Lab Procedure
Hardware Interfacing Virtual

Introduction

1. Make sure you have Quanser Interactive Labs open in the Qube 3 - DC Motor → Servo Workspace.
2. Launch MATLAB and browse to the working directory that includes the Simulink models for this lab.

In this lab, we will make a Simulink model using QUARC blocks to drive the DC motor and then measure its corresponding angle – as shown in Figure 1.

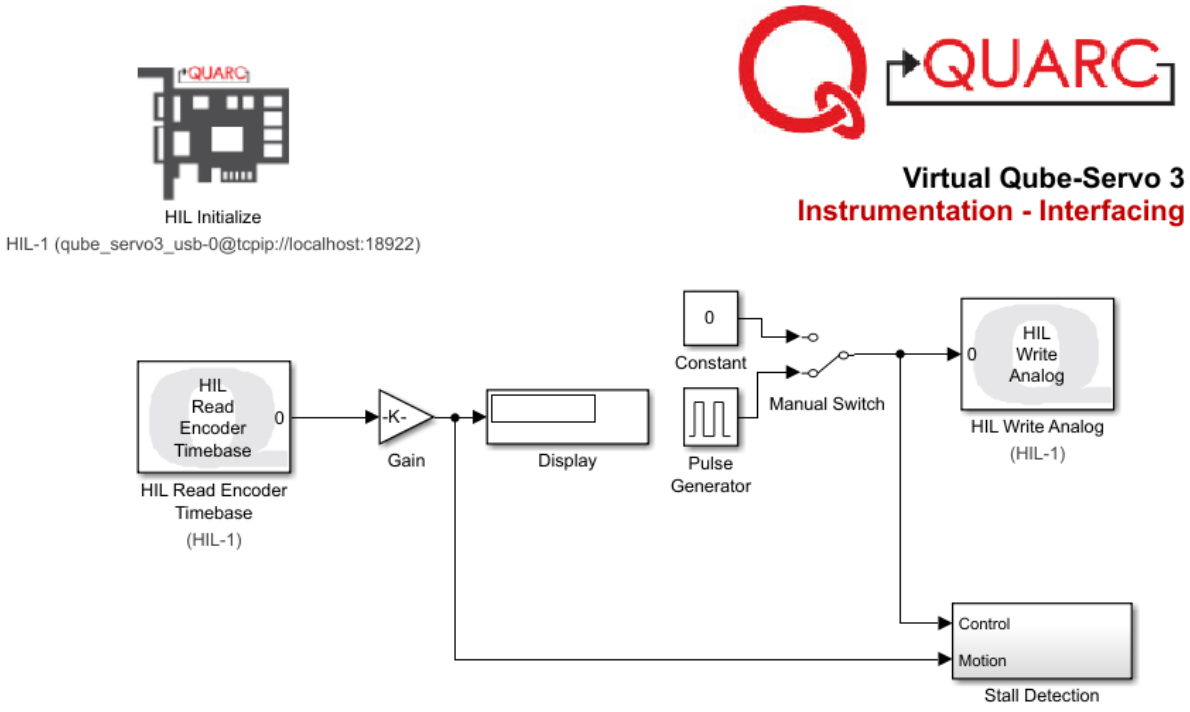


Figure 1. Simulink model used with QUARC to drive motor and read angle on Qube-Servo 3

Configuration

Follow these steps to see how a Simulink model can be created that will interface to the Qube-Servo 3 using QUARC,

