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Unit and Constant Definition

cycle := 2·π·rad

Air Density : ρ := 1.21·kg·m⁻³

Hz := cycle·sec⁻¹

Speed of Sound : c := 342·m·sec⁻¹



Part 1 : Thiele-Small Consistent Calculation

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

Series Resistance

R_{add} := 0.0·Ω

Driver Thiele / Small Parameters : Fostex FE-164 Average Driver Properties

f_d := 48·Hz

V_{ad} := 15.85·liter

Adjustments

R_e := 6.6·Ω

Q_{ed} := .824

R_{ew} := R_e + R_{add}

L_{vc} := .465·mH

Q_{md} := 3.5

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

Bl := 6.386· $\frac{\text{newton}}{\text{amp}}$

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

S_d := 132·cm²

Q_{td} = 0.667

Enclosure Geometry Definition : Model of Internal Air Volume

L := 48·in

(Internal Height)

z_{driver} := 15.5·in

(Driver Internal Distance From Top < Height)

z_{port} := 46·in

(Port Internal Distance From Top < Height)

S₀ := 31.5·in·10·in

(Internal Area of the Top End, z = 0)

S_L := 31.5·in·10·in

(Internal Area of the Bottom End, z = L)

Density := 0.25·lb·ft⁻³

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

r_{port} := 1.5·in

(Inside Radius of the Port)

L_{port} := 1.75·in

(Length of the Port)

Power := 1·watt

(Input Power) Applied Voltage Reference ---> R_{ref} := 8·Ω

End of Abbreviated User Input

Pre Formatted Geometry and Stuffing Location Input (Only Edit Details Below to Change Defaults)

Ported Box Definition

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

$$n_{\text{top}} := 4$$

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

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

$$n_{\text{open}} := 4$$

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

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

$$n_{\text{bottom}} := 4$$

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

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

$$n_{\text{port}} := 4$$

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

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

Geometry Definition

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

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

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

$$S_D = 0.203 \text{ m}^2$$

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

$$S_P = 0.203 \text{ m}^2$$

Top Section of Enclosure

(Driver ----> Top of Enclosure)

Section Length	Initial Area	Final Area	Stuffing Density
$L_{c_0} := x_{\text{top}} \cdot (n_{\text{top}} + 1)^{-1}$	$S_{c_{0,0}} := S_D$	$S_{c_{0,1}} := S_{c_{0,0}} - TR \cdot L_{c_0}$	$D_{c_0} := \text{Density}$
$L_{c_1} := x_{\text{top}} \cdot (n_{\text{top}} + 1)^{-1}$	$S_{c_{1,0}} := S_{c_{0,1}}$	$S_{c_{1,1}} := S_{c_{1,0}} - TR \cdot L_{c_1}$	$D_{c_1} := \text{Density}$
$L_{c_2} := x_{\text{top}} \cdot (n_{\text{top}} + 1)^{-1}$	$S_{c_{2,0}} := S_{c_{1,1}}$	$S_{c_{2,1}} := S_{c_{2,0}} - TR \cdot L_{c_2}$	$D_{c_2} := \text{Density}$
$L_{c_3} := x_{\text{top}} \cdot (n_{\text{top}} + 1)^{-1}$	$S_{c_{3,0}} := S_{c_{2,1}}$	$S_{c_{3,1}} := S_{c_{3,0}} - TR \cdot L_{c_3}$	$D_{c_3} := \text{Density}$
$L_{c_4} := x_{\text{top}} \cdot (n_{\text{top}} + 1)^{-1}$	$S_{c_{4,0}} := S_{c_{3,1}}$	$S_{c_{4,1}} := S_0$	$D_{c_4} := \text{Density}$

Open Section of Enclosure

(Driver ----> Port Position)

Section Length	Initial Area	Final Area	Stuffing Density
$L_{o_0} := x_{\text{open}} \cdot (n_{\text{open}} + 1)^{-1}$	$S_{o_{0,0}} := S_D$	$S_{o_{0,1}} := S_{o_{0,0}} + TR \cdot L_{o_0}$	$D_{o_0} := \text{Density}$
$L_{o_1} := x_{\text{open}} \cdot (n_{\text{open}} + 1)^{-1}$	$S_{o_{1,0}} := S_{o_{0,1}}$	$S_{o_{1,1}} := S_{o_{1,0}} + TR \cdot L_{o_1}$	$D_{o_1} := \text{Density}$
$L_{o_2} := x_{\text{open}} \cdot (n_{\text{open}} + 1)^{-1}$	$S_{o_{2,0}} := S_{o_{1,1}}$	$S_{o_{2,1}} := S_{o_{2,0}} + TR \cdot L_{o_2}$	$D_{o_2} := \text{Density}$
$L_{o_3} := x_{\text{open}} \cdot (n_{\text{open}} + 1)^{-1}$	$S_{o_{3,0}} := S_{o_{2,1}}$	$S_{o_{3,1}} := S_{o_{3,0}} + TR \cdot L_{o_3}$	$D_{o_3} := \text{Density}$
$L_{o_4} := x_{\text{open}} \cdot (n_{\text{open}} + 1)^{-1}$	$S_{o_{4,0}} := S_{o_{3,1}}$	$S_{o_{4,1}} := S_P$	$D_{o_4} := \text{Density}$

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
$L_{p_0} := x_{\text{port}} \cdot (n_{\text{port}} + 1)^{-1}$	$S_{p_{0,0}} := \pi \cdot r_{\text{port}}^2$	$S_{p_{0,1}} := \pi \cdot r_{\text{port}}^2$	$D_{p_0} := 0.0 \cdot \text{lb} \cdot \text{ft}^{-3}$
$L_{p_1} := x_{\text{port}} \cdot (n_{\text{port}} + 1)^{-1}$	$S_{p_{1,0}} := S_{p_{0,1}}$	$S_{p_{1,1}} := \pi \cdot r_{\text{port}}^2$	$D_{p_1} := 0.0 \cdot \text{lb} \cdot \text{ft}^{-3}$
$L_{p_2} := x_{\text{port}} \cdot (n_{\text{port}} + 1)^{-1}$	$S_{p_{2,0}} := S_{p_{1,1}}$	$S_{p_{2,1}} := \pi \cdot r_{\text{port}}^2$	$D_{p_2} := 0.0 \cdot \text{lb} \cdot \text{ft}^{-3}$
$L_{p_3} := x_{\text{port}} \cdot (n_{\text{port}} + 1)^{-1}$	$S_{p_{3,0}} := S_{p_{2,1}}$	$S_{p_{3,1}} := \pi \cdot r_{\text{port}}^2$	$D_{p_3} := \text{Density}$
$L_{p_4} := x_{\text{port}} \cdot (n_{\text{port}} + 1)^{-1}$	$S_{p_{4,0}} := S_{p_{3,1}}$	$S_{p_{4,1}} := \pi \cdot r_{\text{port}}^2$	$D_{p_4} := \text{Density}$

