Subject: Why SE in SET amps?
Posted by granch on Tue, 04 Sep 2007 04:41:29 GMT
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Could someone succinctly explain to an old duffer like me why it has to be "SE" in Triode amps. In my youth that was asking for even order harmonic distortion which a push-pull would cancel. My first big project involved replacing a push-pull parallel 2A3's amp with another to get more power in a high school auditorium. I must have been committing a terrible sacriledge (unintentionally, of course). I was so innocent in those days I even tried to explain negative feedback by going around the loop and got myself lost. Granted even order distortion is less objectional to the ear than odd order. But wouldn't less be even better? Please no cursing, folks.-Dick

Subject: Re: Why SE in SET amps?
Posted by Wayne Parham on Tue, 04 Sep 2007 13:46:07 GMT
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It's probably not something you'll be able to discuss in terms of math. If you look at the numbers, you're right. Push-pull offers lower distortion. Well-executed solid state even lower distortion. But to a SET purist, push-pull is "flat and uninvolving" and there is no such thing as well executed solid state. They're lured by the warmth of SET magic.A Taste of TubesThere are two things that may explain some of the reasons why people prefer SET. For one thing, Class A amplifiers have no crossover distortion. The entire audio signal is handled by one amplifying element. And for another thing, the distortion that is made is largely low-harmonics, mostly second and third. This is mostly due to the fact that the tube conductivity isn't perfectly linear, and doesn't have anything to do with more complex things like feedback nonlinearity. A tube clips gracefully too, not with sharp harsh-sounding square edges but almost sounding like it just won't go any further. So without resorting to romantic adjectives, you can see some things that may be part of the SET magic.

Subject: Re: Why SE in SET amps?
Posted by granch on Tue, 04 Sep 2007 19:58:23 GMT
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Thanks a million, Wayne. Just what I thought. The reference was really terrific! A great read and a great refresher. As I recalled, the best sounding amp ought to be a push-pull triode amp operating in class A or AB.I'm still using my old ultra-linear Wiliamson amp -in my organ I think. I don't think it was a kit and it did use a peerless (altec) output transformer as I recall. For serious power I use solid state but very conservatively rated.-Dick

Subject: Re: Why SE in SET amps?
Posted by Wayne Parham on Tue, 04 Sep 2007 22:50:01 GMT
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For SET amps, I really like the Audio Note Kit 2. The Kit 1 is nice too, but I'm partial to my Kit 2. Good value at under $2K. For Ultra-Linear, check out the Stoetkit Jr. MkII. It's a real sleeper. Best value for under $1K tube amp kits, in my opinon.

Subject: Re: Why SE in SET amps?
Posted by SteveBrown on Wed, 05 Sep 2007 12:12:20 GMT
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Dick, while it isn't exactly a kit, there is a really nice design called the SETH that you can find info on at the Magnequest website. This is a PP triode design using 2A3's. I built it using PP iron salvaged from a Fisher 500C receiver, 6550's strapped in triode mode, and in a stereo chassis. I have to say, it sounded great. The secret here is the phase splitting transformer, which provides a very elegant way to split the phase, is easier to implement than tube splitters, but costs more. At any rate, others who have heard my PP amp agreed that it was one of the better PP designs they'd heard. I've built lots of PP and SE amps and they each have their charms. The PP stuff definately seems to control the bass better, and the SETh design maintains the integrity of the mids and highs as well - without making them sound strained or dead, as many amps using feedback seem to do. Anyway, hope that helps. The MQ site has extensive info on building one of these, and again, you don't have to be stuck using just MQ iron (though it is very good). I believe Jack at ElectraPrint also makes a splitter like this. Best of luck!
SETH @ MQ

Subject: Re: Why SE in SET amps?
Posted by granch on Thu, 06 Sep 2007 02:53:13 GMT
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I want to thank all of you for the helpful suggestions. Actually I am not in the market and was just being curious. When I buy amps in the next year or so (if I do) they will be great big momma's for bellowing my organ concerts to the lake I live on. Like 2500 watts for sub woofers and I am still figuring alternatives for the mids and tweets. Mids will be 4 Altec A-7s, per channel (8 in all) and tweets will be the horns that come with the A-7s - but driven separately with a 3 way electronic crossover. I have been using 3 A-7's per side driven by 200 watts per channel with no subwoofers. I want it louder with less strain on the equipment, but have to be careful because my property is atop a 20 ft sand cliff and there is no earthquake insurance up here in northern MN.-Dick

