Novel circuit isolates temperature sensor from its host

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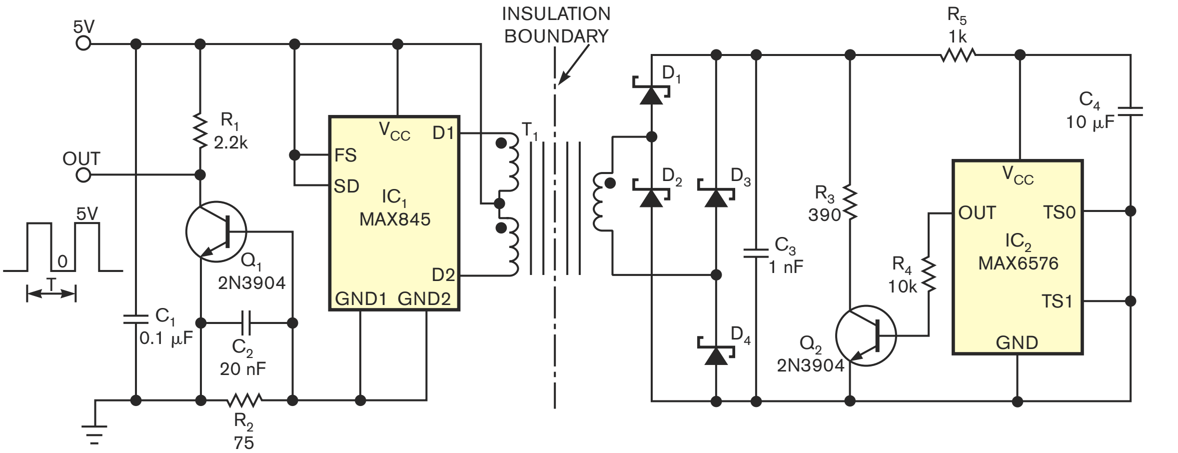
Temperature sensors must sometimes operate at locations whose return potentials differ considerably from that of the data-acquisition system's common—that is, equipotential—ground. In consequence, the temperature sensor's support circuitry must provide galvanic isolation between the sensor and its data-acquisition system. Also, the data-acquisition system seldom provides an isolated source of power for the sensor. The circuit in **Figure 1** solves both problems by isolating the sensor's signal and power supply.

The complementary, fixed-frequency square-wave outputs of a power-transformer driver—IC_1, a Maxim (www.maxim-ic.com) MAX845—drive a Halo Electronics (www.haloelectronics.com) TGM-010P3 1-to-1-to-1 transformer with dual primary windings and a single untapped secondary winding (**Reference 1**). The secondary winding feeds a Graetz-bridge rectifier that generates approximately 4.5V to power IC_2, a Maxim MAX6576 sensor. Combining a temperature sensor, signal-processing electronics, and an easy-to-use digital-I/O interface in a low-cost package, the MAX6576 draws little current from a single supply source and maintains its specified accuracy over a 3 to 5V supply-voltage range.



NOTE: D_1 THROUGH D_4: MBR0520L.

Figure 1 Transformer T_1 isolates the temperature sensor, IC_2, from the equipment under test. The period of IC_1's digital output varies as a function of temperature. The circuit's output period varies at a rate of 10 µsec/°K. User-selected scale factors range from 10 to 640 µsec/°K.

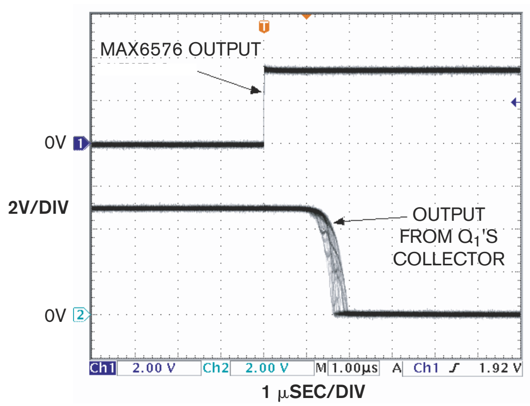


Figure 2 Measured from the positive-going edge of IC_2's output to the circuit's output at Q_1's collector, the relative jitter averages less than 1 µsec.

