Lab Procedure
Hardware Interfacing

Introduction

1. The Qube-Servo 3 has been setup and tested.
2. Inertia disc load is attached to the Qube-Servo 3.
3. 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.

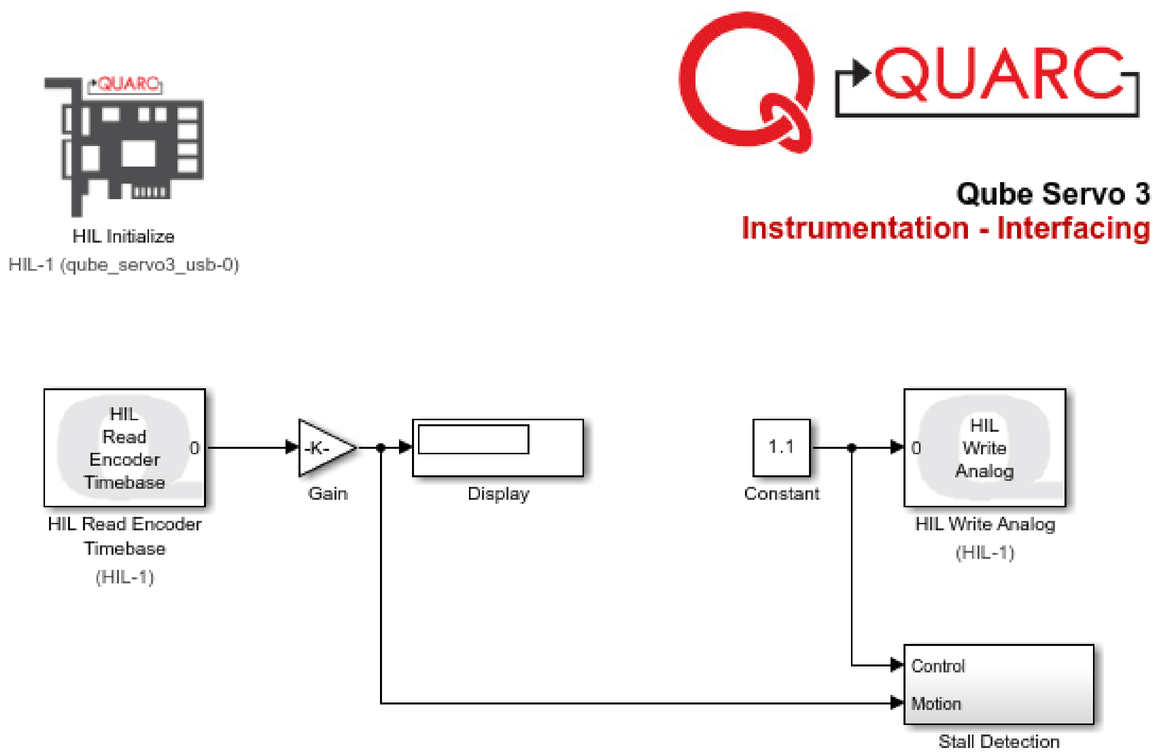

Figure 1. Simulink model used with QUARC to drive motor and read angle on Qube-Servo 3

Configuration

Follow these steps to build a Simulink model 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.