Subject: Re: Why SE in SET amps?
Posted by RC Daniel on Sat, 22 Sep 2007 03:59:27 GMT
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Hi DickI have not posted over here for a long time; anyhow...I am thinking that (within reason) some folks may be more sensitive to the ratios of odd : even harmonc distortions, rather than absolute levels. Could a reduction in 2nd harmonic distortion expose odd-order artifacts or somehow make them more obvious / offensive?Hmmm, perhaps this is analagous to dietary intake of omega6 : omega3 fatty acids or blood HDL : LDL ratios and their effects on health?Got to runRaymond

Subject: Re: Why SE in SET amps?
Posted by granch on Sat, 22 Sep 2007 04:35:26 GMT
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Howdy!It could be. I know that even harmonic disrtortion is much more tolerable than odd, so that its presence could possibly mask the odd. I know of no studies on this. But there are other forms of distortion that are very bad news. I haven't seen anyone mention "intermodulation distortion" (IM). That is supposed to be very bad news as it produce all sorts of trash besides harmonics. It occurs when two or more tones are fed through a non-linear (ie. distorting) device (like an amp). It produces sums and differences of the two (or more) tones which vary with the signals. I don't know why it isn't mentioned anymore - perhaps because its easier to sweep under the rug and forget. I believe that its one kind that negative feedback amps are good at suppressing, since the distortion products are generally not in the original signal. There is also FM or doppler distortion caused by the loudspeakers themselves. Think of a cone vibrating at high frequency while it is simultaneously being driven slowly back and forth by a low frequency. Causes the doppler effect or a frequency modulation of the higher freq by the lower. That's one reason why horns sound so good - they minimize the excursion of the diaphragm by loading it heavily and uniformly. Also a good reason for sub woofs to only cover a narrow frequency range. I believe that the common answer to all these problems is to make the amp as absolutely linear as possible. A very well designed amp with feedback run well within its ratings (both bandwidth and power) can be the nearest thing to linear that I know of.

Subject: Re: Why SE in SET amps?
Posted by RC Daniel on Sun, 23 Sep 2007 21:35:53 GMT
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>>>A very well designed amp with feedback run well within its ratings (both bandwidth and power) can be the nearest thing to linear that I know of.

Subject: Re: Why SE in SET amps?
Posted by granch on Mon, 24 Sep 2007 01:49:41 GMT
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There is a great amount of truth in what you say. As my sainted mother used to say, "'Every one to their own taste', said the old lady as she kissed the cow." There are also things like the placebo effect. And there is a big variation in the hearing acuity of various people.Due to a common old service injury, I am now losing my hearing to the point where I have to use hearing aids in both ears to help understand speech. But for music listening I have to remove the aids. And I am still busily designing sound systems.I used to make a lot of distortion measurements (total distortion is easy to measure). The distortion levels got so low that I couldn't measure them anymore with my dated equipment.My original question was why only single ended triode amps when push pull triode had lower distortion.-Dick

Subject: Re: Why SE in SET amps?
Posted by Wayne Parham on Mon, 24 Sep 2007 14:06:29 GMT
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On first inspection, the relative percentage of harmonics seemed to be the biggest difference between amps. But after looking at it a bit more, I started to realize that it would be possible for nonlinear distortion to be caused by negative feedback loops in certain conditions. The one that is most obvious is output near clipping, but there are others. Then there are things like noise floor, the kinds of noise made, be they AC frequency (60/120Hz), rectification switching artifacts, or hiss from electron collisions and other noise sources. There are a lot of differences, to tell the truth.

Subject: Re: Why SE in SET amps?
Posted by granch on Mon, 24 Sep 2007 22:32:12 GMT
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Plse tell me more about the "others".The reason "total distortion" (not necessarily harmonic) is so easy to measure is that all you have to do is run a pure sine wave thru the amp, null it out, and see what's left. Anything left is by definition distortion - hum, noise, or whatever.I agree that there are lots of differences between amps, but let's face it: they are the least distorting part of the reproducing chain - unless you count the wires, which many of your contributors find make "huge" differences. Anyway, compared to electromechanical devices, amps can be "perfect".

