Subject: Question about magnetic flux modulation
Posted by Duke on Tue, 20 May 2008 21:18:35 GMT
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Is flux modulation level-dependent?I'm looking at a very high-efficiency prosound woofer that doesn't have shorting rings, but in this application it probably wouldn't see more than 5 watts peak at the most (and typically less than 1/2 watt). Thanks!Duke

Subject: Re: Question about magnetic flux modulation
Posted by Wayne Parham on Wed, 21 May 2008 18:17:09 GMT
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Distortion rises with power as flux modulation increases with power. Magnetic loss increases as power rises too. For that matter, excursion also rises at higher power levels, and that brings in its own set of non-linearities.The thing is, distortion tracks the power levels pretty closely. Say a driver without a shorting ring has -30dB distortion from 100Hz to 500Hz at 100 watts. This same driver may have -35dB distortion at 10 watts and -40dB at 1 watt.Now take the motor and machine a shorting ring of the right size and position to reduce distortion as much as possible. Add back some magnet and metal to make up the flux difference so the electro-mechanical specs are the same. If done right, the driver will have the same electro-mechanical specs, but wiull have about 15dB reduction of distortion, which is about a 50x improvement. That's what you see from good shorting rings.At 100 watts, from 100-500Hz, the driver would now have -45dB distortion. That's as good or better than the driver without the shorting ring does at 1 watt. At 10 watts, the driver is down to -50dB and at 1 watt, it's at -55dB. So medium/high power to a driver with a shorting ring is cleaner than low power to a similar driver without.I like to have both types of speakers available at different price points. It's sort of a good/better/best arrangement, allowing for many budgets. The same system design principles are used, but drivers are available with varying quality levels.Beyond the numbers, these are my listening impressions, for what they're worth. Forgive my subjective impressions, but it's the best way I can describe what I perceive. We can look at distortion charts, they're pretty easy to read. Distortion goes up as power goes up. At some point, when thermal effects start to come into play, bass response shifts. My alignments are slightly overdamped, a safe way to do it since thermal effects tend to reduce damping. You can see this in the response curve at high power levels. But beyond the numbers, these are my descriptions of what I hear.Let me use the little Alpha 10 and Delta 12LFA woofers as an example, since I'm real familiar with them. They sound great at moderate listening levels. They're inexpensive but very good bang-for-the-buck parts. They have nice round bass with deep extension, especially in large boxes. But the midrange quality cannot match that of a speaker with a properly designed shorting ring.This is more apparent at moderate to high volume levels. The difference to me is the midrange doesn't sound quite as pure. I also notice listening fatigue happens sooner at the same volume level. Looking at another example, if I have a JBL 2226 in a loudspeaker and swap it with an Eminence Omega 15, all other things being equal, the sound from the Omega is fatiguing at a lower volume level than the JBL. The bass from the Omega sounds "rounder" and the JBL sounds "tighter". It isn't the amplitude response, they're tuned very similarly. It's the amount of distortion, because the JBL driver has a shorting ring and the Eminence driver doesn't.At low

levels, the Omega woofer sounds nearly the same as the JBL. At medium levels, you start to hear a difference in the midrange and the pluck of bass strings. At high levels, neither speaker sounds strained, but the one with the JBL woofer sounds tighter and doesn't give you listening fatigue. The Omega gives listening fatigue sooner than the one with the JBL.There's another place I notice it. Even at very low levels, there seems to be a time factor involved that spans hours or days rather than minutes. So even at low volume levels, listening fatigue sets in sooner on a driver with higher distortion. Before experiencing this, I wouldn't have expected to ever become fatigued from a speaker played at very low volume levels, low enough you can talk over. At these levels, even the driver without a shorting ring has very low distortion. But the one with a shorting ring is still better by 15dB. I find that the lower the distortion present, the longer I can listen at a given volume level.When we're at those weekend long shows, the volume levels aren't very high. But the music is on constantly. When I go to them with a pair of low-distortion speakers, I feel refreshed even after I leave. I enjoy listening to the radio on the way home. But if I take out speakers with drivers that don't have shorting rings, I'm ready to shut down on Sunday and I don't really want to hear anything for a while. My ears are tired and I just feel exhausted. The volume level isn't high enough for the distortion to make an obvious difference in sound between the driver with a shorting ring and the one without. But over the course of the weekend, listening fatigue sets in on the drivers without shorting rings even at low volume levels.

Subject: Re: Question about magnetic flux modulation
Posted by Duke on Thu, 22 May 2008 07:59:52 GMT
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Wayne, thank you very much for this extremely in-depth reply based on your experience. Sounds like that's not a corner that's worth cutting. Since I'm not offering kits, I'd be shaving at the most maybe 10% off of retail but making a significant sacrifice in long-term enjoyment. Not a good trade.You just saved me from making a mistake. Thank you sir!Duke

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Subject: Re: Question about magnetic flux modulation
Posted by Wayne Parham on Thu, 22 May 2008 16:39:23 GMT
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I agree. But sometimes, the extra couple hundred bucks for a JBL 2226 as opposed to an Omega 15 prevents someone from being able to get it. So in that case, it's nice that Eminence makes a part that is tuned so similarly. There are a whole lot of people that I think fall into the bang-for-the-buck market. I like to offer good/better/best choices when I can. But I definitely agree about sound quality. For my own personal systems, I always go with the better part. Definitely worth the couple hundred extra dollars.

