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ASK THE EXPERTS

Unexpected Filter Behavior

Editor:

I designed an L-C anti-aliasing filter for the input to an A/D converter, but when it was built and tested, the response was nothing like the computer predicted. It had a rounded shape in the region near the cutoff, and instead of a nice steep rolloff to infinity, there were some unusual responses in the stopband.

I'm sure it has something to do with the components, but I'm mainly a digital guy and hope to learn more from what your experts say.

J.C.
Los Altos, CA

J.C., You're on the Right Track

The lack of a clean transition between passband and stopband is a classic result of low-Q components, almost always inductors, since capacitor manufacturing is not subject to as many physical effects as are found with inductors. We are guessing that you simulated the filter either with ideal components, or with components having a Q higher than the ones used when constructing the filter.

You didn't identify the cutoff frequency of the filter, but since you chose to use an L-C filter, we are quite certain it is no more than a couple hundred MHz, probably lower. Mass-produced inductors have a Q in the range of 40 to 60, but it takes Q greater than 100 to get good response near cutoff. Lower-Q inductors can be used successfully, but will require some compromise in passband flatness or cutoff frequency (usually some of each) to get a reasonably sharp "knee" and a fast rolloff above cutoff. Most design software allows you to optimize to the parameters you select—in this case, the filter would be optimized to the maximum passband ripple you can tolerate, and to the particular value of attenuation desired at a frequency not far beyond cutoff.

Re: Unwanted Responses in the Stopband

The most likely reason for unwanted responses in the stopband is board layout, but component behavior can be the culprit, as well. Improper layout can create coupling from input to output, or magnetic coupling between inductors if they are located too close to one another. Coupling is largely frequency-dependent and if this is, say, a filter with a 100 MHz cutoff, we would consider layout the prime suspect. Often, a designer will try to save space by "folding" the circuit, which can place the input an output close together. It may also place inductors in proximity, where the magnetic fields can be coupled.

A more remote possibility is that the filter uses a design that requires a larger-than-normal inductance value. An inductor has low-reactance transmission modes above its self-resonant frequency (SRF), as well as a high impedance near SRF. If the design allows either of these to come into play, the response of the filter can be dramatically affected.

In summary, J.C. should look at his board layout to see if it allows coupling, then see if the inductors are behaving as expected.

A Short Explanation for Digital Predistortion?

An unsigned question received by e-mail asked about digital predistortion, a method for enhancing the linearity of power amplifiers. The reader asked for a brief, non-mathematical description.

It's a Type of Error-Correction

The simplest description of digital predistortion is that it is a type of error-correction that anticipates the effect that nonlinear amplification will have on the eventual demodulated data. Unfortunately, the details of how that is accomplished are not so simple!

One technique that is fairly easy to grasp is the coding of the data with a coding sequence that is designed to minimize the size of the transitions between data states in adjacent symbols. In simpler terms, the data is manipulated so that it doesn't create big spikes in the modulated signal. A large, nearly instantaneous phase or amplitude shift is hard for an amplifier to reproduce accurately, compared to relatively small transitions.

Questions Wanted

We welcome questions *and* answers from readers who have helped their colleagues, particularly from applications support engineers at supplier companies. We know you get some excellent questions, and our readers would benefit from your sharing of these Q&A examples!

Whether it is a question for our experts, or an example Q&A as noted above, send them by e-mail to: editor@highfrequencyelectronics.com. You can also mail them to the Editorial Office address on page 6.