Total Amount of Stuffing

$$\sum_{r=0}^{n_{\text{top}}} \left[\frac{(S_{c_{r,0}} + S_{c_{r,1}})}{2} \cdot L_{c_r} \cdot D_{c_r} \right] + \sum_{r=0}^{n_{\text{open}}} \left[\frac{(S_{o_{r,0}} + S_{o_{r,1}})}{2} \cdot L_{o_r} \cdot D_{o_r} \right] \dots = 2.097 \cdot \text{lb}$$

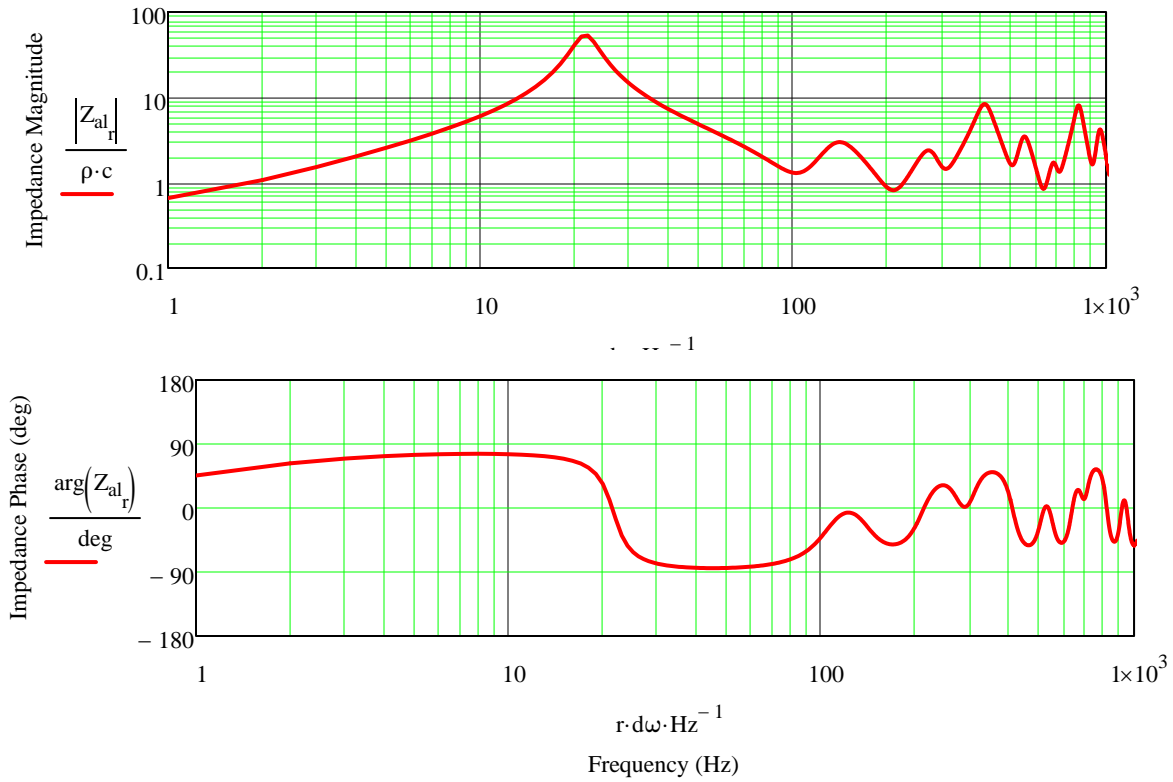
$$+ \sum_{r=0}^{n_{\text{bottom}}} \left[\frac{(S_{b_{r,0}} + S_{b_{r,1}})}{2} \cdot L_{b_r} \cdot D_{b_r} \right] + \sum_{r=0}^{n_{\text{port}}} \left[\frac{(S_{p_{r,0}} + S_{p_{r,1}})}{2} \cdot L_{p_r} \cdot D_{p_r} \right]$$

