WPI. ME 3901 Engineering Experimentation

D-2012

Pressure Transducer Calibration

Objectives:

The objectives of this laboratory are to:

- calibrate a pressure transducer;
- perform a linear regression of data;
- verify appropriate manufacturer's specifications.

Problem Statement:

A pressure gage, such as that shown in Fig. 1, requires the operator to take manual readings. A pressure transducer produces an electrical output that can be recorded continuously with an automated data acquisition system. In this experiment a pressure transducer will be calibrated and the results will be compared to the specifications shown in Fig. 2.

The transducer requires a regulated excitation voltage between 8 and 16Volts. With 8Volts excitation the nominal output is 1 V at zero pressure and 6 V at a full-scale pressure of 100 psig. Therefore, the nominal voltage change is 5.00 V (6-1) for a pressure change of 100psig (100-0). This gives a V/EU (Volts/Engineering Unit) of 50 mV/psi combined with an offset at zero psi. If the excitation voltage is doubled to 16 V, the output voltage is also doubled to give a V/EU value of 100 mV/psi. See Note 1 below

You will calibrate the pressure transducer using a mechanical gage as the reference. (See Note 2 below.)

Note 1: For our experiment a regulated excitation voltage selectable between 10, 12 and 15 volts will be provided by a strain gage amplifier. Voltages less than 8 volts are outside the specified limits for the transducer and should not be used.

Note 2: We will assume that the mechanical pressure gage is calibrated and reads exactly. You should be able to read the pressure to ± 0.5 psi – half the least significant digit (*if graduations on gage are 1 psi increments*). When you record your measurements write down the appropriate number of digits. For example, 24 is not the same as 24.0. In the first instance you are implying that it is +/– 0.5 psi while in the second you are implying +/– 0.05 psi. A note should indicate the all readings are **+/– 0.5 psi**. In a certified calibration lab we would use a much more accurate and precise calibration standard such as a dead-weight tester or a pressure transducer with an accuracy of at least four times that of the transducer we are trying to calibrate.

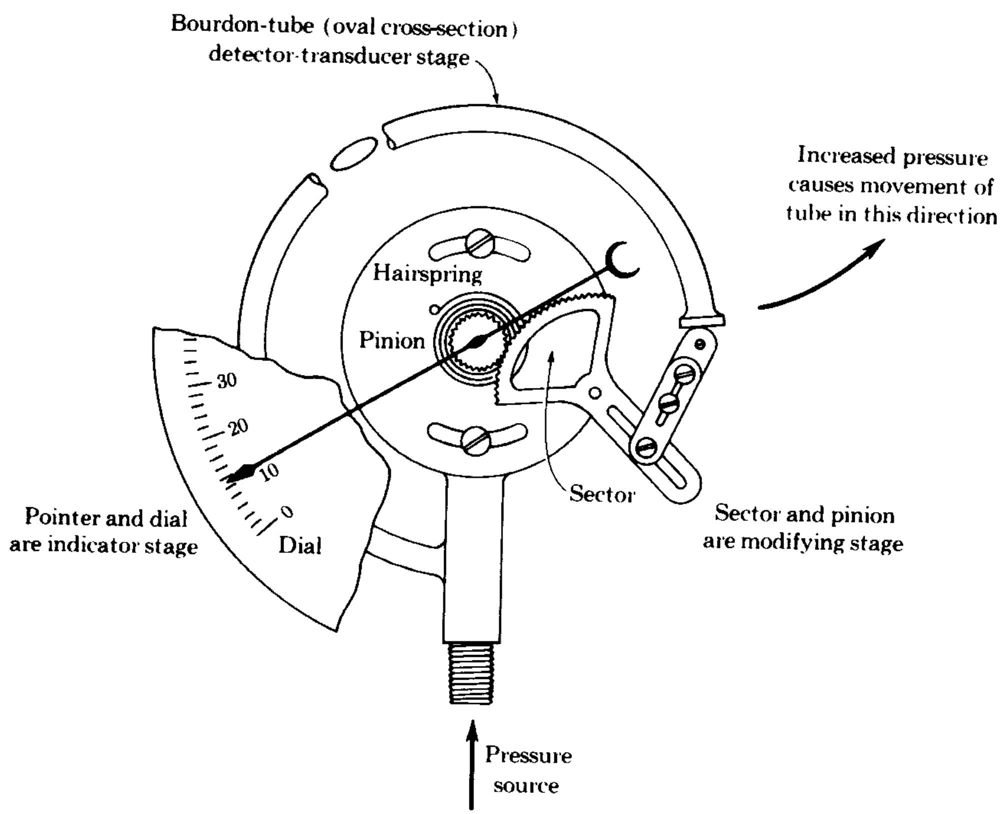

Figure 1: Small displacement of tube is amplified at center of gear, which visually displays the pressure (Holman, 1989).

