Lab 1: Open Loop Control

Background:

<u>Open Loop Hydraulic Control</u>:

A system is considered open loop if the input is not dependent upon the output, also referred to as a non-feedback system. For an electro-hydraulic system, the open loop control is used as a velocity control of an actuator. The feedback is essentially the operator's eye and a manual adjustment is needed to change the actuator speed to a desired speed. Examples are heavy equipment controlled by an operator to do a function. The operator is giving an input to control the speed of the machine functions. A block diagram and a picture of the open loop motion control system are shown in Figures 1 thru 3. The process is the hydraulic cylinder, input to the process is the net flow rate of hydraulic oil, and output from the process is the speed of the piston. The linear variable differential transducer (LVDT) measures the displacement of the piston which will be plotted along with the command. The controller receives its input from the potentiometer and outputs a signal to the electro-hydraulic valve. The electro-hydraulic valve controls the process input, i.e. the oil flow based on the signal from the controller.
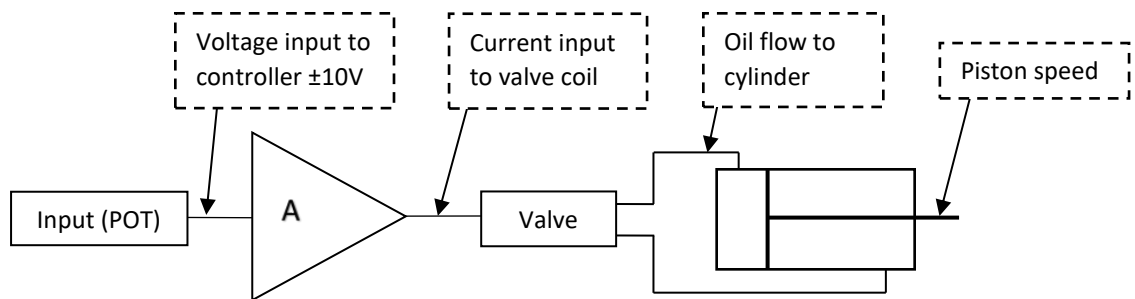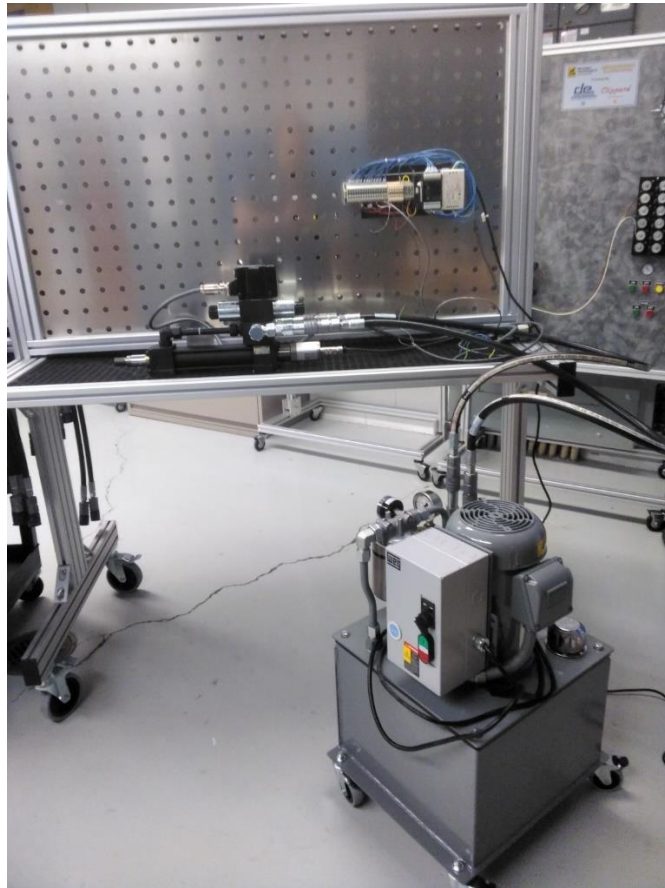