End of Pre Formatted Default Input

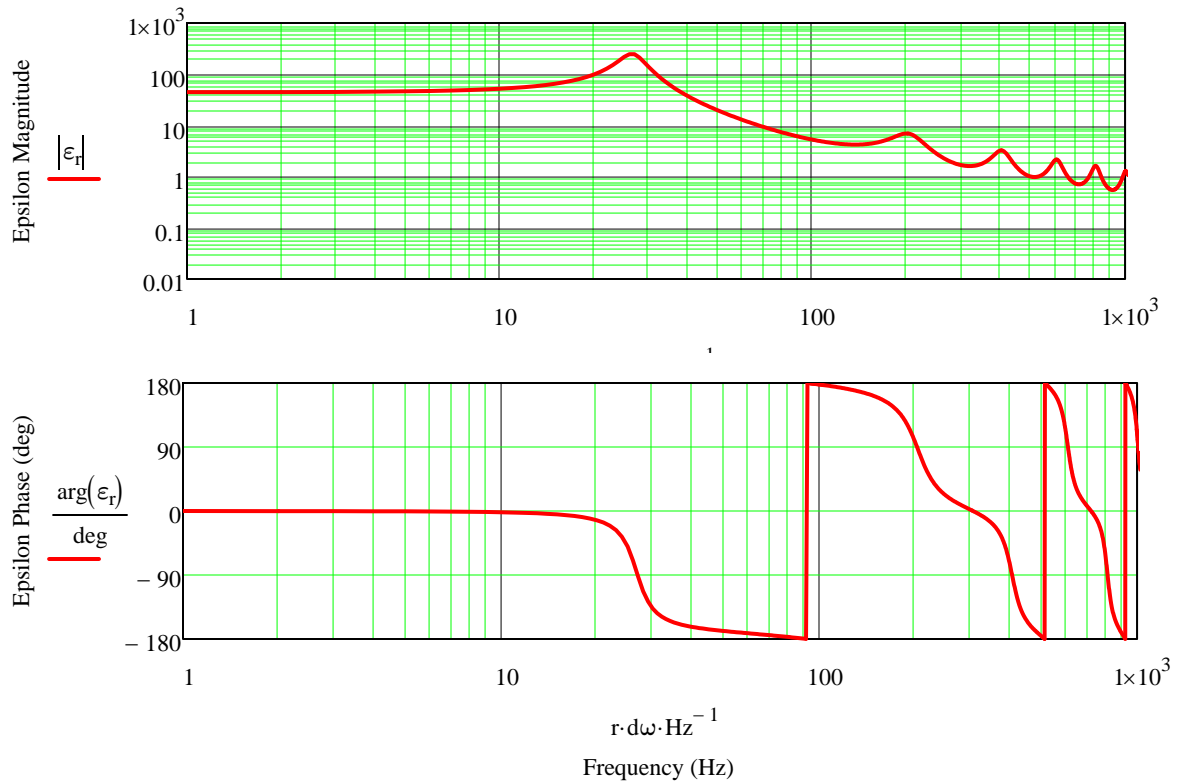
End of Part 1 Input



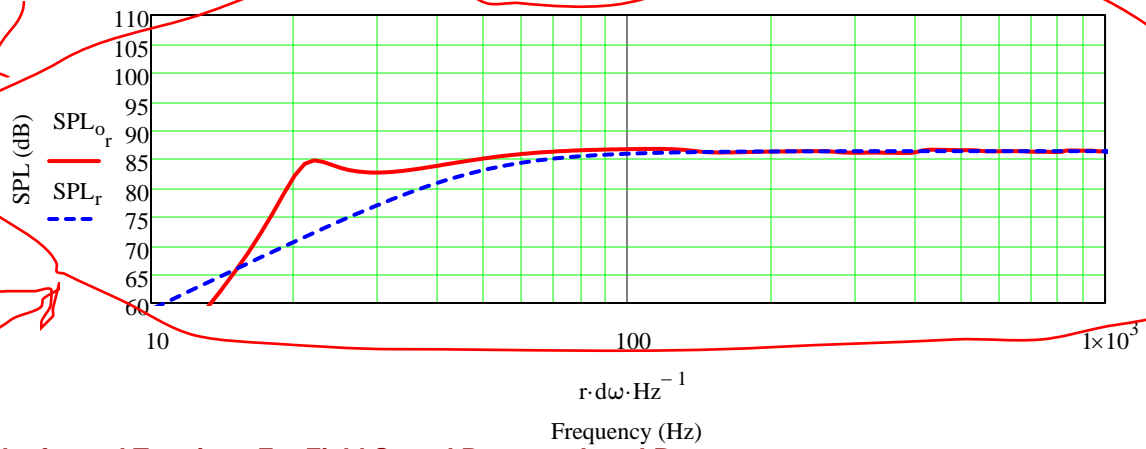
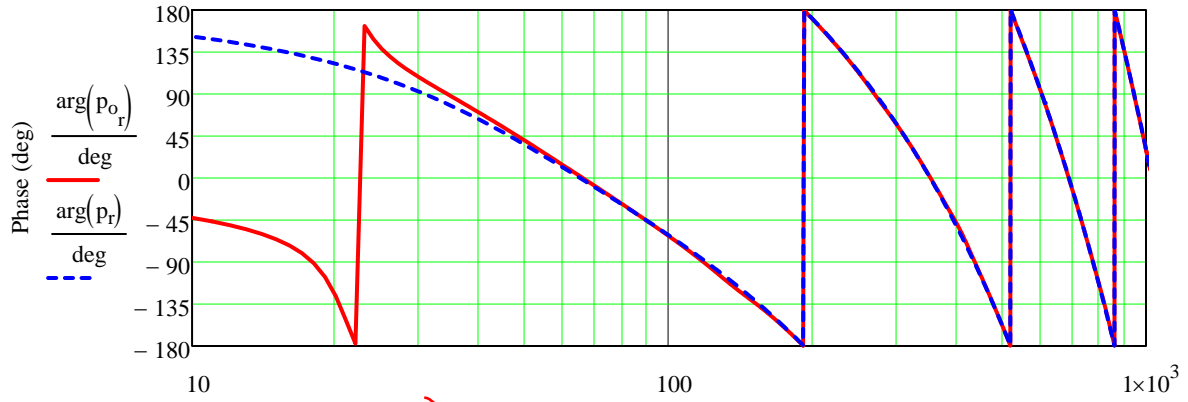
Resulting Acoustic Impedance for the Enclosure



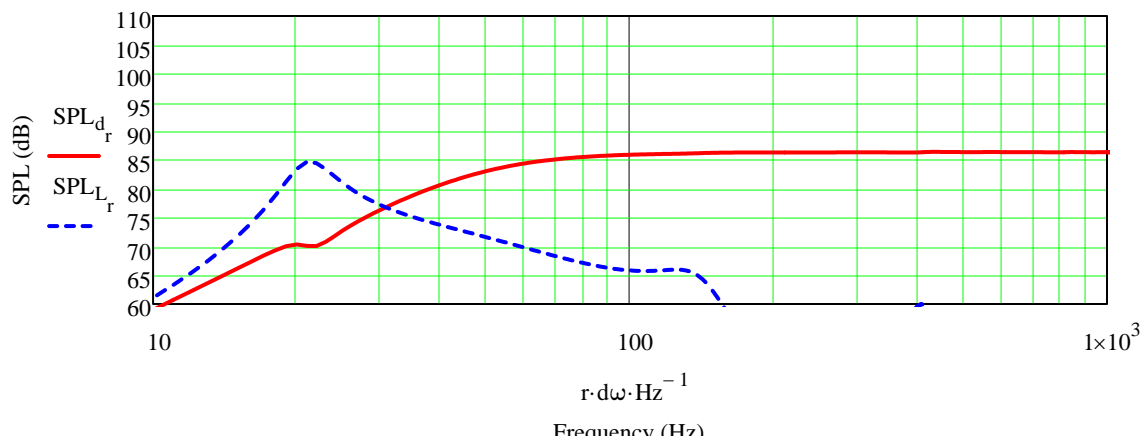
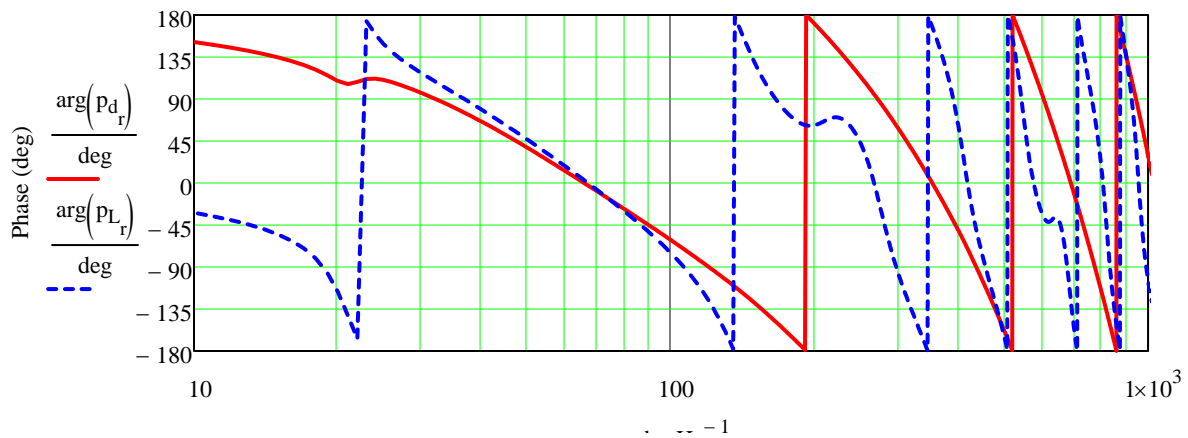
Velocity at the Terminus of the Ported Box for a 1 m/sec Excitation at the Driver Position



