Subject: Quick and simple formulae for Ra
Posted by Damir on Wed, 26 Jan 2005 20:14:26 GMT
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In transformer - coupled output stage with output triode we must do a graphical load - line analysis to find load resistance Ra (primary resistance, or reflected secondary load). Ra is max. AC voltage "swing" divided with max. current "swing" through the load, orRa = Ua pp/ Ia pp = Ua p / Ia p = Ua rms / Ia rmsPower at the primary: Pa=Ua rms^2 / Ra = Ia rms^2 * Ra = Ua rms*Ia rmsNote that Ia p = Ia dc, Ia pp = 2*Ia dc, Ia rms = Ia dc / 1,4142The "goal" is to avoid graphic analysis, and find the simple formulae, "good enough" for "everyday use". Our triode output tube with its "bias" Ugk, can have max. peak AC input voltage in class A1 equal to Ugk, or Ugk rms = Ugk/1,4142.With very high load Ra, AC voltage at the load Ra is:Ua = mu * UgkBut, our "real" load Ra form voltage divider with tube plate resistance rp, and voltage at the load Ra is actually lower:Ua = (mu * Ugk) / (1 + rp/Ra)And from Ra = Ua / Ia, we have Ua = Ra * IaIf we put together these equations:Ra*Ia = (mu*Ugk)/(1+rp/Ra), and Ra*Ia = (mu*Ugk)/((Ra+rp)/Ra), andRa*Ia = (Ra*mu*Ugk)/(Ra+rp), and Ia = (mu*Ugk)/(Ra+rp), andRa+rp = mu*Ugk/Ia, and finally:Ra = ((mu * Ugk) / Ia) - rp FORMULAE FOR RaWhat does this mean in practice? If we have some DC operating point for our output triode, say 300B - Uak=400V, Ia=80mA, Ugk=-85V and we know (about) rp and mu from tube manuals (simplification, assumed that rp and mu are constant, but error is minimal and negligible). Say, rp = 700 Ohms and mu = 3,9. Then:Ra = ((3,9 * 85) / 0,08) - 700 = 3443,75 Ohms ~3,5 kOhmsIn agreement with load - line analysis and tube manual data!

Subject: Re: Quick and simple formulae for Ra
Posted by Manualblock on Wed, 26 Jan 2005 20:44:43 GMT
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Thanks for taking the time to do these tutorials. It is very kind and generous and well appreciated.

Subject: and now to include "air resistance"
Posted by PakProtector on Fri, 28 Jan 2005 01:14:27 GMT
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a.k.a. changing plate z. Drawing the 3k5 load line on the WE 300B curves shows a significant variation in plate z from one end to the other. Less variation from idle to g1=0, but from idle to g1=cut-off the variation is more pronounced and damping factor goes from 5:1(3k5 load/700R plate z) to a significantly lower number. I suspect this effect is responsible for some of what is referred to as SE magic. change in output z dependant on position on the waveform. Looks to vary a lot more than Class A PP. I do prefer to listen to PP power stages, and am always searching for an answer to the 'WHY' question...regards,Douglas

Subject: Re: and now to include "air resistance"
Posted by Damir on Sun, 30 Jan 2005 07:46:36 GMT
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Wonderful world of tubes .Formula has it`s limitations, it is based on the analysis of the typical DHT output stage, where close to the max. power is the goal, and is assumed that current swing through the load is maximum, or from zero to the value 2*Ia dc. Formula gives such Ra with Ua/Ia proportion as described, and is not effective in the area close to the Ug=0 line - resultant load line is too steep...For example, for AD1 tube (close to 2A3), OP 250V/-45V/60mA and rp~670 Ohms, mu~4 , Ra is:Ra=(Ugk*mu)/Ia - rp = (45*4)/0,06 - 670 = 2330 OhmsJust like reccomended Ra=2k3 in manuals. But, if you want the "extreme" OP, say 100V/-5V/90mA, then Ia can`t "swing" from 0-2Ia dc value and formula can`t give the "right" result, you must "compensate" it with real current swing...

Subject: Re: and now to include "air resistance"
Posted by Manualblock on Sun, 30 Jan 2005 16:32:35 GMT
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Do you guy's agree with this? In Class A1 PP The magnetizing effects of the DC on the Iron core cancels out. Therefor there can be no DC saturation in the core of the output trans regardless of how great the average plate current may be. The incremental inductance will be higher and therefor will improve low-freq response. Large variable plate current will produce proportionate changes in the magnetic flux rather than be distorted by the saturation bend in the magnetisation curve of the iron.

