

DESIGN NOTES

True Rail-to-Rail, High Input Impedance ADC Simplifies Precision Measurements – Design Note 400

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Introduction

High input impedance and a wide input range are two highly desirable features in a precision analog-to-digital converter, and the LTC[®]2449 delta-sigma ADC has both. With just a few external components, the LTC2449 forms an exceptional measurement system with very high input impedance and an input range that extends 300mV beyond the supply rails.

A designer may trade off the LTC2449's 200nV resolution for faster conversion rates, but otherwise the LTC2449 requires few to no performance tradeoffs. It simultaneously achieves 1ppm linearity (Figure 2), 200nV input resolution and a 5V input span. Ten filter oversample ratios are available, providing data rates from 6.8 samples per second to 3500 samples per second. Normal mode rejection of 50Hz and 60Hz is better than 87dB in the 6.8sps mode. *All DC specifications hold for all speeds*—only the resolution changes. Such persistent high performance simplifies the design of otherwise challenging applications, such as 6-digit voltmeters, sensor interfaces,

and industrial control. In addition, the LTC2449 digital interface and timing are extremely simple, and the No Latency architecture eliminates concerns about filter settling when scanning multiple input channels.

Solving Common Issues

One unique feature of the LTC2449 is that the analog inputs are routed to the MUXOUT pins, and an external buffer isolates these signals from the switched capacitor ADC inputs (See Figure 1). The external buffer yields high impedance through the multiplexer and back to the analog inputs. This has a distinct advantage over integrated buffers because the analog inputs are truly rail-to-rail, and slightly beyond, with appropriate buffer supply voltages.

The LTC6241 is a precision CMOS amplifier with 1pA bias current and impressive DC specifications: the maximum offset is 125 μ V and the open loop gain is 1.6 million,

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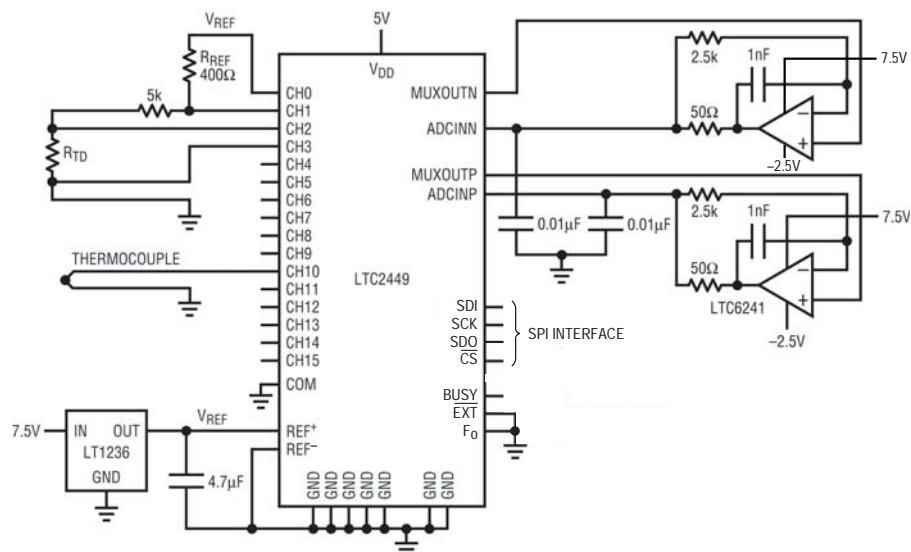


Figure 1. Temperature Sensing Application Example

typical. While the offset is not important in this application because it is removed by the LTC2449's multiplexer switching technique, the high open loop gain ensures that the 10ppm typical gain error of the LTC2449 does not degrade. Figure 1 shows proper interfacing of the LTC6241 to the LTC2449. The amplifier's 0.01 μ F capacitive load and compensation network provides the LTC2449 with a charge reservoir to average the ADC's sampling current while the 2.5k feedback resistor maintains DC accuracy.

The LTC6241 has a rail-to-rail output stage, and an input common mode range from the negative supply to 1.5V lower than the positive supply. Since no rail-to-rail amplifier can actually pull its outputs to the rails, an LT3472 boost/inverting regulator is used to create the

-2.5V and 7.5V op amp supplies from the 5V supply as shown in Figure 3. This regulator can provide enough current for several amplifiers and other circuitry that *really* needs to swing to the rails. In addition, the LT3472's 1.1MHz switching frequency is close to the middle of the LTC2449 digital filter stopband. The center of the stopband is 900kHz when using the internal conversion clock and is independent of the selected speed mode.

Applications

The LTC2449 is commonly used with thermocouples and RTDs as shown in Figure 1. Thermocouple outputs produce very small changes (tens of microvolts per degree C) and the output will be negative if the thermocouple is colder than the "cold junction" connection from the thermocouple to the copper traces on the PCB. The RTD is measured by comparing the voltage across the RTD to the voltage across a reference resistor. This provides a very precise resistance comparison and it does not require a precise current source. Grounding the sensors as shown is a good first line of defense for reducing noise pickup; however, the ADC must accommodate input signals that are very close to or slightly outside the supply rails. The LTC2449 handles these signals perfectly.

Conclusion

The LTC2449 solves many of the problems that designers encounter when trying to apply delta-sigma ADCs in demanding applications. High impedance, rail-to-rail inputs and a very simple serial interface simplify both hardware and software design.

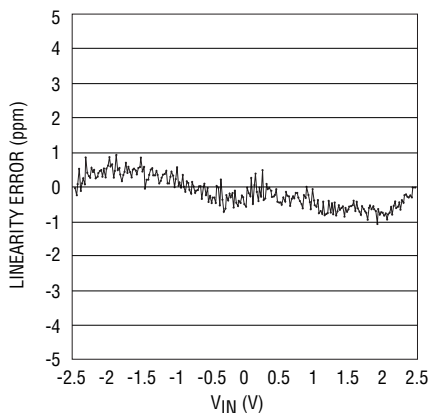


Figure 2. LTC2449 Integral Non-Linearity

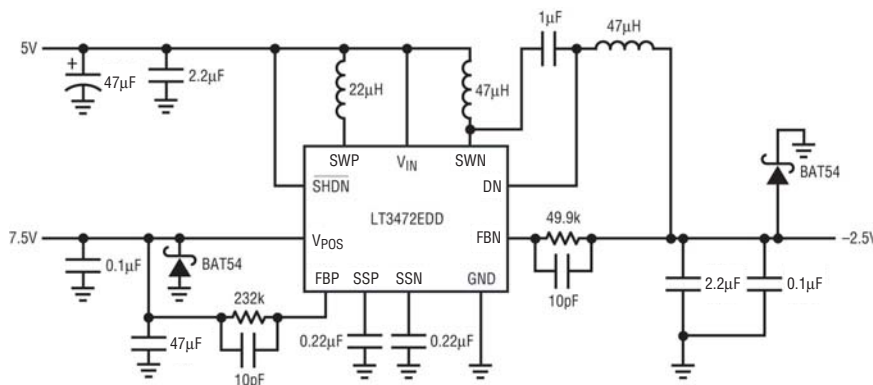


Figure 3. Power Supply for Buffers

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