04-27-2012, 09:29 AM #1

ilya-v
Member

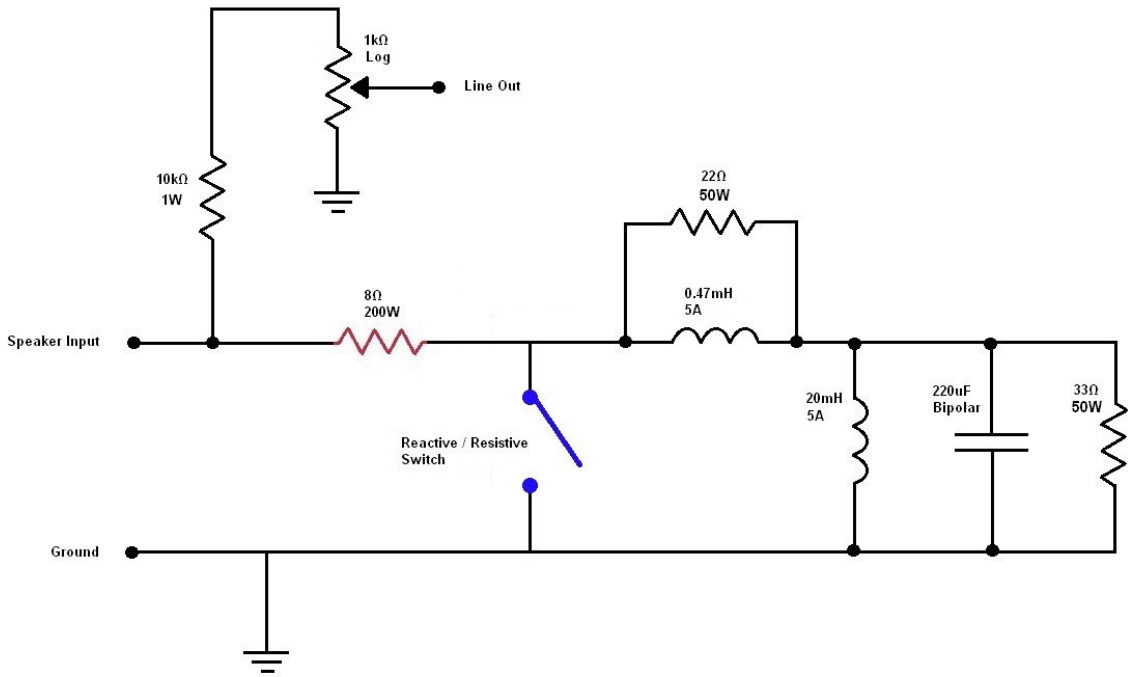
Join Date: Sep 2010
Posts: 196

Aiken's Reactive Dummy Load.

I have been planing to build a good dummy load box to my tube amp with
a line-out, then re-amp with a quality Solid-State Power Amp into my Guitar Cab.

