# Temperature Sensors: General Operating Principles

## Thermocouples

Thermocouples are the most common, convenient and versatile devices used to measure temperature. They convert units of heat into useable engineering units that serve as input signals into process controllers and recorders.

A Thermocouple consists of a welded "hot" junction between two dissimilar metals - usually wires - and a reference junction at the opposite ends of the parent materials. Heating the "hot" junction in the working environment produces a temperature gradient which generates an EMF. The EMF appears across the free ends of the thermocouple wires, where it is measured and converted into units of heat calibration. Through selection of appropriate thermocouple wires and sheath components, thermocouples are suitable to be used in temperature ranges from -450° F (-184° C) to 4200° F (2315° C).

## Resistance Temperature Detectors (RTDs)

The Resistance Temperature Detector (RTD) accurately senses heat with an excellent degree of repeatability and interchangeability of elements. The RTD is composed of certain metallic elements whose change in resistance is a function of temperature. In operation, a small excitation current is passed across the element and the voltage, which is proportional to resistance, is then measured and converted to units of heat calibration. The RTD element is manufactured by winding a wire (wire wound elements) or plating a film (thin film elements) on a ceramic or glass core and hermetically sealing the element within a ceramic or glass capsule.

## Thermistors

A Thermistor is an economical means of precisely sensing heat over a limited range of temperatures. A thermistor is a metal oxide whose change in resistance is an inverse function of the change in temperature. An excitation current is passed across the sensor and the voltage, which is proportional to the resistance, is measured and converted to units of heat calibration.

Since thermistors usually have a large base resistance and a large change in resistance per unit of temperature change, lead wire length does not generally need to be compensated for. Thermistors can operate across a temperature range of -40° F (-40° C) to 300° F (150° C) by selecting the proper sensor and protective materials.

## Additional Requirements

Other components usually essential in integrating the principles of Thermocouples, RTD's, and Thermistor sensor into a functioning system may include: (1) A protection tube or sheath of a material suitable to protect the sensing element from the environment surrounding the point of measurement, (2) A connecting head and terminal block, or possibly a temperature transmitter, (3) Leadwire of the correct material and insulation to connect the temperature sensor and the process instrumentation, and (4) Recording or controlling instrumentation and control devices to provide a continuous temperature history of the system and to provide constant or programmed temperature regulation.

All **CONVECTRONICS'** temperature sensor products are designed and manufactured to applicable ISA standards with accuracy traceable to the National Institue of Standards and Technology (NIST).

American National Standard Institute (ANSI) nomenclature is used by **CONVECTRONICS**. Standard or Special Limits of Error contained in ANSI Circular MC 96.1 – 1982 can be specified by the customer when ordering **CONVECTRONICS'** Thermocouple products.

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