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Subject: Electrical filters and Acoustic Filters

Posted by [Wayne Parham](#) on Mon, 19 Sep 2005 13:04:19 GMT

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I've received a lot of E-Mails lately about this particular topic. I'm not exactly sure why I'm the one that has been asked to evaluate this, because I'm not directly involved with the debate. But I've used both electrical and acoustic filters, so I am pretty familiar with it. In fact, everyone that has ever designed a speaker has used both, whether they know it or not. The very nature of the loudspeaker itself - just the raw driver - has three filter functions. It has the electrical filter, formed by the voice coil inductance and resistance. That forms a damped first-order filter, all by itself. So without any additional components, you have a coil and a resistor in the circuit. The output circuit of the amplifier often interacts with the voice coil to form an additional filter. Then there is the mechanical filter, formed by the mass and suspension of the driver. This forms a mass-spring resonator, damped by the resistance to movement. These two interact to form a complex reactive system. So they act like a complex filter, having a resonator and low pass filter combined. Next we have the acoustic filter. This one is even more complex. The size of the radiator sets a wavelength related filter, one that creates collapsing DI and modifies response as a result. The shape of the cone and its stiffness make a non-linear filter. At low frequencies, the driver acts like a piston but at higher frequencies, the cone flexes like ripples on a pond. And of course the cabinet is another filter chamber, adding to the set of filters in the system. So as you can see, a single driver has a lot of filters built-in, even if there are no additional electrical components. No matter what. When designing loudspeakers, it makes sense to look at the broader picture, and to include these things in your analysis. At least being aware of them is a good first start. When discussing loudspeaker cabinet types, it makes sense to discuss the other features, because they are all inter-related. It is probably best to consider driver Qes, for example, when analyzing overall driver suitability and performance in a specific cabinet. But Qes is modified by amplifier output circuitry and by additional components in the circuit. You can talk about a hypothetical voltage source amplifier, one that has high damping factor and no anomalous behavior. That is the normal way to discuss speakers. Or you can consider a specific output impedance, and look at its effects. You can be more general, and talk about a range of values that perform well. But consider this. A constant current source amp is one that acts like it has output resistance. A constant voltage amp is one that acts like it has none, or very little. If you have one loudspeaker manufacturer that finds his speakers work very well with tube amps or constant current sources, he is saying his speakers work best with a touch of series resistance. This increases Qes and tends to increase bass and reduce midrange and treble. If you have another loudspeaker manufacturer that says adding a small value of series resistance acts as a sort of compensation circuit when using solid state amps, then the two manufacturers are saying the exact same thing. These are equivalencies. I hope that helps. There are a lot of good ways to implement loudspeakers. Sometimes it gets confusing, but there are a lot of numbers that add together make 10.