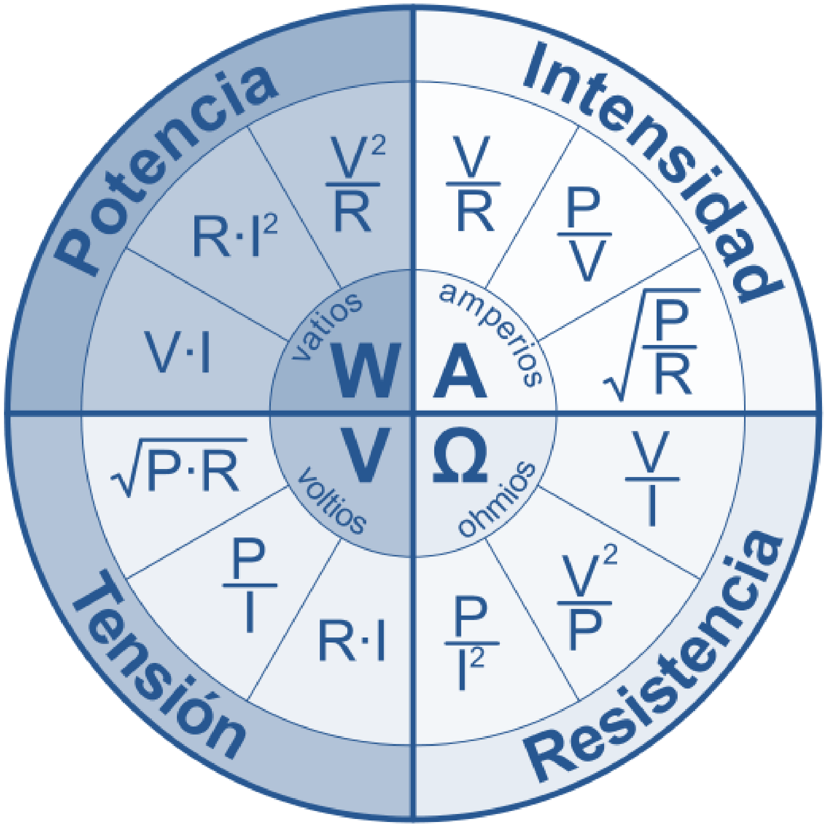
Resistive Sensors

Sensores Resistivos



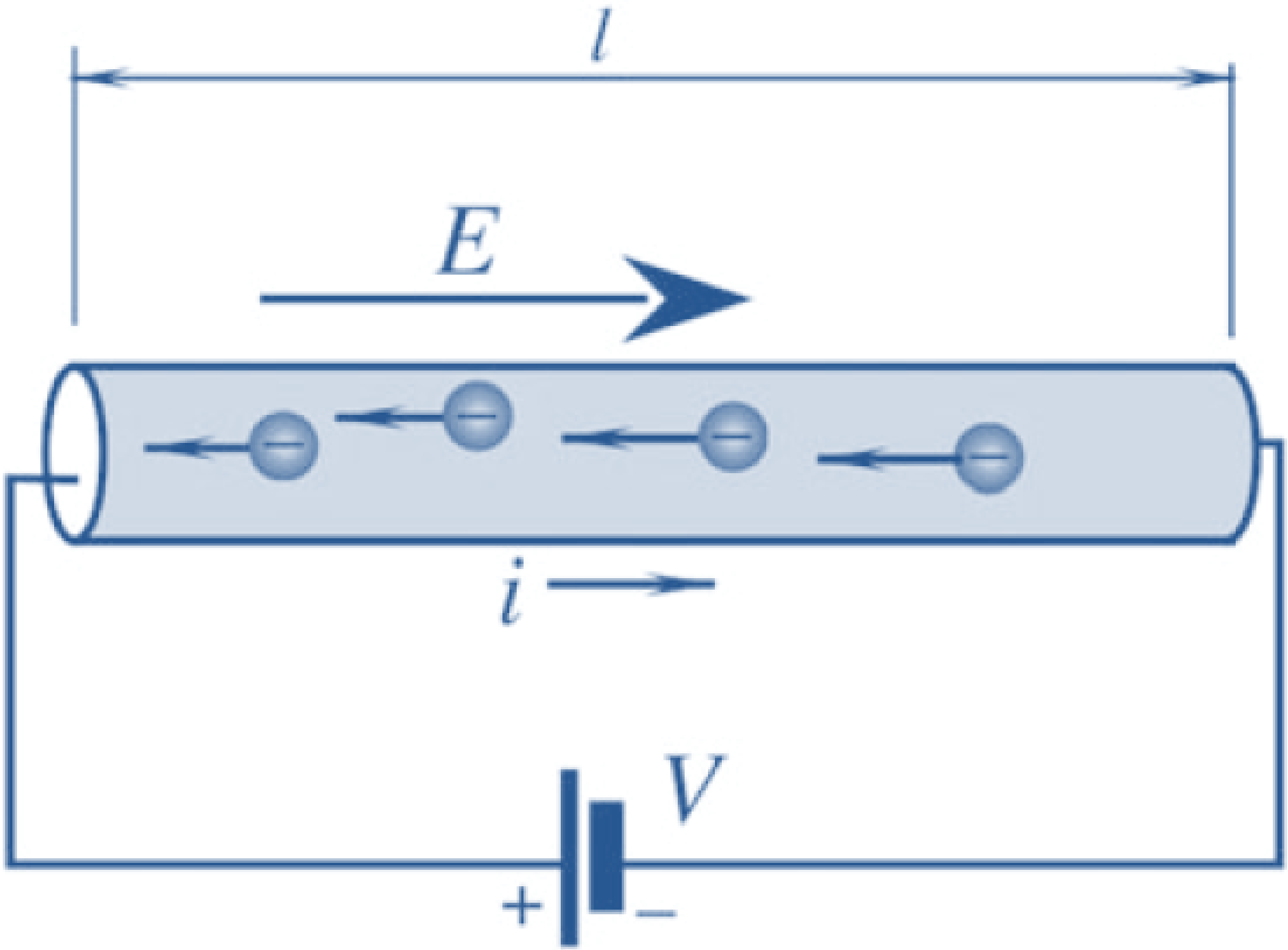
Resistive Sensors

Resistance

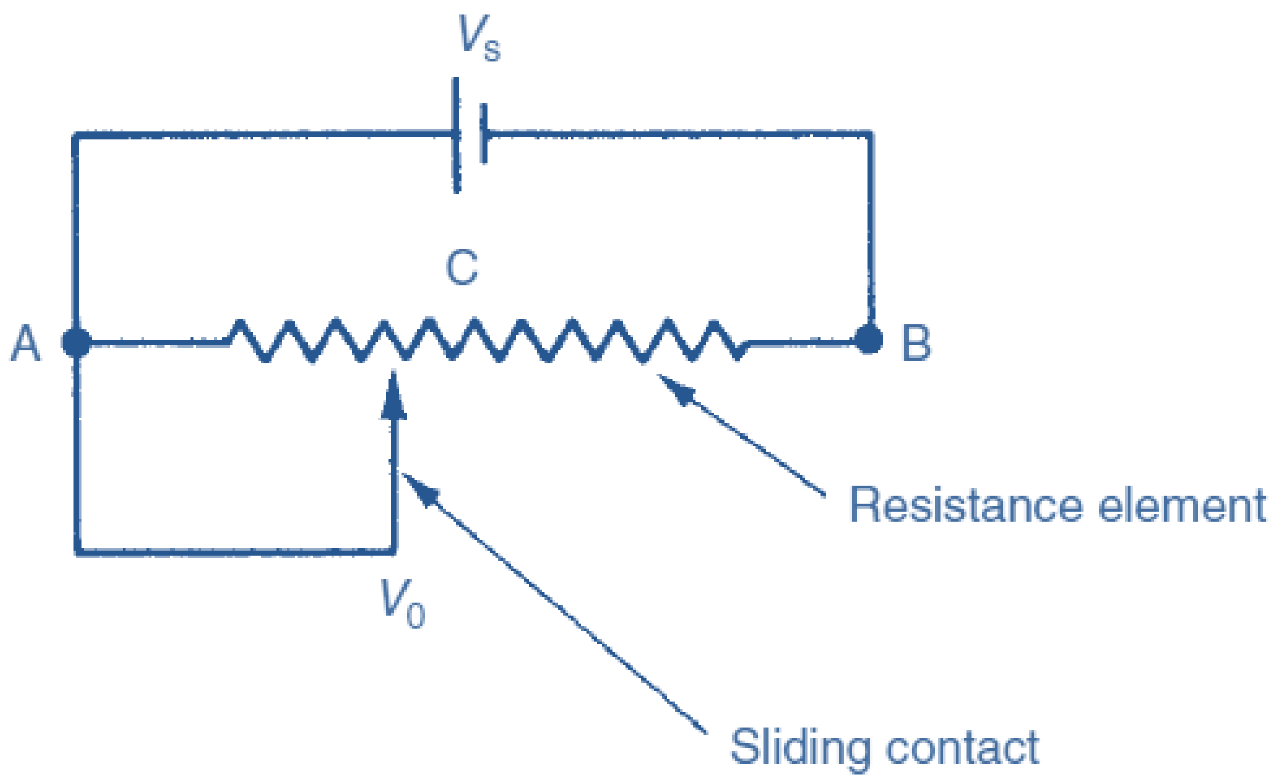
$$E = \frac{V}{l} \qquad i = \frac{dq}{dt}$$

1 milliampere (mA)	10^{-3} A
1 microampere (µA)	10^{-6} A
1 nanoampere (nA)	10^{-9} A
1 picoampere (pA)	10^{-12} A
1 femtoampere (fA)	10^{-15} A

