Instrumentation and Measurement

Lab 2

Control System Components and Connections

Date the Lab was performed (mm-dd-yy): 01 / 19 / 2024

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Submission Instruction:

Review the lab report before submitting and put a check mark (√) in the appropriate check box on the left if the item has been duly completed in your lab report. The bracket on the right side will be filled out by your instructor with your gained mark.

1. Scan and create .pdf of all pages.
2. Combine ALL pages of your lab report into a SINGLE .pdf file. Meaning, do not submit each Page of your lab report as a separate file
3. The lab report file must be named in the following manner:
   "Your First Name_YourLast Name.pdf",
4. Upload and submit the pdf of your lab report in Blackboard.

Marking:

- ☐ Section 1 [ ] / 25
- ☐ Section 2 [ ] / 25
- ☐ Section 3 [ ] / 30
- ☐ Assignment [ ] / 20

Every 20 minutes late is subjected to 10 marks deduction from attendance.

Control System Components and Connections

Objective:

- To be familiarized with Measurement reading and Control Interface device and software
- Read a P&ID and operate a basic flow circuit
- Sensor Characteristic observation

1) Measurement and Control System

Interface Module:

1-1) Figure (L2-1) presents the control system block diagram and the corresponding elements in the lab. The sensor converts other forms of energy to electrical form such as varying amperes (like 4-20 mA) or varying voltage like (0-10 V). The voltage or current are not readable directly by PC. They need to be digitized by Analog to Digital Converter (ADC) and then transferred to PC via USB cable. The Controller inside the computer provides a signal proportional to the desired speed for the speed controller. Since the speed controller accepts analog signals in the form of electrical voltage or current, then the computer produced digital value should be converted to analog and this is done by a Digital to Analog converter (DAC). The interface module called LabVolt 9065-B0 has both ADC and DAC inside.. Figure (L2-1)illustrates the control system block components and interface module connections. Study the figure, identify the components and then move to step 2.

