Subject: LAB12 driver - why is it so good and efficient?
Posted by adamzuf on Mon, 13 Apr 2009 15:00:41 GMT
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Hi,I read in speakerplans FAQ that a high EBP is good for horns. However this is not the case with this driver... The low Fs is needed for the horn to go low, but isn't a lower Qts would make it a faster driver?It also doesn't have tons of BL, however Xmax is good..Thanks for the helpAdam

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Subject: Re: LAB12 driver - why is it so good and efficient?
Posted by Wayne Parham on Mon, 13 Apr 2009 17:25:33 GMT
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A driver tuned to be a subwoofer needs low fs and high xmax. Those characteristics tend to reduce sensitivity when used as a direct radiator. However, anything can be used for horn loading, and when properly matched, efficiency will be increased. High EBP will give higher bandwidth, but that's not required (or even desired) for a subwoofer. So the combination of low fs and high mechanical excursion limits are more important for a subwoofer driver. When used in a horn, it is also important to match the driver with the front and rear chambers and the horn flare.By the way, we don't use the LAB12 driver anymore. Ours in an OEM driver that is essentially the same as a LAB12, but that is machined to fit our cooling plug. This makes a big improvement in thermal performance, which is really important in high-power basshorns. Since excursion is reduced by horn loading, the effectiveness of the woofer's cooling vent is reduced too. Our

effectiveness

Subject: Re: LAB12 driver - why is it so good and efficient?
Posted by adamzuf on Mon, 13 Apr 2009 19:17:51 GMT
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Thanks Wayne.As far as I've seen from simultions and discussing with people, The EBP is a simple weight of fs and qts, when actually it seems to me that the higher fs is more crucial to extention then low qts..What do you think about that?Also, what are your thoughts about qms ratings in different types of horns, in regard to sound quality?

Subject: Re: LAB12 driver - why is it so good and efficient?
Posted by Wayne Parham on Mon, 13 Apr 2009 19:45:16 GMT
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The resonant frequency shifts when you put the woofer on the horn, with the front chamber and flare shifting it downwards and the rear chamber shifting it upwards. When you model the horn and modify electro-mechanical driver values, you'll find that lighter cones increase output mostly at the top end, not at the bottom end.It's all about what you want to do. If you want a midbass horn, use a lighter cone, by all means. It will give better output up into the midrange. But if you're looking for drivers to use in a hornsub, you probably wouldn't need (or even want) the HF extension. For a subwoofer, I would prefer a driver that does its best work down low and is robust enough to handle high excursion and current.

Subject: Re: LAB12 driver - why is it so good and efficient?
Posted by adamzuf on Thu, 16 Apr 2009 22:16:08 GMT
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Wayne,What are your thoughts about "how much is left" from the original driver's specs like response graph, efficiency etc?I've seen how midrange drivers that are predicted to have different efficiency in HR are much closer or even the "lesser" driver had better efficiency in real life, when talking with people about results they've had with horn loading.For a subwoofer, the inital efficiency seems to have nothing to do with the outcome after the loading.. For a midbass, how should I look at that? How should I look at xmax requirements for midbass?Is there any importance to look at a driver's efficiency at 100Hz if I aim for a 100Hz horn?Many thanks for your timeAdam

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Subject: Re: LAB12 driver - why is it so good and efficient?
Posted by Wayne Parham on Thu, 16 Apr 2009 22:58:17 GMT
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Hornresp simulations of basshorns have been very accurate for me. Below 200Hz, the driver operates as a rigid piston so the mathematical models David uses in Hornresp predict the response very accurately. The low-pass acoustic filter of the front chamber and the folds tends to suppress output up high, so in a basshorn, most of the output is from pistonic cone motion. As a result, the measurements of physical models usually correlate very well with the simulations from Hornresp models.At higher frequencies, from midrange up, the diaphragm begins to flex. The cone no longer acts as a rigid piston, instead, parts of the cone become decoupled and operate independently, like smaller diaphragms with less mass. This makes the response at higher frequencies different than what a rigid piston would produce. It usually has more output than expected. Some cones that are pretty well damped have relatively smooth response in this region, but many become jagged up high. As a result, I find that midhorns should be built and measured to know the high frequency response. The Hornresp model does a pretty good job of predicting response at the low end, but it doesn't have the input data to predict what happens up high. That would require more sophisticated FEM models.

