



Software : by Martin J. King
e-mail MJKing57@aol.com

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Unit and Constant Definition

cycle := 2 · π · rad

Hz := cycle · sec⁻¹

Air Density : ρ := 1.21 · kg · m⁻³

Speed of Sound : c := 342 · m · sec⁻¹



User Input (Edit This Section and Input all of the Parameters for the System to be Analyzed)

R_{add} := 0 · Ω

Driver Thiele / Small Parameters : Fostex FE-207E Manufacturer's Driver Properties

f_d := 39 · Hz

V_d := 56.25 · liter

R_e := 6.73 · Ω + R_{add}

Q_{ed} := 0.28 · (R_e) · (R_e - R_{add})⁻¹

L_{vc} := 0 · mH

Q_{md} := 3.86

Bl := 9.41 · $\frac{\text{newton}}{\text{amp}}$

Q_{td} := $\left(\frac{1}{Q_{ed}} + \frac{1}{Q_{md}} \right)^{-1}$

S_d := 206 · cm²

Q_{td} = 0.261

Enclosure Geometry Definition

L := 42 · in

(Height)

z_{driver} := 6 · in

(Driver Distance From Top < Height)

z_{port} := 38 · in

(Port Distance From Top < Height)

S₀ := 3.5 · S_d

(Area of the Top End)

S_L := 3.5 · S_d

(Area of the Bottom End)

Density := 0.25 · lb · ft⁻³

(Stuffing density : 0 lb/ft³ < D < 1 lb/ft³)

r_{port} := 2.0 · in

(Radius of the port)

L_{port} := 6.0 · in

(Length of the port)

Ported Box Definition

$$n_{top} := 4$$

$$n_{open} := 4$$

$$n_{bottom} := 4$$

$$n_{port} := 4$$

$$(0 \text{ lb/ft}^3 < D < 1 \text{ lb/ft}^3)$$

$$(n_{top} > 1)$$

$$x_{top} := z_{driver}$$

$$(n_{open} > 1)$$

$$x_{open} := z_{port} - z_{driver}$$

$$(n_{bottom} > 1)$$

$$x_{bottom} := L - z_{port}$$

$$(n_{port} > 1)$$

$$x_{port} := L_{port} + 0.6 \cdot l_{port}$$

Geometry Definition

$$TR := (S_L - S_0) \cdot L^{-1}$$

$$S_D := S_0 + TR \cdot z_{driver}$$

$$S_P := S_0 + TR \cdot z_{port}$$

$$TR = 0 \text{ m}$$

$$S_D = 0.072 \text{ m}^2$$

$$S_P = 0.072 \text{ m}^2$$

Top Section of Enclosure

(Driver ----> Top of Enclosure)

Section Length

$$L_{c_0} := x_{top} \cdot (n_{top} + 1)^{-1}$$

$$L_{c_1} := x_{top} \cdot (n_{top} + 1)^{-1}$$

$$L_{c_2} := x_{top} \cdot (n_{top} + 1)^{-1}$$

$$L_{c_3} := x_{top} \cdot (n_{top} + 1)^{-1}$$

$$L_{c_4} := x_{top} \cdot (n_{top} + 1)^{-1}$$

Initial Area

$$S_{c_{0,0}} := S_D$$

$$S_{c_{1,0}} := S_{c_{0,1}}$$

$$S_{c_{2,0}} := S_{c_{1,1}}$$

$$S_{c_{3,0}} := S_{c_{2,1}}$$

$$S_{c_{4,0}} := S_{c_{3,1}}$$

Final Area

$$S_{c_{0,1}} := S_{c_{0,0}} - TR \cdot L_{c_0}$$

$$S_{c_{1,1}} := S_{c_{1,0}} - TR \cdot L_{c_1}$$

$$S_{c_{2,1}} := S_{c_{2,0}} - TR \cdot L_{c_2}$$

$$S_{c_{3,1}} := S_{c_{3,0}} - TR \cdot L_{c_3}$$

$$S_{c_{4,1}} := S_0$$

Stuffing Density

$$D_{c_0} := \text{Density}$$

$$D_{c_1} := \text{Density}$$

$$D_{c_2} := \text{Density}$$

$$D_{c_3} := \text{Density}$$

$$D_{c_4} := \text{Density}$$

Open Section of Enclosure

(Driver ----> Port Position)