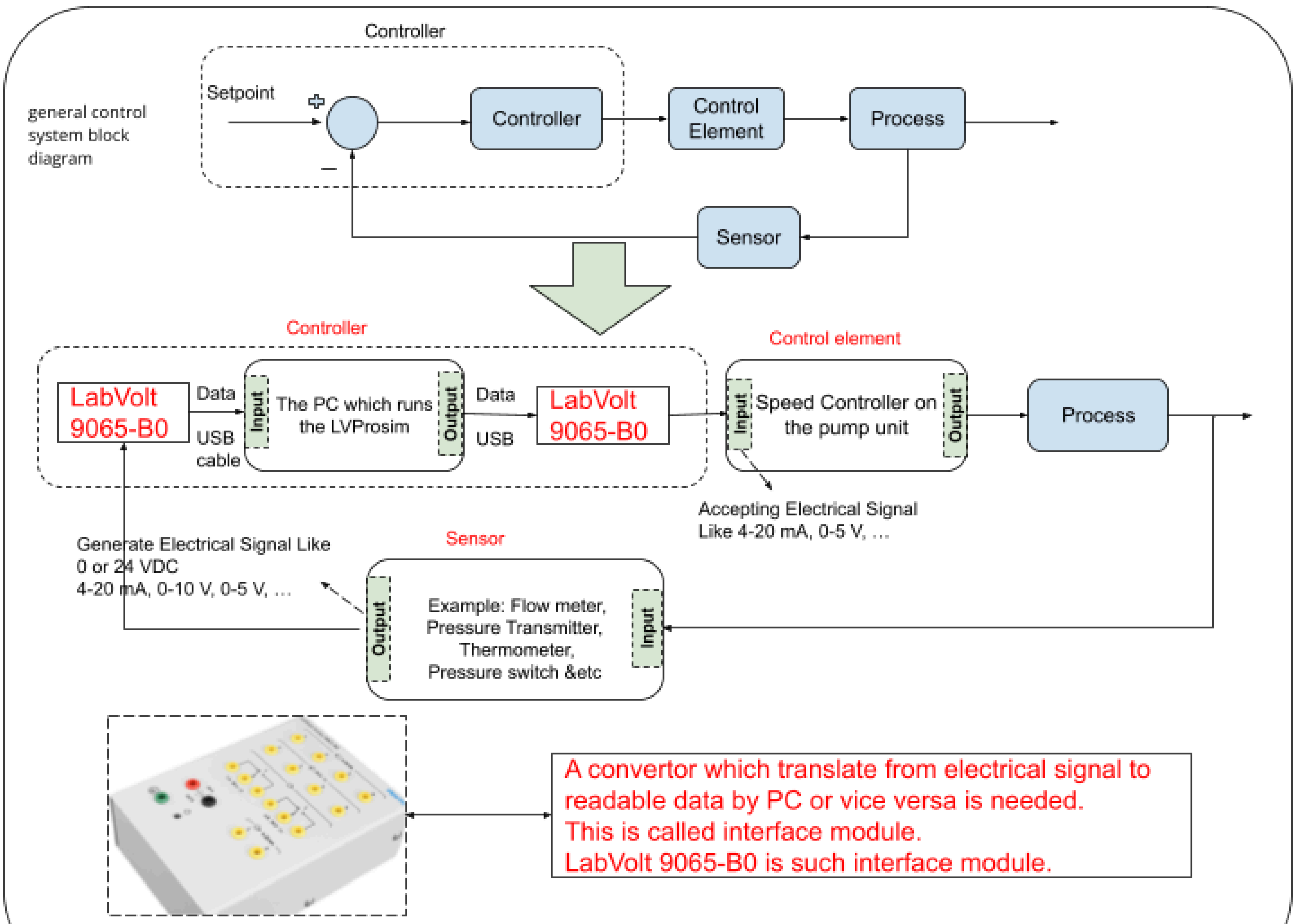

Figure (L2-1) - Control system components and interfacing

1-2) Figure (L2-2) shows the connection of the sensor output to the input port of the interface module and also the connection of the interface module output to the input of the actuator. The connection of the interface module to the computer is via USB cable. Study the Figure (L2-2) and look at the interface module and identify the input ports, output ports and USB connections to the computer. Check the USB cable is connecting the interface module to your station computer.