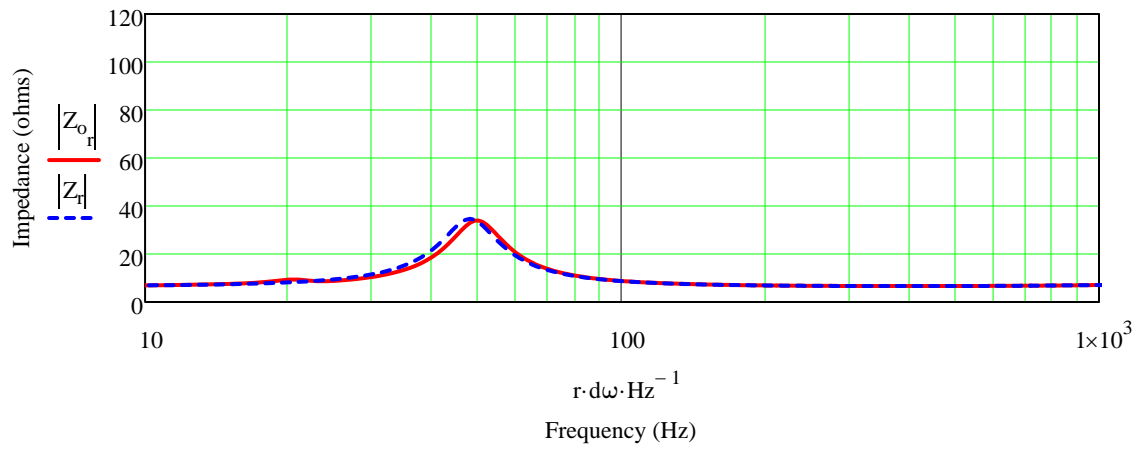
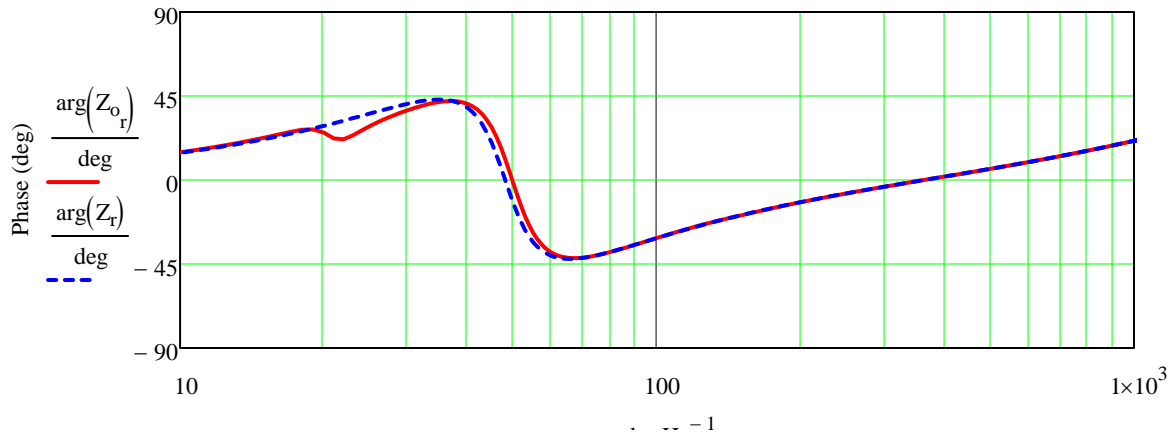
Far Field Ported Box System and Infinite Baffle Sound Pressure Level Responses



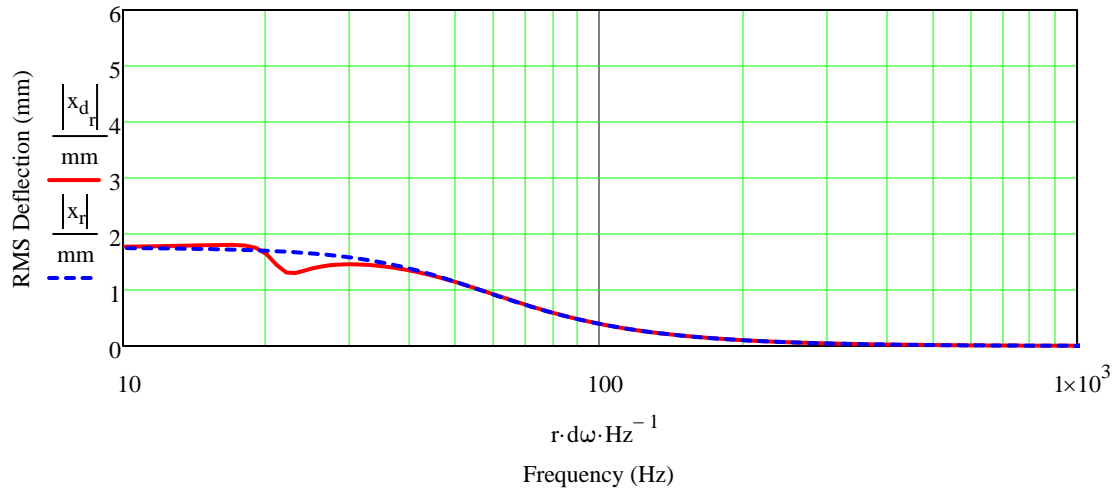
Woofer and Terminus Far Field Sound Pressure Level Responses



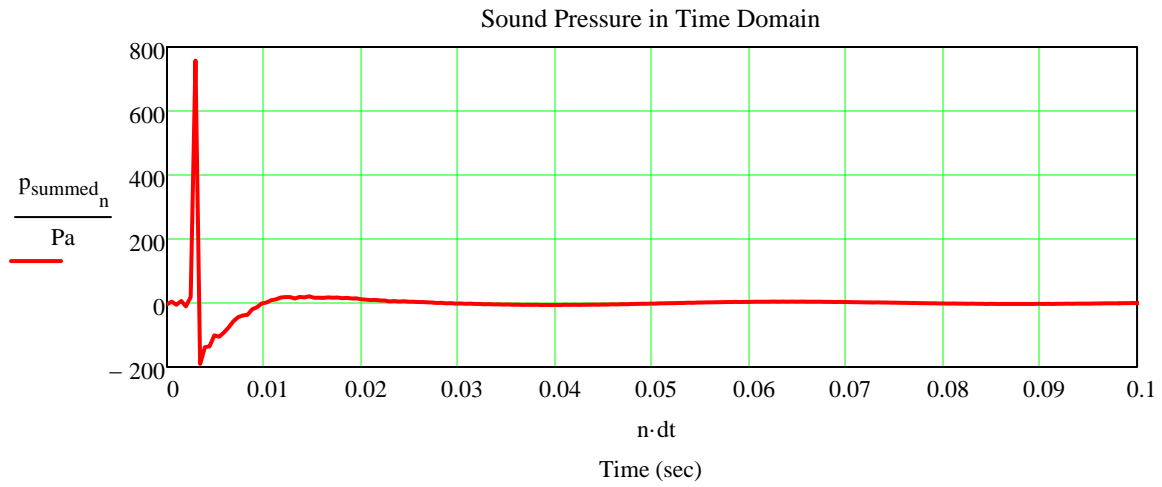
Ported Box System and Infinite Baffle Impedance



