Subject: Hi-Efficiency vs Lo-Efficiency Speakers
Posted by HaknHendrix on Sun, 02 Jan 2005 14:10:34 GMT
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The beginning of the New Year often causes one to be reflective. Over the past year, we (my son's & I) have built a Bottlehead Foreplay, Grounded Grid Preamp, moded ASL Wave 8's, did the Swenson/Vinnie mods to a Toshiba 3950 (twice, another story), built 2 Pi Towers, purchased John LaPaires beautiful 4 Pi Tower's & 2 Pi's - installed drivers, and built a cross-over.For the New Year - I will be refitting my 4 Pi Towers with Delta Pros, and hopefully building a Transcendent OTL amplifier.Time to pause, and ask a question. What are the benefits of high efficiency speakers over low efficiency. Why isn't the mass consumer space using high-efficiency drivers.Also interested in what some of you did during 2004, and your plans for 2005?ThanksHakn

Subject: Re: Hi-Efficiency vs Lo-Efficiency Speakers
Posted by spkrman57 on Sun, 02 Jan 2005 15:14:34 GMT
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Quoted from Hakn:"Time to pause, and ask a question. What are the benefits of high efficiency speakers over low efficiency. Why isn't the mass consumer space using high-efficiency drivers."I think the reason why folks don't have "high-efficiency" drivers in the average home market is because: a)they like cute little cube speakers that sound just like "little POS", cosmetic looks are higher priiority than sound! b)is because the higher efficiency speakers are more revealing of the sound sources, and that would show the inadequacies of their mainstream amps/recvrs which are mass produced across the great pond, compared to our SET's which are more costly than the entire "stereo-in-a-box" type systems(which include "cute little cubes" again). c)decent high efficiency drivers usually cost more than the "made by the thousands" stuff across the great pond d) most importantly you must understand that for "most" folks, the quality of audio is not a critical need. Only a few of us(me included) actually spend time dedicated to "audio only", sit in the perfect spot(the sweet spot), and spend money like I had it to burn(sometimes missing meals and other luxuries) to get the ultimate in sound reproduction according to what we think the best sound should be like.My apologies in advance to the Bose and other fans who like the little cute cubes, but just remember, just like engines, there really is no substitute for cubic inches!!! Little speakers sound just like little speakers. You can't change the laws of physics.Ron (fan of refrigerator sized speaker systems)

Subject: Re: Hi-Efficiency vs Lo-Efficiency Speakers
Posted by Manualblock on Sun, 02 Jan 2005 16:19:52 GMT
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Most high efficiency drivers require materials and manufacturing methods that are prohibitively expensive to mass market. I read that the drivers in a mass market speaker equal less than 10% of the manufacturing cost. Then there is the question of size. High efficiency usually requires large drivers in large boxes; or smaller but costly drivers in complicated transmission line or horn loaded enclosures.Mass market audio is marketed with such a tight profit margin they must squeeze literally pennies from each product. There is a great article written by an individual who used to design loudspeakers for Jensen where he claims they would change the temperatures of the ovens used to cure the glue on coil formers by 10 degrees to save fractions of a penny per unit.

Subject: Re: Hi-Efficiency vs Lo-Efficiency Speakers
Posted by akhilesh on Sun, 02 Jan 2005 18:50:36 GMT
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HI Hakn,Happy new year to you as well. My belief is that high eff. speakers :a) allow the use of low powered SET amps, and b) produce significanlty lesser distortion at normal listening volumes. Other than that, I don't see any purpose. It is also true that it is much harder to get a flat frequency response from high eff speakers, i think becuase of the limitations of materials that can be used to make high eff. speakers. Just my beliefs,as of today (they may change asi learn more) mostly empirical. -akhilesh

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Subject: Re: Hi-Efficiency vs Lo-Efficiency Speakers
Posted by Wayne Parham on Sun, 02 Jan 2005 22:30:50 GMT
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The dynamic range and low distortion characteristic of high-efficiency designs are what do it for me. That and the fact that the better drivers tend to be built for prosound, so high quality and high efficiency tend to go hand in hand.As an example, the first drivers I ever saw that used shorting rings were prosound units. That made them waaaay better where distortion was concerned because for one thing they were very efficient, so required low drive levels for a given SPL and for another thing, they resisted flux modulation distortion, so even-orders were like 20dB less.Now days, I think there are some high quality low-efficiency drivers. High excursion woofers have relatively low efficiency because the geometry of the coil and magnet makes high excursion and high flux density mutually exclusive. You can increase magnetic strength, but if the flux is spread out over more space to make high excursion possible, that reduces magnetic density. This requires more power in the coils to move the diaphragm greater distances. So even if the build quality is there, the efficiency is not.I suppose some of those high-power, high-excursion designs can be made to provide high output, and maybe low distortion. With greater power, they can be expected to provide high SPL, which then means it is possible to get them to produce high dynamic range. There is the compression issue to deal with, but I am not closed minded that it couldn't be done. So I suppose there are possible solutions using low-efficiency designs that provide high dynamic range and low distortion.But most low-efficiency designs aren't particularly

