EL301

26.02.2019

Sensors & Transducers

Ammeter, Voltmeter, Wattmeter, Energy meter are also "sensors" of current, voltage, power, energy, respectively.

Here, we are looking at "sensors" like

- tachometer (velocity → electronic circuit → display)
- temperature (temperature → resistance change → ")
- force, pressure (force, pressure → capacitance change → ")
- humidity / moisture (humidity → ? → "
- light (light → current → ")
- sound (sound → current → ")
- accelerometers (motion → current → ")

We are talking about these sensors here. Why? sensing elements

Predominantly, these are interfaced with electronic circuits for ease of use.

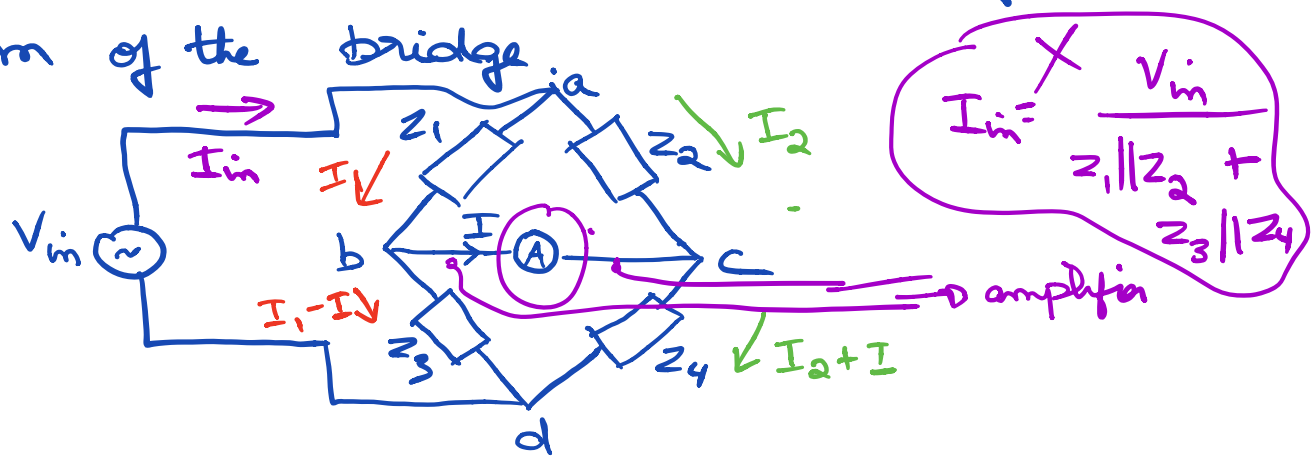
What are the fundamental units?

Mass
Length
Time
K temperature
Cd luminosity
Ampere
mole

sensors / transducers: all of these, or their combinations, are converted into a unit containing 'A'.

Wheatstone Bridge

- often used as the first interface between the sensor and other electronic circuitry, i.e the sensor is one of the arms of the bridge



What is I?

What is relation between impedances for $I = 0$?

- If $I = 0$, $V_b = V_c$

$$\Rightarrow \frac{Z_3}{Z_1 + Z_3} \cdot V_{in} = \frac{Z_4}{Z_2 + Z_4} V_{in}$$ (voltage dividers)

$$\Rightarrow Z_3 (Z_2 + Z_4) = Z_4 (Z_1 + Z_3)$$

$$\Rightarrow Z_2 Z_3 = Z_1 Z_4$$

In general, $I = V_{in} \left[\frac{Z_2 Z_3 - Z_1 Z_4}{(Z_1 Z_2 (Z_3 + Z_4) + Z_3 Z_4 (Z_1 + Z_2)} \right]$??

Using this expression we want to find how I changes when $Z_1 \to Z_1 + \Delta Z_1$

$$-V_{in} + I_1 Z_1 + (I_1 - I) Z_3 = 0$$

$$-V_{in} + I_2 Z_2 + (I_2 + I) Z_4 = 0$$

$$\Rightarrow I_1 (Z_1 + Z_3) = V_{in} + I Z_3$$

$$I_2 (Z_2 + Z_4) = V_{in} - I Z_4$$

$$\Rightarrow I_1 = \frac{V_{in}}{Z_1 + Z_3} + I \frac{Z_3}{Z_1 + Z_3}$$

$$I_2 = \frac{V_{in}}{Z_2 + Z_4} - I \frac{Z_4}{Z_2 + Z_4}$$

$$\Rightarrow I_1 - I_2$$