

Errata for
Introduction to Electroacoustics and Audio Amplifier Design

by

W. Marshall Leach, Jr.

Last revised at 10:30 PM on 4/26/99

Starting 2/2/99, all changes are individually dated.

- Page 9, Table 1.1. Change “Quite” to “Quiet”
- Page 9, 1st line in Paragraph 3. Change “ones hearing” to “one’s hearing”
- Page 15, Fig. 1.9. Change “Compensating E” to “Compensating Low End Rolloff”
- Page 19, Problem 13. Change “[59 dB]” to “[59 dBA]”
- Page 19, Problem 15(b). Change “*SPL* of 90 dB” to “*SPL* of 90 dBA”
- Page 25, line 2 of Eq. (2.25). Change “ ω_{01} ” to “ ω_0 ”
- Page 28, Example 5. Change “sinusoidal sound wave” to “sinusoidal plane wave”
- Page 32, line 4. Change “Eq. (2.38)” to “Eq. (2.37)”
- Page 38, last line in paragraph 1. Change “ $\lambda = C$ ” to “ $\lambda = C/4$ ”
- Page 38, Fig. 2.7. Change the caption to “(a) $\lambda = C$, (b) $\lambda = C/2$, (c) $\lambda = C/3$, (d) $\lambda = C/4$, (e) $\lambda = C/5$, (f) $\lambda = C/10$ ”
- Page 46, Problem 4. Change “characteristic” to “specific.” Change the answer to “[is multiplied by $1/\sqrt{2}$]”
- Page 55, Eq. (3.24). Change “5.09” to “2.54”
- Page 79, Fig. 4.9(a). Change “ R_{M2} ” to “ $1/R_{M2}$ ”
- Page 92, Problem 7. The “ C_{A1} ” and “ C_{A2} ” are reversed in the answer
- Page 97, line 1. Change “Chapter 2” to “Chapter 3”
- Page 97, Replace Fig. 5.5 with the one at the top of the following page

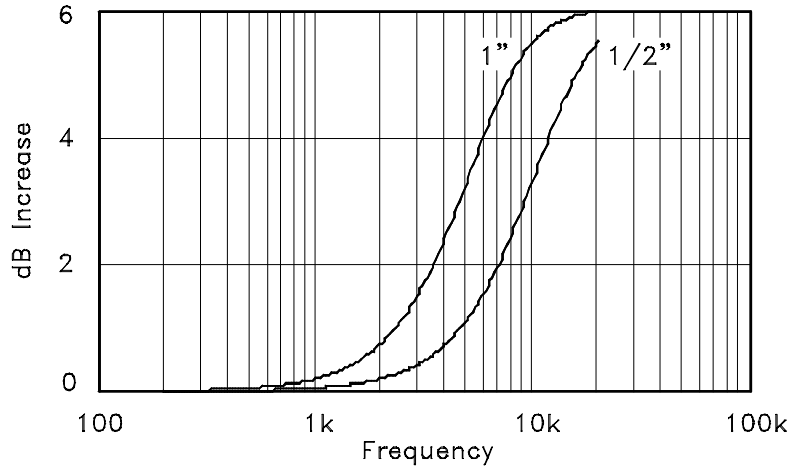


Figure 5.5: dB plots of $20 \log |T(j2\pi f)|$ versus frequency for piston diameters of 1/2 inch and 1 inch.

- Page 107, Fig. 5.15(c). Add a resistor R_{AF} in series with capacitor C_{AB}
- Page 109, Replace Example 1 with:

Example 1 For a diaphragm diameter of 1/2 inch, the frequency at which reflections for normal incidence cause the response of a microphone to be boosted by 3 dB is approximately 9 kHz. It is desired to design a dynamic microphone having a diaphragm diameter of 1/2 inch such that $f_b = 9$ kHz. For $f_a = 40$ Hz, calculate the required resonance frequency and quality factor and plot the expected frequency response both for normal and parallel incidence of the sound wave.

Solution. It follows from Eqs. (5.36) and (5.37) that $f_0 = (40 \times 9,000)^{1/2} = 600$ Hz and $Q = 600 / (9000 - 40) = 0.06696$. The coefficients in the transfer function $T(s)$ given by Eq. (5.1) are calculated from Eqs. (5.2) and (5.3). For the 1/2-inch diameter diaphragm, the coefficients are $b_1 = 2.946 \times 10^{-3}$, $b_2 = 2.408 \times 10^{-9}$, $c_1 = 1.817 \times 10^{-5}$, and $c_2 = 1.204 \times 10^{-10}$. The plots for the frequency response are given in Fig. 5.16.

