from the location of the last compass calibration
- The aircraft heading is not reporting correctly
- The aircraft is exhibiting abnormal flight behaviour
- The aircraft has been involved in a tip over, crash, or impact

To perform the compass calibration setup, power on the aircraft, and connect it to the GCS and DGround Control.

- Within DGCS tap on the "d" icon and select "vehicle setup"

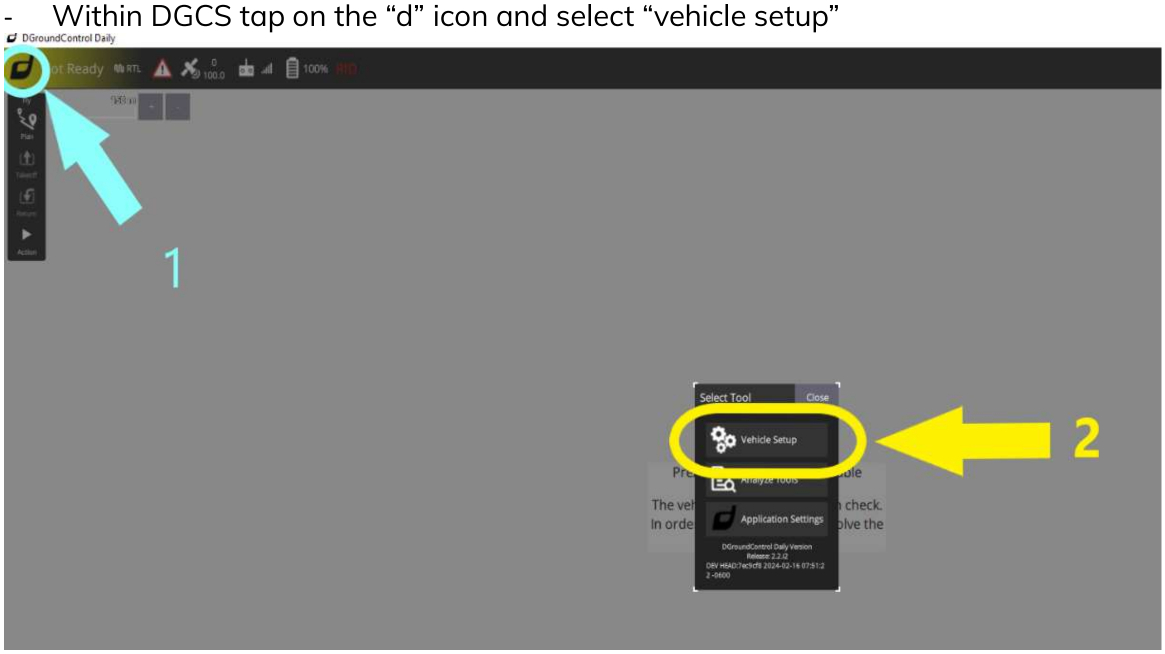


Figure 70: DGCS Vehicle Setup

- On the left hand menu select "Sensor" then "Compass"