Figure 2: Omega Pressure Transducer for the 0-100 psig range

MADE IN USA

PX242

Metal Case Transducer for Measuring Low Pressure and Vacuums

$ 149.00

PX242-100G5V

- **Silicon Diaphragm**
- **Buna-N Seals**
- **8.0 Vdc Excitation**
- **12 Inch Lead Wires**
- **-40 to +85°C**
- **1 to 6 Vdc Output**
- **Temperature Compensated**
- **Rugged Low Profile Easy-to-Mount**

Click **here** for larger image.

Click Here for Product Specs.

SPECIFICATIONS

Excitation: 8 Vdc regulated (16 V max.)
Output: 1 to 6 Vdc into 800 Ω min
Linearity: ±1.5% FS BFSL, ±0.5% FS for 60 to 100 psig
Hysteresis & Repeatability: ±0.25% FS
Zero Balance: 1.0 Vdc ±0.05, PX243 3.5 Vdc ±0.05
Compensated Temperature Range: 0 to 145°F (-18 to 63°C)
Operable Overpressure: 2 x FS
Response Time: 1 ms
Gage Type: Solid State Piezo-Resistive
Body Material: Die-Cast Aluminum
Pressure Port: 1/8 -27 NPT male

Equipment:

A) A compressed-air tank, of about 3 gallons volume, is displayed in Figs 3 and 4. Note the pressure gage and pressure transducer on the tank, as well as the air hose connection and valve. Make sure all connections are secure before beginning the lab. Make sure all lab partners are wearing safety glasses!

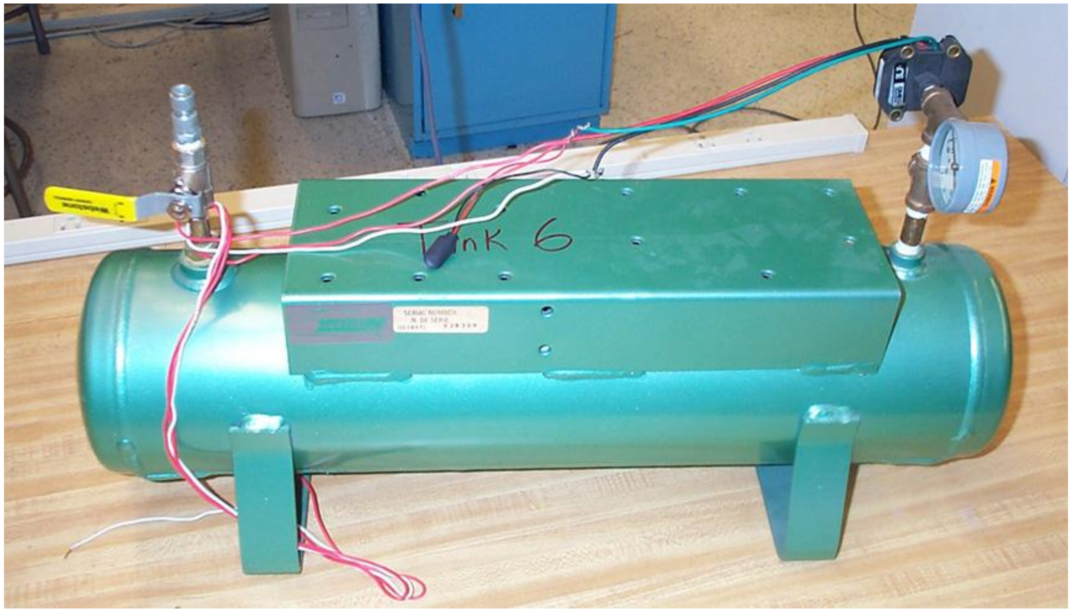

Figure 3: Compressed air tank with pressure gage and pressure transducer on right.
The inlet/outlet valve is shown on the left side of figure.

