Subject: Probable dumb question - Where's the midrange driver?
Posted by NickR on Wed, 09 May 2001 03:28:43 GMT
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It seems all the "audiophile" speakers I have seen contain a midrange driver (5 - 6.5"). Looking at the 3 pi's and 4 pi's I am wondering how they can use a large woofer (12 - 15") without a smaller midrange driver.Please note I'm asking out of sheer ignorance - I'm not trying to kick up any dust.

Subject: Re: Probable dumb question - Where's the midrange driver?
Posted by Wayne Parham on Wed, 09 May 2001 07:35:46 GMT
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That's a very good question. Thanks for asking, giving me the opportunity to explain.The three Pi and four Pi loudspeakers are what I call DI-matched two-ways. They have a high-efficiency midwoofer that operates through the midrange, into the overtone range before crossover to the tweeter. This allows vocals and instrument fundamentals to come from a single driver, with overtones and very high frequencies provided by the tweeter. I think it's a natural place to crossover.The name implies the philosophy, DI-matched meaning the directivity index is matched at the crossover point. The woofer is a round radiator and at higher frequencies, it begins to become directional. At low frequencies, the cone is small compared to wavelength but at high frequencies, the distance from edge to edge becomes closer to wavelegth proportions. As the woofer enters this frequency range, it's radiating angle begins to narrow into a cone shape. This is because an off-axis listener is closer to the near edge than the far edge, and where the path length distance is 180 degrees apart, a notch forms, marking the edge of the pattern. In a DI-matched speaker, this angle is matched to the horizontal pattern of the tweeter, so they both have approximately the same directivity at that point.I prefer to use tweeters with narrower vertical coverage than horizontal, usually something around 90x40 degrees. In this case, the directivity index of the tweeter is usually a little higher than the midwoofer at the crossover point, because its vertical directivity is narrower than the horizontal, making the combined DI figure slightly higher. But precise DI matching isn't important. What is important is that coverage is uniform along both horizontal and vertical axis, and that requires an asymmetrical pattern with DI approximately matched at crossover. The horizontal patterns overlap coherently, but the vertical patterns only do within a certain angle, depending on the distance between woofer and tweeter.Vertical stacking of the midwoofer and tweeter make nulls appear above and below the speaker in the crossover region. These nulls are closer together - at a narrower angle - than the nulls from the edge-to-edge path length difference from the midwoofer alone. The reason is the same, there are path length differences between the listener and the closest sound source and the furthest sound source. In the case of the vertically stacked woofer/tweeter pair, the distance from top of tweeter to bottom of woofer is greater than woofer edge to edge, so the null angle is smaller. This modifies the vertical radiating angle, narrowing it in the crossover region. That's why I like to use a tweeter with narrow vertical pattern, so it is nearly matched to the null angle imposed by vertical stacking of drivers.The overall effect of all this is you have a speaker that sounds very much the same at all angles within the tweeter's coverage pattern. Outside this pattern, sound falls off sharply as it enters into null areas. The net result is a uniform coverage, with spectral balance in the reverberent field. This sound much more natural than a speaker that has less uniform off-axis coverage, even if its on-axis response is very good. That is because even though you may listen on-axis with the speakers pointed at you, the aggregate of all on and off-axis energy is what makes up the reverberent field, and that is responsible for much of what you hear.

Subject: Thanks for the reply
Posted by NickR on Thu, 10 May 2001 11:35:37 GMT
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I didn't know that large woofers could go to the 1k-2k range. I keep reading about 'beaming' and distortion and all that.That's the danger of trying to learn about this stuff. It's hard to 'learn a little'. There's really too much ground to cover for someone who isn't doing this full time.Thanks again -Nick

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Subject: Re: Thanks for the reply
Posted by Wayne Parham on Thu, 10 May 2001 17:44:24 GMT
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All speakers beam at high frequency, depending on their dimensions. Even a 5" midrange will begin to beam above about 3kHz. That's where it's angular coverage has collapsed to a 90 degree cone shape. It will continue to get more and more narrow above this point. So if it is used to, say 5kHz and then crossed over to a dome or ribbon tweeter, then the angular coverage will narrow through the midrange band, and then suddenly widen up again as the tweeter comes online. That's why I am an advocate of DI-matched speakers. If the angular coverage isn't matched, or at least uniformly collapsed, then the spectral balance of the reverberent field will be way off.You mentioned distortion and that's one thing I forgot to talk about earlier. There are several kinds of distortion and potential sources in a speaker, but the one most vulnerable for a DI-matched two-way is cone breakup. A speaker is designed to operate as a rigid piston, but it usually only acts like a rigid piston for a couple octaves or so. Above that point, the cone begins to flex, forming ripples across its surface. If a speaker is used to high frequency, it is important that the cone be well damped. That way, the cone flex resonant modes aren't so severe.

Selection of cone material and shape is important, because it determines cone flex damping. You can easily see cone flex resonant modes in a response chart, because they appear as a notch followed by peaks in amplitude at high frequency. These affect both on and off-axis response, so it is important to choose a driver with well behaved breakup modes when using in a DI-matched two-way speaker, as it will be used well past thge frequency where it is moving as a rigid piston.