1. Open MATLAB and open the qs3_interfacing.slx file. This will start Simulink.

2. Open the Simulink Library Browser window by clicking on the icon highlighted in Figure 2.

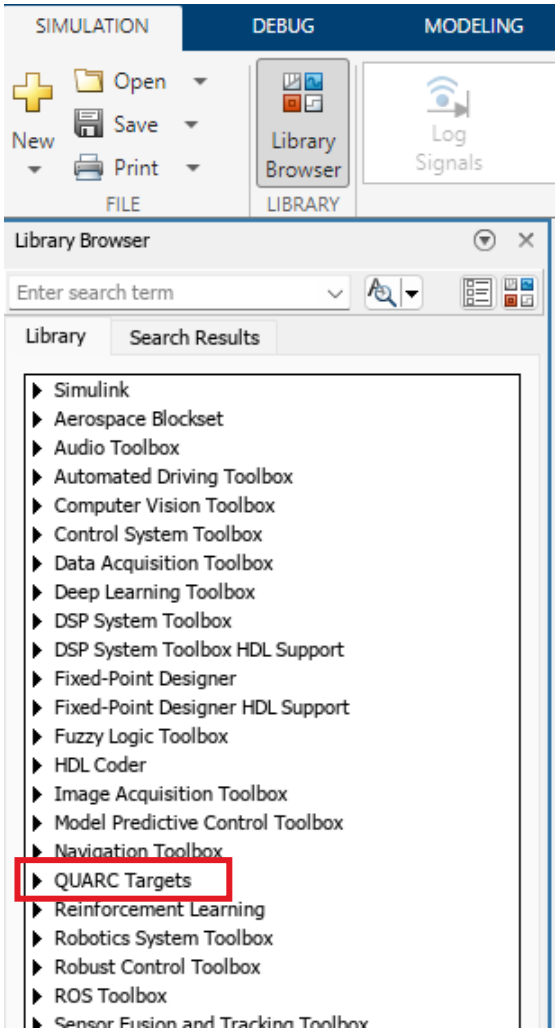


Figure 2. QUARC Targets in the Simulink Library Browser

3. Expand the `QUARC Targets` item and go to the `Data Acquisition | Generic | Configuration` folder.

4. Click-and-drag the `HIL Initialize` block from the library window into the Simulink model. This block is used to configure your data acquisition device.

5. Double-click on the `HIL Initialize` block to open its options.

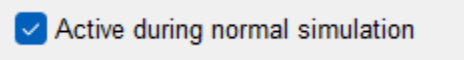
6. Configure the following in the Main tab:

    a. In Board type: select qube_servo3_usb

    b. Click Defaults at the bottom of the window to make sure the Board-Specific Options are set properly.

c. Set the Board identifier to: 0@tcpip://localhost:18922 (In the case of a virtual Qube-Servo 3, this is what tells your model that you will be using a Virtual Qube 3 with a disc.)

d. Make sure to select the option Active during normal simulation.



e. Click OK to close the window and save the settings.

7. Make sure the Qube-Servo 3 disc is open in Quanser Interactive Labs.

Running the Model

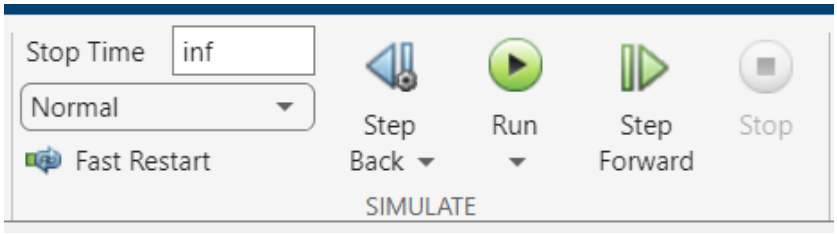


Figure 3. Simulation tab | Run button to start virtual Qube

8. Run the QUARC controller using the **Run** button on the **Simulation** tab as shown in figure 3.

9. If you successfully ran the QUARC controller without any errors, the LED strip on the Qube-Servo 3 should turn green.

10. The run button should have become a Stop button. Click it to stop the model.

Driving the DC Motor

Follow these steps to drive the DC motor:

11. Using the Simulink model you configured for the Qube-Servo 3 in the previous section, add the HIL Read Encoder block from the **QUARC Targets | Data Acquisition | Generic | Timebases** category in the Library Browser.

