Aero 2 Lab Procedure
Hardware Interfacing

Setup

1. Make sure the Aero 2 has been tested as instructed in the Quick Start Guide.
2. Launch MATLAB and browse to the working directory that includes the Simulink models for this lab.
3. Configure the Aero 2 in the 1 DOF pitch-only system:
    a. Unlock the pitch axis and lock the yaw axis.
    b. Both rotors are horizontal.
    c. Adjust weights on rotors so the Aero 2 body sits level.
4. Connect the USB cable to your PC/laptop.
5. Connect the power and turn the power switch ON. The Aero base LED should be red.

Motor Control

1. In this lab, we will make a Simulink model using QUARC blocks to drive the DC motor in thruster 0 and measure the corresponding angular velocity, similar to what is shown in Figure 1.

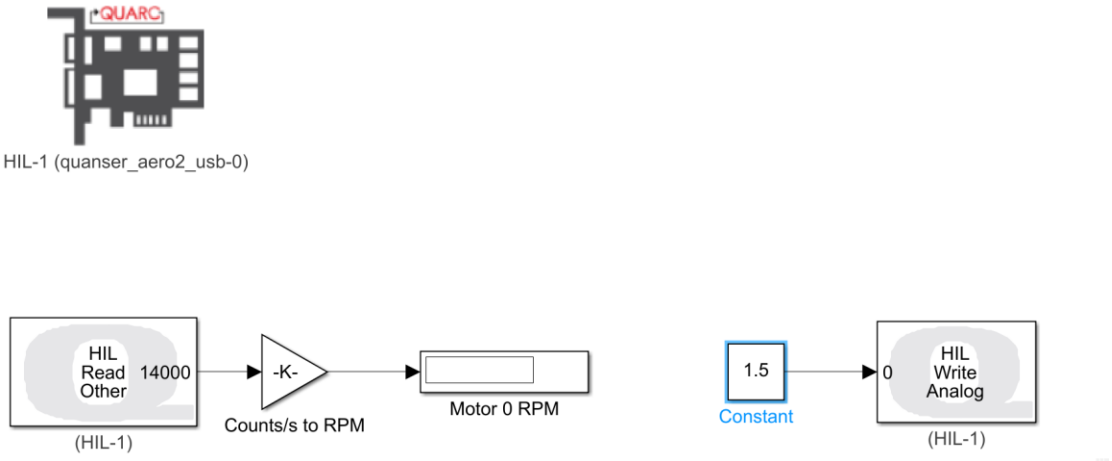

Figure 1: Simulink model used with QUARC to drive motor 0 and read the tachometer on Aero 2

Configuring Simulink Models for Aero 2

Follow these steps to build a Simulink model that will interface to the Aero 2 using QUARC.

1. Launch the Simulink Start Page by typing *simulink* in the command window in MATLAB.
2. Under the QUARC templates section, select and launch Blank QUARC Model.

3. Open the *Simulink Library Browser* 

window by clicking on the Simulation tab and opening the Library Browser item in the Simulink ribbon.

4. Expand the *QUARC Targets* item and go to the Data Acquisition | Generic | Configuration folder, as shown in Figure 2.

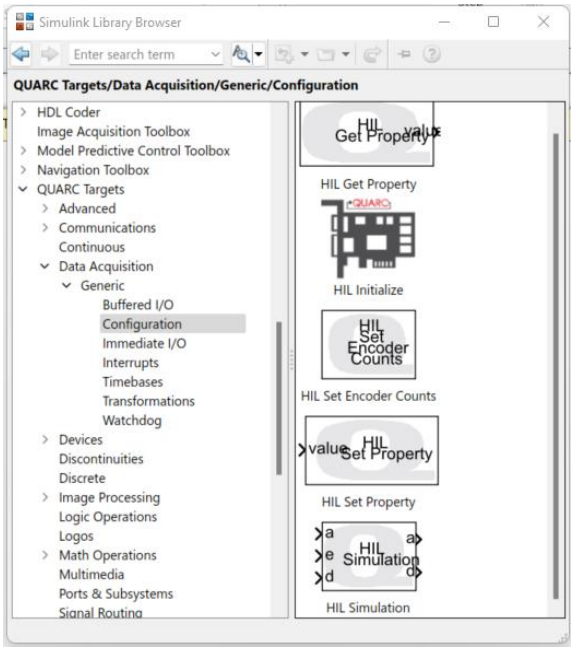

Figure 2: Simulink Library Browser QUARC Target Configuration Blocks

5. Click-and-drag the *HIL Initialize* block from the library window into the blank Simulink model. The block is used to configure your data acquisition device.

