Closed box - Keep it Simple!

2009-07-16 Ask Bojesen

Symbol	Explanation
F_s	Driver Resonance Frequency
V_{as}	Driver volume of air having the same acoustic compliance as the driver suspension.
Q_{ts}	Driver - Total Q-damping at F_s. $Q_{ts} = \frac{Q_{ms}Q_{es}}{Q_{ms}+Q_{es}}$
Q_{tc}	Speaker - Q-damping factor
F_b	Speaker - Resonance Frequency
V_b	Speaker - Inside volume

$$\frac{F_s}{F_b} = \frac{Q_{ts}}{Q_{tc}} \qquad \text{or} \qquad F_b = \frac{Q_{qtc}}{Q_{ts}} F_s$$

$$V_b = \frac{V_{as}}{\left(\frac{Q_{tc}}{Q_{ts}}\right)^2 - 1} \qquad \text{or} \qquad Q_{tc} = Q_{ts}\sqrt{\frac{V_{as}}{V_b} + 1}$$

When using isobaric setup only $V_{as}$is changed:

$$V_{as}^{\text{Isobaric}} = \frac{1}{2} V_{as}$$

Amplitude A at frequency f:

$$A(f) = \frac{f_r}{\sqrt{(f_r - 1)^2 + \frac{f_r}{Q_{tc}^2}}}, \qquad \text{where } f_r = \left(\frac{f}{F_b}\right)^2$$

Observations:

$$A(f_B) = A(f_r = 1) = Q_{tc}$$

$$A\left(f\right) = \frac{f_r}{\sqrt{f_r^2 + 1}}, \qquad \text{for} \quad Q_{tc} = \sqrt{\frac{1}{2}} = 0.707\ldots$$

$$A\left(f\right) = \frac{f_r}{f_r + 1}, \qquad \text{for} \quad Q_{tc} = \frac{1}{2}$$

$$\text{Gain in dB} = 20\log\left(A\right) = 10\log\left(\frac{f_r^2}{(f_r - 1)^2 + \frac{f_r}{Q_{tc}^2}}\right)$$