Resistive sensors

The resistance of conductor or semi-conductor changes predictably with changes to its environment. Sensors that are based on this principle are called resistive sensors and are the most common type of sensor in use, today.

The following are common types of resistive sensors

Resistance temperature detector (RTD)

RTDs are usually
— a wire wound around an insulating support or
— a thin wire or
— a thin strip of metal or
— a thin insulating strip with a deposited conducting film.

The metals are typically platinum, copper, or nickel.

Let R_0 and T_0 be the resistance of the RTD at temperature T_0 and the reference temperature T_0, respectively. Let α_T be the thermal coefficient of expansion of the metal used in the RTD.

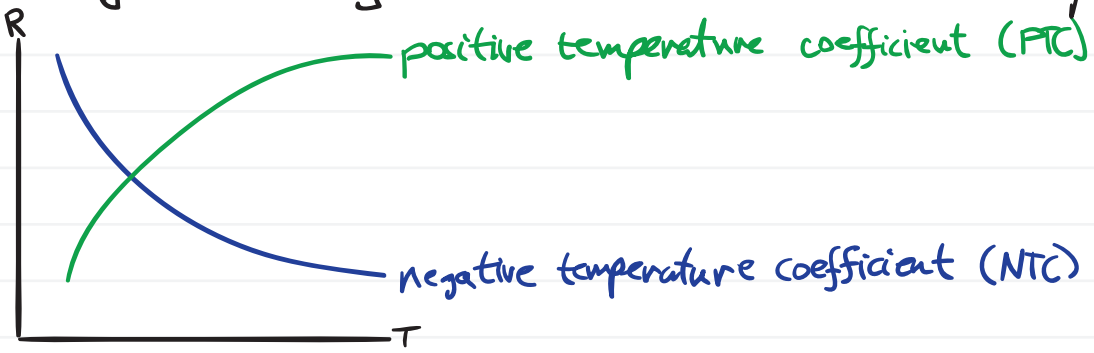
Then we can relate a given resistance R of the RTD to its temperature T with

$$T = T_0 - \frac{R - R_0}{\alpha_T R_0}.$$

Thermistor

Thermistors are made of two wires connected across a small semiconductor. The resistance of the semiconductor

changes (directly or inversely) with the environmental temperature.



Let R_0 and T_0 be the resistance of the thermistor at temperature T_0 and the reference temperature T_0, respectively. Let β_T be an inverse thermal coefficient of expansion.

Then we can relate a given resistance R of the thermistor to its temperature T with

$$T = \frac{T_0}{\frac{T_0}{\beta_T} \ln \frac{R}{R_0} + 1}.$$

Example

A given thermistor has references $T_0 = 0\,°C$ and $R_0 = 10\,\Omega$. It now has resistance $50\,\Omega$. What is the temperature measurement if the thermistor has $\beta_T = 2e4\ K$? Is the thermistor PTC or NTC?

$$T = \frac{T_0}{\frac{T_0}{\beta_T} \ln \frac{R}{R_0} + 1} = \frac{273.15}{\frac{273.15}{2e4} \ln\left(\frac{50}{10}\right) + 1} = 267.30\ K = -5.8749\,°C.$$

Since $T < T_0$, NTC.