COEP Tech

SENSORS AND AUTOMATION

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SY Comp Div-2, S5 Batch

Practical-3: Characterization of Strain Gauge

Aim:

1. Plot the characteristics of Strain gauge.
2. Understand the effect of various parameters on the strain gauge performance.

Theory:

Stress is the force generated inside an object in response to an applied external force.This internal force divided by the cross-sectional area of the object is called stress,which is expressed in Pa (Pascal) or N/m2.If the direction of the external force is vertical to the cross-sectional area, the stress is called vertical stress.

Strain: When a bar is pulled, it causes change in its length by ΔL, making its new length = L (original length) + ΔL (change in length). The ratio of this change in length ΔL, to the original length, L, is called strain. The strain is expressed in ε (epsilon): ε = ΔL / L Strain in the same direction as the external force is called longitudinal strain.Each material has a certain ratio of lateral strain to longitudinal strain.This ratio is called Poisson's ratio.

Gauge Factor:

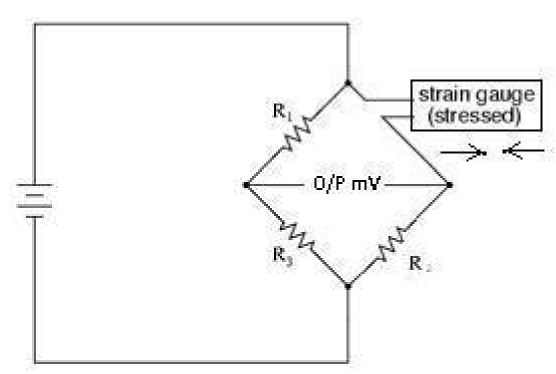
The characteristics of the strain gauges are described in terms of its sensitivity (gauge factor). Gauge factor is defined as unit change in resistance for per unit change in length of strain gauge wire given as

$$G.F. = (\Delta R/RG) / \varepsilon$$

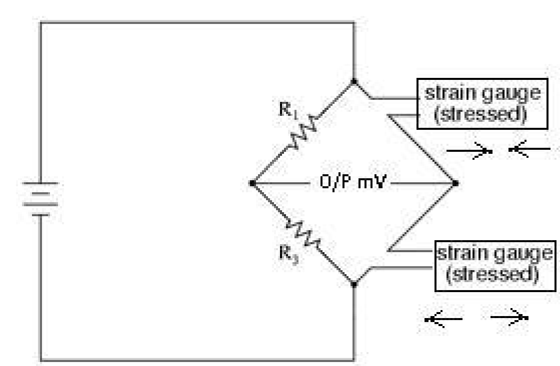
where, ΔR - the change in resistance caused by strain, RG - is the resistance of the unreformed gauge, and ε - is strain.

Arrangement:

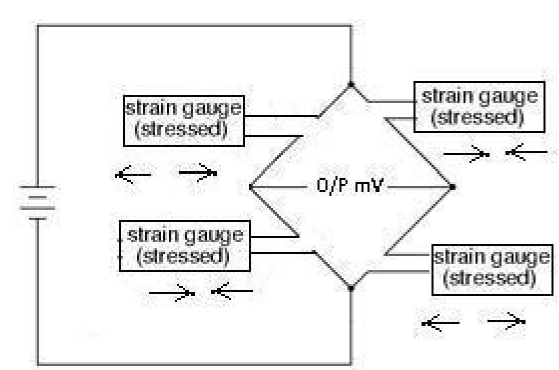
In certain applications where equal and opposite strains are known to exist it is possible to attach similar gauges in way that one gauge experiences positive strain and other negative strain. Depending on the number of gauges used the bridge, the circuit configurations are :



