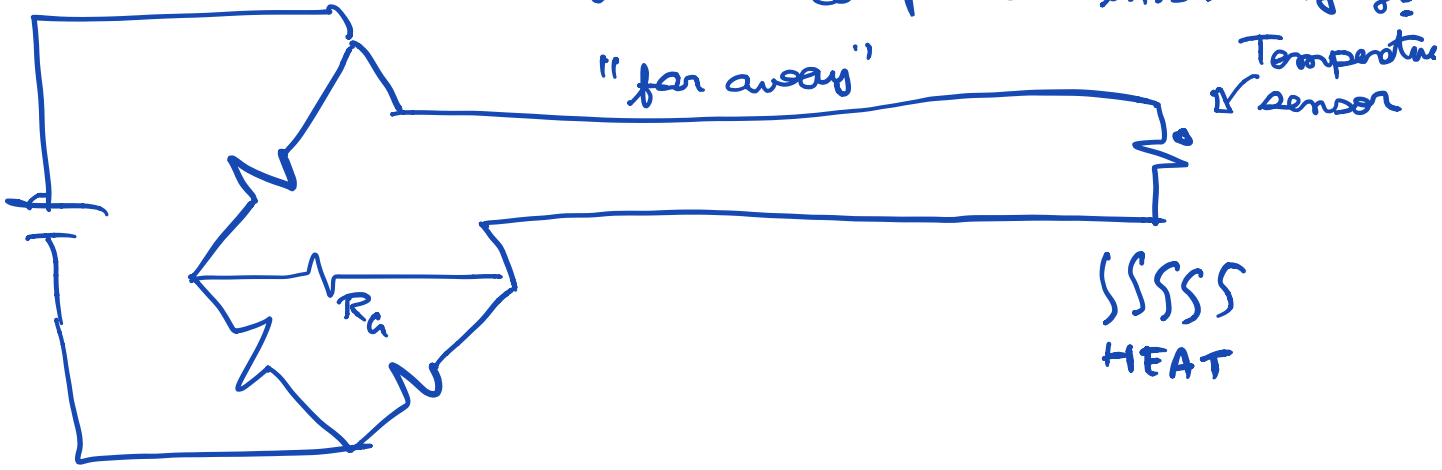
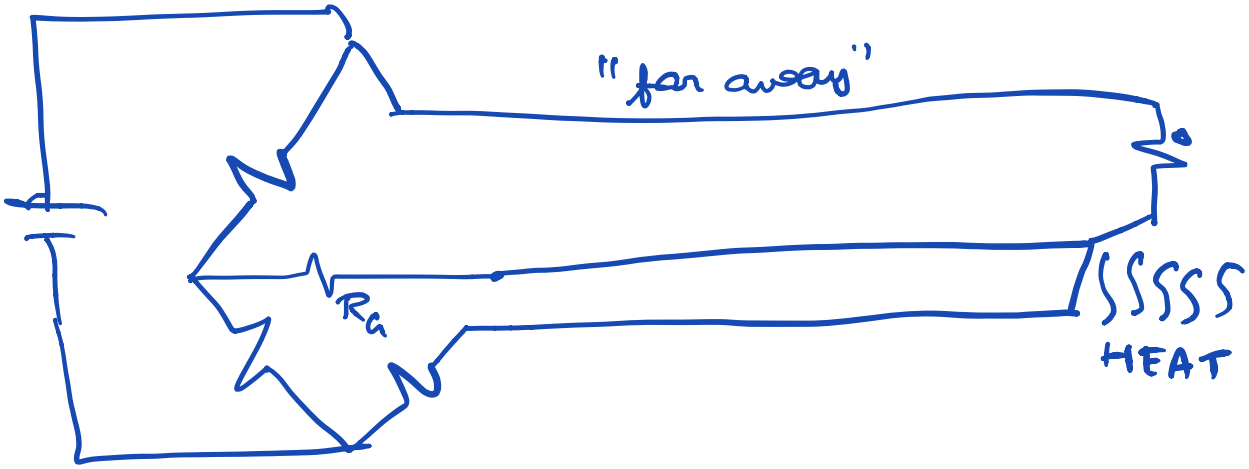
ELL301

22.03.2019

Long leads may introduce errors. How to compensate for their effect? (Just like temperature compensation in strain gauge)

