WORCESTER POLYTECHNIC INSTITUTE
MECHANICAL ENGINEERING DEPARTMENT

Engineering Experimentation
ME-3901, D'2012

Laboratory #2 (Part 2)

General information

Please refer to handout:

"Laboratory 2: Pressure Transducer Calibration"

Objectives

The objectives of this laboratory are:

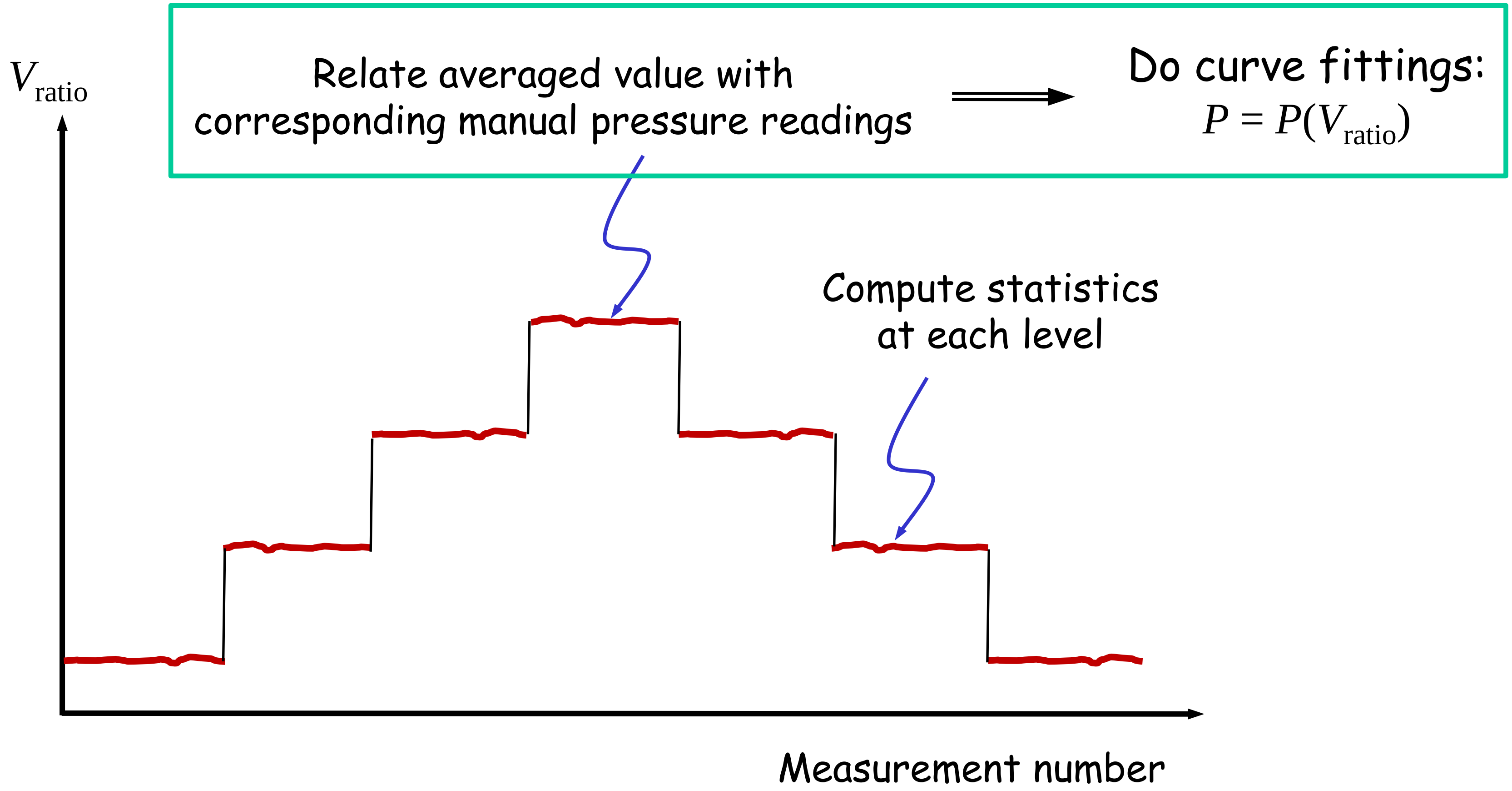
- Calibrate a pressure transducer
- Perform linear regression of data (least squares fitting)
- Verify appropriate manufacturer's specifications