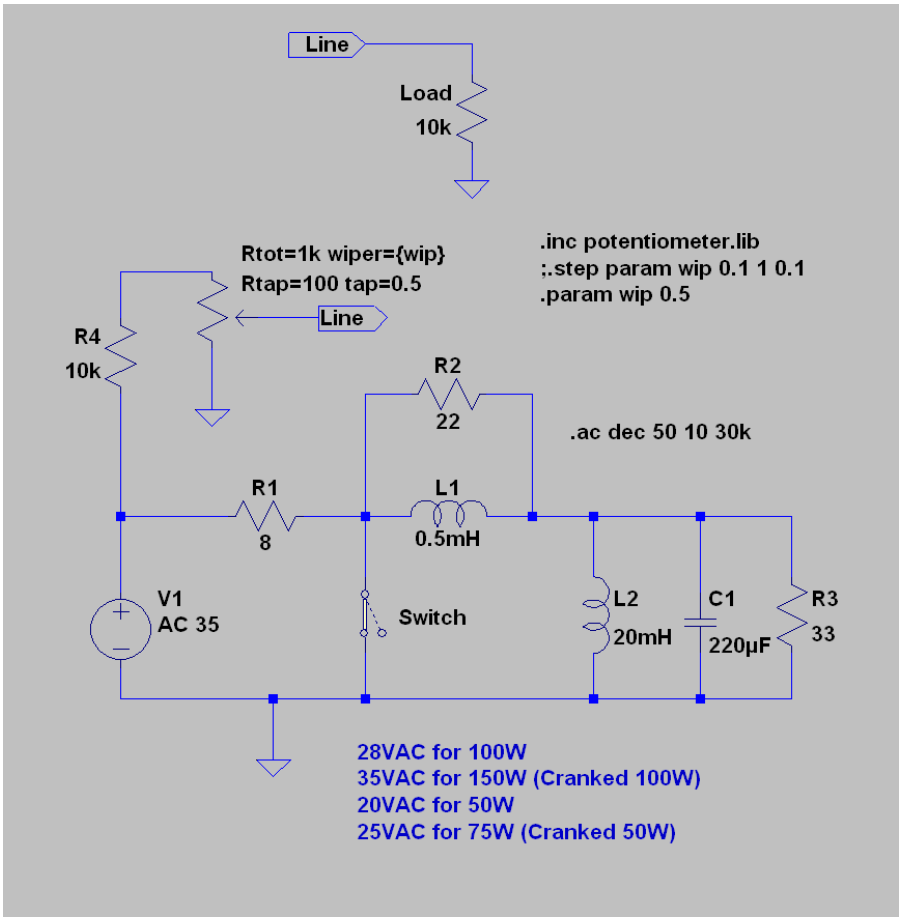
After some research Aikens design seems to load the Tube amp like a speaker would.
http://www.aikenamps.com/spkrload.html
It includes the resonant peak at the Low frequencies and the slope at the highs.
It appears that the big $$$ attenuators are doing just that.
Weber, Aracom, Ultimate Attenuator, Power Brake, etc..

Here is my version with a switch between Resistive and Reactive:

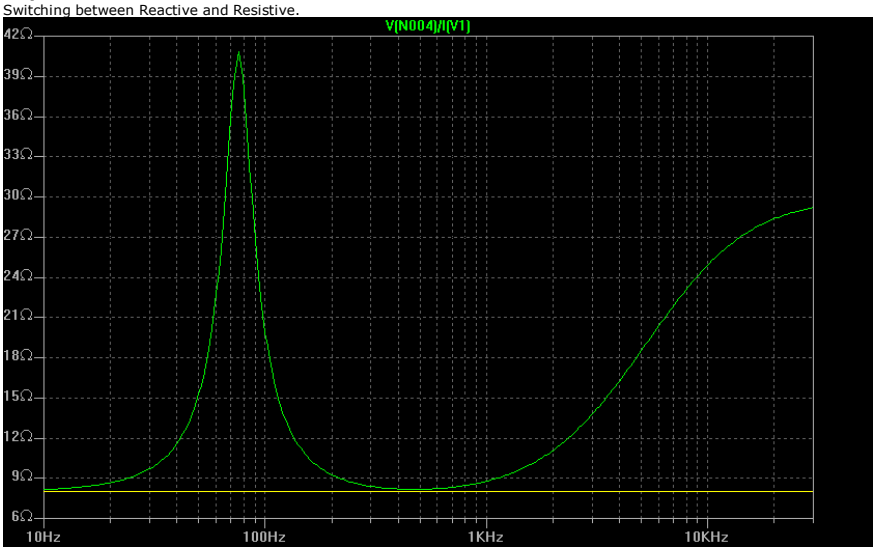


***All measurements are at 150W (Cranked 100W Tube Amp).**

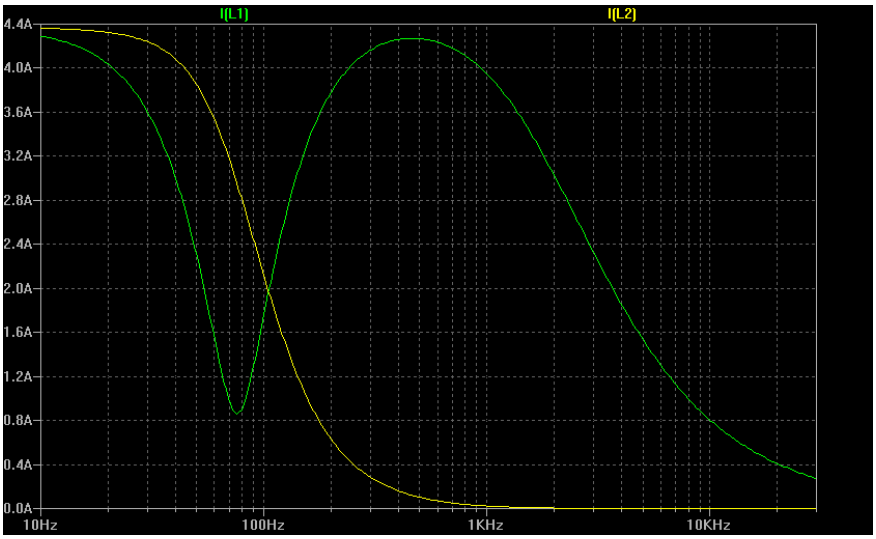
LTSpice Redraw:
With line-Out and the Line-In Load.



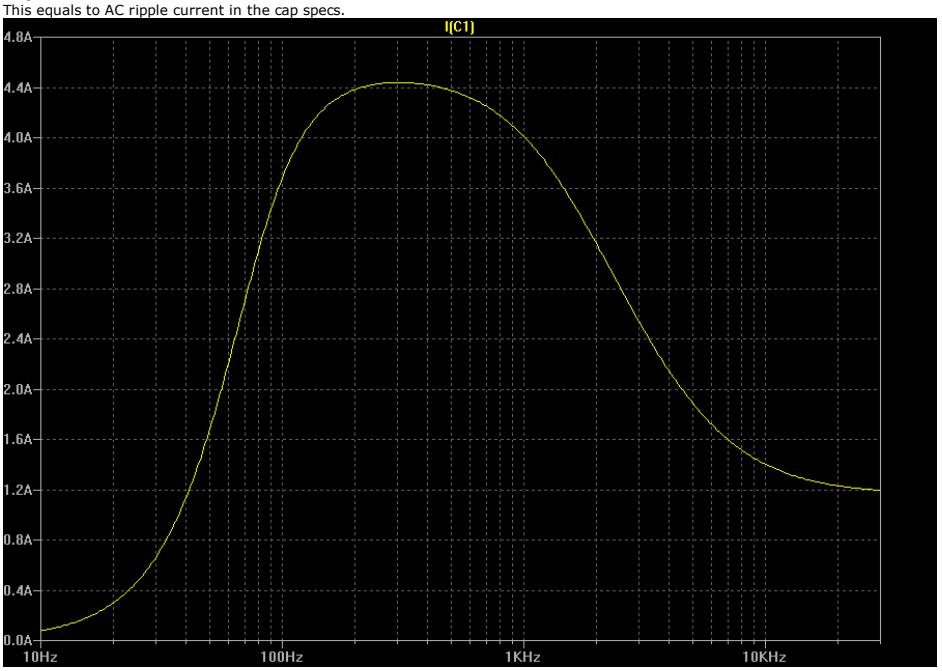
Impedance Curves:
Switching between Reactive and Resistive.



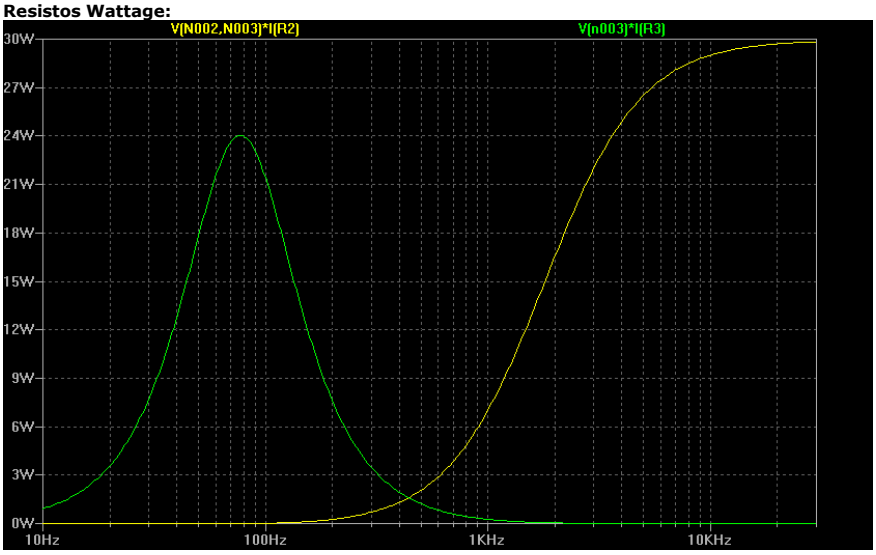
Inductors Currents:



