

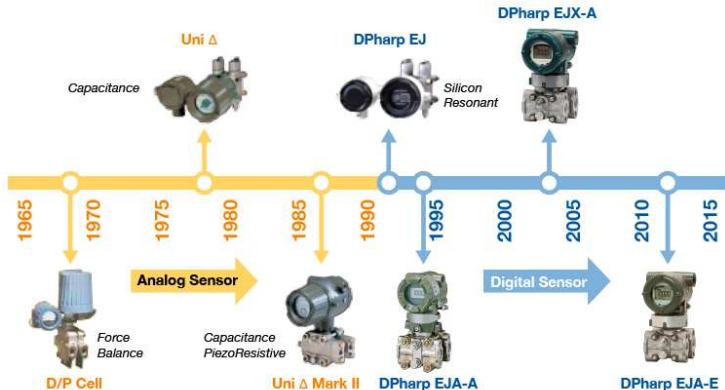
Technical Means of Automation

Pressure Sensors and Measurement

Institute of Information Engineering, Automation and Mathematics

October 15, 2015

Pressure Sensors



Pressure Sensors



Pressure

Pressure - the force (**F**) applied to the surface of an object per unit area (**A**) over which that force is distributed.

$$P = \frac{F}{A} [Nm^2] [Pa]$$

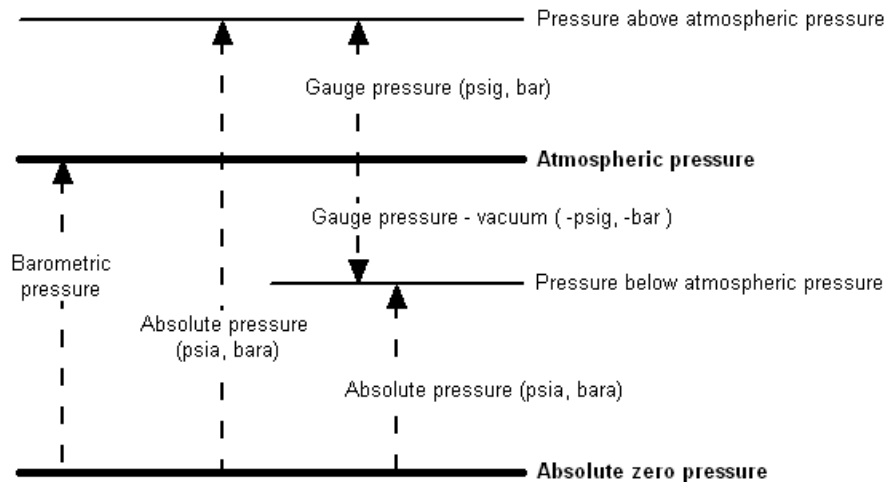
In many ways, pressure is the primary variable for a wide range of process measurements. Many types of industrial measurements are actually inferred from pressure, such as:

- **Flow** (measuring the pressure dropped across a restriction)
- **Liquid level** (measuring the pressure created by a vertical liquid column)
- **Liquid density** (measuring the pressure difference across a fixed-height liquid column)
- **Weight** (hydraulic load cell)

Pressure Sensor Types

- **Absolute pressure sensors** - measure pressure relative to perfect vacuum
- **Gauge pressure sensors** - measure pressure relative to atmospheric pressure
- **Vacuum pressure sensors** - measure pressures below atmospheric pressure
- **Differential pressure sensors** - measure pressure difference