Suggested procedure

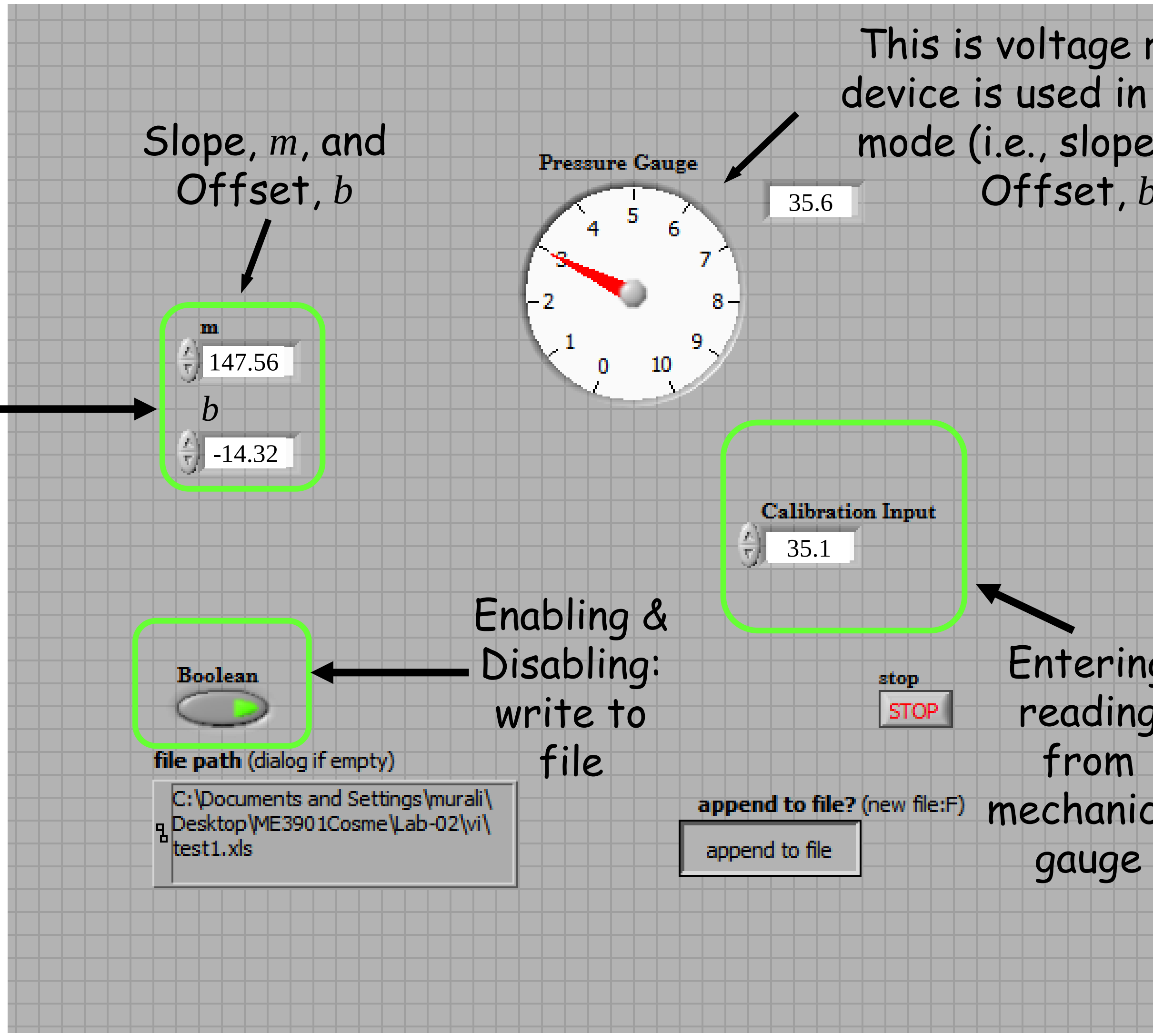
- Verify functionality of the developed VI by
  - Verify 2310 amplifier output signals
  - Account for suitable measuring ranges (DAQ's [-10, 10] V)
- Proper connection and installation of equipment and pressure sensor
- Record pressure sensor data together with manometer readings:
  - use a load and unload approach (e.g., 0→100 psig and 100→0 psig, which will help in verifying linearity and characterize hysteresis, if any)
- Do curve fittings to determine transfer function(s)
- Use results of the curve fittings and enter calibration parameters into your VI
- Record *calibrated* pressure sensor data together with manometer readings:
  - again, use a load and unload approach (e.g., 0→100 psig and 100→0 psig, which will help in verifying linearity and characterize hysteresis, if any)
  - do error analysis between calibrated data and manual readings