impressive. The newer high-excursion woofers of the last ten years or so are a possible exception, but most home hifi speakers in the 85dB-90dB range are just average devices with 100dB maximum power limits. That's where high efficiency speakers start, with a watt or so, just loafing. I have personally never heard a low efficiency design that was of exceptionally good quality. So I guess that's where my observation ends.

Subject: Re: Lab Project Jones
Posted by BillEpstein on Mon, 03 Jan 2005 00:14:29 GMT
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Place Norah Jone's 'Feels Like Home' and Ricki Lee Jones 'It's Like This' in your CD changer and press shuffle all discs.Set the volume where you normally listen to most CD's and press play.Ricki Lee will fill the room with music which is loud only on crescendo's but soft passages are soft. Norah, OTOH goes from LOUD to WAYTOOLOUD!!!!Compression is why those stupid little speakers sell. There are no dynamics in most commercial recordings so no ability to handle them is needed. And why is that? Because at home the masses listen to TV. Where do they listen to music? In their cars.

Subject: Re: Lab Project Jones
Posted by Wayne Parham on Mon, 03 Jan 2005 01:56:17 GMT
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No doubt, that's a good illustration. Find some music with dynamic range and it takes a speaker with some hutzpah to get it right.

Subject: Re: Hi-Efficiency vs Lo-Efficiency Speakers
Posted by Wayne Parham on Mon, 03 Jan 2005 05:23:25 GMT
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You brought up a similar topic a little while back that might be worth linking here:Do more sensitive drivers offer less distortion at "normal" listening levels?

Subject: Re: Hi-Efficiency vs Lo-Efficiency Speakers
Posted by akhilesh on Mon, 03 Jan 2005 16:04:25 GMT
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I agree. Thanks for lthe link, Wayne! -akhilesh

Subject: Also they allow dynamic range,
Posted by akhilesh on Mon, 03 Jan 2005 16:17:43 GMT
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As Wayne said. The ability to fill a larger room with realsitic sound means you need maybe 110-120 DB level systems. Most home audio systems can do about 100. NOrmal listening levels would be about 90-95 db. -akhilesh

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Subject: Re: Hi-Efficiency vs Lo-Efficiency Speakers
Posted by Earl Geddes on Sat, 08 Jan 2005 18:56:12 GMT
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WayneI mostly agree with one disagreement. Shorting rings don't just affect even orders, they can affect both even and odd. We see the biggest effect on the second, but remember that it is the higher ones that have the most audibility.On the issue of high versus low efficiency there is another factor to what you have - correctly - said about why. To get good controlled high directivity to lower frequencies the speakers and waveguides must be large. Larger units are usually higher efficiency. Not that it has to be this way, but it is the more likely. One cannot get high controlled directivity out of smallish speakers - the typical low efficiency type - unless you use several of them. But arrays of speakers are very hard to do right - if possible at all. I have never found a solution that I liked with multiple drivers especially when the larger high efficiency units suite the task quite well.As I have said before, to me the better speakers are always higher directivity - they interact with the room less and bring you more into the recording. This is true of Magnapans, and any of the large panel systems. I just returned from the High End show at CES and to me all the small speaker two way designs all sounded the same and not very good, to a great extent due to the very poor room acoustics, which speakers like this tend to interact with very strongly. ALL of the better speakers were on the larger side with some form of higher directivity and constant coverage control - Magnapans, Edgerhorns, Zimbalies and some others whose names I have forgot. The common factor - high directivity.I think you agree with me on this Wayne, but you did not mention it. Directivity control, smooth response and low diffraction - thats the ticket for me.

