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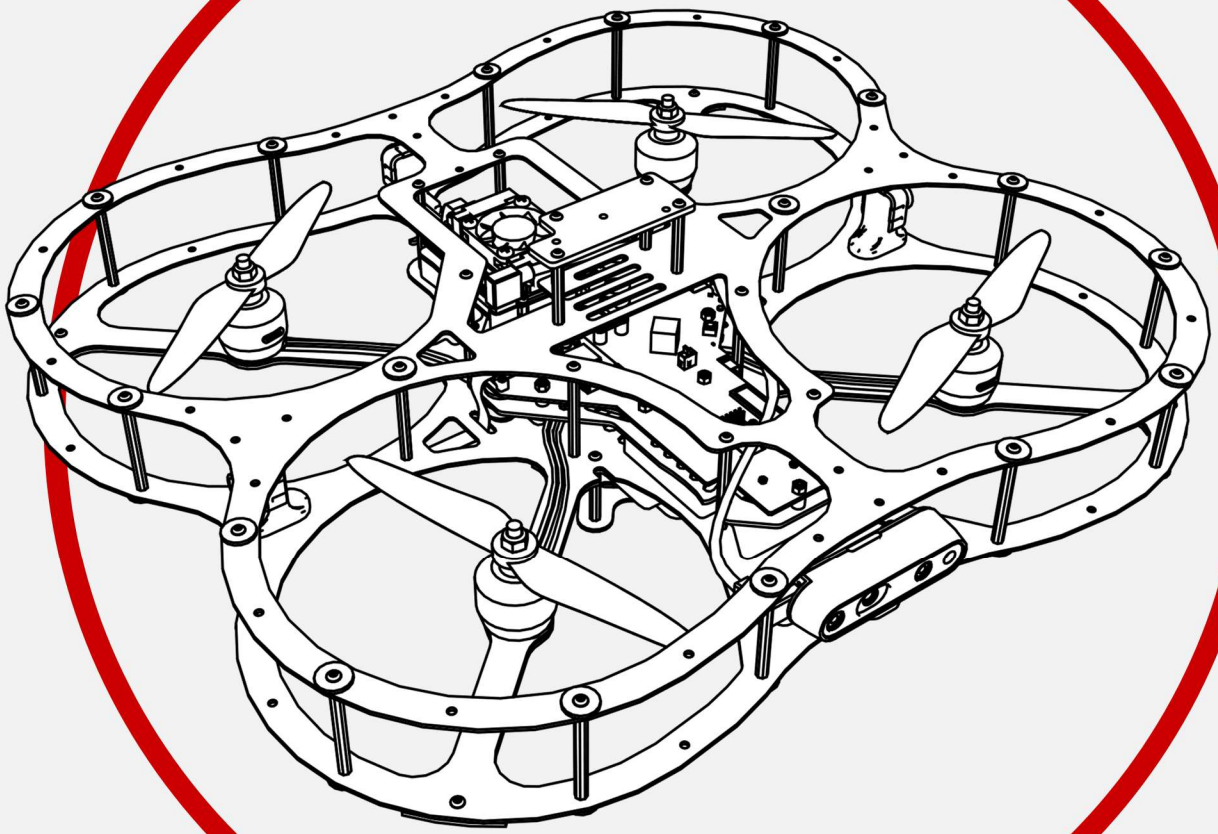


# Autonomous Vehicles Research Studio

## Setup Guide–QDrone 2 Hover Test

*v* 2.0 – 18*th April* 2023

For more information on the solutions Quanser offers,
please visit the web site at: http://www.quanser.com

Quanser Consulting Inc.
119 Spy Court
Markham, Ontario
L3R 5H6, Canada

info@quanser.com
Phone : 19059403575
Fax : 19059403576
printed in Markham, Ontario.



Caution

**This equipment is designed to be used for educational and research purposes and is not intended for use by the public.** The user is responsible for ensuring that the equipment will be used by technically qualified personnel only. **NOTE:** While the GPIO, and USB ports provides connections for external user devices, users are responsible for certifying any modifications or additions they make to the default configuration.

