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Subject: First speakers - a little ambitious - curved array

Posted by [Villain3g](#) on Fri, 07 Aug 2009 02:04:01 GMT

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When I finally decided to build a pair of speakers, I knew that I wanted to do something different. I also wanted it to be relatively "simple". The first thought was a single full range driver in a transmission line but they look like conventional floorstanding speakers. My second thought would be a line array but they require a mixer to combat the combing effect. This is apparently due to each driver from center being a little further from the listener's ear. So I figured, why not have every driver equidistant from your ear. This would create a pretty nice listening experience for focal point.

Keeping cost and final impedance as factors, I went with 16 peerless 2" full range drivers per channel. I arranged them in a curved line array with a radius of 12 ft. I used 3/4" mdf for the sides and internal bracing. Again for cost, I used hardboard for the curved front and back. I wired it up in a configuration to end up with 4ohms. Attached are some pictures.

Originally I was listening to them in a larger room. About 25' wide by 14' deep. In that room they were placed wider apart and I was sitting at the designed height. At first they sounded messy but as I listened longer the speakers started to fill the range. After they had broken in, I was surprised at how deep they were going. I'm not up with all speaker terminology but their presence seemed broad and quite realistic. I tested the speakers with a variety of music. They excelled with acoustic guitar, vocal, and smooth jazz. Where they seemed to fall off is with electric guitar as in heavy metal. The distortion in the guitar is muddled. Maybe I need an equalizer for the different types of music.

Unfortunately I have to move them to my bedroom. They don't have the same presence but its still ok. While in my room played some test tracks through them. I was surprised to hear sound all the way down to 30hz. Now I don't have any instrumentation to measure the drop-off, but I'd say it was usable down to 40hz.

My next step is to stiffen the enclosure. Any advise from the seasoned veterans would be much appreciated. I plan on doubling the wall thickness to two layers of 3/4" mdf. For the curved baffles I want to use two layers of 1/2" mdf. I think it will bend enough. Flush mounting the drivers and back chamfering the baffle is on the list as well. I'll also round over the edges of the cabinet.

If all goes well with that, I want to incorporate a diy powered sub somewhere in the equation. Either one under a center channel or one under each the left and right speakers.

Quite the lengthy first post. Mostly filled with noobish comments but hopefully you enjoyed it and have some input on the topic. If anything they look sexy...

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Subject: Re: First speakers - a little ambitious - curved array

Posted by [Eric J](#) on Sat, 08 Aug 2009 02:11:16 GMT

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Did you read Dr. Griffin's white paper before you built the speakers? Just wondering.

I was also wondering if you notices a lack of upper frequencies without the addition of a tweeter in the array.

Eric

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Subject: Re: First speakers - a little ambitious - curved array

Posted by [Villain3g](#) on Mon, 10 Aug 2009 21:12:33 GMT

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I peeked at the white paper but it was way over my head. So I just dove in head first. These speakers are suprisingly both bright and deep. And I think they will improve with a thicker front and back pannel.

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Subject: Re: First speakers - a little ambitious - curved array

Posted by [Eric J](#) on Tue, 11 Aug 2009 11:27:32 GMT

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I'm glad you like the result.

But... anyone designing line arrays at this current time who fails to follow Jim Griffins ground breaking research parameters, is returning to a time when it was hit or miss. Small far field listening Speakers are pretty forgiving; Line arrays are not forgiving at all, and its easy to produce a set that in comparison to even forgiving 2 way or 3 way far field listening are minimal for all the work involved.

But again, I'm glad you like the result. It took me awhile to digest Jim Griffin's paper, but I followed it to the letter and my system covers all the bases. Although building time did exceed a year of Saturday mornings especially with the design of 32 separate outside air separated 4 lb/sq in fiberglas stuffed 23.5 inch x 6 inch tubes for each midrange speaker, as well as cutting the flanges in 60 Dayton 3/4 inch dome ND20A's so that the comb filter distortion didn't go lower than 16khz, and the c-to-c distance was no more than .80 inch.

To each his own.

Eric J

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Subject: Re: First speakers - a little ambitious - curved array

Posted by [Villain3g](#) on Wed, 12 Aug 2009 15:54:17 GMT

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I remember the white paper only dealing with flat baffel line arrays. Is there any documemts written on focussed line arrays?

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Subject: Re: First speakers - a little ambitious - curved array

Posted by [Eric J](#) on Wed, 12 Aug 2009 16:12:25 GMT

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Focused line arrays are not usually used in home settings.