Subject: Re: Question about magnetic flux modulation
Posted by Adrian Mack on Sat, 24 May 2008 03:45:40 GMT
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This will help you as
wellhttp://www.klippel.de/download/bin%5Can11%20-%20flux%20modulation.pdf

Subject: Re: Question about magnetic flux modulation
Posted by Duke on Sat, 24 May 2008 20:41:25 GMT
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Thanks, Adrian!I hadn't realized how non-linear the situation was between positive current and negative current. Very illuminating. Must confess I skipped over the math, but between the text and the illustrations I think I still got a lot of it.Duke

Subject: Re: Question about magnetic flux modulation
Posted by Wayne Parham on Tue, 27 May 2008 22:03:40 GMT
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I've studied this mechanism a lot over the years. From the first time I heard JBL's woofers with shorting rings, I was impressed with their clear sound. So I studied their approach and learned that they used an induction ring to counter the flux, basically reducing the difference between weak and strong half cycles and making the driver motion more symmetrical.What I didn't realize until relatively recently is how much the effectiveness of the ring weakens as frequency is reduced. I mean, I could see from measurements that distortion rose as frequency dropped, but I didn't realize how completely ineffective the shorting ring was at low frequencies. It's still a great idea, and I always prefer a driver with a shorting ring when used as a midwoofer or midrange. But below 100Hz or so, a shorting ring just can't do very much.The reason is pretty simple. Since the ring requires magnetic induction to work it needs to be made physically large to work well at low frequencies. Opposing requirements make it virtually impossible to make a woofer motor with a shorting ring that's effective below 50Hz. You want both the magnet and the ring in close proximity to the voice coil, near the pole piece. Make one bigger and the other has to get smaller. So the designer has to strike a balance.When I realized this, it became very clear to me that the best way to improve symmetry at subwoofer frequencies is with push-pull drive. Shorting rings are nice for midrange frequencies up.
Push-pull verses shorting rings

Subject: Do not overlook intermodulation distortion

Some people say they are not disturbed by distortion from speakers because it is inaudible or euphonic or some such thing. This view overlooks intermodulation which can be extremely annoying.A small amount of low order distortion can go unnoticed but this does not hold true when nonlinearities are large. This is almost always the case at low frequencies. Here again we see many people saying bass distortion is less noticable than higher frequencies, usually pointing to the Fletcher Munson curve or something like that. If it were just harmonics that were generated that might be true but the thing that tips the scales is intermodulation distortion.Harmonic distortion is easy to measure and gives an indirect indication of nonlinearity. Whether or not harmonic distortion is "euphonic" or not is not the issue. The same nonlinearities that create harmonic distortion are what also cause intermodulation distortion. IM distortion generates nonharmonically related tones that easily stand out. When two or more frequencies are present in the input signal, nonlinearities in the speaker produce sub and difference tones. Not only that but the harmonics also combine to generate sum and difference tones, creating high order intermodulation. The result is a garbled sound that is not harmonically related.It is easy to demonstrate the harmonic spectrum of distortion in a loudspeaker system. For constant SPL the displacement decreases as 1/f2 with increasing frequency and it could be expected that distortion decreases correspondingly. Distortion in a speaker is caused primarily by three factors: force factor Bl(x), stiffness of suspension Kms(x), and electrical inductance Le(x). The effect of Bl(x) and Kms(x) should decrease as 1/w2 with frequency, but since the inductance increases as wLe its effect should only decrease as 1/w and possibly overtake the effects of the other two non-linearities.In a nonlinear system the relationship between input 'x' and output 'y' is often of the formy = a0 + a1 x + a2 x2 + a3x3 + ...+ anxnwhich is a power series expanded around x = 0.If the input is a sinusoidal voltage x = A sin(wt), thenx2 = A2 [1 - 0.5 cos(2wt)]x3 = A3 [0.75 sin(wt) - 0.25 sin(3wt)]x4 = A4 [0.375 - 0.5 cos(2wt) + 0.125 cos(4wt)]and so on for higher powers of x.Thus harmonics nw are generated and dc terms. w will also decrease by dA, but the second harmonic amplitude will decrease by dA2, the third harmonic amplitude by dA3, the fourth by dA4, and so on, at least to a first order approximation.This by itself is not the biggest problem. The implication is however. Wherever you see harmonic distortion, it is created by nonlinearity. Wherever you see nonlinearity, you will find intermodulation distortion. That means even low order distortion is bad, because it indicates nonlinearity in the system.