Subject: Re: Finished Pi 4 with photos
Posted by Wayne Parham on Wed, 24 Jun 2009 16:46:12 GMT
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Excellent, interesting project.

I like the implementation. That's the horn some of the folks at AK use in their "Econowaves". I would probably have used that horn if I were looking. From the measurements, I'd say it was basically equivalent to the horns I use.

derivatives. They're the same basic speaker. Same crossover, same design approach. So I definitely give the thumbs up.

The only thing that concerns me is what you mentioned about the position of the lobes and nulls. That is affected by crossover phase (set by crossover values and topology), acoustic phase (set by electro-mechanico-acoustic rolloff of drivers), directivity (set by horn flare and/or size of direct radiators) and position of the drivers on the baffle (vertical, horizontal and depth/distance). This means that the changes you have made most likely moved the positions of the lobes and nulls, and while you can guestimate them by looking, you can't know for sure without measurements.

The horizontal performance is set by the size of the woofer, the pattern of the horn and the crossover frequency. Since the size of the woofer and the directivity of the tweeter are constants, the only thing you need to set is the crossover frequency.

Your horn provides uniform directivity of 90° above about 1kHz. The woofer directivity collapses

of course, radiator diameter isn't advertised diameter, it is approximately where the surround meets the cone, maybe half way into the surround or so. This is what sets the crossover point, because you want to match the horizontal directivity of the horn to the woofer's pattern at crossover. By doing this, you avoid response ripple at wide off-axis angles, ensuring uniform power response and spectral balance throughout the room.

You actually have a fair amount of wiggle room where horizontals are concerned because movement along the horizontal doesn't change the delta distance between the woofer and the

point, which is where directivity is approximately 90°. The horizontal lobes are fairly far apart, and aren't due to woofer/tweeter interaction like the verticals are, they're due to path length distances across the woofer, itself.

The verticals aren't so easy. This is where crossover phase and baffle spacing are most important. When I was first designing loudspeakers, I didn't have good measurement equipment so my calculations were probably better than my measurements. What I had at my disposal were Radio Shack SPL meters, microphones and oscilloscopes. I found early on, in the 1970's and 1980's, that I really had little visibility, so I tried to calculate everything. It was very tedious math, and even though I was dilligent, I couldn't get the accuracy I have now from a PC measurement system.

In the past, I would spend all day calculating a series of phase angles at various frequencies and positions, calcualting first the crossover phase and then relating that to physical distances to find the lines where I expected the null angles to be. This was all outlined in the original first couple of drafts of my "Speaker Crossover" document, but I later took those pages out, the ones dealing with phase angles and manual calculations. It was long, tedius and boring, and these days, just doesn't make sense anymore. Take the time you'd spend to calculate one set of vectors, use that same time to work your regular day job and apply the money towards a good measurement system.

It's absolutely trivially easy, in comparison, to take measurements at various points in front of the loudspeaker, to find where the nulls are. Of course, you have to be in the ballpark to start with, but there's a wealth of information here, on this website, to help find a good starting point. I see

close and may not need to be changed at all.

You may find that you have to move the horn forward or backward a bit, to fine tune the position of the forward lobe. Or if you want the horn to be baffle mounted (as I see you do), then you might choose instead to modify crossover values a little bit, if needed to fine tune the position of the forward lobe and vertical nulls.

Sometimes just slightly modifying the value of a crossover component or two will do it, other times you will have to modify the slope of the core splitter filter (by adding or removing a reactive component). Even orders tend to form symmetrical lobes, but electro-mechanico-acoustic rolloff adds to the acoustic slope, so you may end up with odd orders electrically. Or you may have an asymmetrical filter, with different slopes on the drivers. More than likely, you'll have what appears to be a different crossover points for each driver, by textbook values, because acoustic summing comes into play.

My advise is to spend an afternoon or two measuring your speakers. Lay one of them on its back and use a boom to position the microphone over it. Take a measurement with the mic in one position and then move it to take another. Do this enough times you have a grid of measurements to see what the loudspeaker's pattern looks like. If its response is clean through a wide forward lobe of 40° or so (20° or more up and 20° or more down) then you're doing fine. That vertical arc is tall enough to be useful, and will ensure that the speaker sounds good at various heights at virtually all listening distances in your room, even fairly close up. If the pattern isn't right - if a null is too close to the forward axis - modify the crossover and take measurements again. Repeat this process until you are satisfied with your speaker's performance.