Section Length

$$L_{o_0} := x_{open} \cdot (n_{open} + 1)^{-1}$$

$$L_{o_1} := x_{open} \cdot (n_{open} + 1)^{-1}$$

$$L_{o_2} := x_{open} \cdot (n_{open} + 1)^{-1}$$

$$L_{o_3} := x_{open} \cdot (n_{open} + 1)^{-1}$$

$$L_{o_4} := x_{open} \cdot (n_{open} + 1)^{-1}$$

Initial Area

$$S_{o_{0,0}} := S_D$$

$$S_{o_{1,0}} := S_{o_{0,1}}$$

$$S_{o_{2,0}} := S_{o_{1,1}}$$

$$S_{o_{3,0}} := S_{o_{2,1}}$$

$$S_{o_{4,0}} := S_{o_{3,1}}$$

Final Area

$$S_{o_{0,1}} := S_{o_{0,0}} + TR \cdot L_{o_0}$$

$$S_{o_{1,1}} := S_{o_{1,0}} + TR \cdot L_{o_1}$$

$$S_{o_{2,1}} := S_{o_{2,0}} + TR \cdot L_{o_2}$$

$$S_{o_{3,1}} := S_{o_{3,0}} + TR \cdot L_{o_3}$$

$$S_{o_{4,1}} := S_P$$

Stuffing Density

$$D_{o_0} := \text{Density}$$

$$D_{o_1} := \text{Density}$$

$$D_{o_2} := \text{Density}$$

$$D_{o_3} := 0.0 \cdot \text{lb} \cdot \text{ft}^{-3}$$

$$D_{o_4} := 0.0 \cdot \text{lb} \cdot \text{ft}^{-3}$$

Bottom Section of Enclosure**(Port Position ---> Bottom of Enclosure)****Section Length****Initial Area****Final Area****Stuffing Density**

$$L_{b_0} := x_{\text{bottom}} \cdot (n_{\text{bottom}} + 1)^{-1}$$

$$S_{b_{0,0}} := S_P$$

$$S_{b_{0,1}} := S_{b_{0,0}} + TR \cdot L_{b_0}$$

$$D_{b_0} := 0.0 \cdot \text{lb} \cdot \text{ft}^{-3}$$

$$L_{b_1} := x_{\text{bottom}} \cdot (n_{\text{bottom}} + 1)^{-1}$$

$$S_{b_{1,0}} := S_{b_{0,1}}$$

$$S_{b_{1,1}} := S_{b_{1,0}} + TR \cdot L_{b_1}$$

$$D_{b_1} := 0.0 \cdot \text{lb} \cdot \text{ft}^{-3}$$

$$L_{b_2} := x_{\text{bottom}} \cdot (n_{\text{bottom}} + 1)^{-1}$$

$$S_{b_{2,0}} := S_{b_{1,1}}$$

$$S_{b_{2,1}} := S_{b_{2,0}} + TR \cdot L_{b_2}$$

$$D_{b_2} := 0.0 \cdot \text{lb} \cdot \text{ft}^{-3}$$

$$L_{b_3} := x_{\text{bottom}} \cdot (n_{\text{bottom}} + 1)^{-1}$$

$$S_{b_{3,0}} := S_{b_{2,1}}$$

$$S_{b_{3,1}} := S_{b_{3,0}} + TR \cdot L_{b_3}$$

$$D_{b_3} := 0.0 \cdot \text{lb} \cdot \text{ft}^{-3}$$

$$L_{b_4} := x_{\text{bottom}} \cdot (n_{\text{bottom}} + 1)^{-1}$$

$$S_{b_{4,0}} := S_{b_{3,1}}$$

$$S_{b_{4,1}} := S_L$$

$$D_{b_4} := 0.0 \cdot \text{lb} \cdot \text{ft}^{-3}$$

Port Section of Enclosure**(Port Inside ---> Port Outside)****Section Length****Initial Area****Final Area****Stuffing Density**

