Subject: Symmetrical and asymmetrical slopes in crossovers
Posted by Marlboro on Wed, 30 Sep 2009 13:23:43 GMT
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Rick has made several references to the use of asymmetrical slopes in crossovers.

While I'm only knowedgeable about this aspect of crossover design by reading about it, but not in its use, I wonder if someone might share something about this.

As I understand it, this is something that is more important when one is using acoustic slopes as opposed to the filters used in an electronic cross.

Also, the reason for asymmetrical slopes is due to the path length difference between two drivers such as the woofer's acoustic center being behind the tweeter. The phase difference between the two different slopes can be used to accommodate this path length difference and bring the drivers back into phase alignment. But.....if you have DSP or an analog crossover that can delay the tweeter then it makes much of this discussion a moot point.

Could someone(perhaps Rick Craig) expand on this is how its used, and could they please try to avoid falling into audio or electrical engineer language that us non-engineers would most certainly get confused and have to take a long time in trying to decipher it with our trusty electronic term dictionary.

This is more of a WHY question, not a HOW TO question.

Subject: Re: Symmetrical and asymmetrical slopes in crossovers
Posted by Wayne Parham on Wed, 30 Sep 2009 15:16:56 GMT
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This is where measurements really help you. It would be hard to make a computer model that could include all the variables required to accurately predict the polar response of a loudspeaker. Instead, simplifying assumptions are used, such as considering each driver to be a purely pistonic radiator with specific position and acoustic phase. The electrical slope is only partly responsible for phase, as there are mechanical and acoustic properties that come into play as well.

Almost all my speakers use asymmetrical slopes in the crossovers, and most have what appears to be non-contiguous crossover frequencies as well. What I mean by that is two adjacent drivers may have electrical crossover points that don't meet. One may be higher than the other, sometimes appearing to overlap and sometimes appearing to have a gap. The truth is, only the electrical transfer function is non-contiguous, hopefully, the acoustic response is smooth.

The whole thing is acoustic phase. This affects summing, and steers where the lobes and nulls form. For more information, see the posts called "Baffle spacing, phase angles and time alignment, revisited" and "Crossover optimization for DI-matched two-way speakers". Whether or not you're interested in building a DI-matched two-way loudspeaker or something else, these concepts are transferable, having relevance in other loudspeaker types.

Subject: Re: Symmetrical and asymmetrical slopes in crossovers
Posted by Marlboro on Wed, 30 Sep 2009 17:00:33 GMT
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Thanks for the information, Wayne.

I have the suspicion that what you are talking about goes way beyond most DIYers. Most of us don't have the measuring equipment that is necessary or the crossover(acoustic or electronic)expereince that is necessary to do what you are talking about. And DIYers who get into this kind of nuance are usually getting ready to actually sell their products and thus have to compete with professionals like yourself in the market place.

Additionally, most of our listening rooms are living rooms, and even with those that aren't, we have way more problems with reflections in the room that will swamp these fine detailed measurements that you are talking about.

Finally, many of us are not young and are not experienced in hearing lots of really top end equipment like yours, so our ears(and brains) are not trained to actually hear what seems so significant to the audiophile at your level. We are mostly happy with our 9 dollar bottle of wine and can't really tell the difference between it and the $44 one.

IMO, measurement for the DIYer really consists of measuring the speakers we built IN THEIR LISTENING ROOM, and modifying it with an equalizer, or with simple changes in crossover or in frequency of crossover.

But its nice to know about these things even if most of us can't even begin to think about doing it. If we should ever get to that level we have some idea of what we have to do to compete.

Marlboro

p.s.: I asked a similar question on PE some time ago, and got a "What?????" type answer from one of the more well trained engineers there. This validates your assertion that these people spend more time with models than they do with actual measurements.

Subject: Re: Symmetrical and asymmetrical slopes in crossovers
Posted by Wayne Parham on Wed, 30 Sep 2009 19:03:49 GMT
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Yeah, I understand. I used to depend on calculations and models very heavily because good measuring gear wasn't available a few decades ago unless you had pretty deep pockets. Even then, I don't suppose it is as good as what we have now.

Before I had good measurement gear, I tried to design speakers with wide tolerance in mind, for example, using overdamped cabinet alignments that wouldn't shift towards being peaky even at high power. I electrically damped crossover networks to ensure they wouldn't have peaks too. I calculated phase and baffle offset, trying to put null angles far enough above and below the forward axis (baffle normal, straight in front) that the listener couldn't be sitting in one, even if my calculations were off because of electro-mechanico-acoustic properties I couldn't see in my simplifying assumptions.

In fact, my first few drafts of my speaker crossover document showed the math I used to do. I removed those pages on phase/summation calculations in the final draft because ultimately, acoustic measurements are easier and more accurate. However, there are a lot of forum posts here that discuss the process of manual calculations of phase and summing, like the one about baffle spacing and phase angles. There are also some Spice models illustrated in the Crossover Electronics 101 seminar I do every year or so at LSAF. These show some of the things I do in crossover design, what to watch out for and how to deal with things like driver reactance.

Now days, with measurement gear so affordable (some is free, like Speaker Workshop), I have the ability to see into the acoustic realm and I take advantage of it. It is work to make a few dozen measurements to get polar plots, but it's a heck of a lot easier to move the microphone around and find the nulls than to manually calculate them, for example. So in a way, having the measurement gear makes design work a lot easier, certainly if you're trying to be fairly rigorous.

I think you still have to do the initial homework, to get the design in the ballpark, so to speak, prior to measurements. You have to make appropriate driver selections, for example. Crossover frequencies have to be pretty close, certainly for speakers designed for uniform directivity (even through crossover points). The measurements help you refine the design, to get things just right. The final design phase becomes a test/adjust cycle, where you fine tune crossover components to set the phase, frequencies and slopes for perfect summing throughout the pattern.