Subject: Speaker damping - Overdamped, Underdamped or Critically Damped
Posted by Wayne Parham on Fri, 12 Feb 2010 04:53:39 GMT
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In resonating systems - whether they are electrical circuits with inductance, capacitance and resistance, mechanical systems with mass, springs and resistance or acoustical systems with mass, compliance and resistance - all resonating systems can be described very precisely in how they will respond to an input stimulous.

If a system is underdamped, that means there is very little resistance proportional to the reactance, which is the coil and cap of an electrical circuit or the mass and spring of a mechanical system. When a system is like that, very little input energy causes wild swings in motion of the resonating system.

Here's an example of an underdamped system. When you see a car going down the street that is bouncing uncontrollably, the shocks are bad so there is no resistance to motion. The weight of the car is the mass and the coil or leaf in the suspension is the spring. When the car hits a bump, the thing seems to bounce forever.

If the shocks were good, it would only go up and down maybe once or twice and the bounce would be over. This is closer to a critically damped system. It is one where the mass is free to move but with some resistance, enough to prevent the system from ringing wildly but not so much as to limit movement excessively.

If the shocks are set very tightly, the spring doesn't really have a chance to "cushion" the mass. The resistance is so great it becomes more of the motion-limiting factor than the spring. This is a condition that is known as overdamped.

In a loudspeaker, there is a range of acceptable values where the sound is good. Anywhere from critically damped to slightly overdamped is fine. You can get away with being slightly underdamped too, although I would caution a DIYer to stay away from underdamped alignments, even if only slightly.

Overdamped speakers tend to sound tight and sometimes a little bit lean. This is because the response rolls off slowly and gradually near cutoff, and there is less energy down low. Underdamped has a hump at cutoff, a peak that can sound powerful but more often sounds unpleasantly boomy, muddy and uncontrolled. So I prefer slightly overdamped to slightly underdamped in almost all cases.

Another thing to consider is the fact that speaker parameters shift, quite a lot actually, in response to varying tempatures and power levels. This is the main reason I suggest to DIYers to choose a slightly overdamped alignment, and almost never design to be underdamped. If a speaker is underdamped at low power levels (where T/S values are measured) then it will really be underdamped at high power levels.

When the speakers are played loudly, the amplifier current heats the voice coil and this moves it towards the underdamped direction. Speaker drivers are also almost always underdamped when

new. So if the loudspeaker system is designed to be slightly overdamped, this is a conservative alignment that will shift from slightly overdamped to critically damped and possibly just a smidge over into the underdamped when power is increased. That's probably the best approach.