Instrumentation and Measurement

Lab 6

Pressure Switch Test & Calibration

Date the Lab was performed (mm-dd-yy): 03/15/2024

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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. Submission with handwriting for explanatory questions will not be accepted.
2. Scan and create a SINGLE .pdf of all pages, do not submit each Page of your lab report as a separate file
3. Type the answer of the explanatory questions like 2-10 and 2-12 on your pdf file. You can use Edge browser for typing on a pdf file.
4. The lab report file must be named in the following manner:
   "Your First Name_YourLast Name.pdf",
5. Upload and submit the pdf of your lab report in Blackboard.

Marking:

☐ Section 2	[ ] / 40
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☐ Assignment	[ ] / 20

* Every 20 minutes late is subjected to 10 marks deduction

Pressure Switch Test & Calibration

Objective:

1) To study and test a pressure switch
2) Observing diaphragm mechanism and spring balanced force measurement
3) Calibrate a pressure switch

1) Preparation:

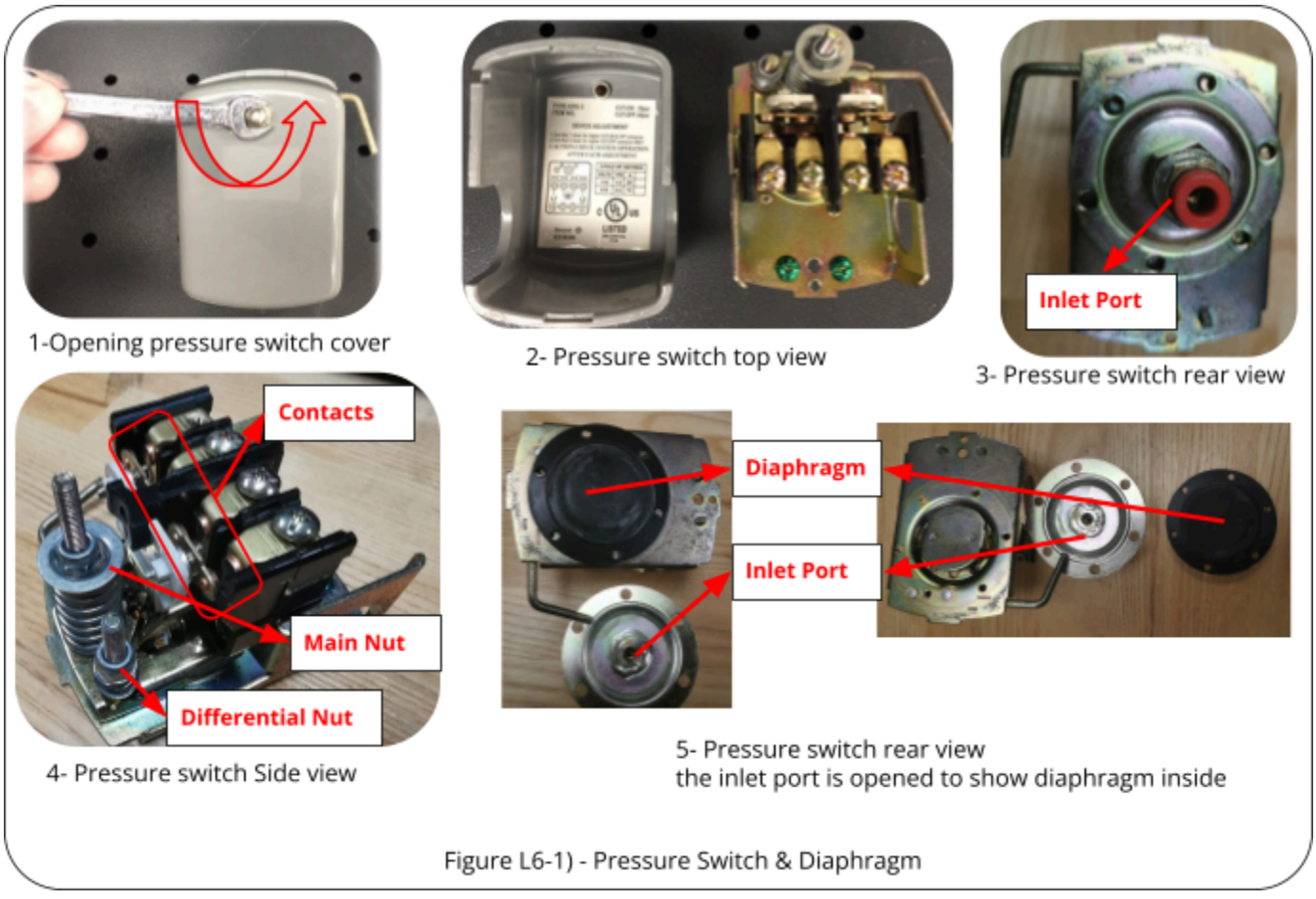
1-1) Fluid (Either Gas or Liquid) pressure is the force applied to fluid surrounding per unit area. There are different units to measure the pressure. The one which is used today is psi which stands for pound-force per square inch. For example if the pressure of water inside a hose is measured by a pressure gauge as 10 psi, it means the water applies 10 pound-force to every 1 square inch to the inner surface of the hose.