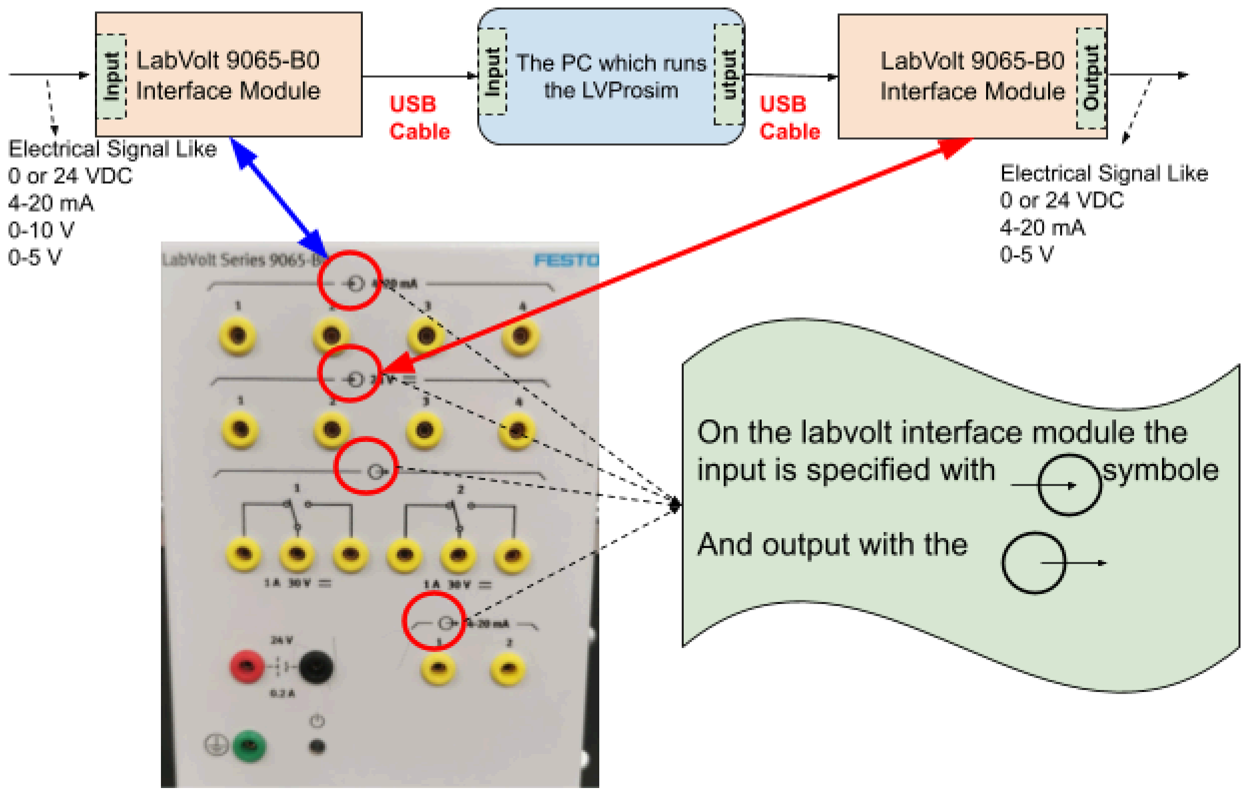

Figure (L2-2) - LabVolt interface module connection to Measurement devices, PC and the pump unit

1-3) The interface module needs power to turn on. The power can be provided to the module through the red and black port. At your station there is a 24 VDC power supply module. Wire the power supply module to the interface module and power it up. Connect the ground port of the interface module to the 0 VDC. If your connection is correct the light on the interface module should turn on.

LVProsim Software startup:

1-4) For the electrical connection refer to Figure 1 in the "Using LVProSim_en.pdf" manual in blackboard.

1-5) Turn on the station computer and log in.

1-6) Run the program "LVProSim Start Server" in "Start Menu/Festo Didactic" . Wait for a few seconds to automatically close.

1-7) Run the program "LVProSim" in "Start Menu/Festo Didactic.

1-8) The software will open. In the pop-up window, select "USB-IO" and then click "Confirm". (Figure (L2-4))

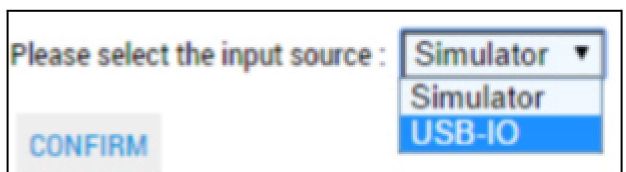

Figure (L2-4)

1-9) Figure (L2-4) shows the LVProsim user interface which you should be able to see on your computer screen now. For more information about the software you can refer to the "Using LVProSim_en.pdf" manual on the blackboard.

1-10) On the right side of the screen you can see a window called "PID Controller". PID1 is associated with output1 and PID2 with output2 on the interface module. Set up your PID1 and PID 2 parameters as Figure (L2-5).

For the next step make sure the multimeter is set up for measuring the current and will be connected to the circuit in series.otherwise the multimeter fuse will burn.