$$L_{p_0} := x_{\text{port}} \cdot (n_{\text{port}} + 1)^{-1}$$

$$S_{p_{0,0}} := \pi \cdot r_{\text{port}}^2$$

$$S_{p_{0,1}} := \pi \cdot r_{\text{port}}^2$$

$$D_{p_0} := 0.0 \cdot \text{lb} \cdot \text{ft}^{-3}$$

$$L_{p_1} := x_{\text{port}} \cdot (n_{\text{port}} + 1)^{-1}$$

$$S_{p_{1,0}} := S_{p_{0,1}}$$

$$S_{p_{1,1}} := \pi \cdot r_{\text{port}}^2$$

$$D_{p_1} := 0.0 \cdot \text{lb} \cdot \text{ft}^{-3}$$

$$L_{p_2} := x_{\text{port}} \cdot (n_{\text{port}} + 1)^{-1}$$

$$S_{p_{2,0}} := S_{p_{1,1}}$$

$$S_{p_{2,1}} := \pi \cdot r_{\text{port}}^2$$

$$D_{p_2} := 0.0 \cdot \text{lb} \cdot \text{ft}^{-3}$$

$$L_{p_3} := x_{\text{port}} \cdot (n_{\text{port}} + 1)^{-1}$$

$$S_{p_{3,0}} := S_{p_{2,1}}$$

$$S_{p_{3,1}} := \pi \cdot r_{\text{port}}^2$$

$$D_{p_3} := 0.0 \cdot \text{lb} \cdot \text{ft}^{-3}$$

$$L_{p_4} := x_{\text{port}} \cdot (n_{\text{port}} + 1)^{-1}$$

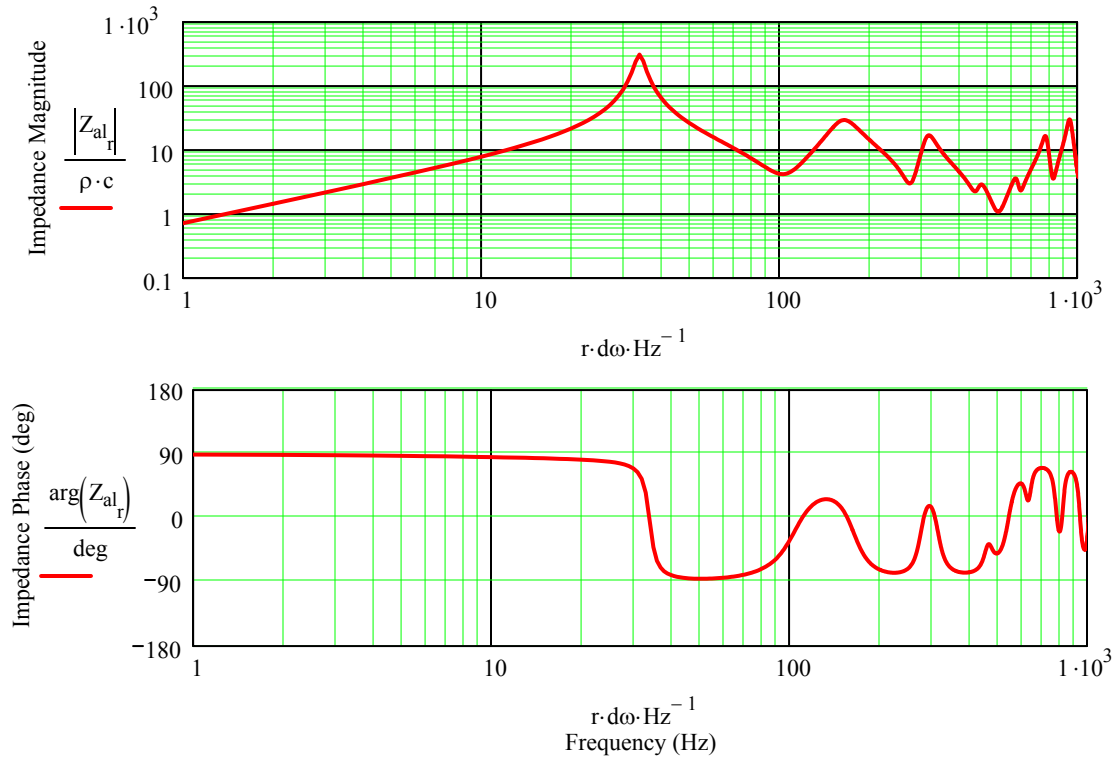
$$S_{p_{4,0}} := S_{p_{3,1}}$$

$$S_{p_{4,1}} := \pi \cdot r_{\text{port}}^2$$

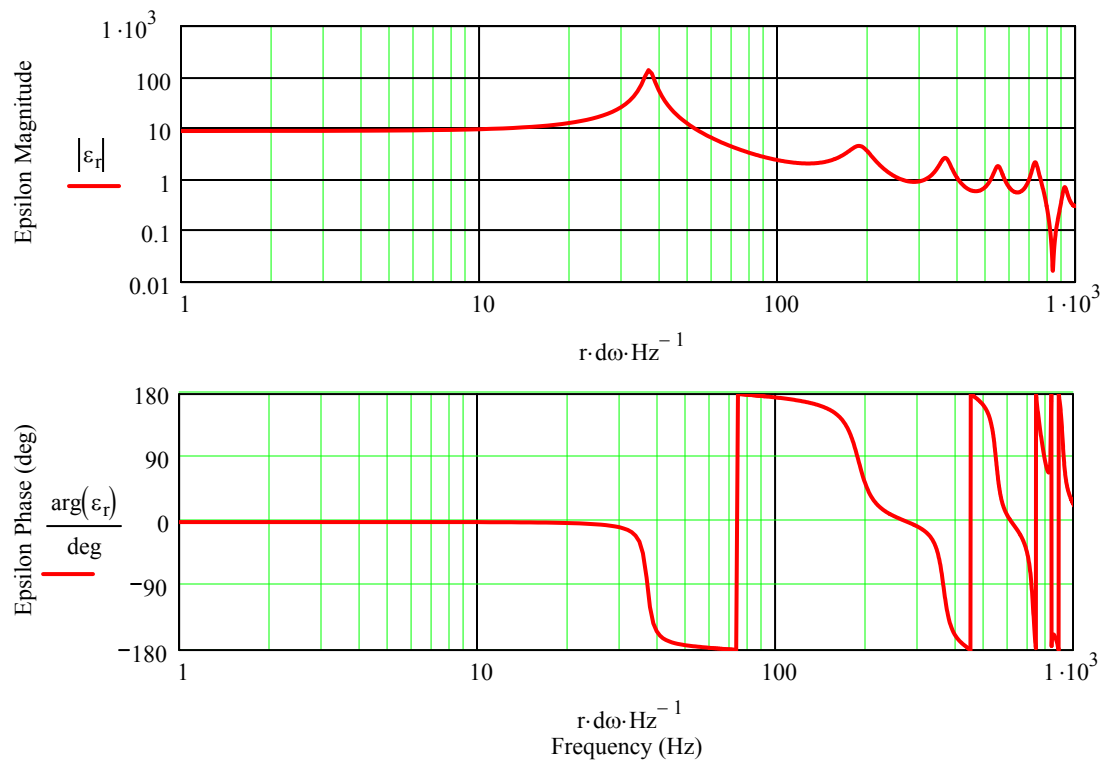
$$D_{p_4} := 0.0 \cdot \text{lb} \cdot \text{ft}^{-3}$$