Subject: Re: Why SE in SET amps?
Posted by Wayne Parham on Tue, 25 Sep 2007 23:30:01 GMT

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See the link below. There are a couple of articles by Norman Koren in the post that might interest you. One talks about possible problems in the feedback loop from reactance that causes phase shift. Load capacitance that makes total phase shift exceed 180° causes oscillation. If near 180°, a peak is evident in the response curve. The problem is exacerbated in amplifiers with output transformers because of the phase shift inherent in the system. Other problems include susceptibility to RF interference in amplifiers with global feedback, as the speaker output lines are long and make good antennas. The speaker wires are connected to the feedback loop, so they tend to pass RF back into the amplifier. Then there is the matter that negative feedback tends to sharpen clipping. It reduces distortion until the amplifier reaches saturation, and then distortion rises abruptly.Bear in mind that Norman Koren appears to be an advocate of no feedback SET designs. But he also appears to be pretty objective, making a strong case for the proper use of limited negative feedback in some designs. It's an interesting read, in any case.
Oddball note: Speaker cables, feedback loops and Spice

Subject: Re: Why SE in SET amps?
Posted by granch on Wed, 26 Sep 2007 01:53:44 GMT
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Thanks for all the very interesting links. Much of it was familiar to me - as familiar as stuff not thought about for 30 yrs can be. And I agree with him. However, I will still stand by my original statement that a "well designed" feedback amp (one that has taken all these factors into consideration), operated within its ratings (i.e., without overload and clipping) is the most linear thing we have in the audio chain. One might argue that, say, loudspeakers can maintain the same if they (and their enclosures) are well designed and not driven into nonlinearity. I don't really know the answer to that, but speaker design has not changed that much in 50 years and Vilchur certainly demonstrated that air was a more linear suspension than the usual speaker designs - yet I seem to recall that air compression is not all that linear. I think the point about RF entering through the output cables is a very good one and one not often thought of. Even that can be handled usually by good engineering (shielding, balancing and filtering). I believe that Koren is very objective and knows what he is talking about. He is not one of those worried about which ankle of the centipede has arthritis.

Subject: Re: Why SE in SET amps?
Posted by Wayne Parham on Wed, 26 Sep 2007 03:31:01 GMT
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I agree with you. We must think a lot alike in this matter.

Subject: Re: Why SE in SET amps?
Posted by granch on Wed, 26 Sep 2007 19:28:40 GMT
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Probably in others as well - after all, don't all great minds think alike? Well, all right, often anyway.-Dick

Subject: Re: Why SE in [all kinds of Class A] amps?
Posted by Wayne Parham on Mon, 08 Oct 2007 05:29:18 GMT
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Slightly off-topic, but related: Check out the ProFet post in the Class A Semiconductor forum. The Selectronic ProFet is a single-ended FET amp and it really sounds nice. If you're not averse to solid state gear, give it a look and listen.

Subject: Re: Why SE in [all kinds of Class A] amps?
Posted by granch on Tue, 09 Oct 2007 01:31:47 GMT
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I gave it a look. It's pretty. The circuit diagram would likely be even prettier.But no way for me to give it a listen - and besides I wear hearing aids in both ears, now which ruin everything. Actually I remove them for music, but I still miss a lot.-Dick

Subject: Re: Why SE in [all kinds of Class A] amps?
Posted by Matts on Mon, 16 Nov 2009 16:25:32 GMT
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in my estimation, your question about why people prefer a topology that doesn't test as well as another is interesting. Testing and engineering are very important and we wouldn't have audio reproduction w/out them, but they are not the end goal for many- enjoyable sound is. Scientific testing is important to testing theories and circuits, but you can't listen to a scope trace! (at least not on my monster HP...) So those us who prefer SET simply think it sounds better to us and the amount of harmonic distortion doesn't matter. The tone of all music instruments, to the extent they vary from a pure sine tone, is "distortion" from overtones. Many great violins have a second harmonic louder than the primary in spectograms! The Hammond electronic organs have something like 9 overtones blended into each note to create it's "tone". All topologies can sound excellent if properly implemented, and everyone should listen to the one they like best that produces the power they need. The whole art of making guitar amps is creating the pleasing

distortion, usually through overdriving, even though almost all of them are P-P.

Subject: Re: Why SE in [all kinds of Class A] amps?
Posted by Wayne Parham on Mon, 16 Nov 2009 19:10:43 GMT
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For a few years, I was working under an impression that tube amps distorted more than solid state amps, but that perhaps tube distortion was more "euphonic" than transistors because lower order harmonics weren't as disagreeable as higher order harmonics. As an example, something that produces mostly second harmonics is definitely going to sound better than something that generates a sharp edged clipping sound with lots of very high harmonics. If nothing else, the spectral content is very different. But there is another thing to consider, and that's the fact that most tube amps use very different topologies than solid state. The circuit configurations are different, and is probably more responsible for low THD ratings on solid state amps than anything else.