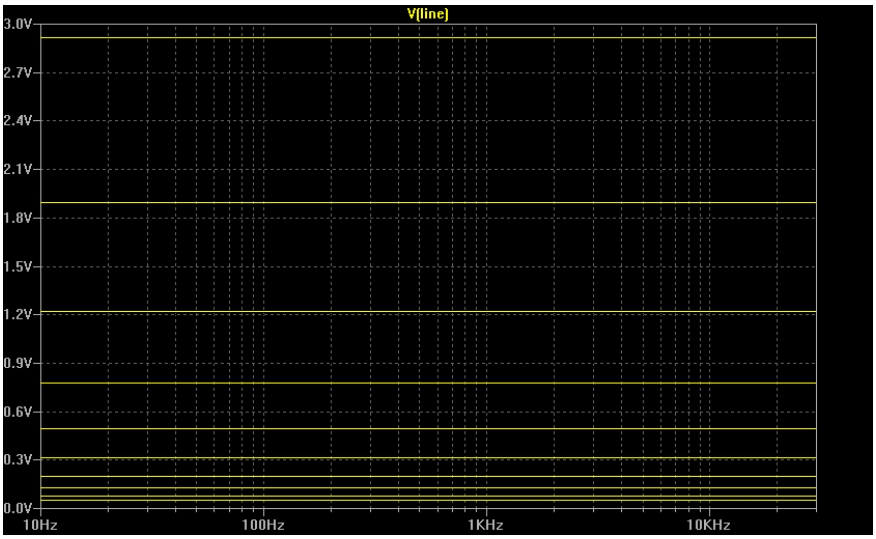
Capacitor Current:
This equals to AC ripple current in the cap specs.



Resistos Wattage:



Line Out Pot Steps:
Line Out Voltage 0 to 10 on the pot.



I'm also winding my own Inductors because the 20mH 5A is nowhere to be found.
I am using these calculators for the inductors:
http://www.nessengr.com/techdata/toroid/toroid.html
http://hyperphysics.phy-astr.gsu.edu...ic/indtor.html

Use this web site to measure Inductance/Capacitance with just a multimeter and a sound card:
(*TESTED this website and works like charm and very accurate).
I use my DAW with an Oscillator plugin to tune the frequency and volume (output voltage).
Guitar Jack to resistor to 2 crocodiles for quick component change.
http://www.edn.com/article/511051-Ci...inductance.php

In Google using these equations:
L = R/(2pi*f*sqrt(Vin/Vout)^2-1)
C = (sqrt(Vin/Vout)^2-1)/(2pi*f*R)

EDIT:
Changed everything to eliminate confusion for newcomers.

Last edited by ilya-v; 05-04-2012 at 10:26 AM.

Quote

04-27-2012, 10:02 AM #2

pdf64
Senior Member

Join Date: Aug 2008
Location: Staffordshire, UK.
Posts: 877

A voltage source is pretty far from being equivilant to a tube guitar amp.
Due to the source impedance, the voltage output will rise with the load impedance.
Unfortunately, with a marshall etc, the source impedance with vary according to the presence control setting, the overall feedback ratio etc.
Open loop may be 50-100 ohms.
Pete.

Quote

04-27-2012, 10:06 AM #3

teemuk
Senior Member

Join Date: Apr 2009
Posts: 1,660

> Quote:
> It appears that the higher the Impedance the lower the Power at that point.
> Means the highs are cut (Low-Pass), with a dip in the Resonance frequency.

