Subject: Biamping-xovers-12, 18, or 24db/oct?
Posted by Paul C. on Fri, 22 Jun 2001 03:37:53 GMT
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Wayne: OK, I am going to go all the way and biamp my next project. Is there a particular rolloff rate you recommend with horn systems--12, 18, or 24db/oct?I can easily roll my own op-amp active xover... is there a particular topology you recommend?

Subject: Re: Biamping-xovers-12, 18, or 24db/oct?
Posted by Wayne_Parham on Fri, 22 Jun 2001 04:45:43 GMT
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Selection of crossover slope is all about excursion and summing. The higher the slope, the greater bandstop rejection there is. So a high-order slope on a the high-pass filter of a midrange or tweeter can increase its power handling capacity, for example. The ability to stop low frequency content from reaching the HF driver will prevent over-excursion at high power levels.Higher orders also increase the phase shift as you approach the stop band. The rolloff is faster, and accompanying this is a faster phase change. Of course, frequency-dependant attenuation is greater too, so the signal content with the most phase shift is what is most attenuated. The problem the designer has is knowing what frequency and slope to choose given a particular baffle spacing between drivers, or vice versa.Crossover design is a balancing act, one that requires a mutual effort in loudspeaker layout, so the two are designed together, as a system. Failure to access the interactions properly can (will) cause a cancellation notch in the crossover band. Since there is actually no way to prevent this at all frequencies and all positions, the careful designer chooses where to place the cancellation notch. Certainly, one seeks to prevent it from happening on the forward axis, and the best designs place it far out off-axis, ideally outside the radiation angle of the speaker. This approach requires horn drivers with controlled directivity, of course.You can't really say one crossover slope is better than another, without knowing all the specifics of a design. The whole goal is to split the signal into frequency bands each driver can safely cover, and to give them all signals that will combine coherently in the acoustic realm. This involves a lot of factors besides electrical phase, including acoustic phase, driver position and desired directivity and coverage angle.

Subject: Re: Biamping-xovers-12, 18, or 24db/oct?
Posted by Paul C. on Fri, 22 Jun 2001 11:49:41 GMT
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Wayne: Thanks for a excellent answer to my query. I can see there is more to it than a simple answer like 24db/oct is better than 12db/oct.While I understand phase causing a notch at the crossover point, I have another observation.... while in college, as a music major, I spent a lot of

time in a sound lab playing with an Arp synthesizer, o-scope, etc... learning what was what in terms of what we hear. (The Arp was an early, crude synth, could make only one note at a time, but you could put together a tone from sine, square, sawtooth waves, add filtering, etc)As far as phase of overtones in relation to fundamental, which is what we are doing when the signal passes through the crossover from woofer to mid or tweeter, this can all be demonstrated on a synthesizer. You can compare two sawtooth waves, for example, one with the peak on the left (HF leading) and another with the peak on the right (HF lagging)... the sound of both is identical. Now, you can hear it while you are playing with phase, and moving from one to the other, but once the the phase of the higher partials is stable, and the slope completely reversed, the tone quality is the same either way. Just an observation from actual experience, you guys. Oh, I found some other interesting things, in how we identify and differentiate musical instruments by ear, but that is another chapter...Paul

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Subject: Re: Biamping-xovers-12, 18, or 24db/oct?
Posted by Wayne_Parham on Sat, 23 Jun 2001 00:04:57 GMT
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You'll notice I am careful to describe phase interaction problems as summing problems. This is because the thing I am most concerned about is the notches formed by incoherent summing. That is the thing you most want to avoid. The thing is, to me it is important not only to avoid cancellation notches straight on the forward axis, but also at angles within the coverage angle of the loudspeaker. This raises the bar, because there are more places in 3D space where interactions between drivers are important than just one on-axis point.To illustrate the issues a little better, here's a chart that shows electrical phase of various crossover slopes:1st order - 45 degrees at crossover, 90 apart for adjacent drivers2nd order - 90 degrees at crossover, 180 degrees apart3rd order - 135 degrees at crossover, 270 degrees apart4th order - 180 degrees at crossover, 360 degrees apart5th order - 225 degrees at crossover, 450 degrees apart6th order - 270 degrees at crossover, 540 degrees apart7th order - 315 degrees at crossover, 630 degrees apart8th order - 360 degrees at crossover, 720 degrees apartThis gives you an idea of the amount of phase movement each crossover slope introduces. Combine this with the path length disfferences between each driver and the listener, and you can see how complex summing is in the acoustic realm. At locations where the path length difference plus the phase difference from the crossover combines to make the sound sources any multiple of 180 degrees apart, there is destructive interference which causes a notch. The goal of the designer is to place any notches off-axis, away from the intended listening position. If the speaker is designed for uniform coverage through some angle, then notches must be off-axis far enough to be outside the edge of the coverage angle.By the way, I agree with you completely on the matter of absolute phase verse moving phase. I made the exact same observation you did with synthesizers, as I'm sure everyone has that has ever been exposed to VCO or any signal generator that can produce a sawtooth wave. I played piano as a boy and got a MOOG synthesizer when I was a teenager. I was initially surprised that a sawtooth sounds the same regardless of its polarity. This made me realize that our ears aren't particularly sensitive to phase by itself - we hear phase change only because of the amplitude response anomalies it creates. I've heard that snakes and reptiles can't see a non-moving object very well, and in a way, we're like that with phase. We cannot hear

phase relationships very well unless they're moving.

Subject: Re: Biamping-xovers-12, 18, or 24db/oct?
Posted by Paul C. on Sat, 23 Jun 2001 12:45:11 GMT
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Wayne: Thank you for the thorough, thoughtful, and lengthy treatise on crossovers. I feel like I have just sat through half a semester of Crossovers 202, and gotten an A on the midterm!You would have made a great elec eng prof!Paul

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