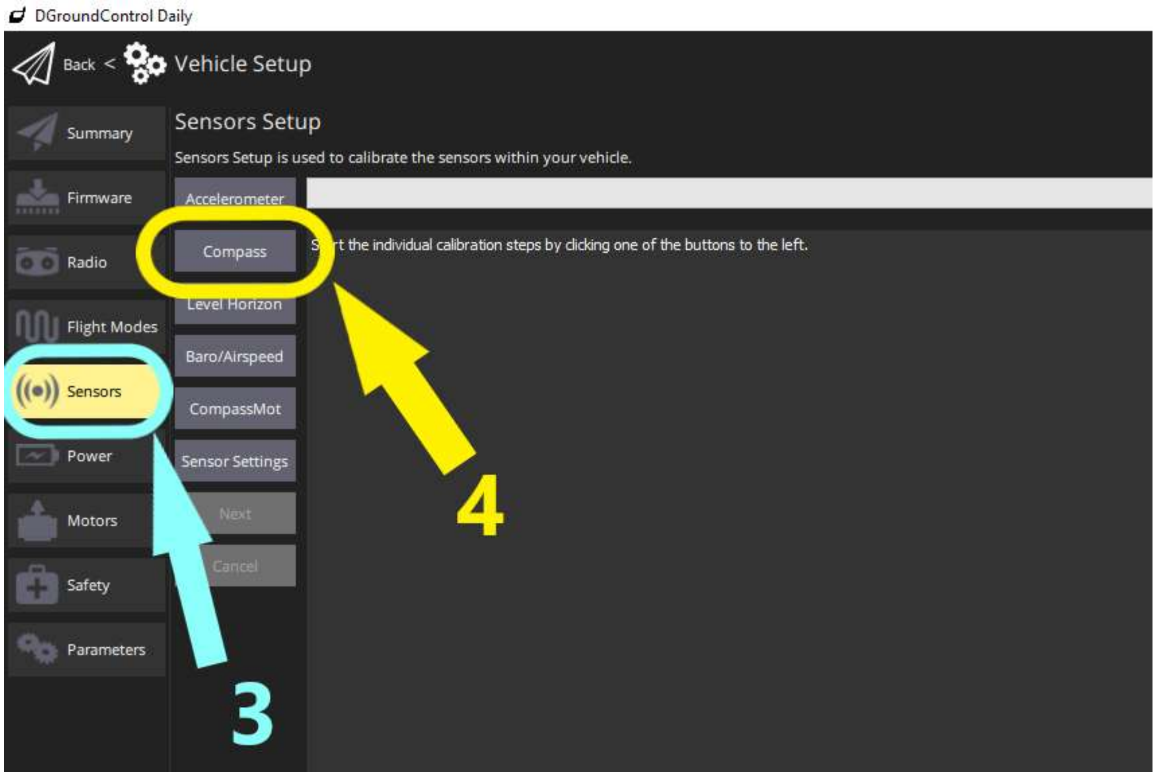


Figure 71: DGCS Compass

- Before starting the compass calibration verify that the field "autopilot rotation" displays a value of "yaw 270"

- You will likely see to compass available to select, please ensure that "external compass" is set as the primary.
- Tap "Ok" in the top right corner

