The resistor determines the accuracy of industrial Pt100s

The properties of Pt100 sensors are largely determined by the construction of the temperature-sensitive resistor. Non-fixed Pt wires and free air admission are necessary to achieve the best accuracy, which the best reference sensors always have. This article discusses what limitations can arise from other priorities.

Reference sensors for precision calibration (SPRT) are constructed with non-fixed wires, for example on ceramic support, and free air admission. The reason is that this construction design is intended to produce a thermometer that can expand or contract when heated or cooled without the platinum wires stretching and then rubbing or scraping against their support. These reference thermometers are usually filled with dry air to ensure that the platinum is functioning in an oxidising and not a reducing environment.

Industrial platinum thermometers

The most accurate industrial wirewound IPRTs conform very closely to the two most important above-mentioned requirements in SPRTs. The thin wire is pulled through laser-drilled sapphire or diamond die plates, both of which give repetitive results without contaminating the platinum wire. The platinum wire is then built into narrow cavities in a ceramic body, which minimises the risk of additional contamination. All introduction of foreign materials risks altering the platinum's sensitivity and thereby causing measurement errors. See Figure 1.

At least 30 g

The technique of using supported wire involves winding the wire in thin coils and inserting it into a ceramic body equipped with small holes. (Figure 1) The wire is connected to sturdy platinum legs that are fixed in place with glass or ceramic. The coiled wire runs almost equally freely inside the ceramic body's channels as in an SPRT. This allows air to circulate around the platinum wire. This design combines high vibration resistance with high stability (accuracy). The wirewound resistors that Pentronic uses as standard can withstand a vibration level of 30 g in the range 10–1000 Hz.

Thin film resistor

Platinum resistors can be divided into two general categories: wirewound and thin film resistors. Industrial Pt100 sensors conform to IEC 60751:2008, which addresses such topics as tolerances, measuring ranges and the temperature-resistance ratio, and differentiates between the properties of wirewound and thin film resistors. The properties of ready-made sensors are also differentiated based on resistor type. [Ref. 1]

Modern thin film resistors are equipped with a platinum coating that is steamed onto a ceramic substrate under vacuum. See Figure 2.

However, this construction does not satisfy a number of important requirements and the areas of use are thereby limited. The pattern in the film is fixed to the substrate, in contrast to the almost totally free wire in the above-mentioned case of the supported wire. The platinum content is also low in the very thin film layer, making it sensitive to contamination by coating materials such as glass or ceramic.

Thin film resistors are so small that there is noticeable self heating of the excitation current. This risk increases for Pt1000s in particular, and such a sensor can be 100 times more sensitive to self heating than a medium-size wirewound resistor.

The link between the film pattern and the legs is a known mechanical weakness in thin film resistors that is worth taking into account when dealing with measurement environments with a high vibration level.

The advantages of thin film resistors include their suitability for the white goods industry and especially for surface measurement thanks to their flat construction. The automotive industry is another major user. These resistors are most accurate in the range of -50 to between 200 and 300 °C.

For measuring in larger temperature ranges the wirewound resistor that resembles the reference resistor is to date unsurpassed in terms of accuracy. It is also mechanically strong, easy to adapt to round probe tips, and is also easy to build into metal sheathed cable.

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[Ref 1] Pentronic News 2009-4, page 4

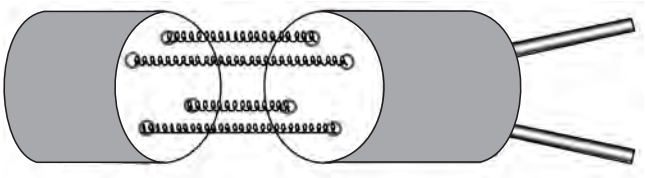

Figure 1. Hypothetical diagram of the technique of using supported platinum wire shown on a cutaway diagram of a resistor. Approx. 20% of each coil of the wire is fixed to the ceramic (Al_2O_3) body. The leads (legs) are well anchored inside the body's cavity.

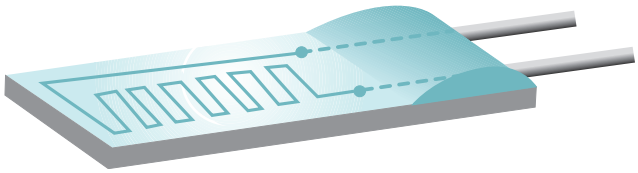

Figure 2. Thin film resistors can be made very tiny but do not satisfy the requirements of mobility and air supply. High resistance values like those in Pt1000s plus small dimensions make the resistors particularly sensitive to self heating.

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