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Subject: High output basshorn

Posted by [Wayne Parham](#) on Tue, 02 Nov 2004 17:38:29 GMT

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As many of you know, I am investigating options for a high-output, low-distortion basshorn. Since choices for low-distortion woofers with shorting rings are somewhat limited, I'm thinking of using a pair of 12" drivers in a push-pull arrangement to reduce distortion. The LAB12 is probably a good choice, mounted in a push-pull arrangement. I am also considering a larger version with high-power 15" drivers. Probably use a pair of drivers like the 1000 watt Beyma 15P1000 or Eminence Kilomax 15. It would be larger and have a slightly higher cutoff point, but would provide greater average SPL. What do you think? I'm thinking of doing some modeling and see where it takes me.

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Subject: Re: High output basshorn

Posted by [GraemeG](#) on Wed, 03 Nov 2004 10:26:21 GMT

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Hi Wayne, Without modelling, I would say either 15" would run out of Xmax before they get anywhere near their thermal ratings - the 12" 12LX60 I'm playing with does (although it is smaller, Xmax is larger and power is lower), so I expect a waste of power capability (which would help with power compression anyway I suppose). Of course a lot is dependant on how low you want to go. The cone strength of the Beyma was also a concern to me with the 12", but the larger voice coil diameters should help stiffen the cone somewhat. This will be an area to watch when my prototypes go into service (hopefully within month). The talk of maximum output makes me wonder what the goal is. If the size of the box is small enough to be handled, then 6 or 8 may be required in a stack to get flat response and maximum efficiency - if each box is going to get 1500W, then is the goal to have the audience throw up at the first kick drum beat?? Somewhere around the 130 to 135 dB at 1 metre maximum should be plenty.. Cheers Graeme

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Subject: Re: High output basshorn

Posted by [Bill Wassilak](#) on Wed, 03 Nov 2004 15:38:55 GMT

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Most 15's I've looked at usually want a throat area around 80 sq in, so your already starting at a 2:1 compression ratio. According to Tom Danley when you start getting compression ratio's above 3:1 you take a big chance on ripping cones. Also with such a large throat area your horns going to turn out massive anyway trying to get 1/4 wave length at your lowest freq. Example: When I modeled my EV 15's with 80 sq in throat and a 5.5' path length for a 50 Hz cutoff, the smallest box I could cram it in was still about 36-42"H x 36"D x 22.5"W so if your going lower in freq your box dimensions are still going to be larger yet. Like Bill Fitzmaurice says, now days it's easier to use a

smaller driver with more horn length to achieve a lower cutoff and it keeps the box size reasonable. And you can stack more of them to overcome the smaller mouth size limitations or corner load them like you said. What would be cool is if you come up with something like the Bdeap's from Servodrive. That cabinet has 2-12's in it but it relies on boundary reinforcement to get it down to 30 Hz, free standing they say it's good to about 45 Hz with out any sort of boundary. And I think it's mainly a conical shape horn on the inside that starts the initial horn flare. HTHBill W.

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Subject: Re: High output basshorn

