Subject: resistive load
Posted by johnnycamp5 on Thu, 03 Sep 2020 13:30:51 GMT
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In a home hifi system, I often read about how a tube amp (generally) likes a "resitive load".

I'm assuming the loudspeaker usually presents this load?
Is it due to the overall loudspeaker impedance (and its curve)?
The passive crossover components? A combination of these, or none?

I'm certainly generalizing here (or perhaps completely off base)....
so I'm interested in learning more about it.
Any input (or links to the subject) appreciated!

Subject: Re: resistive load
Posted by Wayne Parham on Thu, 03 Sep 2020 14:35:15 GMT
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Most everything "likes" a resistive load for a variety of reasons. The interactions of various kinds of current sources and reactive loads is an interesting topic, so I encourage you to study it. But we can simplify to just one for examination to understand why the loudspeaker's impedance curve interaction with the output impedance of the amplifier modifies the response curve. We can look at the voltage divider created by the amplifier and its load.

The amplifier is never a perfect current source having zero output resistance. The output resistance is generally small, often less than a few tenths of an ohm. But tube amps usually have a little higher output impedance, sometimes even a few ohms. They have so many turns in their output transformers, so there are hundreds of feet of wire in the circuit.

If the source and the load were purely resistive, then the output circuit would be a purely resistive voltage divider, with current constant with respect to frequency. So the voltage division would be the same at any frequency. The output signal across the loudspeaker would be the same at all frequencies.

But loudspeakers usually have crossover circuits and remember that inductors cause impedance rise with increasing frequency and capacitors cause impedance that falls with increasing frequency. A combination of the two of them can cause impedance peaks at resonance or impedance drops at resonance, depending on the configuration. Series connection causes a peak at resonance and parallel causes a dip. Resonance, by the way, is the condition where inductive reactance and capacitive reactance are the same. Said another way, it is the frequency where the impedance of the inductor and the impedance of the capacitor are equal.

Also note that there are mechanical features that act the same as electrical inductors and capacitors. Mass acts like an inductance and (spring) compliance acts like capacitance. So the weight of the cone and the compliance of its suspension tend to make it act reactively. There is also mechanical resistance, and that damps the cone resonance much like a shock absorber does

on a car suspension. These are all reactive elements.

Now consider the interaction of the loudspeaker's reactive load with the amplifier's output resistance. And - just as an aside - realize that the output impedance of the amplifier is at least partially reactive too. It is generally pretty close to being a purely resistive load, but this is less true of tube amps with their output transformer coils. So for now, let's assume a purely resistive output impedance of a few tenths of an ohm to maybe as much as an ohm. This forms a voltage divider with the loudspeaker, which has an impedance curve that varies with frequency. The proportion of signal across the loudspeaker rises when the impedance is high and drops when impedance is low. The current flow through the circuit drops when load impedance is high and rises when impedance is low. So you can see that the signal itself is modified by the changing impedance load from the loudspeaker.

One thing that tends to counter this - at least with respect to the mechanical resonance of the drivers - is that the driver tends to be most efficient in resonance. So even though the motion-causing force from current drops because of the impedance rise at resonance, the efficiency of the driver at resonance tends to counter this. I usually see that a constant voltage across the terminals causes a relatively constant SPL as the signal passes through resonance in a sweep. But even here, the voltage presented to the driver is modified. It's not just a current drop we see from the increased impedance. The voltage divider between the output impedance and the load impedance changes, and this tends to be what changes the response curve.

So the bottom line is that the voltage division between output impedance and load impedance changes with respect to frequency, since the load isn't purely resistive. The current flow through the circuit changes too. That's why amplifiers with higher output impedance are more affected by the load than amplifiers that have very low output impedance.

Subject: Re: resistive load
Posted by johnnycamp5 on Fri, 04 Sep 2020 13:57:32 GMT
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Much obliged Wayne....

