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Lab Manual # 8

Bump Test of Servo Motor on LabVIEW and on hardware QUBE Servo Motor

Objectives:

- Bump test.
- First order equation

Hardware:

Introduction:

The bump test is a simple test based on the step response of a stable system. A step input is given to the system and its response is recorded. As an example, consider a system given by the following transfer function:

$$\frac{Y(s)}{U(s)} = \frac{K}{\tau s + 1}$$

Step response shown in Figure-1 is generated using this transfer function with K=5 rad/V and $\tau = 0.05\ s$.

The step input begins at time t0. The input signal has a minimum value of u_{min} and a maximum value of u_{max}. The resulting output signal is initially at y_0. Once the step is applied, the output tries to follow it and eventually settles at its steady-state value y_{ss}.

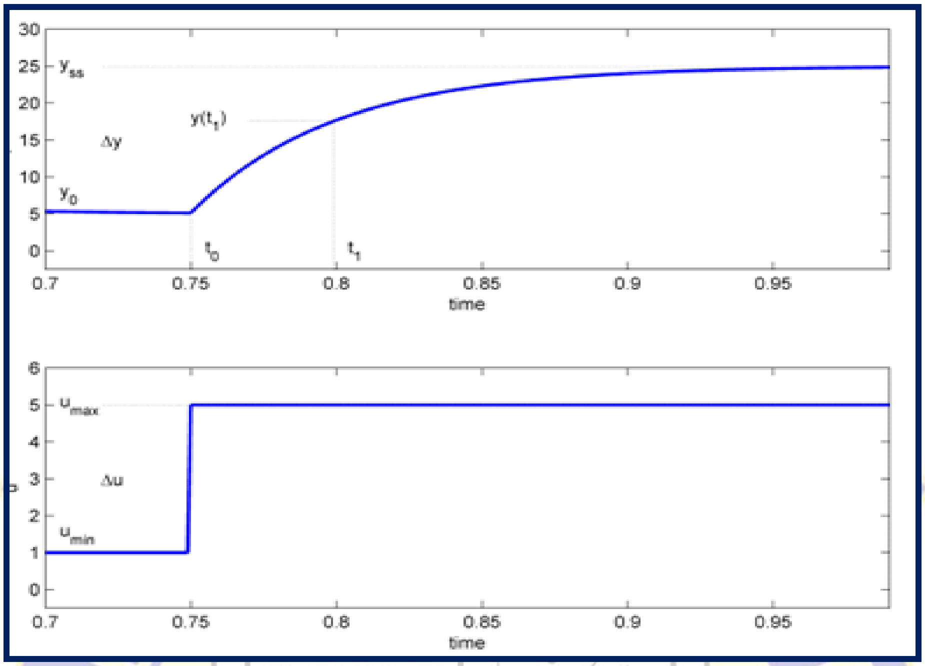


Figure 1: Input and output signal used in the bump test method

From the output and input signals, the steady-state gain is

$$K = \frac{\Delta Y}{\Delta u}$$

where $\Delta y = y_{ss} - y_0$ and $\Delta u = u_{max} - u_{min}$. The time constant of a system is defined as the time it takes the system to respond to the application of a step input to reach 1-1/e = (63.2%) of its steady-state value. Then, we can read time t_1 when output reaches 63.2% in Figure 1.

Exercise:

Apply bump test and find gain and time constant of the system. Clearly write all your calculation.

Calculations:

Input Voltage $\Delta u = u_{max} - u_{min} = 2 - 0 = 2$ V

Initial output $y_o = 0$ rad/s

Final output $y_{ss} = 46.6043$ rad/s

$\Delta Y = y_{ss} - y_o = 46.6043 - 0 = 46.6043$ rad/s

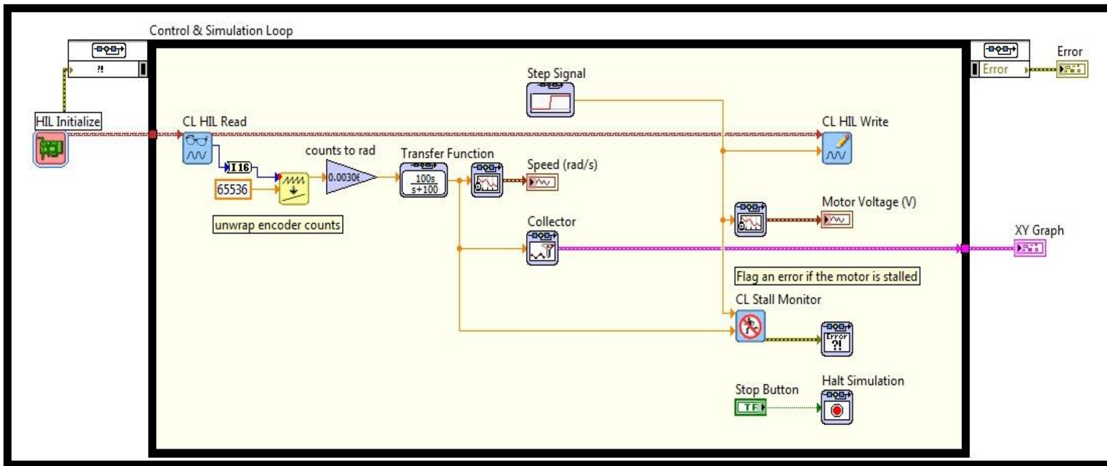
$$\boldsymbol{K = \frac{\Delta Y}{\Delta u} = \frac{46.6043\,\frac{rad}{s}}{2\ V} = 23.30125\ \frac{rad}{Vs}}$$

$t_1 = 1.128$ s

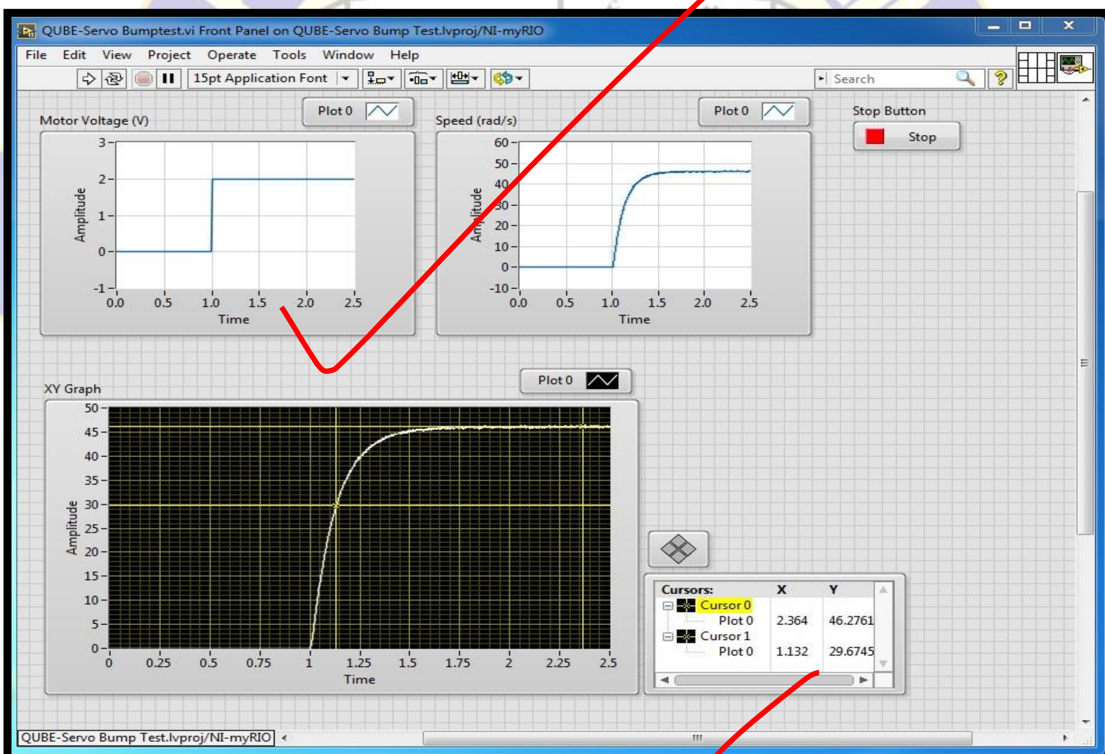
$t_o = 1$ s

$\boldsymbol{\tau = t_1 - t_o = 1.128 - 1 = 0.128\ s}$

Simulated Circuit:



I/O Waveforms:



Conclusion:

In this lab, we have performed the bump test on Qube Servo Motor. The bump test is a simple test based on the step response of a stable system. A step input is given to the system and its response is recorded. The QUBE-Servo is a high-fidelity DC servo motor for teaching control theory. The QUBE-Servo features a brushed DC motor with an optical encoder to allow students to learn position and velocity control concepts through hands-on experimentation. We plotted the step response and calculated the time constant and gain of the system.