1-2) A pressure switch is an electrical switch which closes (makes) or opens (breaks) contact when the pressure of the fluid reaches a certain point known as *Preset Value.*

1-3) The pressure switch like any other switches can have either Normally Open (NO) contact or Normally Closed (NC) contact.

1-4) In today's pressure switch, the pressure value which closes a contact (either NO or NC) is referred to as “Cut-On” pressure and the pressure which opens a contact is referred to as “Cut-Off” pressure.

1-5) Take one pressure switch you see in Figure L6-1 and a wrench from the blue toolbox in the cabinet then open the cover.



1-Opening pressure switch cover

2- Pressure switch top view

3- Pressure switch rear view

4- Pressure switch Side view

5- Pressure switch rear view
the inlet port is opened to show diaphragm inside

Figure L6-1) - Pressure Switch & Diaphragm

1-6) After opening the cover identify different parts of the pressure switch. Please do not open the inlet port, your instructor will open one for you to show the diaphragm and how pressure is counterbalanced with spring force and converted to motion to open and close the contacts.

1-7) You see a spring under the main nut. The fluid pressure pushes the diaphragm and beam underneath, until it overcomes the main spring force. Turning the main nut could compress or release the spring and change the force applied by spring on the diaphragm beam. Then the cut-on and cut-off pressure to open and close the contacts can be adjusted. During the experiment you will observe how turning the main nut changes the cut-on and cut-off pressure on the pressure switch.

1-8) Take a multimeter to check if the electrical contacts are open or close. Figure L6-2 shows how to set up your multimeter in the "Continuity Mode" step by step. You need to press the yellow button after step 1 and 2 in Figure L6-2 until you see the beep symbol on the top of the display. After setting up, if you connect the black and red lead head to each other, you should be able to hear a beep sound.

Figure L6-2) Multimeter in continuity check mode

Figure L6-3) Air pressure regulator

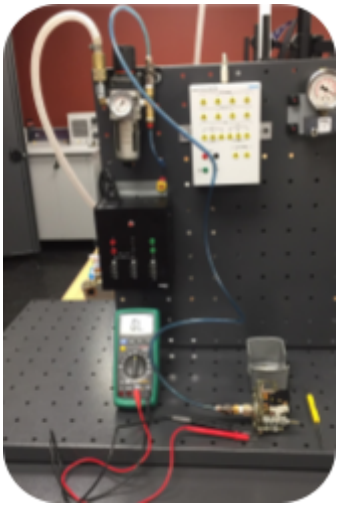


Figure L6-4) Hose connection


Figure L6-5) Multimeter connection

2) Test Pressure Switch:

2-1) There is a label inside the pressure switch cover. Study the label and write down the specification and factory initial calibration setting. *(5 Marks)*

Cut-On Pressure ..20..... psi Cut-Off Pressure .....40..... psi Electrical contact max amperage under 115V ..20.... A

2-2) The compressed air will be used to apply pressure and test the pressure switch. You can see the air pressure regulator in Figure L6-3.

