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Subject: Rationale for single driver speakers  
Posted by [akhilesh](#) on Fri, 09 Jan 2004 20:22:47 GMT  
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Hi Everyone, Just wanted to start a thread on WHY single driver speakers are a good (or bad) idea. Let's consider some initial ideas: 1. Some people believe the crossovers in multi driver speakers result in phase shift, and the placing of different drivers result in different frequencies coming from different sources. I have not been able to hear this. A well made pair of multiway speakers sound pretty good to me. 2. Having one driver reproduce the bulk of the audible spectrum results in more natural sound (somehow). IMHO, I like a single driver speaker because I have an inherent bias against a \$100 multiway unit where 90% of the spectrum is reproduced by the \$5 unit (the tweeter). I'd much rather spend the money on a high quality driver that reproduces most of the spectrum. IMHO, this approach should lead to subjectively well produced sound (does anyone know how to quantitatively measure the accuracy of reproduction of a trumpet, or a saxophone or a piano?). Does anyone have other thoughts? Anyone know of any real scientific studies that PROVE that crossovers (if well executed) will still be AUDIBLY worse than no crossovers? thanx-akhilesh

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Subject: Re: Rationale for single driver speakers  
Posted by [Adrian Mack](#) on Thu, 15 Jan 2004 08:41:11 GMT  
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Hi Akhilesh Phase shifts can be minimized well below audibility, so that's not a concern in a multi-way system. Comb filtering between subsystems can also be highly minimized by using steep order crossovers, controlled dispersion horns, close driver spacing, and avoiding very high crossover points (above ~5KHz or so). Fullrange drivers are good in that there's only one subsystem so there's no issue of path length differences between two sound sources which cause nulls at various frequencies and positions. But fullrange drivers become extremely "beamy" at high frequencies, so polar response is very poor (i.e.: very bad off-axis response). That happens because the speaker ceases to function as an omni directional point source when the speaker itself is acoustically large compared to wavelength being produced. Sound is radiated into a continuously smaller angle as frequency rises. Diffraction can even occur across the diaphragm at these frequencies. Intermodulation distortion is also higher on a fullrange driver at the upper bounds as well, for obvious reasons. Fullrange drivers also often have difficulty reaching the highest frequencies, as well as the lowest frequencies as it needs to find a balance between cone weight and suspension stiffness. If the cone is too heavy it will extend deeper, but it will also limit its HF extension at the same time - a balance must be found and it is always a trade off. No real studies that I know of prove crossovers are audibly worse than no crossovers. Reason is, they aren't. Selection of the correct crossovers in a multi-way system, and using high quality parts in those crossovers to keep distortion low is what you want to do. And if you do, then there's nothing wrong with them. Here is a good document concerning the audibility of phase.  
[http://www.music.miami.edu/programs/mue/Research/dkoya/title\\_page.htm](http://www.music.miami.edu/programs/mue/Research/dkoya/title_page.htm) It's long, and boring (university paper), but it's good stuff. It's one of the best studies I know of. Everything into account, a good multi way system can excel in terms of distortion, polar response, bandwidth, and output

capability. Adrian

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Subject: Re: Rationale for single driver speakers  
Posted by [paba](#) on Thu, 15 Jan 2004 13:40:44 GMT  
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There must be something to the simplicity of single driver speaker, no crossover makes the signal path much shorter, the single point source is closer to what you get in nature as well. Granted it is a tall order for one driver to cover 20Hz to 20kHz. In fact it is a tall order for many multi driver systems as well so in that case why not go for simplicity. Just my 2 cents. Paul

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Subject: Re: Rationale for single driver speakers  
Posted by [akhilesh](#) on Thu, 15 Jan 2004 14:29:40 GMT  
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Hmmm... So it seems that single driver designs don't really offer an audible advantage. Of course, they are simpler to build. My experience with my single driver is that it is clean and, if you use a good driver (like I did) there is a purity to the sound. However, it is not as "impressive" as a 3 way system (my other speakers are 3 way horns). Stereophile did a review of 2 single driver speakers, primarily because they have a SET/single driver fanatic on staff (Art Dudley). The single drivers they measured seemed inferior to most high end multi way designs, and yet, they were very listenable. Maybe single drivers capture some aspect of listenability that we cannot measure yet.  
-akhilesh