Since I have a flat baffle line array which I have alluded to in the past, the concerns that you spoke about are completely un-noticable if they are there at all. But all the rest of the information on how to build line arrays are the same and should be followed.

You usually see focused arrays in arenas where the people aren't able to be listening in the nearfield such as a church or a stadium. In these instances, it is necessary to focus the array to keep the listeners getting the full music. If you are listening from 10 feet away you are in the near field, and the time delay issues are compensated for in your brain, if they exist at all.

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Subject: Re: First speakers - a little ambitious - curved array

Posted by [Jim Griffin](#) on Fri, 21 Aug 2009 13:43:18 GMT

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Just a short note on curved arrays.

Concave (curves inward) arrays limit the sweet spot listening area and in fact become one or two rows of listeners deep if your are close to their focal point. In the limit you have a one listener in the sweet spot. In reality the drivers are directed to overlap essentially the same volume in space so you attain none of the advantages of near field arrays that I have stated.

On the other hand concave curved arrays (curved outward typically in a J-shaped curve) are widely used in the pro sound field. The goal for the convex curved arrays is to blend their near and far fields so that the sound quality is improved for additional listeners within the audience.

Bottom line is that concave arrays limit the listening space while convex arrays expand the listening space.

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Subject: Re: First speakers - a little ambitious - curved array

Posted by [Villain3g](#) on Fri, 21 Aug 2009 18:58:25 GMT

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Heres an update. To fill in the low end I built a pair of powered subs to double as speaker stands. Now I can get back to design of the arrays. I'll whip up some strait enclosures to compare.

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## File Attachments

- 1) [speakers 006jhb.JPG](#), downloaded 13618 times
  - 2) [speakers 002dfv.JPG](#), downloaded 12309 times
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Subject: Re: First speakers - a little ambitious - curved array  
Posted by [darkmoebius2](#) on Sat, 22 Aug 2009 05:57:17 GMT  
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Villain3g wrote on Fri, 21 August 2009 13:58I'll whip up some strait enclosures to compare. Just follow Dr Griffin's white paper and they'll turn out great. Since you are using fullrange drivers which will be covering HF's all the way up, too, the driver flanges should probably be as close to touching each other as possibleQuote:Near field. Urban, et al [1] derives a more restrictive criterion of no more than a half wavelength separation between drivers at their highest operating frequency...Wavelength is equal to the velocity of sound (344 m/s or 1130 feet/s) divided by the frequency.

For the tweeter line very close center-to-center spacing is difficult to attain as very small circular drivers would be necessitated for either the one wavelength or especially the half wavelength criteria. Consider operation to 20 kHz where one wavelength is 17.2 mm (0.68") and a half wavelength is only 8.6 mm (0.34"). Without regard to their surrounding flanges, dome tweeters are available in 25 mm (1"), 19 mm (0.75") and 13 mm (0.5") diameters. Hence, with any mounting flange allowance at all, the one or half wavelength c-t-c criteria are very difficult--if not impossible--to satisfy at 20 kHz. But, if we relax the c-t-c criterion, more secondary lobes would appear in the 10 to 20 kHz frequency range. Fortunately, in this octave the ear is less sensitive (per Fletcher-Munson curves) so any secondary lobes likely would be less audible to the listener. Thus, if one wavelength spacing at 10 kHz is adopted as a compromise, then tweeter spacing would need to be 34.4 mm (1.35") c-t-c apart. While more off axis secondary lobes would be generated in the far field, small flange tweeters are available to meet this dimension. The tradeoff is possible sound degradation from comb lines near 20 kHz. Experts out there, do I have that right?

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Subject: Re: First speakers - a little ambitious - curved array  
Posted by [Eric J](#) on Sat, 22 Aug 2009 15:32:38 GMT  
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In my opinion, you are pretty much limited to 3/4 inch dome tweeters by the combination of

frequency range covered and the need to avoid comb filter distortion.

There is only one dome tweeter on the market that actually allows cutting the flanges to make the distortion occur below between 15K-16Khz, and that is the Dayton Neo 20A. I did that with mine and got the C-to-c distance at just slightly over the actual width of the speaker itself, or .80 inches. If you use a 1/2 inch dome, you can't go low enough in the crossover to be usable. If you use above a .75 inch dome, you will have comb distortion kicking in at actually hearable levels. Most people's perception of sounds drops substantially above 14000hz, so for most people the comb filter distortion is un-hearable IF YOU HAVE LIMITED IT TO BE ABOVE 15KHZ.

You are also required to use midranges no bigger than about 4 inches to be assured of not getting nasty CFD in the midrange.

