Lab Procedure

Step Response Modeling

Introduction

Ensure the following:

1. You have reviewed the Application Guide - Step Response
2. The Qube-Servo 3 has been previously tested, is ON and connected to the PC.
3. Inertia disc load is attached to the Qube-Servo 3.
4. Launch MATLAB and browse to the working directory that includes the Simulink models for this lab.

The **Hardware Interfacing** and **Filtering** labs explained the basic blocks to read and write from the Qube-Servo 3. For simplicity, all labs forward will use a Qube-Servo 3 block that sets up the system beforehand and outputs the available information from the Qube.

Using the gains found to convert tachometer counts/s into rads/s from the instrumentation labs, use the qs3_step_response.slx file to design a model that applies a step of 5 V to the motor at second 1 and reads the servo velocity using the digital tachometer, as shown in Figure 1. Do not connect the `Transfer Fcn` block yet. It will be used later in the lab.

Using the saved response, the model parameters will then be found as discussed in the **concept review** referenced in the **application guide** for this lab. For information on saving data to MATLAB for offline analysis, see the QUARC help documentation (under QUARC Targets | User's Guide | QUARC Basics | Data Collection).

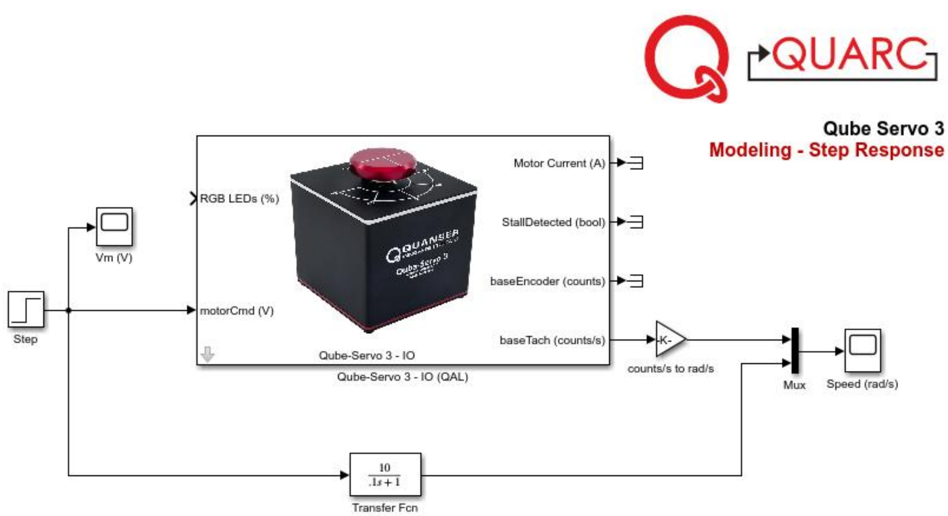


Figure 1: Applies a step voltage and measures corresponding servo speed

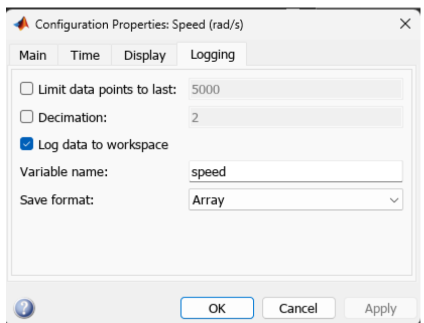
Finding and Analyzing the Step Response

1. Add a `Step` block into your model, by double clicking on an empty part of your model and typing the block name. Configure the step to be a 5V step that starts at a time of 1 second.

2. Use the gain value found in previous labs to convert the tach's counts/sec to rad/s. Connect the blocks, except the `Transfer Fcn` block, as shown in Figure 1.

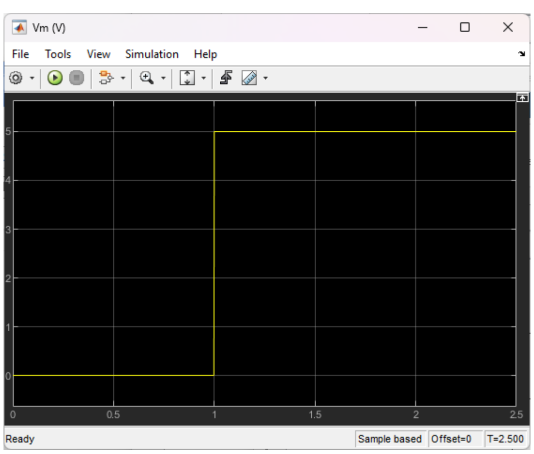
3. In your Simulink model, go to the `Hardware` tab, and change the Stop Time to 2.5 seconds.