2-3) Connect the air pressure to the inlet port of the pressure switch by a hose as Figure L6-4 shows. Then put the lever on the pressure switch side on "Start".

2-4) Turn the knob on top of the air pressure regulator to apply air pressure to the pressure switch. You should be able to see that the electrical contact at some point closes and opens again.

2-5) After step 4 turn the pressure knob again to make pressure zero (the pressure gauge should show 0 psi).

2-6) Put the multimeter on the continuity mode as step 1-9 shows and then connect the multimeter to the pressure switch as Figure L6-5 to check if the contacts are open or closed.

2-7) Start to increase the pressure by turning the pressure knob and listening to the multimeter and look at the pressure gauge. Write down your reading for: *(5 Marks)*

Cut-On Pressure ...10..... psi Cut-Off Pressure ...25..... psi

Instructor Signature for Step 1 to 7 .....

2-8) Make the pressure zero again. Turn the main pressure nut 5 complete turns clockwise using the 5/16" – 11/32" / 11mm wrench as Figure L6-6 shows. Do not adjust the differential pressure nut.

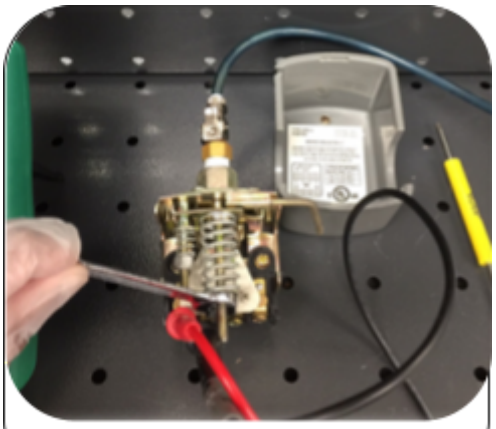


Figure L6-6 Pressure Nut Adjustment

2-9) Repeat Step 7 and write down: *(10 Marks)*

Cut-On Pressure ...18..... psi Cut-Off Pressure ...38..... psi

2-10) Compare Step 2-7 and Step 2-9 observation, explain what has happened? *(5 Marks)*

After tightening the main nut, the spring compressed further increasing the overall pressure cut on and cut off range for the pressure switch.

2-11) Make pressure zero again and this time turn differential pressure nut 5 complete turns clockwise. Do not adjust the main pressure nut. Repeat step 7 and write down: *(10 Marks)*

Cut-On Pressure ...18..... psi Cut-Off Pressure ...40..... psi

2-12) Compare Step 2-11 and Step 2-9 observation, explain what has happened. The differential knob made the cut-on and cut-off differences smaller or larger? *(5 Marks)*

After tightening the differential pressure nut, the cut on value for the switch state where as the cut off value increased therefore increases the range of the switch.

Instructor Signature for Step 9 and 11 .....

3) Pressure Switch calibration:

The objective of this section is to calibrate the pressure switch for desired Cut-on and Cut-off pressure value. Let's assume the desired cut-on pressure is 22 psi and cut-off is 38.

3-1) Make the air pressure zero.

3-2) Set the air pressure from the pressure regulator on 22 psi. The pressure gauge should show 22 psi.

3-3) Start to turn the main pressure nut on the pressure switch until the electrical contacts closes.

3-4) Set the air pressure from the pressure regulator on 38 psi. Start to turn the differential nut on the pressure switch until the electrical contacts open.