If you want to avoid any possibility of hearing it, AND reduce your massive work of cutting the flanges on the neo's you must use ribbon or planar speakers. However, these speakers are far from flat in their frequency responses unless you are willing to buy those that exceed \$75 each. For me this raised the price to unacceptable levels. I was building the best I could for under \$1500---complete including electronic crossover, 3 amps and a preamplifier for a full tri-amped system.

So.... you either use Dayton Neo 3/4 inch domes and cut each flange and then put them together tightly, or you use a ribbon. Considering the effort I had to go into to cut each flange, I cannot imagine any manufacturer doing that.

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Subject: Re: First speakers - a little ambitious - curved array

Posted by [Villain3g](#) on Sat, 22 Aug 2009 22:21:59 GMT

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Is this comb filter distortion why metal music sounds a little off? I thought that curving the baffle would counteract that affect. Acoustic guitar and vocal music sound incredible but the high end in metal music gets confusing. Its hard to describe. Maybe having them wired at 4 ohms is overloading the receiver?

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Subject: Re: First speakers - a little ambitious - curved array

Posted by [Eric J](#) on Sun, 23 Aug 2009 03:29:20 GMT

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Exactly. Heavy metal uses those frequencies, AND REQUIRES THE UPPER HARMONICS. Other music also requires it but you can get along without it if the array has all the other good things.

This is how Jim Griffin describes it:

"Comb lining will dull the highs and will be most noticeable in the lack of air (dull highs) especially

as you move off axis. Essentially, the high frequencies are rolled off as the ensemble of the tweeter outputs don't add up but start to cancel. Now the ear is less sensitive in the upper octave (10-20 kHz) you may not observe the full impact of this effect. But if you compare to an array that is properly designed, then there is no comparison as the proper array will yield a more airy (and accurate) sound."

Jim Griffin on Parts Express Tech board on 11-21-06

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Subject: Re: First speakers - a little ambitious - curved array

Posted by [Villain3g](#) on Mon, 24 Aug 2009 02:18:58 GMT

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I was just thinking. Can you offset the drivers of a line array in a zipper pattern to get the vertical c to c closer?

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Subject: Re: First speakers - a little ambitious - curved array

Posted by [Eric J](#) on Mon, 24 Aug 2009 03:06:48 GMT

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Distance is distance.

I thought ab out that but when you get to measuring its usually less. You have to look at the whole picture: the frequency response of your speakers, where you are crossing them, the slope of your crossover(for the overlap and where they fit), and the comb filter distortion for how far apart they have to be.

Like i said, for the system I developed for me I could only use 3/4 inch domes that had the domes literally silk to silk. I would have liked to put my 3.5 inch mids closer together but i also wanted each one to be separated physically completely from the others so that there was no backwave interference, and i wanted to make sure that the backwave for each was completely negligible so that nothing from the back of the speaker was coming back through the front to muddy the midrange sound.

Eric J.

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Subject: Re: First speakers - a little ambitious - curved array

Posted by [Villain3g](#) on Mon, 12 Oct 2009 20:28:13 GMT

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Before I go and build the big lines, I want to modify these. My goal is to stick a Dayton PT2C-8 in the middle of the curved arrays. This will eliminate the combing. Now I need some sort of crossover. I would like to have a separate high-pass for the tweeter and a low-pass for the line. This would allow me to bi-amp. This will also allow me to match the volume of tweeter to the line.

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I'd like it to be as steep a slope as possible at 5k. A 4th order crossover satisfies that criteria. I found a calculator online at:

<http://www.apicsllc.com/apics/Misc/filter2.html#fourth>

The values it gave me are not available. How close of a tolerance should there be on the components?

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Subject: Re: First speakers - a little ambitious - curved array

Posted by [Villain3g](#) on Wed, 21 Oct 2009 21:27:11 GMT

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Second iteration. Two-way, bi-amped, 24db passive crossover at 5khz, and curved for time alignment.

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1) [speakers 010.jpg](#), downloaded 603 times

2) [speakers 012.jpg](#), downloaded 555 times

3) [speakers 011.jpg](#), downloaded 569 times

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Subject: Re: First speakers - a little ambitious - curved array

Posted by [selahaudio](#) on Thu, 22 Oct 2009 05:55:43 GMT

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Villain3g wrote on Mon, 12 October 2009 15:28 Before I go and build the big lines, I want to modify these. My goal is to stick a Dayton PT2C-8 in the middle of the curved arrays. This will eliminate the combing. Now I need some sort of crossover. I would like to have a separate high-pass for the tweeter and a low-pass for the line. This would allow me to bi-amp. This will also allow me to match the volume of tweeter to the line. I'd like it to be as steep a slope as possible at 5k. A 4th order crossover satisfies that criteria. I found a calculator online at:

<http://www.apicsllc.com/apics/Misc/filter2.html#fourth>

The values it gave me are not available. How close of a tolerance should there be on the components?