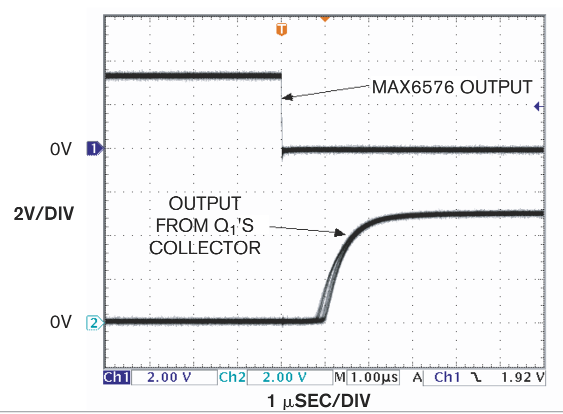


Figure 3 As in Figure 2, Q_1's average output jitter with respect to IC_1's negative-going output also averages less than 1 µsec.

If you connect the sensor as **Figure 1** shows, it operates as an absolute temperature-to-period converter and provides a nominal conversion constant of 10 µsec/°K, which, at room temperature, yields a period of approximately 2.980 msec—a frequency of 335 Hz. You can adjust the conversion constant from 10 to 640 µsec/°K. Note that longer conversion constants allow more signal-integration time to minimize noise effects. The sensor's symmetrical square-wave output drives NPN transistor Q_2's base through R_4, a 10-kΩ resistor. A 390Ω resistor, R_3, serves as Q_2's collector load and connects to the same lines that deliver power to the temperature sensor. When Q_2 conducts, it draws an asymmetrical power-supply current that exceeds the supply current during the sensor output's positive half-cycle.

In IC_1's sensor output-to-ground return on the data-acquisition system's side, resistor R_2 and capacitor C_2 shunt Q_1's base-emitter junction. The values of R_2 and C_2 ensure that the sum of IC_2's current and transformer T_1's magnetizing current cannot drive Q_1 into conduction. When Q_2 conducts, it draws about 12 mA from the isolated 4.5V power-supply line. Reflecting to the primary, Q_2's conduction current flows from the 5V supply into IC_1, out through its ground terminals, and partly through R_2. The voltage drop across R_2 exceeds Q_1's base-emitter voltage threshold and supplies sufficient base current to turn on Q_1.

Thus, when Q_2 conducts, so does Q_1, which copies IC_1's isolated square-wave output to Q_1's collector circuit. As the waveforms of **figures 2** and **3** show, Q_1's output rise and fall times, jitter, and propagation delay total about 2 µsec. The equivalent measurement error due to timing jitter amounts to less than 0.1°K at the fastest conversion constant of 10 µsec/°K. Varying the circuit's supply voltage through a range of 4.5 to 5.5V introduces an error of less than 0.1°K. The output at Q_1's collector can sink several milliamperes at a voltage excursion of 0 to 5V.

This design can accommodate temperature-to-frequency converters and other types of temperature sensors. For further information on IC_1 and IC_2, review the devices' data sheets and the data sheet for the MAX845 evaluation kit (**references 2, 3,** and 4).EDN

REFERENCES

1 "PCMCIA DC/DC Conversion Isolation Modules," Halo Electronics Inc, www.haloelectronics.com/pdf/lowpower-oper.pdf.

2 "Isolated transformer driver for PCMCIA applications," Maxim Inc, October 1997, http://pdfserv.maxim-ic.com/en/ds/MAX845.pdf.

3 "SOT Temperature Sensors with Period/Frequency Output," Maxim Inc, April 1999, http://pdfserv.maxim-ic.com/en/ds/MAX6576-MAX6577.pdf.

4 MAX845 Evaluation Kit, Maxim Inc, October 1997, http://pdfserv.maxim-ic.com/en/ds/MAX845EVKIT.pdf.