Subject: midrange horns
Posted by adamzuf on Fri, 17 Apr 2009 09:09:36 GMT
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"The cone no longer acts as a rigid piston, instead, parts of the cone become decoupled and operate independently, like smaller diaphragms with less mass....Some cones that are pretty well damped have relatively smooth response in this region, but many become jagged up high"Damped = low qms = good for midrange horn?(BTW, how does cone breakup come into play in a midrange horn?)So, as you see it, for a midbass horn (up to 250), you would trust almost blindly upon simulations? No worries if a superior modeled driver is 6 db less efficient then another?I gather, from a list of driver characteristics and people view about them, that it's generally a good idea to have a good BL/mass ratio (low mid and up).. What do you think about that?

Subject: Re: midrange horns
Posted by Wayne Parham on Fri, 17 Apr 2009 14:55:23 GMT
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Qms is a measure of suspension damping, but this isn't the same thing as cone surface flex. That's what I was talking about, cone breakup. A cone that is damped is one that is resistant to flex. A cone's stiffness will determine how high in frequency it can remain pistonic, but its damping will determine how violently the cone flexes and resonates as ripples begin to appear on its surface.About basshorn simulations, it's not that I would trust them "blindly", rather it is my informed opinion that the simulations track reality very closely. I think that's probably what you meant, but it is important to be aware this isn't blind faith. I've done a lot of simulations and I've measured a lot of horns, built as specificed by the models. Under about 500Hz (depending on the cone), the models are very accurate. At higher frequencies, cone flex prevents the models from being accurate because the models assume pistonic diaphragm motion.

Subject: Re: midrange horns
Posted by adamzuf on Fri, 17 Apr 2009 17:06:04 GMT
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sohigher stiffness = higher frequency in which flex startslower Qts = more control over flex when it startsHow can I know how stiff is the driver?BTW, didn't meen to say you trust things blindly - I trust you not to do that.. I value your work and word and am thankful for your time.Adam

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Subject: CORRECTION

Posted by adamzuf on Fri, 17 Apr 2009 18:19:28 GMT
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"lower Qts = more control over flex when it starts "Replace that with Qms...