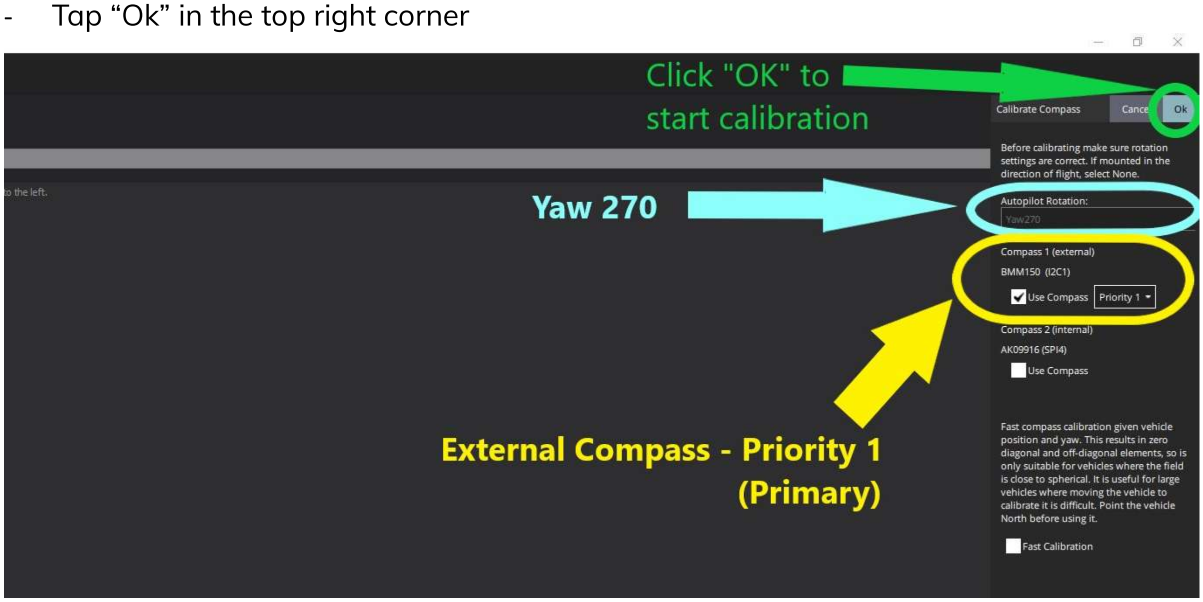


Figure 72: DGCS Compass Calibration

- Smoothly rotate the aircraft around each axis for at least two full rotations. Monitor the progress bar at the top of the DGCS screen. If the progress bar appears to get “stuck” this usually means that the current motion has been learned and a new motion should be used. Random motions can also be used as part of the calibration process. Once complete the screen will provide results for the calibration.
- Set the aircraft down and tap the “reboot” button.
    - After rebooting, DGCS will need to be reconnected.

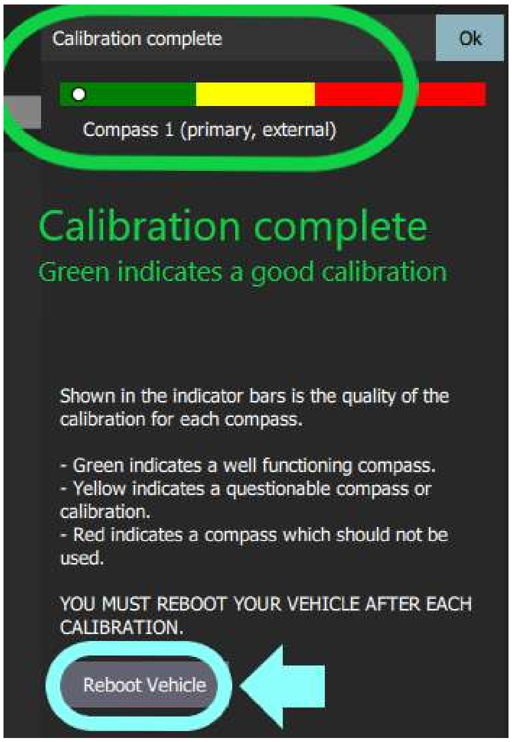


Figure 73: DGCS Calibration Complete

Note: *it is best practice to perform compass calibrations with propellers and payloads removed. This is also best done with two people as the aircraft can be difficult for one person to smoothly maneuver.*

5. Emergency Operating Procedures (EOP's)

The following emergency operating procedures shall be considered the manufacturers best practice guidelines and should be adhered to in the event of an emergency scenario or unexpected flight operating condition. The below EOP's may reference additional processes that are detailed in appendices or additional chapters throughout this manual. Please read and understand the full manual prior to operations.

Warning: Failure to adhere to any of the following procedures may result in damage or destruction of equipment and property as well as personal injury or death.

5.1. Propulsion System Failure

The failure of one or more of the propulsion system assemblies on the aircraft will result in uncontrollable instability with extremely high likelihood of an unavoidable crash. In the event of this type of failure the aircraft will violently rotate about one more axis and nearly immediately reach an unrecoverable attitude angle. (See Appendix **Error! Reference source not found. Error! Reference source not found.**)

- DGCS may present the alarm message "Potential Thrust Loss."
- PIC shall announce "Crash Crash Crash"
- VO shall announce "Crash Crash Crash" and attempt to caution any personnel in the area.
- PIC shall perform control inputs for *Flight Termination to disarm remaining motors.*
- PIC and Observer shall maintain line of sight with the aircraft as long as possible to aid with recovery.
- Report as required by aviation authorities.
- Follow *Post Crash* procedures.

5.2. Fire (Airborne)

Should an onboard fire occur during flight, take all action possible to safely avoid injury and property damage shall be taken.

- If aircraft is still controllable, Observer and PIC shall immediately observe the area below the aircraft for hazards or risked involved with *Emergency Landing, or Flight Termination.* If the location is safe for emergency landing proceed to Emergency Landing, if location is not safe continue horizontally to more appropriate location to initiate *Emergency Landing.*
- The PIC shall announce, "Emergency Landing, Emergency Landing, Emergency Landing."
- PIC shall follow *Emergency Landing* procedures.