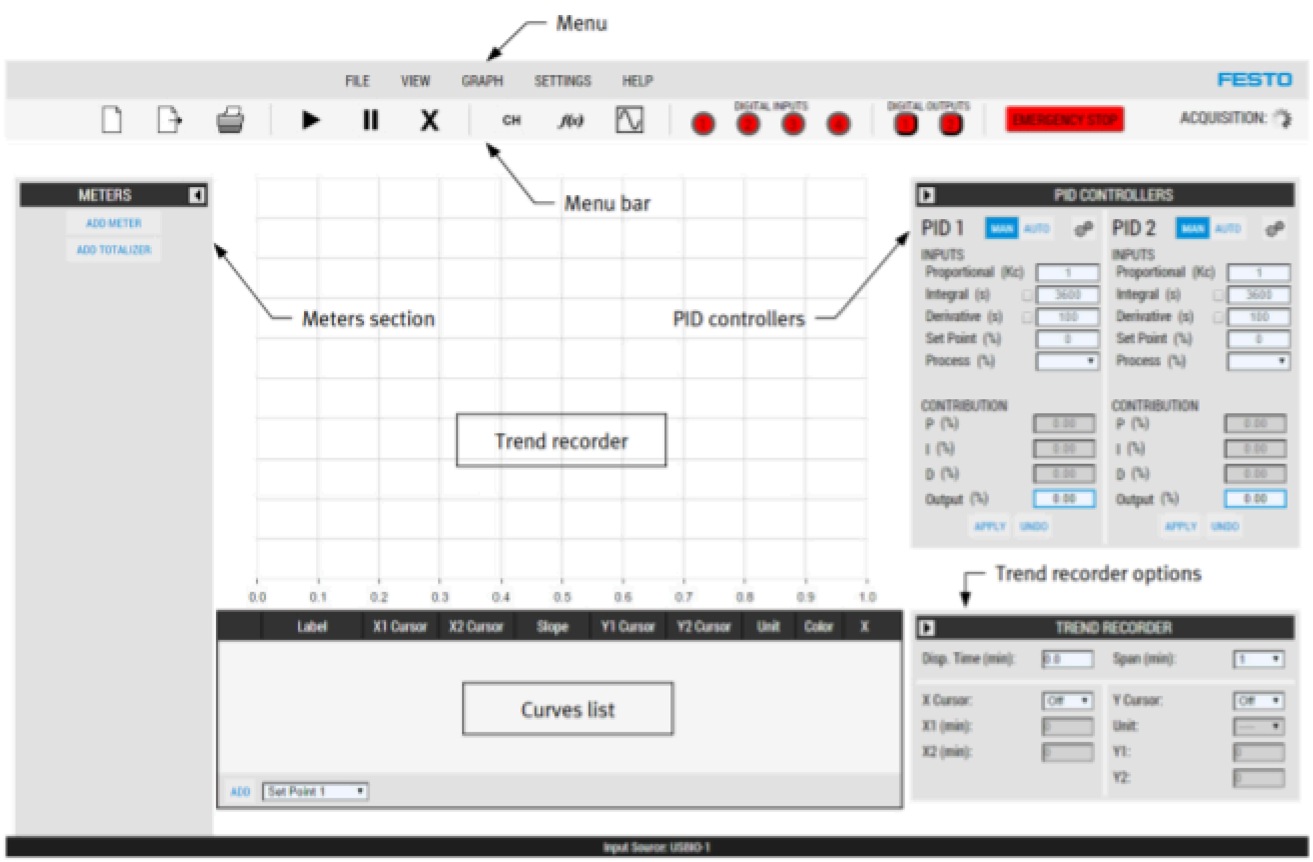

Figure (L2-4) LVProsim User interface

1-11) Take a multimeter and measure the electric current coming out of Output1 and Output2 of the interface module.

Output1 ...7.20... mA

Output2 ...10.75... mA

1-12) Change the PID1 output to 100% click apply and measure the output 1 current.

Output1 ...20.05... mA

1-13) Make the output1, 0% and then 50% and measure the output current in mA. Repeat this step 5 times and fill out the below table.

	1st try	2nd try	3rd try	4th	5 th
Output in mA	11.96	12.01	12.01	12.01	12.01
Average	12 mA				
Error from average in %	0.3%	0.1%	0.1%	0.1%	0.1%
Multimeter repeatability in % (Maximum Error)	0.3%				

Instructor Signature for Section 1 ....

