

Lab Procedure

Block Diagram Modeling

Introduction

Ensure the following:

1. You have reviewed the **Application Guide – Block Diagram Modeling**
 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 rad/s into rads from the instrumentation labs, use the [qs3_block_modeling.slx](#) file to design a model that applies a 2-6 V, 0.4 Hz square wave to the motor and reads the angular velocity using the encoder as shown in Figure 1. We will complete the *QUBE-Servo Model* subsystem during this lab.

The goal of this lab is to model the angular velocity of the Qube-Servo 3 when a 2-6 V, 0.4 Hz square wave is inputted.

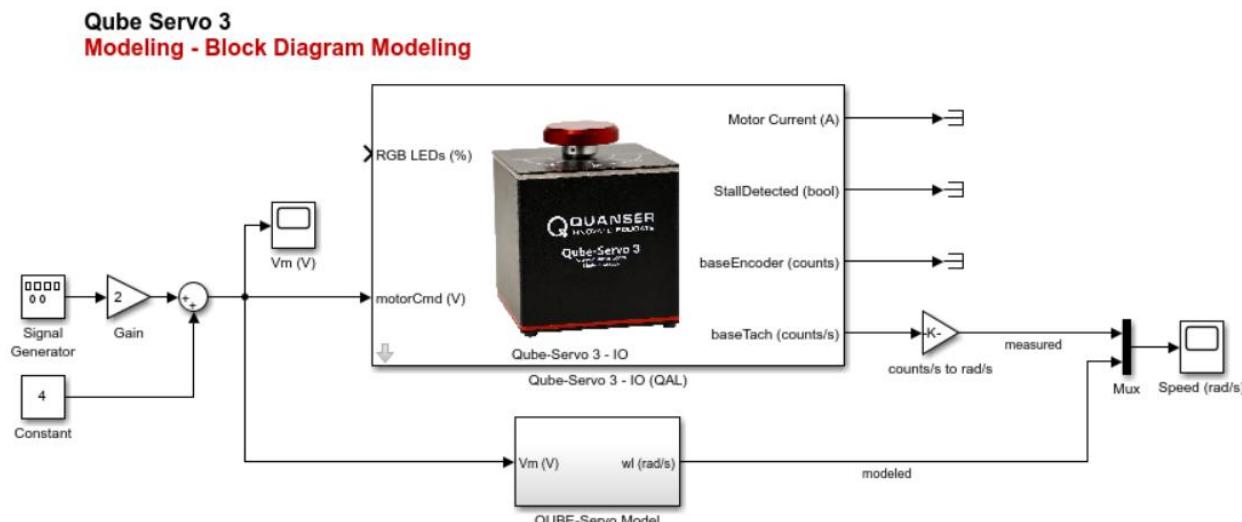


Figure 1: Model that applies a square wave voltage and displays measured and modeled speeds.

Block Diagram Modeling

1. Open the subsystem called `Qube-Servo Model` in your model.
2. Using the Qube-Servo 3 User Manual, record constants that are important to modeling the system dynamics.
3. Implement the partial solution shown in Figure 2. While modeling you'll need a few `Gain` blocks, a `Subtract` block and an `Integrator` block (to go from acceleration to speed). The subsequent steps will highlight important components in your model.
 - a. It may help to write a short MATLAB script that sets the various system parameters in the workspace so that they can be used by the Simulink model. For example, Figure 2 uses R_m for motor resistance and k_t for the current-torque constant as shown below:

```
% Resistance
Rm = 7.5;
% Current-torque (N-m/A)
kt = 0.042;
```

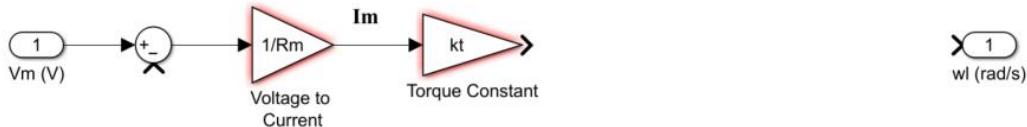


Figure 2: Incomplete Qube-Servo 3 Model.