Posted by [Wayne Parham](#) on Wed, 03 Nov 2004 20:32:17 GMT

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Hi Graeme, It is just an idea, really. I had Eminence working on a low distortion subwoofer, but there were complications that kept that project from coming together. Using rings the size of their Magnums wouldn't reduce distortion at the lowest frequencies and re-tooling to make a speaker with a larger ring would be costly. They aren't interested in that right now, saying "We can still get those sales today with the LAB 12 even if the improved product doesn't exist." There is another way to decrease motor asymmetry, and therefore reduce second harmonics. That is to use two similar motors arranged in a push-pull configuration. My thinking is to mount drivers so they pressurize the front chamber in a slot loaded push-pull arrangement. This configuration greatly reduces 2nd order harmonics entering the throat. Of course, horn loading reduces excursion, which also reduces distortion. But at high excursion, the harmonic components are there and are acted upon by the horn, just as if they were intended signal components. The folds of a basshorn attenuate higher frequencies, but harmonics within the passband are still passed through and acted upon by the horn. That's the reason why I'd like to decrease distortion entering the throat. Basically what I'm thinking is that the horn and folds reduce distortion, but reducing it at the motor too increases performance that much more. I suppose there is no reason the LAB12 or HL10 or other similar drivers could be used in this configuration to make smaller horns. But I'm thinking that a pair of 1000 watt 15" drivers might work. With the motor chambers and front chamber being roughly 18" deep, there is still room enough for 8 feet of path length within a 4x4x2 foot box. That should support output down to about 35Hz. Below that, it's a direct radiator. But in this case, the direct radiators are slot loaded push-pull devices, so they should cancel harmonics and provide low distortion output even at the deepest frequencies. I know that down low, excursion will be the limit. But with larger radiators, displacement is greater even at lower excursion levels because there is more surface area. So between the increased thermal power handling and the larger radiators, this may balance out. I'll have to run the numbers and see. This is still sort of a conceptual thing. Once the project gets nearer to completion, I suppose the acid test will be to beat 'em up and see what falls out. One suggestion was to plug the box into the 120v AC line. I know that when I was talking to people about the B12 flux stabilized woofer, they were telling me that there were numerous reports of LAB12 thermal failures. No driver is immune, and certainly something like that is going to be pushed very hard. So it's not surprising, and really shouldn't be seen as anything other than what it is. But the point is that the LAB12 is a 500 watt device, and certainly a pair of 1000 watt devices can handle more heat.

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Subject: Re: High output basshorn  
Posted by [Wayne Parham](#) on Wed, 03 Nov 2004 20:47:56 GMT  
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Hi Bill,I did some initial modeling with a 150in<sup>2</sup> throat to support a pair of 15" drivers. The models looked pretty good, and I think the horn could be built in less than 40ft<sup>3</sup>. Naturally, the 12" version is even smaller, easily being less than 35ft<sup>3</sup> to fit in a 4x4x2 foot box. I suppose you could use the same parameters as the LABhorn, if you wanted, i.e. rear chamber volume, front chamber volume, horn length and area. Using the push-pull configuration should have lower distortion because of the way the drivers are connected and pressurize the front chamber. But I'm not so sure there isn't an advantage using larger, more powerful drivers. I'll check the math and see, maybe build a model or two and test them. Check out my other comments in the reply I made to Graeme. There's a quick drawing of what I'm thinking about there too. My main focus was on decreasing even order harmonics entering the throat. There are a few good techniques that can be employed to do that, so it always seemed to me to be a good idea to do for high-quality and/or high-power systems. They are built at a price point that makes it more than possible, at least from my way of thinking. As for boundary reinforcement, I think you and I would agree that all basshorns

designed to be used in corners or in groups. Wayne

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Subject: Boundary loading  
Posted by [Bill Fitzmaurice](#) on Thu, 04 Nov 2004 12:15:53 GMT  
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My feeling on boundary loading is that you use it where you can. The long pathway/small mouth subhorns I've designed for HT/hl-fi/Autosound all depend on it to provide response in the bottom octave or so. But for pro-sound, where boundary loading is seldom available to you, and large venues make even cabin gain non-existent from 50 Hz up where you really need it, I've made my subs optimized for free-standing via short pathways and large mouths. Danley's concept is fine if you have boundaries that can be utilized, or if you have the luxury (deep pockets) of having multiple boxes, and the necessary transportation/roadies. But for the great majority of bands and small sound companies that have to make due with a pair of subs rather than a stable it's a concept that has little practicality. As to drivers, I prefer an eight for HT, while for for mid-level pro-sound a ten is adequate. For pro-touring a single twelve loaded sub seems adequate, but some of my disciples are now in the process of prototyping with a single 15, not so much because they think that they need it but more from just wanting to see what it will do.

