

Keywords: temperature measurement, galvanic isolation, temperature-to-period converter, digital output

APPLICATION NOTE 4432

Isolated Temperature Sensor

Sep 08, 2009

Abstract: This application note presents a novel circuit that isolates and powers a temperature sensor. The MAX6576 temp sensor and MAX845 isolated transformer driver are featured in the design.

This design idea appeared in the August 6, 2006 issue of *EDN* magazine.

In some temperature-sensing applications, the sensors are mounted at locations where the potential is very different from that of the data-acquisition-system common (i.e., the equipotential, usually referred to as ground). The operating temperature sensor must then be galvanically isolated from its data-acquisition system. As an added difficulty, these systems seldom provide an isolated source of power for the sensor. Featuring the [MAX6576](#) temp sensor, the **Figure 1** circuit solves these problems by providing both isolation and power for the sensor.

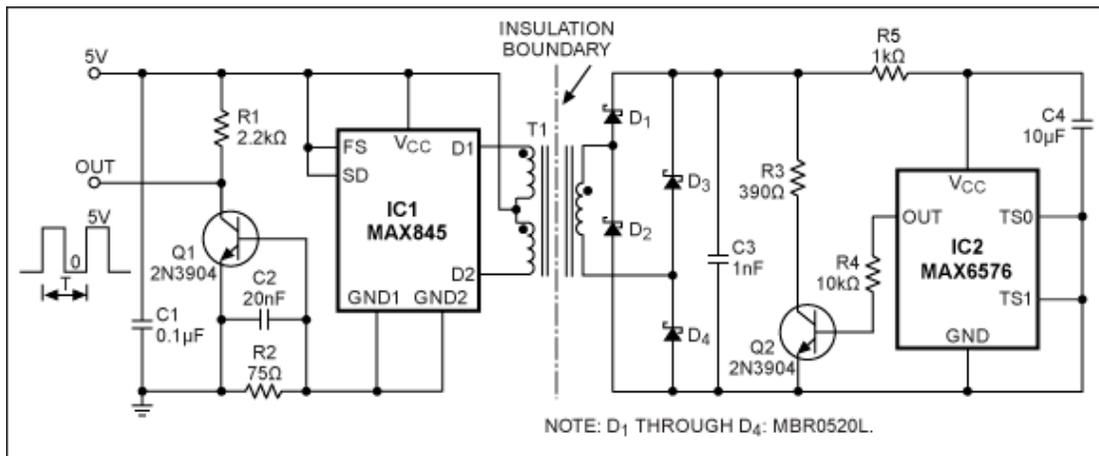


Figure 1. This temperature sensor (IC2, the MAX6576) is isolated by the transformer, and provides a digital output whose period encodes the temperature ($10\mu\text{s}/^\circ\text{K}$ to $640\mu\text{s}/^\circ\text{K}$).

The complementary, fixed-frequency square-wave outputs of a power transformer driver (IC1, the [MAX845](#)) drive a 1:1 transformer with primary center tap. The secondary winding feeds a Graetz bridge rectifier that generates about 4.5V for powering the temperature sensor. The MAX6576 suits many applications because it combines the temperature sensor, signal-processing electronics, and easy-to-use digital I/O interface in a single low-cost package. It draws very little current from a single supply voltage, and maintains its accuracy specs while operating in the range +3V to +5V.

The temperature sensor is an absolute temperature-to-period converter. Connected as shown, it provides a conversion constant of $10\mu\text{s}/^\circ\text{K}$, which at room temperature gives a period of approximately 2.980ms (335Hz). The conversion constant can be adjusted from $10\mu\text{s}/^\circ\text{K}$ to $640\mu\text{s}/^\circ\text{K}$. (Note that the longer constants allow more signal-integration time, which minimizes noise.) The sensor's output, a symmetrical square wave, drives

the base of an NPN transistor (Q2) with a 10kΩ resistor. Q2's collector load, a 390Ω resistor, is connected to the same line powering the temperature sensor. That configuration causes an asymmetrical supply current that is higher in the positive half cycle of the sensor's output.

On the primary (system) side, note in the ground return of the MAX845 a parallel RC circuit shunted by the base-emitter junction of Q1. The value of RC ensures that the sum of the temperature sensor's current and transformer magnetizing current is insufficient to make Q1 conduct. When Q2 conducts, it draws about 12mA from the 4.5V line. Reflected to the primary, that current flows from the +5V supply into the MAX845, out through its ground terminals, and (partly) through the 75Ω resistor. Because the drop on the resistor exceeds Q1's base-emitter diode threshold, the rest of the current goes through the base-emitter diode and turns Q1 ON.