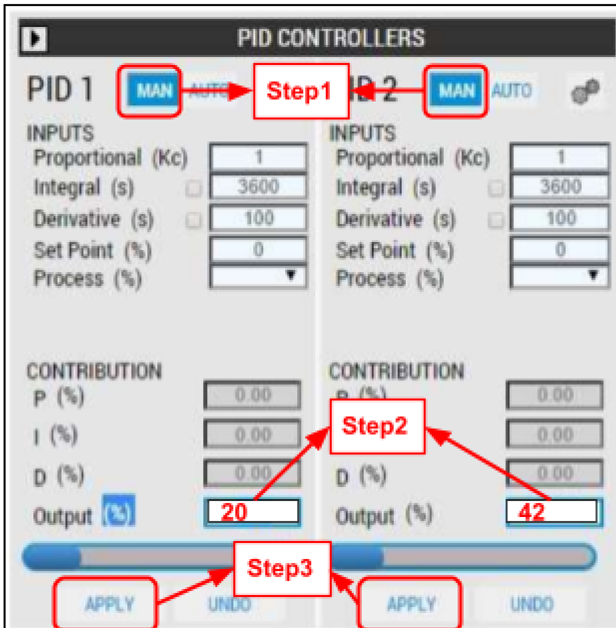

Figure (L2-5)- Output manual setup

2- Read a P&ID and make a system

2-1) Figure (L2-6) is a P&ID of a flow system, Take the component you require from the cabinet and connect the hoses.

Instructor Signature for Section 2 ....

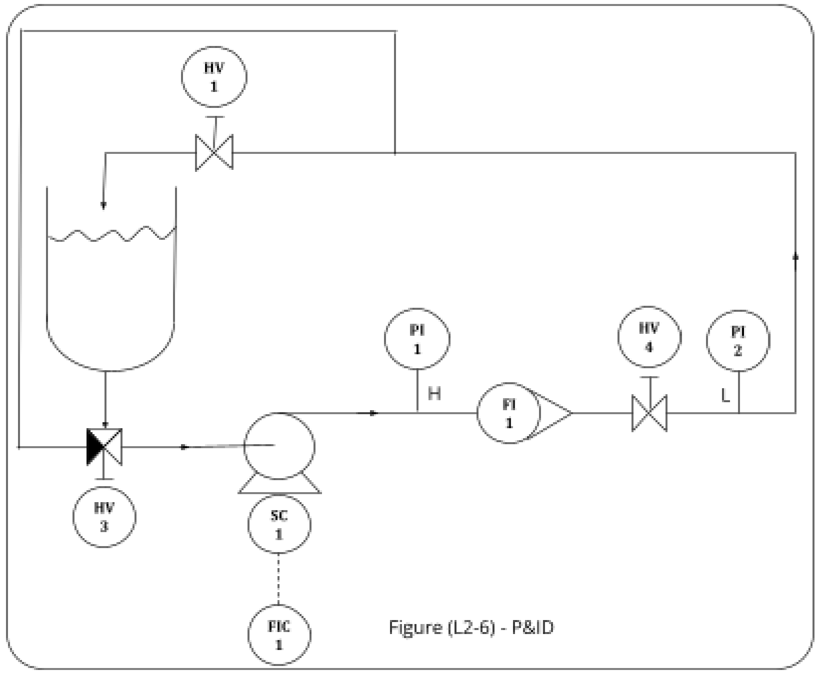

Figure (L2-6) - P&ID

3- To set up and operate a basic flow circuit:

3-1) On the pump unit,

a. Open HV1 completely (turn the handle fully counterclockwise)
b. Close HV2 completely (turn handle fully clockwise)
c. Set HV3 for directing the full reservoir flow to the pump inlet (turn handle fully clockwise)
d. Open the HV4 fully

3-2) Now follow wire up the interface module output1 to the speed controller input on the pump unit. Make sure the ground of the pump unit is connected to 0 VDC of power supply.

3-3) Turn the pump unit ON by setting its POWER switch at I. Then, increase the PID1 controller output gradually to 100% to make the variable-speed drive of the pump unit rotate at maximum speed.

3-4) You should be able to see that the motor shaft is rotating and water passing through the rotameter and returns to the reservoir.

3-5) Change the controller output to see the speed of the motor and the flow changes on the rotameter.

3-6) If you do not observe this, start over from Step 3-5 and troubleshoot the system.

3-7) Amount of water flowing out of the pump in a given amount of time is called ***flow rate***.

3-8) **Flow rate** is measured in Liters / minute (L / min), gallons US / minute (gal US / min), cubic meters / hour (m^3 / h), etc.