If plotted in current. If plotted in voltage the amp's gain at those frequencies will increase. ...or at least it will if the amp has a poor damping factor. Amps with lots of negative feedback will actully try to produce a very linear output even to such load.

> Quote:
> On the contrary, the purely Resistive load the is dead flat across all its frequency range.
> Any WAY easier to build.

Yep, and the very same dead flatness is why people do not really prefer purely resistive dummy loads and instead try hard to mimic the characteristics of an actual loudspeaker.

> Quote:
> My point is Aikens Reactive Load is actually worsens the high frequency
> response and makes the sound even duller which is the main complaint with attenuators.

Nope. It will actually make it brighter because the gain increases at higher frequencies and at the resonant frequency. It will be a totally different sound - not to mention very different behaviour when the amp is overdriven into clipping - than what you would get with a purely resistive load. The main complaint about attenuators is that coupling a basic resistive attenuator to a reactive load will damp the peaks in impedance and the amp's response becomes too linear.

Have you actually build either and compared the difference?

I also see you are taking a line out for - what I assume - some sort of reamping purposes or as a DI output. Note that it will not sound like a real loudspeaker unless you also include circuitry that mimics the loudspeaker's frequency response. Speaking about brightness... without a cabsim it will probably have way too much of it and sound fizzy as hell.

Quote

04-27-2012, 10:42 AM #4

ilya-v
Member

Join Date: Sep 2010
Posts: 196

> Quote:
> Originally Posted by **teemuk**
> *Nope. It will actually make it brighter because the gain increases at higher frequencies and at the resonant frequency.*

Perfect. Exactly what I wanted to hear.
My Wattage plot is reversed.

> Quote:
> Have you actually build either and compared the difference?

Still waiting for parts from Ebay.
I WILL post everything including the process of winding the inductors.
Build process, and finally some good sound clips for comparison.

I am going to compare the output from my Zero-Loss FX Loop (pure Preamp), to
at low output volumes (PI & Power tubes not clipping) from the dummy load
to hear if there is any difference between Reactive & Resistive Loads before the Power amp distortion comes into play.
Then I'm going to crank the hell out of them poor tubes and Compare the Loads again.

It will be a huge favor for the Tube Amp world.

> Quote:
> I also see you are taking a line out for - what I assume - some sort of reamping purposes or as a DI output.

In the top of the post I mentioned that its going to be used into a quality Solid State power amp for Quiet to Bedroom levels.
And for recording with some Convolution Impulse Responses.

The only thing that worries me is the Output Impedance of the 5K log pot.
At 50% the output impedance will be close too 500-ohm which is perfect for the Line-In 10K Input Load.
But at 100% the impedance ratio will be 1:2 which is a bit on the low side.
What are the audio-able consequences (except voltage loss) for impedance mismatch?

Thanks for the clarification.

Quote

04-27-2012, 11:50 AM #5

teemuk
Senior Member

Join Date: Apr 2009
Posts: 1,660

Actually the output impedance is at least 47K + something.

That's first part of the voltage divider. The second is the 5K pot with a 10K load on the wiper.

> Quote:
> What are the audio-able consequences (except voltage loss) for impedance mismatch?

Actually we are talking about "impedance bridging". You do not want to match source impedance to input impedance, you want source impedance to be considerably lower than input impedance so that you get the most ideal voltage transfer.

So... as long as there are not mentionable RC filters involved the effect of a poor ratio in an impedance bridge is merely signal attenuation. BUT an important thing is that the low impedance load at the wiper will skew the pot's taper function somewhat since you practically have that load in parallel with the resistance from wiper to common. In your case, a logarithmic taper function turns to something else and this may ruin the sensitivity of the adjustment.

Why not just use a 1K pot and 10K series resistor?

Quote

04-27-2012, 12:31 PM #6

ilya-v
Member

Join Date: Sep 2010
Posts: 196

Thanks teemuk.