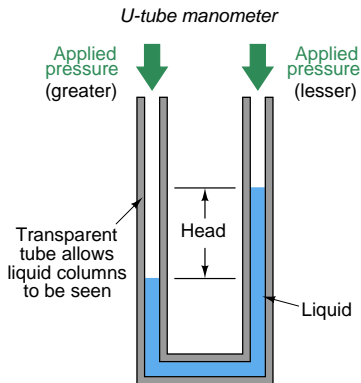
Pressure Sensors



Pressure Sensors - Manometers

Manometers

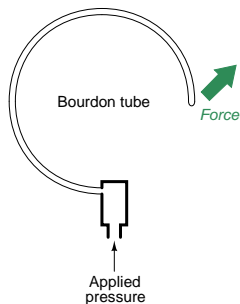
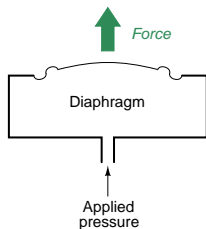
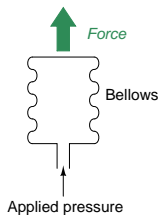
Fluid-filled tube where an applied gas pressure causes the fluid height to shift proportionately. This is why pressure is often measured in units of liquid height (e.g. inches of water, inches of mercury).



Pressure Sensors - Mechanical

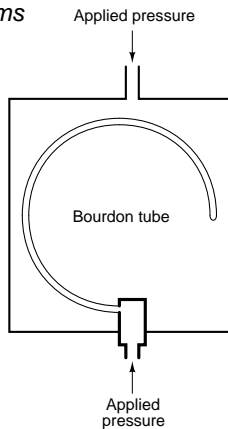
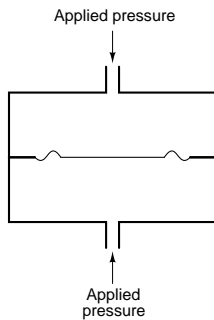
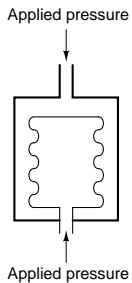
Mechanical Pressure Elements

Mechanical pressure-sensing elements include the bellows, the diaphragm, and the bourdon tube. Each of these devices converts a fluid pressure into a force. If unrestrained, the natural elastic properties of the element will produce a motion proportional to the applied pressure.



Pressure Sensors - Mechanical

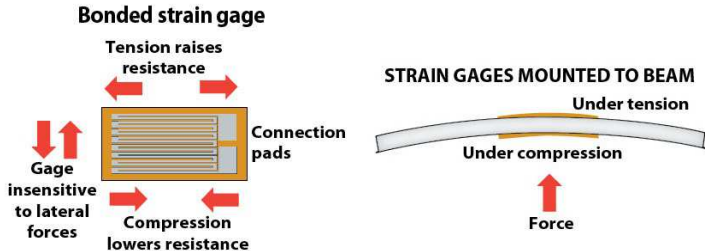
Differential pressure sensing mechanisms



Pressure Sensors - Strain Gauge

Piezoresistive sensor (strain gauge)

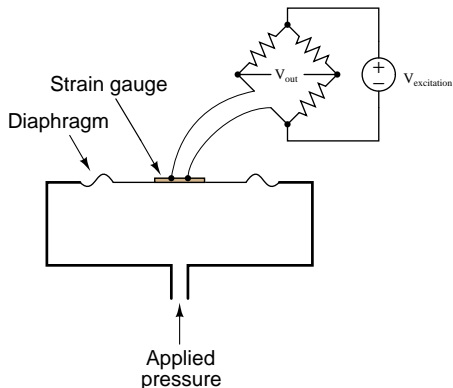
Piezoresistive means “*pressure-sensitive resistance*”, or a resistance that changes value with applied pressure.



Pressure Sensors - Diaphragm Sensor

Diaphragm sensor with strain gauge

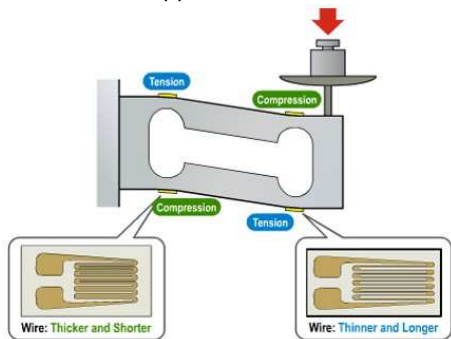
Most modern piezoresistive-based pressure instruments use silicon strain gauge elements to sense deformation of a diaphragm due to applied fluid pressure.