Quarter Bridge



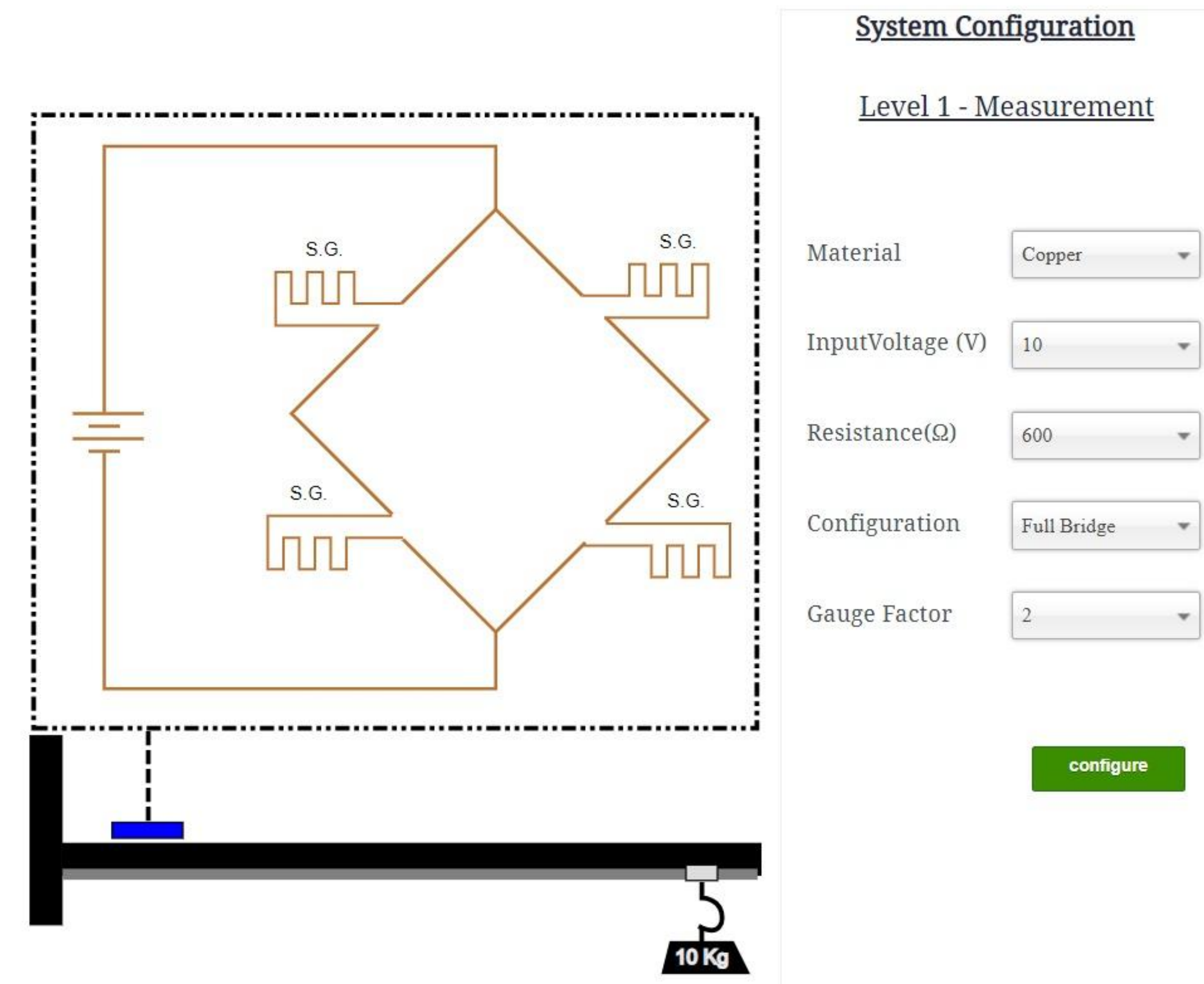
Half Bridge



Full Bridge

Selected Values:

1. Material:Copper
2. Input Voltage :10
3. Resistance :600
4. Gauge Factor :2
5. Configuration :Full Bridge
6. Weight : 4 Kg
7. Output Voltage : 20.09



