Pt100 Sensors for Industrial Use

The use of a platinum resistance thermometer probe in industrial and scientific applications will normally result in good, accurate temperature sensing without the need for special cables (unlike thermocouples). To achieve the best possible accuracy and reliability, care is needed with installation of the probe, connections, and choice of the host instrumentation.

Choice of wire-wound or flat film sensing resistor.

The resistance element is produced in one of two forms, either wire-wound or flat film. Metal film resistors consist of a platinum layer on a ceramic substrate; the coil of a wire wound version is fused into ceramic or glass.

Wire-wound resistors.

Various methods of detector construction are employed to meet the requirements of differing applications. The unsupported "bird cage" construction is used for temperature standards, and the partially supported construction is used where a compromise is acceptable between primary standards and use in industrial applications. Other constructional methods include the totally supported construction which can normally withstand vibration levels to 100g, and the coated wire construction where the wire is covered with an insulating medium such as varnish. The maximum operating range of the latter method is limited by the wire coating to usually around 250^{o}C.

Flat Film Resistors

Flat film Pt resistors take the form of a thin (1 micron) film of platinum on a ceramic substrate. The film is laser trimmed to have a precise Ro value and then encapsulated in glass for protection.

A wide range of styles and dimensions are produced to allow for different applications. Such sensors have fast thermal response and their small thermal mass minimises intrusion in the media being tested. Such sensors are known variously as flat film, thin film or chip sensors.

2,3 or 4 wire termination

Fundamentally, every sensing resistor is a two-wire device. When terminating the resistor with extension wires during probe construction, a decision must be made as to whether a 2,3 or 4 wire arrangement is required for measurement purposes. In the sensing resistor, the electrical resistance varies with temperature. Temperature is measured indirectly by reading the voltage drop across the sensing resistor in the presence of a constant current flowing through it using Ohm's Law: V = R.I

The connection between the thermometer assembly and the instrumentation is made with standard electrical cable with copper conductors in 2,3 or 4 core constructions. The cabling introduces electrical resistance which is placed in series with the resistance thermometer. The two resistances are therefore cumulative and could be interpreted as an increased temperature if the lead resistance is not allowed for. The longer and/or the smaller the diameter of the cable, the greater the lead resistance will be and the measurement errors could be appreciable. In the case of a 2 wire connection, little can be done about this problem and some measurement error will result according to the cabling and input circuit arrangement.

For this reason, a 2 wire arrangement is not recommended. If it is essential to use only 2 wires, ensure that the largest possible diameter of conductors is specified, and that the length of cable is minimised to keep cable resistance to as low a value as possible.

The use of 3 wires, when dictated either by probe construction or by the input termination of the measuring instrument, will allow for a good level of lead resistance compensation. However, the compensation technique is based on the assumption that the resistance of all three leads is identical and that they all reside at the same ambient temperature; this is not always the case.

Note: The wiring configuration (2,3, or 4 wire) of the thermometer must be compatible with the input to the associated instrument.

High Accuracy Options (tolerance classes)

Assuming a 3 or 4 wire connection, and the use of a class B sensing resistor, a standard thermometer assembly will provide an accuracy of around 0.5^{O}C between 0^{O}C and 100^{O}C. Considerable improvement on this figure can be achieved by various means including the use of closer tolerance sensors..

The overall accuracy of any measuring system (e.g. sensor, instrument, interconnection, application etc) is compromised by the sum of the uncertainties in that system.

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