

## 1 Formula

### Gauge Factor

$$G.e = \frac{\Delta R}{R}$$
$$\frac{\Delta R}{R} = \frac{\Delta \rho}{\rho} + (1 + 2k) \frac{\Delta L}{L} = G.e$$

### RTD(Resistance Temperature Device)

$$R_T = R_0(1 + a_1T + a_2T^2 + \dots + a_nT^n)$$
$$\epsilon(T) = R(T) - R(ideal)$$

### Thermistor

$$R = R_0 e^{\frac{1}{\beta}(\frac{1}{T} - \frac{1}{T_0})}$$

### Hamming Code

$$2^r = n + 1$$
$$r = 3.322 \log_2^n$$

### Accelerometer

Steady-state sensitivity

$$S_0 = \frac{\text{Steady state voltage}}{\text{acceleration}}$$

Unit:  $\frac{V}{g}$

### First-order System

$$x(t) = x(\infty) + (x(0) - x(\infty))e^{-\frac{t}{\tau}}$$

### Hamming Distance Between A and B

$$A \oplus B$$

## 2 Definition

- **Sensitivity:** Sensitivity is a measure of change in output of an instrument for a change in measurement input variable.
- **Resolution:** Resolution is smallest increment of measurand, which can be measured by instruments.
- **Nonlinearity:** Nonlinearity is defined as maximum deviation of any of output readings from the approximate transfer function.
- **Hysteresis:** Hysteresis is the deviation of sensor's output at a specified point of input signal, when the input signal is approached from opposite direction, it is expressed as maximum hysteresis.
- **MEMS:** Micro-Electro-Mechanical Systems. Micro-components integrated on a single chip, which allows the micro-system to control the system.

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#### 3.1 Transient Response Analysis

1. Find the point with proper  $\frac{\omega}{\omega_n}$  and  $\zeta$
2. Read  $\frac{S}{S_0}$  from the graph
3. Convert from dB, then find S
4.  $V = S \times a$ , where a is acceleration
5.  $V_{p-p} = 2 \times V$

#### 3.2 Thermalcouple

1. Denote the voltage with reference temperature  $T_1$  is  $V_1$
2. Find voltage at reference temperature  $V_2$
3. The voltage with reference temperature 0 is  $V = V_1 + V_2$
4. Find the temperature.

#### 3.3 RTD

1. Write down  $R_T = R_0(1 + a_1T + a_2T^2 + \dots + a_nT^n)$
2. Find R
3.  $\epsilon(T) = R(T) - R(ideal)$
4.  $\frac{d\epsilon(T)}{dT}$ , find  $T_0$
5. Find  $\epsilon(T_0)$
6.  $\epsilon(\%FSD) = \frac{\epsilon(T_0)}{R_{Max} - R_{Min}}$

#### 3.4 Strain Gauge

- **Temperature Compensator:** Does not measure strain, use cross axis.
- **Amplifier:**  $Gain = \frac{R_{Right}}{R_{Left}}$

#### 3.5 Resistive Potentiometer

- **Error:** Caused by the resistance of potentiometer, or resistance of wires.

#### 3.6 Fuel Tank

Capacitance change when dielectric constant changes. The reading is not affected by the movement because the capacitors are connected in parallel, the total C does not change.

### 3.7 Accelerometer

#### Advantages of Servo Accelerometers

- Electronically control damping and spring coefficient, easy to get desired characteristics
- Low Hysteresis.

### 3.8 Noise Elimination

- **Capacitive:**

1. Differential Amplifier
2. Connect the inner conductor to outer conductor which is grounded

- **Electromagnetic:**

1. Twist the conductors(cancel induced voltage).
2. Physical separation.

- **Ground Loops:**

1. Remove one of the ground paths, thus converting the system to a single point ground.
2. Isolate one of the ground paths with an isolation transformer, common mode choke, optical coupler, balanced circuitry, or frequency selective grounding.