Pressure Sensors - Load Cell

Strain gauge load cell

A load cell is comprised of one or more strain gauges bonded to the surface of a metal structure having precisely known elastic properties. The strain gauges bonded to this structure measure applied force into electrical resistance changes.



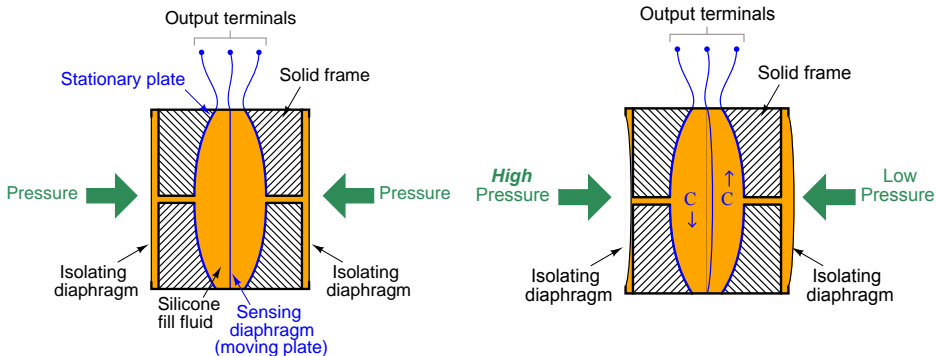
Pressure Sensors - Load Cell



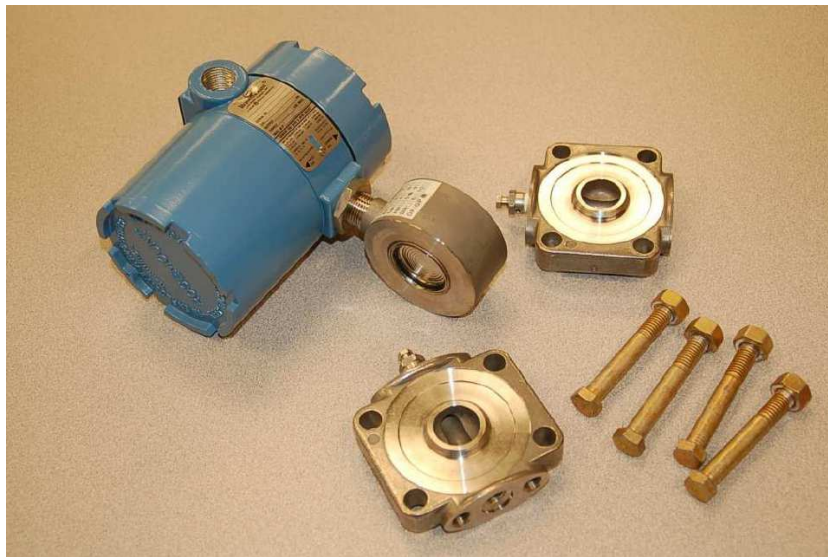
Pressure Sensors - Capacitance

Capacitance pressure sensors

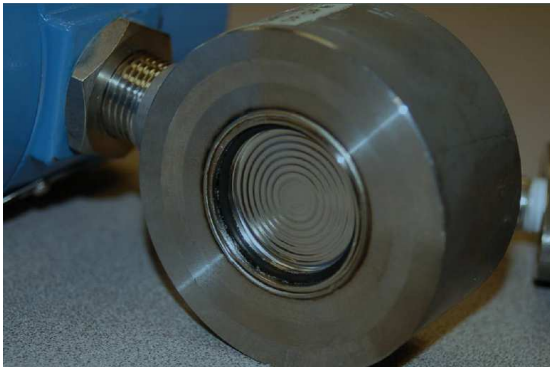
Differential capacitance pressure sensor design works on the principle of differential capacitance.



Pressure Sensors - Capacitance



Pressure Sensors - Capacitance



Pressure Sensors - Piezoelectric

Piezoelectric pressure sensors

Piezoelectric pressure sensor uses the oscillation of string, mounted on diaphragm to determine the amount of pressure applied.