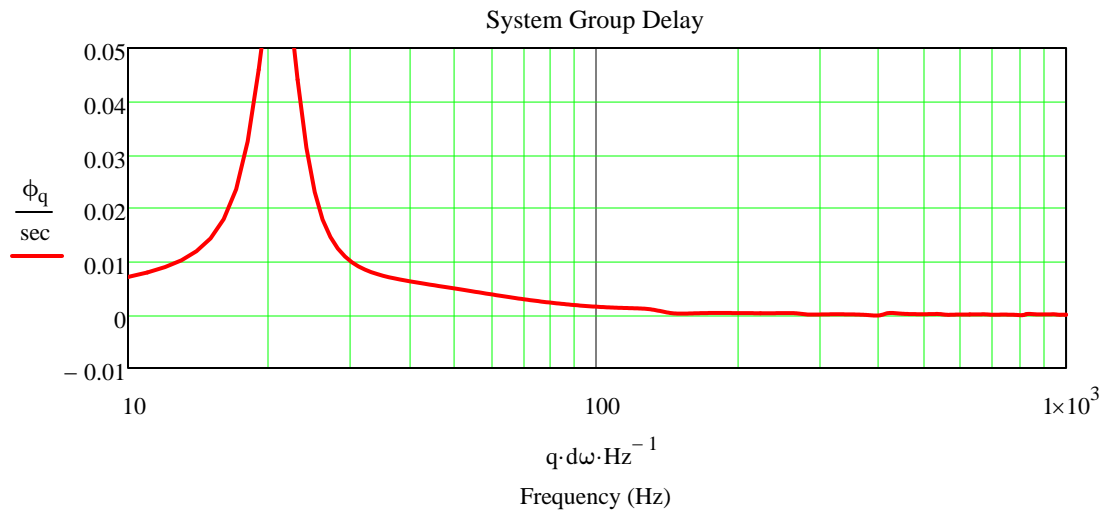
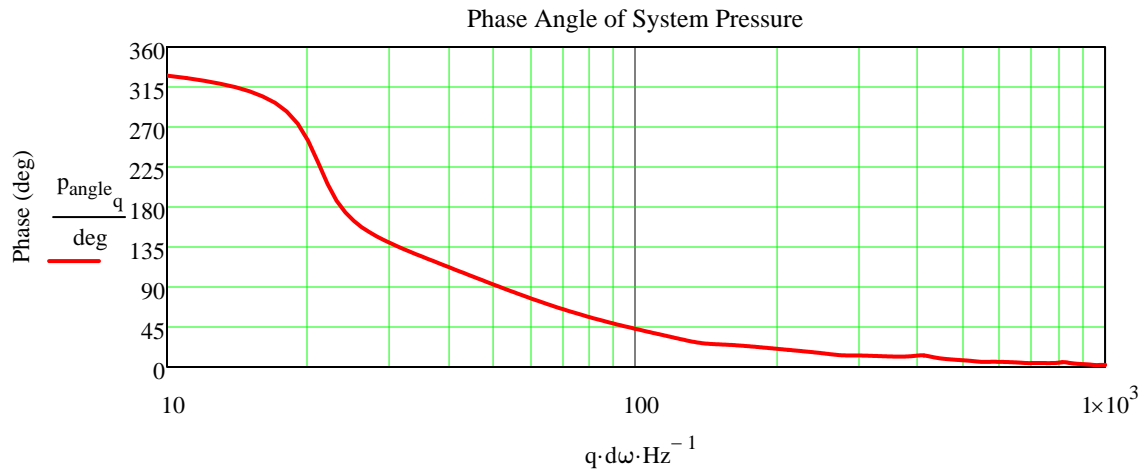
Woofer RMS Displacement



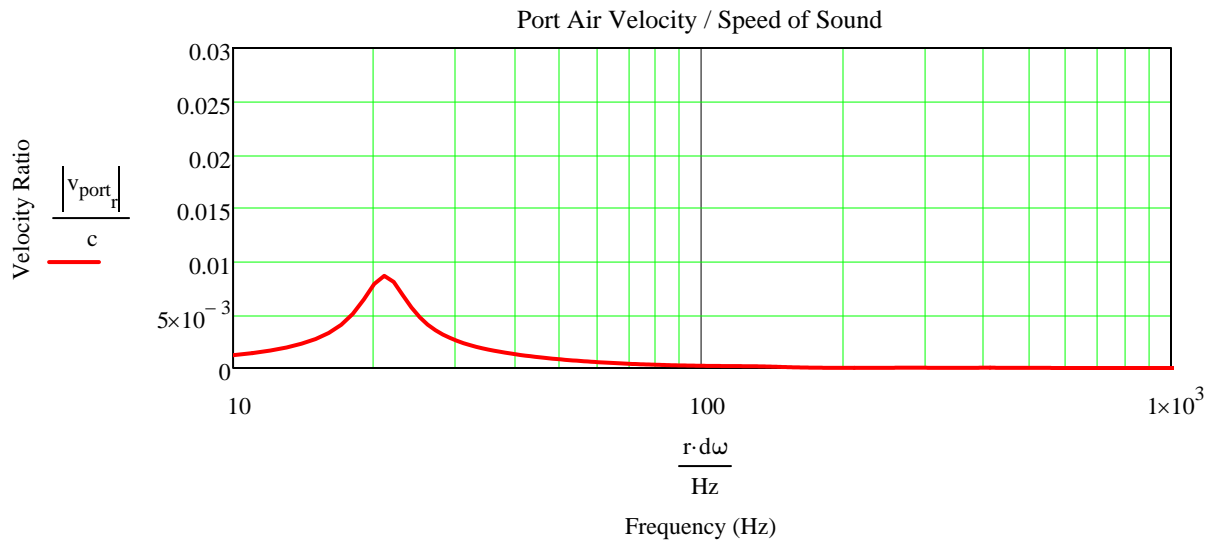
System Time Response for an Impulse Input



System Group Delay



Port Air Velocity (should be $< 10 \text{ m/sec} / 342 \text{ m/sec} = \underline{0.03}$)



Part 2 : Detailed SPL Response Calculation

Calculation Includes :

Position of Driver and Port on the Baffle.

Baffle Step Defraction for the Driver and the Port.

Floor and Rear Wall Reflection for the Driver and the Port.

Geometry

Coordinate System :

Origin is the lower left corner of the front baffle

x = horizontal direction

y = vertical direction

The variables num_r, n_drv, and n_mth control the number of simple sources used in the calculations. Increasing each will improve accuracy at the expense of longer calculation times. Increase each variable until final plotted SPL stops changing at which point the solution has converged.

