University of Idaho

Assume $L_b \ll \lambda$, then we can model the branch impedance as a Helmholtz resonator; ..

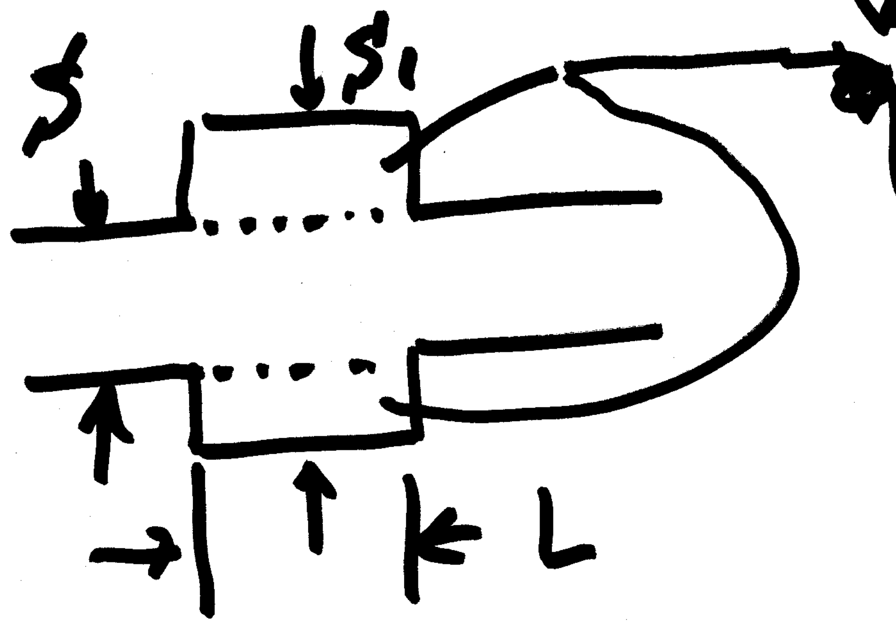
$$\hat{Z}_b = \frac{Z_b}{j\tan kL_b} \approx \frac{1}{j\omega \frac{V}{\rho_0 c^2}} \qquad V = S_b' L_b$$

branch of arb length

$$\Rightarrow \hat{Z}_1 = \frac{\rho c/S}{j\omega \frac{V}{cS} + 1} \Rightarrow \hat{R} = -\frac{j\omega \frac{V}{cS}}{2 + j\omega \frac{V}{cS}}$$

University of Idaho

$$T_\pi = \frac{1}{1+\left(\frac{\omega V}{2cS}\right)^2}$$



$$V = (S_1 - S)L$$

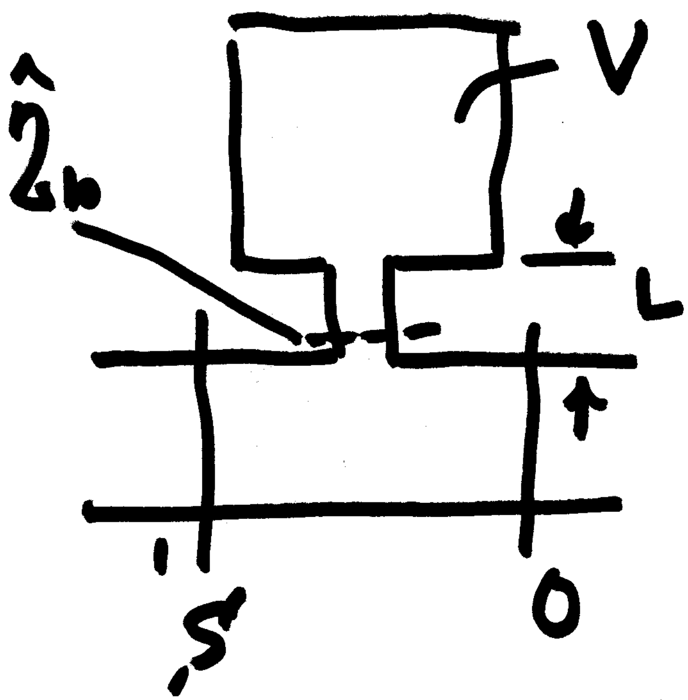
$$T_\pi = \frac{1}{1+\left[\frac{\omega(S_1 - S)}{2cS}L\right]^2}$$

T_π minimum when

$$\frac{\omega}{c}L = \frac{2S}{S_1 - S}$$

University of Idaho

Application 2 - Bandstop Filter



Helmholtz resonator as a branch

$$\hat{Z}_b = j\omega \frac{\rho_0 L'}{S_b} + \frac{1}{j\omega \frac{V}{\rho_0 c^2}}$$

$$\hat{Z}_1 = \frac{1}{\frac{1}{\hat{Z}_b} + 2\frac{S}{\rho_0 c}} \Rightarrow T_\pi = \frac{1}{1 + \left(\frac{c/2S}{\omega L'/S_b - c^2/\omega V}\right)^2}$$

University of Idaho

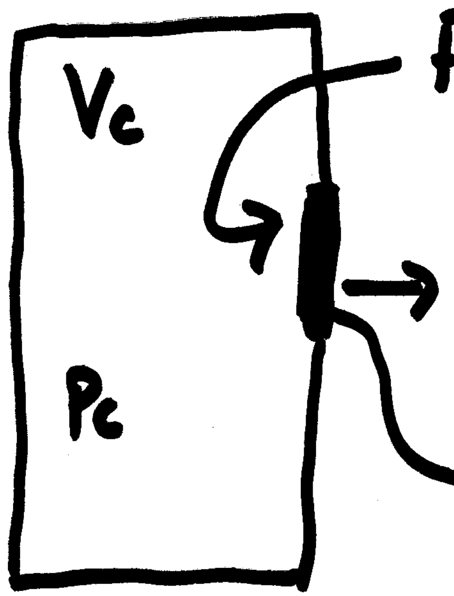
Now, the filter is band stop, and the stop frequency is

$$\omega = 2\pi f = c\sqrt{\frac{S_b}{L'V}} \qquad S_b = \text{Neck area}$$

University of Idaho

Sealed Cabinet Design

Start with a loudspeaker driver, assume that we know the Thiele/Small parameters.



F_e = electromagnetic force to the diaphragm

$x, \dot{x} = u(t), \ddot{x}$

speaker diaphragm, treat as a rigid piston of area S_d

University of Idaho **Write Newton's Law for the Diaphragm**

~~Fa(t)~~ =

$$F_a(t) + (Bl)i = m_d\ddot{x} + R_m\dot{x} + Sx \quad ; \text{NL for dia}$$

$$V(t) = Ri + L\frac{di}{dt} + (Bl)\dot{x}$$

$(Bl), m_d, R_m, S, R$ are the T/S pars for the loudspeaker driver;

$F_a(t)$ = Force of fluid on the diaphragm $= p_e S_d + F_r(t)$

$F_r(t)$: force of fluid on radiating side of dia.