Subject: Re: Lobes and nulls, crossover phase and baffle spacing
Posted by Wayne Parham on Fri, 27 Nov 2009 01:40:24 GMT
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Thanks for the kind words, guys. This was prompted by a private conversation and it seemed worthwhile to post here. Here is some more dialog from this continuing conversation.

Three (and a half) quick points that I am pretty sure you already realize but a reminder doesn't hurt:

1. Electrical crossover slope almost never is the same as the combined acoustic slope + electrical crossover slope, especially where horns are concerned. The acoustic rolloff "adds an order" or two usually.

2. Our sound sources in a design like this are directional in the crossover region and this affects the shape of the lobes somewhat, mostly the minor lobes. The major lobe is within the drivers' patterns so it usually looks the same as it would if the sound sources were omnidirectional. But the secondary lobes are usually at least partially outside the pattern and so are smaller than they would be if the sound sources were omnidirectional.

3. You actually can shift the lobes predictably with crossover phase (from minor component value changes) if everything is close to right, meaning the (major) forward lobe is pretty close to the baffle normal and the side lobes are pretty symmetrical. That takes some effort to begin with, and I usually calculate first and then tweak the crossover to fine tune. If the forward lobe isn't pretty close to straight out front and the secondary lobes aren't pretty symmetrical, then the whole system gets kind of "twitchy". That's what I was trying to say earlier in my post when I said "the vertical nulls seem to be too close and sort of shady". Multi-cycle shifts are one culprit, another is when the electrical and acoustic phase simply points the forward lobe too far up or down.

This is where the work comes in. Play with various slopes and crossover points until you find a combination that gives symmetrical side lobes. You want the nulls to be pretty symmetrical - that's a clue. Even though the side lobes are smaller even when things are right (because of the directivity of the individual sound sources), you can still use the depth of the nulls as a clue. They should be pretty equal. If not, the forward lobe is probably aimed up or down a bit, sort of like what you see in the sims of an odd-order crossover. As an aside, remember that those usually are sims of idealized acoustical crossover slopes and omnidirectional sources, so they don't completely apply but they do give a good picture of a lopsided lobe situation. Again, you can get this oddball lobing from multi-cycle shifts or from just having the forward lobe pointed off too far. The latter can be corrected by crossover but the former will probably take physical movement or a delay line. Could possibly do it with two very different slopes, but I wouldn't want to do that with a passive crossover 'cause I don't like going past third or fourth order. Too much insertion loss or (large) expensive components or both.

Look back at my "Crossover optimization for DI-matched two-way speakers" thread. Notice that the Spice model I use has every (textbook BW) filter from first-order to fourth-order between 1kHz and 2kHz. That's so I can easily swap them in when designing. Those make good starting points, but I almost always modify the basic filter to something that isn't Butterworth, Bessel, Linkwitz,

Chebychev, or anything like that. I'll modify values to dial in the phase. That's what really matters.

Man, that WTPro ICD is really great for doing this. I got soooo spoiled with it. I used to wrack my brain trying to calculate the estimated phase to the Nth degree, using Hornresp to see the acoustic phase, combine that with electrical phase and baffle spacing and try to set the forward lobe that way. Then I'd model in Spice to get the electrical amplitude response and phase that I wanted and hope for the best. It was really hard work, and frankly isn't as accurate as just plugging in the numbers, building the crossover (in the ICD) and measuring the end result. Then when I build a physical model with caps and coils, it's right on the money. It is absolutely wonderful for this, and I honestly attribute it for why I'm able to get the results I get. Without it, you'd have to build a dozen physical models or more to dial it in, and you'd probaby give up and call it good after three or four, tops. But with the ICD, I can do a dozen in an hour, no sweat. Sweeeeeeet.