Speaker Crossover

\[ \omega_{-3}(HF) = 1/(R_{HF}C) \]

\[ \omega_{-3}(LF) = R_{LF}/L \]

\[ \omega_{-3}(LF) = \omega_{-3}(HF) \]
Bode Plot: Speaker Crossover

Normalized Frequency

+20. dB
+0. dB
-20. dB
-40. dB
-60. dB

0.01  0.10  1.00  10.00  100.00
Normalized Frequency
Parallel L-C Circuit II

\[ V_{out} = I Z = I \left( \frac{j\omega L}{(1 - \omega^2 LC)} + j\omega L/R \right) \]

\[ \omega_0^2 = \frac{1}{LC} \]

\[ Q = \frac{R}{(\omega_0 L)} \]
Bode Plot: LRC Circuit: $Q=50$
Bode Plot: $Q=50$ (Close-up)
Bandwidth and $Q$

\[ V(\omega_{-3}) = \frac{V(\omega_0)}{\sqrt{2}} \]
\[ V(\omega_{+3}) = \frac{V(\omega_0)}{\sqrt{2}} \]

\[ BW = \omega_{+3} - \omega_{-3} \]

\[ Q = \frac{\omega_0}{BW} \]
Q for Parallel Circuit 2

\[ Z = \frac{j\omega L}{(1 - \omega^2 LC) + j\omega L/R} \]

\[ Z(\omega_0) = R \]

\[ Z(\omega_{\pm 3}) = R/\sqrt{2} \rightarrow (1 - \omega^2 LC) \approx \omega L/R \]

\[ (\omega_0 \pm \delta\omega)^2 \approx \omega_0^2 \pm 2\omega_0 \delta\omega \]

\[ 2LC\omega_0 \delta\omega \approx \omega_0 L/R \]
\[ \frac{\delta \omega}{\omega_0} = \frac{1}{2}(1/2)\omega_0L/R \]

\[ BW = (\omega_0 + \delta \omega) - (\omega_0 - \delta \omega) \]

\[ BW = 2\delta \omega \]

\[ Q = \frac{\omega_0}{BW} = \frac{R}{\omega_0L} \]
Parallel L-C Circuit I

\[ V_{out} = I Z = I \frac{R + j\omega L}{(1 - \omega^2 LC) + j\omega RC} \]

\[ Q = \frac{1}{(\omega_0 RC)} = \frac{\omega_0 L}{R} \]
Q Equations Transform Circuit

\[ Q(\text{series} R) = \frac{\omega_0 L}{R_{\text{series}}} \]

\[ Q(\parallel R) = \frac{R_{\parallel}}{(\omega_0 L)} \]

\[ R_{\parallel}(\text{equiv}) = R_{\text{series}} \times Q^2 \]

\[ R_{\text{series}}(\text{equiv}) = \frac{R_{\parallel}}{Q^2} \]