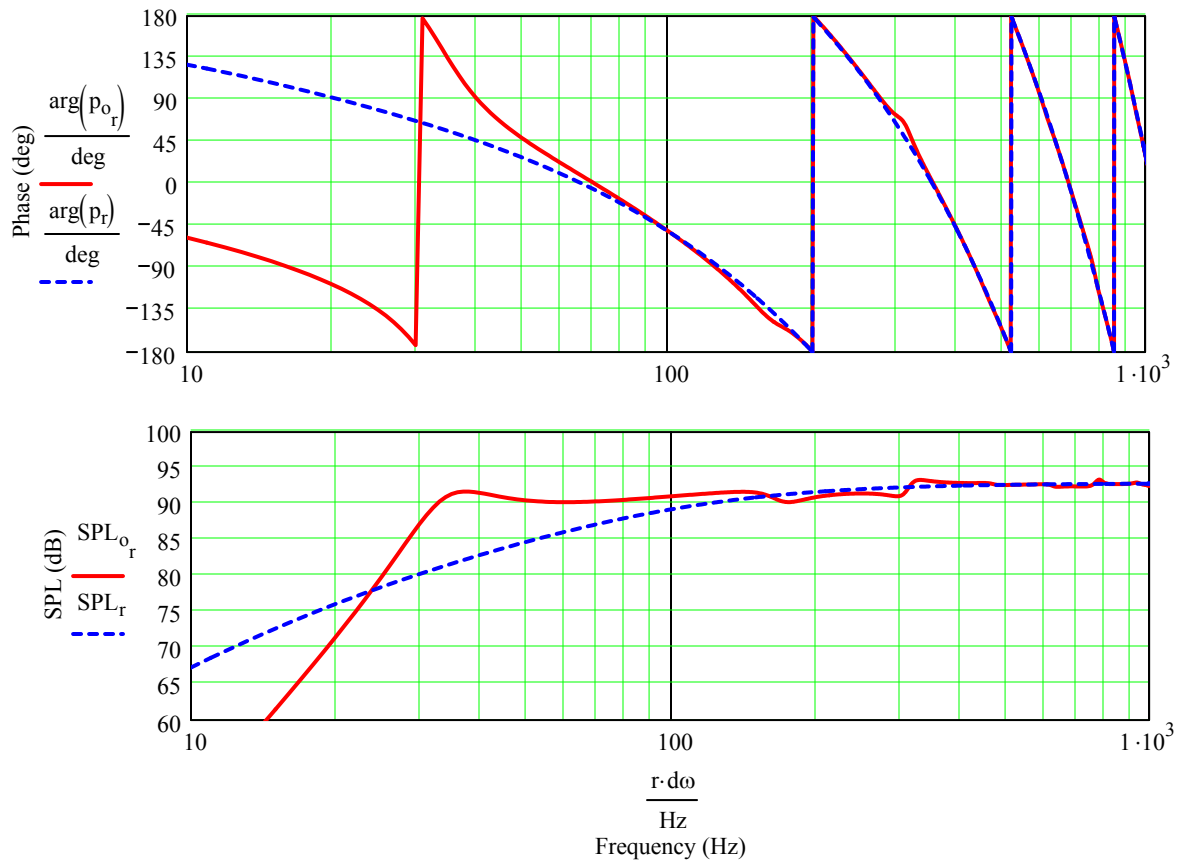
Resulting Acoustic Impedance for the Enclosure



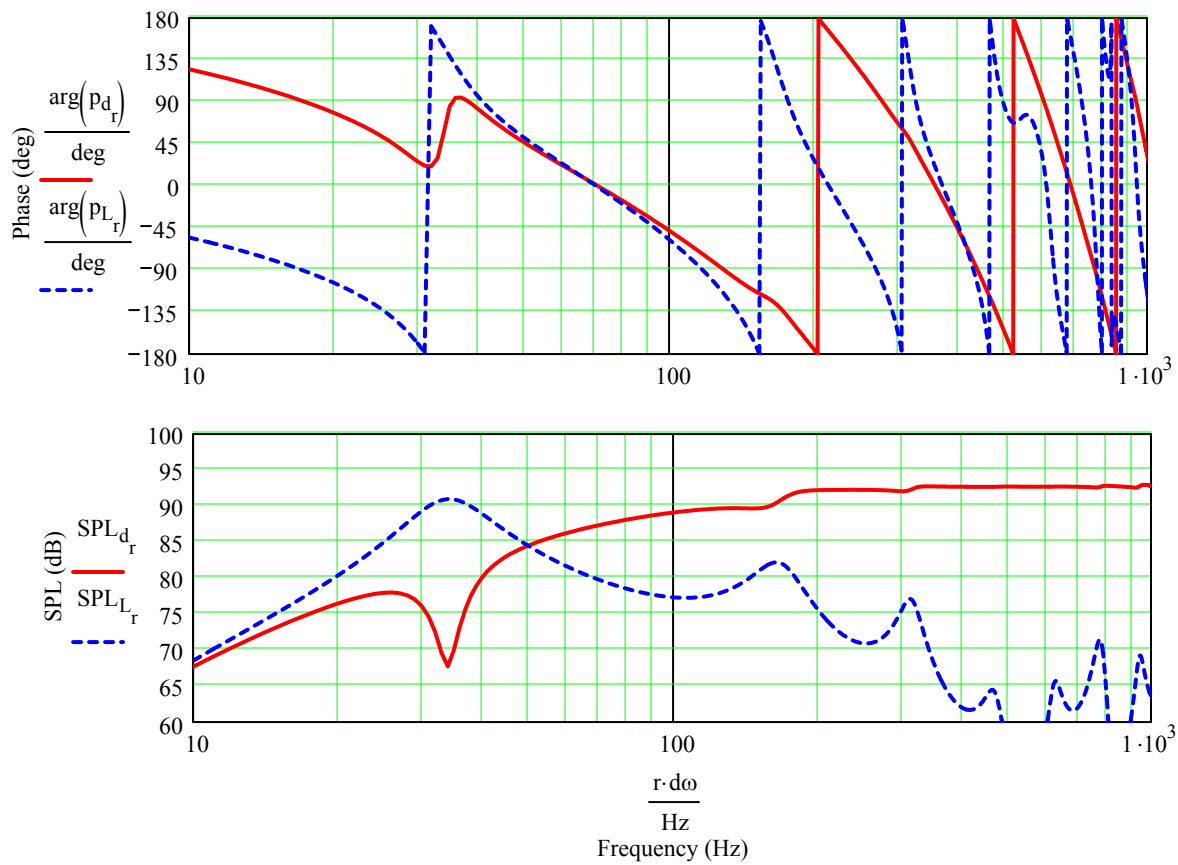
Velocity at the Terminus of the Ported Box for a 1 m/sec Driver Excitation