Isn't the Impedane of a voltage divider is the two resistors in parallel?
http://webcache.googleusercontent.co...&hl=en&ct=clnk
So anything in parallel with 5k will be less than 5k.
Which giver about 2.8v if the pot is on 100% (5k), with 28VAC (100W at 8ohm Cranked Amp) output.
Which is WAY over the Power amp Line Input sensitivity that is 200mV.
At 50% of the pot the resistance is 500 ohm resulting in a 51.5k to 0.5k divider, and 0.269mV from 28V, that is closer to line level with the Amp fully Cranked.

The Line-Out Divider values came straight from the Weber Mass series.
If the only effect is some pot tapper linearity change then its all good.

10k 1K?
The higher the Divider compared to the 8 ohm Load resistor the less it effects
the whole circuit impedance, but also give higher output impedance (but you already knew that).
The 47K and 5K may be an overkill.
EDIT: 10k & 1k still too big to change the Load Impedance so the schematic is changed to 10k & 1k for better impedance mach with Line-In level.

I also don't want to use active components (Emitter Follower) to keep the impedance low.
No PSU here.

Last edited by ilya-v; 04-27-2012 at 02:05 PM.

Quote

04-27-2012, 01:15 PM #7

ilya-v
Member

Join Date: Sep 2010
Posts: 196

Double post for another question and first post edit heads-up.

IS my 220uF Bi-Polar 50V Capacitor going to withstand the 3.5A+ current?
The max voltage it will see is 25V.

Quote

04-28-2012, 03:47 AM #8

ilya-v
Member

Join Date: Sep 2010
Posts: 196

EDIT:
First page updated.

Obsolete post.

Last edited by ilya-v; 05-03-2012 at 02:02 PM.

Quote

04-28-2012, 09:52 AM #9

reaiken
Senior Member

Join Date: Jan 2002
Location: Greenwood, SC
Posts: 1,461

Quote:

> Originally Posted by **ilya-v**
> *Just to be sure the last question about the capacitor is not answered, anyone knows?*

You have to find a capacitor that specifies ripple current over the frequency range of interest, or calculate the self-heating that will occur with the capacitor's ESR and the RMS current flowing through the capacitor and make sure it doesn't exceed the capacitor's temperature rating. Note that the RMS current will change with frequency. Also note that capacitor ESR and rated ripple current are also frequency-dependent, usually only specified at either 120Hz (for linear power supply applications) or 100kHz or above (for switchmode power supply applications). Side note: The Marshall Power Brake uses a very similar version of this circuit. They have a very dinky little bipolar cap that has been known to fail on occasion, because it cannot handle the ripple current. They also don't limit the high frequency impedance peak, so it can tend to sound a bit buzzy.

You can plot the worst-case RMS current with your spice circuit by putting in a peak-to-peak square wave corresponding to the amplitude you expect to see for the max power you plan to put in. For example, a 100W amp into an 8 ohm load will put out a 28VRMS, or 80V p-p sine wave prior to clipping. When the amp clips, that will become an 80V p-p square wave, which will have more power than the sine wave (twice, to be exact). Since you will likely be using your load for full output stage distortion, you should design it to handle worst-case, or at least enough margin to handle around 1.5 times the sine-wave power (since you won't be running it flat-out constantly, the average power won't be twice the sine wave power).

One tip: If you can't find a suitable bipolar electrolytic, you can make a bipolar capacitor out of two polarized electrolytics connected back-to-back in series (+ to + or - to -). The total capacitance will be half the value of one of them.

Another tip: You can use a simple SPST switch for your resistive/reactive load switch, you don't need a DPST switch (which will break the contact during switching, leading to a momentary no-load condition on the amp). Simply short out the reactive part of the load with the SPST switch. Just connect the switch to short R1 to ground in your spice circuit (the junction of the load resistor and reactive components). Be sure to use a switch rated for the total RMS current the amp will put out.

Yet another tip: Make sure your inductors can handle the current without saturating. If the inductor saturates, the inductance will drop to near zero and the circuit will sound like crap. An air-core inductor would be best because they can't saturate, but they would be rather large. An iron or ferrite core inductor will change inductance depending on the current flowing through it, which may actually be a good thing, as long as it doesn't saturate, because it will make the response more varied with signal level, as you will get with a real speaker.

