**Lab2 (Modeling of DC servo-motor SRV02):**

Pre-Lab: Read section 1.1 of the SRV02 Workbook and answer all the questions in section 1.2 before coming to the lab. The specifications that are needed for the questions can be found in the SRV02 User Manual in Table 3.1-3.3 on pages 11 and 12 or in the tables at the end of this document.

Lab Experiment:

1. Open the document “SRV02 Quick Setup guide” located in the “Getting Started” folder and follow the instructions to connect the SRV02, VoltPaq, and Q2_USB data acquisition board.
    a. Use the black RCA to RCA connector instead of the 2xRCA to 2xRCA cable.
    b. Connect the disk load to the load shaft by aligning the holes on the load to the ones on the gear and using the thumb screws to hold it in place.

2. In MATLAB, browse to the following directory:

    C:\Users\Student\Documents\Matlab\SRV02\Controllers\01 – Modeling

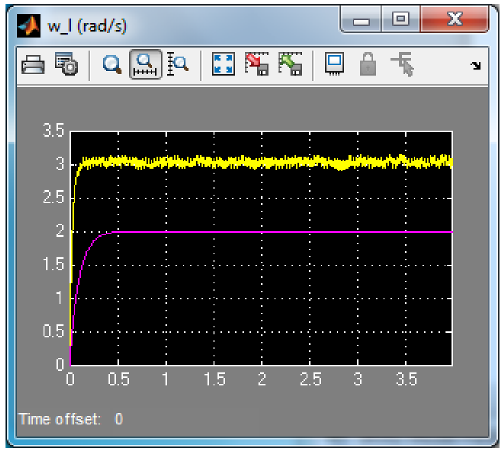
3. Open the model “**q_srv02_mdl.mdl**”. This model file will be used for modeling the actual SRV02 setup. Read section 1.3 (page 9) for details. You need to go to section 1.4.2 and follow the steps to configure the model for use. You essentially need to run the script file “setup_srv02_exp01_mdl.m” first and ensure that you see the default parameter values as given in step 10 of section 1.4.2.
    a. Before running the setup file, edit the MODELING_TYPE to MANUAL. Everything else should be set correctly.

4. We will first perform the **frequency response** experiment, detailed in section 1.3.1 of the student workbook **SRV02 Workbook - QUARC (Student).pdf** located in

    C:\Users\Student\Documents\Matlab \SRV02\Documentation

5. In running the experiment, follow the instructions in the workbook closely, with the following additional comments:

    a. In step 1 of section 1.3.1.1 you can keep the frequency unchanged. Simulink will not accept 0.0 as a valid frequency. We will anyway keep the amplitude of the sine wave to be zero for the steady-state test, so its frequency will be immaterial.
    b. Also, when you execute in real-time, the acquired load shaft speed data will look like the plot below, which shows a different steady-state value than the one given in Fig.1.7. *Which one is correct and why?*




c. Next we find gains at varying frequencies, following the steps in section 1.3.1.2. Follow the instructions in this section to complete the experiment.

   i. The inputs to the scope may be reversed.

   *Note:* *Here you do not need to rebuild the code. Just connect to target and start the real-time code. Then change the offset slider to zero, the amplitude of sinusoid to 2 and then you can keep changing the frequency on-the-fly and for each frequency record the amplitude of the tachometer signal. Alternately, you could set a frequency on-the-fly, acquire data for some time, stop the real-time execution, zoom-in the plot to get the amplitude accurately and then re-connect to the target and change the frequency.*

6. Next perform the **bump test** experiment, detailed in section 1.3.2. In running the experiment, follow the instructions in the workbook closely, with the following additional comments:

   a. The steps for calculating the steady-state gain and time-constant from the acquired data are explained in the pre-lab material.

7. Next perform the model validation experiment as detailed in section 1.3.3. Answer all questions in section 1.3.3 and fill out your results in section 1.3.4.

8. **Important:** Before closing the model, select "QUARC → Clean all …" and click "Yes" on the prompt to delete all generated code.

Post-Lab: Write a lab report detailing the procedure and results of the experiments run. Guidelines for writing the lab report can be found in section 1.5 of the SRV02 Workbook.

