Temperature Sensor Technology Brief

There are four main types of temperature detection technology, thermocouples, thermistors, resistance temperature detectors and infrared sensors. For the “Mars Rover” project, we will be detecting the ambient temperature of the atmosphere of operation. For this reason, we do not require a technology that is capable of measuring extremely high temperatures. On Earth and Mars, we would be more likely to want to measure temperature in the -100⁰C to +100⁰C range. Ambient temperature does not fluctuate wildly, so a quick response time is not entirely necessary, but having a response time on the order of a few seconds would be nice to have for testing purposes. We are also required to contain op-amps in the temperature sensing circuit, so using a silicon IC with serial bus communications is potentially out of the question.

Thermocouples consist of two leads that contact each other. Each lead consists of a metal that is different and dissimilar from the metal in the other lead. Thermocouples take advantage of an effect called the thermoelectric effect. The thermoelectric effect states that when two dissimilar metals are in contact, a difference in temperature across the contact junction produces a voltage. [1] For this to be useful, one of the pieces of metal must be kept at a constant temperature as a reference, otherwise the reading would always drift towards zero as the metals begin to approach the ambient temperature. Thermal couples can work from -250⁰C to +2750⁰C, much larger than the range we need. [2]

Thermistors are basically resistors that are made up semi-conductor material that is especially sensitive to temperature. Resistance increases as temperatures decreases and vice versa. Thermistors have a stated nominal resistance at 25⁰C. Thermistors are noted for their fast response as they are used in medical care situations where a fast response is key. [2]

Resistance temperature detectors are very similar to thermistors as they vary their resistance with temperature. However, RTDs have a much quicker response, almost simultaneous with the temperature of the device. They are also completely constructed out of metal materials, with no semiconductor material used. The temperature ranges they can measure vary with the construction of the device. Thin film is cited as being capable of measuring between -50⁰C and +500⁰C and wire-wound RTDs are capable of measuring -200⁰C to +500⁰C. [2]

Infrared sensors measure temperature by measuring the amount of thermal energy (light) in the infrared range coming from the object the sensor is pointed at. The wavelengths measured are 0.7 to 20 micrometers. [2] Infrared sensors are expensive and not really necessary for the project, as we wish to measure the ambient air and not specific spots

It seems that all temperature sensor technologies are capable of performing the duties that we require for the project. As such, it will most likely come down to the cost of the sensors available. However, we can rule out infrared sensors, as they are used for measuring the location they are pointed at, not the ambient air. IC circuit sensors can also be ruled out, as they eliminate the possibility of including op-amps in the interface circuitry.

**References:**

[1] L. van Dommelen. “A.11 Thermoelectric effects”, (Quantum Mechanics for Engineers), online [2011], <http://www.eng.fsu.edu/~dommelen/quantum/style_a/nt_pelt.html> (Accessed: 4 October 2013)

[2] C. Mathas. “Temperature Sensors – The Basics”, (Digi-key), online [2013], <http://www.digikey.com/us/en/techzone/sensors/resources/articles/temperature-sensors-the-basics.html> (Accessed: 4 October 2013)