4. The motor shaft of the Qube-Servo 3 is attached to a load **hub** and an **inertia disc** load. Based on the parameters given in the user manual, calculate the total moment of inertia that is acting on the motor shaft. Save your calculations.
5. Add the total moment of inertia to your block diagram model of the Qube-Servo 3.
6. Add the Back-EMF constant to your block diagram model of the Qube-Servo 3.
7. Save a screenshot of your block diagram model and the parameters you used.
8. Build and run the QUARC controller using the **Monitor & Tune** button on the **Hardware** or **QUARC** tab. The speed (rad/s) scope response should be similar to Figure 3. Take a screenshot of the scope.

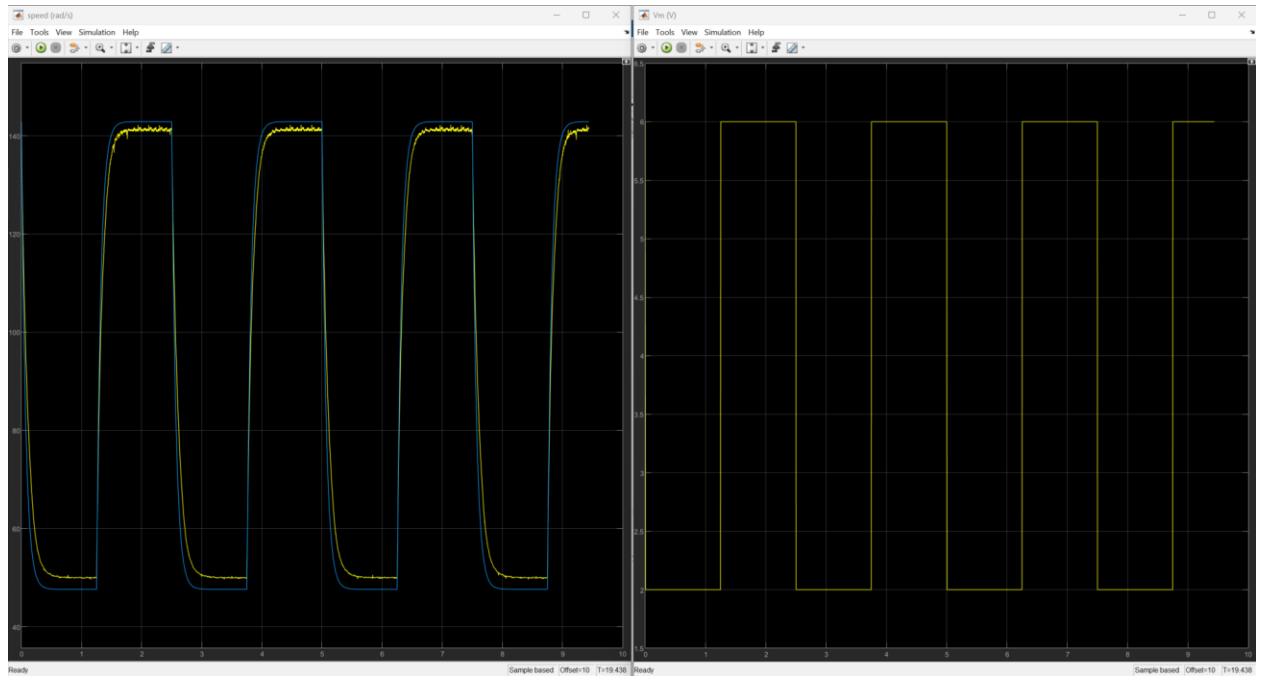


Figure 3: Speed scope of the Qube-Servo 3 Physical Vs. Model

9. Stop the Simulink model. Ensure you save a copy of the files for review later.
10. Close your model.
11. Power OFF the Qube-Servo 3.