Resistive Sensors

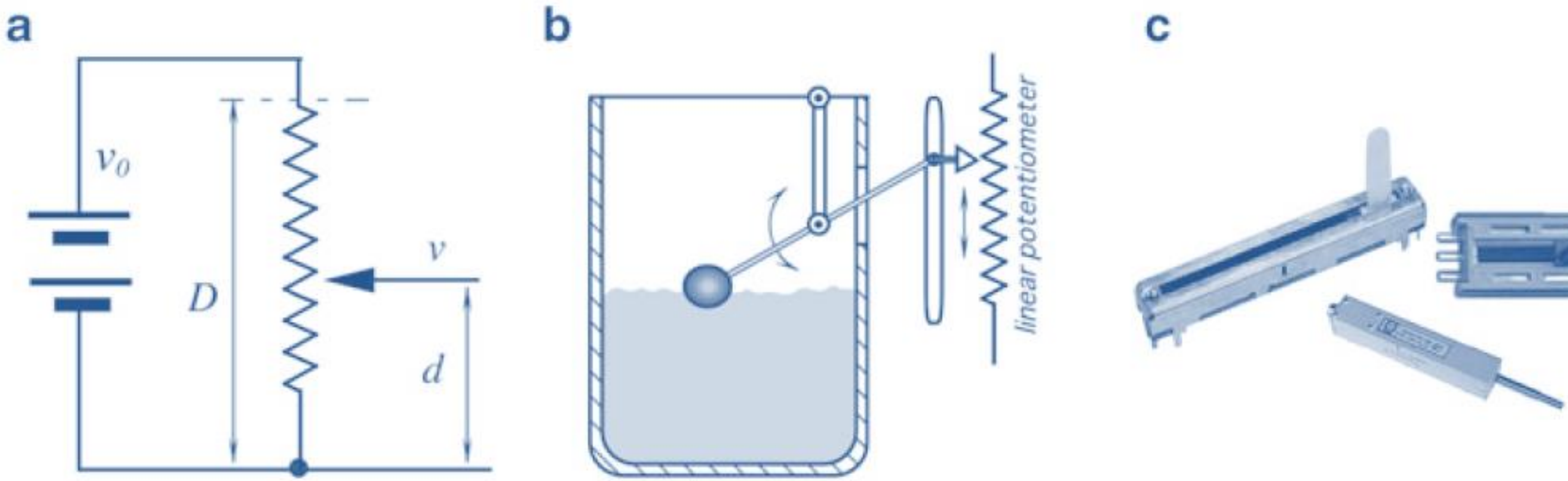


The resistive potentiometer

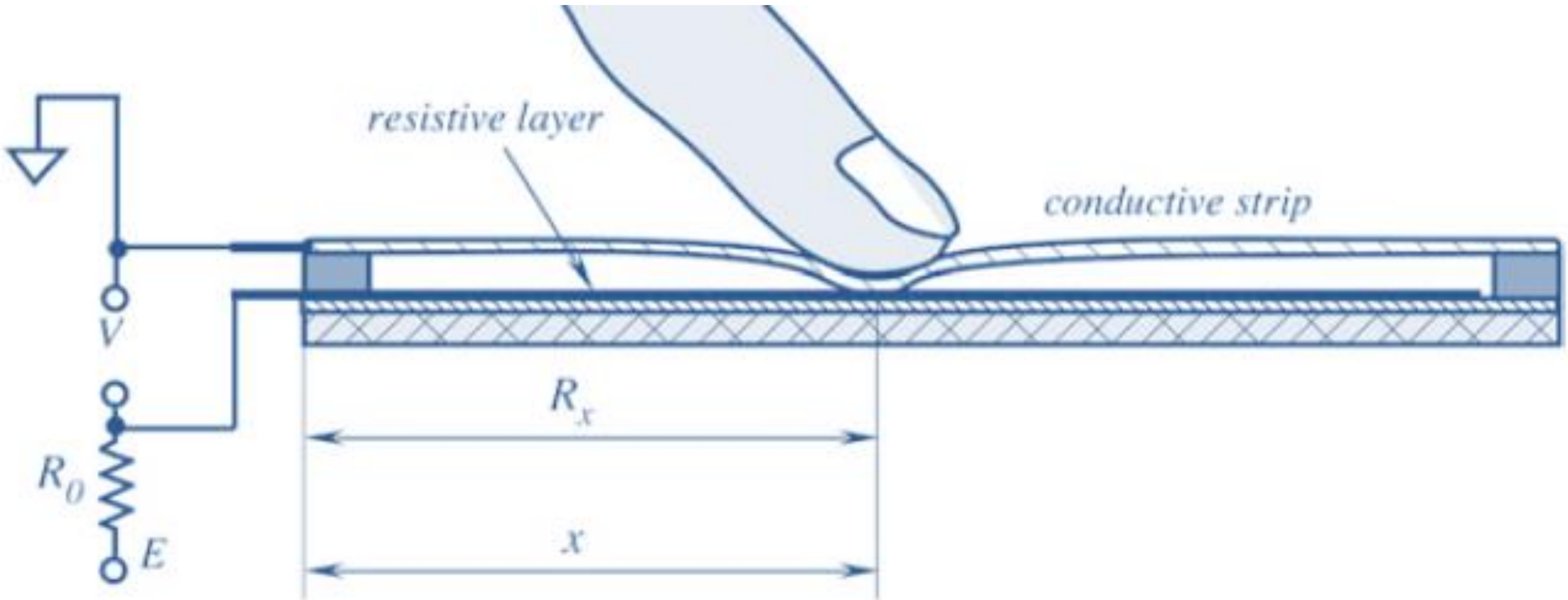


Resistive Sensors

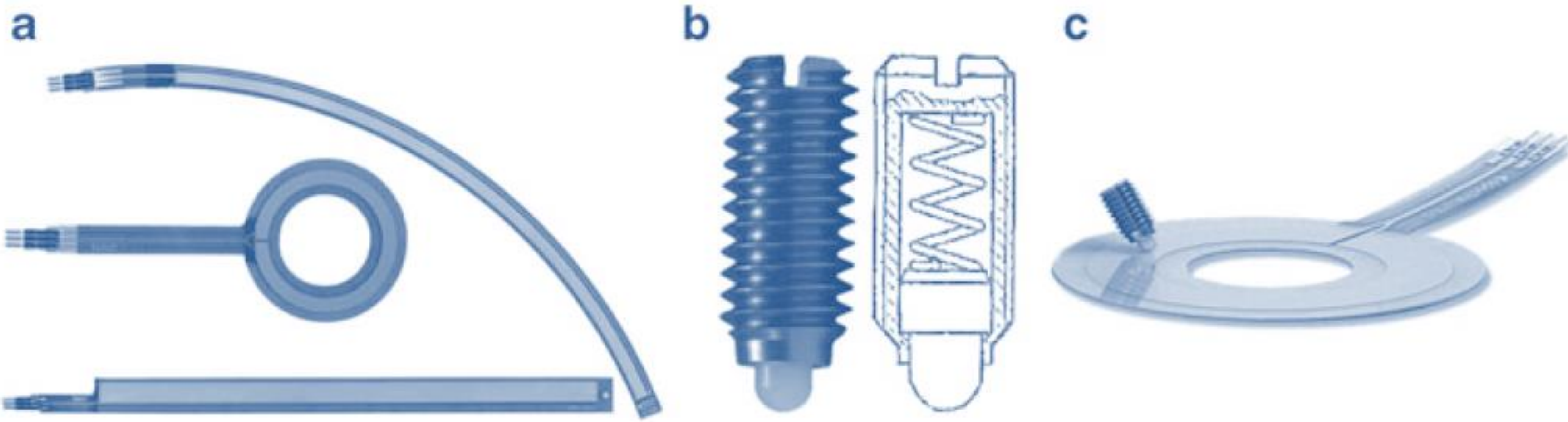
Resistive Sensors



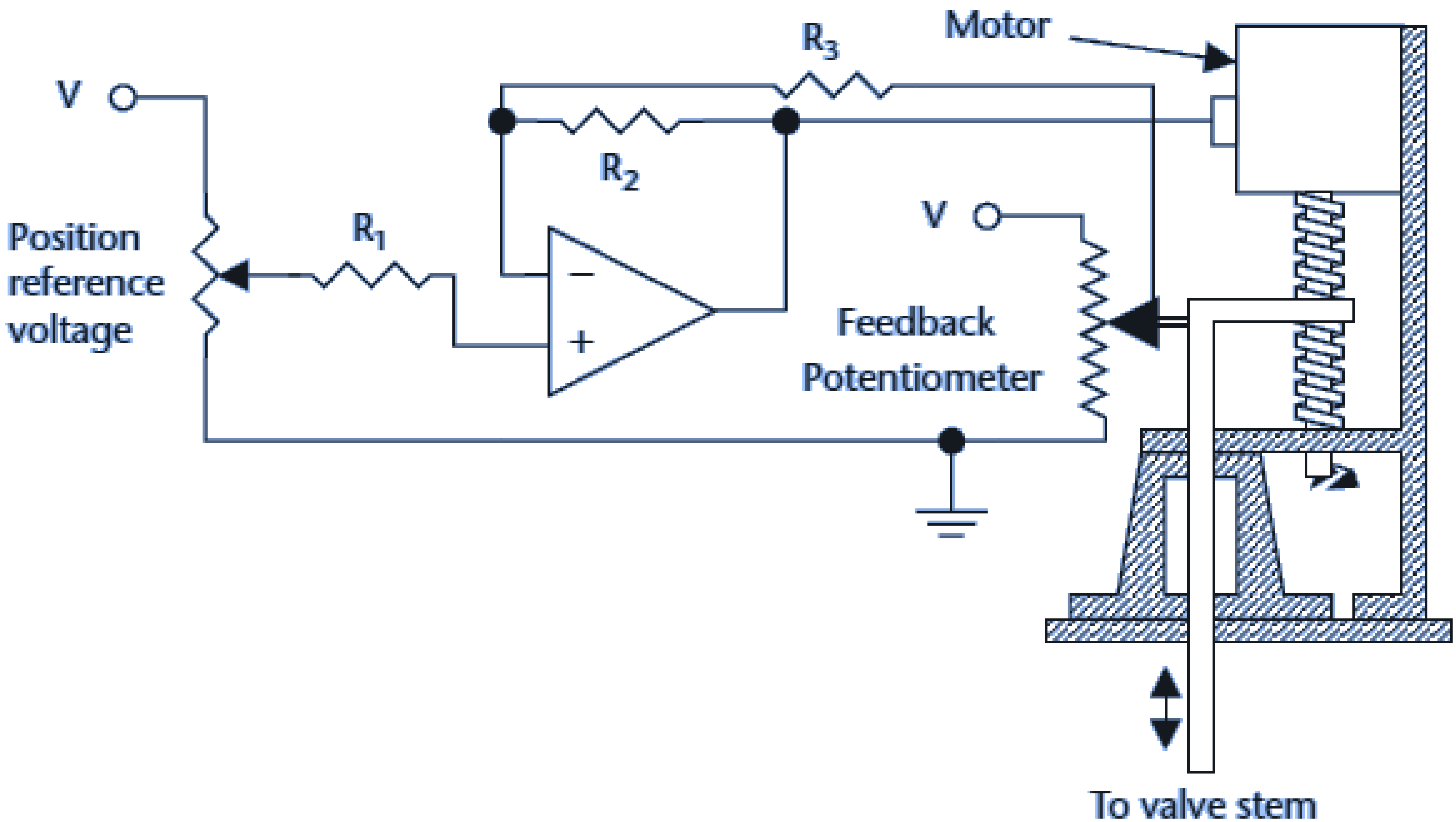
Resistive Sensors



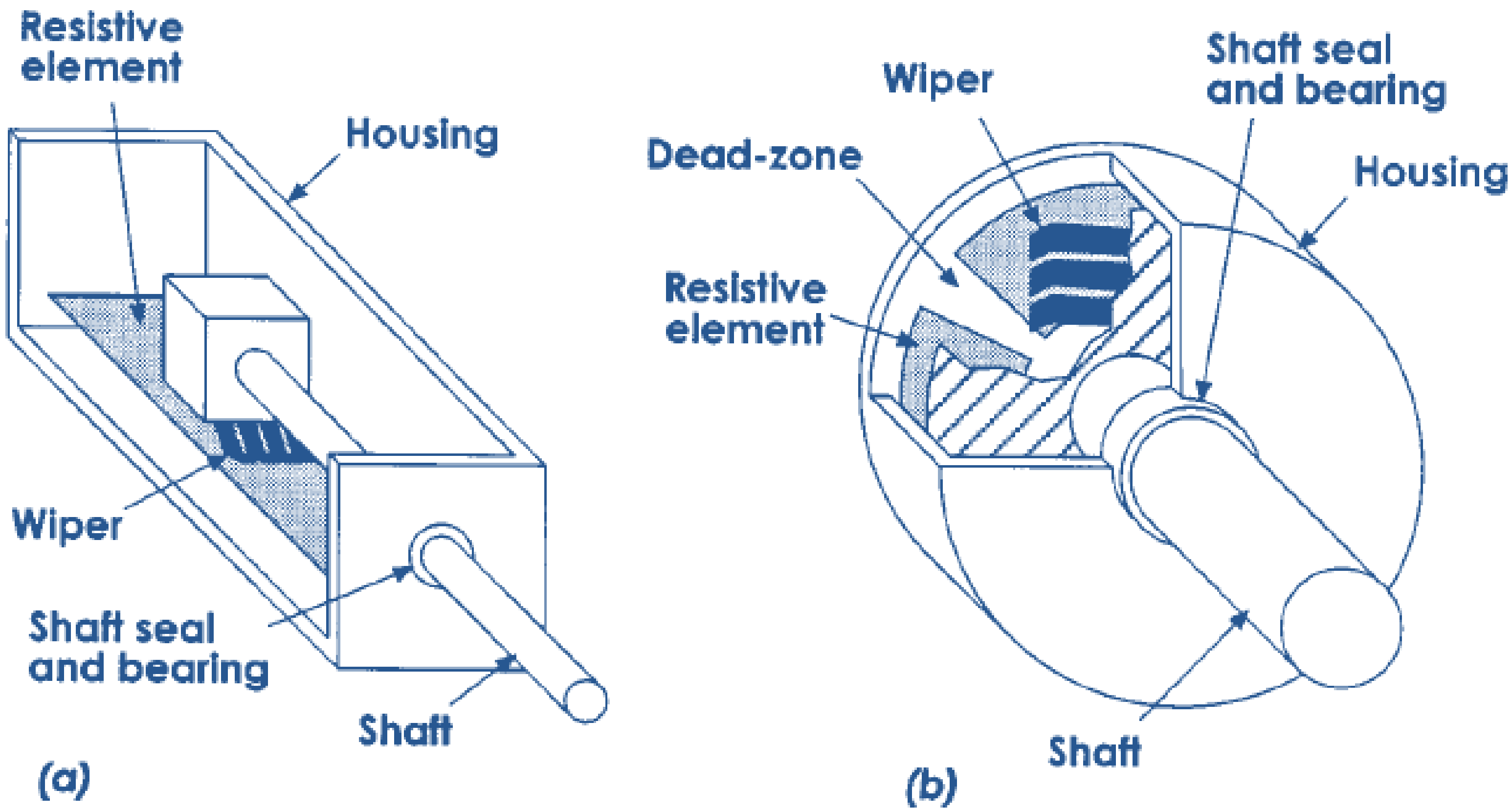
Resistive Sensors



Resistive Sensors

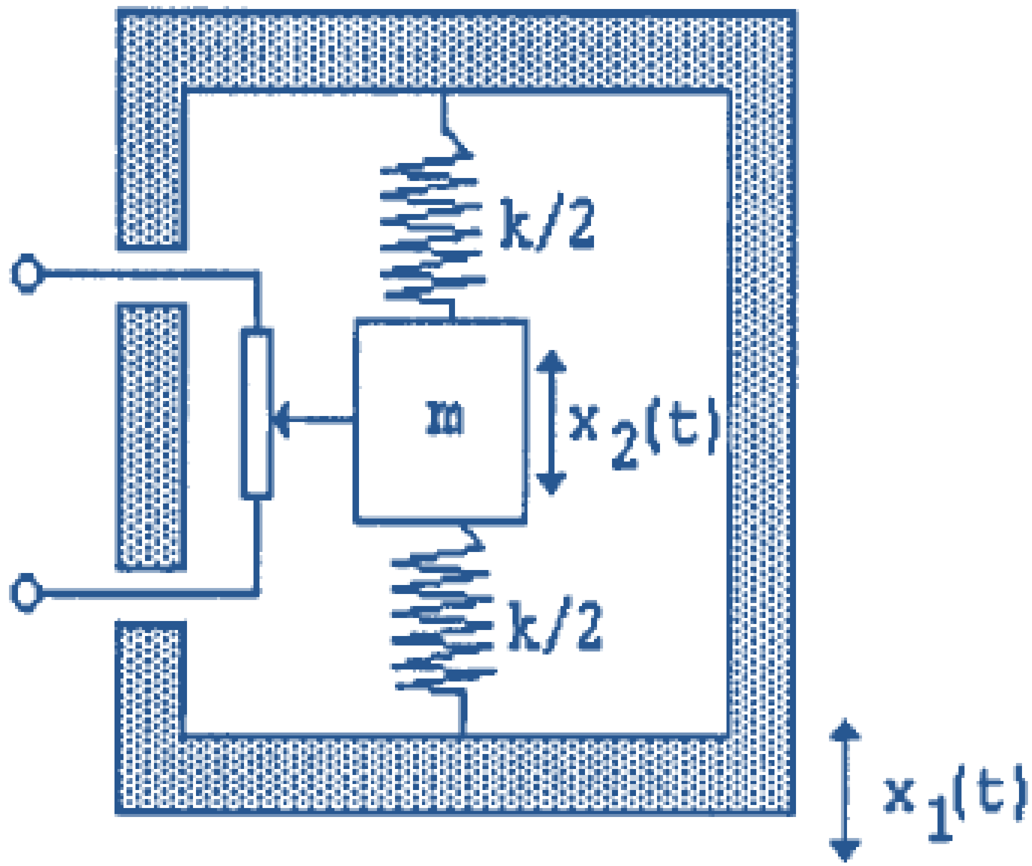


Resistive Displacement Sensors

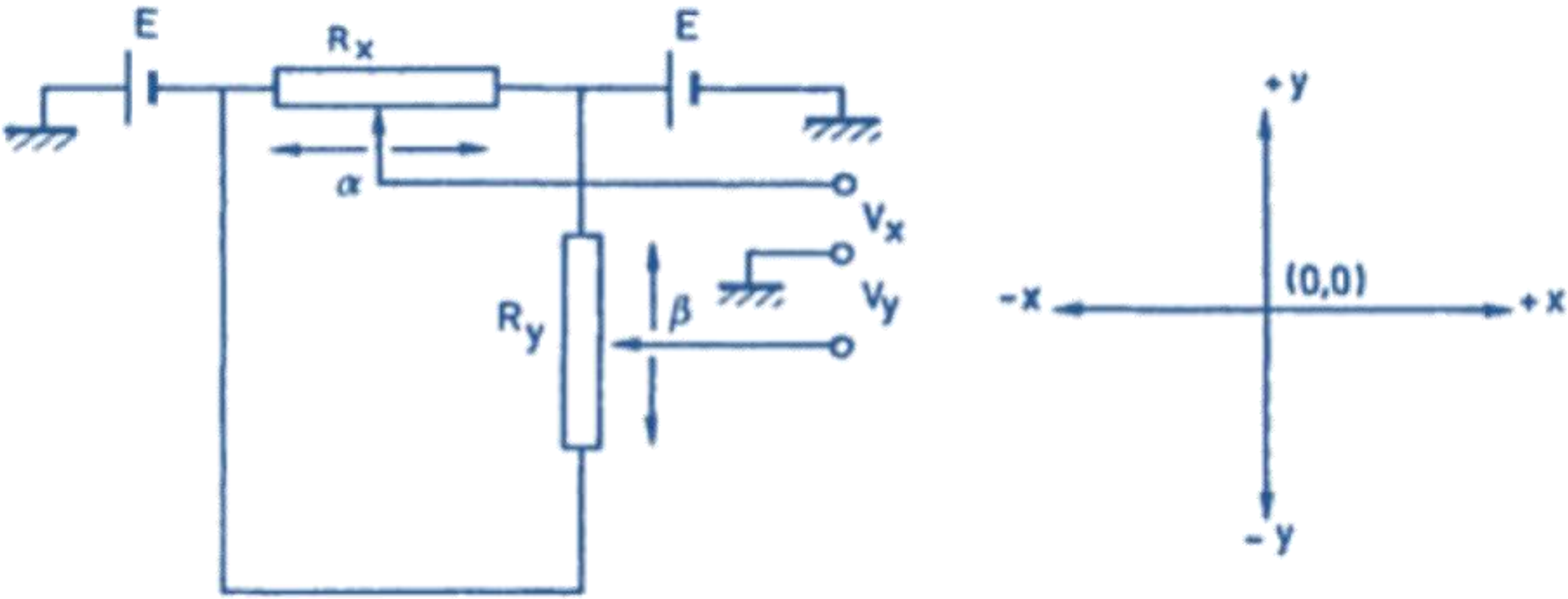


Resistive Sensors

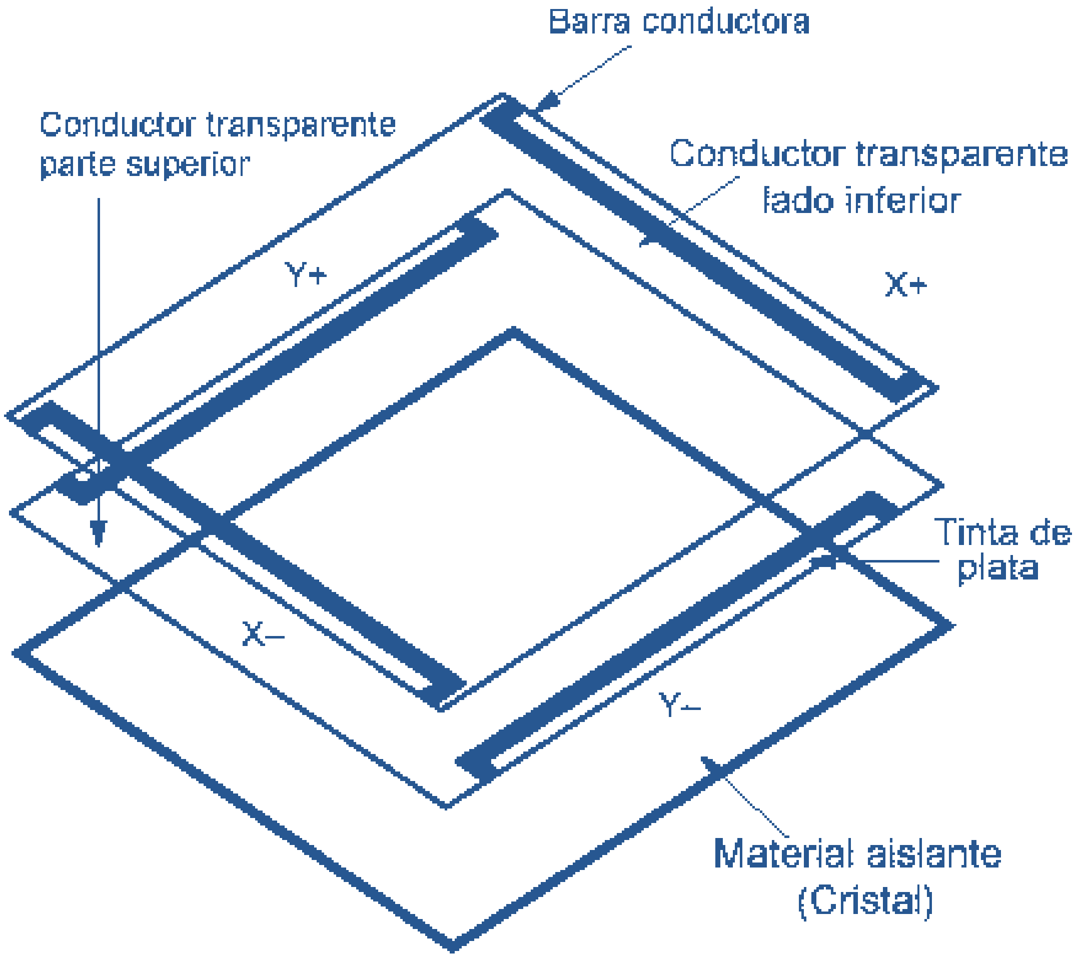
Potentiometer accelerometer



Resistive Sensors