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Subject: Re: Boundary loading  
Posted by [Wayne Parham](#) on Thu, 04 Nov 2004 16:22:58 GMT  
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to point out realistic size constraints and the fact that at the lowest frequencies, the basshorn is usually too small to effectively act as a horn. It either must be used in groups or it must function as a direct radiator/bandpass box because the dimensions of the horn prevent it from acting as a horn at the deepest frequencies. There are two things I am really looking to address with this possible project horn: 1. Reduced distortion. At the deepest frequencies, the horn is ineffective and distortion rises dramatically. Harmonics generated by the woofers enter the horn and are amplified by it. This design proposal is intended to reduce distortion from the motor assembly by use of a push-pull arrangement. 2. Increased output. I haven't really decided what driver to use, but there are some that would increase average SPL over that of a pair of 500 watt LAB12's. Basically, I just never understood why a mechanism wasn't used to decrease distortion at the bottom end of the response curve. I expected that Eminence engineers put a great deal of effort into the basket and motor and that they could have used a shorting ring like in the Magnums to increase performance. Evidently not. Flux stabilization and the push-pull mounting arrangement both reduce 2HD, so it seems to me like there is benefit in employing one or both of these mechanisms to increase performance of the system. While I was working with Eminence on the B12, I received lots of letters asking for increased power handling too. Lots of people are smoking the LAB12's in LABhorns. It would appear that the common failure mode is thermal, because the voice coils are brown and open. So it seems that the thermal limit might be reached before the mechanical limit. My guess is that it isn't from 20-30Hz signals, it's from an abundance of 60-100Hz energy. That's actually where the LABhorn is performing at its best, but maybe a little more power handling would offer some benefit. Wayne

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Subject: Re: Boundary loading  
Posted by [Bill Wassilak](#) on Fri, 05 Nov 2004 20:41:46 GMT  
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>>While I was working with Eminence on the B12, I received lots of letters asking for increased power handling too. Lots of people are smoking the LAB12's in LABhorns. It would appear that the common failure mode is thermal, because the voice coils are brown and open. So it seems that the thermal limit might be reached before the mechanical limit. This could be very well true, that's why they prefer the aluminum covers because of the small chamber volumes, that cover will help act as a heat sink because I think you only have .25"-.375" clearance to the back of the driver. Not only that the high compression ratio in the throat of the horn, I think they said it was like 2.8 to 1. Some pro sound company measured the pressure in the throat running it at full tilt and the pressure in the throat was like 15Lb's per sq. in.. Also even though it's rated at 400wrms a driver, 800wrms total, pro sound guys usually run amplifiers at twice the RMS ratings of the speakers, and this is with hi-pass filters on them at 30 Hz. So yes I can see where this could cause a great thermal problems on the drivers themselves.

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Subject: Re: Boundary loading

Posted by [Wayne Parham](#) on Fri, 05 Nov 2004 21:55:21 GMT

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Yeah, as an example, Tamas Tako is looking for another driver to use because he has had real trouble with his. He has 48 of them, and had considered the new B12 driver before Eminence nixed it. Instead, he and several other people are looking for other options. My original focus was on reducing distortion, but as soon as I mentioned the B12, lots of people asked that it be made to handle more power. So that became a secondary matter, maybe a primary one in many people's minds. I always thought that the LAB12 speaker probably handled 500 watts just fine, and what was killing them was the fact that many people thought a pair of them could be used at much higher levels than that. But whatever the case, people want a higher level of performance.

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Subject: Re: High output basshorn

Posted by [Tom Danley](#) on Sat, 06 Nov 2004 17:09:31 GMT

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Hi WayneA couple thoughts, the lab sub low cutoff and dimensions were chosen by the group as was the 32Hz low cutoff target and the desire to have the greatest maximum output per size for Pro sound use. In the side by sides that have been done, many with the big name pro gear, so far the lab sub is both the most powerful and possesses the lowest distortion. One lab, used in the home already would have vastly lower harmonic distortion than any direct radiator at the same SPL (in band). Also, being proportioned to run out of excursion at full input power results in a great acoustic output this means one in the home, even if not in a group, at full blast one is driving it with few Watts max. It is the mechanical and electromechanical non-linearity that is the primary distortion mechanism in LF horns and this problem is minimized by having the greatest maximum output compared to the normal level. If I were designing a LF horn for a living room, one wouldn't design for half space. One could drop the 145 dB+ peak spl capacity and shape based on concert use and trucking. One could look at the driver in a modeling program to figure out where, based on Xmax the onset of gross distortion begins and then what percentage of that is "normal" operation. One could figure that increased power handling for a given size motor is generally equal to more power compression if its used because it is the increased VC temps which allow the increased power capacity (with a few exceptions where air is actually moved through the gap). One can count on thermally related dynamic non-linearity beginning on essentially all drivers at and above about 1/8 to 1/5 rated electrical power. One could size the driver parameters and front volume to give the maximum acoustic attenuation above the intended crossover, thus minimizing radiated distortion. One could keep in mind that a driver suspension is always more non-linear than the air in the sealed box behind the driver and chose a driver with a low FS, resulting in the least distortion due to suspension non-linearity's. One could limit the bandwidth such that the driver is in the range where its impedance is raised by the acoustic loading (and is efficient) and use Leach's math to find the horn / driver parameters that result in this condition. Push pull mounting would cancel the second H (like using a push pull transformer vs single ended) however of all the harmonics the second is the least objectionable. That's no reason not to do it how ever. So far as what the Bdeap means, (boundary dependent external air path), the idea is more than just accounting for fractional space. A horn is (among other things)