Subject: Re: Hi-Efficiency vs Lo-Efficiency Speakers
Posted by Earl Geddes on Sat, 08 Jan 2005 19:04:41 GMT
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I used to work in automotive audio. This fractions of a penney is very true. When one sells 6 million speakers even a fraction of a penny adds up to some real money.It is also true that audio today is a pennies business for the drivers. I can get decent woofers from China for a couple bucks. Tweeters - about a dollar. These end up at Best buy, etc. at the price point of $50 - $100.But then there is the absurdity of The High End where they will package about $100 worth of Seaes drivers into a $30,000 system, because it has "magic" in it or some other thing.But the truth is that cabinetry IS very expensive. In my own speakers the cabinets now rule the cost as they far outweigh the driver costs. This was not my intent, but it is the practicality. I have spent nearly a year trying to get the cost out of the enclosures to the point where they are practicle. They are no wood, by the way, they are molded out of fiberglass and polyester and/or urethane backfills. To make the highly rounded corners in wood is prohibitively expensive - been there - done that. And making the waveguide into the front baffle in wood is all but impossible.My 2 cents

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Subject: Re: Hi-Efficiency vs Lo-Efficiency Speakers
Posted by Wayne Parham on Sun, 09 Jan 2005 09:20:15 GMT
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Hi Earl,I agree with you about directivity. I didn't mention it because while most high-efficiency speakers are (directional) horns, not all are.About shorting rings, I'm not sure how they could reduce odd-order harmonics. I think that mechanical suspension movements and reduction of excursion reduce third-order though, so some of the better high-efficiency drivers probably have reduced third-order from improvements in that regard, in addition to reduced even-order distorton from the use of flux control rings.Wayne

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Subject: Re: Hi-Efficiency vs Lo-Efficiency Speakers
Posted by Earl Geddes on Sun, 09 Jan 2005 18:27:54 GMT
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WayneYou need to move away from even and odd order and second and third order thinking in terms of distortion.Our research showed no difference in even versus odd order distortion perception and it also showed that subjects were virtually imune to second and third order nonlinearities. Even though flux modulation IS a dominately even order phenomina, second order effects CAN be odd order. This is especially true of the higher orders. It is these higher orders that are most audible and hence most important.

Subject: Re: Hi-Efficiency vs Lo-Efficiency Speakers
Posted by Wayne Parham on Sun, 09 Jan 2005 18:57:32 GMT

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I'm not sure I've ever seen any data showing harmonic distortion from loudspeakers except 2nd and 3rd harmonics. But the shorting ring definitely reduces 2HD.

Subject: Re: Hi-Efficiency vs Lo-Efficiency Speakers
Posted by Earl Geddes on Sun, 09 Jan 2005 19:52:20 GMT
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Quite True!! But this is the problem! If the low order nonlinearities are irrelavent and the higher order ones are the important ones, then we are looking at the wrong thing, right!I get a lot of calls from loudspeaker manufacturers who say that they have found no correlation in second and third harmonic distortion levels and subjective quality. They want to know if I have a way out of this situation. Of course I do - Hire us! Not always what they wanted to hear.

Subject: Re: Hi-Efficiency vs Lo-Efficiency Speakers
Posted by Wayne Parham on Sun, 09 Jan 2005 21:20:51 GMT
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I've also heard the statement uttered that harmonic distortion wasn't objectionable and that some people even like it. You and I probably heard that line from the same OEM. But I know that I can immediately hear the difference between a bass or midrange driver with an effective shorting ring and a similar one without it. So to me, the companies that say "distortion doesn't matter" are just engaging in wishful thinking. Seems most often said by companies that don't have a low-distortion part available.

Subject: Re: Hi-Efficiency vs Lo-Efficiency Speakers
Posted by Earl Geddes on Mon, 10 Jan 2005 01:59:34 GMT
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I think that you might be missing the point and that both points of view are right.People do often like 2nd and 3rd order distortion. We did a test in the hearing aid business once with amps that clipped with a soft clip - mostly 3rd order (about 25% THD) and people liked them better than linear amps. But even a small amount of higher order distortion (about .01%) at the waveform crossover and it sounds awful.So anyone who says that distortion is irrelavent is absolutely wrong, but saying that there are cases where people like distortion is also quite correct. The point is that there is NO correlation between THD (or IMD) and subjective perception - the proof of this is on

my web site.