Figure 1. Block diagram of the hydraulic system
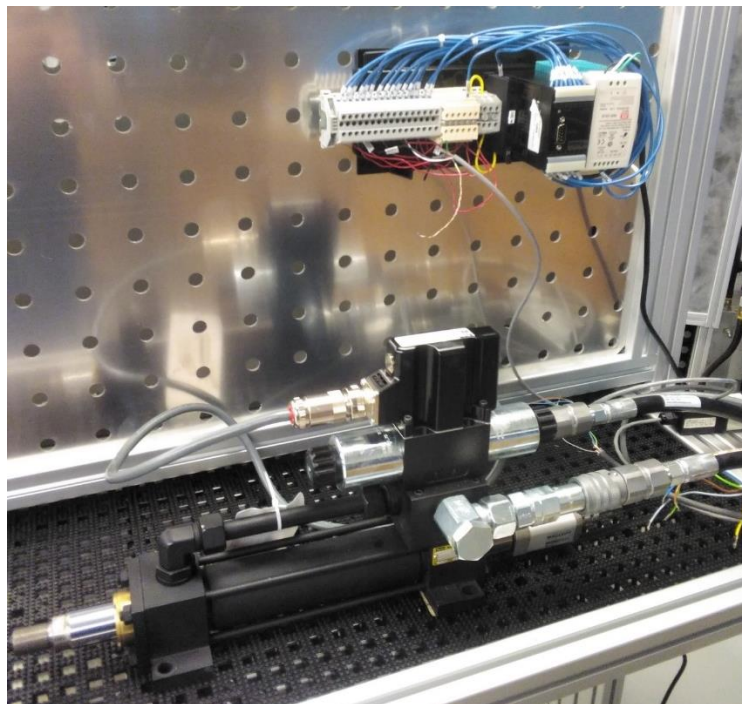
Figure 2. Components of Hydraulic Circuit

Figure 3. Hydraulic Cylinder and Controller

Objectives

The objectives of this lab are to:

- Understand the fundamentals of hydraulic open loop motion control.
- Compare the response of the lab with a simulation in Amesim.

Experiment

Materials/Equipment:

HPU
H1B2.7T1OPOX13909/14
H1: 10-gallon reservoir (37.9L)
B: Relief valve w/ unloading valve
2.7: Pump - PGP505A0060CJ1H1ND3D2B1B1 (6 cc/rev) (0.366 CIR)
T1: Electric Motor - Baldor H1B27T1OBOX13909/14 (1 HP - 1725 RPM – 56C Frame – single phase)
O: Pressure & Return Port Manifold w/ Relief Valve

Cylinder:
Parker AXEHS0090022
Bore: 40mm (1.5")
Rod: 28mm (1.10"
Stroke: 150mm (5.91")

LVDT:
Baluff BTL7-A110-M0155-B-S32
A: Signal: 0-10V Analog
1: Supply: 20-28 VDC
10: Output Gradient: Rising + Falling
M0155: Stroke: 155mm (6.10")
B: Metric mounting thread M18x1.5, O-ring, rod diameter 10.2 mm
S32: 8-pin, M16 plug per IEC 130-9

Pinout
1 - Yellow: Not used
2 - Gray: OV (signal reference)
3 - Pink: 10-0V (not used)
4 - Red: programming input
5 - Green: 0-10V (signal return)
6 - Blue: GND
7 - Brown: 24VDC