Load and unload approach: calibration

- Record pressure sensor data together with manometer readings:
  - use a load and unload approach (e.g., 0→100 psig and 100→0 psig, which will help in verifying linearity and characterize hysteresis, if any)



Front panel after calibration: enter calibration parameters



Slope, m, and Offset, b

This is voltage ratio when device is used in calibration mode (i.e., slope, $m=1$, and Offset, $b=0$)

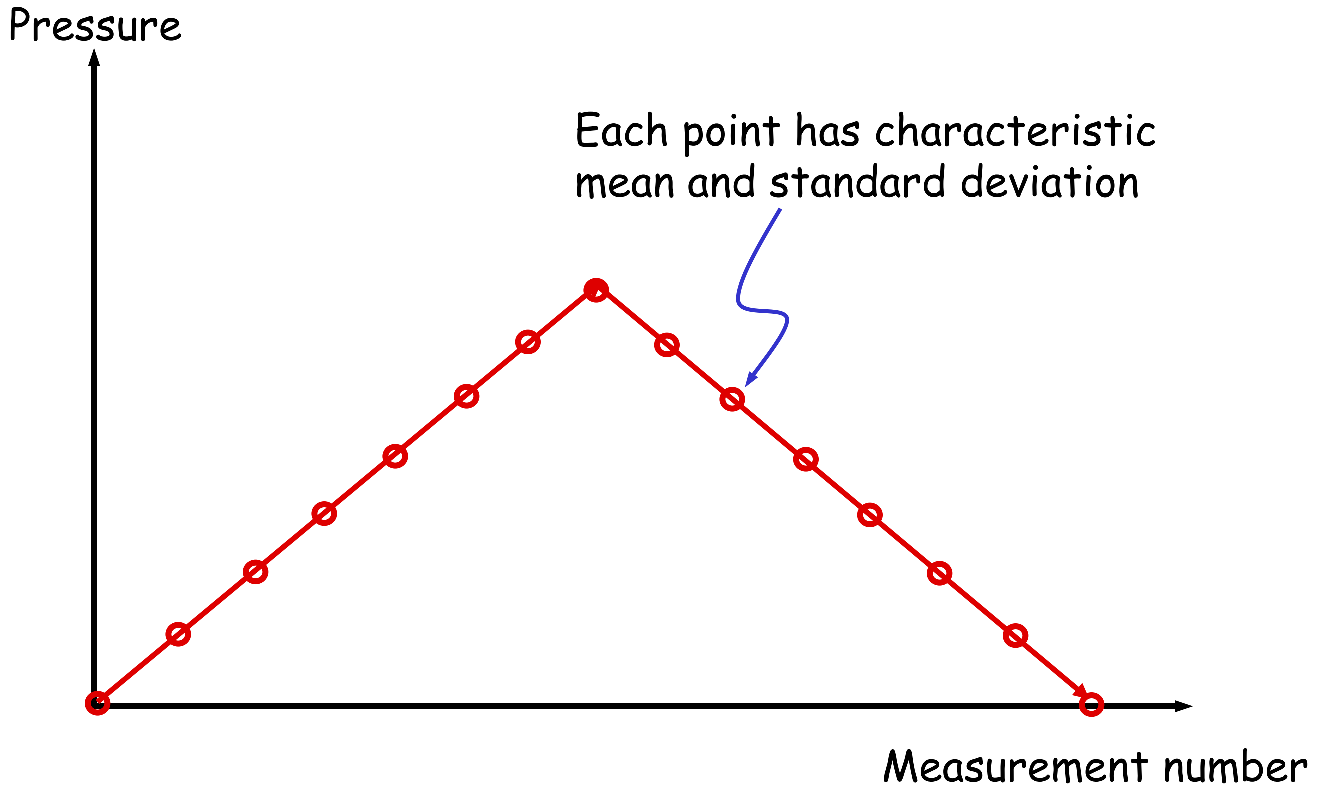
Data for transfer function

Enabling & Disabling: write to file

Entering reading from mechanical gauge

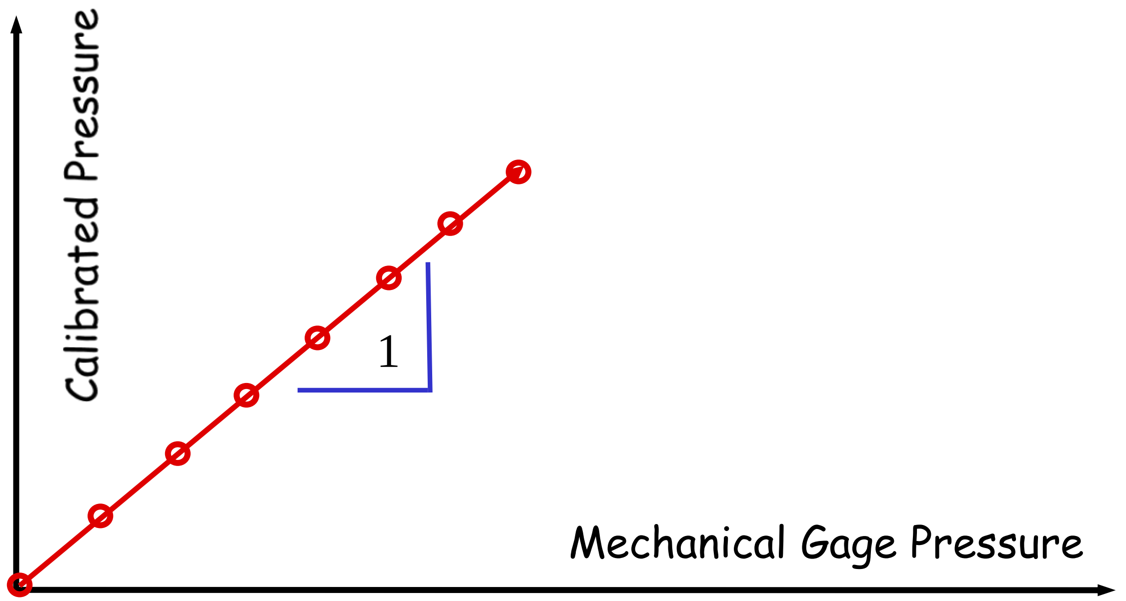
Load and unload approach: measuring mode

- You need to take measurements in two different modes:
  - **Calibration mode** (*gathering of data*, i.e., set slope to 1 and dc offset to 0)
  - **Measuring mode** (*verify calibration*, i.e., using your VI with slope and dc offset as obtained by your curve fitting computations)



Measuring mode (verify calibration)