Enclosure Geometry Input

dist := 100·m (Front Baffle Distance from Rear Wall > Depth, to Eliminate Rear Wall use 100 m)
stand := 0·m (Height from Floor to Bottom Edge of Front Baffle, to Eliminate Floor use 100 m)
num_r := 10 (Number of Points per Unit Length of Baffle Edge)

Corner Coordinates

X coordinate	Y coordinate	
$x_{o_0} := 8.0\cdot\text{in}$		(Bottom Right Corner)
$x_{o_1} := 8.0\cdot\text{in}$	$y_{o_1} := 61.5\cdot\text{in}$	(Top Right Corner)
$x_{o_2} := 0.0\cdot\text{in}$	$y_{o_2} := 61.5\cdot\text{in}$	(Top Left Corner)
$x_{o_3} := 0.0\cdot\text{in}$		(Bottom Left Corner)
depth := 5.5·in		(Depth of Enclosure)

Driver Geometry Input

$x_{dc} := 4.0\cdot\text{in}$ (Driver Center x Coordinate)
 $y_{dc} := 32.0\cdot\text{in}$ (Driver Center y Coordinate)
n_dvr := 5 (Number of Points Across Diameter)

Port Geometry Input

$x_{mc} := 4.0\cdot\text{in}$ (Port Center x Coordinate)
 $y_{mc} := 3.0\cdot\text{in}$ (Port Center y Coordinate)
n_mth := 4 (Number of Points Across Diameter)
Locate := 0 (0 = Front Baffle Port, 1 = Rear Baffle Port)

Listening Position (Default Location is at 1 m Distance Along the Driver's Axis)

$\text{radius} := 3 \cdot \text{m}$

(Calculation Radius, Effective Radius is Greater if y_p is Changed from Default)

$\theta := 0 \cdot \text{deg}$

(0 deg is along the Driver's Axis)

$y_p := y_{dc}$

(Default Height is equal to Driver Height)

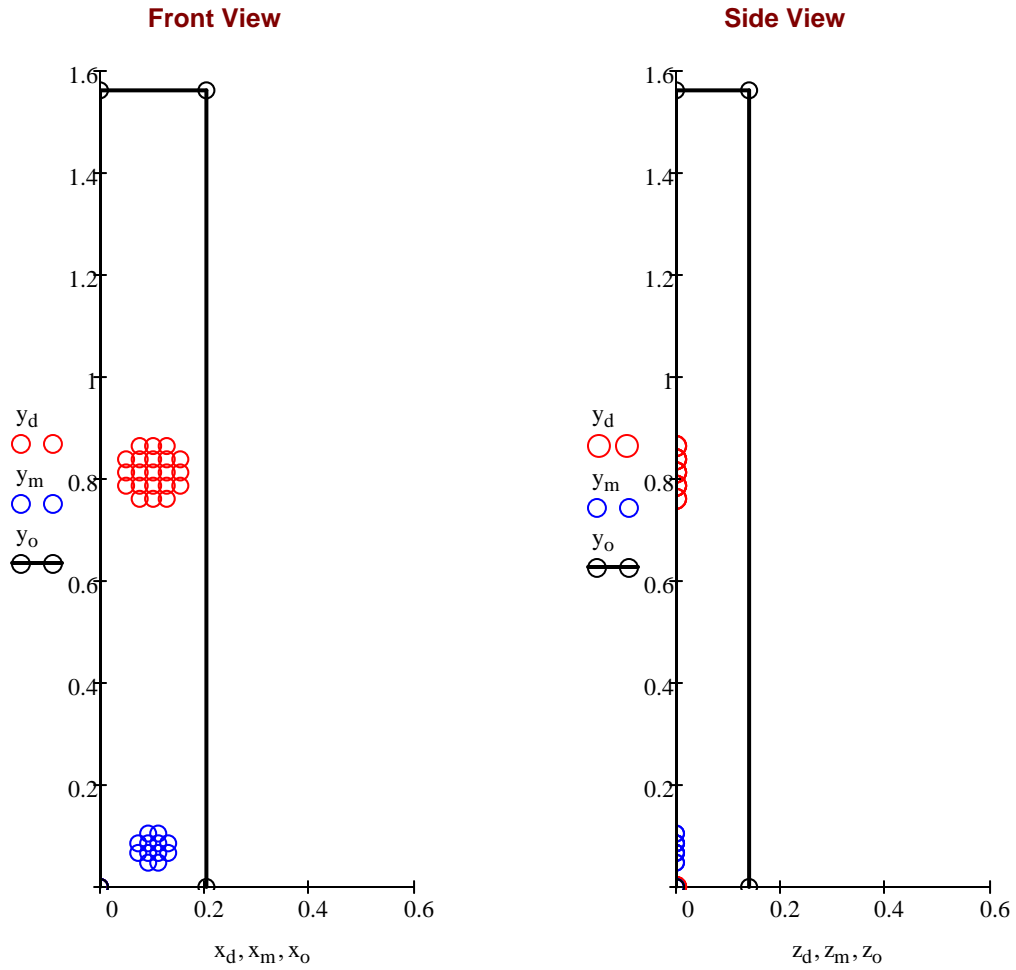
Floor Condition

$\text{Reflect} := 0$

(0 = hardwood or concrete, 1 = carpeted)