Subject: Re: Hi-Efficiency vs Lo-Efficiency Speakers
Posted by Wayne Parham on Mon, 10 Jan 2005 11:13:00 GMT
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You might be right. I suppose that higher-order harmonics might have the most negative impact, even from loudspeakers. I've heard that said of amplifiers too.Here's a little thought experiment that might be interesting to perform on actual devices.Lets assume we have two similar devices, one built with flux control and the other without. They each use the same cone, voice coil and suspension, and the magnets produce the same flux in the gap. The magnet geometry is the same, with the one difference being that one has an effective shorting ring and a little more magnet to make up the difference in strength lost by adding the ring.These two speakers sound very much the same, especially at low and moderate listening levels. But as power is increased, the diffrences become a little more apparent. The one with flux control sounds more clean. When a bass drum is struck, you hear the impact of the head as well as the resonance of the drum. And it is not as fatiguing to listen to for extended periods at high volume levels. The one without a shorting ring sounds a little less defined, and the resonance of the drums sounds more pronounced than the impact. The drum head impact becomes lost in the drone of the bass.The shorting ring reduces even-order harmonics. Measurements show a significant ~20dB reduction of 2nd harmonics. I'm not sure what he levels of 4th, 6th, 8th, ...20th, etc. are. But it stands to reason that they are reduced too.The driver is capable of generaing from approximately 40Hz to 2kHz on axis within a 20dB range. So the fact that it is capable of generating 40Hz-2kHz sound means that it capable of generating harmonics in this range when sent a low frequency fundamental if the motor produces harmonic artifacts.That leaves us with the question, what are the proportions of the harmonics and how objectionable are they? This begins to look like the tube-transistor debate. In one sense, it doesn't matter since the mechanisms that reduce 2nd harmonics also reduce 20th harmonics. The trick is improving symmetry, and that reduces all the even-orders. But the reason it might be important is that if, in fact, the high-orders are what are really objectionable, then this gives more credibility to the argument that mechanico-acoustic filtering is a good thing to do.Absorbent material can be used to attenuate high frequencies. Front chambers like are used in horns and bandpass boxes attenuate high frequencies. The folded path of basshorns attenuate high frequencies. Any of these techniques can be used. A low crossover point won't do it, because harmonics are generated by the motor, not transformed by it. But the lower crossover point will reduce intermodulation distorton and is required if the upper frequency response is to be attenuated anyway.I guess the thing to do is to measure high-frequency harmonics and see.

Subject: Re: Hi-Efficiency vs Lo-Efficiency Speakers
Posted by Earl Geddes on Mon, 10 Jan 2005 16:31:56 GMT
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WayneMosty very perceptive. But one error, I think. I don't think that this statement: "The shorting ring reduces even-order harmonics." is true since the shorting ring will work on odd orders too."Measurements show a significant ~20dB reduction of 2nd harmonics." True but the higher order odd harmonics are also reduced. "I'm not sure what he levels of 4th, 6th, 8th, ...20th, etc. are. But it stands to reason that they are reduced too. " This is true.You have to understand that there is a big difference in the "order of the nonlinearity" and the "order of the Harmonic". Don't get the two confused. You can see a description of this difference in my book in the chapter on distortion.But I certainly agree, and my experince bears this out, that acoustical low pass schemes do result in a cleaner sounding system.Waveguides and horns tend to have more gain at low frequencies so they naturally decrease the presence of the electro-acoustically generated harmonics.Mechanical systems are inherently lower order systems when compared to electronics - although I have seen exceptions. This means that loudspeakers tend to not have objectionable nonlinear distortions at lower sound levels but can become quit objectionable at higher sound levels. Electronics tend to be just the opposite. They can have very high orders of nonlinearity and can be quite objectionable at lower levels and sound OK at higher levels. One should look for low nonlinearity in electronics at low levels and never use the speakers at levels where the become audibly problematic. Almost any loudspeaker - even very tiny speakers used in hearing aids, have insignificant nonlinearities at low output levels. And they all have some point at which they will start to sound bad. Keep below this point and IMO, nonlinear distortion is not an issue.