Subject: Electro-mechanical properties and diaphragm motion
Posted by Wayne Parham on Fri, 17 Apr 2009 20:56:32 GMT
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Qms does not describe the damping of the cone. It describes damping of the suspension. This is a very important distinction. I'll try to explain, generally, some of the details and how it all works together.Motor strength and electro-mechanical parameters (Bl, Cms, Rms or the Thiele/Small transformations Fs, Qts, Vas etc.) are very important for describing the pistonic behavior of the driver. You'll enter those values into Hornresp and it will tell you what the horn will do with the driver described by those parameters. But this only describes how the system acts when the cone moves purely as a rigid piston, with no ripples across its surface. That only happens at low frequency, from midrange frequencies down, in the pistonic range. The pistonic range is different for every woofer, depening on cone material and shape and also on its acoustic loading.Think of the woofer as a mass/spring system. The cone is a weight and the suspension is a spring. You can determine exactly what the resonant frequency is by knowing the stiffness of the suspension and the mass of the cone. There is another property - resistance to motion - which determines the amount of ringing there will be after excitation. A shock absorber in a car is such a resistance. Without it, the car would bounce a long time after hitting a bump. This resistance damps the resonance, and the amount of resistance sets the mechanical damping of the system.A speaker's motor is connected to its cone, so the motor interacts with the cone/suspension and its damping. The suspension should not provide much resistance to motion, so without electrical damping, the cone would be free to vibrate. But when you short the voice coil, back-EMF tends to resist motion providing a sort of motor braking effect. That's why the damping factor of an amplifier modifies the tuning of the speaker - resistance in the woofer circuit sets the damping of the system. Electrical damping is almost always an order of magnitude greater than mechanical damping.The thing is, all this sets the values of the mass/spring system. It determines how the mass will move as a whole. That's why most mathematical models assume a rigid piston - they only describe the motion of the mass as a solid lump. Since the radiating surface is a flat (or cone or dome shaped) disk, the motion of the disk makes waves. But again, the model assumes the disk is perfectly rigid and non-bending. This is where the simulation deviates from reality most strongly. In truth, the cone only operates as a rigid piston at bass and midrange frequencies, depening on it's size, shape and composition material. This is refered to as the pistonic range. At higher frequencies, the cone begins to bend and twist, making its surface motion look like ripples on a pond. In this frequency range, the cone itself acts like many smaller mass spring systems along its surface. Non-pistonic motion is sort of like several masses connected together along a flexible surface. The surface becomes elastic, partially decoupling each section from one another.In truth, the cone is elastic in both the pistonic and non-pistonic ranges. The difference is that in the pistonic range, the forces required to bend the diaphragm are small enough that it operates as a rigid piston. Above the pistonic range, the cone flexes and ripples appear across its surface, effectively decoupling regions from one another. This is purely a technical distinction, but mechanical engineeers find this important as it tells them how the cone will act structurally.In the non-pistonic range, the lumped mass model isn't effective anymore. You have to know how the cone flexes, and this is much more complex than the simple mass/spring model. You could model it, but not with the tools available to most of us. So this makes it important to understand that above the pistonic range, you really need measurements to gain any visibility.There are some rules of thumb that are moderately useful. Cone damping is usually highest in paper and some composites, lower is plastics and lowest in metals. However, the rigidity of these materials is just the opposite, with metals being strongest, followed by plastics and composites and lowest in paper. The reason is pretty easy to see - stuff that is more rigid tends to breakover sharper, like how plastic can bend but glass shatters.Diaphragm flex is also modified by shape and features like corrugation. Surface features can break up standing waves by modifying the structure of the cone, providing additonal strength in some places. These kinds of features can increase the pistonic range or increase damping. Usually the things that extend the pistonic range tend to reduce internal damping and vice versa. This is not always the case, but usually if the cone is made stiffer, it tends to breakup later but harder. Again, think of the analogy of plastic and glass. Speakers designed to be used over a wide range are generally made to favor damping over trying to extend the pistonic range. The idea seems to be that you can't avoid breakup modes in a wide band transducer, so its better to make them well behaved.One thing that is rarely considered in direct radiators but that you'll find in horns is the final range of surface deformation - the plastic range. Do not be confused by the name, it has nothing to do with the material. Plastic deformation can happen to any homogenous solid material, such as metal, ceramic, plastic, polymer or resin. Woods, laminates and composites are a little different because they are not homogenous, having fibers and different things in them, but the principles of elastic verses plastic deformation still apply. When the ripples across the surface move with enough force to irreversibly deform the diaphragm, it is said to have deformed plastically. After a few cycles of this, the cone will break or tear.Ironically, compression drivers with aluminum diaphragms are often enjoyed by hifi enthusiasts because they are smooth sounding. This is because aluminum, as a material, has no elastic range. Any force applied to aluminum causes plastic deformation which causes stress fractures. But this tends to damp the surface modes, and makes the driver sound smoother.Basshorns driven hard, especially ones with higher compression ratio, sometimes push the cones into their plastic range. It's usually when a woofer that isn't really suited for a basshorn is used and the internal stresses cause massive cone flex that bends it enough to crease or tear it.

Subject: Re: Electro-mechanical properties and diaphragm motion
Posted by adamzuf on Sat, 18 Apr 2009 11:09:07 GMT

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Wayne,Thank you for such a detailed answer."Electrical damping is almost always an order of magnitude greater than mechanical damping"Sorry I don't understand the expression (English ain't my first language)"The difference is that in the pistonic range, the forces required to bend the diaphragm are small enough that it operates as a rigid piston. "Is that because higher frequencies are smaller to "fit" into the diaphragm and push it into the non pistonic range? (smaller driver = higher frequency of cone breakup)"usually if the cone is made stiffer, it tends to breakup later but harder."I assume you meen "higher in frequency?"So, as I gather from what you are saying, the damping of the system loses control over the cone's independant motions, and one can not tell from thiele/small parameters the properties of the non pistonic range at all..?This is great info. Thank you.Adam

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Subject: General evaluation of midrange drivers
Posted by adamzuf on Sat, 18 Apr 2009 11:27:35 GMT
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Wayne,I'm now comparing two 5" drivers in HR - in a sealed box, one is 93dB and the other 99dB. However, in HR, they compare, and the 93dB driver even is a bit more sensitive... I am modeling an exponential horn above 300Hz.How would you treat such information?

