Temperature Sensor

INTRODUCTION

Temperature as we all know is one of the most commonly measured parameter in life. A temperature sensor basically describes how hot or cold a body is. Temperature sensors usually measure temperature by sensing some change in a physical characteristic of the measuring device or material.

They’re several types of temperature sensing instruments and how they work differs from one another. The following are the different types of temperature sensors:

THERMOCOUPLE

This is a type of temperature sensing device that uses two wire legs made from different metals welded at one end, creating a junction, this junction is the temperature measurement point, when the junction experience temperature change, a voltage is produced that can be correlated back to the temperature. The thermocouple alloys are commonly available as wire. It measures temperature between the range of -200°C to 2000°C. The figure below illustrates a thermocouple system.[1]

![Figure 1: A diagram illustrating a basic thermocouple system.[1]](image)

THERMISTOR
This are also known as temperature sensitive resistor. Originally derived from combination of "therm"-
ally sensitive res-"istor". They are usually made of ceramic materials. Their great advantage lies in their
swift response to temperature.[1]

![A Thermistor](image)

**Figure 2: A Thermistor[1]**

**INFRARED SENSOR**
These form of temperature measuring device works using thermal radiation. Infrared thermometer works using a lens to focus infra red light from one object onto a detector called thermopile, the thermopile then turns the infrared radiation into heat.

![Figure 3: An infrared sensor system][3]

The more the infrared energy, the hotter the thermopile, this heat is then turned into electricity and then sent to a detector which determines the temperature of whatever the infrared thermometer is pointed to. [2]

**BIMETALLIC DEVICES**

This type of temperature sensing device transforms temperature change into mechanical displacement, it contains a metallic strip which usually contain two metals which has different expansivity as they are heated, steel and copper are usually used in this type of temperature sensor. They are majorly employed in Iron, refrigerators and air conditioners.[4]
A thermometer measures temperature by a change in the size/length of the material when heated or cooled. Material used includes mercury and sometimes alcohol. This material is placed in a scaled glass, which indicates the temperature. Popular scales are done in Celsius, Fahrenheit, and Kelvin. They are mostly used in clinics and hospitals.
Figure 5: A mercury in Glass Thermometer[5]

SILICON DIODE
This type of temperature sensing device are used in electronic devices. They work by exploiting the relationship between current and voltage in a diode; the diode used is usually the base-emitter diode of a bipolar junction transistor.[6]

RESISTANCE TEMPERATURE SENSOR

This type of temperature sensor operates using the principle that resistivity of a material changes with change in temperature. Platinum is the most popularly used metal but others like copper and nickel are good options too. They operate between -100°C to 600°C and there are two types in which they are constructed:

The wire wound type which are produced by winding wire into a coil on a suitable winding bobbing, the other alternative uses a thin film element which contains a thin layer of the base metal placed on a ceramic substrate and then laser is used to set it to the required resistance value.[7]

Figure 6: A wire wound RTD and Thin-Film RTD[8]

For more details check Adventures in wireless temperature measurements with TMP36 by Analog Devices.
INTERFACE ELECTRONICS

Sensing for most sensors require proper amplification to detect and correctly read signal, even though different sensors require different electronic circuitry to match their purpose. The thermocouple below uses series of differential amplifiers which allow the reference and sense points to allow offset adjustments.

Figure 7: Semiconductor-based cold-compensation references can be built into the thermocouple amplifier. Here, a series of differential amplifiers allow the reference and sense points to allow offset adjustment. [9]

Also for a thermocouple bias and compensation is key. A way for handling this is to create a voltage source calibrated to be 0 V at 0°C with slope equal to the Seebeck coefficients over the expected range of temperatures for a specific type of thermocouple. The resulting Thermocouple Compensator can now be used with any amplifier to create a linear temperature response biased to the voltage swing needed. The diagram below depicts that.
Figure 8: In addition to cold-junction compensation, the Linear Technology Thermocouple Compensator also contains a BOW Correction circuit to improve accuracy over a wide range. [9]

The circuit picture below shows a reference design is the combination of differential amplifiers and different voltage reference levels.
Figure 9: A reference design and eval board from National (TI) allows experimentation for single-ended and differential types of thermocouple amplifiers as well as for different voltage reference levels [9]

REFERENCES