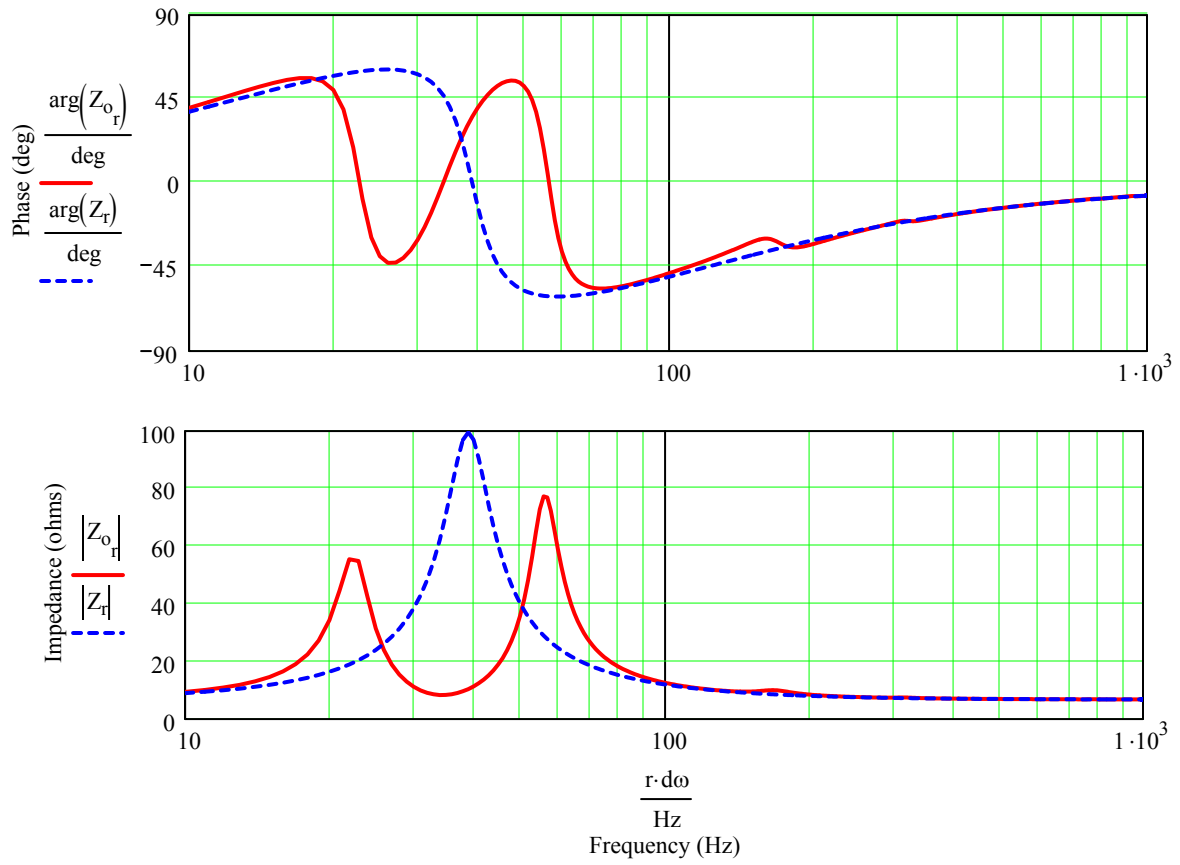
Far Field Ported Box System and Infinite Baffle Sound Pressure Level Responses