4. Confirm that the scopes are configured to save the output information on your MATLAB workspace. Open the scopes and click the configuration/gear icon  on the top left side of the window, right below `File`. The logging tab in the window should look like this for the speed scope. The variable name should be voltage for the Voltage scope.

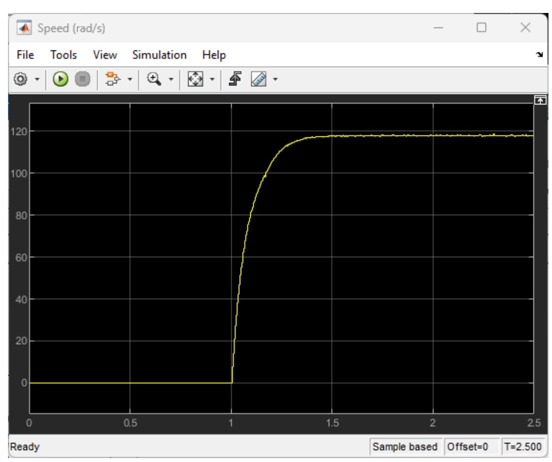


5. Build and run the QUARC controller using the `Monitor & Tune`  button on the `Hardware` or `QUARC` tab.

6. The controller should apply a 5 V step to the servo. The scope for the input voltage and the Qube's response should look like the scopes in Figure 2.



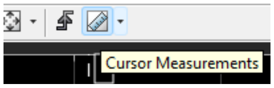
(a) Motor Voltage



(b) Load Speed

Figure 2. Sample QUBE-Servo 3 Voltage and Speed Response Scopes

7. Measure K (the steady-state gain) and τ (the time constant) of the response. Refer to the concept review described in the application guide if needed. Capture a screenshot of your measurements.
   Hint: Use the `Cursor Measurements` tool in the Simulink Scope to take measurements directly from the response plots.



8. To verify if your derived model parameters K and τ are correct, modify the Simulink diagram to connect the `Transfer Fcn` block as shown in Figure 1. Make sure you use a `Mux` block instead of two inputs into the scope block. Modify the transfer function to be the first order model for the Qube-Servo 3.

9. Build and run your QUARC controller. Look at the Speed Scope output to compare your derived model with the real output. Your output should look like figure 3 but across the 2.5 seconds the model ran for.

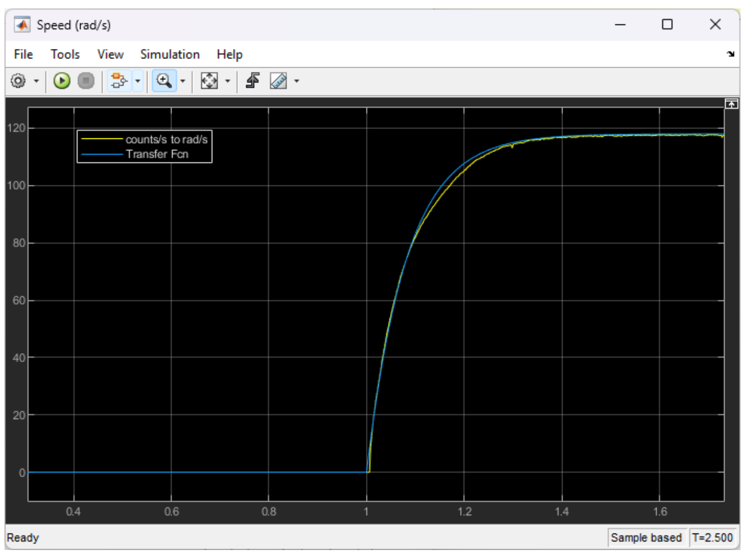


Figure 3. Sample QUBE-Servo 3 Measured and Simulated Speed Response

10. Using the data saved in your MATLAB workspace, create and save a MATLAB figure displaying the following:
    a. The measured and simulated response in one plot
    b. The input voltage

11. Close your model.

12. Power OFF the Qube-Servo 3.