Subject: Acoustic filter Q and PiAlign's "Qe"
Posted by Wayne Parham on Tue, 05 Feb 2002 04:55:54 GMT
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I received an E-Mail question today and as I wrote my reply, I realized that many of you might have wondered the same thing. So I'm posting my the question and my reply here:"Is there a relationship between how Pialign requests motor Qd as 1/Qts and produces cabinet Qe's above 1, and how motors with lower Qts have better control at resonance, and this books idea of cabinet Q where smaller is more damped. I'm betting that if I used the other set of fomulae, I'd get 1/Qe values. I consider PiAlign cabinets on the over-damped side of things."I understand what you are saying, and you are right in the general trend. You also make an accurate observation when you see that PiAlign tends to generate overdamped cabinets. Oddly enough, the cabinet size is small and this would make a person expect underdamped systems. If the woofer is grossly underdamped, then the system does indeed remain that way. But PiAlign usually favors a small box, tuned from maximum extension to a half octave above maximum extension, and that's how it keeps distortion low. This is a function of Qe, and that's why I say it's not directly related - or inversely related - to the acoustic filter Q you've seen mentioned. Examples of acoustic filter Q included "critically damped" at 0.707. This isn't the same as PiAlign's cabinet Qe or its reciprocal, 1/Qe.So I can see why you've made this inferrence, because many results are between 1 and 2, which would then make it logical to assume the reciprocal were filter Q of 0.5 to 1.0. But it just isn't so. The cabinet Qe is a derived function - It is a function of the distance between Frd and Fre - and as such, is not directly or inversely related to the system's acoustic filter Q. It is a sort of "virtual Q" because it indicates a relationship between Frd and Fre, and is part of the set of functions that describe port size requirements. In this sense, it is like the terms "fs" and "fb" in Davies' 1982 implementation of Thiele's and Small's works. In Davies' work, "fs" is the woofer resonant frequency and "fb" is the box resonant frequency.Filter Q, as one would expect to see it, is more likely to be expressed using the terms "fh" and "fs", where "fs" is again the woofer's resonant frequency, but "fh" is the upper resonant event, or the frequency where the Helmholtz resonator and the woofer cone are maximally coupled constructively. Another frequency of interest in Davies' paper, expressed as "fl" which is the frequency where the Helmholtz resonator and the woofer cone are maximally couple destructively. And the final frequency expressed, more important for understanding of sealed cabinet systems but shown for ported cabinets nonetheless is the term "fo" which expresses the resonant frequency of the woofer, when installed in the cabinet.So the point of all this is that the cabinet Q shown in the PiAlign program (and formula) expresses the ratio of "fs" and "fb" where filter Q is found by using the terms "fs" and "fh". If you are interested, you may find filter Q using the appropriate formulas:Using the PiAlign formulas, you can obtain the Helmholtz frequency "Fre" and then substitute it as "fb" into the following formula for simultaneous solution. Remember that the woofer's resonant frequency Frd=fs, and volumes "Vb"="Ve" and "Vas"="Vad".I retain the author's original terms out of respect to his work, and not to confuse the reader.fo=fs[(Vb+Vas)/Vb]½(fl)(fh) = (fs)(fb)fl2 + fh2 = fo2 + fb2After solving for "fh", you can find the filter Q of the acoustic filter chamber formed by the PiAlign'ed speaker cabinet.Qt = fs/fhAs you can see, this is different than PiAlign's cabinet Qe, which is described as:Qe = fb/2|fb-fs|They are related, but not as reciprocals.