AN-699 APPLICATION NOTE

Noise Filtering and the ADT7461

by Susan Pratt

INTRODUCTION

The ADT7461 is a digital temperature monitor with one external and one internal temperature monitoring channel. It is capable of measuring the temperature of an external sensor accurate to ±1°C, and communicates with a host over the SMBus. This application note explains how to build a filter to reduce the effect of noise on the temperature measurements, and shows why the ADT7461 is uniquely suited for this application.

Using digital temperature sensing methods in a noisy environment is difficult. Noise is easily coupled into the temperature sensing circuit and can result in a large temperature error. Until now, adding an adequate filter in front of the digital temperature sensor for such applications has been virtually impossible. This is because both the capacitance and resistance associated with a filter interfere with the measurement technique used, and cause offsets that lead to errors in the temperature measurement result.

IMPLEMENTATION

The ADT7461 is capable of measuring the temperature of an external sensor to ±1°C accuracy. The remote sensor can be a substrate or discrete transistor, and is connected to the D+ and D– pins on the ADT7461. The ADT7461 also has an internal temperature sensor to measure the device's ambient temperature.

Figure 1 shows how the ADT7461 temperature monitor can be used in noisy environments by building an R-C-R filter between the external temperature sensor and the ADT7461 inputs. The remote sensor is a diode-connected, standard PNP transistor with its emitter connected to the D+ pin on the ADT7461 and its base collector connected to the D– input.

The filter consists of two 100 Ω resistors and a 1 nF capacitor. The filter should be placed as close as possible to the D+ and D– inputs and should be connected as shown in Figure 1. This filter has a cutoff frequency of 1.6 MHz.

Other values of resistance and capacitance can be used to build a filter with the required cutoff frequency. The value of the capacitance is limited to a maximum of 2.2 nF; any greater value affects the temperature measurement. Likewise, the resistance value is limited to a total of 3 kΩ for the D+ and D– paths combined.

WHY IT WORKS: THE ADT7461'S SERIES RESISTANCE CANCELLATION FEATURE

The ADT7461 has the ability to automatically cancel out the effect of resistances in series with the external temperature sensor. Any resistance in the path between the remote sensor and a standard digital temperature sensor affects the accuracy of the temperature measurement. Typically, there is a 0.5°C offset in the measured temperature value per ohm of parasitic resistance in series with the sensor. The ADT7461, however, automatically cancels out the effect of this series resistance. Up to 3 kΩ of series resistance can be cancelled out of the temperature measurement and is transparent to the user. This allows a filter to be built between the ADT7461 and the remote sensor. The filter in Figure 1 shows 100 Ω of resistance on both the D+ and D– paths to the external sensor. Using a standard temperature monitor, these resistors would result in offsets of a massive 100°C in the external temperature measurement, thus rendering it useless.

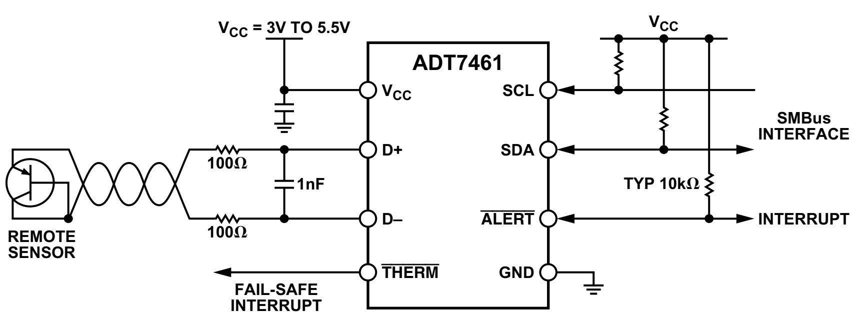

Figure 1. Circuit Diagram

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With the ADT7461, series resistance is automatically cancelled; thus, adding resistors to the path does not interfere with the temperature measurement result. No user calibration is required, and the ADT7461 can be hooked directly and immediately to the filter and on to the remote sensor. Also, any resistance associated with the PCB tracks or other connectors will be cancelled, allowing the remote temperature sensors to be placed some distance from the ADT7461.

The ADT7461 can typically cancel up to 3 kΩ of resistance in total between the device and the remote sensor. In an R-C-R filter, the maximum value each resistor could have is 1.5 kΩ.

RESULTS

Figures 2 and 3 show how effective the filter is at reducing the effect of noise on the ADT7461. Figure 2 shows how effective the filter is in combating common-mode noise in the circuit. The noise applied in this instance was a 40 mV square wave applied with the same phase to both the D+ and D– paths. Without a filter in place, the ADT7461 temperature measurement is in error by up to 4°C; with a filter, the error is reduced to less than 1°C.

Figure 3 shows the results for common-mode noise of 100 mV. Without a filter in place, the temperature measurement is in error by up to 50°C. However, with the filter in place the error is reduced to between 0.25°C and 0.5°C. With this level of noise in the system, using a temperature monitor IC without a filter is not possible. However, the effect of the filter negates the effect of the noise, allowing the ADT7461 to be used in noisy applications. The filter brings the error to a level below the specified ±1°C accuracy of the ADT7461.

Similarly, the filter can reduce differential noise where the noise on the D+ and D– paths is not in phase.

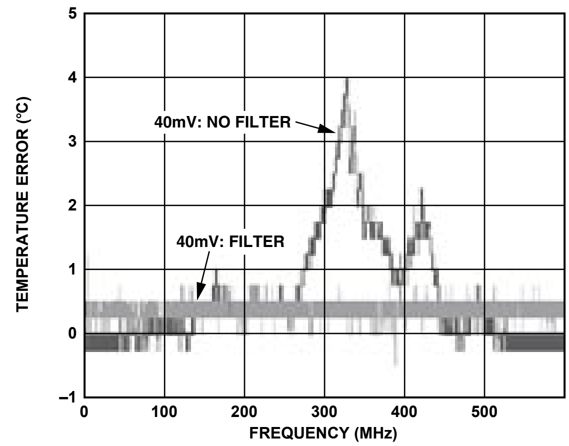

Figure 2. Effect of Filter on 40 mV Noise

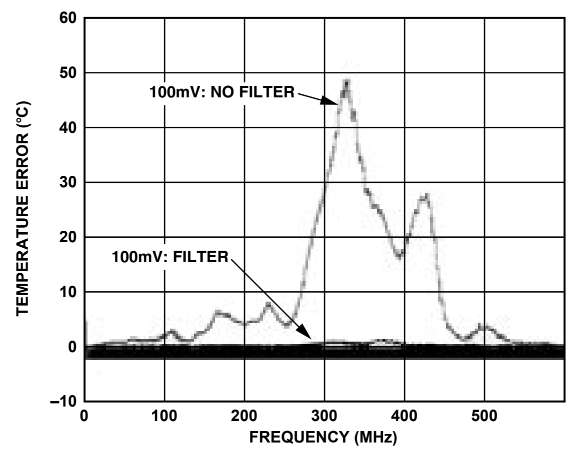

Figure 3. Effect of Filter on 100 mV Noise

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