Using the AD7400A Isolated ΣΔ Modulator as an Isolated Amplifier

The AD74xx family of isolated ΣΔ ADCs is typically used in combination with an FPGA or DSP, such as a Blackfin®, in motor drives to measure the phase-current across shunts or monitor DC bus voltages. However, where a less capable microcontroller is used, ΣΔ modulation may not be a suitable approach. That doesn't mean the AD74xx cannot be used in such situations, because there's a straightforward way to convert the AD74xx into an isolated amplifier using a simple RC filter. If you need to push the performance envelope, you could also use more sophisticated active filters. This note describes how to implement an isolated amplifier with an AD7400A.

Basic Operation of Isolated ΣΔ ADCs

The AD74xx ΣΔ ADCs convert analog input signals into a high-speed single-bit data-stream as shown in Figure 1. A differential signal of 0 V produces a stream of 1s and 0s with a 50% duty cycle. The full-scale bipolar input range is ± 320mV with a resolution of 16 bits – in practice the usable linear input-range is ± 250mV for the AD7400A, which translates into a bit-stream from 10.94% to 89.06% of 1s.

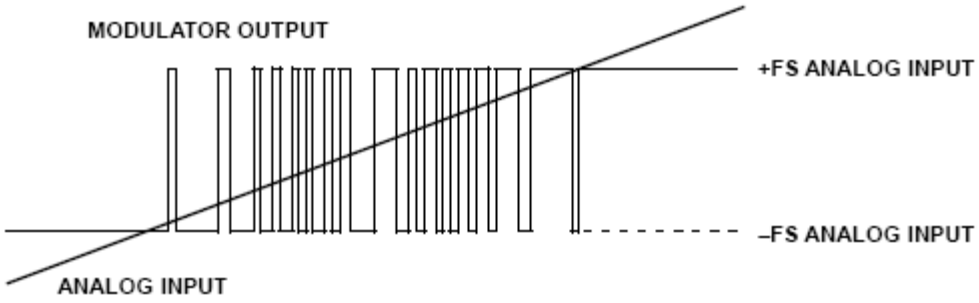

Figure 1 Analog Input vs. Modulator Output

How to Use AD7400A as an Isolated Amplifier

The modulated single-bit data-stream form the self-clocked AD7400A, with a typical output data-rate of 10 MHz, resembles a pulse width modulated (PWM) signal. The typical bandwidth of the generated output signal is only about 1 to 10 Hz. Through 2nd order modulation of the AD7400A bit stream, the bandwidth can be much higher. A simple RC filter has been shown to provide bandwidths up to 100 kHz. The block diagram in Figure 2 shows the implementation with the ADuM5000 providing isolated power to the secondary side. The ADuM5000 is a small form factor isolated DC/DC converter.

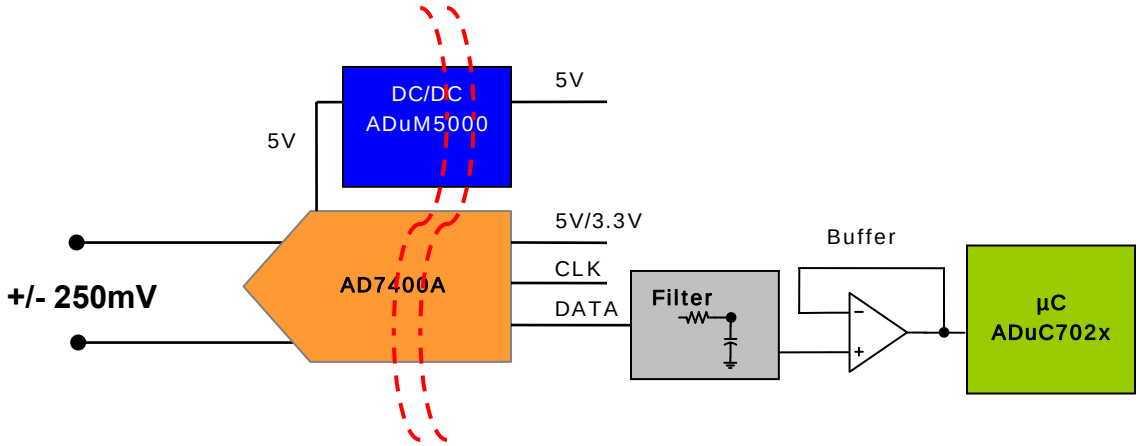

Figure 2 Block Diagram of AD7400A as Isolated Amplifier with ADuM5000 for Isolated Power

Considerations

There are some things to keep in mind when using the AD7400A as an isolated amplifier. If the signal from the RC filter is used with a microcontroller, such as the ADuC702x family of Analog Microcontrollers, it is recommended that an op amp be used to match the input impedance of a SAR ADC. Calibration can also be performed, enabling the microcontroller to remove errors in software. To achieve even better performance, one could use an op amp as a buffer and configure the circuit with an active buffer. The Analog Filter Wizard™ can be used to assist in such an implementation (please refer to http://www.analog.com/en/amplifiers-and-comparators/products/dt-adisim-design-sim-tool/Filter_Wizard/resources/fca.html).

Another consideration is that the standard digital output of the AD7400A does not have guaranteed voltage levels – only minimum and maximum ranges are guaranteed. To overcome this, one can use an analog switch, such as the ADG852, to alternate between analog ground (AGND) and power (VDD) controlled by the output data. This solution increases the flexibility of this design, allowing for larger output signal ranges, such as ±15V.

This basic concept, using the AD7400A as an isolation amplifier, is interesting for a wide range applications such as motor drives and patient monitoring, just to a name a few. Please check out ADI's "Circuits from the Lab" at www.analog.com/en/verifiedcircuits for updates and more circuit ideas.

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