DESIGN NOTES

The LTC1392: Temperature and Voltage Measurement in a Single Chip – Design Note 106

Ricky Chow and Dave Dwelley

Introduction

The LTC®1392 is a new micropower, multifunction data acquisition system designed to measure ambient temperature, system power supply voltage and power supply current or differential input voltage. No external components are required for temperature or voltage measurements, and current measurements can be made with a single low value external resistor. An on-board 10-bit A/D converter provides a digital output through a 3- or 4-wire serial interface. Supply current is only 350μA when performing a measurement; this automatically drops to less than 1μA when the chip is not converting. The LTC1392 is designed to be used for PC board temperature and supply voltage/current monitoring or as a remote temperature and voltage sensor for monitoring almost any kind of system. It is available in SO-8 and DIP packages allowing it to fit onto almost any circuit board.

Measurement Performance

Wafer level trimming allows the LTC1392 to achieve guaranteed accuracy of ±2°C at room temperature and ±4°C over the entire operating temperature range. The 10-bit A/D converter gives 0.25° resolution over the 0°C to 70°C (LTC1392C) or –40°C to 85°C (LTC1392I) range. Temperature is output as (ADC code/4) – 130°C with a theoretical maximum range of –130°C to 125.75°C. Figure 1 shows the typical output temperature error of the LTC1392 over temperature.

In supply voltage monitor mode, the A/D converter makes a differential measurement between the 2.42V reference and the actual power supply voltage. Each LSB step is equal to approximately 4.727mV, giving a theoretical measurement range of 2.42V to 7.2V. The LTC1392 has guaranteed accuracy over a voltage range of 4.5V to 6V, with a total absolute error of ±25mV or ±40mV respectively, over the commercial or industrial temperature range.

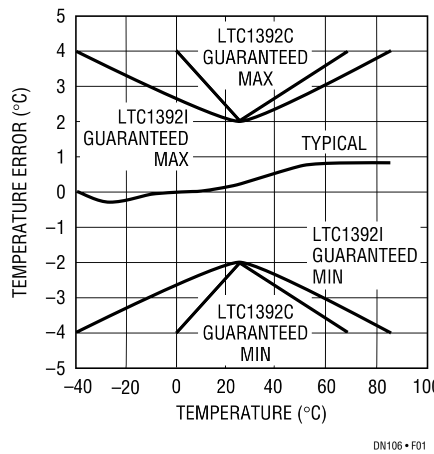

Figure 1. Output Temperature Error

Voltage is output as (ADC code × 4.727mV) + 2.42V. Figure 2 shows typical integral and differential nonlinearity performance of V_{CC} measurement.

The differential voltage input mode can be configured to operate in either 1V or 0.5V unipolar full-scale mode. Each mode converts the differential voltage between input pins V^+ and V^- directly to bits with the output code equal to ADC code × (full scale/1024). The 1V mode is specified at 8 bits accuracy with the eighth bit accurate to ±0.5LSB or ±2mV, while the 0.5V full-scale mode is specified to seven bits accuracy ±0.5LSB, giving the same ±2mV accuracy. The differential inputs include a common-mode input range including both power supply rails allowing them to be used to measure the voltage across a sense resistor in either leg of the power supply. They can also be used to make a unipolar differential transducer bridge measurement or to make a single-ended voltage measurement by grounding the V^- pin.

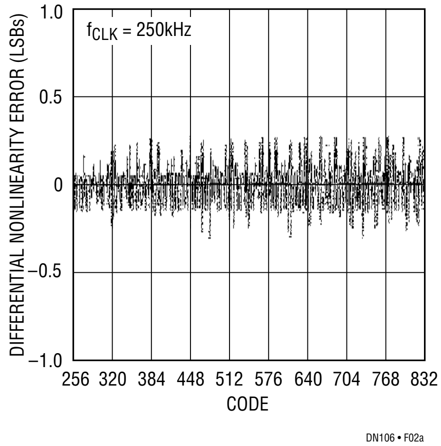

Figure 2a. Differential Nonlinearity, Power Supply Voltage Mode

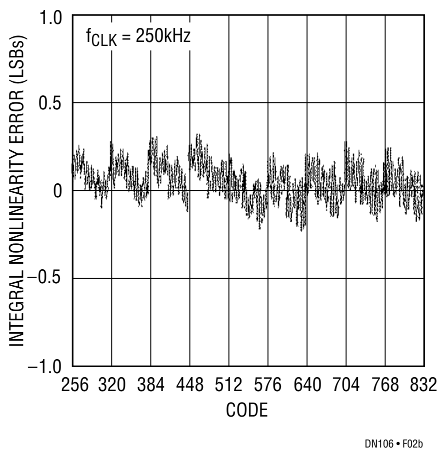

Figure 2b. Integral Nonlinearity, Power Supply Voltage Mode

The serial interface in the LTC1392 allows all of its functionality to be implemented in an 8-pin SO or DIP package and makes connection easy to virtually any MPU. Four pins are dedicated to the serial interface: active low chip select ($\overline{CS}$), clock (CLK), data input (D_{IN}) and data output (D_{OUT}). The D_{IN} pin is used to configure the LTC1392 for the next measurement and the D_{OUT} pin outputs the A/D conversion data. The D_{IN} pin is disabled after a valid configuration word is received and the D_{OUT} pin is in three-state mode until a valid configuration word is recognized, allowing the two pins to be tied together in a 3-wire system. The serial link allows several devices to be attached to a common serial bus, with separate $\overline{CS}$ lines to select the active chip.

Typical Application

A typical LTC1392 application is shown in Figure 3. A single point "star" ground is used along with a ground plane to minimize errors in the voltage measurements. The power supply is bypassed directly to the ground plane with a 1µF tantalum capacitor in parallel with a 0.1µF ceramic capacitor.

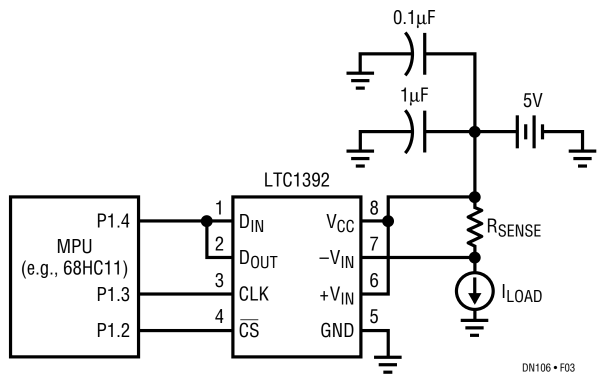

Figure 3. Typical Application

Conclusion

The LTC1392 provides a versatile data acquisition and environmental monitoring system with an easy-to-use interface. Its low supply current, coupled with space-saving SO-8 or DIP packaging make the LTC1392 ideal for systems which require temperature, voltage and current measurement while minimizing space, power consumption and external component count. The combination of temperature and voltage measuring capability on one chip make the LTC1392 unique in the market providing the smallest, lowest power multifunction data acquisition system available.

For literature on our A/D Converters, call **1-800-4-LINEAR**. For applications help, call (408) 432-1900, Ext. 525

Linear Technology Corporation
1630 McCarthy Blvd., Milpitas, CA 95035-7487
(408) 432-1900 • FAX: (408) 434-0507 • TELEX: 499-3977

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