I was talking with a guy that used to work for Svetlana a few years back, and he made the case that a triode almost always distorted less than a transistor with comparible ratings. The whole deal is really related to feedback. The transistor amps provided more gain, but then used feedback to reduce distortion. He claimed that the reason solid state amps distort less wasn't even the fact that they were solid state, but more the fact that they used a lot of negative feedback, which cancelled distortion. If you did the same thing with tubes, you'd get lower distortion still. But people don't do that because they don't have to - the distortion levels aren't objectionable. The main thing about tubes is you can't make as much power, or at least not cheaply. Higher power is the big advantage of solid state, not lower distortion. The distortion advantage is mostly from the topology, putting a lot of gain stages in and then using negative feedback.

I didn't bother to study this further, to try and confirm or deny this. Instead, I sort of took it as fact, although I guess I haven't really bothered to check. But it does appear to be reasonable to me. I do know that negative feedback reduces distortion, but also that once you've gone past the limits of the amp, once it is clipping, negative feedback no longer works - it can't. So negative feedback works well up to a point, and then completely comes apart. As far as whether or not a class A triode distorts less than a class A bipolar transistor or a class A FET, I suppose that is probably something that is different from device to device, and how far into the load lines you push them.

Subject: Re: Why SE in [all kinds of Class A] amps?
Posted by Matts on Tue, 17 Nov 2009 17:38:05 GMT
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on an intuitive level, I'd agree with the guy from Svetlana. My guess is there are some micro-variations in the a.c. signals that are lost when a neg. feedback loop "blends" slightly

different parts of the signal together, and this causes some loss of the cues that give our brains the sense of "live" music. It's almost standard when someone hears my system the first time they say "It sounds just like live music" whatever the recording...but even more so on older, more simply recorded music. The better p-p designs I've heard use no or very little neg. feedback, good tubes (like el84's), and quality iron. Many folks need the higher power because they have to drive less efficient speakers for "decorative" reasons...I'm glad we don't have that problem!!

Subject: Re: Why SE in SET amps?
Posted by Pano on Sun, 23 May 2010 22:54:00 GMT
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OK, I jump in and embarrass myself in my 1st post here.

I was lucky enough to be introduced to the DHT & SET "cult" in the mid 80's by none other than Mr. Jean Hiraga himself. I was as surprised as anyone at the sound of these little amps. Quite a learning experience hanging around with Hiraga and crew.

So here is what I know about "Why Triodes, why single ended, why direct heated?" Mostly it comes down to harmonic distortion and the structure of that distortion. It's the structure that is so important. A good SET amp does not give dominant even order harmonics, it give a very regular fall off of all harmonics, odd and even. This is very important.

Back in the 30's Wegel and Lane established that a regular fall-off of harmonics is the audible equivalent of no harmonics. Each successive harmonic is masked by the one above it, so it is not heard. So up to several % of THD will sound like a pure tone if the harmonic structure is right. This work was continued in the 70's by Matti Otala and others. I'll elaborate on that if anyone is interested.

The great thing about direct heated triodes in a singled ended configuration is that they can come very close to approaching the "ideal" harmonic structure. No other device can, not even other tubes. And they can do this with little change in the harmonic structure a different frequencies and power levels. Again, something no other device can do.

But what about amps with 0.0001% THD? Shouldn't they be better? By that number, they should be. But that does not tell us what the harmonic structure is. And the ear is very good at hearing those harmonics, even if they are tiny. Also, those amazing numbers are usually taken only at 1Khz and a fixed level. That is far form the whole story. The harmonic structure determines the sound of the amp.

Short end of the story. Harmonic structure relates best to what and how we hear. THD does not. It's more complicated than that, but that gets us started.

Subject: Re: Why SE in SET amps?
Posted by Wayne Parham on Tue, 25 May 2010 15:25:43 GMT
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Remember that little pamphlet called "A Taste of Tubes"? I always thought that did a pretty good job of introducing the subject for those that have never tried SET amps for themselves.
What's good about tubes?