Directional Valve:
Parker D1FBB31FC0NF0019
D: Directional Valve
1: NFPA D03
F: Proportional Control
B31F: 20/10 LPM @ ΔP = 5 bar
C: 3-position
N: Nitrile seals
F0: Input Signal 0...+/-10 V, Function 0...+10 V > P-A, POT Supply -10V...+10V
Valve Harness:
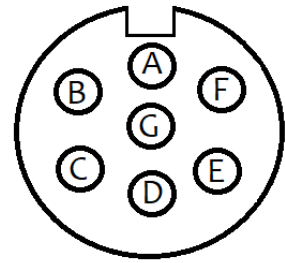A - Brown: Supply 18V...30VDC
B - Blue: Ground (OV)
C - White: Pot Supply +10VDC
D - Green: Signal 0...+/-10VDC
E - Yellow: Signal Reference
F - Pink: Pot Signal -10VDC
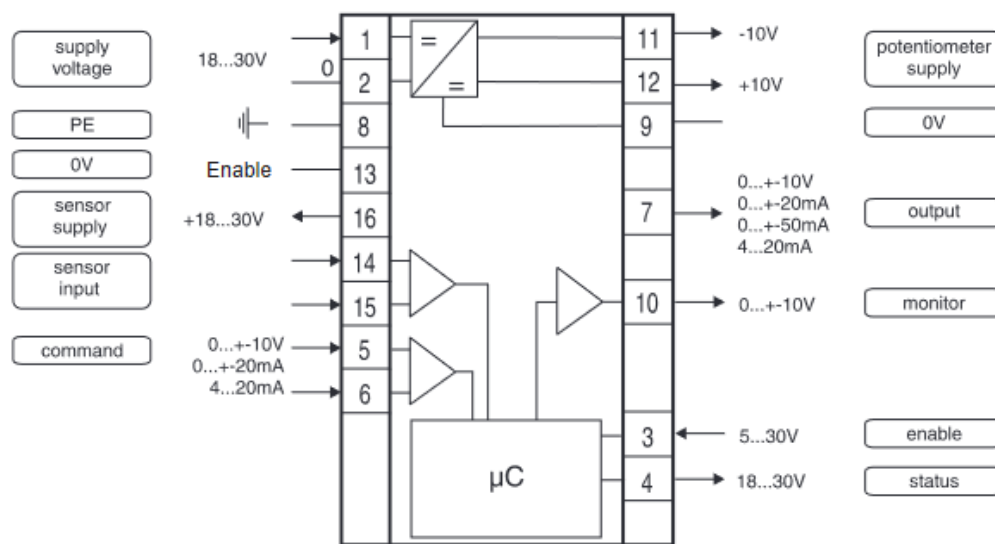G - Gray: PE

Controller:
Parker PID-00A-40-98288

Figure 4. Parker PID00A-40 Wiring Diagram

Potentiometer:
Red: Supply +10VDC
Black: Supply -10VDC
White: Wiper
Green: Reference

Potentiometer Wire Color	Connected to Terminal Port
Red	12
Black	11
White	Wired together with Green (+ command) of Valve
Valve Wire Color	Connected to Terminal Port
Brown	DC (+)
Blue	COM (-)

Table 1: Open Loop Wiring

Procedure:

1. Make sure to wear eye protection at all times while you are running the equipment.
2. Familiarize yourself with the various parts of the set-up, controls and instrumentation.
3. Wire the Parker PID004A-40 controller per the diagram.
4. Turn the pressure relief valve on the hydraulic power unit (HPU) fully counter clockwise. This will make sure that when you turn the pump on, it will initially have no load.
5. Plug in the power cord for the HPU, the Parker PID004A-40 controller, and the NI CompacDAQ data acquisition system.
6. Push the start button on the HPU.
7. Increase the system pressure to 200 PSI on the pressure relief valve on the HPU. DO NOT EXCEED 200 PSI.
8. Use the potentiometer to control the speed of the cylinder while extending and retracting.
9. If the control of the cylinder with the potentiometer doesn't work properly, turn the pressure relief valve on the HPU fully counter clockwise and turn the HPU off.
10. Use the digital multimeter to troubleshoot the wiring of the controller.
11. Once the wiring is corrected repeat steps 6 thru 8.
12. Press the record data button on the data acquisition and record for a few cycles of the cylinder. Make sure to go to zero speed and max speed partway through the stroke of the cylinder.
13. Once finished, turn the pressure relief valve on the HPU fully counter clockwise and turn the HPU off.
14. Unplug the HPU, the Parker PID004A-40 controller, and the NI CompacDAQ data acquisition system.

Data Analysis:

1. Graph the cylinder speed versus input voltage from the potentiometer. Include axis titles with description, symbol and units, along with the graph title.
    a. Compare the speed of the cylinder to the input voltage.
    b. Discuss the relationship between these two values. Is there a lag?
2. Model this circuit in Amesim.
    a. Compare the physical results with the Amesim results.

Data Reporting:

Create a report discussing what you have found.