Temperature Sensors: From sense of touch towards smart dust

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Temperature is one of the most frequently measured variables. It affects many other physical and chemical parameters, so it needs to be recorded and/or controlled in many situations or used as a compensation parameter for other sensors.

Many kinds of instrument, based on different phenomena, have been devised to measure temperature. This tutorial reviews the working principle of the most commonly used methods and presents a few special purpose ones.

All-electronic temperature sensors are of particular interest in order to easily integrate them in systems, leveraging the ongoing progress of electronic technology. Thus, semiconductor based temperature sensors will be emphasized in the tutorial. The effects of temperature in semiconductors will be presented showing how they affect parameters of semiconductor devices and several ways to use this devices in circuits for temperature sensors.

The latest trends in these circuits will be presented, showing how they can be optimized for accuracy or power consumption and how to define figures of merit to ease comparison between different architectures.

Finally, ultra low power temperature sensors will be reviewed. They are an enabling technology for the next step in the evolution of temperature sensors, already in research labs: sensors that harvest energy from their environment and are small enough to remain largely unnoticed.