LINEAR TECHNOLOGY
DESIGN NOTES

1- and 2-Channel No Latency ΔΣ™, 24-Bit ADCs Easily Digitize a Variety of Sensors, Part 2 – Design Note 237

Michael K. Mayes

Introduction

This Design Note is a continuation of application ideas using the LTC®2401/LTC2402 high accuracy, tiny (MSOP), 24-bit delta-sigma converters. Part 1 introduced the two new devices and bridge digitizer circuits utilizing the unique features of these devices. It showed how to remove offset/full-scale errors due to excitation currents using the full-scale and zero-scale set inputs. Furthermore, part 1 showed pseudo-differential application circuits for directly digitizing 4- and 6-terminal bridge circuits.

This article introduces two new applications using the 2-channel LTC2402. The first is a digital cold junction compensation circuit for remote measurements. The second shows how to digitize an RTD sensor and remove voltage drop errors digitally by using the ADC's second channel and underrange capabilities.

Digital Cold Junction Compensation

In order to measure absolute temperature with a thermocouple, cold junction compensation must be performed. The LTC2402 enables simple digital cold junction compensation. One channel measures the output of the thermocouple while the other measures the output of the cold junction sensor (diode, thermistor, etc.); see Figure 1.

The selection between CH0 (thermocouple) and CH1 (cold junction) is automatic. The LTC2402 alternates conversions between the two input channels and outputs a bit corresponding to the selected channel in the serial data output word. This simplifies the user interface by eliminating a channel select input pin. As a result, the LTC2402 is ideal for systems performing isolated measurements; it only requires two optoisolators (one for serial data out and one for the serial data output clock).

Alternating conversions between two input channels is difficult with conventional delta-sigma analog-to-digital converters. These devices require a 3-5 conversion cycle settling every time the input channel is switched. On the other hand, the LTC2402 uses a completely different architecture than previous delta-sigma converters. This results in latency free, single cycle settling. The LTC2402 enables continuous conversion between two alternating channels without the added complexity associated with other delta-sigma A/D converters.

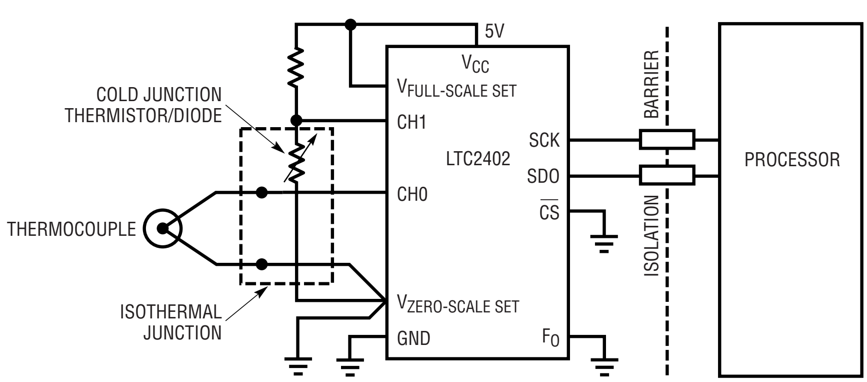

Figure 1. Digital Cold Junction Compensation Circuit

RTD Temperature Digitizer

RTDs used in remote temperature measurements often have long lead lengths between the ADC and RTD sensor. These long lead lengths result in voltage drops due to excitation current in the interconnect to the RTD. This voltage drop can be measured and digitally removed using the LTC2402; see Figure 2.

The excitation current (typically 200µA) flows through a long lead length to the remote temperature sensor (RTD). This current is applied to the RTD, whose resistance changes as a function of temperature (100Ω to 400Ω for 0°C to 800°C). The same excitation current flows back to the ADC ground and generates another voltage drop across the return lead. In order to get an accurate measurement of the temperature, these voltage drops must be measured and removed from the conversion result. Assuming the resistance is approximately the same for the forward and return paths (R1 = R2 = R), the auxiliary channel on the LTC2402 can measure this drop. These errors are then removed with simple digital correction.

As in the previous example, the LTC2402 alternately converts CH0 and CH1. The result of the first conversion on CH0 corresponds to an input voltage of $V_{RTD} + R \bullet I_{EXCITATION}$. The result of the second conversion (CH1) is $-R \bullet I_{EXCITATION}$. Note, the LTC2402's input range is not limited to the supply rails, it has underrange capabilities. The device's input range is –300mV to V_{REF} + 300mV. Adding the two conversion results together, the voltage drop across the RTD leads are cancelled and the final result is V_{RTD}.

Conclusion

Linear Technology has introduced two new converters to its 24-bit delta-sigma converter family. The family consists of the LTC2400 (1-channel 8-pin SO), LTC2404/LTC2408 (4- and 8-channel 24-bit ADCs) and the LTC2401/LTC2402 shown here.

Also recently introduced are the LTC2420 reduced cost 20-bit delta-sigma ADC with a 100 samples-per-second turbo mode, as well as 4- and 8-channel versions, the LTC2424 and LTC2428.

Additionally, the LTC2410, a fully differential input/reference device in a GN16 is available as well as a pin-compatible LTC2413 featuring simultaneous 50Hz and 60Hz rejection. These devices feature 800nV$_{RMS}$ noise over a wide input range of 5V, near zero offset error, full-scale error and linearity drift.

If board space is an issue, a fully differential input/reference device (LTC2411) is available in a 10-lead MSOP package.

Each device features absolute accuracy, ease-of-use and near zero drift. The LTC2401/LTC2402 also include full-scale set and zero-scale set inputs for removing errors due to systematic voltage drops. The performance, features and ease-of-use of these devices warrant designers to rethink their future industrial system and instrumentation designs.

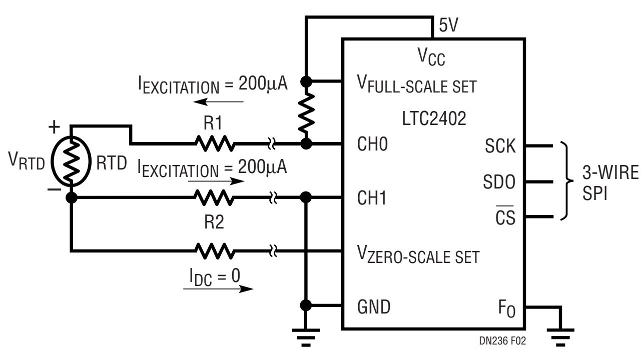

Figure 2. RTD Remote Temperature Measurement

Data Sheet Download

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Linear Technology Corporation
1630 McCarthy Blvd., Milpitas, CA 95035-7417
(408)432-1900 • FAX: (408) 434-0507 • www.linear-tech.com

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