TURCK works

Industrial Automation

Pt-100 Sensor Technology

A White Paper

TURCK Inc.
3000 Campus Drive
Minneapolis, MN 55441
Phone: (763) 553-7300
Fax: (763) 553-0708
Application Support:
1-800-544-7769
www.turck.com

Not Your Average Thermostat

Industrial Automation

There are quite a few devices commonly used to measure temperature in industrial applications. Thermocouples, thermistors and resistance temperature detectors (RTDs) are just a few commonly used devices for temperature measurement applications, like those found in the pharmaceutical or food and beverage industries. Each device has inherent design advantages, but some are better suited for certain applications. Where there may be no right or wrong device for your application, newly designed temperature sensors incorporate an array of features to aid in usability and functionality.

Let's compare a few different technologies. Take thermocouples, for example. These sensors contain two dissimilar metals that are soldered at a junction. The bimetallic junction develops a small voltage, only about 50μV per degree Celsius, that varies with temperature. The manufacturer supplies tables to convert the voltage to temperature.

Thermocouples are simple, inexpensive devices. The main limitation of a thermocouple is accuracy, as system errors of less than 1°C can be difficult to achieve. The main source of error in a thermocouple is parasitic voltages that develop in the system where the thermocouple wire is attached to the measuring instrument. To accommodate for this, they require cold junction compensation, often done by exposing one junction to a reference temperature, generally 0°C, and the other to the desired temperature to measure. The thermocouple wire must run the entire distance between the measurement point and the processor. Thermocouples are generally less repeatable and stable than other sensing devices, but their no-frills styling provides a product that gets the job done.

Thermistors are non-metal resistors that measure the change in temperature via resistance. Thermistors are generally made of ceramics and metal oxides and can therefore measure much higher temperatures than thermocouples and RTDs. Thermistors are generally used in applications where only a small temperature range is required for measurement since their output can be approximated as linear over a narrow range. Their output is exponential in nature.

There are two kinds of thermistors: positive temperature coefficient (PTC) thermistors where the resistance increases with increasing temperature, and negative temperature coefficient (NTC) thermistors where the resistance decreases with increasing temperature. With PTC thermistors, there is generally a sharp rise in resistance at a critical temperature, while NTC thermistors are used as resistance thermometers in low temperature applications.

RTDs also use electrical resistance to measure temperature. They require a small power source in order to measure resistance. The resistance experienced by the sensor is proportional to the temperature changes being experienced by the media being sensed. RTDs contain a platinum wire that is wrapped around a core or patterned as a thin film on a substrate so that it experiences minimal differential expansion or other strains. RTDs made using platinum, preferred for its linear resistance-temperature relationship, are referred to as Pt-100 and Pt-1000.

The International Electrotechnical Commission's IEC 751:1983 specifies the tolerance and temperature to electrical resistance for platinum resistance thermometers. The most common

devices used in the industry, Pt-100s, have a nominal resistance of 100 ohms at 0°C. Pt-1000s measure 1000 ohms at 0 °C, and have a finer resolution but a smaller range than Pt-100's. All Pt-100 sensors are manufactured to the 100 ohm standard to provide an increased level of reliability and accuracy. However, two specifications exist: the European standard a = 0.00385, and the American standard a = 0.003916. Both are commonly used, and it is only important to note which one a processor accepts.

Manufacturers often incorporate basic Pt-100 technology into their advanced temperature sensing technologies to make the whole package more desirable for temperature measurement. Though they generally come with a higher price tag, these sensors are typically designed with added features that make them easy to use, like push button programming and control, with highly visible digital readouts. Several manufacturers also style their Pt-100 sensors in a compact housing that permits its usage in harder to reach positions.

When applying a temperature sensor it is important to consider all the components that make the system work. Often when applying an RTD, there are several accessories that make installation easier. Thermowells and compression fittings allow RTDs to be installed in pipes, tanks and other applications that require special process connections, like sanitary fittings. Thermowells allow the user to insert the thermowell into the process and to remove/insert the RTD as needed. Thermowells provide a barrier between the RTD and the media being sensed, and therefore reduce the response time of the sensor while protecting the probe. A compression fitting threads into the pipe or tank and then compresses on the probe fixing it in place.

RTDs come in many different styles for different applications. Probes with dairy style sanitary fittings are available, as well as cable versions. Furthermore, remote mounting allows higher temperatures to be measured. When the electronic processor is moved out of hot ambient conditions and connected to a probe via a cable, temperature measurements up to 900°F can be reached.

Many different temperature sensors exist for applications that require temperature measurement. Choosing the temperature technology for your application depends on several factor. While there may be no right or wrong solution for your application, different technologies have been, and continue to be, developed to meet the needs of new temperature sensing applications.