3-5) Repeat Step 2-7 and write down your reading:

Cut-On Pressure ..22.. psi Cut-Off Pressure ..38.. psi

if the measured value are not close to 22 and 38 psi, you need to repeat to refine your calibration

Instructor Signature for section 3 .....

4) Strain Gauge Observation and Measurement:

4-1) In Figure L6-7 , you see a cantilever beam which is equipped with a metal strain gauge. Pick up one of those from the cabinet and look up the strain gauge on it.

4-2) Measure the resistance of the pad in three states as below:

Beam straight 0.999 KΩ ⟶ 990Ω

Apply force to the head of the beam and bend it

clockwise to 45 degrees 0.994 KΩ → 994Ω

Counter clockwise to 45 degrees 1.002 KΩ → 1002Ω

What type of stress is applied to the beam Shear

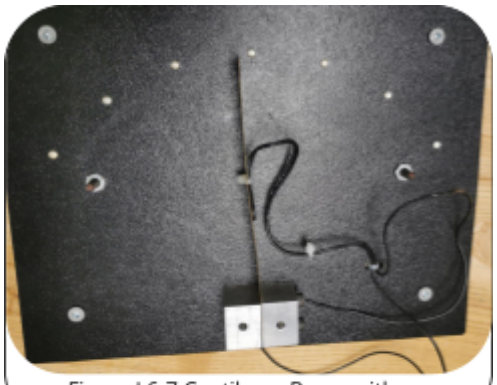


Figure L6-7 Cantilever Beam with metal strain gauge

Figure L6-8 Metal strain gauge

5) Assignment:

5-1) If this switch is directly used for turning on and off a motor, what could be the maximum power of the motor? Show the calculation in steps *(10 Marks)*

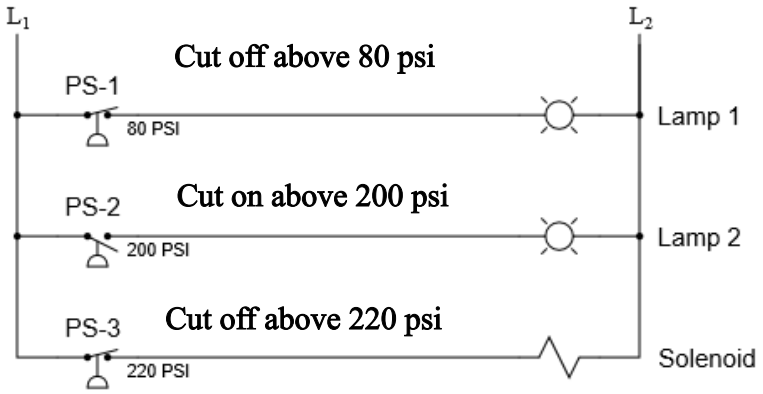
$$H_P = \frac{I_{(amp)} \times V_{(volts)} \times E_{(efficiency)} \times PF_{(power\ factor)}}{746}$$

$$H_p = \frac{20 \cdot 115 \cdot 1\,(\text{assuming } 100\%) \cdot 1}{746}$$

$H_p = 3.08$

3.08 HP

5-2) In the ladder diagram below, all three Pressure Switches PS-1, PS-2 and PS-3 are controlled by the same process pressure. In other words, PS-1, PS-2 and PS-3 are always sensing the same pressure. Each pressure switch has only one triggering point, either cut-on or cut-off. The cut-on and cut-off pressures for the switches are shown beside their symbols. Complete the Table below, based only on the given Cut On and Cut Off pressures, to show the state of Lamp 1, Lamp 2 and Solenoid for each process pressure in the Table. *(10 Marks)*



Pressure (psi)	Lamp1 On/Off	Lamp2 On/Off	Solenoid On/Off
0	On	Off	On
150	Off	Off	On
210	Off	On	On
220	Off	On	Off
250	Off	On	Off