**FCC Notice** This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.
**Note:** This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.
**Contains FCC ID: SQG-60SIPT**

**Industry Canada Notice** This Class A digital apparatus complies with CAN ICES-3 (A). Cet appareil numérique de la classe A est conforme à la norme NMB-3 (A) du Canada.
**Contains IC: ST60-2230C-PU**

**Waste Electrical and Electronic Equipment (WEEE)**

This symbol indicates that waste products must be disposed of separately from municipal household waste, according to Directive 012/19/EU of the European Parliament and the Council on waste electrical and electronic equipment (WEEE). All products at the end of their life cycle must be sent to a WEEE collection and recycling center. Proper WEEE disposal reduces the environmental impact and the risk to human health due to potentially hazardous substances used in such equipment. Your cooperation in proper WEEE disposal will contribute to the effective usage of natural resources.

CE Compliance CE

This product meets the essential requirements of applicable European Directives as follows:

- 2014/35/EU; Low-Voltage Directive (safety)
- 2014/30/EU; Electromagnetic Compatibility Directive (EMC)
- 2014/53/EU; Radio Equipment Directive (RED)

**Warning**: This is a Class A product. In a domestic environment this product may cause radio interference, in which case the user may be required to take adequate measures.

Caution

**During flight QDrone 2 sound pressure level has been measured at 92 dBA at 1m away from the QDrone 2 and it is considered hazardous. Users shall ensure that they are not exposed to a sound level greater than the hazardous level as defined by the local authority. Use protective earpieces during operation.**

Caution

The Intel RealSense D435 RGB-D camera is classified as a Class 1 Laser Product under the IEC 60825-1, Edition 3 (2014) internationally and EN 60825-1:2014+A11:2021 in Europe. The camera complies with FDA performance standards for laser products except for conformance with IEC 60825-1 Ed. 3 as described in Laser Notice No. 56, dated May 8, 2019.
Do not power on the product if any external damage is observed. Do not open or modify any portion of any laser product as it may cause the emissions to exceed Class 1. Invisible laser radiation when opened. Do not look directly at the transmitting laser through optical instruments such as a magnifying glass or microscope. Do not update laser product firmware unless instructed by Quanser.

**Regular maintenance of QDrone 2:**

- Inspect the propellers before flight to confirm they are not damaged or loose (able to move while the motor is not moving).
- Prior to using the QDrone 2, visually inspect the LiPo battery for damage (e.g., bloating). **DO NOT USE** the battery if damaged.
- Ensure that the battery and its cables are secured using the provided straps to avoid movement or damage during flight.
- Inspect the QDrone 2 frame before and after each flight to confirm that no major structural damage exists. Repair if needed.

# Table of Contents

# A. Before the Hover Test

At this point, all the checkpoint tasks outlined in the table below should have been completed.

1. Your localization system should have been set up and functional.
2. You should be comfortable setting up and using the FrSky Taranis X9 Lite S Joystick
3. Your ground control station PC should be set up and functional.
4. The communication infrastructure between the ground control station PC, router and vehicles should be functional.

**Note:** Please contact the Quanser Engineer supporting you to start planning the commissioning and training process.

| Step | Done? | Section |
|---|---|---|
| **1** | ☐ | Set up Workspace with Nets |
| **2** | ☐ | Mount OptiTrack Cameras |
| **3** | ☐ | Ground PC Setup (Connecting All Components) |
| **4** | ☐ | Software Licensing and Testing (Sine Scope Demo) |
| **5** | ☐ | Joystick Testing and Visualization Demo |
| **6** | ☐ | Connectivity PC-Router-Vehicles (TCP/IP Demo and Vehicle Communication) |
| **7** | ☐ | Camera Orientation and Calibration |
| **8** | ☐ | Rigid Body Definition (OptiTrack Visualization Demo) |
| **9** | ☐ | Vehicle I/O Check |

The Hover Test for the drones is a test to ensure that all the components work together. The model will retrieve localization data from the Optitrack camera system. The user will issue commands via the joystick and a model running on the ground control station PC will forward the Optitrack camera data and joystick commands to a model running on the QDrone. The QDrone will be commanded to Arm, Takeoff, Land and Disarm, and will complete a Hover cycle in the process.

