Subject: Crossover considerations - power handling, frequency, slope, etc.
Posted by Wayne Parham on Sat, 13 Mar 2010 16:35:54 GMT
View Forum Message <> Reply to Message

All of my speakers, and the components used within (crossovers, drivers, etc.) are rated to take the full listed power. One of the things I take as a design requirement is that the crossover deliver signals that the drivers can handle with respect to bandwidth, crossover slope, etc. I never publish a design that requires a driver or component to be derated due to power - instead, I design the system so it can be used to its maximum potential. Not only does this help protect them, but it also usually makes them sound better because they aren't stressed. Distortion is usually much lower and the overall sound is better when the system is designed this way.

I've examined this in some detail, various crossover types (first through third order, with and without compensation, Zobels, notch filters, etc.) and I've shown an analysis of the voltage (power) levels across each component in the document below:
Speaker Crossover DocumentDrivers usually have to be limited on the lower end (frequency and slope) to protect from overexcursion. Through the passband and approaching their upper range, drivers are more vulnerable to thermal overload, getting so hot the voice coil adhesive fails, unwinds and begins to rub or buzz. Another thing I consider a design requirement is that the components used in the crossover have sufficient voltage and current capacity to handle the full rated power. This usually means selecting capacitors with sufficient voltage limits and choosing resistors with appropriate power ratings. Coils aren't usually an issue, because if they aren't large enough to handle the current, they'll modify the transfer function due to excessive resistance. Most times, if the coil is large enough to sound good, it is large enough to take the current.

To answer your specific question about the DE250, or any of the compression drivers used in my designs, there are two issues to consider where power handling is concerned and my loudspeaker designs address them both quite fully. One is the thermal limit, set by passband power level, and the other is the maximum excursion, usually occuring near the lower cutoff point.

The passband power level is reduced 10dB by the crossover, mostly to match sensitivity with other drivers and to allow passive equalization for mass rolloff. A side effect of this is that it means power input to the loudspeaker system can be 10dB higher than the driver alone could handle. When the loudspeaker system is presented a signal at ~2kHz that would result in 600

tweeter and sets the level, ultimately presenting a much lower signal that dissipates approximately 60 watts in the tweeter. So it is quite safe, nowhere near its limits.

The lower frequency excursion limits are a little more complicated, in that the horn provides acoustic loading and this sets the lower limit to some degree. At frequencies high enough that the horn is providing acoustic loading, excursion is reduced. Below that point, excursion rises rapidly and one thing compression drivers cannot handle is excessive excursion. The diaphragm will literally hit the phase plug and begin to make a clacking sound, sometimes even shatter. Long before that occurs, distortion goes through the roof, so this isn't something you want.

Even where the horn loads the diaphragm, excursion still rises as frequency goes down. So even though the horn is providing acoustic loading, even if it is used above cutoff, this is still not a

guarantee that the driver won't reach its excursion limit. Excursion limits are so small many compression drivers rate them as having 0mm xmax, which isn't really the case, of course, they have to move to make sound. But the point is they are designed to move very little.

It is important to design the crossover so the crossover point is high enough and the slope great enough to reduce low frequency energy. This is what limits excursion - don't allow low frequency signals to be developed across the compression driver. You can get away with first-order slopes on a dome tweeter with wide surround, it has relatively large suspension travel (for a tweeter, anyway) and no phase plug to hit. But you really can't do this with a compression driver, at least not if you plan to ever use more than 10 watts. Granted, 10 watts is plenty loud on a driver like this, but still, I think it's important to design a speaker to allow it to reach its full potential. It lets you crank it up without fear, and even if you never do that, it still is better with respect to distortion.

Of course, all this has to be juggled with other competing priorities. The crossover isn't there just to protect the driver. It also has to achive flat response on-axis, and to provide the right phase relationships between sound sources to put the forward lobe and vertical nulls where you want them to be. Getting all these things right simultaneously is not trivial. But it is possible, and really should be done, in my opinion. Anyone can throw together a crossover that works, but to build a really great loudspeaker, you have to pay attention to all these details, to get them all right.