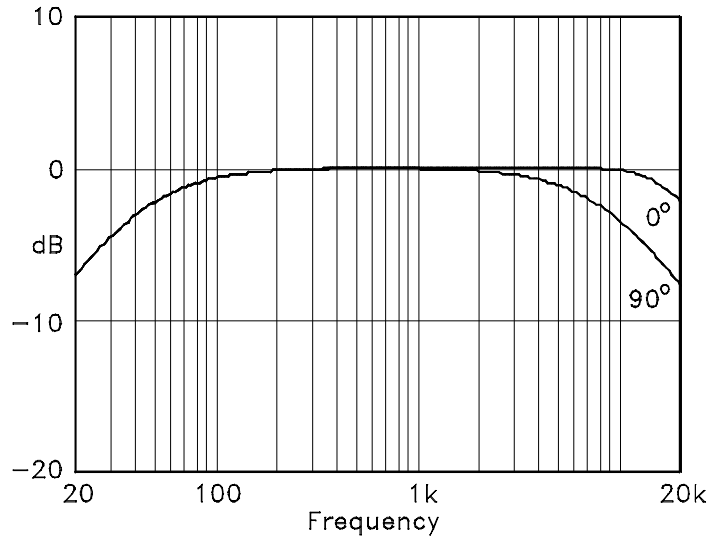


Figure 5.16: Dynamic microphone response plots.

- Page 118, Problem 2. Change parts (a) and (b) to:

- (a) 1/2 inch. [3.37 dB]
- (b) 1 inch. [5.54 dB]

- Page 124, Fig. 6.7. Change the caption for (c) to “Acoustical”
- Page 130, Eq. (6.20). Change “ Q_{TS} ” in the denominator to “ Q_{ES} ”
- Page 154, Problem 6(a). Change “ $2R_{A1} = 11.4 \text{ N}\cdot\text{s}/\text{m}^5$ ” in the answer to “ $2R_{A2} = 25.9 \times 10^3 \text{ N}\cdot\text{s}/\text{m}^5$ ”
- Page 162, equation for B . Change the “3²” to “3³” in the denominator after the second equal sign
- Page 182 (3/16/99), change Eq. (8.6) to

$$Y_{A2} = C_{AB}s + \frac{1}{R_{AL}} + \frac{1}{M_{AP}s} = \frac{M_{AP}C_{AB}s^2 + M_{AP}s/R_{AL} + 1}{M_{AP}s}$$

- Page 182 (4/8/99), Eq. (8.10). Change s^3/ω_0 to s^3/ω_0^4
- Page 186, under Eq. (8.25). Change the rule for choosing the roots to: “For $r < 1$, pick the root that satisfies $d \square r^2$. For $r > 1$, pick the root that satisfies $d \geq r^2$ ”
- Page 187, 1st line under Eq. (8.31). Change “ f_n ” to “ f_1 ”
- Page 191 (3/5/99), change Fig. 8.8 to the one given below.

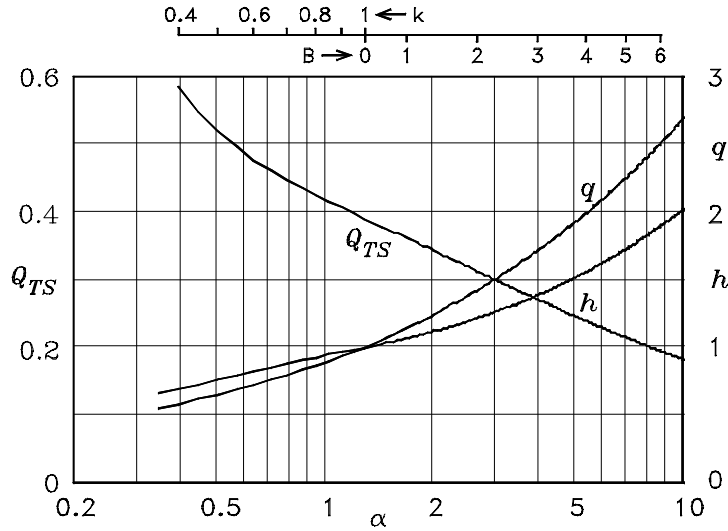
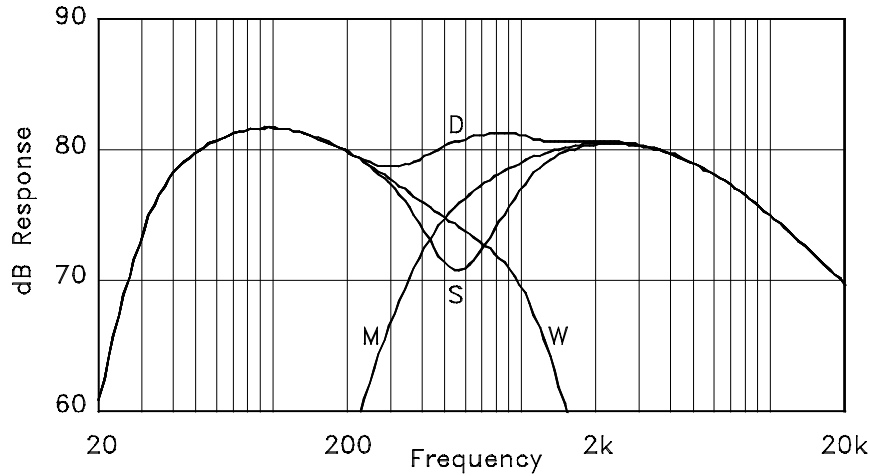