Particularly, paragraphs 4 and 5 clear up some notions I had about the subject.
The remainder of your response also answers some of my questions regarding the reaction to a loudspeakers mechanical parameters (the mass and compliance you mention).

Related-
I'm looking to build a pair of corner line arrays (this winter) using 30 full range 3.5" drivers (actually about 2.5") per side..
In this case no crossovers involved, just some dsp is necessary to correct an inevitable 20db falling FR.
Approx. 104" tall, the enclosures are to fit tightly into the left and right front corners.
The front baffle should not exceed 9" wide, roughly 4.5" out from the apex (corner) so shaped like a triangle from an overhead perspective.

I do expect there to be some measured mid range "ripple" but I'm hoping its not too stark for actual listening (enjoyment) purposes..

These drivers have a 8oHm nominal impedance, with a spike to +- 20 oHms at around 125hZ-

https://www.parts-express.com/pedocs/specs/264-1062--tymphany-tc9fd18-08-spec-sheet.pdf

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Subject: Re: resistive load
Posted by Wayne Parham on Fri, 04 Sep 2020 17:32:49 GMT
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Those will be excellent, and no trouble for any tube amp to drive.

issues.

Subject: Re: resistive load
Posted by johnnycamp5 on Fri, 04 Sep 2020 18:04:32 GMT
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These drivers alone are quite "low" sensitivity.

Apparently using 25 in a vertical row (tightly spaced) increase the sensitivity by 10db.

I cant quite understand that, perhaps they obliterate the 1W/1M standard.

Subject: Re: resistive load
Posted by Wayne Parham on Fri, 04 Sep 2020 18:25:29 GMT
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Yes, each driver by itself has relatively low sensitivity. But by having several, you'll increase the sensitivity, just like you said. Double the number of drivers and you'll get 3dB increase. So two drivers is 3dB more sensitive than one, four drivers is 6dB more sensitive than one, and so on.

That's if you keep the impedance the same using a series/parallel arrangement. If you run 'em in parallel, the impedance is cut in half which sort of "cheats" by giving higher voltage sensitivity. What I mean by that is your amp will be supplying more current at a given voltage level, because of the decreased impedance, so that gives an SPL increase too - 'cause the power level has increased for the same voltage drive level. So if impedance changes, we're not comparing apples to apples anymore.

So really, if you just connected two drivers, you'd get a 6dB voltage sensitivity increase - provided the two drivers were connected in parallel. That's because you're get 3dB from the additional driver, and 3dB from the decreased impedance.

Anyway, after it's all said and done, by adding a bunch of drivers in an array, you'll increase the sensitivity as well as getting some other benefits.

Subject: Re: resistive load
Posted by johnnycamp5 on Fri, 04 Sep 2020 20:08:45 GMT
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Yes definitely using series/parallel wiring to retain 8 Ohm load!
According to the attached chart, In the case of 30 drivers there are these 2 examples-

1st-
5 units in parallel (per group).
6 groups of these in series= 9.6 net impedance +14db over single driver.

2nd-
6 units in parallel (per group).
5 groups of these in series.= 6.7 net impedance +15.5db over single driver.

I doubt either way would make an audible difference. Is the second example a more "resitive" load? :lol:

That's if this chart is correct. The math makes sense to me-

http://ratch-h.com/arrayimpedance-revised.html

Subject: Re: resistive load
Posted by Wayne Parham on Sat, 05 Sep 2020 00:13:34 GMT
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The connection topology won't change the reactivity of the load. They're all the same driver, and we're not changing any reactive components or properties. So the reactivity will be the same.

If something is purely resistive, then it is not reactive. So when I talk about the reactivity of the load, I'm also talking how much resistivity is there too. Reactivity is proportions of the inductive, capacitive and resistive elements.

That maybe isn't interesting here as we talk about the possible connections and how they'll affect

sensitivity. But I did want to point out that the reactive proportions won't change when we connect these drivers in series / parallel groups. What will change is the overall average impedance, as

configuration, because it will give a slight increase in voltage sensitivity.