And a final tip: this circuit is a reactive load simulator only. It does not simulate the frequency response of the speaker. It will sound like crap going straight into a board unless you also build a circuit for your line out that emulates the frequency response of the speaker. This circuit will typically take the form of a 3rd order highpass around 100Hz or so, a 2nd or 3rd order lowpass around 4-5kHz, and a few low-Q notch filters to simulate the mid-band response dips. Without these, the tone will be flat and buzzy. If you don't want to design your own, buy something like an H&K red box or use software speaker simulation. For a typical response plot, see here: http://www.aikenamps.com/Marshall4x12response.htm

If you are just reamping or slaving, you don't need the speaker simulator, but it is still a good idea to roll of some of the highs before going to the slave amp. A simple 1- or 2-pole RC filter at around 5kHz should suffice to take the buzziness out.

Randall Aiken

_____
http://www.aikenamps.com

Last edited by reaiken; 04-28-2012 at 10:30 AM.

Quote

04-28-2012, 01:22 PM #10

ilya-v
Member

Join Date: Sep 2010
Posts: 196

Thank you very much for answering Aiken.

For the cap I will go with a 220uf 100v BP and pray.

80vac p-p (40ac peak) sine is not enough to measure the current ratings?
So for a cranked amp 1.5 x 40 = 60vac (120vac p-p) then measure the resistors watts, inductors and caps currents right?

With Voltage source of 60VAC (instead of 28VAC) the inductor currents should be 7.6A. and the impedance limiting resistors wattage sould be 75W and 88W.
Don't you think its a bit of an overkill?

As for the inductors:
I boughs a Super Ferrite 49x34x16 (mm) toroid cores, with permeability of 2500 & 1mm (18 AWG) Magnetic wire.
The 20mH should be around 100 turns and the 0.5mH about 15, so it will be an easy task.
But I'm afraid it will not be able to handle the 7.6A currents at peak power.

I'm starting to think I should just build the Resistive one.

Thanks for the other tips.

Quote

04-28-2012, 02:50 PM #11

reaiken
Senior Member

Join Date: Jan 2002
Location: Greenwood, SC
Posts: 1,461

Quote:

> Originally Posted by **ilya-v**
> *Thank you very much for answering Aiken.*
>
> *For the cap I will go with a 220uf 100v BP and pray.*
>
> *80vac p-p (40ac peak) sine is not enough to measure the current ratings?*
> *So for a cranked amp 1.5 x 40 = 60vac (120vac p-p) then measure the resistors watts, inductors and caps currents right*
>
> *With Voltage source of 60VAC (instead of 28VAC) the inductor currents should be 7.6A. and the impedance limiting resistors wattage sould be 75W and 88W.*
> *Don't you think its a bit of an overkill?*

No, your math is wrong. If you multiply the current by 1.5, you are effectively multiplying the power by 2.25, not 1.5, because P = I^2*R, or P = E^2/R.

A 100W amp will put out: V= sqrt(100*8), or 28VAC rms sine wave, with a current of I = sqrt(100/8) = 3.5A. The effective power of a square wave of that amplitude would be twice that, or 200W. If you decide to use a 1.5x safety factor instead, the power will be 150W. This would result in a sine wave voltage of V = sqrt(150*8) = 34.6V rms, or a current of I = sqrt(150/8) = 4.3A rms.

However, we are not talking about increasing the sine wave power into the load (although it would give the same result), we are simply taking into account the increase in power that would occur when using a square wave of the same voltage at the 100W sine wave, which was 28VAC rms, or 40V peak. The square wave of 40V peak would result in an RMS voltage of 40V, not 28V, so the resulting power would be 40^2/8 = 200W.

If you simulate your circuit with a spice Vpulse instead of Vsin or Vac, you will be able to measure the increase in RMS current when using a square wave instead of a sine wave, and it should all become clear. The RMS value of a sine wave is sqrt(2) times the peak value. The RMS value of a square wave is equal to the peak value. Since power is equal to I^2*R, or E^2/R, if you increase the peak current or voltage by a factor of sqrt(2), you increase the power by a factor of sqrt(2)^2, or 2. This is why a square wave of the same amplitude as a sine wave would produce twice the power into the same resistive load, all other factors being equal.