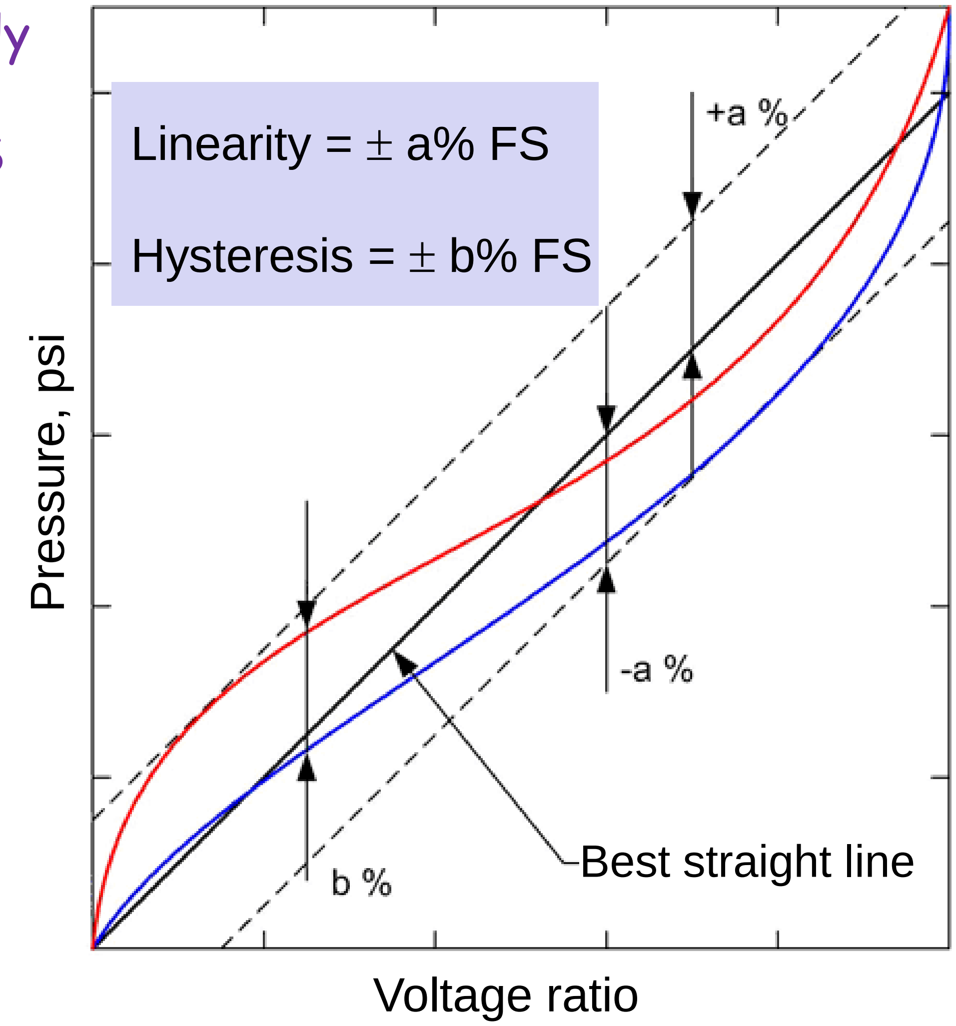
- Measuring mode (verify calibration, i.e., using your VI with slope and dc offset as obtained by your ***best*** curve fitting computations)
  - *Verify calibration*. Plot calibrated pressure versus mechanical gage pressure. Result should be a linear function with slope=1 and offset of 0.