- If aircraft becomes unstable or no longer can be controlled in by the PIC in an expected manor, PIC shall follow ***Flight Termination*** procedures.
- Recover aircraft and Follow ***Fire (ground)*** *procedures as quick as safely possible.*
- Follow procedure for ***Post Crash***

5.3. BATTERY FIRE

Lithium Polymer batteries contain flammable materials with high reactivity that may ignite, when exposed to temperature exceeding 150C or when damaged, abused, or misused. Lithium battery fires burn quickly and are very difficult to extinguish and may reignite. Fire will produce irritating and toxic gases, please remain upwind of fire, and only attempt to extinguish fire if you can maintain safety for yourself and other personnel.

Attempt to extinguish or contain fire using a combination of CO2 extinguishers and sand.

If safe to do so attempt to remove nearby flammable objects to help minimize the risk of the fire spreading.

Contact EMS for assistance with fire mitigation.

Please refer to SDS supplied with the battery.

Warning: *Lithium batteries contain amazing energy density and fires will burn for prolonged periods of time and may re-ignite several hours after initially being extinguished.*

5.4. POTENTIAL THRUST LOSS

DGCS may present an alarm message "Potential Loss of Thrust". If this occurs during flight it may indicate a potential imminent motor failure or lack of control system stability. This alarm is triggered when the commanded control to one or more motor have saturated at full power. Should this alarm be present during flight the PIC shall immediately:

- Toggle to attitude flight mode
- PIC shall Reduce horizontal flight speed to less than 2m/s.
- PIC shall Stop climbing regardless of rate.
- PIC shall announce "Thrust loss, manual flight."
- PIC and VO shall monitor airspace and ground immediately below aircraft and identify potential emergency landing locations.
- PIC shall maneuver the aircraft back to launch or an alternative landing location at a slow horizontal speed of less than 2.5m/s and should avoid climbing.
- PIC shall continue manual flight and standard landing procedure at the target launch/landing location.

- Should the Potential Thrust Loss Alarm be during flight or is accompanied by an EKF alarm PIC shall perform an *Emergency Landing* at an alternative landing location that will allow for safe recovery of the aircraft.
- All flight operations with this aircraft MUST be suspended until the aircraft has been serviced and the cause of the alarm has been rectified.

> *Caution: Do NOT use Loiter or any automated flight modes including automated RTL features in the presence of this alarm.*

5.5. FLY AWAY

A Fly-Away scenario occurs when the aircraft is operating erratically, not following an automated mission and control cannot be regained by the PIC using either the HHC or DGCS. In this scenario the following procedures are recommended but may require variation depending on your specific aviation authority operating requirements:

- PIC announce, "Fly Away, Fly Away, Fly Away."
- PIC attempt to regain control by toggling flight modes, changing position and orientation of the HHC and/or GCS.
- VO notate the last reported bearing, altitude, velocity, and approximate flight time remaining.
- VO contact nearest aerodrome and notify of fly away.
- PIC and VO maintain visual contact as long as possible while attempting to regain PIC control.
- Attempt to recover aircraft.
- Complete *Post Crash* procedure
- Report as required to appropriate aviation authority.

5.6. DEGRADATION OF BAROMETRIC PRESSURE DATA

The aircraft uses multiple barometric pressure sensors to help manage altitude control. These sensors can be susceptible to drift and if the drift or known error increased beyond a set threshold the system will switch to the backup barometer. A degradation of barometric pressure data can typically be identified by undesired changes in altitude, usually a slow gradual change, this may also be accompanied by the error message "EKF Lane Switch" in DGCS.

If this error message is presented more than 3 times in a 30 second time frame, please follow procedures for *Mission Abort* and resolve the issue prior to continuing flight operations.

5.7. EMERGENCY LANDING

An emergency landing can be conducted at any point during the flight when deemed necessary by the PIC.