Subject: Re: Hi-Efficiency vs Lo-Efficiency Speakers
Posted by Wayne Parham on Mon, 10 Jan 2005 17:28:40 GMT
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Hi Earl,Shorting rings are used to make motor movement more symmetrical, as you know. I have only seen evidence that this reduces even harmonics, i.e. 2nd, 4th, etc. Speaking only of harmonic distortion, are you saying that you believe odd harmonics are reduced too?Other non-linearities are present in the system, to be sure. At high power levels in particular, there are many other matters than just push-pull flux symmetry. But push-pull symmetry is what the shorting ring is used for. Can you think of other benefits it may bring?Wayne

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Subject: Re: Hi-Efficiency vs Lo-Efficiency Speakers
Posted by Earl Geddes on Mon, 10 Jan 2005 18:18:59 GMT
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WayneI think that Our discussion comes down to what a shorting ring does.In my understanding, and I have some considerable experience with large loudspeakers companies in this, a shorting ring does two things.The first is basically what you said, except that it does not just make the flux symmetrical, but stabalizes it, symmetrical or not. A shorting ring, if it had zero resistance, would not allow for any flux that pasess through it to change. Any change in the flux would result in a

ring current which would produce exactly the counter flux required to make this change zero. This change is MOSTLY symmetrical, but since the entire flux circuit is nonlinear it also has a non-symmetrical part. All changes - symmetrical or not - are canceled. But shorting rings are not zero resistance, so they cannot do this perfectly. The lower the resistance the better. JBL once used silver. Today we know that a lot of copper works just as well at a much lower cost.The other effect of a shorting ring is to linearize the inductance change with position. This is closely coupled with the above effect in many respects in that the inductance change with current is closely associated with flux modulation. It is different than the inductance change with position. A shorting ring will tend to negate the inductance increase due to the steel core of the motor structure, thus decreasing the change with position. This lowering of the inductance is a primary effect in compression drivers particularly at high frequencies. The previous effect (flux modulation) is more dominate in woofers, but both effects exist in both components. The change of inductance with position is again dominately non-symmetrical, but it has signifcant symmetrical aspects to it.I hope that this discussion sets well with your understanding.Earl Geddes

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Subject: Re: Hi-Efficiency vs Lo-Efficiency Speakers
Posted by Wayne Parham on Mon, 10 Jan 2005 19:54:20 GMT
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You're right that shorting rings tend to reduce voice coil inductance and to make inductance more linear. That's pretty significant, especially for HF devices. And you're right that the inductance change is nonlinear. Klippel has done a lot of work in that regard, and I understand now that you have too. Now I see where we have been sort of talking apples and oranges, because I've been focused on linear distortion mechanisms and you've been focused on the non-linear ones.When I speak of symmetry and flux stabilization, I'm talking about the fact that the voice coil adds to the fixed magnetic flux in one direction and subtracts from it going the other way. You're right that the shorting ring has to be carefully sized and positioned so that its effect balances these forces and reduces asymmetry from flux modulation. But when properly implemented, it does a very good job of making the motor movement more symmetrical.One thing I've realized about shorting rings is that, like you said, the conductor isn't perfect so there is a minimum speed they work at. This translates to a lower frequency limit where they become ineffective. If the ring were superconductive, I suppose it could be made very small and it probably could work at very low frequencies. But since it isn't, a large conductor is required and that displaces magnetic material. There comes a lower limit where increases in ring size become prohibitive. The geometry of the gap and the position and size of the voice coil are important features too. They sort of set a baseline, and if static flux is asymmetrical, there is little point in AC flux stabilization. Using a shorting ring on a motor with asymmetrical static flux in the gap is a waste. The really cheap drivers sound bad even at low volume levels because the static flux is asymmetrical. The diaphragm moves further in one direction than the other even at very low drive levels. But better drivers do a pretty good job at low levels, and only start becomming asymmetrical at high drive levels. That's where flux stabilization can help them achieve that extra level of symmetry.

Subject: Re: Hi-Efficiency vs Lo-Efficiency Speakers
Posted by Earl Geddes on Tue, 11 Jan 2005 00:28:02 GMT
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WayneWe seem to see things differently and I don't want to be argumentative, but here are the palces that we differ on.A shorting ring is purely resistive, no reactance at all. Hence ther can not be any time constants associated with it.I don't agree that the flux has to be symmetrical for a shorting ring to work. I don't even agree that a symmetrical flux is even necessary at all. Sure if it is symmetrical the second harmonic will be reduced, but the third will go up. I no of no data to show that this is a subjective improvement.Honestly, from the data that I have virtually all long held beliefe about nonlinear distortion are incorrect. Time will tell.