*Edited: (01/03/2013), Tuhin Das and Sigitas Rimkus.*
*Last Edited: (01/22/2013), Nicholas Paperno*

# 3 SRV02 SPECIFICATIONS

Table 3.1 lists and characterizes the main parameters associated with the SRV02. Some of these are used in the mathematical model. More detailed information about the gears is given in Table 3.2 and the calibration gains for the various sensors on the SRV02 are summarized in Table 3.3.

| Symbol | Description | Matlab Variable | Value | Variation |
|---|---|---|---|---|
| $V_{nom}$ | Motor nominal input voltage | | 6.0 V | |
| $R_m$ | Motor armature resistance | Rm | 2.6 $\Omega$ | $\pm$ 12% |
| $L_m$ | Motor armature inductance | Lm | 0.18 mH | |
| $k_t$ | Motor current-torque constant | kt | $7.68 \times 10^{-3}$ N m/A | $\pm$ 12% |
| $k_m$ | Motor back-emf constant | km | $7.68 \times 10^{-3}$ V/(rad/s) | $\pm$ 12% |
| $K_g$ | High-gear total gear ratio | Kg | 70 | |
| | Low-gear total gear ratio | Kg | 14 | |
| $\eta_m$ | Motor efficiency | eta_m | 0.69 | $\pm$ 5% |
| $\eta_g$ | Geabox efficiency | eta_g | 0.90 | $\pm$ 10% |
| $J_{m,rotor}$ | Rotor moment of inertia | Jm_rotor | $3.90 \times 10^{-7}$ kg $\cdot$ m$^2$ | $\pm$ 10% |
| $J_{tach}$ | Tachometer moment of inertia | Jtach | $7.06 \times 10^{-8}$ kg $\cdot$ m$^2$ | $\pm$ 10% |
| $J_{eq}$ | High-gear equivalent moment of inerta without external load | Jeq | $9.76 \times 10^{-5}$ kg $\cdot$ m$^2$ | |
| | Low-gear equivalent moment of inerta without external load | Jeq | $2.08 \times 10^{-5}$ N $\cdot$ m / (rad/s) | |
| $B_{eq}$ | High-gear Equivalent viscous damping coefficient | Beq | 0.015 N $\cdot$ m / (rad/s) | |
| | Low-Gear Equivalent viscous damping coefficient | Beq | $1.50 \times 10^{-4}$ kg $\cdot$ m$^2$ | |
| $m_b$ | Mass of bar load | m_b | 0.038 kg | |
| $L_b$ | Length of bar load | L_b | 0.1525 m | |
| $m_d$ | Mass of disc load | m_d | 0.04 kg | |
| $r_d$ | Radius of disc load | r_d | 0.05 m | |
| $m_{max}$ | Maximum load mass | | 5 kg | |
| $f_{max}$ | Maximum input voltage frequency | | 50 Hz | |
| $I_{max}$ | Maximum input current | | 1 A | |
| $\omega_{max}$ | Maximum motor speed | | 628.3 rad/s | |

Table 3.1: Main SRV02 Specifications

| Symbol | Description | Matlab Variable | Value |
|---|---|---|---|
| $K_{gi}$ | Internal gearbox ratio | Kgi | 14 |
| $K_{ge,low}$ | Internal gearbox ratio (low-gear) | Kge | 1 |
| $K_{ge,high}$ | Internal gearbox ratio (high-gear) | Kge | 5 |
| $m_{24}$ | Mass of 24-tooth gear | m24 | 0.005 kg |
| $m_{72}$ | Mass of 72-tooth gear | m72 | 0.030 kg |
| $m_{120}$ | Mass of 120-tooth gear | m120 | 0.083 kg |
| $r_{24}$ | Radius of 24-tooth gear | r24 | $6.35 \times 10^{-3}$ m |
| $r_{72}$ | Radius of 72-tooth gear | r72 | 0.019 m |
| $r_{120}$ | Radius of 120-tooth gear | r120 | 0.032 m |

Table 3.2: SRV02 Gearhead Specifications

| Symbol | Description | Matlab Variable | Value | Variation |
|---|---|---|---|---|
| $K_{pot}$ | Potentiometer sensitivity | K_POT | 35.2 deg/V | $\pm$ 2 % |
| $K_{enc}$ | SRV02-E encoder sensitivity | K_ENC | 4096 counts/rev | |
| $K_{enc}$ | SRV02-EHR encoder sensitivity | K_ENC | 8192 counts/rev | |
| $K_{tach}$ | Tachometer sensitivity | K_TACH | 1.50 V/$k_{RPM}$ | $\pm$ 2 % |

Table 3.3: SRV02 Sensor Specifications