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.