## B. QDrone 2 Hover Check

**Ensure that the QDrone 2 IO Check has been run successfully before attempting to run this model.**

1. Ensure that the Optitrack cameras have warmed up for 15-30 minutes. You can warm them up by keeping Motive open. If you have not calibrated the Optitrack cameras lately, do that first and define/export the Drone's rigid body before continuing.
2. Plug in and fasten a battery and turn ON the QDrone 2 using the red button. Place it at the center of the workspace with the front camera pointed away from the ground PC. Ensure that the ESC disable switch is turned **OFF** (that is, the ESCs are **ENABLED**, which is indicated by a **green LED lit** next to the switch) (Figure 1). Ensure netting is secured. Put on SAFETY GOGGLES. Note the IP in the LED screen after startup.

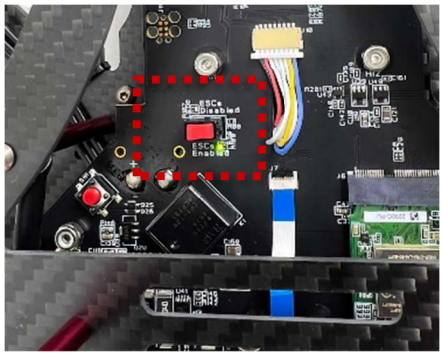



Figure 1. ESCs Enabled (motors allowed to spin)

3. From the same folder containing this file, open the folder QDrone 2 Hover Test, and open QD2_DroneStack_PID_2021a.slx (Figure 2).

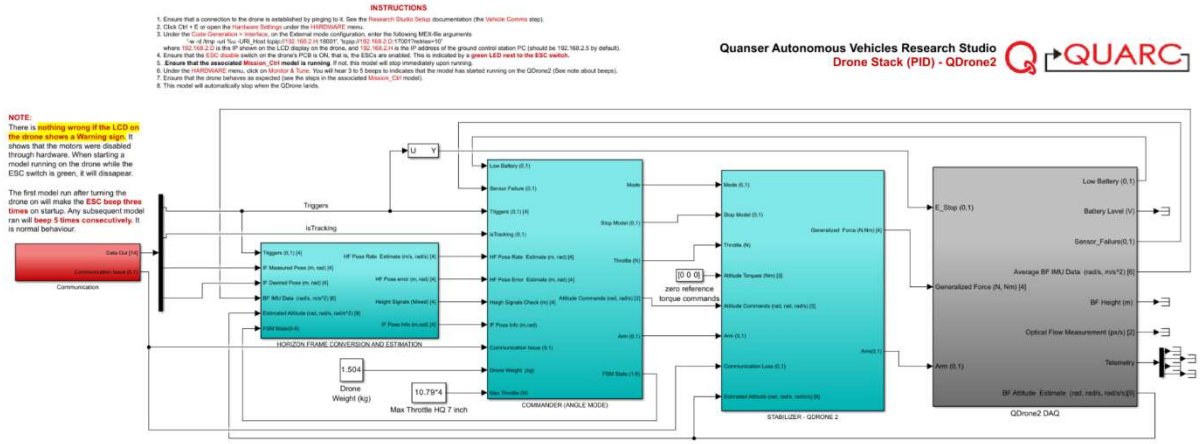



Figure 2. Drone Stack Model

4. In the model that loads, from the **HARDWARE** tab on top of your Simulink model, click on **Hardware Settings** (Gear Icon). (If using an older version, click on **Model Configuration Properties** under the **Simulation** drop menu.)

5. Expand **Code Generation** on the left side of the window, click on **interface** and set the **MEX-file arguments** (Figure 3) as follows

```
'-w -d /tmp -uri %u -URI_Host tcpip://192.168.2.H:18001','tcpip://192.168.2.D:17001?retries=10'
```

where 192.168.2.D refers to the IP address of the QDrone 2 you are using (found on the LCD screen). 192.168.2.H refers to the IP address of the ground control station PC (you can find this by typing ipconfig in the command prompt) (this is set to 192.168.2.5 by default). Press OK.