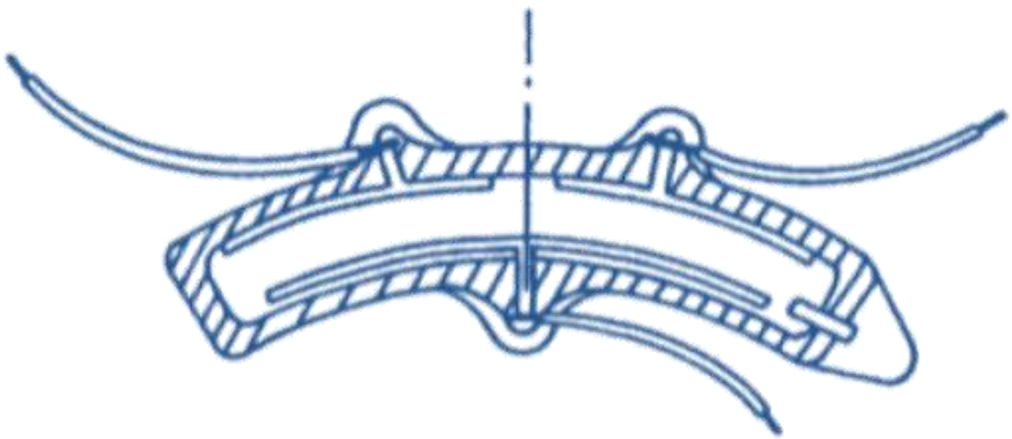


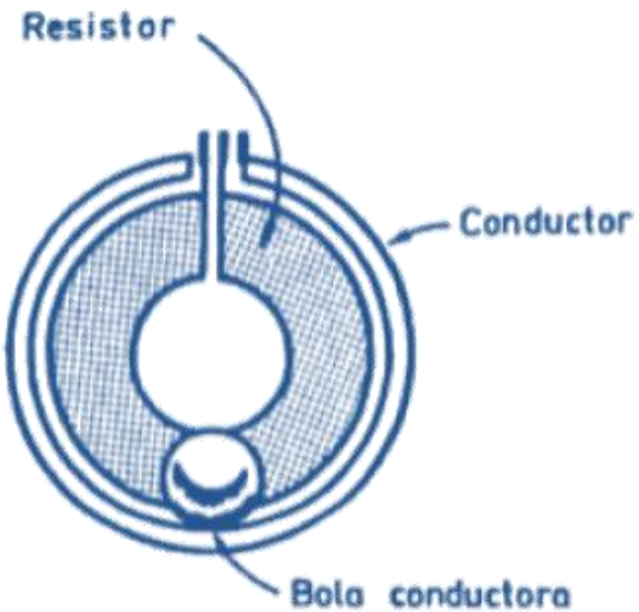
Resistive Sensors



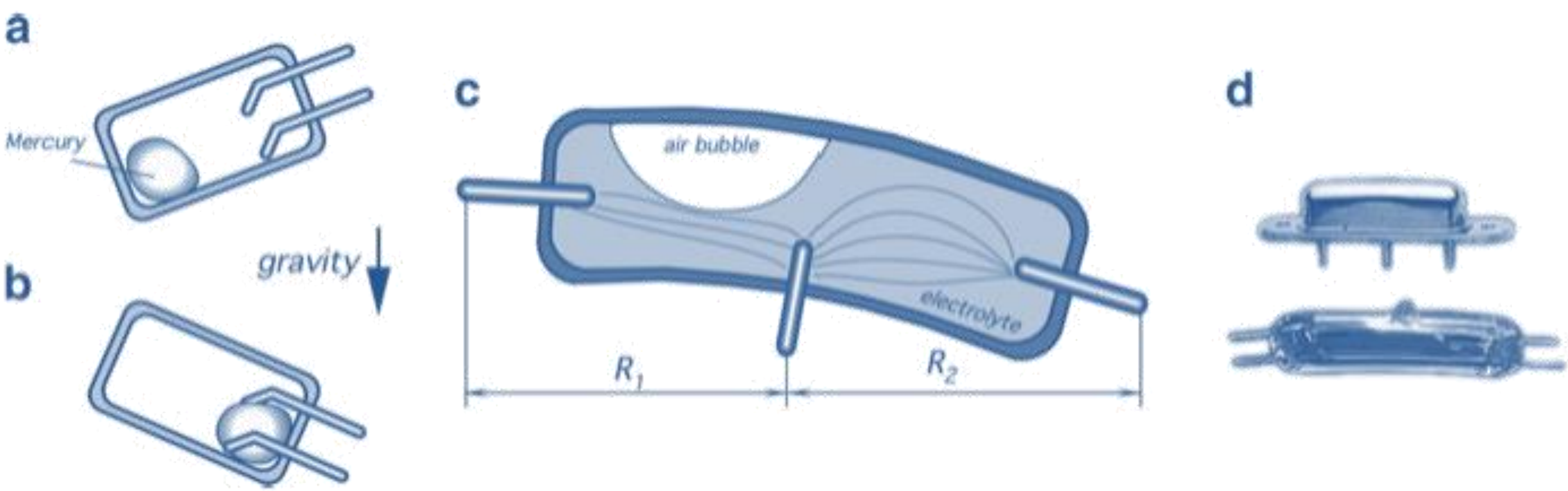
Resistive Sensors

Resistive Sensors



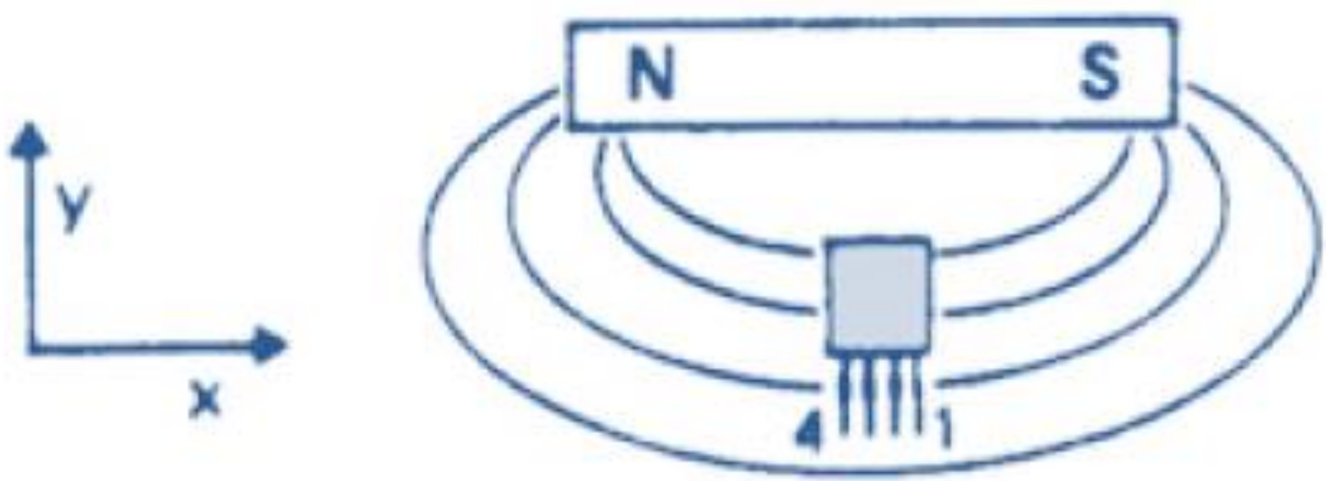


Resistive Sensors

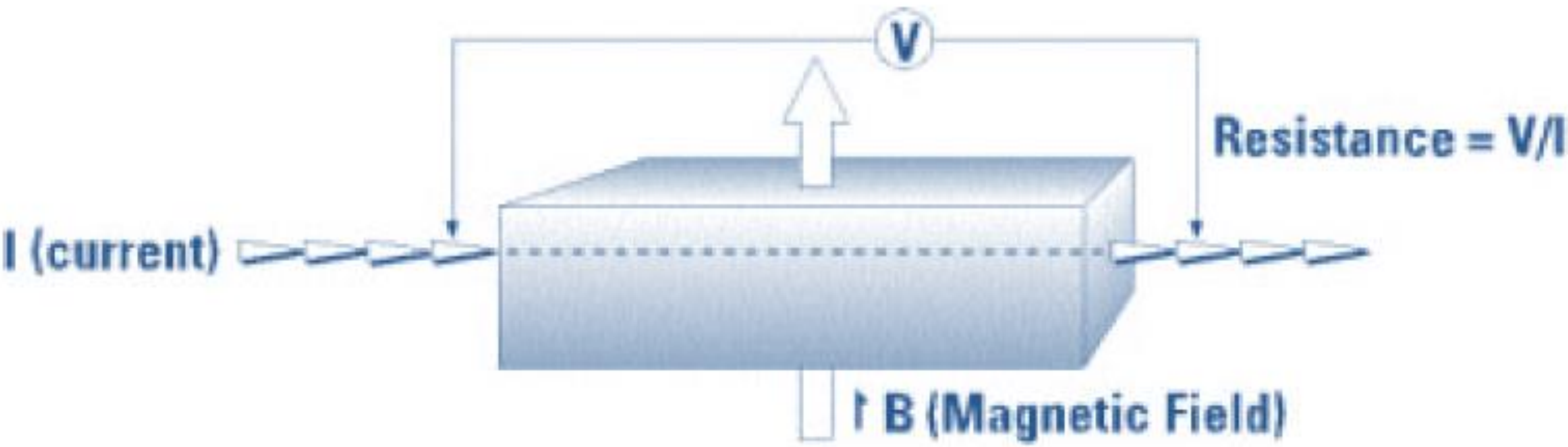


Resistive Sensors

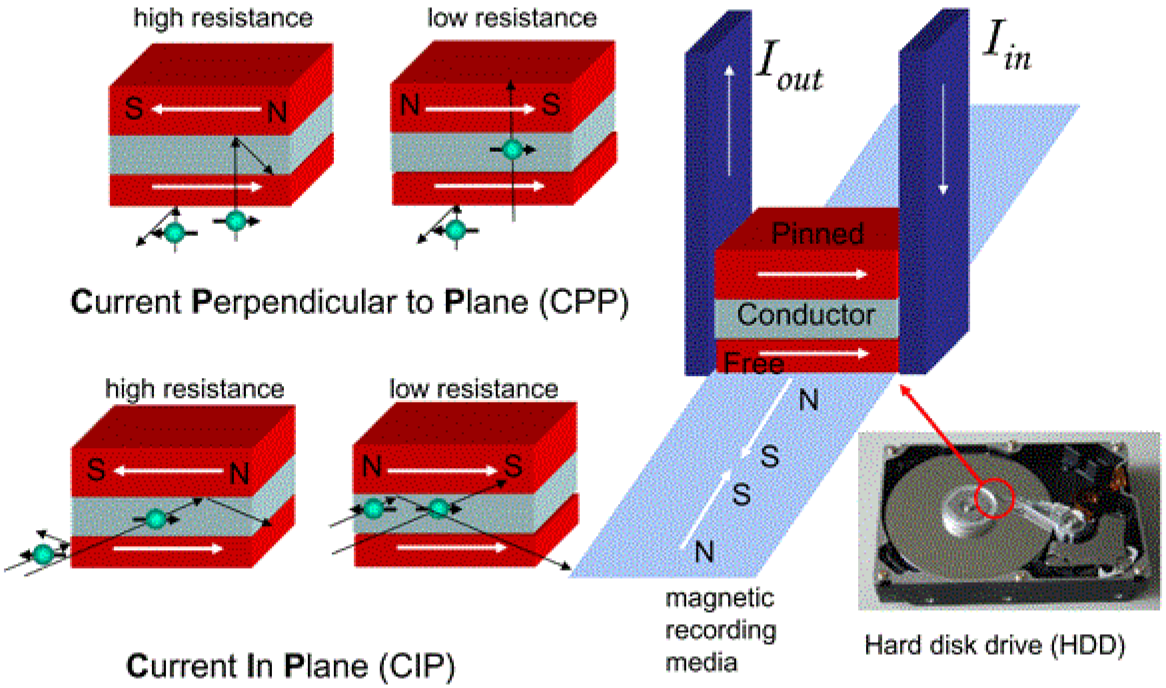
Magnetoresistive Sensors



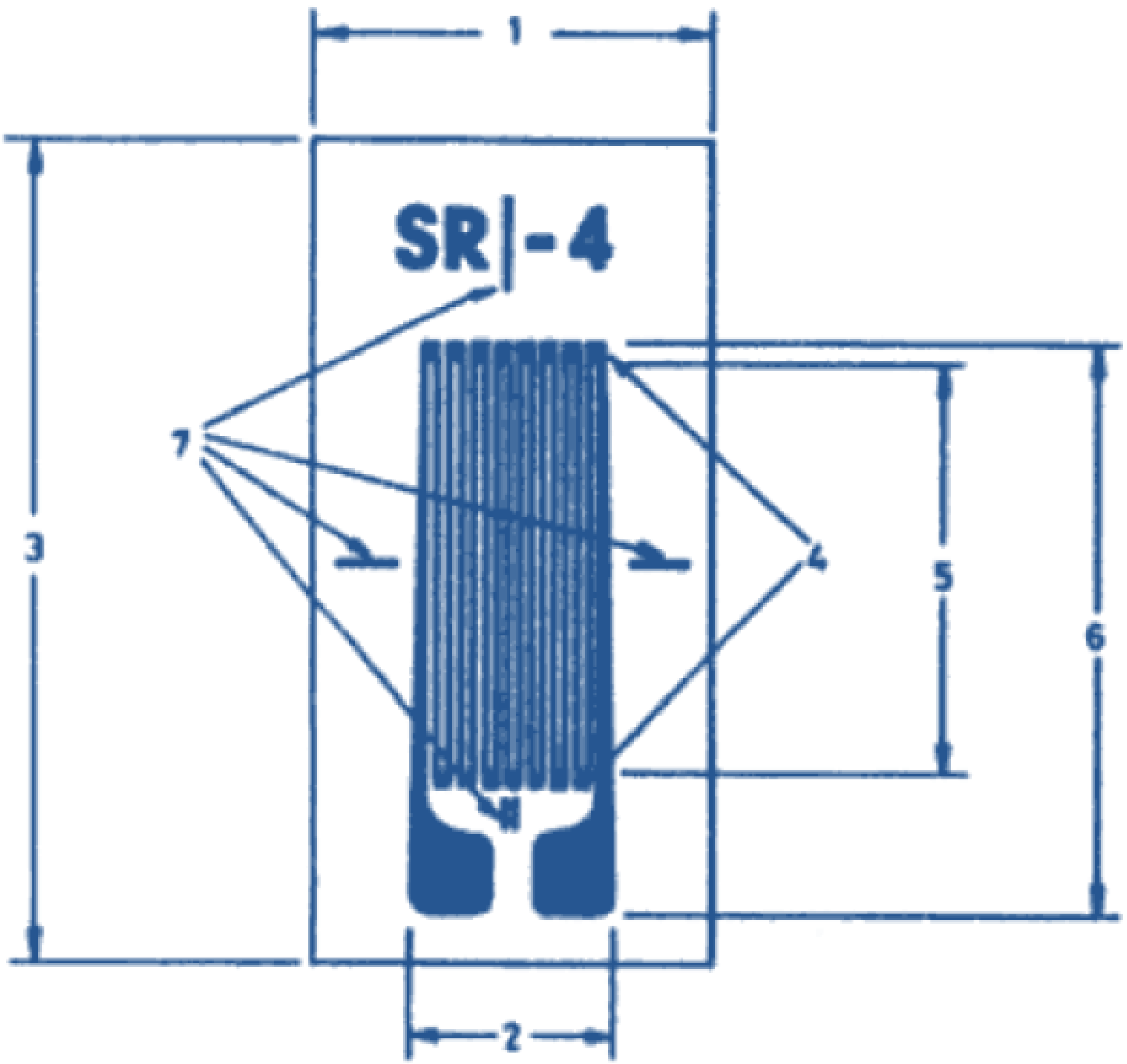
Magnetoresistive Sensors



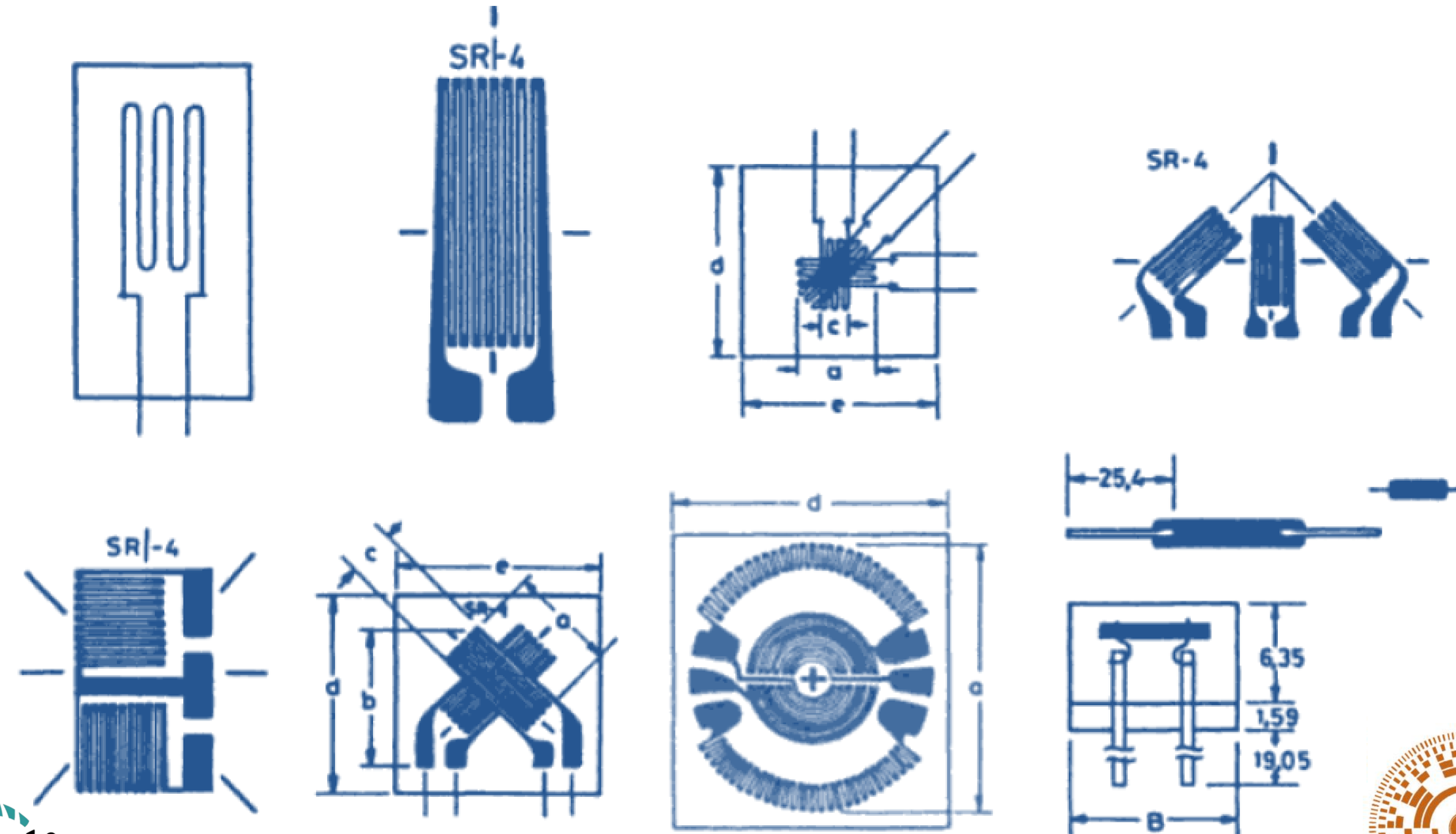
Resistive Sensors



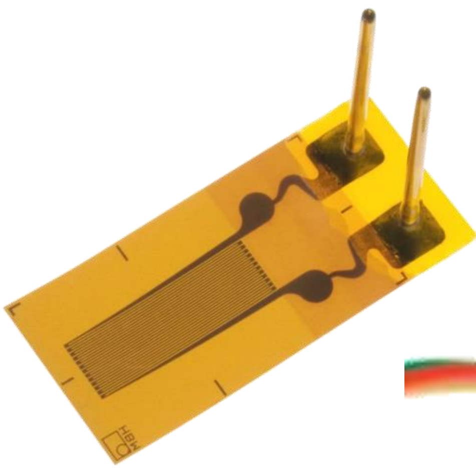
Resistive Sensors

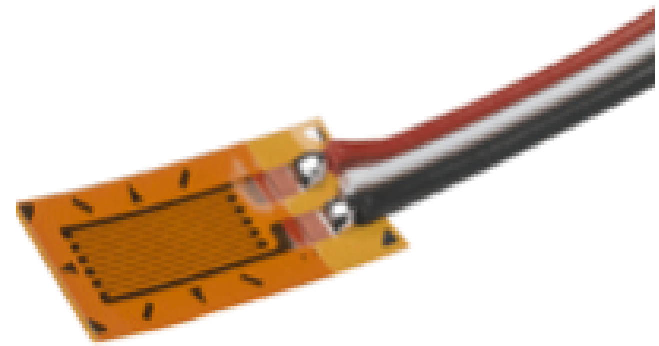