  - *Verify manufacturer's specifications*, e.g., linearity and hysteresis



Linearity

- Linearity relates to the absolute value of the maximum deviation of a transducer's characteristic curve from a reference straight line.

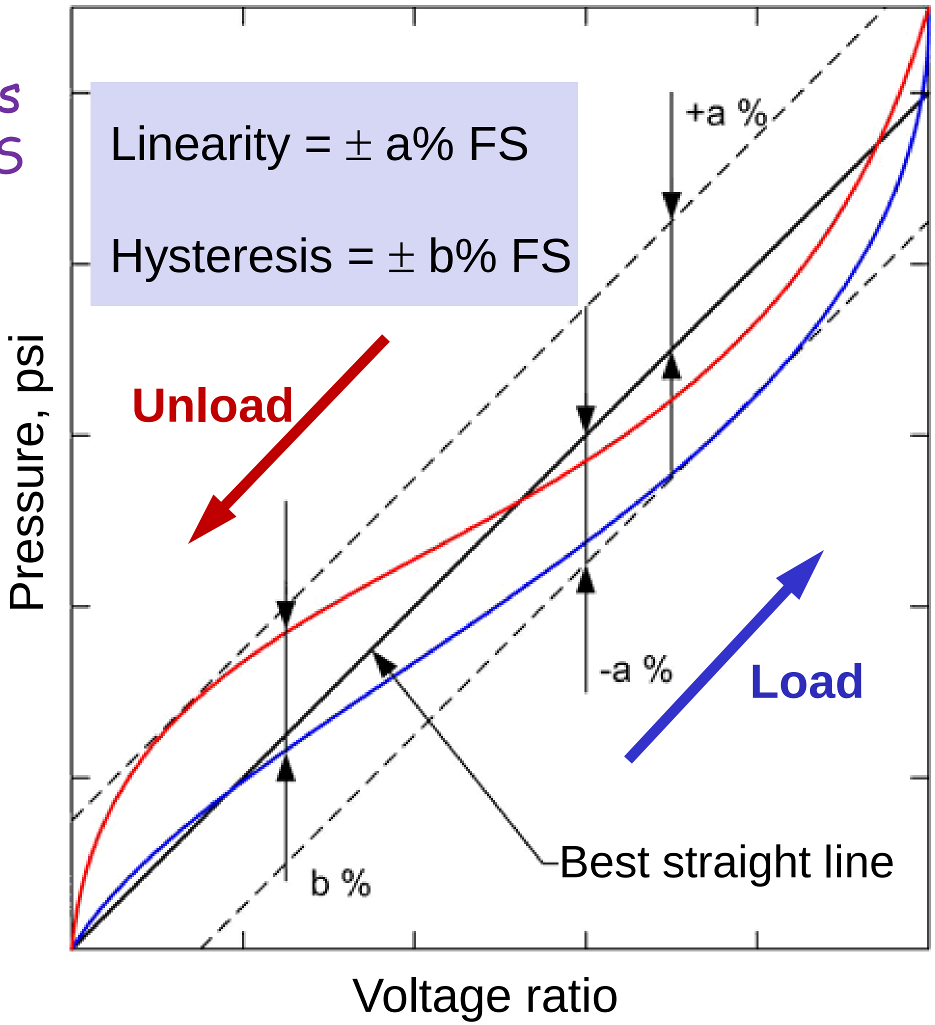
Linearity is usually reported as a percentage of FS