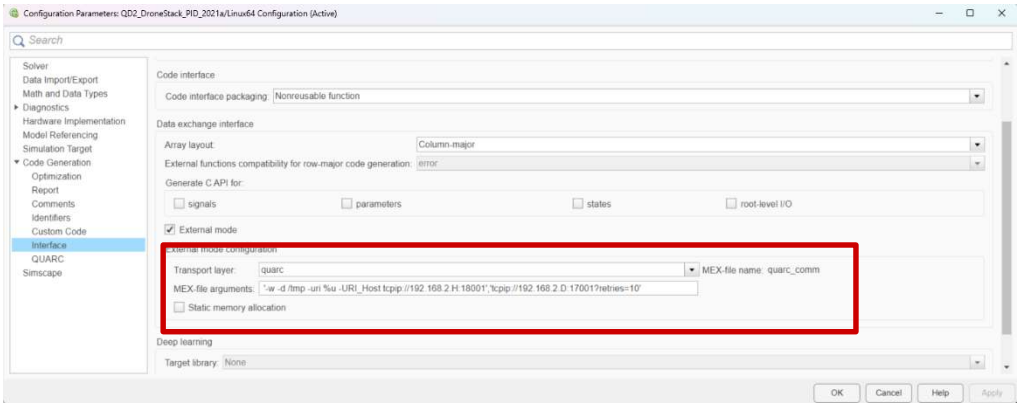



Figure 3. Model Configuration Parameters in the Drone Stack Model

6. Ensure that a connection to the drone is established by pinging to it. See the vehicle communication document for more information.

7. Open a different MATLAB instance and from this window, in the same folder containing this file, open the folder QDrone Hover Test, and open QD2_MissionCtrl_Hover_2021a.slx (Figure 4).

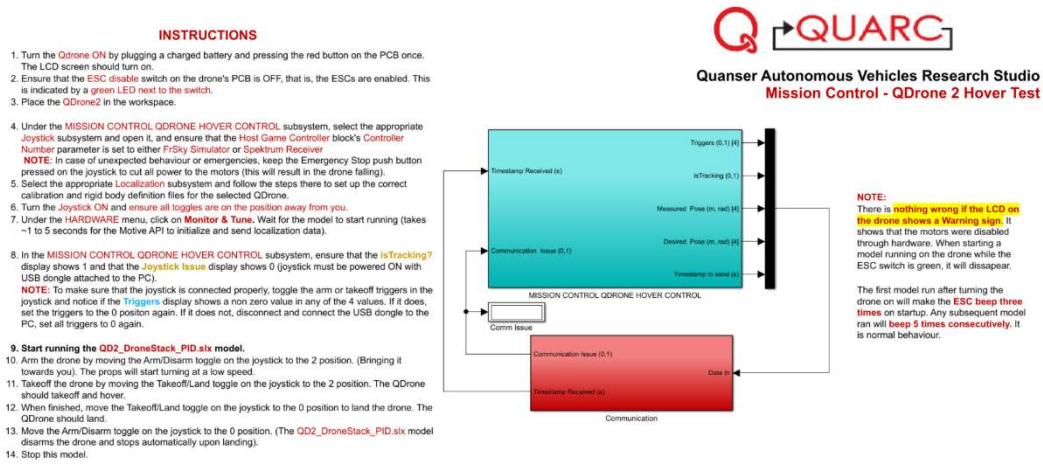
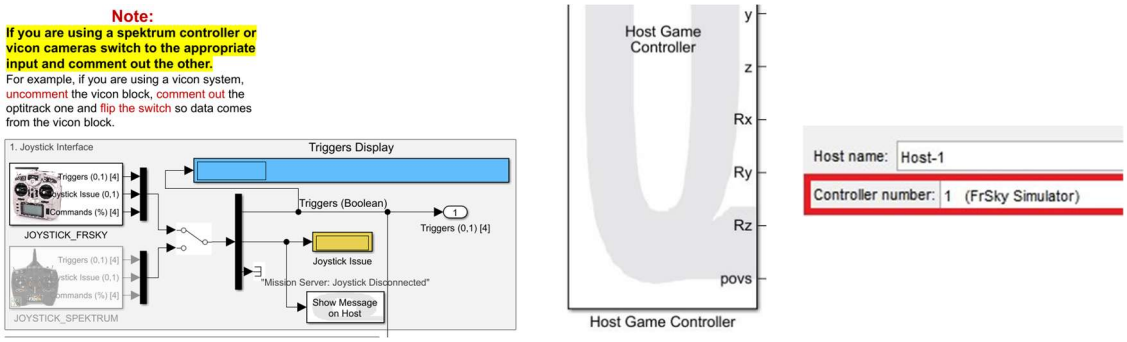