- PIC and VO shall review and identify a clear area that is safe for personnel to perform emergency landing.
- PIC shall announce "Emergency Landing, Emergency Landing, Emergency Landing."
- PIC shall toggle flight mode to Attitude Mode and maintain stable position and location.
- PIC shall give manual control inputs with HHC to reduce throttle to minimum position to descend aircraft as its max. descent rate.
- VO shall continue to monitor airspace and landing location to ensure it remains clear.
- Upon touch down perform standard landing motor shut down
- Upon recovery of aircraft perform *Post Crash Procedure*
- Report to aviation authority as required.
- Flight operations are to be suspended until the cause of emergency landing has been identified and resolved.

Note: Maximum descent rate: 2.5m/s

5.8. FLIGHT TERMINATION / EMERGENCY STOP

Flight termination may be initiated by the PIC at any point during flight operation when deemed necessary. Flight termination shut down all motors and allows the aircraft to free fall. PIC and VO must access the flight overfly area, and airspace to determine if continued flight, evasive maneuver, emergency landing, mission abort, or other recovery procedures will cause imminent and significant danger that will be mitigated only by flight termination. Flight Termination is only to be used as a last resort when absolutely necessary to prevent injury, loss of life or significant property damage.

- PIC shall toggle flight mode to Attitude mode.
- PIC shall attempt to maintain stable position and attitude.
- PIC and Observers shall assess the overfly area and ensure flight termination will not pose risk to personnel on the ground.
- PIC shall announce, "Terminate, Terminate, Terminate!"
    - With the HHC PIC shall move left control stick to lower left position and hold
    - After one second continue holding left control stick to lower left position and press the ***motor stop*** button

      ------------*Alternative control method*--------------
    - Within DGCS tap on the flight status icon on the top tool bar and select "Disarm"
    - Drag the confirmation slider at the bottom of the screen.
- Recover aircraft and follow ***post crash*** procedures.

Warning: Once initiated the Flight Termination procedure can NOT be aborted.

5.9. MISSION ABORT

The PIC and VO may opt to abort a mission if they identify that mission objective cannot be reasonably or safely achieved. Mission Abort will be determined by the operation manager and or PIC once determined the following procedure should be used.

- PIC should announce "Mission Abort."
- PIC should pause or suspend the mission either by toggling flight mode or selecting the "pause" command within DGCS.
- PIC may use *commanded return to launch* procedures or manual flight back to target landing zone and complete a procedural *landing/recover* and *shut down.*
- Flight crew should identify the cause for mission abort and resolve before continued flight operations.

5.10. FORCED EMERGENCY LANDING

Should the autopilot identify an immediate hazard or risk within its operating system during flight it may initiate a forced emergency landing. This flight state will often be accompanied by the alarm message "land mode" or "EKF Failsafe" along with additional possible error messages.

- During forced landing, the PIC and observer shall survey the airspace and landing area under the helicopter to determine if landing will cause a risk and if the system will be recoverable
- PIC should override the forced landing by toggling flight mode and increasing throttle to maintain altitude or climb.
- PIC shall manually fly back using Attitude Mode to a safe landing location and perform a standard *landing/recovery*
- If the aircraft becomes difficult or unreliable to control or navigate the PIC shall follow *emergency landing* procedures.

5.11. CRITICAL BATTERY FAIL SAFE

Battery voltage alarms are set fairly conservatively, and will usually provide adequate energy to safely land. Upon reaching a low power level the aircraft present a persistent low battery alarm to in DGCS. Upon receiving this alarm, the PIC should perform mission abort and plan for return to launch and recover.

If the low voltage alarms are ignored or the battery reaches critical voltage level the aircraft will present a Battery Fail Safe alarm and initiate a forced landing at a descent rate of 2.5m/s

Please refer to the *Forced Emergency Landing* procedures

Warning: PIC shall adhere to all low voltage alarms and cautions presented by the system to prevent reaching a critical voltage state.

5.12. LOSS OF VISUAL NAVIGATION AIDS

Visual navigation aids can include components such as navigation lighting, FPV targeting camera or primary payload camera. These components have no impact on flight performance however the loss of one or more of these aids will result in increased difficulty for the PIC and VO to visually determine behaviour, heading and attitude of the aircraft. If, at the sole discretion of the PIC, flight operations can be safely continued the PIC may choose to continue flight operations with remaining navigational aids.