a high pass filter of sorts, partly controlled by the rate the acoustic passage expands. The Bdeap idea is to envision the air surrounding the speaker and configure the enclosure shape size and outlet position so that when next to a boundary (like one in a corner) , the last few doublings in area happen at the right rate and are comprised of the air trapped between the speaker walls and corner boundaries.If one goes through the math on say a klipsch corner horn, it has a big step in its expansion into a corner (fractional space) where the Bdeaps are a continuous function and hence one box in a corner is flat to 32Hz.Stacking 4 (2on2) Bdeaps outdoors, one sees the effect of the external enclosure boundaries acting as a horn in the directivity (a 180 degree pattern more or less). One also see's that the hemispheric expansion at the outlet is "like" a more rapid expansion horn than being in (its proper position) a corner and so has a higher cutoff also.On axis at 10 meters (-20 dB from 1 meter) the measured sensitivity for the group of 4 (1/4 watt each) is 97.5 dB and with a maximum input power of 6400Watts, this makes "significant" (as in the mid 150's at 1meter) Bass (with drivers similar to the Lab 12). Here, one has an efficiency of about 40% or about 107dB plus about 10 dB of directivity in the forward half of the pattern.I have had a pair in my living room, they are nuts and the Bdeap R (a more refined design and 2 inches thicker) goes even lower (into the 20's in a corner).I have not been on line much lately, working on a nutty and hard project for someone special, how to produce 130 dB at 15 Hz at 10 meters.Anyway, hope things are well.Tom Danley

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Subject: Re: High output basshorn

Posted by [Wayne Parham](#) on Sat, 06 Nov 2004 17:55:45 GMT

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Hi Tom,You wrote:>> Push pull mounting would cancel the second H (like using a push>> pull transformer vs single ended) however of all the harmonics the>> second is the least objectionable. That's no reason not to do it>> how ever. Yes, that's what the shorting ring on a high-quality loudspeaker does too. That's why I asked Eminence to build the B12. The push-pull arrangement might actually work better at low frequencies though. We'll see.As for the expansion of the room from the corner, I did some math and found it to be conical (of course) until the ceiling junction is reached, and then it becomes roughly parabolic. For visualization purposes, I compare the area expansion at different distances from the apex with a rectangular horn having straight walls in the post called "Room Corner Characteristics." I use this feature in some of my designs, but it isn't particularly germane to this particular horn. The horn I'm looking at right now is a high-power horn that probably won't be used in homes and its main feature is the push-pull plenum prior to the throat.Wayne

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Subject: Re: Boundary loading

Posted by [hulkss](#) on Mon, 08 Nov 2004 04:55:10 GMT

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Just a couple quick comments:The original LABsub has a compression ratio of 2:1. I have a

modified pair at 3.0 compression ratio. 1 dB is .0000000029 psi 15 psi would be:  
 $20\log(15/.0000000029) = 194$  dB The actual peak horn throat SPL is more like 155 dB which is 0.2  
psi.

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Subject: High Hz?  
Posted by [rick57](#) on Sun, 02 Jan 2005 10:50:39 GMT  
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Hi Wayne What do you have in mind as the top end of the effective FR? Cheers

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Subject: Re: High Hz?  
Posted by [Wayne Parham](#) on Sun, 02 Jan 2005 20:46:25 GMT  
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Upper response to 150Hz or so.

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