Figure 4: Enlarged view of pressure gage and pressure transducer with its 3 wires (red, black, and blue)

B) Wire the pressure transducer.

The 'red' and 'black' wires need to be connected to the excitation voltage. (A standard 9-volt battery connection is provided. The circular connection is negative.)   The 'blue' and 'black' wires are used to read the output voltage, which is a function of the pressure. Note, the black wire is ground for both excitation and output readings. The source and output voltages need to be read by your LabVIEW program. Therefore, two analog reading channels on the 1322 terminal connection card need to be configured.

C) Check the voltages

If you are not using battery power, ignore this paragraph.

Check that the battery voltage is about +9 volts and the output voltage is in the range of +1 volt when the battery is connected and the tank is NOT pressurized. Once this is verified, disconnect the battery while other parts of the lab are being set-up. Note: Always disconnect the battery when not running a test to conserve the battery (if using a battery).

D) VI Construction

There are two parts to this experiment. Calibration of the transducer and using the transducer. You will need to either build two separate VI's or a combination "Calibrate/Use" VI. Your choice.

"Calibrate" Mode:

Inputs: There will be three inputs (1) V_{supply}, (2) V_{output}, and (3) Pressure (psi). The pressure input is a manual input of the gage reading and the voltages are read by the VI using either two single-channel analog inputs or one multi-channel analog input.

In the calibration mode you are collecting data to determine the calibration factors of the transducer. The slope of the calibration curve (V_{output} /psi/)/ V_{supply}. and the intercept at zero psi input. Data will be collected in sufficient detail to establish the relationships and to evaluate the performance specifications provided by the manufacturer. These characteristics include Linearity, Hysteresis and Repeatability, and Zero Balance. (Other specifications cannot be verified with the data we are collecting.)

Experimental Pressure Calibration:

Make sure all lab partners are wearing safety glasses!

Perform the following procedure **twice**. One set of readings with excitation at 10 volts and another set with 15 volts.

To calibrate: Pressurize the tank to somewhere between 85 and 100psig. It depends on the state of the compressor at the other end of the building! Do not exceed 100 psig. Have the VI record about 10 readings and note the gage reading at the start and end. Open the valve and vent some air such that the pressure gage drops about 10 psig. Note that when you let some pressure out of the tank and close the valve, the pressure will increase! (Thermodynamics is involved here.) After the pressure has stabilized take a set of readings. (Appending to a file would be a convenient approach to take here.) Repeat the process until the tank is at atmospheric pressure. This will comprise the first set of data. Verify that the data is stored on disk. Repeat the experiment **at least 3 times** so that you have enough sets of data to do a reasonable statistical analysis. Now repeat the test for the other excitation voltage.

Note, one does not need to use the ‘same’ pressure gage settings for each experiment. What matters is that you have at least 5-7 readings per full discharge so that the regression line is created with confidence.

"Use" Mode:

This mode will be used for taking pressure readings. The VI should be "user friendly". This means that any technical person should be able to enter the appropriate calibration factors and be able to read the pressure.

Create a VI that will record pressure vs. time to a file. In addition, display instantaneous pressure (psi units) in both analog and digital format along with a graphical readout of pressure vs. time with a horizontal scale that spans 60 seconds.

Inputs: There will be two analog inputs V_{supply}, and V_{output}, and two manual inputs derived from the calibration for intercept and slope.
The calibration factors entered on the front panel should be of the form:

$$psi = C_1*(V_{output}/ V_{supply}) + C_2.$$

(To help you decide if you are on the right track the values for C_1 and C_2 should be close to 160 psi and –20 psi respectively.)

Front Panel attributes:

1. Units must be labeled for all inputs and displays.
2. Appropriate readout resolution on the digital meter. (You determine what it should be.)
3. A fixed time scale on the graph in units of seconds from start. The total horizontal width of the display should cover 60 seconds.
4. The vertical scale must be fixed. **Do not** use auto scaling.

Final Checkout by Instructor:

A variable voltage power supply will be used to power the transducer. Several pressures will be measured with different V_{supply}. This will verify proper calibration and implementation of the equation for pressure.

The report will be a "Calibration Certificate" for the transducer showing the measured performance and indicating whether the unit passes or fails the specifications of the manufacturer.

References

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