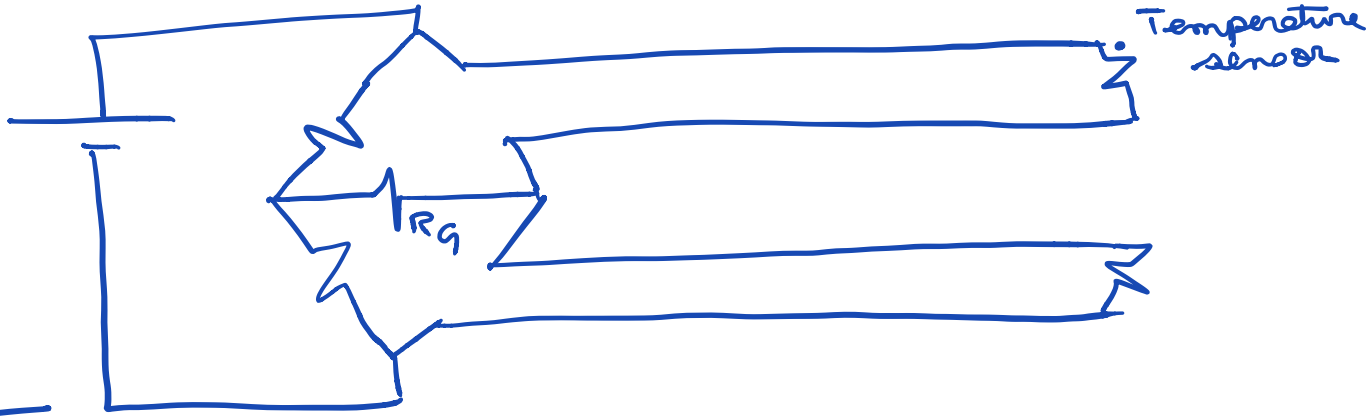


One solution: Three-wire solution



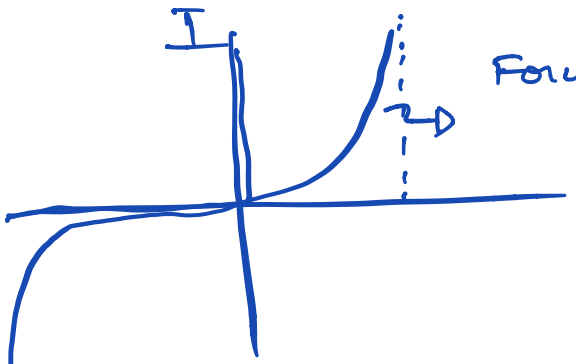
↑ Last time

Four-wire solution



RTDs and Thermistors are examples of Thermo-resistive effect i.e resistances change with temperature

— Operation of Diodes, transistors depends on temperature



Forward bias

function of temperature

Temperature dependence

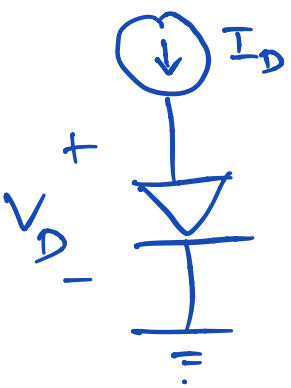
$$I_D = I_S\left(e^{V_D/\beta T} - 1\right)$$

$V_D/\beta T$ constant depends on device parameters, k etc.

$$\simeq I_S e^{V_D/\beta T}$$

How to use this in a temperature sensing application?

$$T = \frac{V_D}{\beta}\left(\ln \frac{I_D}{I_S}\right)^{-1}$$



Diode is in forward bias, driven by a current source. If we can measure V_D, and I_D is set, then we can get T?

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This gives an estimate of T, but I_S can also depend on temperature.

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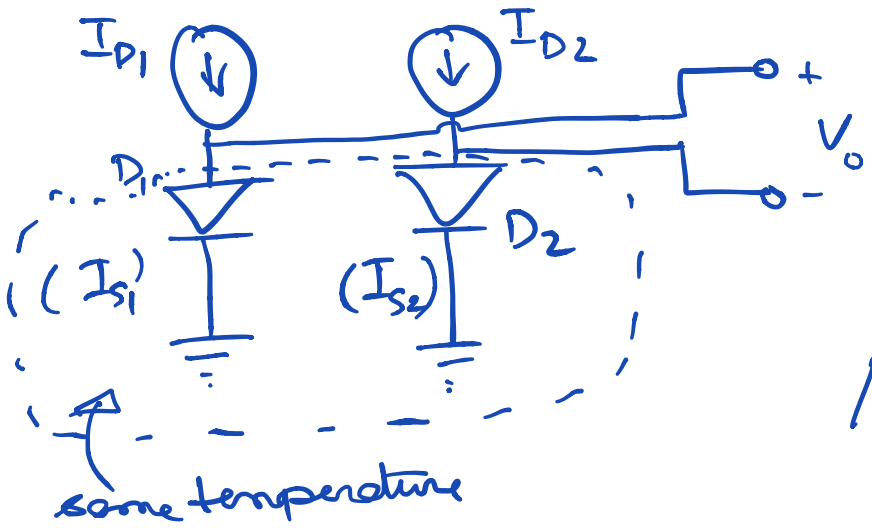
One solution: to use a "difference", just like in previous sensors.



$$I_{D1} = I_{S1} e^{V_{D1}/\beta T}$$

$$\Rightarrow \ln \frac{I_{D1}}{I_{S1}} = \frac{V_{D1}}{\beta T}$$

$$\text{or } V_{D1} = \beta T \cdot \ln \frac{I_{D1}}{I_{S1}}$$

$$\text{//ly } V_{D2} = \beta T \cdot \ln \frac{I_{D2}}{I_{S2}}$$

$$\Rightarrow V_o = V_{D1} - V_{D2}$$

$$= \beta T \cdot \ln \left(\frac{I_{D1}}{I_{D2}} \cdot \frac{I_{S2}}{I_{S1}} \right)$$

$$\Rightarrow T = \frac{V_o}{\beta} \cdot \left(\ln \left(\frac{I_{D1}}{I_{D2}} \cdot \frac{I_{S2}}{I_{S1}} \right) \right)^{-1}$$

We desire this term to be as close to each other as possible by "matching" the diode characteristics.

Ideally, $\frac{I_{S2}}{I_{S1}} = 1$

PTAT

Proportional To Absolute Temperature

See: A Paul Brokaw, "How to make a Bandgap Voltage Reference in one easy lesson"

https://www.idt.com/document/whp/how-make-bandgap-voltage-reference-one-easy-lesson-paul-brokaw