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Subject: Re: Rationale for single driver speakers  
Posted by [Adrian Mack](#) on Fri, 16 Jan 2004 07:00:32 GMT  
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Hi Paul Certainly, there are advantages to single driver's. But then there are disadvantages as

multi-way speaker. Remember that no loudspeaker acts as a true point source for every frequency. When wavelength approaches diameter of the cone, then the speaker ceases to act as a point source and is more like a planar source. That is, the listening window is effectively limited to being directly on-axis. Every loudspeaker functions as a point source at the bottom end of its range, where wavelength being produced is much larger than cone diameter. Unless the loudspeaker is infinitely small to function as a point source at 20kHz, which would mean the cone is a fraction of an inch in diameter, then it'll function as a planar source and that's when beaming starts to occur. And with a full range driver, cone diameter is often around 6" diameter or more, so

the driver becomes beamy very early. You'll find that most full-range driver's become increasingly attenuated off-axis from as low as 3KHz, or even lower if cone diameter is larger. The Single Driver Website has a number of frequency response curves published for several fullrange drivers which demonstrate this narrowing radiation pattern. On the other hand, multi-way speakers make use of tweeter's which are small in diameter so they act like a true point source to a higher frequency. And if a tweeter horn is used - then smooth polar response can be obtained to an even higher frequency. Of course, the issue of getting each subsystem to combine coherently becomes a factor. The solution to this is to use high order crossovers, close baffle/driver spacing, lower crossover points, and directional horns to limit interaction between subsystems. A properly designed multi-way speaker can combine to produce a very flat frequency response over the entire audio spectrum, and phase shift's between subsystems can also be reduced to below audible levels. Static phase is inaudible to our ears anyway; it's really only large, multi cycle phase shifts which are a problem. Phase shifts which are only inside of the time domain are indistinguishable, but when they show up as anomalies in the frequency domain, then they can be identified. As I mentioned in my last post, and as you've just noted, it's exceedingly difficult for a single driver to cover the full audio spectrum. It's also pretty hard for a multi-way speaker as well, unless the number of subsystems is increased to three or more if intermodulation distortion is desired to be kept low. While its impossible for a single driver to cover 20Hz to 20KHz, it isn't impossible for a multi-way speaker to do that. That's because to reproduce 20KHz requires that the ratio of voice coil mass and cone mass be as small as possible, and that isn't what happens on a fullrange driver - the cone is heavier so that LF response isn't minimized, but then HF response is limited too. It's kinda a balancing act when you want to make a single driver cover the widest bandwidth possible. Voice coil inductance will also become a factor in upper frequency rolloff, and generally inductance is greater as cone weight is increased. Use of a faraday ring in the motor assembly of a fullrange driver would be one way to counteract this to an extent. A lot of the commercial multi-way speakers on the market use 6" drivers or so, so bass extension is usually limited to 40 or 60Hz at the low end, but they reach 20KHz easily as they employ tweeters with extremely light mass, very low inductance and they're small in diameter to minimize beaming.

tower's or MTM towers, which is why they don't reach 20Hz; cone weight needs to be heavy to reach 20Hz, and since there's only one woofer in a 2-way speaker (or 2 woofers in an MTM speaker, but each woofer is exactly the same and each cover the same bandwidth), then that woofer is expected to operate right from lower cutoff and all the way up to 3 or 4Khz where it's

crossed over, but it also means it's lower cutoff is increased to 40 or 60Hz. Another reason for not having the woofer in a 2-way system reach down to 20Hz is to reduce intermodulation distortion in the midrange. In a 3-way system though, one can easily have a woofer covering 20Hz through to 200Hz or so, and then a midrange from 200Hz to 3KHz, and then a tweeter from 3KHz to 20KHz. As you can probably see, in a 3-way system, bandwidth can be maximized further over a 2-way system and distortion can be kept low by having each subsystem in operation over a limited range where the driver performs best. Single drivers still do need some sort of filter to protect them from low frequencies. A highpass filter is typically used below cutoff to prevent the driver from mechanical damage caused by low frequencies which require high excursion, and  $x_{max}$  is small on a fullrange speaker. Added to that, cone resonance modes, or breakup modes cause frequency response to become very rippled, or "not smooth" at higher frequencies. There are ways to damp cone modes, but they still become a huge negative in a single driver, especially since they'll start from a lower frequency than what a smaller speaker such as a tweeter will do. Cone breakup modes are also a form of distortion, which isn't a good thing. A multi-way speaker

can be designed to operate each subsystem so that none of them are operating in a region where cone resonance modes are interacting. Whizzer cones and center cap type fullrange drivers typically generate a peak in response where both cones are active. The spike can be over 7db on some drivers. Intermodulation distortion is typically higher on a fullrange driver too. That's because large diaphragm movement at low frequencies interfere's with higher frequencies which are trying to generate only small diaphragm movements at the same time, and that increases intermodulation distortion at both midrange and high frequencies. Bandwidth is expected to be huge on a fullrange device, so intermodulation distortion is increased further over a multi-way speaker. Each subsystem in a multi-way speaker is running over a much smaller bandwidth, so each component generates less intermodulation components. The point is, a multi-way speaker is able to perform much better in all of the important categories. Single driver's are always faced with the problem of a highly uneven polar response, rippled frequency response at higher frequencies, inability to reach both the highest and lowest frequency extreme's, higher distortion, and lower output capability and dynamic range than that of a well designed multi-way speaker. Adrian

