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Designing with temperature sensors, part five: IC temperature sensors

My previous four columns examine thermistors, RTDs (resistance-temperature detectors), and thermocouple temperature sensors (**references 1** through **4**). The integrated temperature sensors on the market can also solve your temperature woes (**Figure 1**). These sensors operate over a temperature range of only –55 to +200°C. However, they are easy to install on your PCB, and they have a user-friendly output format. It is difficult to categorize the various types of IC sensors, but the following paragraphs take a stab at describing the generalities of the inputs, insides, and outputs of these silicon chips.

IC temperature sensors have a variety of input and output options. For instance, you can select an IC temperature sensor that has the actual temperature sensor within the silicon chip. This sensor reports the temperature at the sensor's location. In contrast, you can connect many IC temperature sensors to remote diodes and IR sensors. Remote diodes come in handy when you want an inexpensive way to remotely sense the temperature of your electronics or when you want to interface with the available microcontroller or processor internal diode.

As you acquire the temperature information at the output terminal of these chips, you will see many interfaces, including voltage and current analog output, digital SPI, digital I^2C, and PWM. The analog voltage- and current-output IC sensors let you keep the signals in the analog domain. For die-hard digital-minded people, however, the temperature information is available in the standard SPI or three-wire formats and in the two-wire I^2C and SMBus (system-management-bus) formats. These digital interfaces provide noise immunity with easy PCB-routing alternatives. With these types of digital signals, you can acquire resolution as high as 16 bits and temperature accuracies as high as ±0.5°C over a limited temperature range, with ±2.5°C over the full temperature range.

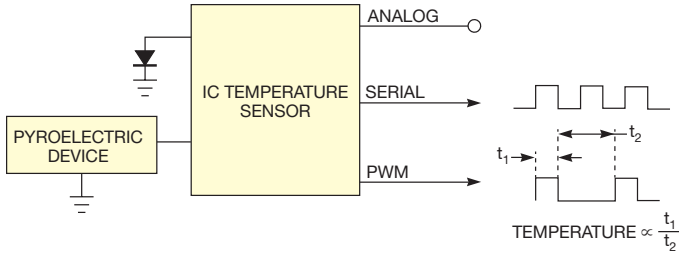

Figure 1 Integrated temperature sensors operate over a temperature range of only –55 to +200°C; however, they are easy to install on your PCB, and they have a user-friendly output format.

Designers exploit the process technology of these silicon-based ICs to everyone's advantage. For instance, some of these chips offer overtemperature signal notifications. If the IC sensor can connect to remote diodes, it may also include compensation features for beta, resistance, and eta factor.

These temperature sensors have some limitations. For instance, you must use RTD or thermocouple temperature sensors to sense temperatures lower than –55°C or higher than 200°C. If your design requires high repeatability and accuracy, an RTD is your best option. The IC temperature sensor's responsiveness to temperature changes depends on the device's package size; smaller packages respond more quickly. RTDs, thermocouples, and thermistors typically respond in 1 to 10 sec. IC temperature sensors respond in approximately 4 to 60 sec.

IC temperature sensors are attractive because they include on-chip signal-conditioning circuitry. System designers need not worry about linearization, cold-junction compensation, comparators, additional ADCs, or voltage references. This low-cost approach may be exactly what you need to protect your systems in the field. EDN

REFERENCES

1 Baker, Bonnie, "Designing with temperature sensors, part one: sensor types," *EDN*, Sept 22, 2011, pg 22, http://bit.ly/rpSnOp.
2 Baker, Bonnie, "Designing with temperature sensors, part two: thermistors," *EDN*, Oct 20, 2011, pg 24, http://bit.ly/s6LIbu.
3 Baker, Bonnie, "Designing with temperature sensors, part three: RTDs," *EDN*, Nov 17, 2011, pg 24, http://bit.ly/u4zJs7.
4 Baker, Bonnie, "Designing with temperature sensors, part four: thermocouples," *EDN*, Dec 15, 2011, pg 24, http://bit.ly/skSvj3.

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