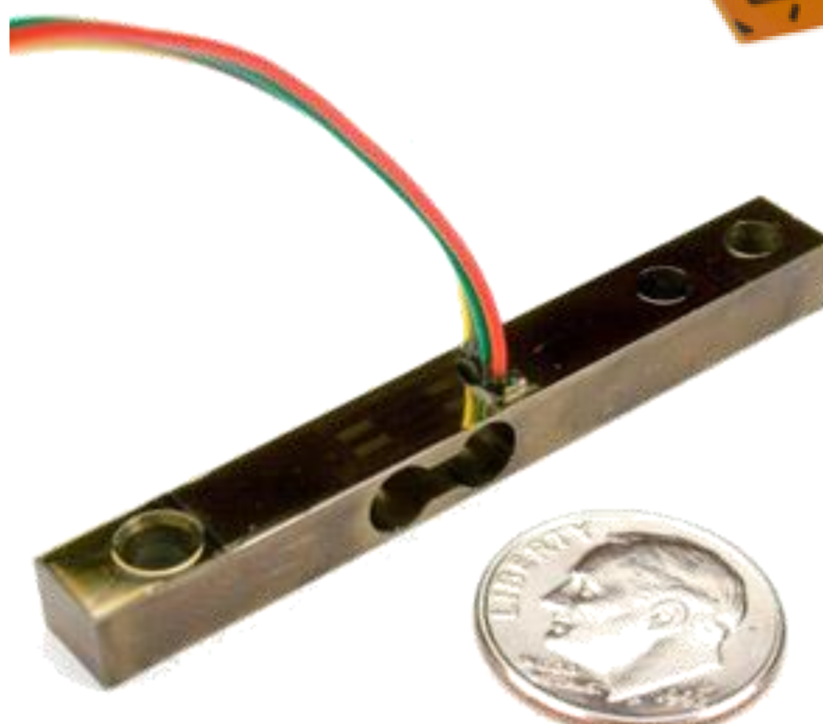
Resistive Sensors



Resistive Sensors



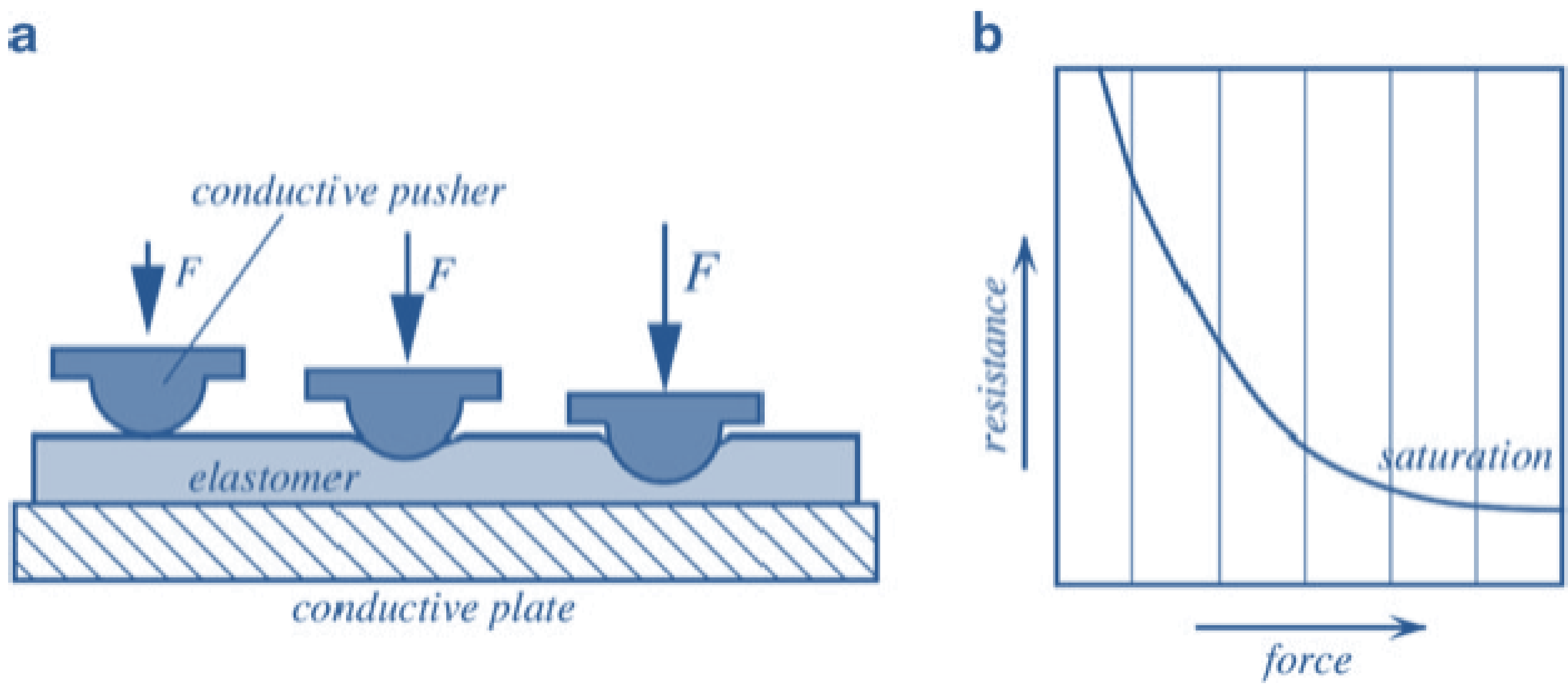




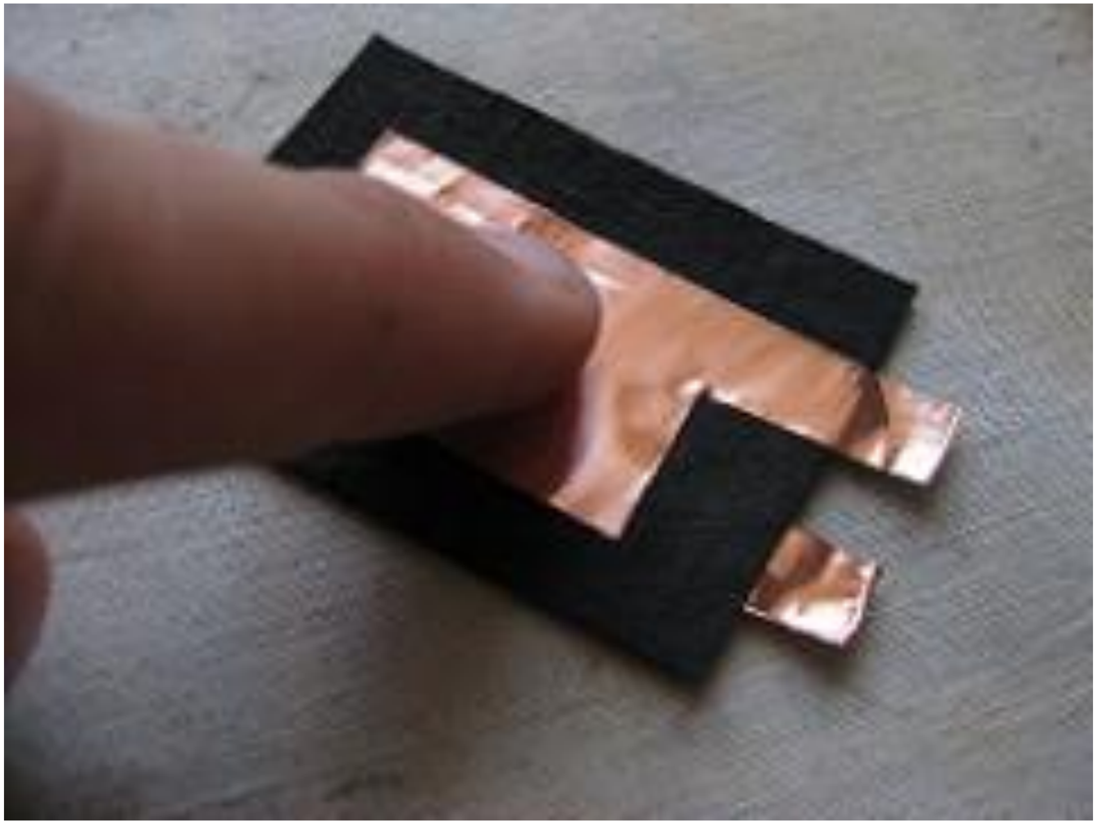
Resistive Sensors

Velostat

Resistive Sensors



Resistive Sensors



Resistive Sensors

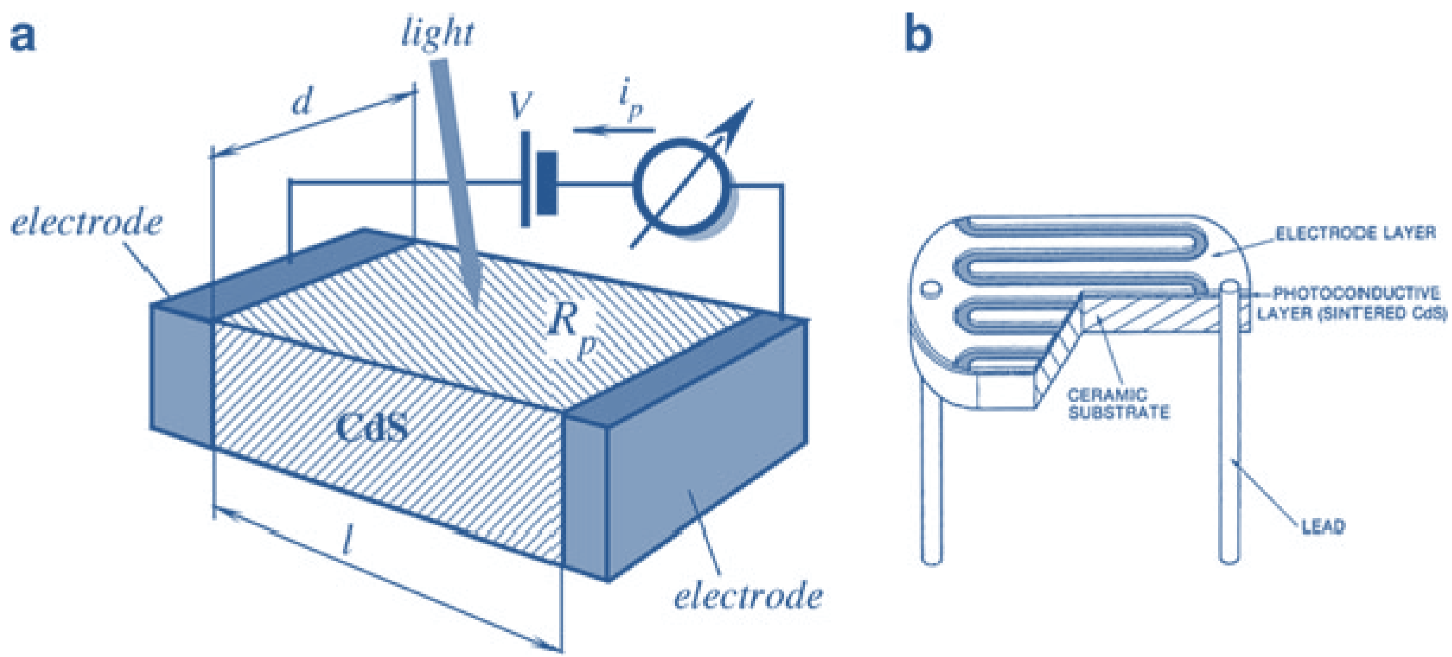
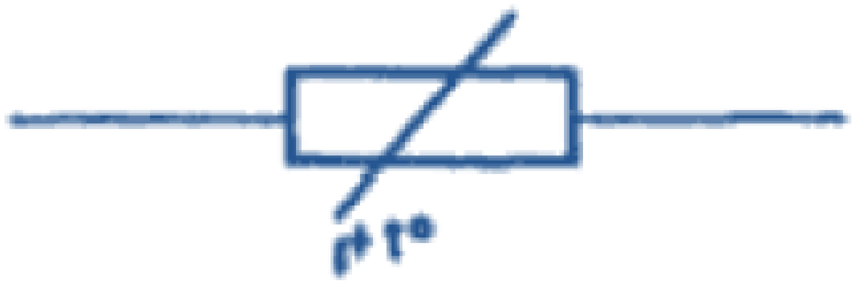


Fig. 14.11 Structure of a photoresistor (a) and a plastic-coated photoresistor having a serpentine shape (b)

Resistive Sensors

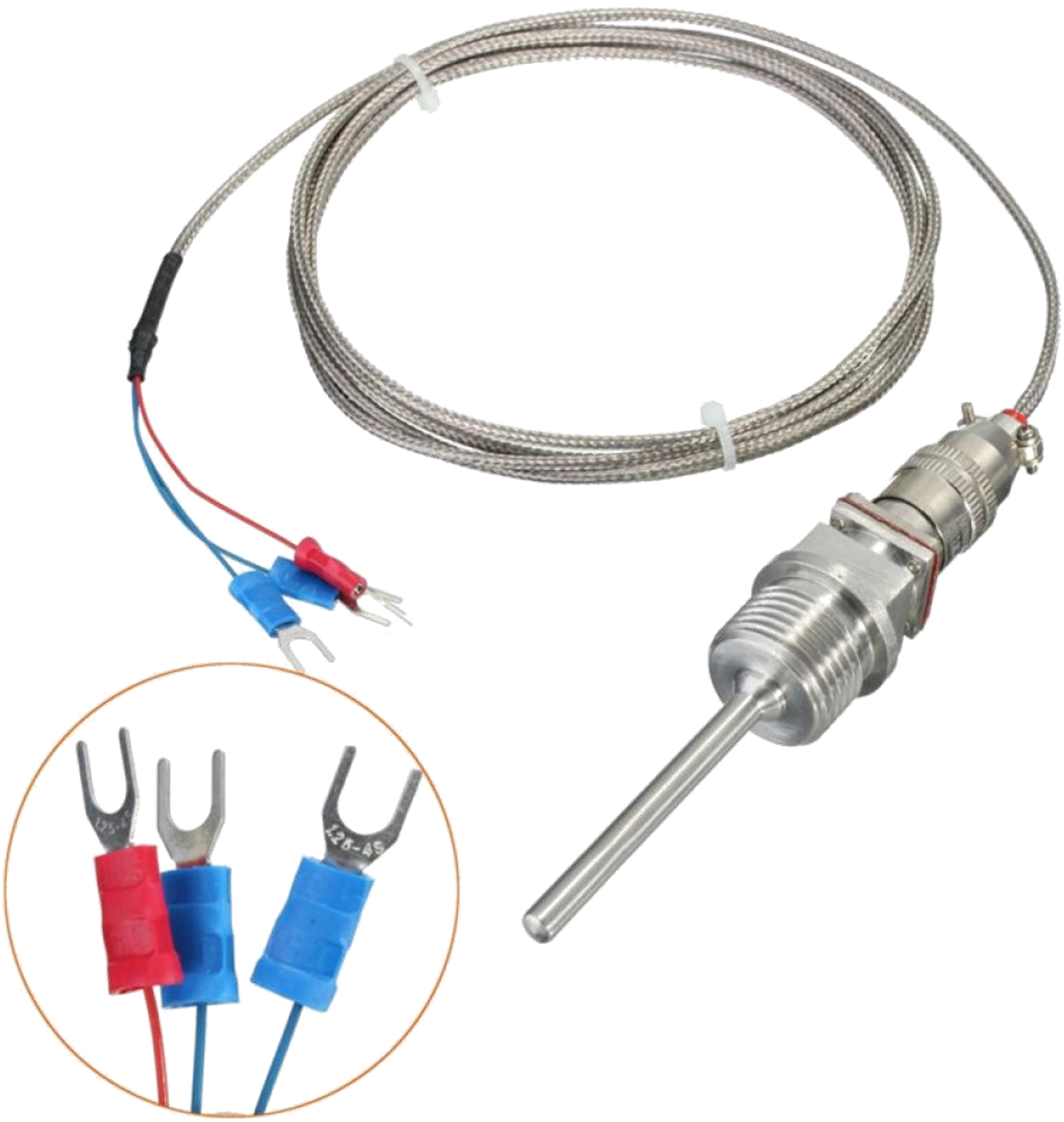
Sensor de temperatura RTD (Resistor Temperature detector) PT100