Subject: Re: and now to include "air resistance"
Posted by Damir on Sun, 30 Jan 2005 17:02:22 GMT
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My toroidal PP OPTs have Lp=490H, and my "C"-core SE OPTs have Lp=22H, both are 3k primary devices:-). Later can stand 80 mA of DC current, but former maybe few mA before degradation of sound, and few more mA - DC saturation buzz. DC cancelation/adjusting between the PP pair is critical, depends of the OPT - toroids are more sensitive.High primary inductance is one of the most important factors in getting "clean" bass/overall sound, low Lp OPTs sounds "warmer" (more distorted, if you like)... There`s entire chapter about that in the book "Modern High-End Valve Amplifiers" by Menno Van der Veen - higly recommendable.

Subject: Re: and now to include "air resistance"

Posted by Manualblock on Sun, 30 Jan 2005 18:48:18 GMT
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Much Thanks; I guess that's the book to read.

Subject: Re: and now to include "air resistance"
Posted by PakProtector on Sun, 30 Jan 2005 19:15:10 GMT
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Hey-Hey!!!,You can still saturate a core with AC. It is inversely propprtional to freq. Drop into the subsonic and start increasing the voltage, and you can damn well be sure, at some point you'll run out of core.AC flux is also proportional to turns count squared, and to core area. This is why you should be sure that the audio PS Iron is wound with enough turns on ots primary, other wise it will hum and buzz with no load. This is because the bloody core is satruating(it will get hot too soon enough).regards,Douglas

Subject: Re: and now to include "air resistance"
Posted by Manualblock on Sun, 30 Jan 2005 21:32:19 GMT
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Thanks T; even though this engineering is mathematically derived; there are so many Opinions that for a novice it is daunting. Maybe opinion is too strong a word but there seems to be so many preferences, lets say.In the above equation is Ra called Ro in some textbooks?

Subject: opinions
Posted by PakProtector on Sun, 30 Jan 2005 22:01:21 GMT
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my opinion is that until there is some easily(and universaly) recongnized abbreviation, that it should be explained in every text before(or immediately after) using it. regards,Douglas

Subject: Re: opinions
Posted by Manualblock on Mon, 31 Jan 2005 00:24:13 GMT
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O'Kay so Ra is the plate to plate load impedance?

Subject: ooops....
Posted by PakProtector on Mon, 31 Jan 2005 00:40:24 GMT
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hey-Hey!!!,my bad, I forgot to answer the question. I got distracted in my ranting...Ra is the SE load in the example given. You'd double its value to expand the model to PP.regards,Douglas

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Subject: Re: ooops....
Posted by Manualblock on Mon, 31 Jan 2005 01:05:27 GMT
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Ranting??? I didn't hear no stinkin' ranting. Was that what that waaas??Seriously Looking at the post I may have mis-phrased that, please allow this old man to slip up one time.So that means it is the load impedance reflected to the full primary by the load on the secondary? For PP that is.BTW your pre-amp sure looks nice. There is a total of 8 tubes? And those three corner screws go into a corner block? Thanks for the hand-holding; figuratively that is.That Transformer; is that a Heybeour? The OPT on the right, nice and shiny, hope mine looks like that! I like the way those coke-bottle 6L6's look BTW if you are considering the amp circuit.

Subject: Re: ooops....
Posted by PakProtector on Mon, 31 Jan 2005 01:16:06 GMT
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Hey-hey!!!,The black TX behind the capacitor(silver cylinder) is the 8039 Heyboer choke. 30 Hy at adequate DC output and designed for L-C service.the grey box is a Paeco from a HP timer. It ran about 35 12AU7's with a regualted power supply.The three holes in the front right are for the volume pot and the two input jacks. I wanted short enough runs to avoid shielding if possible. There are two holes in the back behind the amplifier section for the output jacks.The PS runs two damper diodes, 6AX4's and the amplifier runs 1 12B4 and two 12BY7's per channel. The 12BY7's form the active load/output bufer like the cascode MOSFET circuit used in Guinevere's plate loads. I hope it works, I haven't tried it yet...regards,Douglas

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Subject: Re: ooops....
Posted by Manualblock on Mon, 31 Jan 2005 03:03:44 GMT
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Sounds good. Let me digest that. Thanks Much.