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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.

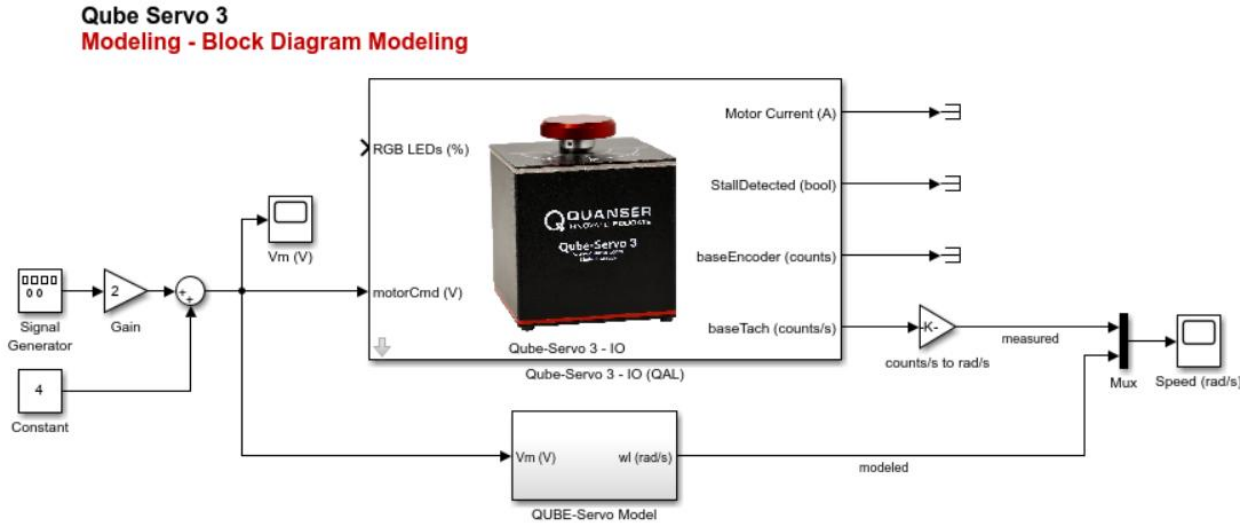

Figure 1: Model that applies a square wave voltage and displays measured and modeled speeds.

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 *Rm* for motor resistance and *kt* for the current-torque constant as shown below:

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

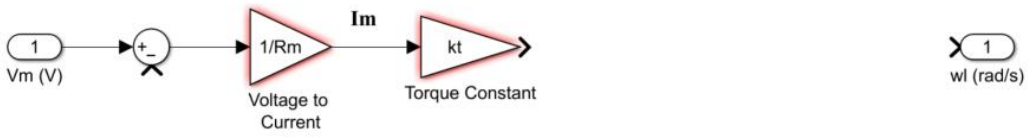

Figure 2: Incomplete Qube-Servo 3 Model.

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.

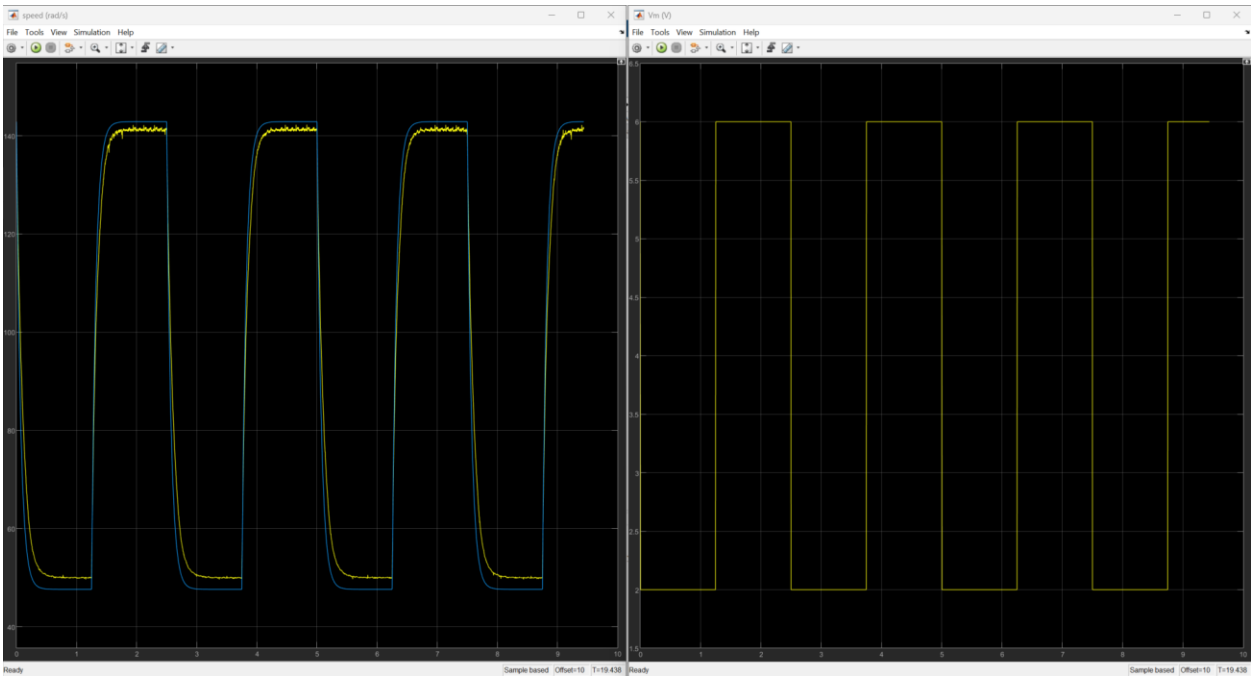

Figure 3: Speed scope of the Qube-Servo 3 Physical Vs. Model

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.