$$R = R_0\,(1 + \alpha_1\, T + \alpha_2\, T^2 + \ldots + \alpha_n\, T^n)$$

$$R = R_0\,(1 + \alpha T)$$

Resistive Sensors



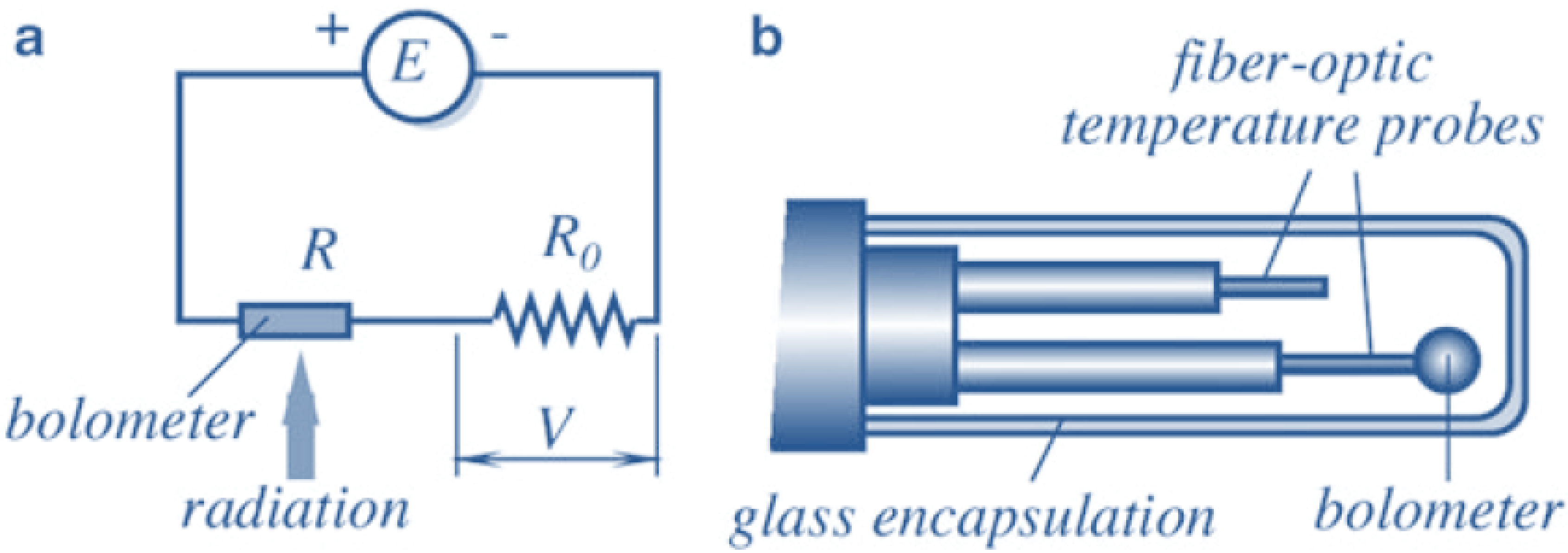
Resistive Sensors

RTD

Coeficiente de disipación térmica σ (W/ K)

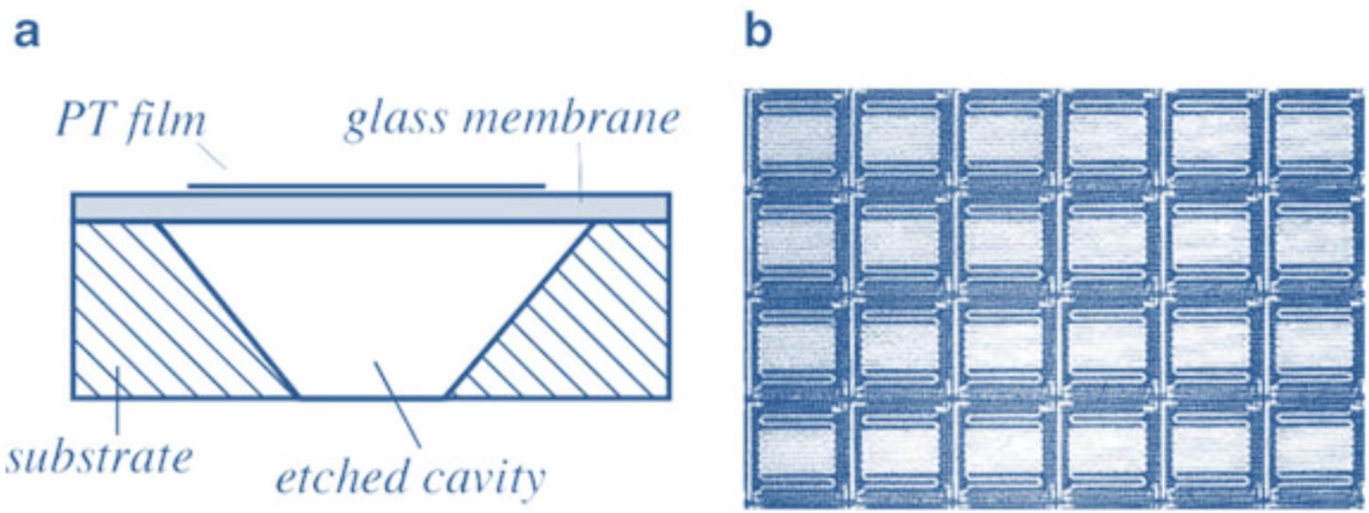
$$DT = dT = Pd / \sigma = I*I*R / \sigma$$

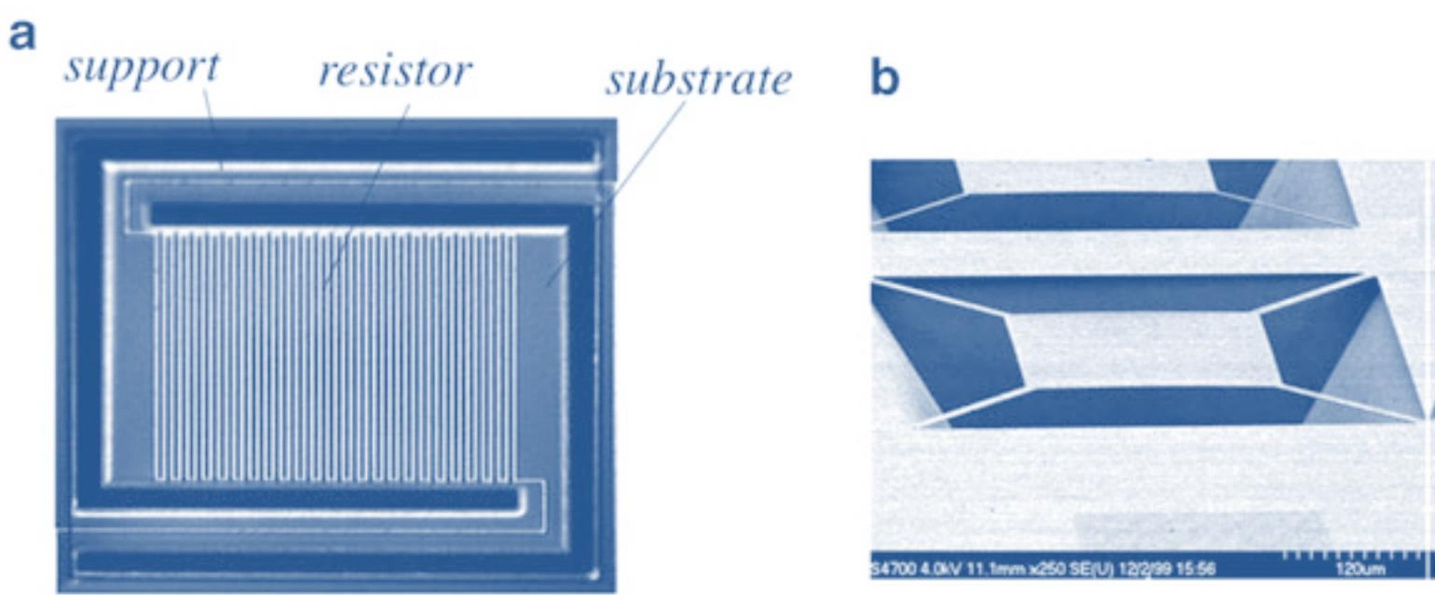
Microbolometers



Resistive Sensors

Microbolometers





Resistive Sensors

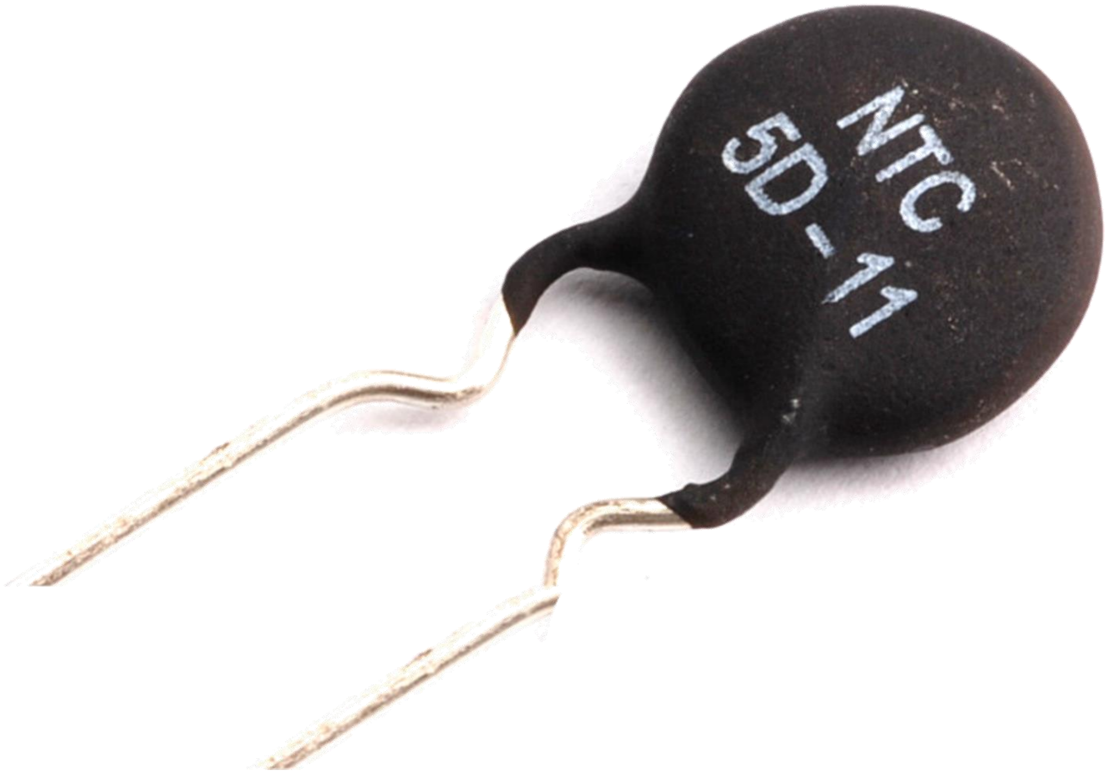
Ceramic Thermistors NTC, PTC.

$$R_T = R_0 \exp\{B\,(1/T - 1/T_0)\}$$

donde R_0 es la resistencia a 25°C u otra temperatura de referencia, y T_0 es dicha temperatura expresada en kelvins. En el caso anterior, $T_0 = 273 + 25 = 298$ K. La figura muestra la dependencia real entre R_T y T para algunos modelos.

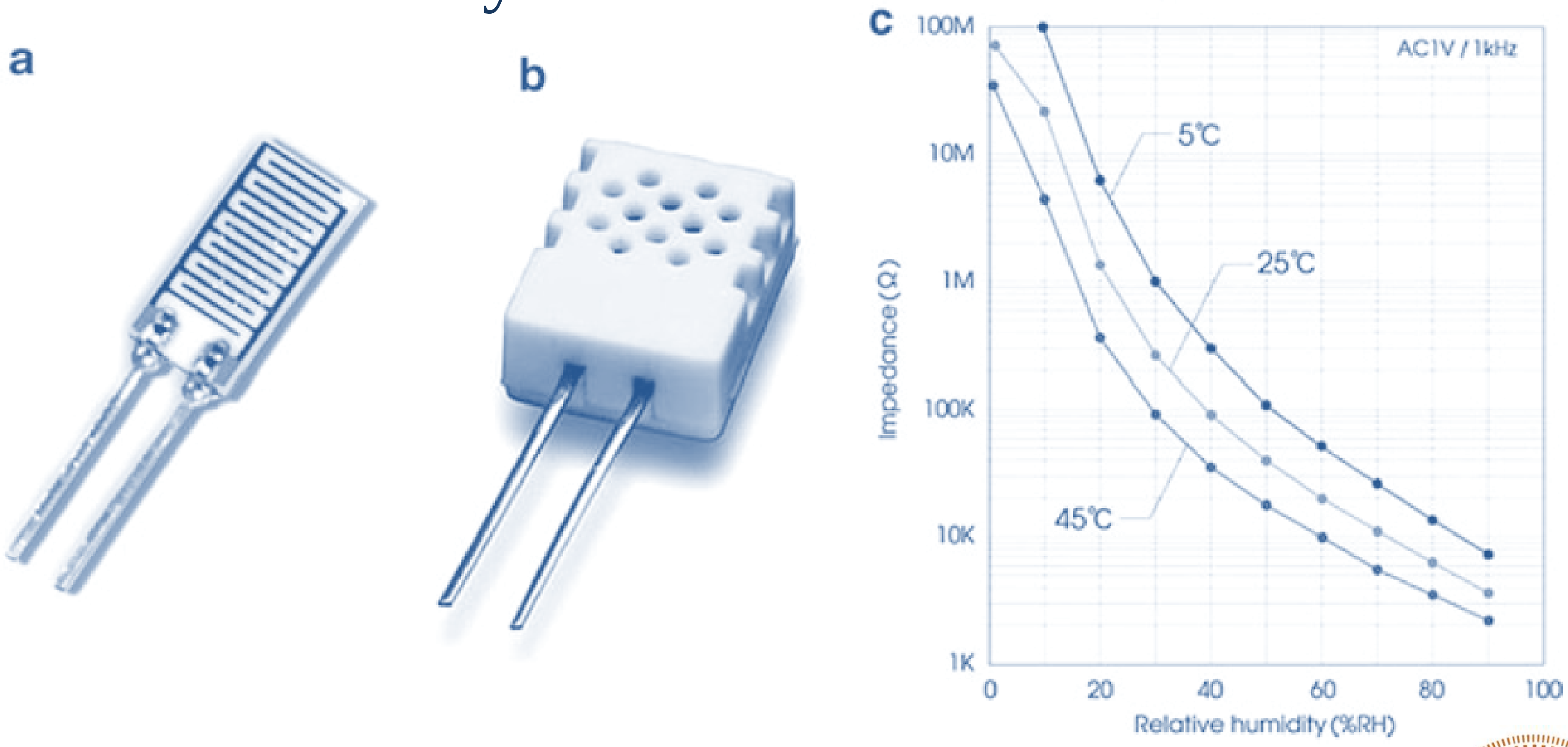
El parámetro B (o β) es la denominada temperatura característica del material, y tiene valores de 2000 K a 5000 K.

