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 PaulCertainly, there are advantages to single driver's. But then there are disadvantages as

multi-way speaker. Remember that no loudspeaker act's 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 xmax 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