Rarely Asked Questions

Strange stories from the call logs of Analog Devices

Switching Bits

Q: With no signal at the input to my ADC, why are the output data bits switching?

A: People unfamiliar with high-speed ADCs might expect a converter's digital output to be constant given a static analog input, but this is similar to expecting to see a simple dc offset error at the output of an op amp with no input signal. If you remove the input signal to an amplifier circuit and measure the output voltage with a DVM, the reading will tell you the amplifier's offset. The DVM is averaging the displayed results (using an ADC!), however, so it will not reveal the noise at the amplifier's output. Measuring the noise requires a scope or a spectrum analyzer.

Like any other component in the signal chain, ADCs have their own thermal noise contribution. Thus, if you want to verify that the ADC is behaving as expected with no input signal, you need to capture a block of data and average it, just as the DVM does with the amplifier circuit. High-speed ADCs typically float to their midscale code, plus or minus any inherent offset, so the resulting average output code should be within the ADC's offset specification. While analyzing the block of data you've captured, you can easily verify the noise performance of the ADC. The data sheet specification is *input referred noise*, which is specified in LSB rms. The measurement is known as a *grounded input histogram* test, although the nomenclature stems from early converters that had a bipolar input range centered on ground, so shorting the input to ground was equivalent to having no input signal. Modern high-speed converters typically operate with a single supply, so their input common-mode voltage is the midpoint of the front-end analog power supply rather than ground. Luckily for you, the histogram test is performed by capturing a block of data with no input signal, which you've already done. Instead of averaging the captured output data, however, make a histogram instead. A typical high-speed ADC might specify 1-LSB rms input noise, so you might see a Gaussian distribution with the offset ±3 codes. The input referred noise is calculated as the standard deviation of the captured data.

So, getting back to the original question, the wideband noise contributed by the ADC will cause the outputs to switch, even with no input signal. Good luck with the rest of your debug.

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Have a question involving a perplexing or unusual analog problem? Submit your question to: www.analog.com/askdavid

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