Resistive Sensors

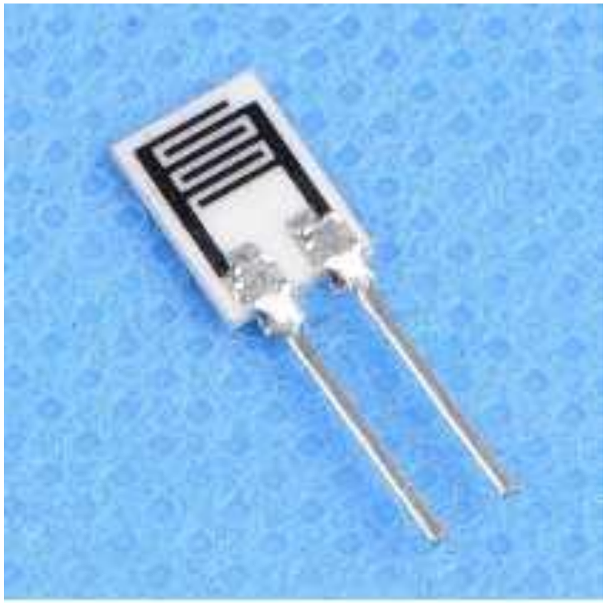


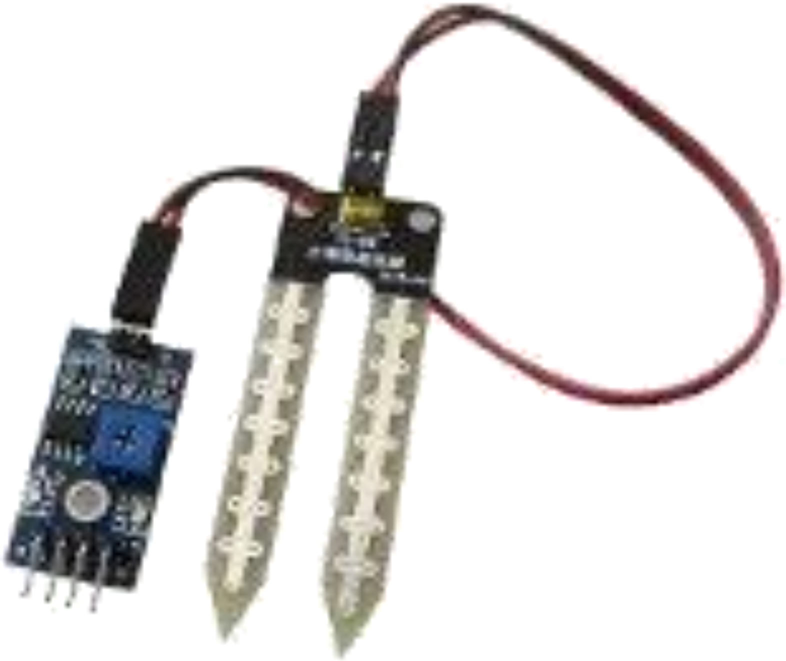
Resistive Sensors

Resistive Humidity Sensors



Resistive Sensors





Resistive Sensors

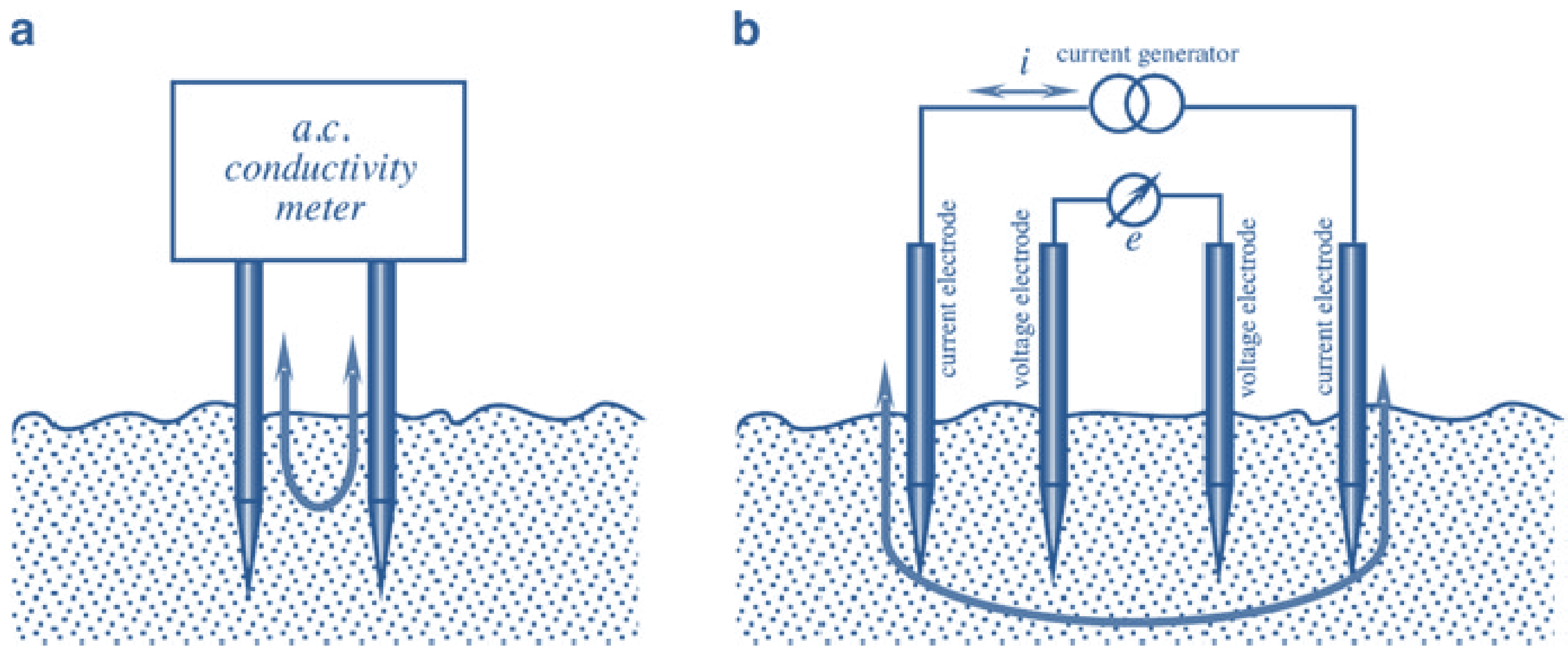
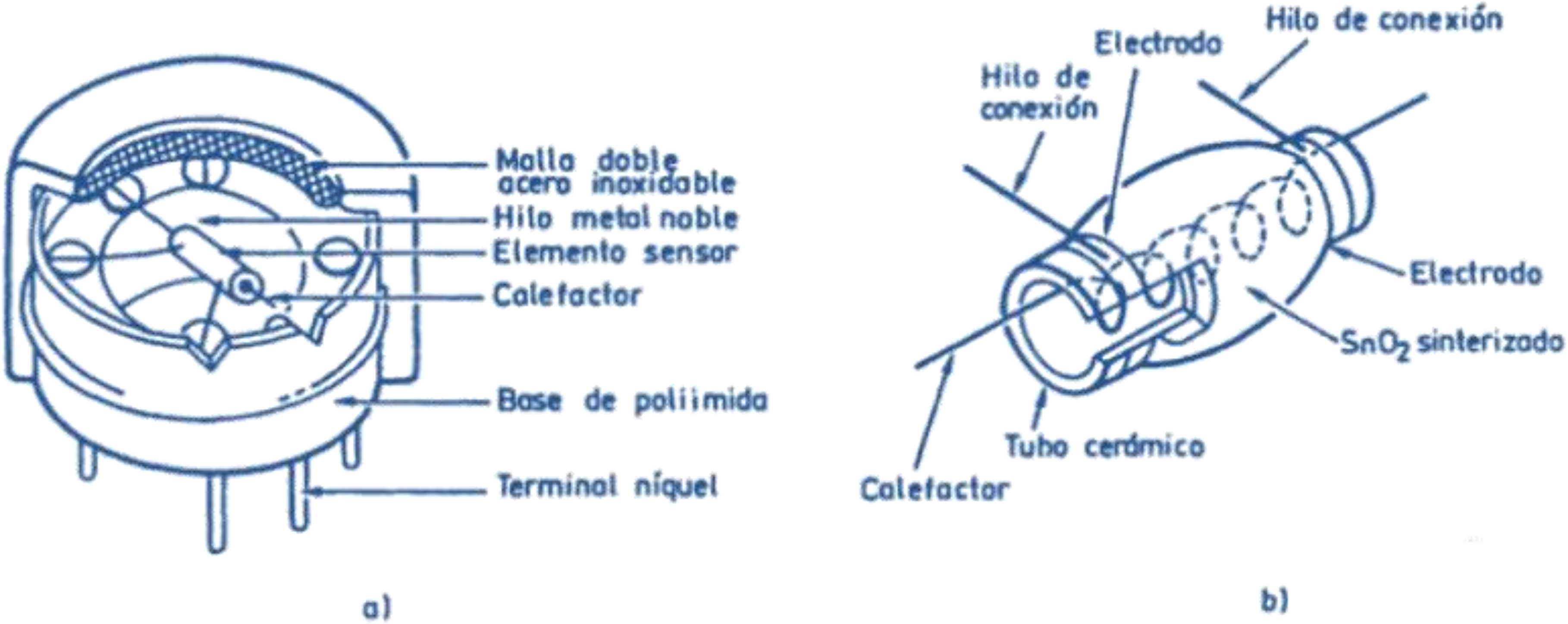


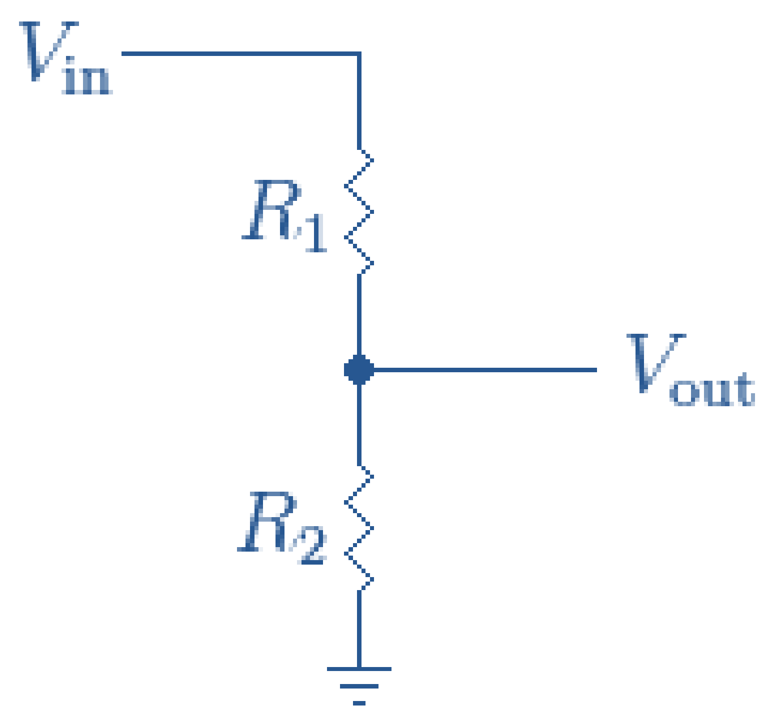
Fig. 13.8 Measurement of soil electrical conductivity with two-electrode (a) and four-electrode (b) systems

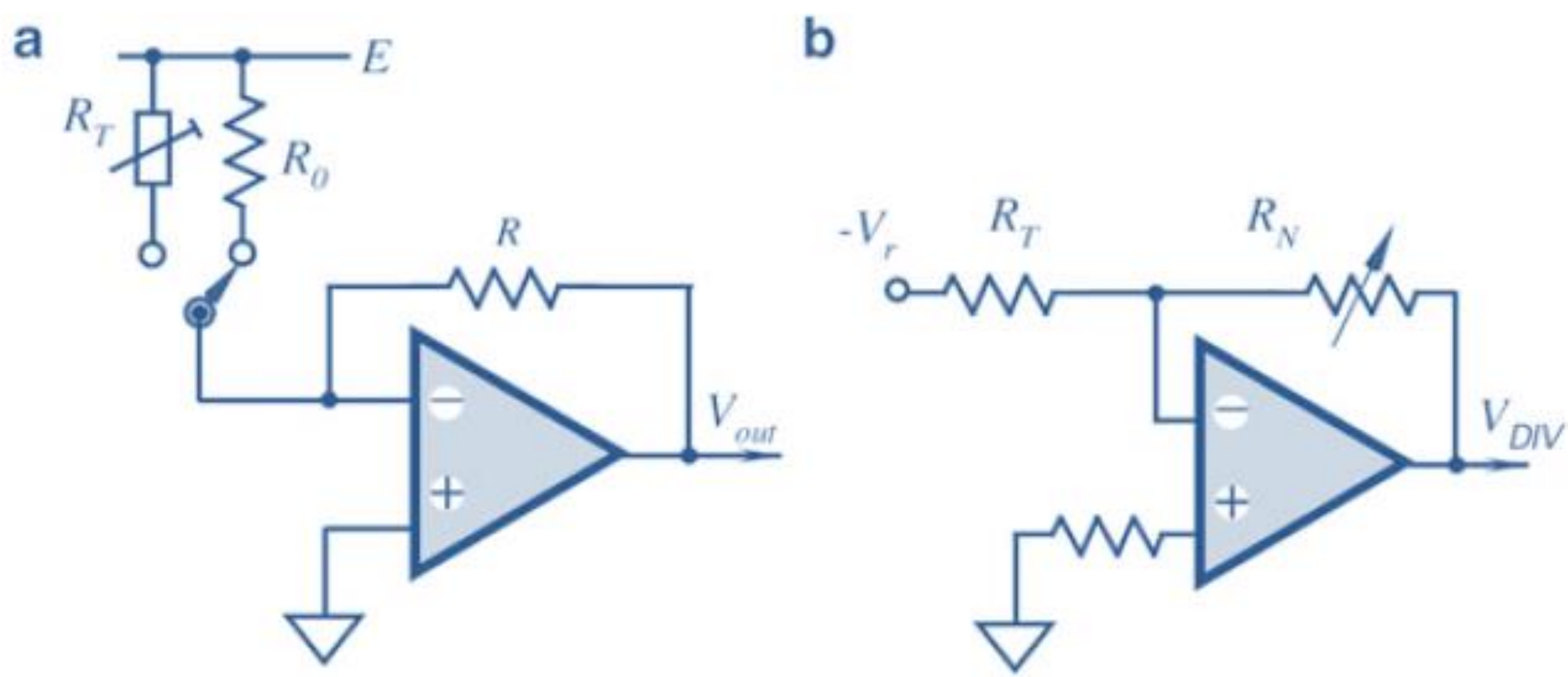


Sensor de gas de óxido de estaño

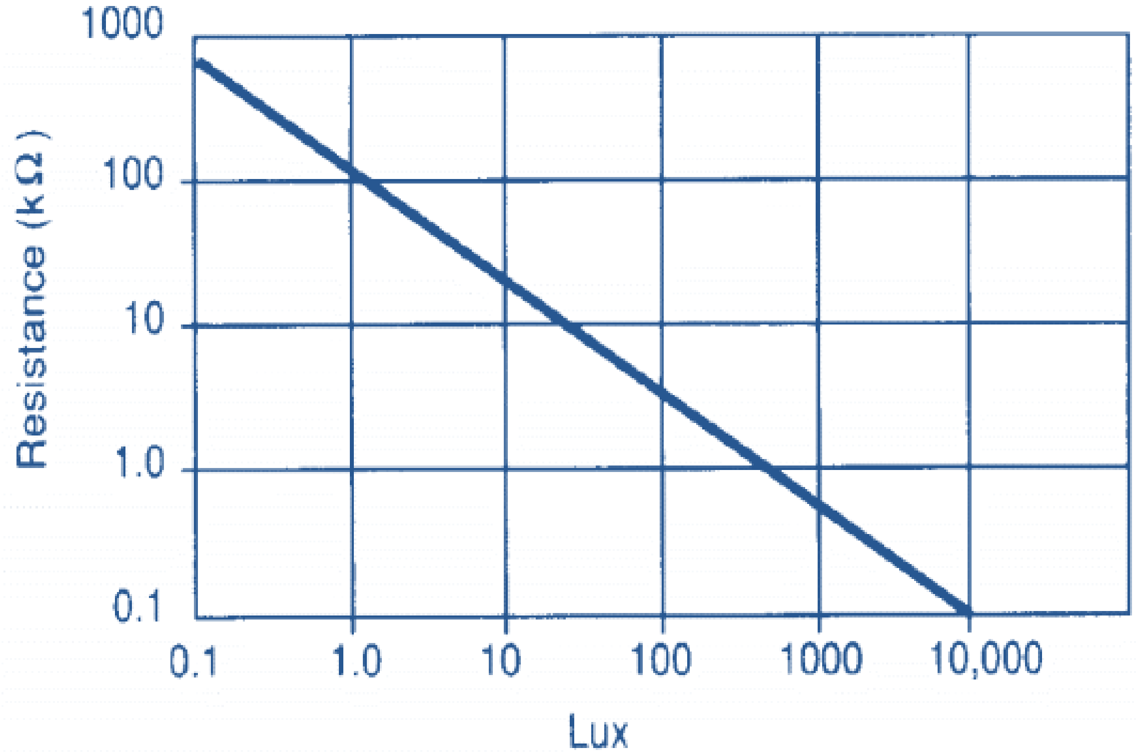
Resistive sensors conditioning

Resistive Sensors




a
E
R_T
R_0
R
V_{out}
b
$-V_r$
R_T
R_N
V_{DIV}

Sensores Resistivos



Demonstrate mathematically by means of differential calculus, analysis of inflection points, maximums and minimums,

What is the value of the resistance R that offers Maximum voltage variation in the voltage divider, with a resistive sensor in a range of operation from Rmin to Rmax?

Sensores Resistivos

Un sensor RTD, tiene una Ro=150Ω, un α=0,0052/K, y un coeficiente de disipación térmica de 6m W/K. Adecue el sensor de forma tal, que se pueda tener un error por auto calentamiento no superior a 0,3° C.

El sensor trabajara en un rango de

(20 a 200)° C. Los cambios de temperatura serán digitalizados por un ADC con referencia de (0 a 5)V.

Diseñe un circuito que permita su adecuación.