Subject: Re: General evaluation of midrange drivers
Posted by Wayne Parham on Sat, 18 Apr 2009 15:25:29 GMT
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If you entered the electro-mechanical parameters of the driver(s) and the specifications/dimensions of the horn flare, I would trust that Hornresp is giving you an accurate prediction of SPL and of amplitude response, at least at the lower end of the curve. You may get more HF from the horn than predicted and it may have some peaks and valleys up high that aren't shown in the prediction due to cone breakup.As to your other questions, when I said electrical damping is almost always an order of magnitude greater than mechanical damping, what I am trying to say is the damping described as Qes is much greater than Qms, having a lower number. The mechanical damping is usually almost nil because the suspension is designed to move freely rather than to provide resistance to cone motion. That's what you want, actually. So all the damping you'll get is acoustic (from the loudspeaker cabinet) and electrical (from the woofer circuit, through the voice coil and amplifier output).About the forces that cause bending of the cone at frequencies above the pistonic range, these are pure physics, related to mechanical stress/strain and resonance. The cone may be very strong, but as force is applied in the middle and the frequency rises, there comes a point where the cone itself goes into resonance. This is like the now famous Tacoma Narrows Bridge. In 1940 it bended and twisted enough to tear itself apart from aeroelastic flutter, a resonant vibration caused by forces from wind acting on the structure.Thiele/Small parameters and the associated electromechanical parameters only describe the motion of the cone as a rigid piston, and they do not say anything about cone breakup. Cone flex behavior is determined by the cone material, shape and size and by the position where drive force is applied and where it is suspended by the spider and surround.

Subject: Re: General evaluation of midrange drivers
Posted by adamzuf on Sat, 18 Apr 2009 17:48:23 GMT
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"I would trust that Hornresp is giving you an accurate prediction of SPL and of amplitude response, at least at the lower end of the curve"The curve of the 93dB driver is a bit higher all over the spectrum, and the strongest frequency is 300Hz. Would you trust this and order that driver?It also got higher EBP (although lower fs) and lower mass.About Qms then, when I try to evaluate a driver (for any type of box), a larger value is better, as long as Qts is kept within range?Thanks much WayneAdam

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Subject: Re: General evaluation of midrange drivers
Posted by Wayne Parham on Sat, 18 Apr 2009 18:38:30 GMT
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If your model accurately describes the horn and driver, then I would trust it. The Hornresp program has been very reliable for me.Qms is a function of suspension compliance. I wouldn't say there are "better" or "worse" values - more like they're a necessary consequence of the system. Total damping is much more set by the electrical Qes than the mechanical Qms of the suspension. The thing is, the driver's mass affects the Qms value, and mass is definitely an important criteria. Qms values will indirectly show this but don't let that confuse you. I would probably not focus on one Thiele/Small parameter because that is short sided. Instead, look at the whole picture. Hornresp simulations will help you to do this.

Subject: Re: General evaluation of midrange drivers
Posted by Norris Wilson on Sat, 18 Apr 2009 19:59:52 GMT
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What were the determining factors that influenced your decision to use the Emminence Delta 10 for the midhorn driver in your Seven Pi design?Were there any characteristics that stood out that makes the Delta 10 especially useful in a horn loaded application?ThanksNorris

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Subject: Re: General evaluation of midrange drivers
Posted by Wayne Parham on Sun, 19 Apr 2009 00:34:04 GMT
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retesting, using what seems like a hundred drivers. In truth, I think I tried probably twenty canidates or so. I've tried a few drivers since the introduction of the midhorn, and have some in mind to try right now. So finding the right drivers is an ongoing thing.