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Subject: Re: Rationale for single driver speakers  
Posted by [Adrian Mack](#) on Fri, 16 Jan 2004 07:08:56 GMT  
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Hi Akhilesh That's my take on it too. It's impossible for a single driver to match the polar response, distortion levels, bandwidth, dynamic range and linearity of a multi-way speaker. That in mind, it doesn't mean single drivers are completely bad and unlistenable. I've seen lots of people use them with success (Fostex seems to be talked of very well), it's just that they cannot match what a multi-way speaker can do. What fullrange driver did you use by the way? The front speakers in my system also utilize horns, and are 3-way type. Adrian

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Subject: Re: Rationale for single driver speakers  
Posted by [elektratic](#) on Fri, 16 Jan 2004 09:51:44 GMT  
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Adrian, On the other hand, with no crossover it's a lot harder to screw up. Have you seen some of the measurements made at Soundstage? Similarly, Dennis Murphy (I think) has been discussing the bizarre measurements he got from one of the Norh speakers and designed a brand new replacement crossover. Particularly when I see a speaker with three or more drivers, I get very nervous because you have no assurance that the designer had any idea what he was doing. One other factor, for me at least -- and I recognize it is utterly subjective -- is that I just find single drivers (at least the Fostexes I've heard) non-fatiguing and easy to listen to. I can listen to my \$140 tube-amp-on-a-board driving a pair of Fostexes all day without fatigue.

Soundstage Speaker Measurements

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Subject: Re: Rationale for single driver speakers  
Posted by [Adrian Mack](#) on Fri, 16 Jan 2004 10:09:35 GMT  
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Hi elektratigl agree with you, no crossover is a lot harder to screw up! I've seen a lot of DIYers completely wreck the crossover's. And I don't doubt that some of the smaller companies probably don't know what they're doing either. In any case, I refer to a well designed multi-way speaker. But I see your point, for sure. Adrian

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Subject: Re: Rationale for single driver speakers  
Posted by [akhilesh](#) on Fri, 16 Jan 2004 12:32:51 GMT  
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Hi Adrian,I used a stephens trusonic 80FR, an 8" vintage full range driver. Very sweet midrange, decent highs, and OK lows. Come listen if you are in the Tulsa area. akhilesh

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Subject: Re: Rationale for single driver speakers  
Posted by [akhilesh](#) on Fri, 16 Jan 2004 12:36:36 GMT  
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And yet, as we all seem to agree (incl. Stereophile Jan 2004) , single drivers are very listenable, especially when driven with a low powered tube amp!Also, and I think this is part of the listenability, they somehow reproduce instruments, voices, etc. in a very NATURAL way.  
-akhilesh

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Subject: Re: Rationale for single driver speakers  
Posted by [Ed Schilling](#) on Fri, 16 Jan 2004 13:31:28 GMT  
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Adrian,I agree with most of your post, it is common "knowledge" and established theory. The problem is, I have built speakers for 30 years and was a subscriber to Speaker Builder for 20. The reality for me is that "my favorite speaker" simply sounds better than anything I ever designed and built.....regardless of how they measured or the "theory" behind them, or the cost. I hate it when that happens. And believe me I have built a few nice ones in that time using the best drivers available.....I have even built ribbon drivers and magnetic planar drivers from scratch ( I have plenty of ribbon material if anyone needs some). And no, I did not get it "right" the very first time.....I started building single driver speakers 10 years ago.....and never looked back. Not

going to either. 20-20k is overrated.My .02Ed

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Subject: Re: Rationale for single driver speakers

Posted by [hurdy\\_gurdyman](#) on Fri, 16 Jan 2004 13:41:11 GMT

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My take on fullrange drivers is that they do work and well. I know they can't extend bass and treble as much as a three way, and that beaming and doppler distortion is greater. Still, a good fullrange driver does something to "music" (vs test tones) that can be close to magical. Perhaps we just don't know what to measure with them yet.It's kinda like tube amps. The measure higher THD, IM, and not as flat or extended frequency response, but they can do something that can make music come alive. I've heard fullrange drivers driven by tubes that can bring spine chills and goosebumps (in a good way) to the musical listening experience. To me, it's obvious the something is not being measured that explains this. With fullrange drivers that I've owned, I like to compromise by adding a very hi tweeter crossed at 10 kHz or higher, and a sub below 60 Hz. This allows the fullrange driver to handle all but the extremes. It works! Best description of the results I can think of is "Coherent".Dave:^^)