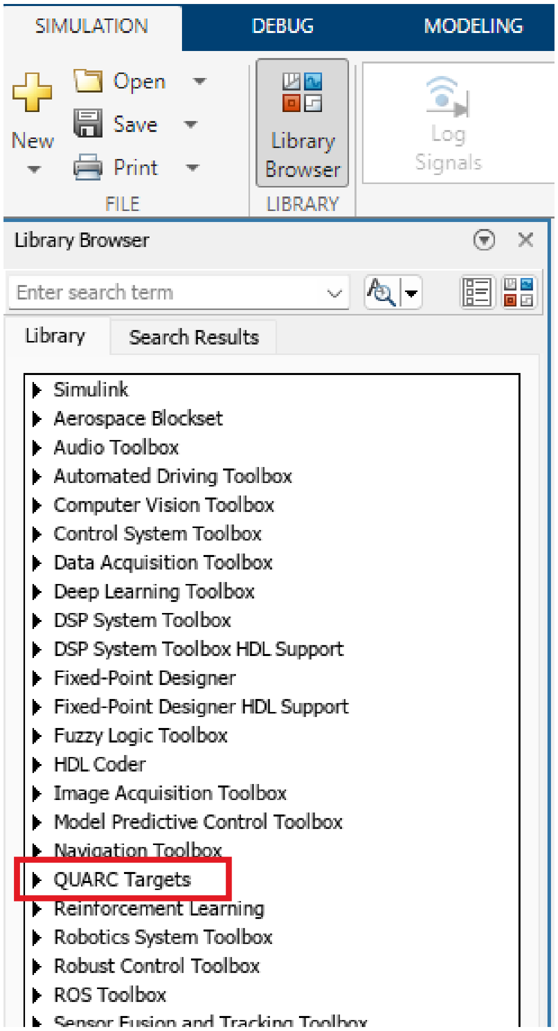

Figure 2. QUARC Targets in the Simulink Library Browser

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. Make sure the Qube-Servo 3 is connected to your PC USB port and the USB Power LED next to the power port is lit green.

7. In the `Board identifier` field, select qube_servo3_usb, on the bottom right corner of the window click **Defaults**, this step is very important to make sure the proper settings for the Qube-Servo are applied. Then click OK to close the window.

Reading the Encoder

Follow these steps to read the encoder:

1. 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.

2. 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.

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

Running the Model

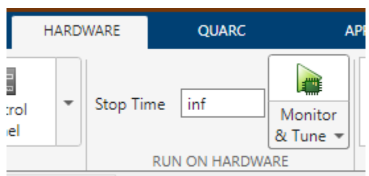

Figure 3. Hardware tab | Monitor & Tune button for compilation, target connection and deployment

1. On the Hardware tab, select the `Monitor & Tune` button as shown in figure 3, which does 4 things automatically.

   a. `Build for monitoring`: this is a compilation step, and the Diagnostic Viewer window should be displayed as the model is being compiled. This creates a QUARC executable (.rt-win64) file which we will commonly refer to as a QUARC controller.

   b. `Deploy`: this step does not apply to the Qube-Servo 3, as the target computer where the QUARC controller is deployed is the local computer. Typically, this step downloads the QUARC controller on the target computer.

   c. `Connect`: this step connects the Simulink development environment to the QUARC controller so that you can monitor the signals in the application and tune parameters in real-time.

   d. `Run`: this step starts running the QUARC controller. The LED strip on the Qube-Servo 3 should turn green.

   Note that you can individually and manually complete each step using the drop-down menu under the `Monitor & Tune` button, but clicking the button is an alternative.

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

5. Rotate the disc back and forth. The `Display` block shows the number of counts measured by the encoder. The encoder counts are proportional to the angle of disc.

6. What happens to the encoder reading every time the QUARC controller is started? Stop the controller using the button you used to start the model, it should now say stop. Move around the disc, and restart the controller. Record your findings.

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

8. 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. Run the QUARC controller and confirm that the `Display` block shows the angle of the disc correctly. Record your gain value.

9. You can now stop the code by clicking on the Stop button in the tool bar (or go to `QUARC | Stop`). The LED strip on the Qube-Servo 3 should turn back red.

Driving the DC Motor

Follow these steps to read the encoder:

1. From the `QUARC Targets | Data Acquisition | Generic | Immediate I/O` category in the Library Browser, click-and-drag the `HIL Write Analog` block from the library window into the Simulink model. This block is used to output a signal from analog output channel #0 on the data acquisition device. This is connected to the on-board PWM amplifier which drives the DC motor.

2. 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.

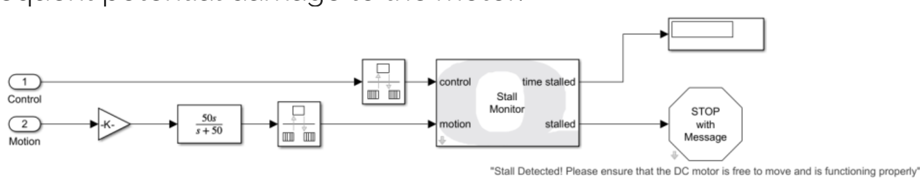

Figure 4. Stall Detection subsystem

3. Build and run the QUARC controller using the `Monitor & Tune` button on the `Hardware` tab.

4. Set the Constant block to 0.5. This applies 0.5 V to the DC motor in the Qube-Servo 3. Confirm that you are obtaining a positive measurement in the display 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. Finally, in what direction does the disc rotate (clockwise or counterclockwise) when a positive input is applied?

5. Stop the model.