In the real world, you typically run into other factors, like power supply sag, transformer and wiring losses, etc., where the amplifier may not be able to put out a square wave of the same amplitude as the clean, unclipped sine wave at max power.

> Quote:
> Originally Posted by **ilya-v**
>
> *As for the inductors:*
> *I boughs a Super Ferrite 49x34x16 (mm) toroid cores, with permeability of 2500 & 1mm (18 AWG) Magnetic wire.*
> *The 20mH should be around 100 turns and the 0.5mH about 15, so it will be an easy task.*
> *But I'm afraid it will not be able to handle the 7.6A currents at peak power.*
>
> *I'm starting to think I should just build the Resistive one.*
>
> *Thanks for the other tips.*

It is not 7.6A, it is 4.3A, if you use a 1.5x safety factor. That is a much more manageable inductor current for the main inductor. The current in the second inductor will be less, because it is split between the inductor, capacitor, and parallel resistor. Your spice sim should be able to tell you the rms current in each component. Note that it will vary with frequency, as the current splits in ratio with the reactance of the components, and in the real world, the signal won't be sitting at one frequency for a long period of time. Also, if your amp has a 16 ohm tap, and you design your reactive load for 16 ohms instead of 8, your inductor currents will be much lower, because the current in a 100W amp at 16 ohms is only 2.5A, and the 1.5x safety factor would result in a current of only 3.1A.

RA

_____
http://www.aikenamps.com

Last edited by reaiken; 04-28-2012 at 03:03 PM.

Quote

04-28-2012, 09:37 PM #12

diagrammatiks
Senior Member

Join Date: Jan 2010
Posts: 2,563

RA, unless the enclosure is size limited would a film capacitor be better then a bipolar electro in this instance?

_____
bros bros bros
bespoke harmonics
toyroom effects
Ataraxia Engineering

Quote

04-29-2012, 03:12 AM #13

reaiken
Senior Member

Join Date: Jan 2002
Location: Greenwood, SC
Posts: 1,461

> Quote:
> Originally Posted by **diagrammatiks**
> *RA, unless the enclosure is size limited would a film capacitor be better then a bipolar electro in this instance?*

Absolutely, if you can find one in that large a value that will fit and can handle the current and voltage. Film caps are way better than electrolytics in every way except for volumetric efficiency and price.

RA

_____
http://www.aikenamps.com

Last edited by reaiken; 04-29-2012 at 04:08 PM.

Quote

04-29-2012, 11:07 AM #14

ilya-v
Member

Join Date: Sep 2010
Posts: 196

Now the cap is the more troublesome part.
I have searched everywhere and there is no 220uF with more than 1A ripple current found.
Of course there are 220uF Ceramics or Tantalum caps but those cost about 100$ for 1 cap.

I'll just buy 2x 470uF 450V (30x50 m"m they are quite big) and do the back-to-back series trick for a non polar cap.
Hope that they dissipate enough heat.

How in the world the audio guys build a crossover with those caps?
Isn't it the same situation here?

Quote

04-29-2012, 01:12 PM #15

diagrammatiks
Senior Member

Join Date: Jan 2010
Posts: 2,563

depends on how big your enclosure is.

Audio cross-overs usually have a lot of space. They usually don't need 220uf either.

but there are plenty of film caps ins 200uf 250vdc.

http://www.parts-express.com/pe/show...number=027-630

http://www.madisoundspeakerstore.com...fast-cap-400v/

I'm sure you could find a polyester version on mouser.

If you need a radial format you have even more choices.

_____

bros bros bros
bespoke harmonics
toyroom effects
Ataraxia Engineering

Quote

Post Reply

Page 1 of 6 **1** 2 3 4 5 6 >

« Previous Thread | Next Thread »

Posting Rules

You **may not** post new threads
You **may not** post replies
You **may not** post attachments
You **may not** edit your posts

BB code is **On**
Smilies are **On**
[IMG] code is **On**
HTML code is **Off**

Forum Rules

Forum Jump
Amps/Cabs Tech Corner: Amplifier, Cab & Speakers Tech Discussions Go

All times are GMT -6. The time now is 11:51 AM.

-- TGP 10th Anny Style