Figure 8.8: Vented-box design chart for $Q_L = 20$.

- Page 195, equation for M_{MS} . Change “0.047.6 kg” to “0.0476 kg”
- Page 196, line 1. Change “ $a_w = 0.12$ m” to “ $a_w = 0.10$ m”
- Page 196, equations for R_{A1P} and R_{A2P} . Change “ a_p ” to “ a_p^2 ”
- Page 196, equation for C_{A1P} . Change “ a^3 ” to “ a_p^3 ”
- Page 196, equations for R_{A1W} and R_{A2W} . Change “ a_w ” to “ a_w^2 ”
- Page 197, equation for C_{A1W} . Change “ a_w ” to “ a_w^3 ”
- Page 198, caption for Figs. (8.15) and (8.16). Change “VD3” to “V3W,” “VD7” to “V7W,” “VD5” to “V5W,” and “VD1” to “V1W”
- Page 199, equations for f_B and L_P in Problem 1. Change “ V_B ” to “ V_{AB} ”
- Page 199, Problem 3. Change the answers to:
 - $f_S = 38.0$ Hz, $Q_{ES} = 0.552$, $V_{AS} = 1.78$ feet³, $\eta_0 = 0.484\%$, $f_B = 32.9$ Hz
 - $f_S = 30$ Hz, $Q_{ES} = 0.468$, $V_{AS} = 3.18$ feet³, $\eta_0 = 0.483\%$, $f_B = 30$ Hz
 - $f_S = 17.4$ Hz, $Q_{ES} = 0.307$, $V_{AS} = 10.4$ feet³, $\eta_0 = 0.469\%$, $f_B = 24.5$ Hz
- Page 218, Eq. (9.28). Change “ Q_2 ” to “ Q_1 ” in the equation for C_2
- Page 223, equation for C_{MS} . Change “ $\sqrt{1 + \alpha}$ ” to “ $(1 + \alpha)$ ”
- Page 224 (3/6/99). Add the following figure to illustrate the effect of adding the matching networks to the midrange voice coil.



Calculated SPL responses after addition of matching networks to the midrange voice coil.

- Page 226, Problem 7. Assume $R_E = 7 \Omega$ for the woofer
- Page 232, 3rd line from bottom. Change “Chapter 2” to “Chapter 3”
- Page 234 (2/2/99), 4th line under Fig. 10.4. Change “ $k_1 = (S_1/S_2)^{1/2}$ ” to “ $k_1 = (S_2/S_1)^{1/2}$ ”
- Page 234, 2nd line from bottom. Change “Chapter 2” to “Chapter 3”
- Page 235 (4/20/99), Fig. 10.5. On the lower center circuit, change 13 to 14, E15 to E25, and R12 to R22.
- Page 235 (4/20/99), Table 10.1. Change the closed parenthesis immediately to the left of each equal sign to a closed brace.
- Page 236 (2/2/99), 7th line from bottom. Change “ $C_{A1} = 29.89 \times 10^{-6}$ ” to “ $C_{A1} = 86.63 \times 10^{-9}$ ”
- Page 236 (2/2/99), 5th line from bottom. Change “ $C_{A1} = 1.913 \times 10^{-3}$ ” to “ $C_{A1} = 5.545 \times 10^{-6}$ ”
- Page 240 (2/4/99), bottom line. Change “ R_{AT} ” to “ Z_{AT} ”
- Page 241 (2/4/99), Eq. (10.31). Change “ $B^2 \ell^2 |e_g|^2 / S_D^2 R_E^2$ ” to “ $|e_g|^2 / R_E$ ”
- Page 241 (2/4/99), Eq. (10.34). Change “ $Q_T = \omega_0 / (\omega_u - \omega_\ell)$ ” to “ $Q_T = \omega_0 / (\omega_u + \omega_\ell)$ ”
- Page 246 (2/4/99), step 1 at top of page. Change “ $\sqrt{45 \times 400}$ ” to “ $\sqrt{40 \times 400}$ ” and “(400 - 5)” to “(400 + 40)”