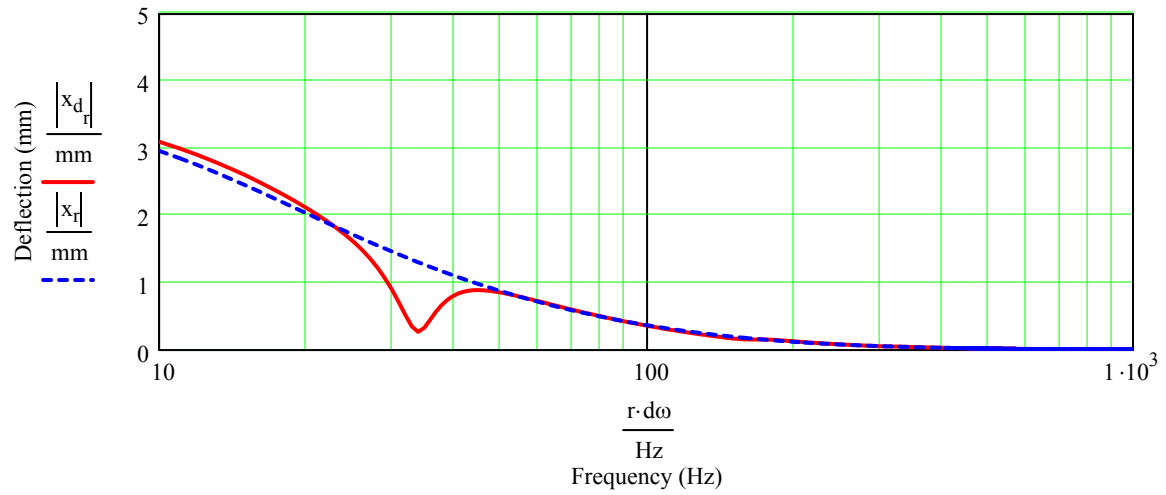
Woofer and Terminus Far Field Sound Pressure Level Responses



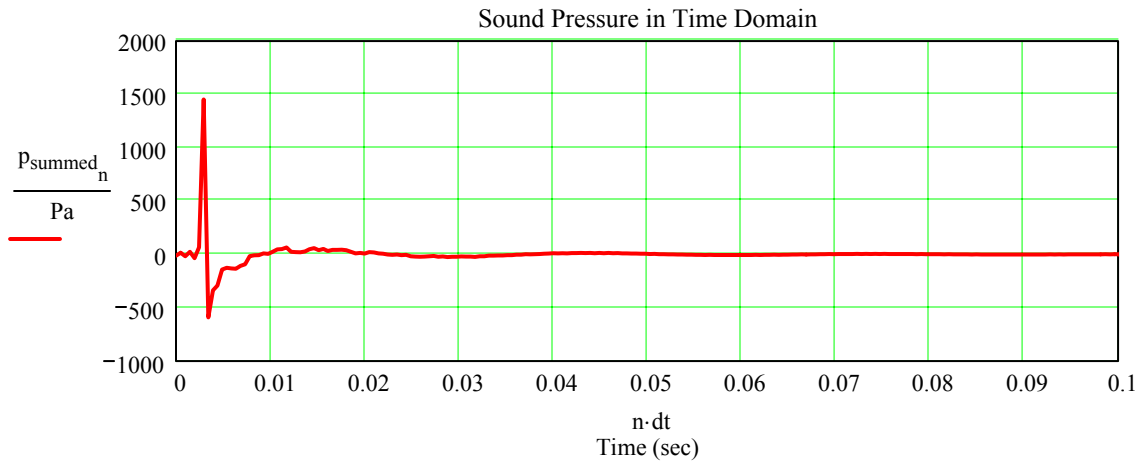
Ported Box System and Infinite Baffle Impedance