Thus, conduction in Q2 causes conduction in Q1, which copies the sensor square-wave output to the collector circuit of Q1. The circuit's rise/fall time, jitter, and propagation time total about 2μs (**Figures 2 and 3**). Measurement error due to jitter is equivalent to less than 0.1°K at the fastest conversion constant (10μs/°K); it is quite negligible at longer constants. Similarly, the equivalent output change caused by varying the supply voltage through its allowed range (4.5V to 5.5V) is less than 0.1°K. The digital output (Q1 collector) swings from 0V to +5V, and is capable of sinking several mA.

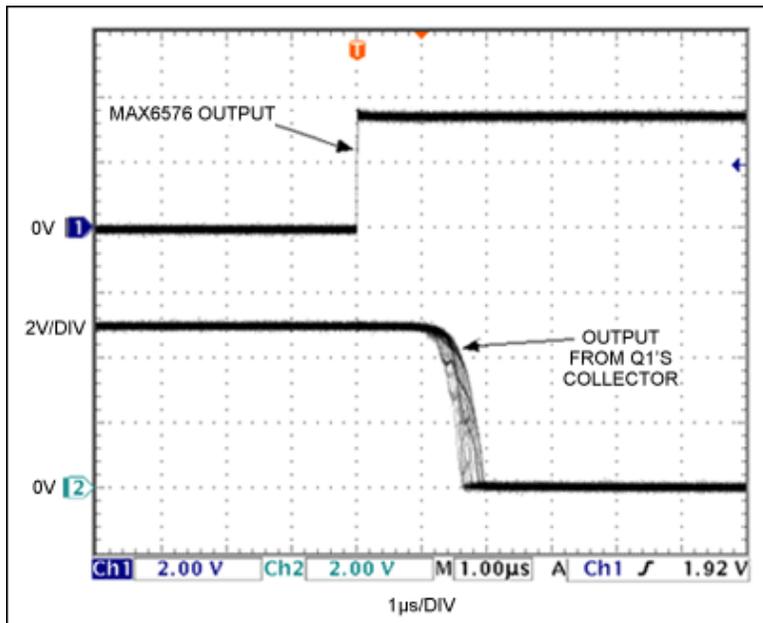


Figure 2. The OUT jitter of Figure 1 with respect to a positive edge at the sensor's output.

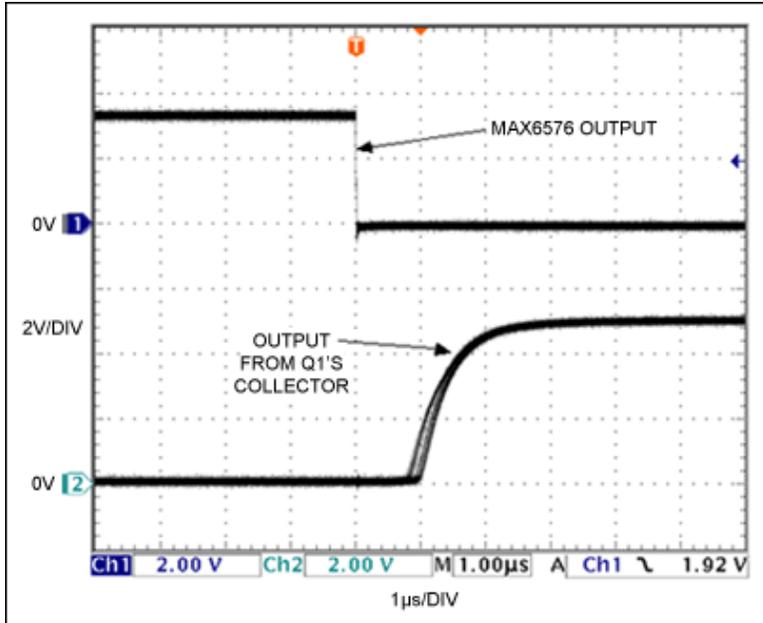


Figure 3. The OUT jitter of Figure 1 with respect to a negative edge at the sensor's output.

This scheme can accommodate temperature-to-frequency converters and other temperature sensors. For further information on the isolation transformer (T1), see the [MAX845EVKIT](#) data sheet.

Related Parts

MAX6576	SOT Temperature Sensors with Period/Frequency Output	Free Samples
MAX845	Isolated Transformer Driver for PCMCIA Applications	Free Samples

More Information

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