Transducers

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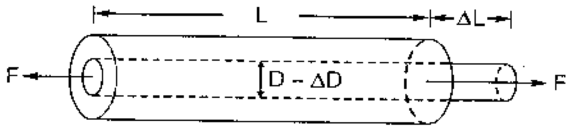
Strain Gauge



- Gauge factor of strain gauge

$$G_f = \frac{\Delta R/R}{\Delta L/L} = 1 + 2\nu + \frac{\Delta\rho/\rho}{\epsilon}$$

where, $\frac{\Delta\rho}{\rho}$ = Per unit change in resistivity

ν = Poisson's ratio

ϵ = Strain

- For $\frac{\Delta\rho}{\rho} \to 0$

$$G_f \approx 1 + 2\nu$$

- Poisson's ratio

$$\text{Poisson's ratio } (\nu) = \frac{\text{lateral strain}}{\text{longitudinal strain}} = \frac{-\partial D/D}{\partial L/L}$$

- Strain

$$\text{Strain } (\epsilon) = \frac{\Delta L}{L}$$

where, $\frac{\Delta L}{L}$ = Per unit change in length

Thermistor

- Resistance of thermistor

$$R_{T_1} = R_{T_2} \exp\left[\beta\left(\frac{1}{T_1} - \frac{1}{T_2}\right)\right]$$

where, R_{T_1} = Resistance of thermistor at absolute temperature T_1; °K

R_{T_2} = Resistance of thermistor at absolute temperature T_2; °K

β = A constant depending upon the material of thermistor

- Steinhart-Hart equation

$$\frac{1}{T} = A + B\, ln\, R + C(ln\, R)^3$$

where, T = Temperature; °K,

R = Resistance of thermistor ; Ω

A, B, C = Curve fitting constant

- Thermistor resistance

$$R_T = aR_o \exp(b/T)$$

where, R_T R_o = Resistance of thermistor at temperature T °K and ice point respectively

Thermocouple

- E.M.F. produced in a thermocouple

$$E = a(\Delta\theta) + b(\Delta\theta)^2$$

Where $\Delta\theta$ = Difference in temperature between the hot thermocouple junction and the reference junction of thermocouple; °C

a, b = Constant

LVDT

- Sensitivity of LVDT

$$\text{Sensitivity} = \frac{\text{output voltage}}{\text{displacement}}$$

Capacitive Transducers

Capacitance

- Capacitance of parallel plate capacitor

$$C = \frac{\in A}{d} = \frac{\in xw}{d}$$

where, A = Overlapping area of plates

x = Length of overlapping part of plates

w = Width of overlapping part of plates

d = Distance between two plates

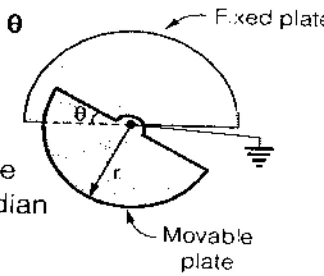
$\in$ = Permittivity of medium

- Capacitance of cylindrical capacitor

$$C = \frac{2\pi \in x}{\log_e(D_2/D_1)}\ \text{F}$$

- Capacitance at angular displacement θ

$$C = \frac{\in \theta r^2}{2d}$$



where, r = Radius of semi circular plate

θ = Angular displacement in radian

Sensitivity

- Sensitivity of parallel plate capacitive transducer

$$S = \frac{\partial C}{\partial x} = \in \frac{w}{d}$$

where, x = Length of overlapping part of cylinders; m

D_2 = Inner diameter of outer cylindrical electrode; m

D_1 = Outer diameter of inner cylindrical electrodes; m

- Sensitivity of cylindrical capacitive transducer

$$S = \frac{2\pi \in}{\log_e(D_2/D_1)}\ \text{F/m}$$

- Sensitivity of variable capacitance transducer

$$S = \frac{\epsilon r^2}{2d}$$

Piezo-Electric Transducer

- Voltage sensitivity of crystal

$$g = \frac{\text{Electric field}}{\text{Stress}} = \frac{\epsilon}{P} \text{ Vm/N}$$

where, P = Pressure or stress; N/m^2

- Charge sensitivity

$$d = \epsilon_r \epsilon_0 g \text{ C/N}$$

- Output voltage

$$E_o = gtp$$

where, t = Thickness of crystal ; m

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