Woofer Displacement



System Time Response for an Impulse Input



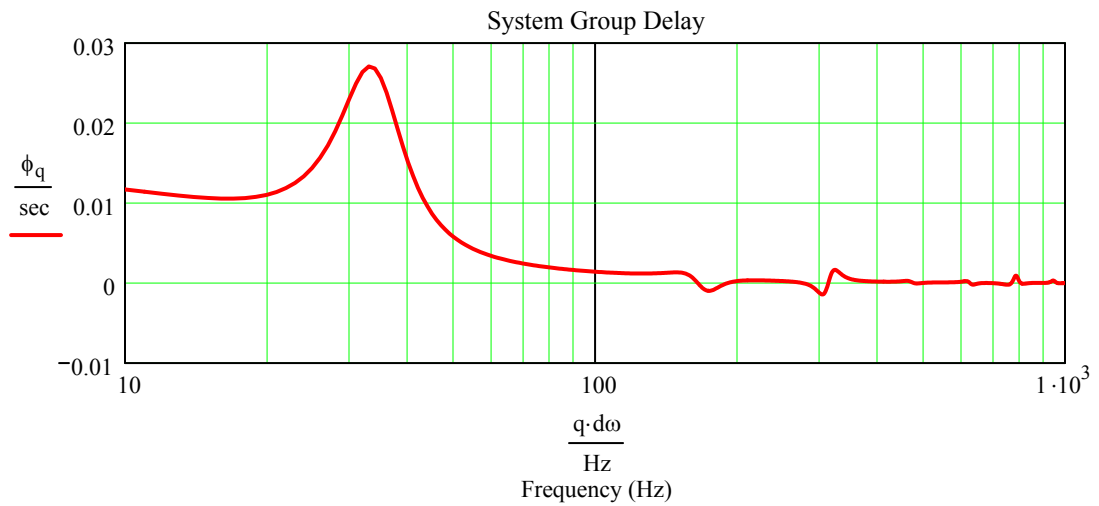
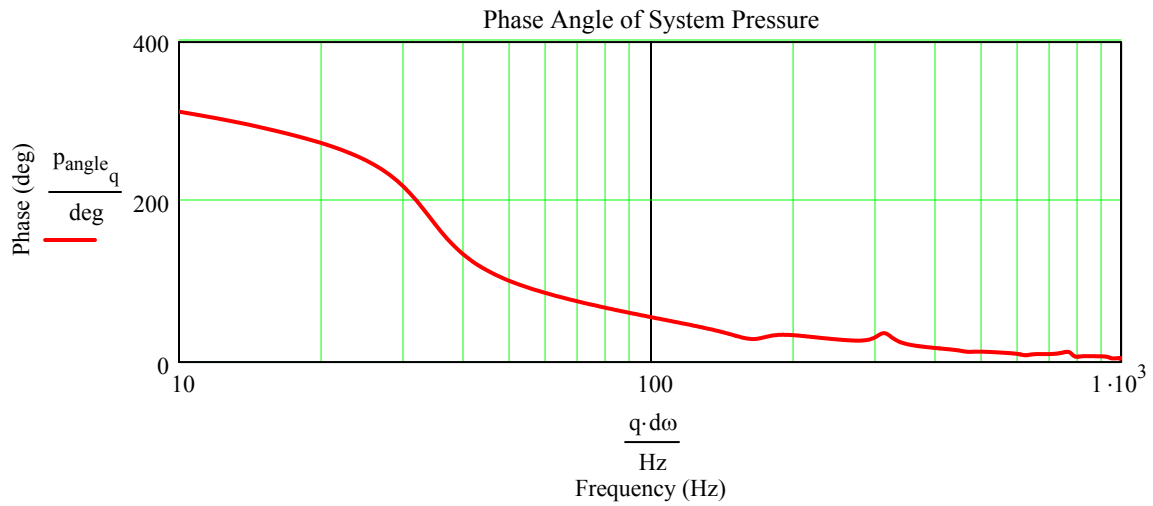
TL System Group Delay Calculation

$q := 2, 3 \dots 1000$

Removing the Phase Change Associated with the 1 meter Measurement Distance.

$$pangle_r := \text{if} \left(\arg \left(p_{O_r} \cdot \exp \left(j \cdot \frac{r \cdot d\omega}{c} \cdot 1 \cdot m \right) \right) < 0, \arg \left(p_{O_r} \cdot \exp \left(j \cdot \frac{r \cdot d\omega}{c} \cdot 1 \cdot m \right) \right) + 2 \cdot \pi, \arg \left(p_{O_r} \cdot \exp \left(j \cdot \frac{r \cdot d\omega}{c} \cdot 1 \cdot m \right) \right) \right)$$

$$\phi_q := -\frac{pangle_{q+1} - pangle_{q-1}}{2 \cdot d\omega}$$



Port Air Velocity (< 10 m/sec / 342 m/sec = 0.03)

$$v_{\text{port}_r} := \frac{U_{L_r}}{\pi \cdot r_{\text{port}}^2}$$

$$|v_{\text{port}_{33}}| = 2.148 \frac{\text{m}}{\text{sec}}$$

