RAQ's

Rarely Asked Questions

Strange stories from the call logs of Analog Devices

Are Your Filters Filtering?

Q. Why is my A/D converter's anti-aliasing filter showing inadequate spurious and noise rejection?

A. It is important to realize that an A/D converter's internal front-end bandwidth, sometimes referred to as full power bandwidth, can be very wide, even if the A/D converter is "slow." The converter needs bandwidth on the internal front-end in order to settle in time for the next sample, preserving the information the designer is trying to capture and represent digitally.

An anti-aliasing filter (AAF) typically precedes the A/D converter and can vary from a simple single-pole RC network to complicated multi-pole topology. In either case the idea is the same, to remove unwanted noise and spurs that can fold back, or alias, into the frequency band of interest. Designers should use caution when building or using an AAF. It is important to understand not only the band of interest (pass band), but the out-of-band (stop-band) rejection of the filter design.

The stop-band should continuously reject unwanted frequencies well beyond the converter's analog internal front-end bandwidth (e.g. ADC sample rate is 100MSPS, input bandwidth is 1GHz; AAF must reject frequencies up to 1GHz, not Nyquist (50MHz)!). Otherwise, if the stop-band frequency response begins to rise, it will create a second pass-band region within the filter design. If this second pass-band region—in the assumed stop-band—is still within the converter's analog internal front-end bandwidth, then it could allow unwanted noise and spurs to fold back into the real band of interest.

To get around this, it's important to understand the filter design, both in and out of

band. Check the converter's datasheet to understand its input bandwidth as well. Some filters, such as elliptical, Chebyshev and multi-stage topologies, are more susceptible to inadequate stop-band rejection than others. Understand this before choosing a specific filter design. Adding a couple of additional components on the last stage of the AAF to create a simple low pass filter can help. The trade-off, however, is more components and additional attenuation through the band of interest.

One way to guard against such a problem is to measure the frequency response of the filter.[1] Measuring the frequency response shows the amplitude outline of the filter's response and attenuation. Measuring the filter's frequency response well beyond the band of interest and the converter's internal front-end bandwidth will indicate how the filter's stop-band region is performing.

For additional information on filters, topologies, and AAF, click on the links below.

[1] AN-835 - Understanding High Speed ADC Testing and Evaluation.

To Learn More About A/D Converters
http://designnews.hotims.com/23091-100

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Have a question involving a perplexing or unusual analog problem? Submit your question to: raq@reedbusiness.com

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