If the PIC feels continued operation is not reasonable, please follow *mission abort* procedures.

Any failed or damaged visual navigation aid components will be serviced prior to future flight operations.

5.13. FAILURE OR LOSS OF MAGNETOMETER DATA (COMPASS)

A compass or magnetometer error or degradation of data quality will often present itself as a gradual change or drift to the aircrafts actual or reported heading. This error or drift will grow or increase over time and in severe cases this drift will become extreme resulting in a divergence from the desired flight path or position following a "toilet bowl" or circular oscillation. This error will present itself when operating in flight modes that rely on GPS (i.e. Loiter, guided, auto, RTL). The error may be accompanied by an error message similar to "compass error", "yaw alignment error", or "mag anomaly."

- The PIC shall immediately toggle to Attitude flight mode.
- PIC shall announce "Manual flight."
- PIC should observe procedures for *mission abort,* and/or *landing/recovery.*
- Cause of the error shall be determined and resolved prior to continued flight operations.

Note: typical cause of this error is an erroneous compass calibration or localized magnetic interference (large metal structures, local geology). Perform compass calibration prior to next flight.

Caution: continuation of flight without resolving the above error may result in erratic and uncontrollable flight conditions. Do NOT attempt to use any automated flight modes during this scenario.

5.14. FAILURE OR DEGRADATION OF GNSS SIGNAL

Loss of or degradation of the GNSS signal during flight is often cause by a hardware failure however it does not always indicate a system failure and does not pose an immediate emergency. This can be caused by a number of factors including environmental interference, GNSS outages or signal obstruction from obstacles or terrain. An alarm may be presented on DGCS to indicate the GNSS signal loss and may include the alarm "EKF Failsafe."

In the event that the aircraft is in an automated flight mode (i.e. Guided, Loiter, Auto) it will begin a *forced emergency landing.*

In the event that the aircraft is in Attitude mode the alarms will be given and no automated action will be taken.

- PIC shall immediately verify that the flight mode is set to Attitude mode.
- PIC shall maintain a stable position and attitude.
- PIC and VO shall verify the cause of the alarm as being due to GNSS failure.
- PIC may choose to continue flight operations using Attitude flight mode if determined operation can be conducted safely.
- PIC should follow standard *landing/recovery* procedures.
- Aircraft should be inspected to determine and resolve the cause of the issue prior to continued flight operations.

Caution: do not attempt to operate using automated flight modes until this failure has been resolved, doing so may result in erratic flight performance and crash.

5.15. FAILURE OF TERRAIN RANGER FINDER

This will largely go unnoticed but may present the alarm "bad/no terrain data". If this occurs during flight, operation may be continued at the PIC's discretion provided no erratic flight behaviours or additional errors/alarm are observed. The failure of the terrain range finder may result in hard landings using Auto, RTL, or Guided flight modes.

- Prior to landing PIC shall toggle flight mode to Attitude or Loiter flight mode and observe standard procedures for *mission abort,* and/or *landing/recovery.*
- The aircraft should be inspected and serviced prior to continued flight operations to resolve the issue.

5.16. LOSS OF C2 LINK

In the event of a loss of communication link between the GCS and aircraft, depending on the failure an alarm may or may not be presented within DGCS. The alarm will be similar to "communication lost" and "return to launch."

If the communication link is not re-established within 5 seconds the aircraft will enter a communication loss fail safe mode during which it will initiate a return to launch flight mode to return to its takeoff location, land, and disarm the motors.

- PIC shall attempt to regain communication by changing orientation and position of the GCS and HHC and verify all antenna connections are secure.
- PIC shall announce "Comm Loss, Comm Loss, Comm Loss."
- While the aircraft is performing the return to launch action PIC and VO shall continue to scan airspace and overfly to ensure clear.
- If the comms link is regained the RTL, the PIC should toggle flight mode and follow standard procedures for *landing/recovery.*
- After landing following standard procedures for *shut down.*

- Aircraft shall be inspected, and the cause of comms loss resolved prior to continued flight operations.