Hysteresis

- Hysteresis relates to the absolute value of the maximum difference between the load and unload characteristic curves of a transducer.

Hysteresis is usually reported as a percentage of FS



Background

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.

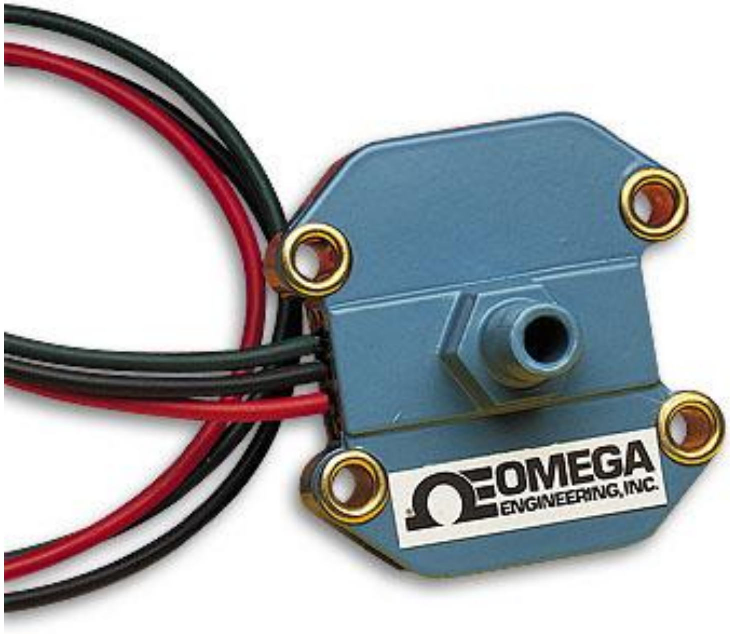


Fig. 2. PX242 Metal Case Transducer for Measuring Low Pressure and Vacuums

Background: major manufacturer's specifications

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

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

Notes:

FS = Full scale
BFSL = Best fit straight line

Background: specifications

- 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 100 psig (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.
- You will calibrate the pressure transducer using a mechanical gage as the reference.

Background: specifications

Note 1:

For our experiment a regulated excitation voltage selectable between 10, 12 and 15 volts will be provided by a strain gage amplifier (2310 signal conditioner)

Voltages less than 8 volts are outside the specified limits for the transducer and should not be used

