



BY BONNIE BAKER



Match sensor to converter or converter to sensor

The initial design approach you might take for an analog-to-digital-converter system is to look at the resolution you need and use an ADC that gives you a comparable resolution. To achieve the required accuracy or precision, add the necessary gain modules to the system so that the analog range of interest covers the dynamic range of the ADC.

There is an alternative, however: You can use a 24-bit converter to eliminate gain modules as well as the contributed offset, drift, and noise that you find in a 12- to 16-bit system. The 24-bit converter leads to a simpler approach. Additionally, you can achieve better performance for about the same or lower cost.

You might finish the design by using only a portion of the 24-bit ADC range. That's right: You might throw away bits! And you will still achieve or improve the resolution and accuracy of the original 12- or 16-bit system. The 24-bit converter gives an immediate system-gain advantage of 4096 over a 12-bit ADC, as well as an additional PGA (programmable-gain-amplifier)

function. The internal PGA function in the delta-sigma converter can increase the gain by another—product-specific—factor of 64 to 128.

As a first step in the design process, you often look at the sensor that you are going to use. You then look at the sensor's output range and match the sensor's output range to the ADC's input. In this process, you need an analog gain cell to make the sensor/ADC match-up work. Alternatively, you may try to blindly find an ADC that matches the output range of your sensor. Be cautious of both strategies. Try to worry more about the system noise contribution, where the actual system

resolution and accuracy are the important specifications.

For instance, if you have a 5V range with an analog gain of 250V/V with a 12-bit system, the system LSB is $5V/250/2^{12}$, or $4.88 \mu V$ (Figure 1a).

Now, put the sensor signal into a 24-bit converter with no gain (Figure 1b). You can use this strategy because the LSB size of the 24-bit system is equivalent to having an analog gain of 4096. When employing this approach, subtract out the effects of any analog level shifting by using the differential inputs of the ADC. This step allows you to apply a voltage to your negative ADC input and to position your positive-ADC input with the output of your sensor. Although the total range of the 24-bit ADC is operational, your sensor output might cover only a portion of the ADC-output codes. By selecting that portion of the ADC range, you can focus on the area of the signal response. Having a 24-bit ADC with an effective resolution of 23 bits is like placing 2048 12-bit converters across the range of the converter.

Future columns will look at implementing these ideas in load-cell and temperature-sensor applications. In both cases, I will compare the systems' performance and cost. By evaluating a few types of low-speed circuits, I'll compare a 12-bit application and a 24-bit implementation and show the advantages of this new way of designing. **EDN**

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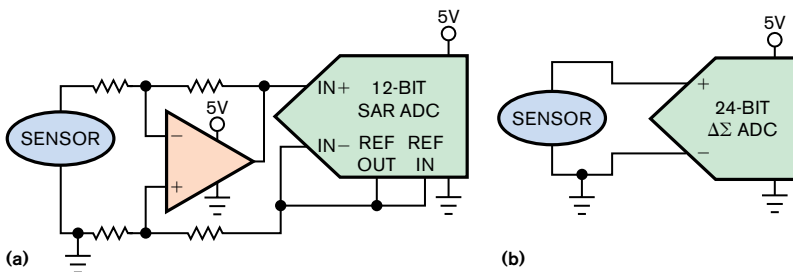


Figure 1 A 12-bit SAR converter (a) shows a sensor that connects through an amplifier to the converter. A 24-bit delta-sigma converter (b) shows a sensor that connects directly to the converter.

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