Lab Procedure
Parameter Estimation

Introduction

Ensure the following:

1. You have reviewed Application Guide - Parameter Estimation
2. Make sure you have Quanser Interactive Labs open in the Qube 3 - DC Motor → Servo Workspace.
3. 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_parameter_estimation.slx file to design a model that applies a constant voltage to the motor and reads the motor current of the Qube-Servo 3 as shown in Figure 1.

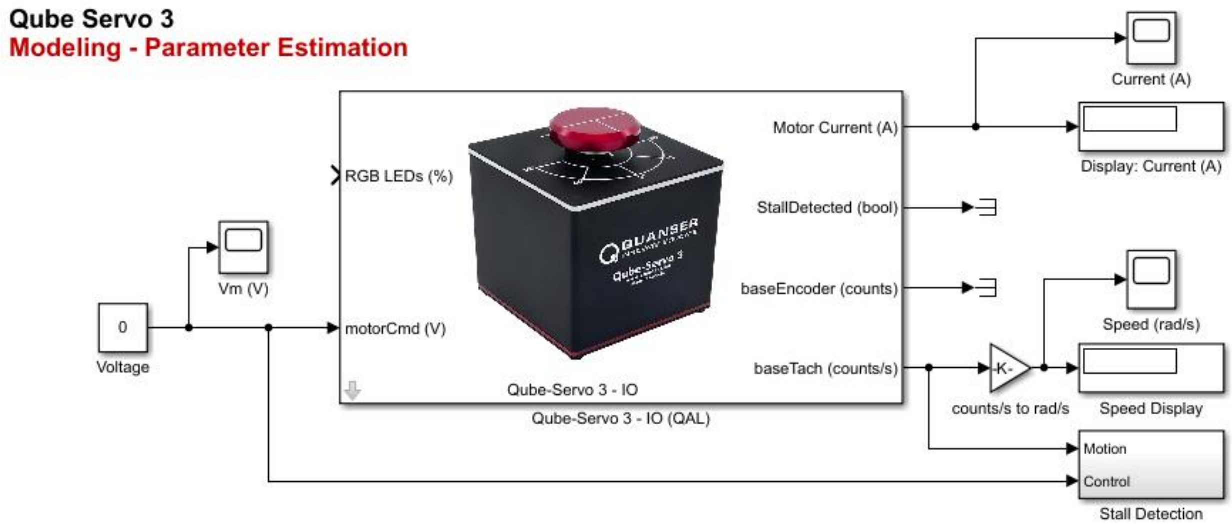


Figure 1: Model applying a voltage to the Qube and measuring motor current and speed.

During the lab, you will be experimentally estimating the motor resistance R_m. This can be done by applying constant voltages to the motor and measuring the corresponding current *while holding the motor shaft stationary*. You will also be experimentally estimating the motor torque constant k_m. Refer to Concept Review – Motor Equations.

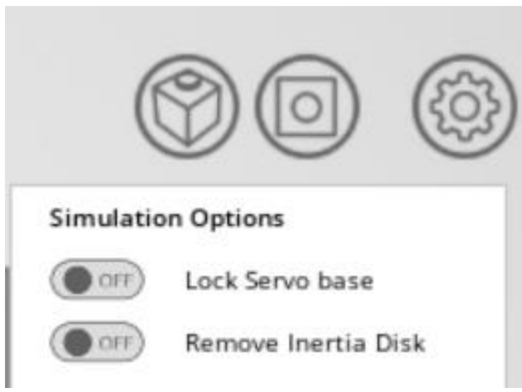
Motor Resistance Estimation

1. Derive an expression that will allow you to solve for the motor resistance R_m by applying constant voltages to the motor and stalling it and measuring the corresponding current.

2. Ensure the inertial disc load is mounted on the Qube-Servo 3.

3. Run the QUARC controller using the `Run` button on the `Simulation` tab.

4. To experimentally estimate the motor resistance, apply a set of voltages to the Qube- Servo 3 using the model in Figure 1. For each measurement, *hold the motor shaft stationery* by stalling the motor virtually. Click on the settings in your Servo Workspace and click on Lock Servo base. This will be the equivalent of manually stalling the motor.



5. Record the current measurement displayed in the Current (A) display.

6. If you accidentally hold the motor stalled for longer at higher voltages, the servo will stop spinning. If that happens, stop the model and start it again.

7. Fill the following table with the measured current for different voltage and calculate the corresponding resistance from the equation you derived in step 1.

Applied Voltage V_m (V)	Measured Current I_m (A)	Resistance R_m (Ω)
-5		
-4		
-3		
-2		
-1		
+1		
+2		
+3		

+4		
+5		

Table 1. Motor Resistance Experimental Results

8. Take the average of all the measure resistance values and compare this with the motor resistance value from the Qube-Servo 3 User Manual.

9. Stop your model.

Motor Back-EMF Estimation

10. Derive an expression that will allow you to solve for the motor torque constant k_m by applying constant voltages to the motor and measuring the steady state current and speed (in rad/s). Assume you already know the motor resistance R_m.

11. Run the QUARC controller using the `Run` button on the `Simulation` tab.

12. To experimentally estimate the motor back-EMF constant, repeat the same procedure by applying different voltage to the Qube-Servo 3 with the motor free to spin (i.e. do not stall the motor) and record the measured speed and current in Table 2.

Applied Voltage V_m (V)	Measured Speed ω_m (rad/s)	Measured Current I_m (A)	Back-EMF k_m (V-s/rad)
-5			
-4			
-3			
-2			
-1			
+1			
+2			
+3			
+4			
+5			

Table 2. Motor Resistance Experimental Results

13. Take the average of the measured back-EMF values and compare this with the motor back-EMF value from the Qube-Servo 3 User Manual.

14. The motor shaft of the Qube-Servo 3 is attached to a *load hub* and a *disk load*. Based on the parameters given in the Qube-Servo 3 User Manual, calculate the equivalent moment of inertia that is acting on the motor shaft. Keep note of your procedure as it may be required in the assessment.

15. Formulate the differential equation for ω_m using the equations from the concept review outlined in the application guide. (*Hint*: Obtain the Voltage V_m(s) to Speed Ω_m(s) transfer function by applying a Laplace Transform to the derived differential equation.) Keep note of your procedure as it may be required in the assessment.

16. Stop and close your model.

17. Close Quanser Interactive Labs.