Temperature Sensor Homework Assignment

Buzz Powell – 4/20/07

Thermocouples

When two dissimilar metals are connected together, a small voltage is generated at the junction. If the temperature of the junction changes, it also causes the voltage to change in a proportional manner. An electronic controller or datalogger is used to measure voltage change and convert it into a calibrated temperature. Thermocouples typically offer much less resolution and accuracy than thermistors. The standard error of thermocouple wire varies from 0.8 to 4.4 °C, depending on the type of thermocouple used. They require the use of an accurate reference temperature and are monitored via dual (differential) channels on a datalogger. Thermocouples are self-powered and produce a smaller signal than thermistors, requiring only simple steps in a datalogger program to process. If you purchase thermocouple wire to make your own sensors, which is more expensive than thermistor wire, you need to make sure the junction is properly soldered/welded.

http://www.campbellsci.com/105t-l

Thermistors

Thermistors are temperature sensitive semiconductors that exhibit a large change in resistance over a relatively small range of temperatures. Thermistors require no reference temperature and are monitored via a single-ended channel, typically exhibiting a rapid response time and good signal stability. They require an excitation voltage and produce a larger signal than thermocouples, requiring multiple steps to process in a datalogger program via nonlinear calibration. Working with thermistors can be a problem if installation requires placement in hot-mix asphalt as it is being laid because they are easily damaged by high laydown temperature and compaction vibration. Survivability is higher when thermistors are installed via post-construction retrofit. Measurement error in a thermistor is reported to be less than 0.2°C.

http://www.campbellsci.com/108-l

iButtons

The iButton is a computer chip enclosed in a small 16mm thick stainless steel can. An iButton uses its stainless steel 'can' as an electronic communications interface. Each can has a data contact, called the 'lid', and a ground contact, called the 'base'. Each of these contacts is connected to the silicon chip inside. The lid is the top of the can; the base forms the sides and the bottom of the can and includes a flange to simplify attaching the button to just about anything. The two contacts are separated by a polypropylene grommet. Temperature iButtons can wake up to take time-stamped temperature at equal time intervals, then store them in a log format in on-board "datalog" memory. The standard units allow 2048 readings with time intervals of 1 to 255 minutes, while the high-capacity models allow 8192 readings with time intervals from 1 second to 273 hours. Information is transferred between an iButton and a PC with a momentary probe contact at up to 142kbps. iButtons are wear-tested for 10-year durability; however battery life is limited a several years as a function of measurement and data transfer frequencies. They can be difficult to recover from pavements without damage after testing has been completed. The accuracy of the iButton appears to be within ± 0.5°C.

http://www.maxim-ic.com/products/ibutton/

Rodeo Possibilities

A precision oven equipped with a traceable thermometer could be used to evaluate the accuracy of various devices before and after vibration and heat extremes.