3-9) Record below, the flow rate indicated by rotameter. The flow rate must be read at the top of the rotameter float, as shown in Figure (L2-7)

3-10) Set the output1 value as following table and fill out the table:

Row #	Motor Speed	Flow rate (L/min)	Flow rate (gal US / min)	PI1 (psi)	PI1 (psi)	Pressure Drop ΔP=PI1-PI2
1	40%	4	1.125	1	0.5	ΔP = 0.5
2	Increase to 60%	6.4	1.75	2.8	1.2	ΔP = 1.6
3	Increase to 80%	8.5	2.6	5.6	2.8	ΔP = 2.8
4	Increase to100%	10.5	2.75	9.30	4.4	ΔP = 4.9
5	Decrease to 60%	6.3	1.5	3	1.4	ΔP = 1.6
6	Decrease to 40%	4	1.25	2	0.5	ΔP = 0.5

Instructor Signature for Section 3 ....

3-11) Stop the variable-speed drive of the pump unit by setting the controller output at 0% (4 mA or 0 V)

3-12) Turn off the pump unit by setting its POWER switch at 0

3-13) Disconnect the circuit. Return the components to their storage location.

3-14) *Wipe off any water from the floor and the Process Control Training System*

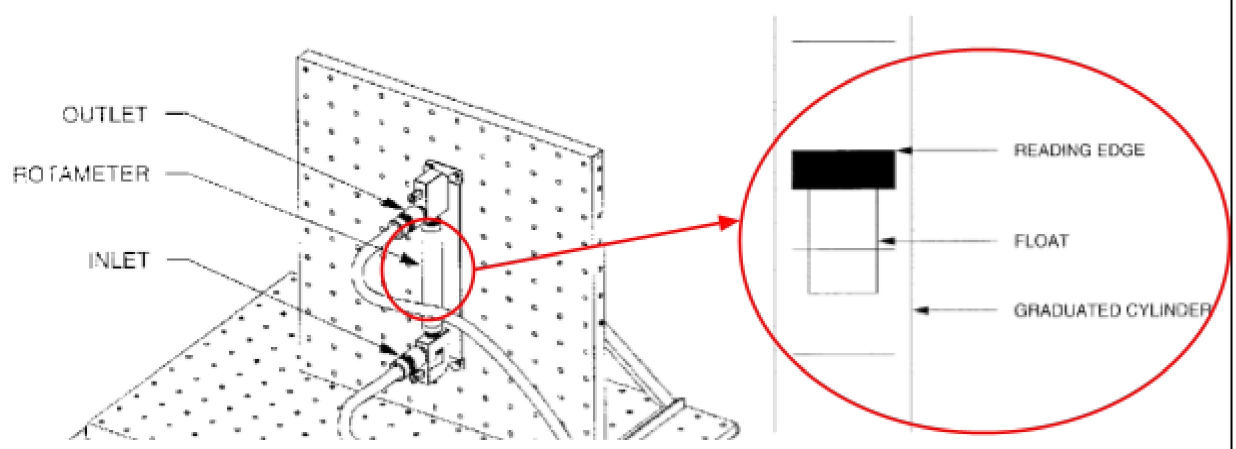

Figure (L2-7) Flow circuit setup

Assignment:

1) Calculate the output value in mA for the applied percentage of output 1 and 2 in step 1-11. If we assume the calculated value is the true value, what is the measurement error in percentage? What might cause the error in measurement?

2) In step 3-10, the pressures PI1 or PI2 are measured two times at 60% of full speed. Do you see any difference between PI1 the first and second readings of PI1 or PI2? If yes, what sensor characteristic is observed here ,name it and elaborate on that.

1) Output 1 = $\left(\frac{20}{100} \times 16\right) + 4 = 7.2\,mA$

Output 2 = $\left(\frac{42}{100} \times 16\right) + 4 = 10.72\,mA$

error could be faulty wiring improper connections or electrical noise.

→ true − measured =

output 1 = 7.2 − 7.2 = 0%

output 2 = $\frac{|10.72 - 10.75|}{|10.72|} = 0.3\%$

2) the hysteresis Sensor characteristic which Displays different readings if the output is increasing or decreasing. So yes there is a difference in the reading