Figure 4. Mission Control Model

8. Ensure that the joystick is turned **ON** by pressing the on button in the center for a couple seconds until the Quanser logo appears and make sure the **USB dongle is plugged** into the ground control station PC. Make sure all toggles are in the position away from you.

9. In the model that loads, under group 1 (Joystick Interface) select the appropriate **JOYSTICK** subsystem (Figure 5a), the instructions on switching them are in the note above the subsystem. Open the subsystem for your joystick (should be uncommented and the other one should be commented out), and double-click on the **Host Game Controller** block (Figure 5b). Ensure that the **Controller number** (Figure 5c) drop down menu is set to the appropriate joystick, either **FrSky Simulator** or **Spektrum Receiver.**




a. Joystick selection and functionality

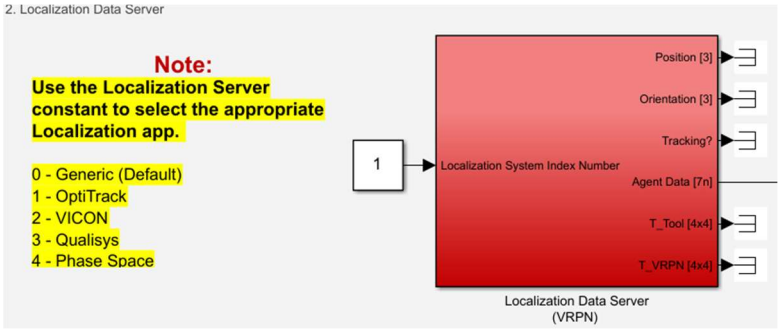
b. Host game controller

c. Setting controller number

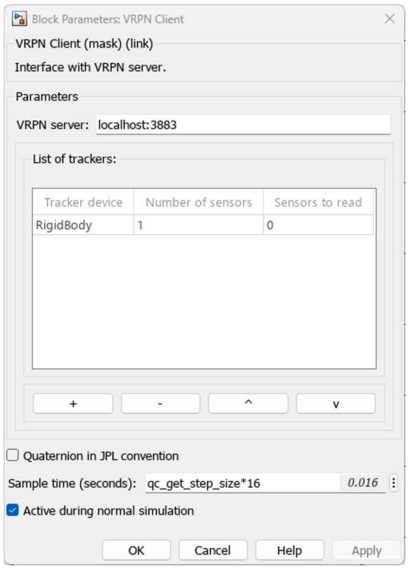
Figure 5. Selecting a Joystick in the Mission Control Model

**NOTE:** In the case of unexpected behaviour or emergencies, keep the Emergency Stop push button pressed on the joystick to cut power to the motors (this will result in the drone falling).

10. Use the **Localization System Index Number** to specify the appropriate Localization system in group 2.




a. Group 2 motion capture system selector




b. Tracking device name definition

Figure 6: Localization data server

Inside the Localization Data Server doble click the VRPN client block and ensure the **Tracker device** name matches the device names defined in the motion capture system.

11. On the Mission Control model, click on the **HARDWARE** tab on the top menu, and then click the green play button (**Monitor & Tune**), It should build and start the model. If you have an older version of Simulink that does not have a Hardware tab, under the **QUARC** drop down menu, click **Build** and once it finishes click **Start**.

12. Ensure the mission control starts running by checking the simulation time bar at the bottom right of the model (figure 7).


Figure 7. Simulation Time bar showing current time stamp

13. In the main diagram in the Localization Data Server area, ensure that the **isTracking?** Display reads 1. (Means drone is being tracked by localization system.)

