BY BONNIE BAKER

Take a risk; throw away those bits!

When designing an ADC, your initial approach may be to define the required resolution and select a device that matches your needs. To get the required system precision, you add the necessary analog gain modules and level shifts so that the signal of interest covers the entire full-scale input range of the ADC. As a first step in your design process, you often look at the source's output range. For example, a typical pressure sensor's output full-scale range is in the hundreds of millivolts. You then match the sensor's output range to the ADC's input by inserting an analog gain cell and level-shift circuitry to match the ranges of the sensor/ADC combination.

Suppose that you change your strategy and stop playing it safe. You can create a 12-bit system using a 24-bit converter and eliminate the need for analog gain and level-shifting circuits. For instance, a true 24-bit ADC is like having 4096 12-bit converters across the output range of the converter. This academic discussion is interesting, but, in reality, you will probably never find a noiseless 24-bit ADC. **Figure 1** shows the relationship between output codes and noisy bits of a realistic 24-bit delta-sigma ADC. The converter accepts a differential input signal and has an effective resolution of 19.5 bits rms.

You can use the 24 bits of the delta-sigma converter to substitute the analog functions of gain and level shift into this digital engine. Then, implement an increase in the delta-sigma converter's process gain by shifting the 12-bit window to the right or toward the converter's LSB (least-significant bit). Each 1-bit shift to the right is equivalent to doubling the process gain. As in the analog domain, an increase in process gain lessens the input range. In **Figure 1**, the output coding scheme of the delta-sigma converter is binary two's complement.

This approach also allows you to use the delta-sigma converter to sense the analog level shift of the circuit. When you ignore a few MSBs (most-significant bits), you actually allow a level shift of the input signal. A process gain of one has a bipolar full-scale analog input range of ±4.096V, or 8.192V p-p. A process gain of 32 changes the analog input range to 256 mV, or 8.192V/32. The value of MSB, MSB-1, MSB-2, MSB-3, and MSB-4 represents the system's average voltage level shift. To sweeten the pot, many 24-bit delta-sigma ADCs have on-chip PGAs (programmable-gain amplifiers). With delta-sigma ADC devices that have on-chip PGAs, you can increase the process gain by another product-specific factor of 64 to 128.

Although the total range of the 24-bit ADC is operational, your sensor might cover only a portion of the ADC's input range and output codes. Some designers dislike throwing away bits, emphatically claiming that they paid money for those bits and so they will use them.

On the other hand, you have the full resolution of 2^{24} codes at your disposal, and you can stand to lose some dynamic range because the goal is to acquire only 12 bits for your measurement. Think about the analog circuitry you have eliminated. By selecting that portion of the ADC range, you can focus on just the area of the signal response. Don't look back. Enjoy throwing away those bits and do so with great pleasure.**EDN**

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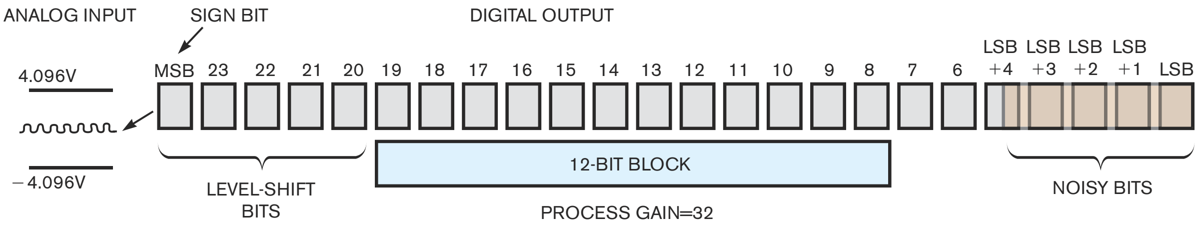

Figure 1 Use delta-sigma converters to implement process gain and level-shifting on an analog signal.