LINEAR TECHNOLOGY

DESIGN NOTES

16-Channel, 24-Bit ΔΣ ADC Provides Small, Flexible and Accurate Solutions for Data Acquisition – Design Note 297

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Introduction

The LTC®2418 is a new 16-channel No Latency ΔΣ™ ADC that addresses applications where a variety of sensors are monitored. The input can be configured as 16 single-ended, eight differential, or any combination of differential and single-ended channels to fit the end application. Furthermore, the polarity of a differential channel can be reversed. Each selection maintains the excellent performance of the core 24-bit ADC, has a full-scale differential input range of $-1/2V_{REF}$ to $1/2V_{REF}$ and the input common mode can be anywhere within GND and V_{CC} with DC common mode input rejection better than 140dB.

The converter has an on-chip oscillator that requires no external frequency setting components. Through a single pin, the LTC2418 can provide better than 110dB differential mode rejection at 50Hz or 60Hz ±2%. The LTC2418 communicates through a flexible 4-wire SPI digital interface. No extra register configuration is required except the channel address.

The circuit in Figure 1 shows the versatility of the LTC2418. A combination of single-ended, differential, unipolar and bipolar input sources are simultaneously applied to the LTC2418. The low noise (0.2ppm RMS) and high accuracy (total unadjusted error is better than 3ppm) performance enable a wide dynamic input range while near zero drift (0.03ppm/°C full-scale drift, 20nV/°C offset drift) ensures consistent accuracy. Unlike typical delta-sigma converters that require several conversion cycles to settle every time a new channel is switched, the first conversion result is accurate after a new channel is selected (no latency). This feature provides a very simple switching scheme between different channels. The selected channel address and a parity bit are included in the data output to ensure data integrity in noisy isolated environments.

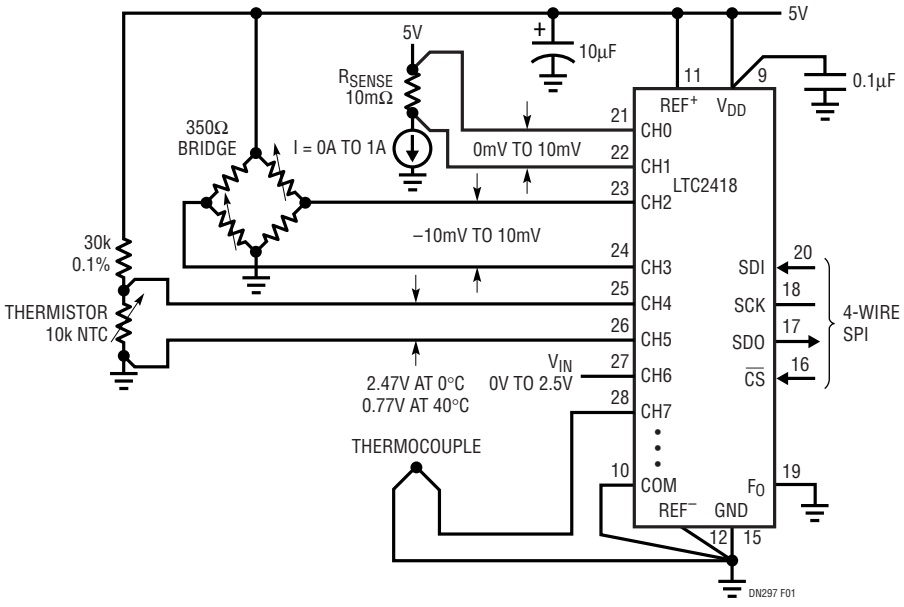

Figure 1. Multiple Measurements with the LTC2418

Sensors with common mode output voltages at ground, V_{CC} or anywhere in between may be digitized. Sensors with only a few mV full-scale outputs may be applied directly to the LTC2418. Large sensor offsets and tare voltages are transparently handled by the converter's wide input range, eliminating complex front-end analog processing. Large level input signals ranging from GND to $V_{REF}/2$ (2.5V) may also be applied to the device. The details of each input circuit are described below.

CH0 and CH1 are configured to measure a current sense resistor with a differential input of 0mV to 10mV and common mode near V_{CC}. The current being monitored can have a common mode up to V_{CC} with a wide range of 0A to 1A. The LTC2418 achieves 10,000 counts resolution (0.1mA) without any gain stage or common mode shift.

CH2 and CH3 form a differential input measuring a 350Ω bridge with common mode near $V_{CC}/2$. Typical strain-gauge-based bridges deliver 2mV/V of excitation, so the bipolar input is from –10mV to 10mV. The resolution is 1 part in 20,000 without averaging or external gain stages.

CH4 and CH5 measure the thermistor in a half-bridge application. In the example, the output varies from 0.77V to 2.47V over 0°C to 40°C. The LTC2418 can digitize the signal directly due to its excellent common mode rejection and linearity.

CH6 is a large swing single-ended signal that can be from ground up to 2.5V (half of V_{REF}). A reading equivalent to that of a 6-digit DVM is possible due to the accuracy (3ppm total) and low noise ($1\mu V_{RMS}$) of the LTC2418.

CH7 measures a single-ended output of a thermocouple with common mode near ground. Cold junction compensation can be performed to get the accurate absolute temperature using a cold junction sensor similar to the thermistor circuit applied to CH4 and CH5. The temperature measurement may then be used to compensate the temperature effects of the bridge transducers like the one connected to CH2 and CH3.

The above application measures a wide variety of sensors while using just half of the available LTC2418 capacity. The channel address readback and the parity bit included in the output bit stream provide a convenient way to verify which sensor is under measurement and check the digital transmission integrity. Similar circuits can be easily added to the remaining eight channels in order to take more measurements.

Noise Reduction

Using its internal oscillator, the LTC2418 can be configured for better than 110dB differential mode rejection at 50Hz or 60Hz ±2% line frequency and harmonics with a single pin set. The unique digital filter design also provides a simultaneous 50Hz and 60Hz rejection if driven by an external clock of 139800Hz. The rejection over 48Hz to 62.4Hz is better than 87dB, as shown in Figure 2. In addition to line frequency rejection, the LTC2418 also exhibits excellent noise rejection due to the $Sinc^4$ low-pass filter architecture.

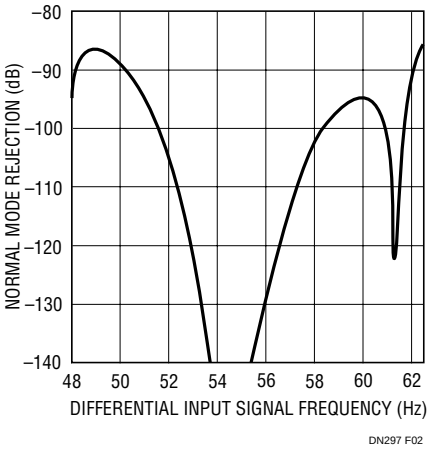

Figure 2. LTC2418 Normal Mode Rejection when Using F_O = 139800Hz

Conclusion

The LTC2418 is the multichannel addition to Linear Technology's 24-bit differential delta-sigma family. A pin compatible reduced channel version, the LTC2414, is also available. It can be configured as four differential inputs or eight single-ended inputs. The LTC2414/LTC2418 are available in 28-pin narrow SSOP packages. With high absolute accuracy, ease-of-use and near zero drift, they provide very efficient solutions for multiple channel acquisition applications.

Data Sheet Download

http://www.linear.com/go/dnLTC2418

For literature on our No Latency ΔΣ ADCs, call **1-800-4-LINEAR**. For applications help, call (408) 432-1900, Ext. 2453

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