  Caution: the Return to Launch fail safe will only function if the aircraft had established a GPS lock prior to takeoff. If this GPS lock was not achieved prior to takeoff the aircraft will perform a forced emergency landing at its current location.

  Caution: The Return to Launch fail safe will operate at the altitude settings defined by the user during preflight planning.

5.17. STRUCTURAL FAILURE

The autopilot is not able to monitor structural components on the UAV and will not provide an alarm or warning message to the PIC and VO. Failure of any component critical to flight will have an immediate effect and will result in an imminent unavoidable crash.

- PIC shall announce "Crash, Crash, Crash!"
- PIC and VO shall maintain VLOS to aid with recovery.
- Follow *post crash* procedures.
  Structural failure of any component that is non-essential to flight will likely go unnoticed until the completion of the flight operation and the *post-flight inspection*. If a structural failure is noticed or suspected by the PIC, VO or any crew member, the PIC shall follow procedures for *mission abort*, and/or *landing/recovery.* Any and all damaged components or failures shall be diagnosed and resolved prior to continued flight operations.

5.18. ERRATIC OR DEGRADED FLIGHT PERFORMANCE

Erratic or degraded flight performance may be identified by but not limited to unexpected and uncontrolled movements, uncorrected deviation from the target position, flight path, altitude, or heading, or a lack of response to control inputs and commands. In the event of erratic flight performance flight operations shall immediately be concluded.

- PIC shall immediately toggle flight modes to Attitude mode.
- PIC shall attempt to manually navigate the aircraft to the target landing location and follow procedures for *landing/recovery.*
  - *Note: only perform this return to target landing if the PIC has confident control over the aircraft*
- If the aircraft continues to be difficult or unreliable to control or navigate the PIC shall follow *emergency landing* procedures.
- Follow *post crash* procedures.
- The aircraft shall be inspected and serviced to resolve any issues prior to continued flight operations.

5.19. POST CRASH PROCEDURE

Following a crash please use caution and discretion to triage actions as needed.

- PIC shall perform the emergency stop action to stop all motors.
- PIC shall ensure the aircraft is disarmed.
- Assess any potential personnel injuries and treat accordingly.
- Document the last reported location of the aircraft.
- Approach the crashed aircraft carefully.

  Warning: the immediate risks are battery fire and motor/propellers still running. Please review the battery safety chapter
- Capture photos or video of the crash site and any actions taken.
- if smoke is present at the crash site, allow the fire to burn out while attempting to mitigate the spread of fire. Immediately contact emergency services for support with fire suppression.
- If the aircraft is still powered on make note of any audible tones, navigation light patterns or indicator light patterns.
- Attempt to power off the aircraft using standard power off process.
- Remove flight batteries from the aircraft and follow quarantine instructions detailed in the battery safety chapter.
- Do NOT attempt to power on any if the crashed equipment including payloads.
- Do Not attempt to use or charge the flight batteries until inspected as per battery safety instructions.
- Capture photos of and make note of the aircraft's orientation and any damaged components.
- Document the incident in your flight logbook.
- initiate any required reporting for regulatory agencies.
- complete a crash report document with a much detail as possible.
- attempt to recover digital logs from the aircraft flight controller, front and rear power boards. (see ***maintenance procedures***)
- report the incident to Draganfly Innovations support team providing any images, video, and log files captured.

Note: a tip for recovery if the crash occurred at a significant distance. Make a note of a geographical feature or landmark in the distance beyond the crash location and walk straight toward this point.

Note: any medical needs or injuries shall take precedence over all other recovery, diagnostic, or reporting actions.

5.20. OBJECT STRIKE/COLLISION

In the event of an inflight collision or loss of separation with an object (i.e. tree, bird, tower, etc.), there is high likelihood that an imminent crash will occur.

In the event of a crash please follow *Post Crash* procedures.

If the aircraft is still operable after the collision, please refer to procedures for *Erratic or Degraded Flight Performance.*

5.21. PILOT INCAPACITATION

In the event of pilot incapacitation, the VO or other Flight Crew member that is qualified for operation of the aircraft shall issue a *Commanded Return to Launch* using DGCS flight software and follow all applicable SOP's and EOP's as required.