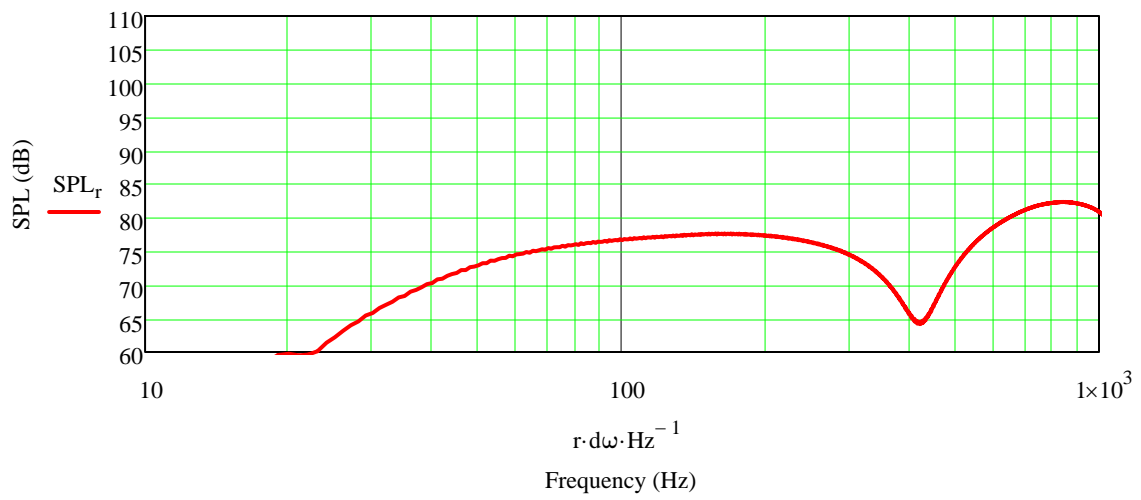
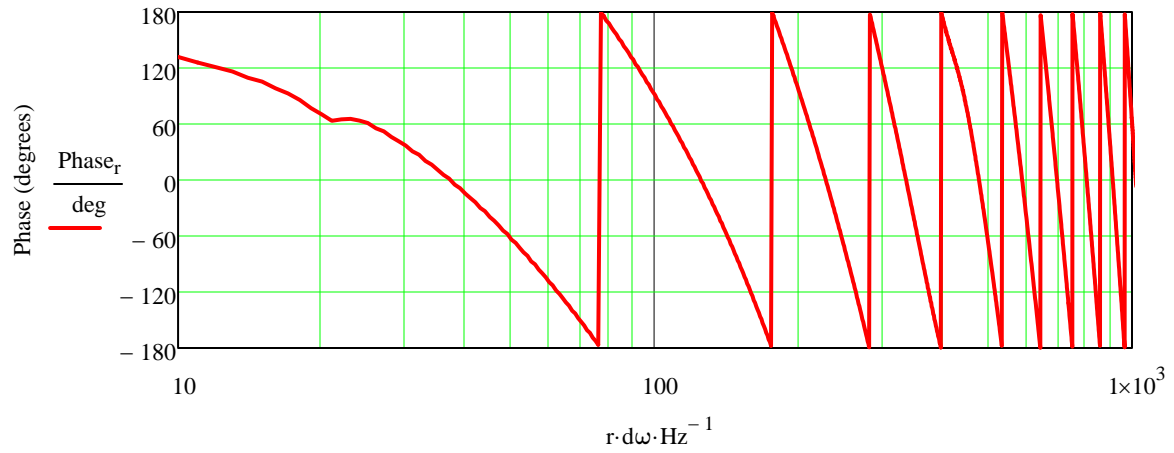
Circular Driver and Circular Mouth Simple Source Pattern with Baffle Edge Outline



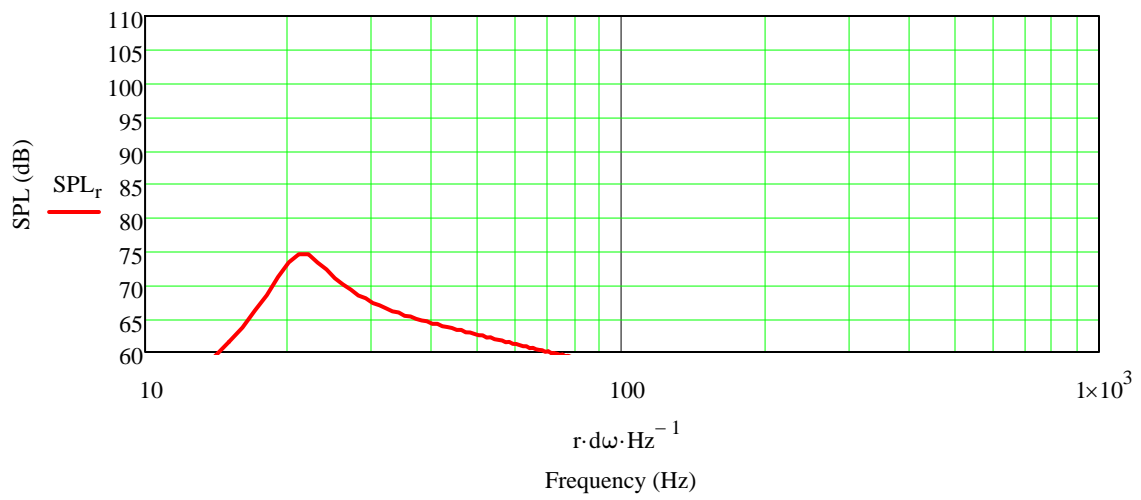
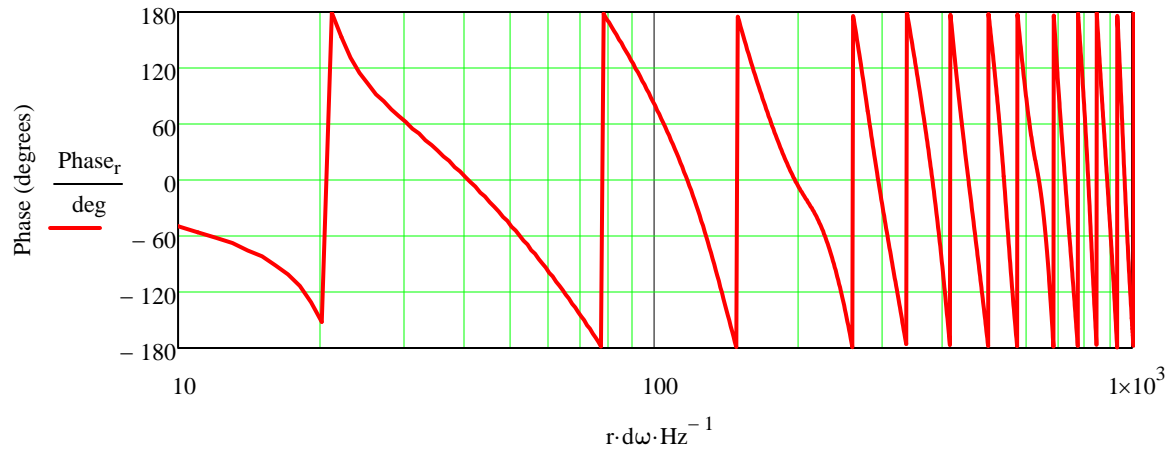
Red sources represent the driver.
Blue sources represent the port.
Black outline represents the baffle edge.
Origin is at the bottom front left corner of the enclosure.