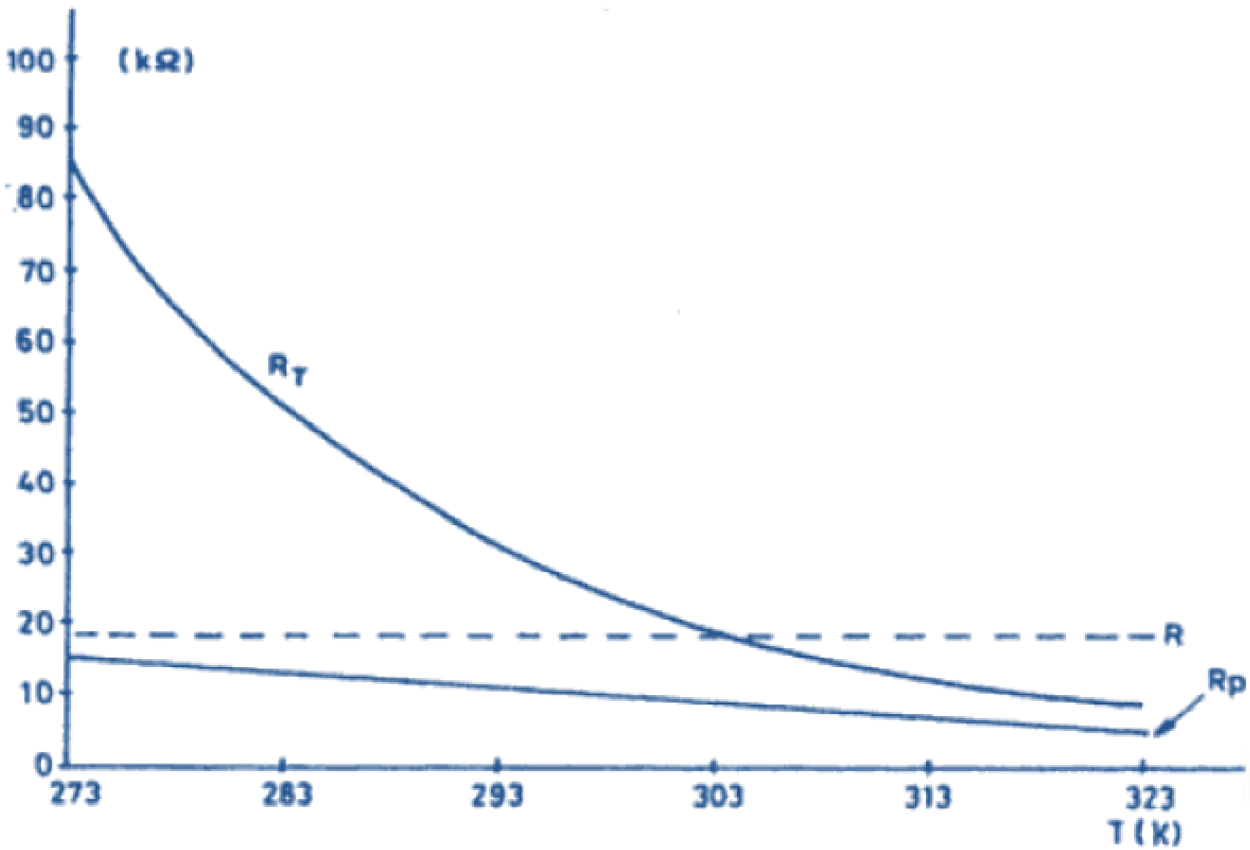
NTC

Linealizar usando un resistencia en paralelo con el termistor.

Entonces puede estudiarse $R_T \,||\, R = R_p$ como elemento independiente. El resultado es

$$R_p = \frac{R\,R_T}{R_T + R}$$

Sensores Resistivos



Sensores Resistivos

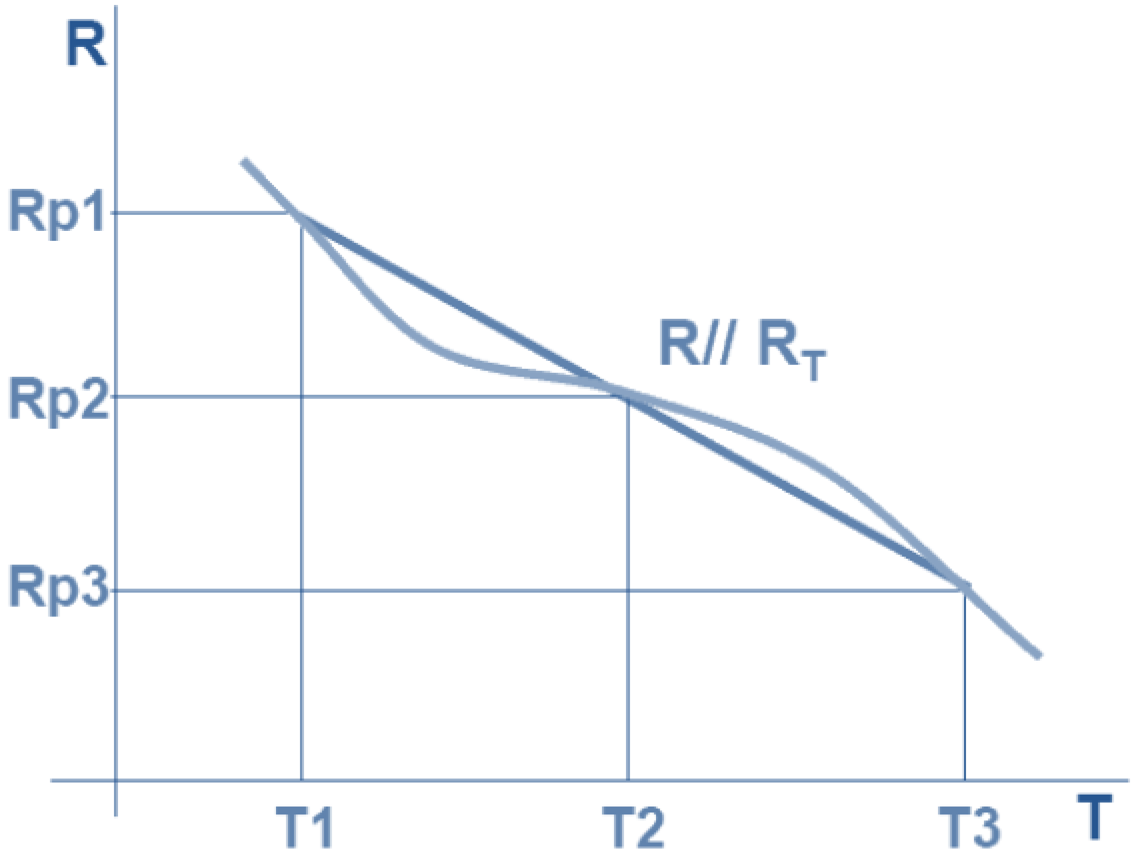
$$T_1 - T_2 = T_2 - T_3$$

$$R_{p1} - R_{p2} = R_{p2} - R_{p3}$$

$$\frac{R\,R_{T1}}{R + R_{T1}} - \frac{R\,R_{T2}}{R + R_{T2}} = \frac{R\,R_{T2}}{R + R_{T2}} - \frac{R\,R_{T3}}{R + R_{T3}}$$

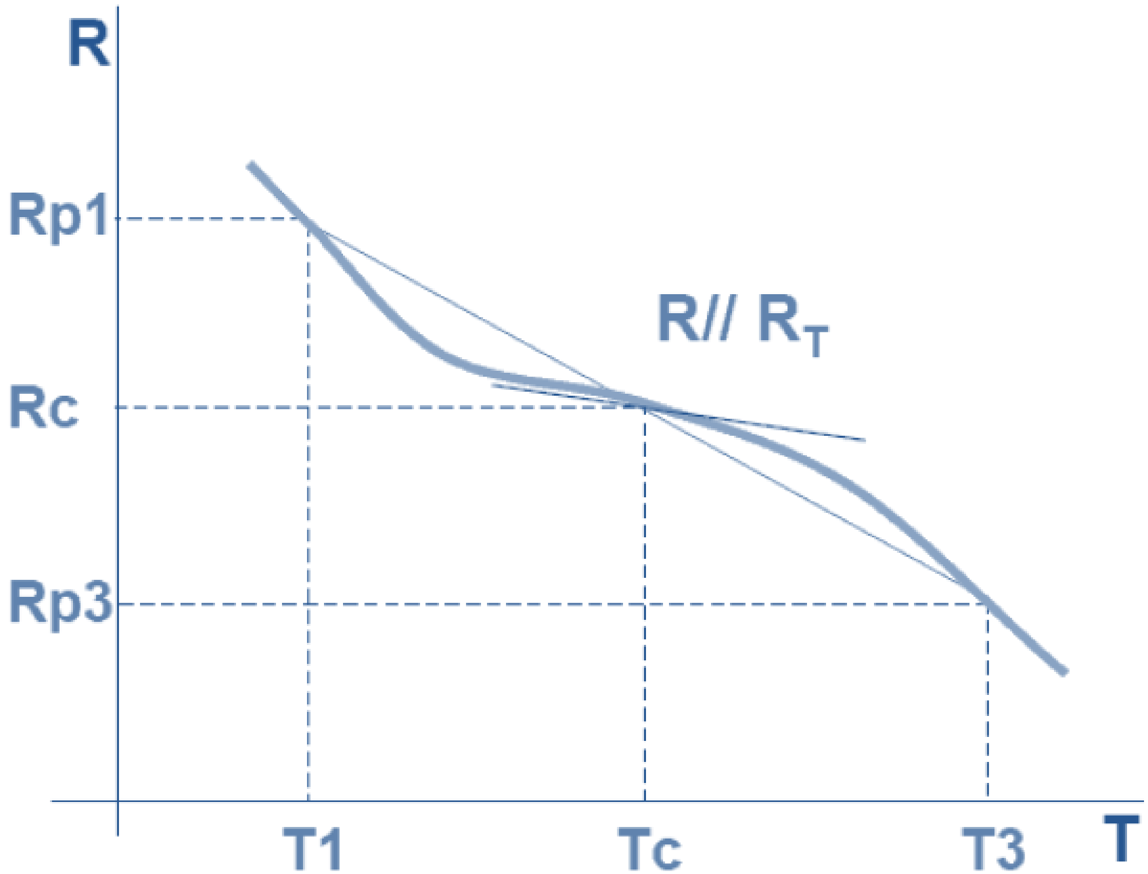
$$R = \frac{R_{T2}\,(R_{T1} + R_{T3}) - 2R_{T1}\,R_{T3}}{R_{T1} + R_{T3} - 2R_{T2}}$$

Sensores Resistivos

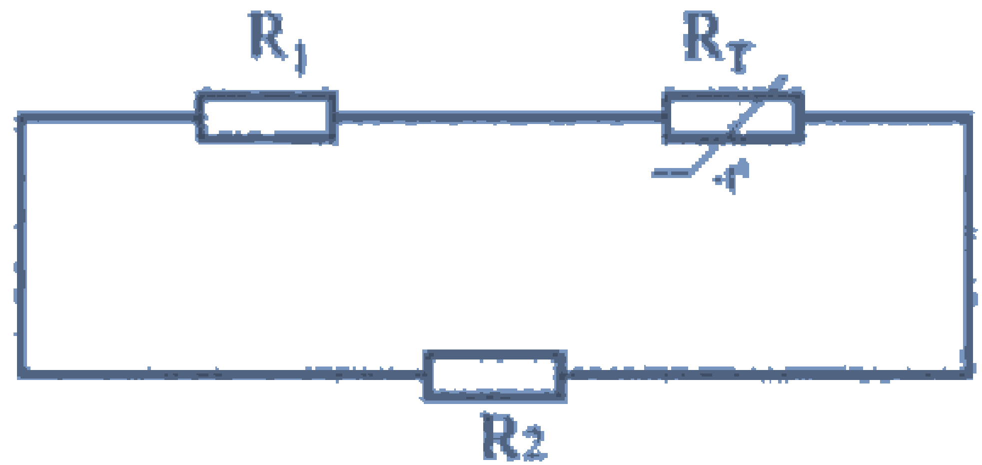


Sensores Resistivos

$$R = R_{T_c} \frac{B - 2T_c}{B + 2T_c}$$


R
Rp1
R// R_T
Rc
Rp3
T1
Tc
T3
T

Sensores Resistivos



$$R_1 = aR_0$$
$$R_2 = bR_0$$

$$b = \frac{2T_0}{B + 2T_0}\left(\frac{-mB}{R_0}\right)^{1/2}$$

$$\frac{B - 2T_0}{B + 2T_0} - b = a$$

Linealización por mínimos cuadrados

$$B = Ax$$

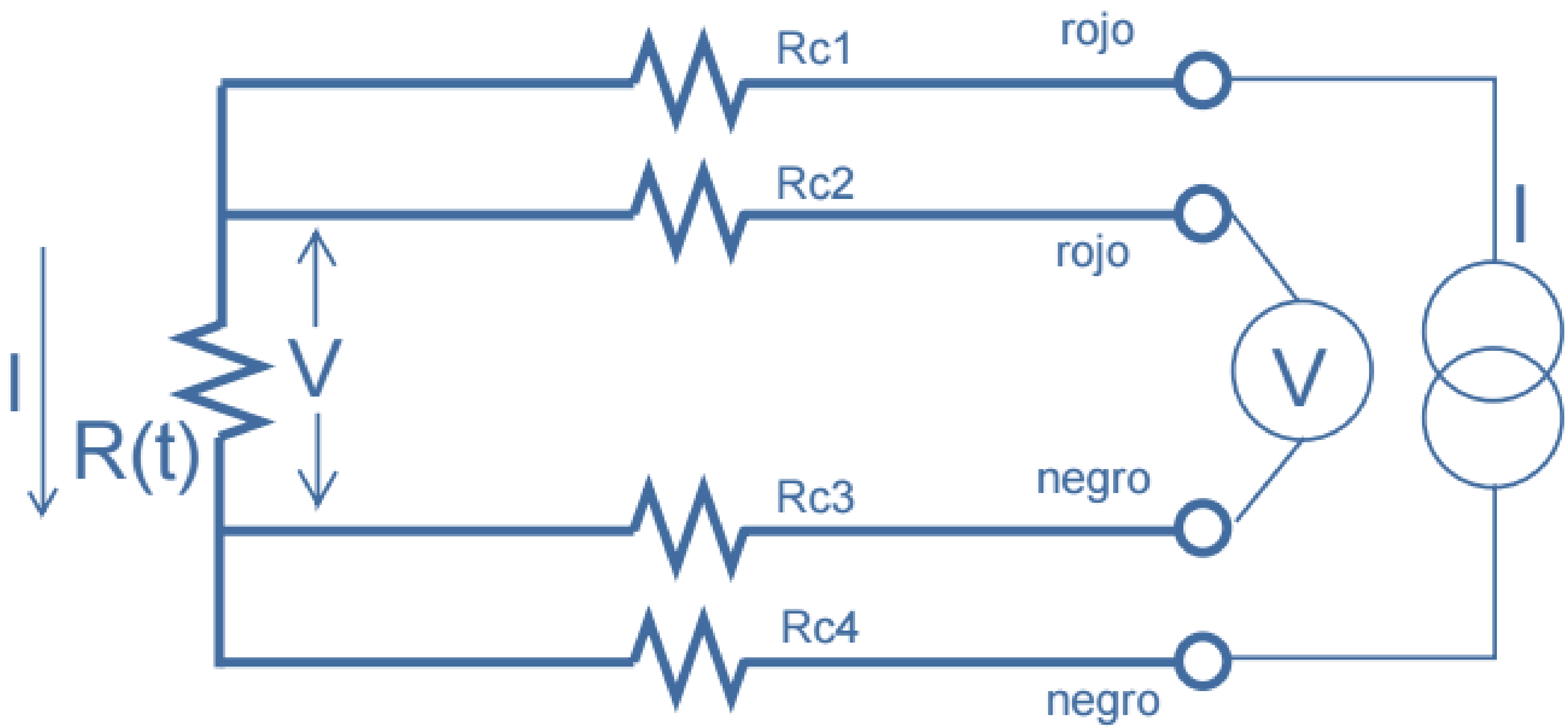
$$A^{+}B = x$$

$$A^{+} = (A^{T}A)^{-1}A^{T}$$

Sensores Resistivos

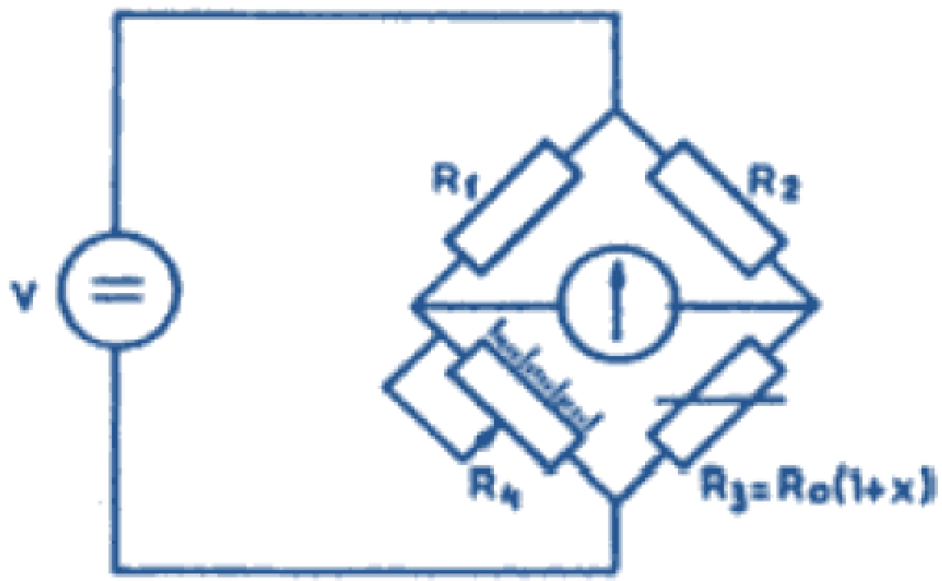
°C	Rt
10	160
20	290
30	560
40	730
50	1005
60	1050
70	1402
80	1510