Background: specifications

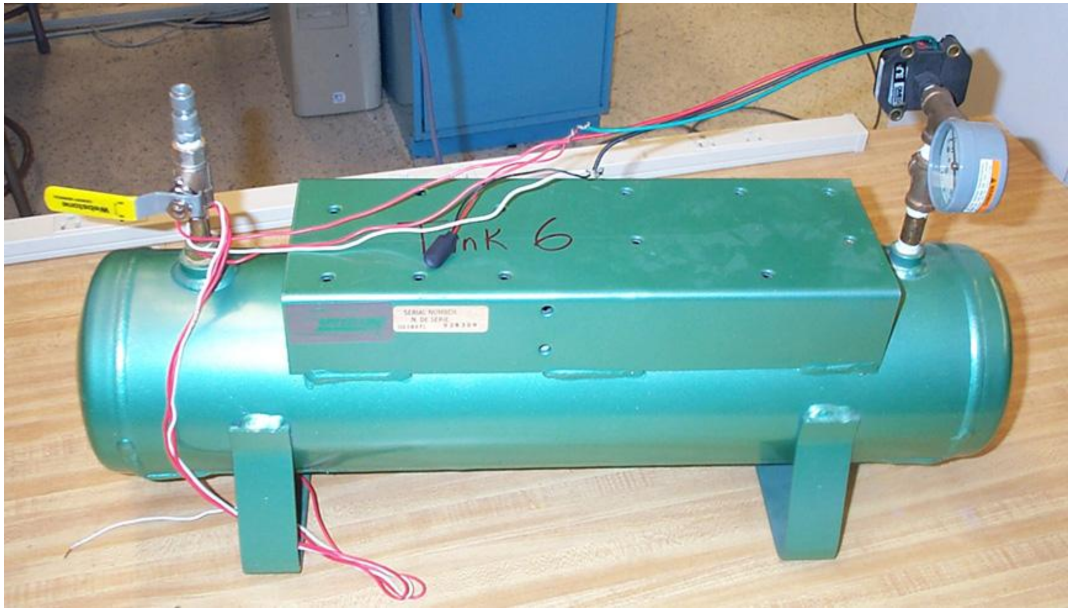
Note 2:

- We will assume that the mechanical pressure gage is calibrated and reads exactly.
- You should be able to read the pressure to within ± 1.0 psi (that is, ± 0.5 of one small division).
- 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 that all readings are within a specific resolution.
- 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.

Equipment

A compressed-air tank, of about 3 gallons volume. 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.

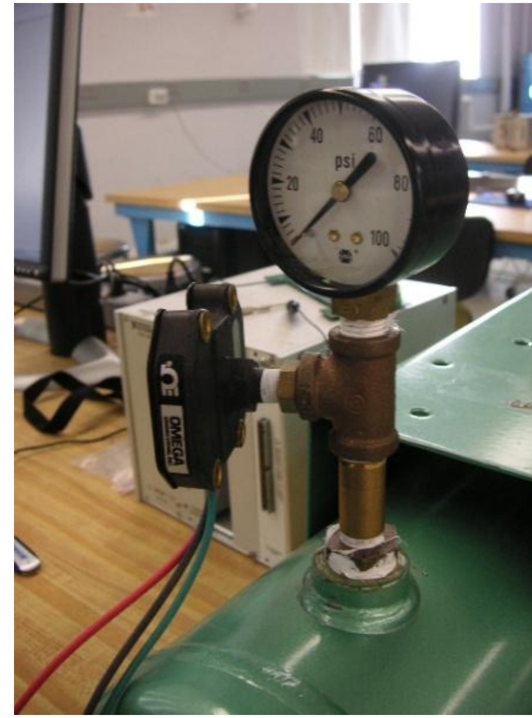
Make sure all lab partners are wearing safety glasses!