Subject: Re: Why SE in SET amps?
Posted by Thermionic on Wed, 26 May 2010 05:38:20 GMT
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Pano wrote on Sun, 23 May 2010 17:54Harmonic structure relates best to what and how we hear. THD does not. It's more complicated than that, but that gets us started. A good SET amp does not give dominant even order harmonics, it give a very regular fall off of all harmonics, odd and even. This is very important.

Welcome to ART, Pano! A great post; thank you for making this very important statement.

It's often said that "even order harmonics are good, and odd order harmonics are bad," but that stops short of telling the whole story. While it's indeed true that odd orders are more dissonant than even orders, the big picture is that the higher the overtone series of the harmonic distortion products present, the worse the amp will sound, regardless of whether the distortions are odd or even order in nature. The other facet of this is that all harmonic distortion products are just that, distortion, and represent a deviation from the original input signal.

In light of that fact, I've always maintained the position that SET amplifiers sound good in spite of their high 2nd harmonic content, not because of it as many contend. As Pano noted, it's because their distortion spectrum typically drops off like the proverbial rock past the 2nd harmonic, leaving them relatively void of high order harmonics (both even and odd). In agreement with Pano's post, I've found during my 25 years of experience with tube amplifiers that this end is best achieved by using highly linear, low-mu triodes. How you operate them is also highly critical, with load impedance and bias point being major determining factors in the all-important harmonic distortion structure.

Matts wrote on Tue, 17 November 2009 11:38My guess is there are some micro-variations in the a.c. signals that are lost when a neg. feedback loop "blends" slightly different parts of the signal together, and this causes some loss of the cues that give our brains the sense of "live" music.

Yep, for sure. The error signal in a global NFB loop is always time-delayed and phase-shifted with respect to the main throughput signal, so that the two cannot ever "mesh together" perfectly. This is mainly caused by the reactance of the signal path capacitors and the output transformer.

Also, as Wayne stated, the error signal will always be tainted by the back-EMF from the speaker drivers, which itself is phase-shifted as it travels back through the crossover network and speaker cables. In short, it's impossible to fix something that's broken with something else that's broken even worse.

While global NFB does greatly lower the overall THD, it multiplies the remaining distortions into higher, more dissonant orders. In a sense, you distort the distortion, so to speak. My take on the

matter is that if avoiding this means you must end up with an amp that produces only 2 watts per channel, then so be it, because sound that's been repaired is never as good as sound that wasn't broken in the first place. By all means, I'd much rather listen to mindblowing sound at mundane levels, than mundane sound at mindblowing levels. Besides, I'm too old to handle it loud any more.....

Thermionic

Subject: Re: Why SE in SET amps?
Posted by Thermionic on Wed, 26 May 2010 06:00:04 GMT
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Pano wrote on Sun, 23 May 2010 17:54But what about amps with 0.0001% THD? Shouldn't they be better? By that number, they should be. But that does not tell us what the harmonic structure is. And the ear is very good at hearing those harmonics, even if they are tiny. Also, those amazing numbers are usually taken only at 1Khz and a fixed level. That is far form the whole story. The harmonic structure determines the sound of the amp.

Indeed! So true! THD tells you absolutely nothing about how the amplifier will sound. On that note, below is an excerpt from a white paper I wrote on THD and IMD a few years back, that I'd like to share. I apologize that much of it has already been covered in this thread, but I had to include it so that what hasn't been covered will make sense.

"Besides the psychoacoustic effects of different orders of harmonic distortions, perhaps even fewer people understand how "on-paper" distortion percentages correlate to the ear's actual perception of them. If you test an amplifier on a harmonic distortion analyzer, and it tells you there is 1% THD, does that mean there's really 1% THD? The answer is yes, and no. The analyzer measures the distortion as a voltage that represents a percentage of the main signal voltage, not its actual sonic perception. Or, as I like to put it, "Test equipment ain't got ears. People do." However, some simple math can provide a relative conversion from volts to perceived sound pressure level.

The HD analyzer tells us that we have 1% THD, which is about 40dB below the fundamental. Converting -40dB to wattage would be 1/10,000 of the full power, which with a 10 watt amp cranked to the point of clipping would be 1 milliwatt worth of distortion. Now, here's where we get down to the nitty gritty.....

These wattage/percentage figures do not tell us how they will be perceived by actual human ears, because the ear does not perceive volume in a linear manner, but on a logarithmic curve. To net a doubling of perceived volume (approximately equal to 10dB) requires 10 times the power; likewise a halving of the perceived volume requires cutting the power by 10 times. So, -40dB roughly represents an actual 16:1 ratio to the ear's perception, not a 10,000:1 ratio as indicated by the voltage percentage, because the ear hears -10dB as one-half the volume, -20 one-fourth the volume, -30dB one-eighth the volume, and -40dB as one-sixteenth the volume.