In the 1980's, some of my best loudspeaker models used a JBL 2105 midrange which has a 5" diameter cone. They sounded great, but required a little higher crossover than what I wanted of

well below 100Hz and that was one of my goals, to be able to cover the entire midrange band, all the way down. I wanted to blend the woofer and midrange smoothly, overlapping fairly wide in the upper modal region to counter floor bounce and smooth room modes. The midhorn also needed to go high enough to blend well with the 1" compression drivers I've used in all my designs.

Much to my surprise, none of the 8" midwoofers I tried worked well at low frequencies. Some could be made to work well, but only in horns much larger than I was prepared to use. Some had too little output but most had too much ripple down low. So I looked at larger drivers with 10" and even 12" cones. Naturally, the larger woofers did well down low, but most lacked the ability to reach up high enough.

The problem now was what I described earlier, that response at the top end of the passband was completely different than what is shown in the models. All cones are beginning to flex by 1000Hz, so pistonic models don't accurately predict response. So to find drivers that would work meant checking them in Hornresp to find canidates that had the required low end response and then building a physical model to measure high end response.

By now, I had pretty much gravitated to a basic horn shape and size. The horn that is now used in my cornerhorn models had pretty much taken shape, with the last unresolved items being throat size and driver choices. Again, I would manipulate the throat size in Hornresp to make sure it didn't cause too much ripple down low, and then build it and measure it with the driver mounted to see actual response, finding drivers that had the necessary top end.

Eventually, I settled on the midhorn as it exists today. I was able to use the JBL 2012 and Delta 10 drivers and get good response through the intended range. I had also hoped to use the Eminence Deltalite 10" driver but couldn't coax it high enough. Eminence has changed the driver since then, and I've been meaning to retry it on the horn. I also want to try drivers from AE.

Subject: Re: General evaluation of midrange drivers
Posted by Norris Wilson on Sun, 19 Apr 2009 04:40:07 GMT
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It looks as if you went through a thorough process in choosing the right midbass driver that would fulfill your design goal in your Seven Pi midhorn.Looking at the intended desire to obtain a driver that would cover the entire midrange frequncy band. I see that you came up just a little short of this goal with a bottom frequency response of 250Hz.Were there any other driver solutions that would fill the bottom octave below this 250Hz? Possibly the use of a 12" midbass driver in a slightly larger horn that would be rolled off to a different 1" compression driver around 1kHz to 1.25kHz?Or, did the early break up mode of the larger 12" driver keep you from accomplishing the correct frequency range for your midhorn?How far above the intended upper crossover frequency of the midhorn driver would one need to have a clean limited cone break up to maintain the sound quality that you are satisfied with, 1 to 2 octaves?Also, looking at the output efficiency drop of the Emminence compression driver in the tweeter horn of the Seven Pi design down to 98db from the use of frequency extension EQ, thus causing you to pad the midhorn down to match.Would the slightly higher efficiency of the B&C DE250 compression driver allow you to remove this midhorn padding resistor?If so, is there anything to be gained in doing so, like a more open sound character of the midrange?And finally, I saw where you had an extension at the mouth of your original midhorn design that you precluded from the final design.My understanding from your removing it was, due to it giving very little bottom frequency extension below the 250Hz in eigth space, it made very little contribution for the added complexity of the horn?Obviously, with the FS of the chosen 10" drivers (Delta 10, JBL 2012) reaching well down into the sub 60Hz region. One would think a larger horn would get you to the bottom of the desired midrange frequency spectrum when using these driver, possibly in the 100Hz to 150Hz range? Doing so in a quarter space loading placement for a more universal design not requiring corner placement to obtain a lower cut off? Could you ellaborate on why you were unable to obtain this lower frequency response with the slightly larger original horn using these drivers? Is it more of a question of quality over a quantity type of design choice?Knowing what will work in a good midrange horn design from your experiemntation. Would it be advantagous to have a driver like the 10" AE TD10M modified to fill your desired goals over an off the shelf driver such as the Eminence Deltalite 10?I am looking forward to your results from experimentation with the AE drivers in this and other applications for your speakers.ThanksNorris

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Subject: Re: General evaluation of midrange drivers
Posted by Wayne Parham on Sun, 19 Apr 2009 05:52:16 GMT
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cornerhorns. It's much too small for that, and flat response to 100Hz isn't required for this application. What I wanted from that design was enough smooth output to allow for blending in the lower midrange, to have the woofer and midhorn share output between 100Hz and 300Hz.