Medical attention shall be given to the PIC as quickly as possible.

Complete any required documentation and reporting.

6. FAILSAFE

Draganfly aircraft are equipped with several failsafe features that help mitigate the risks associated with operating a UAV.

6.1. LOW BATTERY FAILSAFE

In the event of a low battery condition (<30% or < 43.4V) the aircraft will issue constant warning messages but will not (by default) take any action. It is up to the user to return the aircraft at their discretion.

6.2. CRITICAL BATTERY FAILSAFE

In the event of a critical battery condition (<10% or < 42.3V) the aircraft will switch to land mode and land in place. This is a considered a critical event and must be dealt with immediately. If GPS is available, then autopilot will maintain position while in land mode.

6.3. RC FAILSAFE

In the event that control information from the HHC is lost, the aircraft will entry RTL mode (if GPS available) or land mode (if no GPS). The message "RC failsafe on" will be presented in DGCS if communications with DGCS is still available.

It is important to distinguish that this represents a loss of information from the flight controls (sticks and switches) and not necessarily loss of communication to DGCS. Depending on which GCS is used these may or may be concurrent events.

6.4. EKF FAILSAFE

This warning issued by DGCS in the event of a critical system failure in the aircraft that could compromise state estimation. The most likely cause is loss of GPS. The standard action automatically performed is to enter land mode.

6.5. GEOFENCE

A geofence may be configured within DGCS such that if this fence is breached an action, usually RTL, may be performed in response. The geofence is simply represented as a distance from the home point so can only have a circular shape. This is useful for preventing inadvertent operation beyond a certain distance from the home point.

APPENDICES

A. PRE-FLIGHT CHECKLIST

Must be completed prior to each flying session, flying session defined as a series of flight at the same location with the same aircraft and payload for the same operational goal. Below items should be considered best practice and should be incorporated into an organizational level flight operations policy and flight planning documentation.

Inspection	Completed By	Details
Perform UAV system Physical Inspection		
Complete Site Survey		
Organizational Approval for Flight		
Aviation Authority approval for Flight		
Weather Conditions are with operating limitations		
RTL behaviour and altitude have been set to:		
Geofence has been set to:		
Ceiling Limit has been set to:		
Documentation required by aviation authority are on hand		
Automated Flight Plan has been created and approved		

B. PRE-FLIGHT CHECKLIST

The following inspections shall be completed prior to *each* takeoff/launch of the aircraft and shall be considered best practice to incorporate into organizational level flight operations policy and flight planning documentation.

Inspection Task	Completed By	Details
Pre-Flight Checklist completed		
Perform Avionics Functionality Check		
Verify Payload Functionality		
Payload is securely installed		
Verify automated mission loaded (if applicable)		
Verify motor response and shutdown		
Check antennas on aircraft are secure		
Check propellers are secure		
Check arm latches are secure		
Verify GPS HDOP is lower than 1.7		

C. POST-FLIGHT CHECKLIST

The below template should be considered as best practices for inclusion into organization level flight operations and planning documentation.

Payload data recording stopped	
Payload powered off	
Aircraft powered off	
Flight batteries removed	
Close DGCS flight software	
Power off GCS and HHC	
Remove payload	
Perform physical inspection on aircraft	
Complete required flight logbooks and report	
Backup data logs from aircraft	
Complete any regulatory reporting as needed	

D. SITE SURVEY TEMPLATE

The below template should be considered as best practices for inclusion into organization level flight operations and planning documentation.

Center point of Target Flight Location (legal address or Lat/Long)	
Radius of target flight area	
Max. Target altitude	
Airspace classification	
FIC location and phone	
Bearing and Distance to nearest aerodrome	
Designation and Contact phone for nearest aerodrome	
Location of nearest medical center	
Emergency services contact phone	
Details including height and proximity of obstacles in target flight area	
Details including proximity and type of any nearby potential RFI or EMI sources	
Details of any potential hazards to flight ops or personnel	
Details of any additional safety precautions required	
Details of any regional NOTAM's impacting flight operations	