OK, now let's see what 1% measured THD really sounds like to real human ears.

100% ÷ 16 = 6.25%

This illustrates how the ear can very easily pick out tiny percentages of high order harmonics. Consider a nasty high order harmonic that's buried -80dB down. To the ear, a 7th harmonic at -80dB sounds like 3.1% 7th order distortion, very offensive indeed! Add all the other harmonics from 3rd through 6th with it, and you've got yourself a real mess! Then, consider that when listening to music you're not dealing with a single frequency as in an industry-standard THD test, but a very complex arrangement composed of a nearly infinite number of simultaneous frequencies. Once again, psychoacoustic effects carry far more weight than measured specifications on paper!

Finally, as if things weren't already bad enough, we have a lot more than harmonic distortions to contend with. We have non-harmonic intermodulation distortions too! Any time you put two frequencies together you create two new ones, which are the sum of the two and the difference between them. These are, not surprisingly, called the quadratic sum and difference frequencies. Most of the time, the resulting intermodulations are musically unrelated to the original frequencies and therefore horribly dissonant.

Let's use a 440Hz sinewave as an example, which is the tuning standard for musical instruments. It is the open A string of the guitar, the A note above middle C on the piano, and two octaves below the open A string of the violin.

If we add an 880Hz sinewave with it (which is an A note exactly one octave higher), we'll have the original 440Hz and 880Hz frequencies, plus the sum frequency of 1.32kHz and the difference frequency of 440Hz. 1.32kHz is an E note, which is a musical fifth above the 880Hz A note and equivalent to the 3rd harmonic of the 440Hz A note. Not too terribly dissonant sounding, by any means.

Interestingly, if we superimpose that 1.32kHz E note sinewave over the 440Hz A note, we'll get:

Sum: 440Hz + 1.32kHz = 1.76kHz
Difference: 1.32kHz - 440Hz = 880Hz

Notice that 1.76kHz is exactly one octave above 880Hz, or two octaves above our original A-440 note. Therefore, we still have A notes and an E note! This illustrates how low order harmonically-related tones intermodulate to form harmonically related tones of similar nature.

Now, let's move on to a higher order, yet still harmonically related tone, intermodulate it with our A-440 note, and see what comes out. Let's use a musical third, that's in the third octave above the fundamental. This would be a C# note, which would correlate to a 5th order harmonic relative to the A-440 fundamental.

Sum: 440Hz + 2.217kHz = 2.657kHz
Difference: 2.217kHz - 440Hz = 1.777kHz

The resulting intermodulation frequencies are musically unrelated to both the original fundamental tones. The sum frequency falls between a musical E and F in pitch, and therefore that frequency will be dissonant regardless of what the original fundamentals were. The difference frequency is

17Hz sharper than the nearest actual note (an A note), so that it would sound something like two musicians playing the same piece together but with their instruments badly out of tune with each other, which makes for a rather hair-raising discordance.

From these simple examples, you can see two things become very clear when we relate this concept to harmonic and inharmonic distortions in amplifiers. One, the more frequencies that are simultaneously present in the music, the more intermodulation distortions you'll have. Two, high order harmonic distortions give way to some very dissonant intermodulations. These IM distortions are a chief reason why many amplifiers are harsh and fatiguing to listen to, and sound homogenized and congested when playing complex passages."

Thermionic

Subject: Re: Why SE in SET amps?
Posted by Thermionic on Wed, 26 May 2010 06:00:39 GMT
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Wayne,

BTW, thanks for the link to the "A Taste of Tubes" PDF. I've thus far only skimmed across it quickly, but it looks like some great info and fun reading.

Thermionic

Subject: Re: Why SE in SET amps?
Posted by Wayne Parham on Wed, 02 Jun 2010 18:40:13 GMT
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I was talking with Pano last night about tubes verses solid state, and our conversation drifted to the difference between circuits with feedback verses those without. Made me think it might be useful to bring that up again in this thread.

There was some discussion of feedback earlier, in the beginning of this thread. A search of the archives reveals some more real interesting information, complete with links to thesis papers and other documents on the subject. I've cherry picked a few threads below:
Feedback
Output impedance and reactive loads
new amplifier methodology
Glossary