Subject: Re: Hi-Efficiency vs Lo-Efficiency Speakers
Posted by Wayne Parham on Tue, 11 Jan 2005 11:34:57 GMT
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Hi Earl,I don't find you to be argumentative at all. Your posts seem very well mannered to me, and I appreciate your comments. What sort of gets my goat is when people pop up on forums like these with patronizing or arrogant comments, or being downright rude and making personal attacks. But none of that is going on here. We're just kicking some ideas around, and I think it is great.Have you seen John Eargle's document about magnet structures? It illustrates motors with static flux symmetry and those without, and it compares alnico, ferrite and flux stabilized ferrite magnets.Wayne

Subject: Re: Hi-Efficiency vs Lo-Efficiency Speakers
Posted by Earl Geddes on Thu, 13 Jan 2005 02:50:20 GMT
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WayneJohn is a very old friend from my days of working with JBL. He is highly complimentary of my book.I would really like to read his comments, but the link that you had was not readable on my browser. Do you have any other formats for it? Or a link to a PDF or something like that?

Subject: Re: Hi-Efficiency vs Lo-Efficiency Speakers
Posted by Wayne Parham on Thu, 13 Jan 2005 10:48:21 GMT
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It's an old document, and I'm not sure its available in PDF. Right click on each link below, and do

a "Save Target" to save the image files to your computer. Then you can display and print them with a paint program.Symmetrical Field Geometry, Page 1Symmetrical Field Geometry, Page 2Symmetrical Field Geometry, Page 3

Subject: Re: Hi-Efficiency vs Lo-Efficiency Speakers
Posted by Earl Geddes on Thu, 13 Jan 2005 13:25:20 GMT
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WayneThanksYes this is old stuff. John's paper is also misleading or wrong as proved by JBL's own recent product moves.Its not just the gap geometry that lowers the distortion in an ALNICO structure. ALNICO is a good electrical conductor, unlike ceramic, an so it is its own a shorting ring! So his conclusion that the geometry accounts for the changes is incorrect. JBL recently started to use ALNICO again for variuos reasons - lower flux modulation and near zero flux changes with themerature, both of which are very bad in ceramic.Then there is the fact that second and third harmonics are not really the important ones.John's paper was the prevailing philosophy at the time, but now we know more than we did then.Its hard to beat ALNICO for performance, but its price and weight are real drawbacks. The better drivers today are using laminar motor structures with each lamina being copper plated.

Subject: Re: Hi-Efficiency vs Lo-Efficiency Speakers
Posted by Wayne Parham on Thu, 13 Jan 2005 14:37:55 GMT
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Actually, I think the main point of the paper was to describe the benefit of the shorting ring for ferrite structures. The comparisons shown are alnico and ferrite, with and without a shorting ring. There is an illustration of a non-symmetrical gap but the data doesn't compare it to a physically symmetrical ferrite model without a shorting ring. The paper is mostly about flux modulation, not so much about static symmetry.But static symmetry is important too. I'll look around and try to find some comparitive data somewhere. In the meantime, a simple thought experiment should suffice. If gap geometry provides more force in one direction than the other, then motor movement will be asymmetrical, even without considering flux modulation. The shorting ring resists flux modulation, but statically symmetrical flux in the gap is important too.

Subject: Re: Hi-Efficiency vs Lo-Efficiency Speakers
Posted by Earl Geddes on Thu, 13 Jan 2005 21:36:57 GMT
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WayneThe point of this paper is to "sell" JBL's change to ceramic magnets as "OK". John talks

about both the flux ring and the symmetrical geometry. I think that I am missing the rest of your points. I don't think that I ever disputed that the excursion was not symetric in an unsymmetric field or that flux modulation does not modify the excursion in an unsymmetrical way.

Subject: Re: Hi-Efficiency vs Lo-Efficiency Speakers
Posted by Wayne Parham on Thu, 13 Jan 2005 22:11:56 GMT
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Well, I guess you're right about the point of that paper being to sell JBL speakers. But I think they've done a good job with them. Their research and development resulted in very good sounding speaker drivers, in my opinion. I was glad when Eminence started making their Magnum series too, they're pretty similar.

Subject: Re: Hi-Efficiency vs Lo-Efficiency Speakers
Posted by Earl Geddes on Fri, 14 Jan 2005 02:29:12 GMT
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Oh, don't get me wrong. The JBL engineering staff is the best that there is. They were well taught - Harman has bought far more of my books and had more class attendees than any other company. Floyd Toole, Dick Small, Don Keele, etc. are all good friends from a long ways back. Even the current genre of Doug Button and Alex Voishvillo are long time associates. John Eargle I have known the longest. I first met him in about 1978 or there abouts.