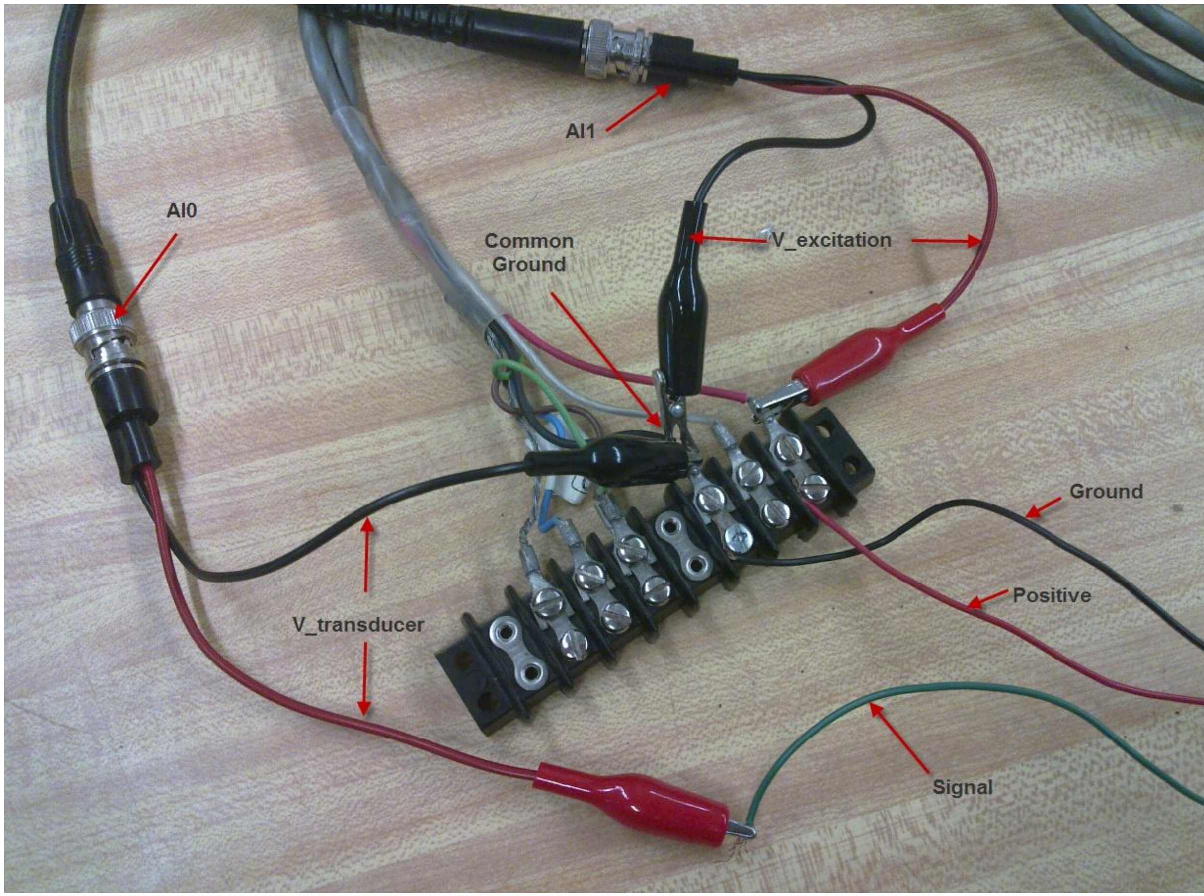


Equipment

Enlarged view of pressure gage and pressure transducer with its 3 wires (red, black, and green)

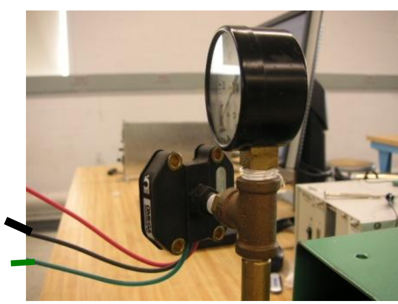
Channel configuration





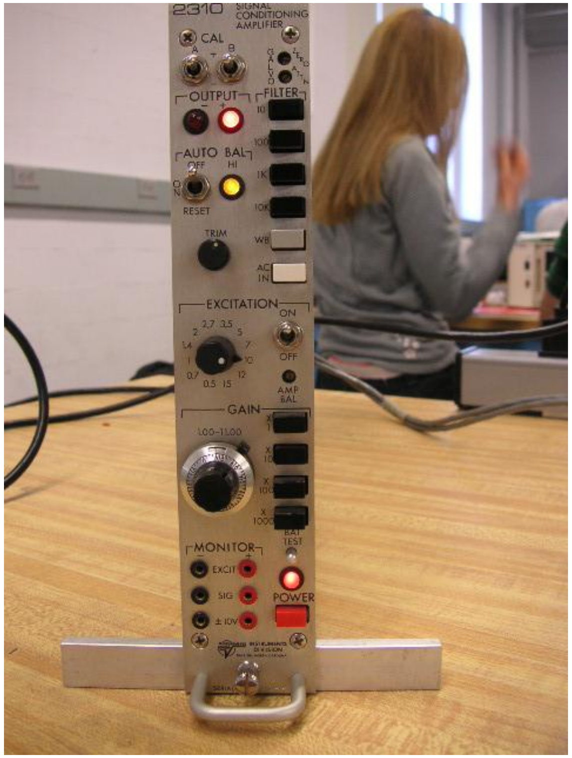
Red

Black



Green

Power supply



Use multiple excitation levels