- Page 248 (2/4/99), step 1. Change “ $\sqrt{45 \times 400}$ ” to “ $\sqrt{40 \times 400}$ ” and “ $(400 - 5)$ ” to “ $(400 + 40)$ ”
- Page 257, Example 3. Change “ $\omega_2 = \sqrt{10}$ ” to “ $\omega_2 = 10\sqrt{10}$ ”
- Page 267, Eq. (11.46) Change the equation for r_e to $r_e = V_T/I_E = 2V_T/I_1$
- Page 270, Fig. 11.20. “ ω_2 ” and “ ω'_2 ” are reversed on the horizontal axis
- Page 276, last paragraph. Change “ C_2 and C_3 ” to “ C_1 and C_2 ”
- Page 277, second paragraph. Change “ C_2 and C_3 ” to “ C_1 and C_2 ”
- Page 306, Problem 2. Change “ ω_0 ” to “ ω_1 ” in the equation for $G(s)$
- Page 322 (4/26/99), Replace the Summary Sheet with the one on the following page.
- Page 327 (3/6/99), Eq. (C24). Change “0.5” to “0.25”

B.7 Summary Sheet

Driver Make and Model _____

Test Performed By _____ Date _____

Voice-Coil Resistance $R_E =$ _____ Piston Radius $a =$ _____

Off Box Resonance Frequency $f_S =$ _____ On Box $f_{CT} =$ _____

Off Box at Resonance $V_B/V_A =$ _____ On Box $V_B/V_A =$ _____

Off Box $R_E + R_{ES} = R_S \times V_B/V_A =$ _____ On Box $R_E + R_{ECT} =$ _____

Off Box $R_1 = \sqrt{R_E(R_E + R_{ES})} =$ _____ On Box $R_1 =$ _____

$V_B = V_A \times R_1/R_S$ at f_1 and f_2 . Off Box $V_B =$ _____ On Box $V_B =$ _____

Off Box $f_1 =$ _____ On Box $f_1 =$ _____

Off Box $f_2 =$ _____ On Box $f_2 =$ _____

Off Box $f_{\text{check}} = \sqrt{f_1 f_2} =$ _____ On Box $f_{\text{check}} =$ _____

Off Box $Q_{MS} = \frac{f_S}{f_2 - f_1} \sqrt{\frac{R_E + R_{ES}}{R_E}} =$ _____ On Box $Q_{MCT} =$ _____

Off Box $Q_{ES} = \frac{R_E}{R_{ES}} Q_{MS} =$ _____ On Box $Q_{ECT} =$ _____

Off Box $Q_{TS} = \frac{R_E}{R_E + R_{ES}} Q_{MS} =$ _____ On Box $Q_{TCT} =$ _____

Test Box Volume $V_T =$ _____ $V_{AS} = V_T \left[\frac{f_{CT}}{f_S} \frac{Q_{ECT}}{Q_{ES}} - 1 \right] =$ _____

Mass Correction Factor $k_M = \sqrt{1 + 10.65 \frac{f_S^2 V_{AS}}{c^2 a}} =$ _____

$f_S/k_M =$ _____ $Q_{MS} \times k_M =$ _____

$Q_{ES} \times k_M =$ _____ $Q_{TS} \times k_M =$ _____

Efficiency $\eta_0 = \frac{4\pi^2}{c^3} \frac{f_S^3 V_{AS}}{Q_{ES}} =$ _____

$C_a =$ _____ $f_a =$ _____ $C_b =$ _____ $f_b =$ _____

$L_E = \frac{1}{4\pi^2} \frac{1}{C_b - C_a} \left[\frac{1}{f_b^2} - \frac{1}{f_a^2} \right] =$ _____

$R'_E = 2\pi f_a f_b L_E \left[\frac{C_a - C_b}{f_a^2 C_a - f_b^2 C_b} \right]^{1/2} =$ _____