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Temperature Measuring Devices

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Sense It

There are many different kinds sensors and their uses are innumerable. Everything from the touch screen of an iPad® to a GPS device uses sensors to convert a physical quantity into an electrical signal. Tangent Labs calibrates sensors--lots of sensors. The most common are pressure, force, and temperature. They can be analog where they are continuously changing their value in response to the stimulus they are measuring, or they can be digital and the signal is sampled at some rate. Typically the smaller a sensor is the less effect it has on its surroundings and therefore the less effect it has on whatever signal it is measuring which is definitely an advantage. Ideally, you want a sensor that creates a directly linear output to the signal being measured so there's a 1:1 correlation. Pragmatically speaking however, only a few sensors have that kind of relationship and the cost of such devices is usually not warranted. Instead the most used and most produced sensors generate a non-linear output that appears like a curve on a graph.

In the case of temperature, most people are familiar with the liquid-in-glass or mercury-filled thermometers. You may have wondered what other sensors there are out there. For instance, some vehicles have a digital temperature readout in their control panel that shows the temperature outside. It's pretty obvious that a mercury-filled or liquid-in-glass thermometer isn't telling the computer's microcontroller how hot or cold it is.

3 of a Kind

There are three other main temperature sensing devices available: Thermocouples, Resistance Temperature Detectors (RTD's), Thermistors.

Thermocouples are by far the most widely used of the four sensors and offer a wider temperature range and (usually) smaller price point. Essentially it's a length of two wires where each is a dissimilar metal. One end has them touching which is called the 'hot junction' and where the temperature is measured and the other end is called the 'cold junction', and this is where a volt meter is used to measure the voltage difference between the two. The resulting voltage difference is then converted into a unit of temperature. This phenomenon is referred to as the Seebeck Effect. Scientists also figured out depending on the types of conductors used, you can get different ranges and different accuracies using that effect. With all the different types of Thermocouples there are, you can find one that suits your needs for temperature concerns anywhere from -270 to 1750°C. They come in accuracies anywhere from ±0.5 °C to 0.75% of reading. So although they aren't the most accurate, they are valued because of their range and their relative price to the other types. They also have a quick response time. The only problem is that they can tend to be unstable, drift, and they wear out much quicker than other sensors.

Resistance Temperature Detectors (RTD's) are another type of temperature sensor. They work differently than thermocouples in that instead of there being a varying voltage difference based on temperature, there is a change in resistance of the probe that correlates to a temperature change. As long as they're cared for properly, RTD's are of the most stable of any temperature sensors. The issues arise when they get a nick or are dropped or bent. They are very sensitive to any of those situations and can render the probe useless as a result. They're usually made with pure copper or nickel wire. These are fairly linear in nature, but still exhibit a curved graph. Some RTD's are wound with Platinum. These RTD's are commonly referred to as 'PRT's'. Pure platinum is almost completely linear and it's also the most stable and repeatable of any of the metals used. The purity of the Platinum determines how linear the PRT is. However, Platinum is expensive and depending on the application, the cost doesn't justify the purchase. Modern software can curve-fit RTD's to give the user greater accuracy so obtaining a PRT that is more pure may not be necessary. PRT's are used frequently in calibrations because of their desirable attributes. They have a range of around -200 to 500°C and can have accuracies as low as ±0.02°C, but they have a slow response time.

Thermistors are kind of in between TC's and RTD's as far as accuracy and stability and response time, and are far worse in linearity. As a matter of fact, thermistors react logarithmically to temperature change. They work like RTD's in that they convert a resistance change to a temperature change. That's where the similarities end. These sensors employ ceramics or polymer materials in their sensing elements. Users try to get dampen the non-linearity issue by pairing offsetting thermistors together. A big advantage over other sensors is that you can have extremely long lead wires because of the high base resistance of the element. They have a range of around -40°C to 260°C. They claim an accuracy of ±0.1 to 0.5°C, but above 100°C that number quickly degrades.