6. Double-click on the *HIL Initialize* block.

7. Make sure the Aero 2 is connected to your PC USB port and powered ON (the 24V Power should be plugged in and switched flipped to ON and USB Power LED should be lit).

8. In the Main tab, change the *Board type* field to select *quanser_areo2_usb*. Click the Defaults button and click Apply and then OK to close the window.

9. Go to the QUARC tab in the ribbon and select *QUARC targets* and select *quarc_win64.tlc* this will set the default options to the correct Real-Time parameters and set up the Simulink model for external use (as opposed to the simulation model).

10. In the QUARC ribbon click *Build for Monitoring*. Various lines should appear in the Diagnostic Viewer Window and should be displayed after the model is compiled. This creates a QUARC executable file (.rt-win64) which we will commonly refer to as a QUARC controller.

11. Run the QUARC controller by clicking the *Deploy* button and finally the *Connect* button. Then click *Start*. You can also do all four of these steps (Build, Deploy, Connect, and Start) in one step by clicking the *Monitor & Tune* button. The status LED strip on the Quanser Aero 2 should be green after the model starts.

12. If you successfully run the QUARC controller without any errors, then you can stop the code by clicking on the *Stop* button.

Driving a DC Motor

1. Add the *HIL Write Analog* block from the Library Browser | QUARC Targets | Data Acquisition | Generic | Immediate I/O category into your Simulink diagram. This block is used to output a signal from analog output channel #0 on the data acquisition device. This is connected to the onboard PWM amplifier which drives the DC motor in thruster 0.
2. Add the *Constant* block found in the Library Browser | Simulink | Sources folder to your Simulink model. Connect the Constant and HIL Write Analog blocks together.
3. Build and run the QUARC controller.
4. Set the *Constant* block to 1.5. This applies 1.5 V to the DC motor in the Quanser Aero.

Reading the Tachometer

Follow these steps to read the tachometer:

1. Using the Simulink model you configured for the Aero 2 in the previous section, add the *HIL Read Other* block from the QUARC Targets | Data Acquisition | Generic | Immediate I/O category in the Library Browser.
2. Double click on the *HIL Read Other* block. In the Source Block Parameters dialog which opens, under Channels enter the number 14000 as shown in Figure 4.

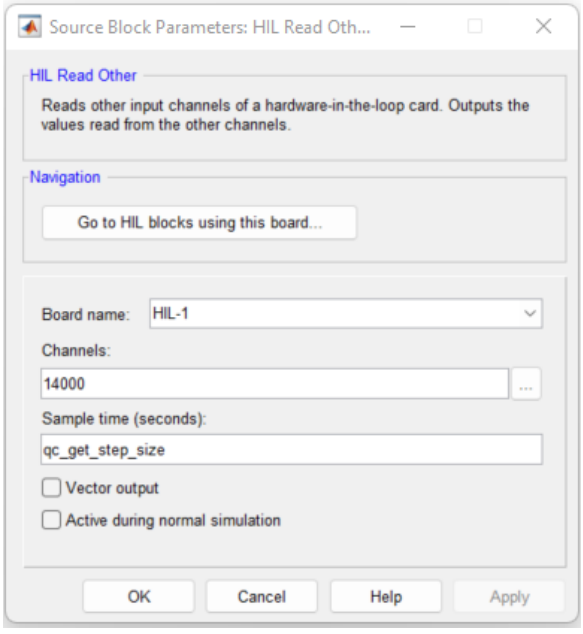

Figure 4: HIL Read Block Configuration

3. Connect the HIL Read Other to a Gain and Display block similar to Figure 1. The *Gain* however can be left at 1. In the Library Browser, you can find the Display block from the Simulink | Sinks and the Gain block from Simulink | Math Operations.
4. Build and Run the QUARC controller by clicking the Monitor and Tune button.
5. Set the *Constant* block to 15. This applies 15 V to the DC motor in the Quanser Aero 2. Confirm that we are obtaining a positive tachometer measurement when a positive signal is applied. This convention is important, especially in control systems when the design assumes the measurement

goes up positively when a positive input is applied. When a positive voltage is applied, does the propeller accelerate the air downwards or upwards?

6. Ultimately we want to display the propeller speed in revolutions per minute, not counts per second. Set the *Gain* block to a value that converts counts/s to RPM using the concept reviews highlighted in the Application Guide to determine the counts per revolution. This is called the sensor gain. Run the QUARC controller and confirm that the *Display* block shows a tachometer reading of approximately 1800 RPM at 15V.

7. Measure the relationship between the motor voltage (in the range of 0-24V) and propeller speed.

8. Stop the QUARC controller. Turn OFF the Aero 2.