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Subject: Re: Rationale for single driver speakers

Posted by [akhilesh](#) on Fri, 16 Jan 2004 17:56:50 GMT

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Hi Dave,Can you tell us which supertweeters & subwoofers worked for you? I want t oadda supertweeter as well, and am curious. thanx-akhilesh

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Subject: Re: Rationale for single driver speakers

Posted by [hurdy\\_gurdyman](#) on Fri, 16 Jan 2004 21:10:16 GMT

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So far, I've only tried two, the EV T-35 and a piezo (using a crossover and matching transformer). The piezo just barely makes it as far as sensitivity goes when hooked with my EV LS-12's (crossed with either a 1 uF or a 1.5 uF cap and transformer with 50 ohm resistor). The T-35 is much more efficient then the piezo, but I kind of like the piezo's sound. I have damped the horn on the outside with plumbers putty, also. Both tweeters work well, but I would like to experiment more before making a recommendation, like using a different horn tweeter, or maybe a ribbon (if I can find an affordable one with enough sensitivity, about 95 dB).Dave

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Subject: Re: Rationale for single driver speakers  
Posted by [Adrian Mack](#) on Sat, 17 Jan 2004 02:36:30 GMT  
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Hi EdThats true, all of that is established theory. My intent was to simply make a point to Paul, as he said since multi-way systems cannot cover 20Hz to 20KHz either, then we may as well use a fullrange driver instead for that reason. I was just presenting a number of other things to consider other than bandwidth. But everyone has their own opinions. Some audiophiles will argue that multi-way systems will smear the sound, whilst others will say fullrange drivers sound like clock radio's. Then others may simply choose a fullrange driver for fear that the designer of a multi-way speaker doesn't know what his doing with the crossovers (which elektrartig brought up). IMO, it's a waste of time to try and change people's opinions, so instead we can discuss what does differentiate the two systems. Adrian

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Subject: Re: Rationale for single driver speakers  
Posted by [Adrian Mack](#) on Sat, 17 Jan 2004 02:45:41 GMT  
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Hi AkhileshSure, I bet some of them are very pleasant to listen too. Everyone has their own opinions. Some audiophiles will argue that multi-way systems will smear the sound, whilst others will say fullrange drivers sound like clock radio's. Then others may simply choose a fullrange driver for fear that the designer of a multi-way speaker doesn't know what his doing with the crossovers (which elektrartig brought up). IMO, it's a waste of time to try and change people's opinions, so instead we can discuss what does differentiate the two systems. What also came to my thoughts - perhaps it's psychological as well. I mean, I've got two different pair's of fullrange drivers here, whizzer cone type. Almost had convinced myself there was something "natural" or "coherent" to the way they sound as well, especially after a lot of listening - I kinda got attracted to them. But after that, I listened to a good multi-way speaker (not the ones I often listen too in my main setup, as I could easily bias in favour of them), and I concluded that the fullrange driver wasn't really that special after going back to listen to a multi-way speaker. But at the time, I had my mind convinced that the single driver sounded better, despite not putting my finger on it. That's the way I view these things anyway. Adrian

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Subject: Re: Rationale for single driver speakers  
Posted by [Adrian Mack](#) on Sat, 17 Jan 2004 02:47:44 GMT  
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Hi AkhileshWould love to listen to your fullranger's, but I'm on the other side of the world in Australia! Adrian

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Subject: Re: Rationale for single driver speakers  
Posted by [Ed Schilling](#) on Sat, 17 Jan 2004 21:37:17 GMT  
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Adrian, I agree. I did not mean to imply anything but rather post why/how "I" came to the single driver table. And that ultimately, what matters is how things sound to you. Yep, there are many ways to "get there". I doubt there is a "best", well at least a "best" that works for everyone. Then again, there is that one little speaker.....EdBTW.....crossovers....whew, now that is a subject that I really dislike! I tweaked a x-over for over 2 years once! Damn near made me insane. Every change was for the better.....well, until I undid the change and then that was better too. Changing slopes improved them also until I went back to the old one. What a nightmare....just choosing the brand of caps was trouble...and then of course I had to try what I did not choose. Which led to different types of inductors.....I am having flash backs already. By the time it was over I had "improved" a very good speaker (an MTM TL, Dynaudio drivers) to the point that it sucked.

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