12. Click-and-drag the **HIL Read Encoder Timebase** block from the library window into the Simulink model. This block is used to read the encoder from the data acquisition device.

13. Double click the **HIL Read Encoder Timebase** block you just added and configure it as follows:

    a. Main tab: select the option Active during normal simulation

    b. Advanced tab: Set the Buffer overflow mode to Synchronize. This option is used to read sensors on Quanser Interactive labs.

14. Connect the **HIL Read Encoder Timebase** block as shown in figure 1, the **HIL Write Analog** should be missing.

15. From the **QUARC Targets | Data Acquisition | Generic | Immediate I/O** category in the Library Browser, find the **HIL Write Analog** block. 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.

16. Double click the **HIL Write Analog** block you just added and configure it as follows:

    c. Main tab: select the option Active during normal simulation

17. Connect the **Constant** and **HIL Write Analog** blocks together, as shown in Figure 1. Note: There is a **Stall Detection** subsystem in Figure 1 and Figure 4. This block will monitor the applied voltage and speed of the DC motor to ensure that it does not stall. If the motor is motionless for more than 20 seconds with an applied voltage of over ±5 V, the simulation is halted to prevent the Qube-Servo 3 from overheating and subsequent potential damage to the motor.

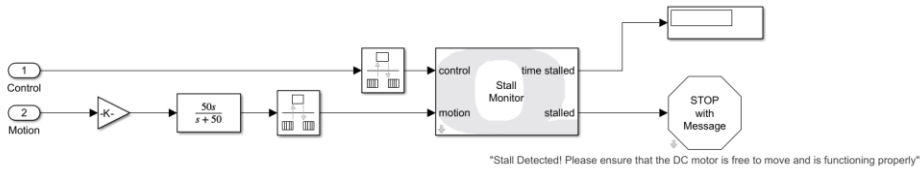


Figure 4. Stall Detection subsystem

18. Run the QUARC controller using the **Run** button on the **Simulation** tab.

19. Set the **Constant** block to 0.5, this applies a 0.5 V to the DC Motor of the Qube-Servo 3. Use the display to confirm that there is a positive measurement when a positive signal is applied. What direction does the disc rotate when a positive input is applied?

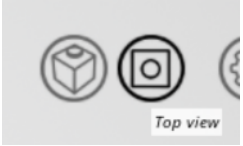
Reading the Encoder

20. In the same section near the Run button as shown in figure 3, set the Stop time to 5 sec.

21. Using the **Manual Switch**, change the input to the **HIL Write Analog** to the **Pulse Generator** to the **Pulse Generator** in its place. It should be set up to an amplitude of 0.15, a period of 10 seconds and a pulse width of 20%.

22. Run the QUARC controller using the **Run** button on the **Simulation** tab. This will apply 0.15V to the motor for 2 seconds and the model will stop after 5 seconds.

23. Record how many rotations the inertia wheel does. The **Display** block shows the number of counts measured by the encoder. The encoder counts are proportional to the angle of disc. Select the Top View in Quanser Interactive Labs to see the number of revolutions more easily.



24. Measure how many counts the encoder outputs and compare that with the number of rotations observed on the virtual Qube-Servo 3.

25. The `Display` block shows the number of counts measured by the encoder. The encoder counts are proportional to the angle of disc.

26. What happens to the encoder reading every time the QUARC controller is started? Restart the controller, it should run for another 5 seconds. Record your findings.

27. Measure how many counts the encoder outputs for a full rotation. Record your procedure and findings.

28. Ultimately, we want to display the disc angle in degrees, not counts. Set the `Gain` block to a value that converts counts to degrees. This is called the sensor gain.

29. Run the QUARC controller and confirm that the `Display` block shows the angle of the disc correctly. Record your gain value. You can try different stop times or using the constant block again and run at 0.15V.

30. You can now stop the code by clicking on the Stop button in the tool bar. The LED strip on the Qube-Servo 3 should turn back red.

31. Close Quanser Interactive Labs.