Adding the tweeter doesn't eliminate the comb filtering, especially with a 5K crossover point.

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Subject: Re: First speakers - a little ambitious - curved array

Posted by [Marlboro](#) on Thu, 22 Oct 2009 17:52:44 GMT

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Villain3g,

To find where the basic level of comb filter distortion starts, you divide the distance of the speakers in inches from the speed of sound in inches per second. This gives you the frequency where comb filter distortion may start. For example  $13560 \text{ inches per second} / 3.5 \text{ inches center-to-center} = 3874 \text{ hz}$ . In this example comb filter distortion will start at 3874hz, and you really can't cross your 3.5 inch center to center midranges much above 3874. If your mid ranges were 5.25 c-to-c, then it would be  $13560 / 5.25 = 2582 \text{ hz}$ , where your cross can't come in higher than 2582.

The center to center distance between your mid ranges can't be any further apart than 2.75 inches to cross at 5000hz. and you would do well to remember that the distance between the highest mid in the lower group and the lowest mid in the higher group is way above that number.

Your planar needs to go on the side of the mid line array. However I've seen a lot of arrays, including Fred's ART array that put a tweeter in the center between the two smaller lines. I don't know what this does.

All this said, I'm not 100% sure how much you can hear comb filter distortion, as long as you sit in one spots and don't move your ears vertically.

Marlboro

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Subject: Re: First speakers - a little ambitious - curved array

Posted by [Villain3g](#) on Thu, 22 Oct 2009 20:19:01 GMT

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my 2" peerless fullranges have a ctc of 2.17. Combe filter starts at 6260. I thought having the ribbon take the high freqs at 5k would make the comb effect not noticable. Is it that im crossing too close?

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Subject: Re: First speakers - a little ambitious - curved array

Posted by [Marlboro](#) on Thu, 22 Oct 2009 21:53:04 GMT

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If your c-to-c on the mids is only 2.17 then they will not comb filter at 5000, and the ribbons don't have that kind of problem.

Looks good then.... to me! Don't worry about comments from people who make cryptic statements and don't tell you why.

How low do those little fellows go for a two way? They look sort of like a 2 inch mid range dome. PE makes one of those and they don't go lower than about 400hz



I don't think that the distance between the two portions of the mid range array are an issue but is there wa reason why you didn't make the baffle wider and put the tweeter on the side?

Marlboro

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Subject: Re: First speakers - a little ambitious - curved array

Posted by [Villain3g](#) on Wed, 04 Nov 2009 02:12:12 GMT

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I've got them running. I went with a straight baffle in the end. It seems to have a more consistent sound when moving through the listening area. The addition of the tweeters is the most significant. Where there was an annoying confusion in metal rock and complex orchestral pieces is now a pleasant accuracy. My only concern is if I'm actually getting down to the subs. Most likely not. I've got to put line arrays on hold for a while though. Been looking at houses and it would be tough to have both. I think I'll be happy with these for a little while. Although, my dreams of the big arrays will always be there.

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Subject: Re: First speakers - a little ambitious - curved array

Posted by [Villain3g](#) on Thu, 05 Nov 2009 01:22:22 GMT

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They definately don't have the same visual effect... Maybe I'll rig up the old enclosures to work for something.

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1) [speakers 002.jpg](#), downloaded 566 times

2) [speakers 005.jpg](#), downloaded 556 times

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Subject: Re: First speakers - a little ambitious - curved array

Posted by [Wayne Parham](#) on Thu, 05 Nov 2009 16:40:59 GMT

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It's definitely cool looking!

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Subject: Re: First speakers - a little ambitious - curved array

Posted by [mr16track](#) on Sat, 01 May 2010 01:38:02 GMT

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Is that a set of Ohm F's there?

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Subject: Re: First speakers - a little ambitious - curved array

Posted by [lcholke](#) on Fri, 04 Jun 2010 18:26:31 GMT

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Hi Villain3g,

Good looking speakers!!

The comb filtering will not be a factor as long as all the speakers are the same distance from the listeners ear. This is tough to do. The nulls happen when 2 sources are 1/2 wavelength different in distance from the ear. The waves sum to zero. But since you have built the array you can be the judge. The sweet spot sounds like having headphones on to me. I have had both focused and straight arrays.

-LC

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