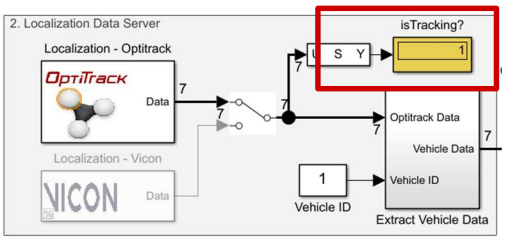



Figure 8. Is tracking display to confirm drone is being tracked

14. Ensure that the **Joystick Issue** display (Figure 10) reads 0 (no joystick issues). Ensure that all the toggles are set away from the user (see FrSky Joystick documentation). Make sure that the joystick's Arm/Disarm toggle is set as in Figure 9a and the Takeoff/Land toggle is set as in Figure 9c.

a. Disarm b. Arm c. Land d. Takeoff

Figure 9. Joystick Arm/Disarm toggle (a and b) and LED toggle (c and d)

15. Move the Arm toggle towards the user (Figure 9a) and make sure that the first position of the triggers display show a 1. Once it does, switch it back to the disarm state (Figure 9b). Seeing the change means that the joystick is working, if it does not change, remove the joystick USB from the computer and connect it again.

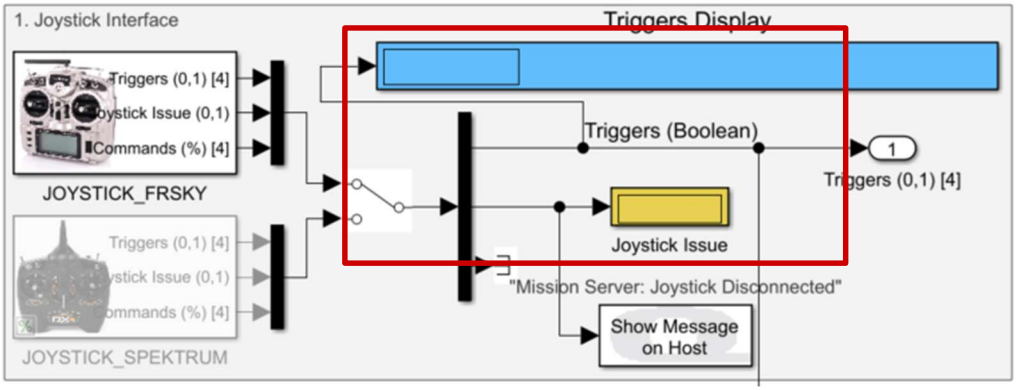



Figure 10. Triggers Display and Joystick Issue

16. Follow step 11 again but switch to the **DroneStack** model and start it.
17. The first model run after turning the drone on will make the **ESC beep three times** on startup. Any subsequent model ran will **beep 5 times consecutively.** It is normal behaviour. It signifies that the ESCs are **ENABLED** and that the **DroneStack** model is running on the drone.
18. After 2 seconds (initialization period), switch the **Arm/Disarm** toggle to 2 (towards the user) (Figure 9b). This should arm the drone and the motors should start spinning slowly. This is QDrone's **Armed** state.
19. Switch the **Takeoff/Land** toggle on the joystick to the 2 position (towards the user) (Figure 9d). The drone should takeoff and hover at the center of the workspace at the height of about 1m.
20. Make sure the drone can hover for a couple of minutes.
21. When ready to land the drone, move the **Takeoff/Land** toggle back to 0 (Figure 9c). The drone should slowly land at the center of the workspace.
22. Move the **Arm/Disarm** toggle to 0 (Figure 9a). The DroneStack model should automatically terminate. The MissionCtrl model will throw an error since the Drone has been disconnected, this is expected. Stop that model.

This completes the **QDrone 2 Hover check** task and confirms that your Autonomous Vehicles Research Studio is functioning correctly (including the Optitrack Localization System, Ground Control Station PC as well as QDrones). If you have any errors, make sure that all the steps prior to this checkpoint have been followed. If further issues persist, please contact Quanser technical support (tech@quanser.com).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