Sensores Resistivos

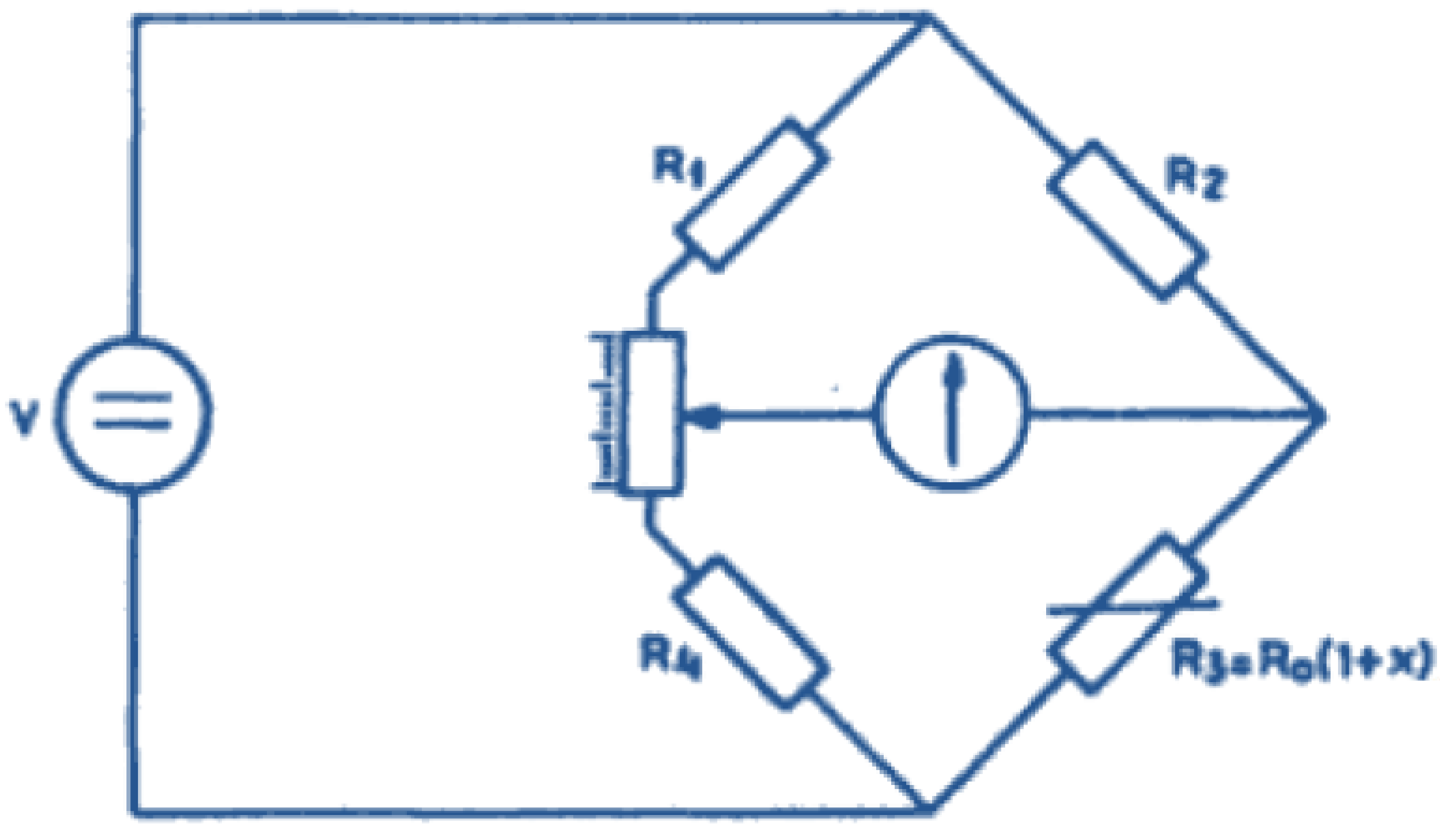


Sensores Resistivos

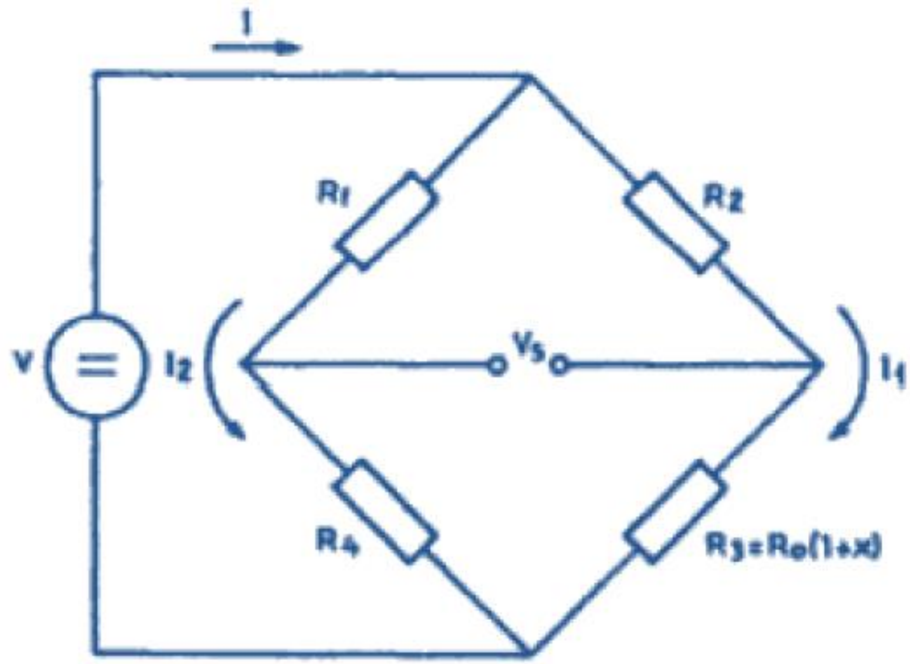
Puente de Wheatstone



$$R_3 = R_4 \frac{R_2}{R_1}$$

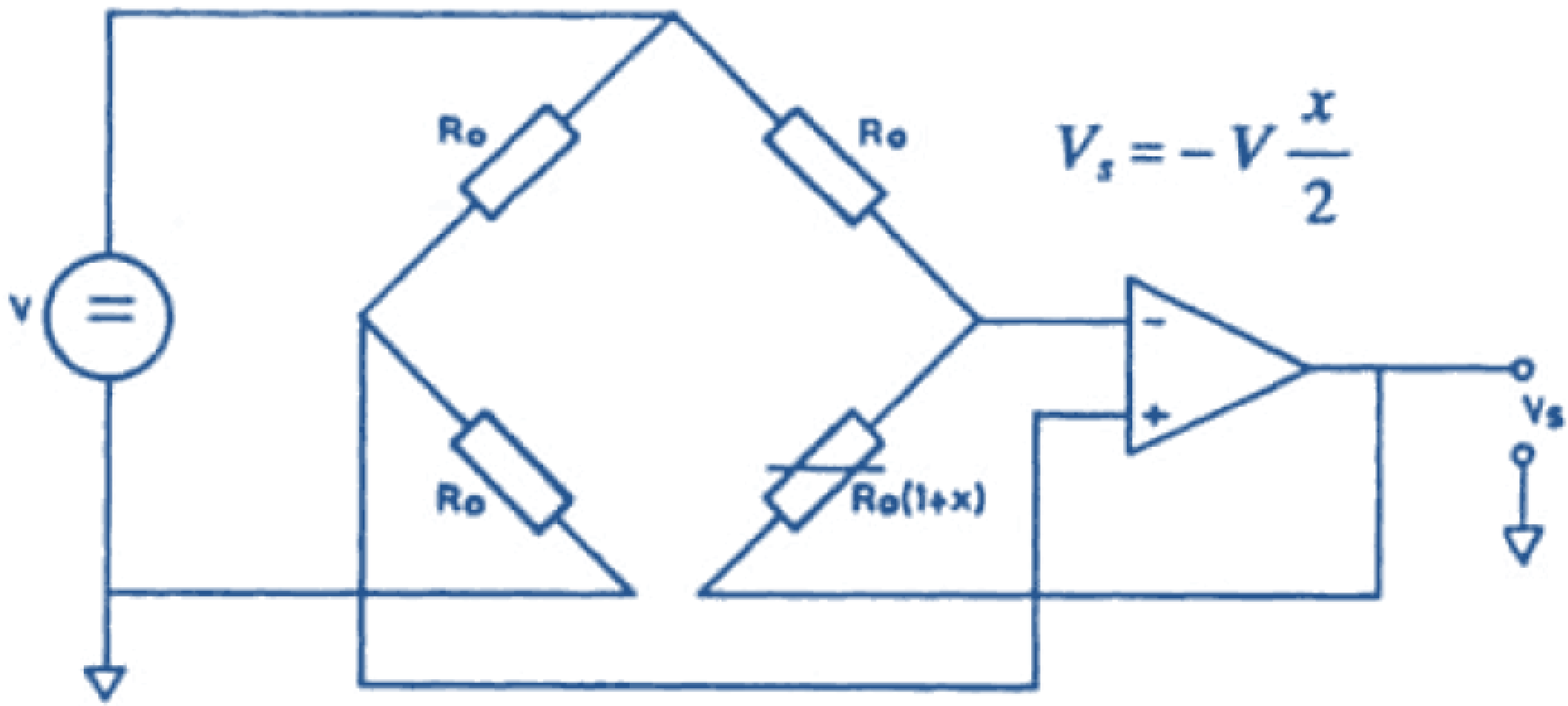

V
R1
R2
R4
R3=Ro(1+x)

Sensores Resistivos



$$V_s = V\left(\frac{R_3}{R_2+R_3} - \frac{R_4}{R_1+R_4}\right)$$

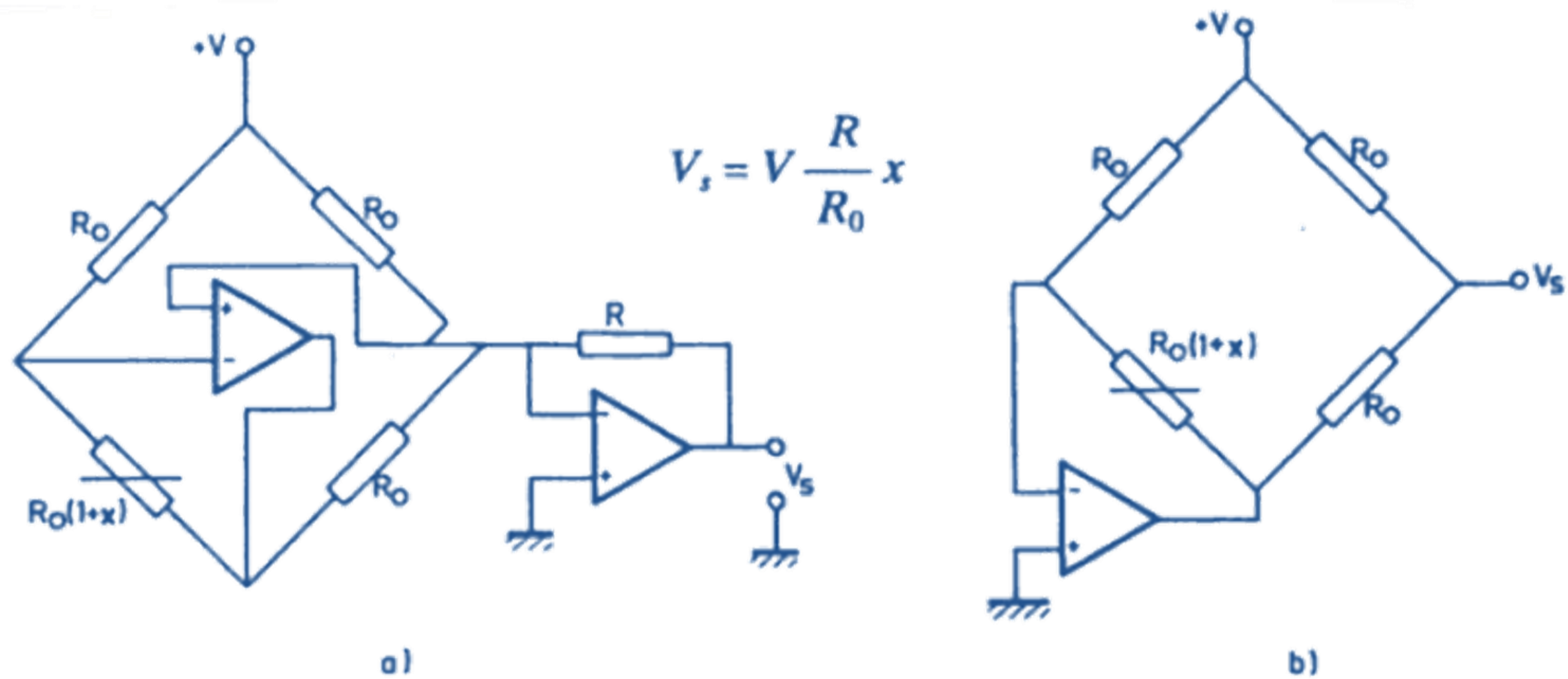
Sensores Resistivos



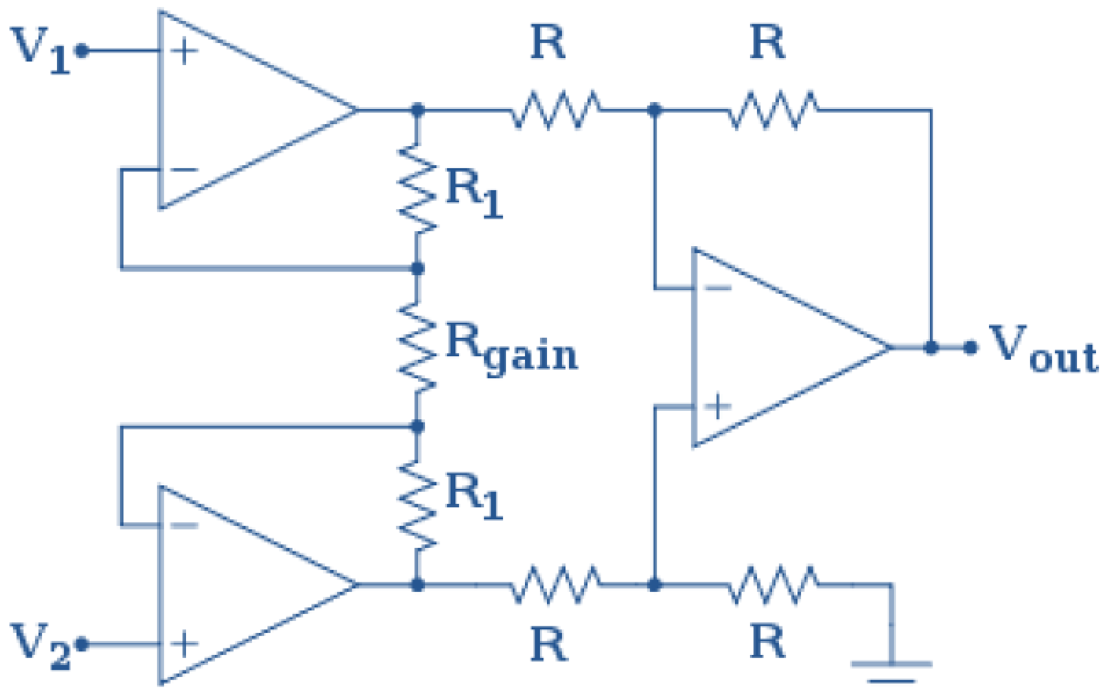
$$V_s = -V\frac{x}{2}$$

Sensores Resistivos

$$V_s = V\frac{R}{R_0}x$$

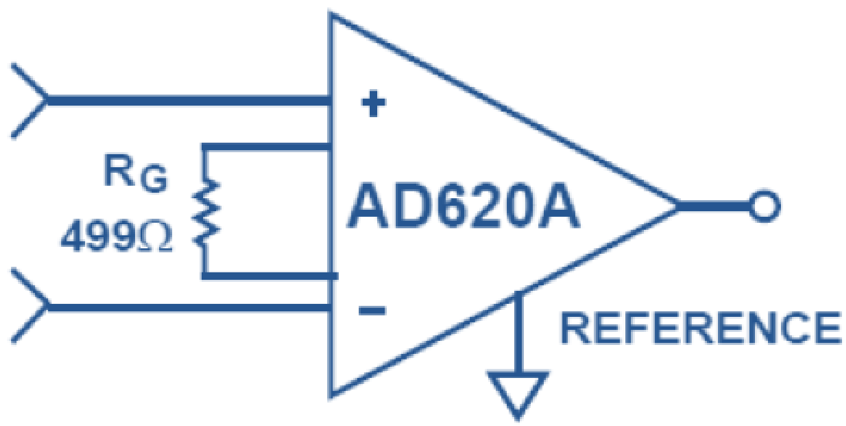


Sensores Resistivos



$$V_{out} = (V_2 - V_1)\left(1 + \frac{2R_1}{R_g}\right)$$

Sensores Resistivos



AD620A MONOLITHIC
INSTRUMENTATION
AMPLIFIER, G = 100

$$R_G = \frac{49.4\,k\Omega}{G-1}$$

Sensores Resistivos

Un termistor tiene una Ro=22KΩ a 25° C, y un β=4600K, el sensor trabajara en el rango de (50 a 150)° C, determine una R en paralelo para linealizar el sensor. Si el coeficiente de disipación termica es de δ=9mW/K, determine el error causado por el auto calentamiento del termistor. Diseñe un circuito de adecuación para digitalizar la temperatura en un ADC con referencias de (0 a 3.3) V.

Sensores Resistivos

Un NTC tiene una Ro=1,6KΩ a 25° C, y un β=3400K, el sensor trabajara en el rango de (0 a 80)° C. Linealice el sensor, y adecue la señal por medio de un puente de Wheatstone. La temperatura será digitalizada con un ADC con referencias de (0 a 3.3) V.