250Hz but used in corners, as intended, it produces output down to below 150Hz.

We do not put horn extensions on the flare to extend response lower, we do it purely for aesthetics. When the cabinet is finished, we use a piece of hardwood stock trim on the front edge. We match the angle of the trim with the flare angle, so it does provide a small extension. But it is done for aesthetics.

With any front-loaded horn, you can expect a decade of usable response, so to hit 2kHz you can't

midhorn, instead, I chose to use a large back chamber that provides gradual rolloff. That was done by design, to obtain the desired response curve in a relatively small package. Eighth space loading helps response at the bottom end, and smoothness is desired more than extension. The result is gradually rolled off lower mids that blend with the woofer. These are some of the reasons why I needed a larger driver to achieve good low frequency response without ripple.

I designed a larger midbass horn that reaches 100Hz flat, even in freespace outdoors, with f3 of 90Hz and f10 of 75Hz. It uses reactance annulling for extension, but as a result, the rolloff slope is greater. It is also a much larger horn, designed to provide a 40° axisymmetrical pattern for prosound applications. The length is 32", mouth dimensions are 28" x 28", throat is 7.5" x 7.5", front chamber is 800in3 and rear chamber is 1200in3. It's designed to use a 15" woofer, such as the JBL 2226.

Subject: Re: General evaluation of midrange drivers
Posted by Norris Wilson on Sun, 19 Apr 2009 16:10:40 GMT
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Thanks Wayne for your information, and intertaining my uneducated questions.A few more questions / thoughts if you would please?In looking at your Nine Pi horn design, I see that it has a 40 degree dispersion angle. Obviously, I know very little to nothing about horn design. But, from looking at a few designs intended to be used in this frequency range for studio or home use. The majority of them are 60 degree to 90 degree horns.I can only assume that a 40 degree horn would require alot of distance between it and the listeners to obtain a proper stereo image?Have you experimented with other midbass horns designed to be used in a home environment where distance is at a premium?If so, what would be a good angle of dispersion for such a horn at these frequencies, from 100Hz and up?Also, have you experimented with a posible double mouthed bass horn using the basics from your 12 Pi subwoofers, a single push-pull set of woofers.The idea of a pair of midhorns mated to a single basshorn positioned in the center between them sounds interesting. Using this main speaker set up with a few more subwoofers placed into the rear of the room for distributed bass response might prove very dynamic?Have you given much thought to this type of system before?ThanksNorris

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Subject: Re: General evaluation of midrange drivers
Posted by Wayne Parham on Sun, 19 Apr 2009 17:04:19 GMT
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I agree with you, 100%. A 40° pattern is useful for prosound, but not for home hifi. I think the best pattern for home sound systems is 90°x40°. That's wide enough to cover the room and yet limited in height to prevent unwanted floor and ceiling reflections.To use a midbass horn like

80°x40° pattern, very close to ideal. Then again, since the horn was designed to work well in freespace, it is probably larger than needed for use in quarterspace or halfspace. That's OK - It's always better with horns to be oversized than undersized, at least where mouth area is concerned. But most people don't want monsterous cabinets for home hifi. It might be worth the

reduction is possible and still obtain the desired response.Regarding push-pull drive, I really like that approach for basshorns but not so much for midrange. I studied distortion reduction

that push-pull drive works best at bass frequencies, and shorting rings work best from midrange frequencies up.Shorting rings work well at frequencies from about 100Hz and higher. They're like transformer windings, and have a lower frequency limit. Push-pull drive is just the opposite, it has an upper frequency limit. The two drivers must be tightly coupled acoustically, so the drivers should be physically close, even better when combined in a common chamber. The coupling is wavelength related, with distance being proportional to wavelength so what's close for a basshorn (where wavelengths are measured in tens of feet) is not so close for a midrange horn (where wavelenths are much shorter). My conclusion is that basshorns are ideally suited for push-pull drive whereas midhorns are better using drivers with shorting rings for flux modulation control.