Characterize the Strain gauge sensor

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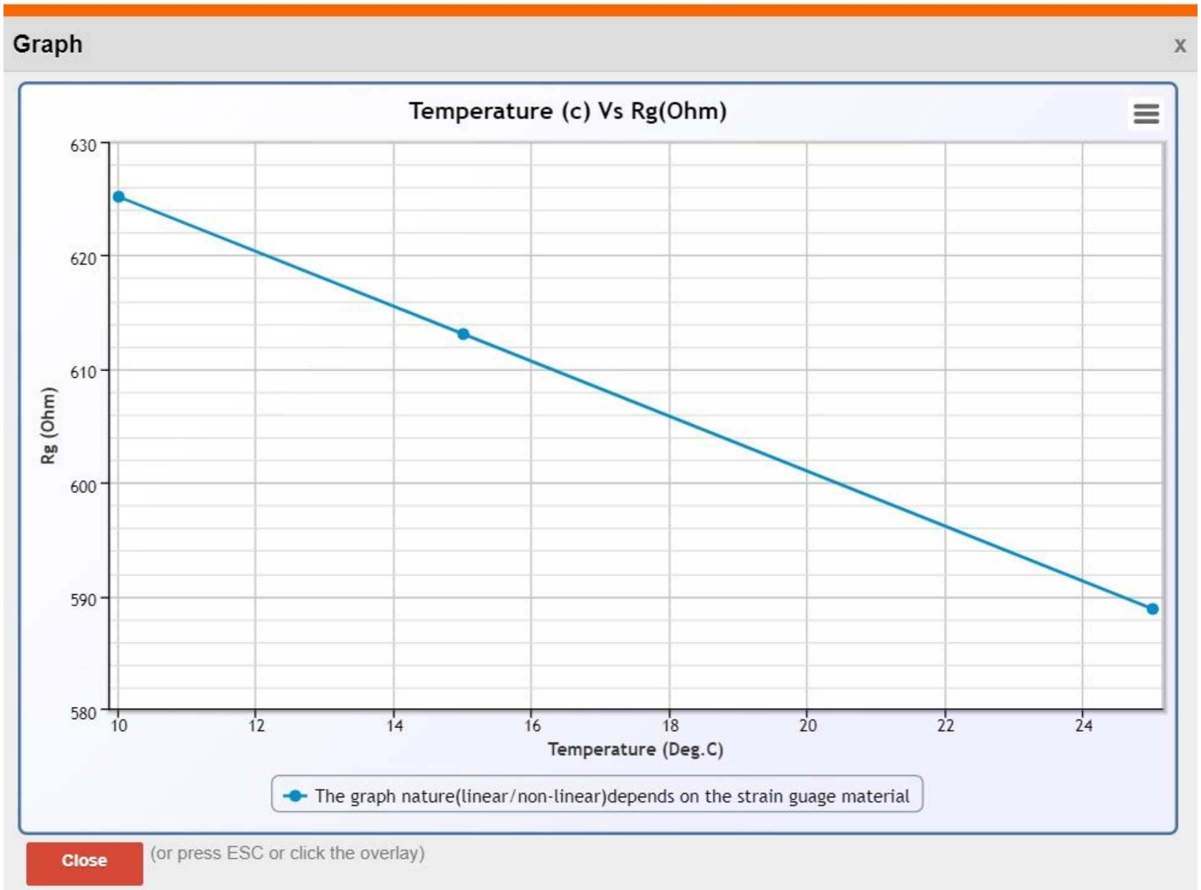

Calculations:

Material: Copper
Input Voltage: 10'
Resistance: 600
Gauge Factor: 2
Configuration: Full Bridge.

$dR = Gf * dL/L * R$

Output voltage in Full Bridge: $e = (dR/R) * E$

$$dR = GF * \frac{M}{(Z * YM)} * R$$

$GF = 2$, $M = WL = 4kg * 16cm = 4kg * 0.16m$
$Z = 1/6 * b * h^2$, $b = 2cm$, $h = 0.4cm$

$$dR = \frac{GF * WL * R}{Z * YM}$$, YM = Young's Modulus

E = Input Voltage.

$$\text{Output voltage} = (dR/R) * E = \frac{GF * WL * R}{Z * YM * R} * E$$

New resistance of Strain gauge: $Rg = R + dR$

Weight = 4kg
$Rg = 601.2052$

$$\Rightarrow \text{Output voltage} = \frac{2 \times 4 \times 0.16 * 600 * 10}{1/6 * 2 * 0.4^2 * 17000000 * 600} = 20.09\ mV$$

Conclusion:

The practical aimed to plot the characteristics of a strain gauge and understand the effect of various parameters on its performance. Through this experiment, we were able to learn about the behavior of strain gauges under different conditions such as varying load, temperature, and gauge factor. It was observed that strain gauges exhibit a linear relationship between strain and resistance, and their sensitivity can be increased by using materials with a higher gauge factor. Overall, this practical provided valuable insights into the functioning of strain gauges and their practical applications in measuring mechanical strain in various engineering fields.