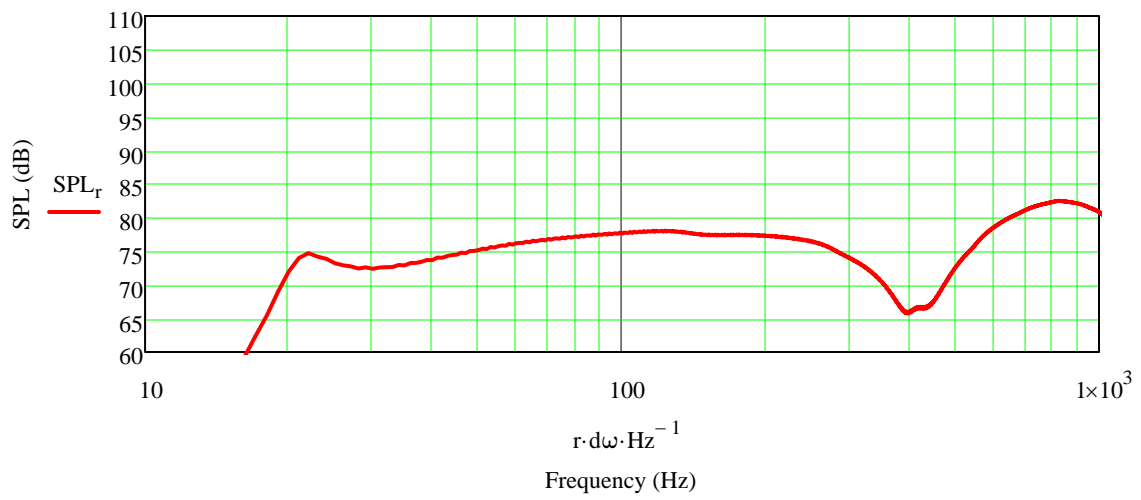
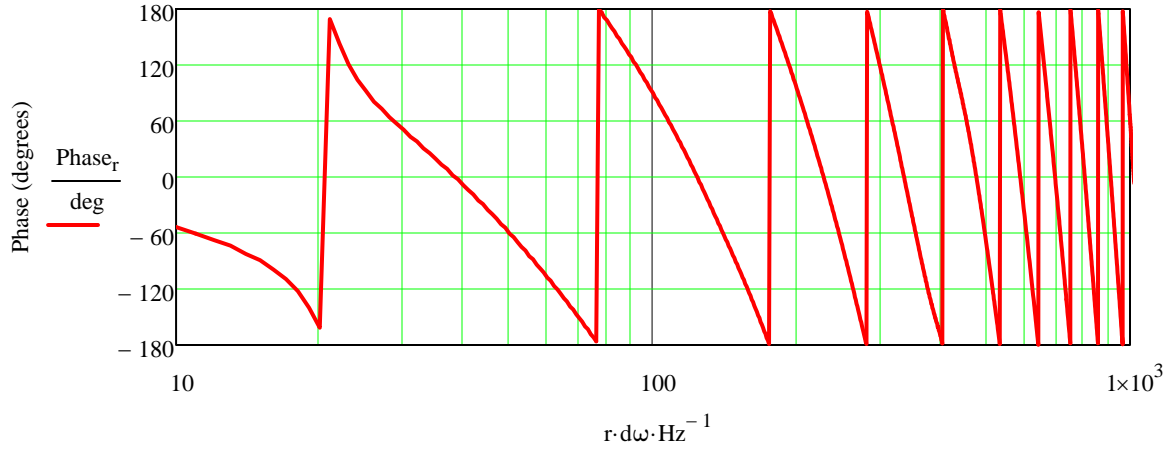
Plotted Baffle Step and Reflection SPL Response for the Circular Driver Source



Plotted Baffle Step and Reflection SPL Response for the Circular Port Source



Plotted SPL Response for the System



Part 3 : Baffle Step Correction Circuit Design

Input Center Frequency of the Baffle Step and the desired dB of Attenuation.

$f_{\text{center}} := 250 \cdot \text{Hz}$ <--- Input Center Frequency

$\text{dB} := 4$ <--- Input dB of Attenuation

Calculated Component Values

User Assigned Component Values
Based on Calculated Values at Left

$$R_e \cdot \left(10^{\frac{\text{dB}}{20}} - 1 \right) = 3.86 \Omega$$

Parallel Resistor

Input Value --->

$$R_{\text{parallel}} := 4 \cdot \Omega$$

$$\frac{R_{\text{parallel}}}{f_{\text{center}}} = 2.546 \cdot \text{mH}$$

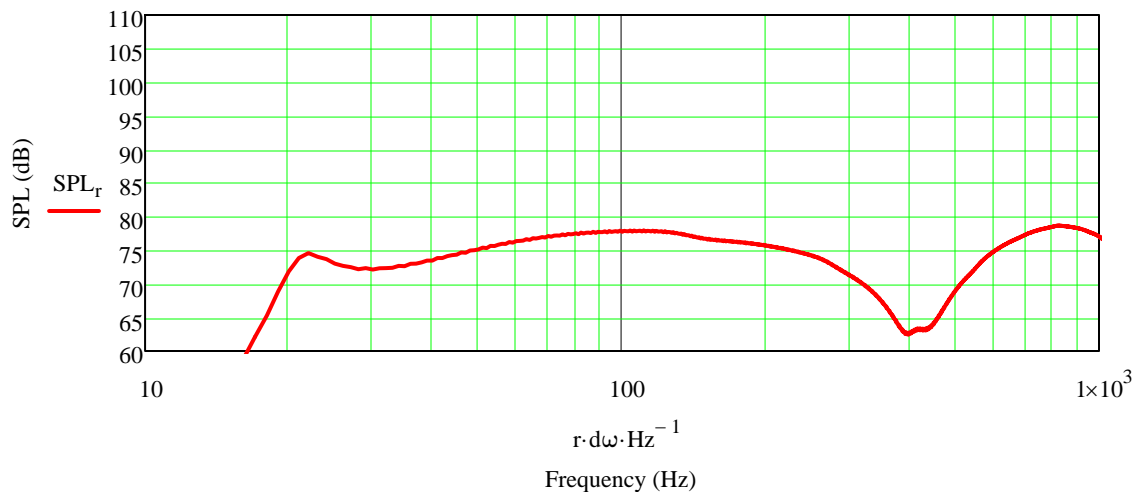
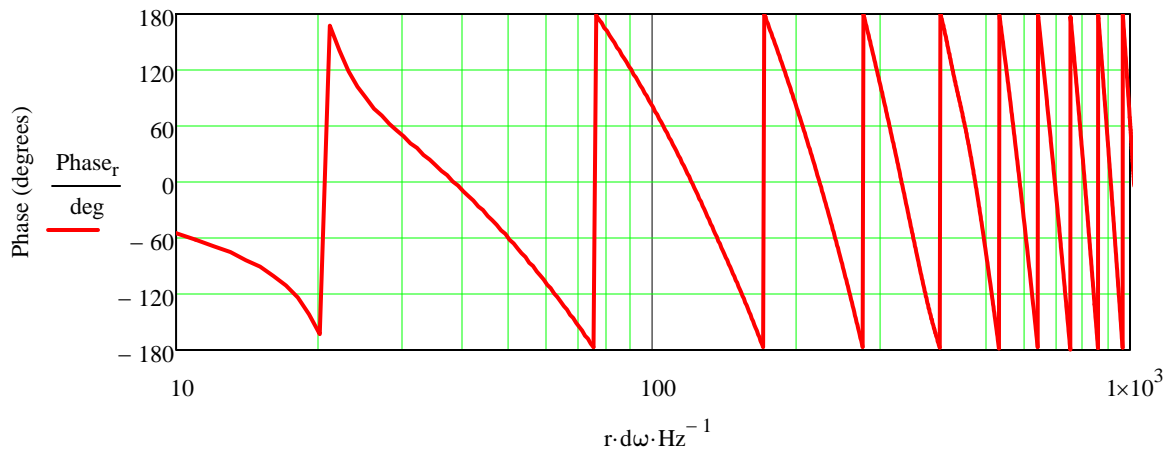
BSC Inductor

Input Value --->

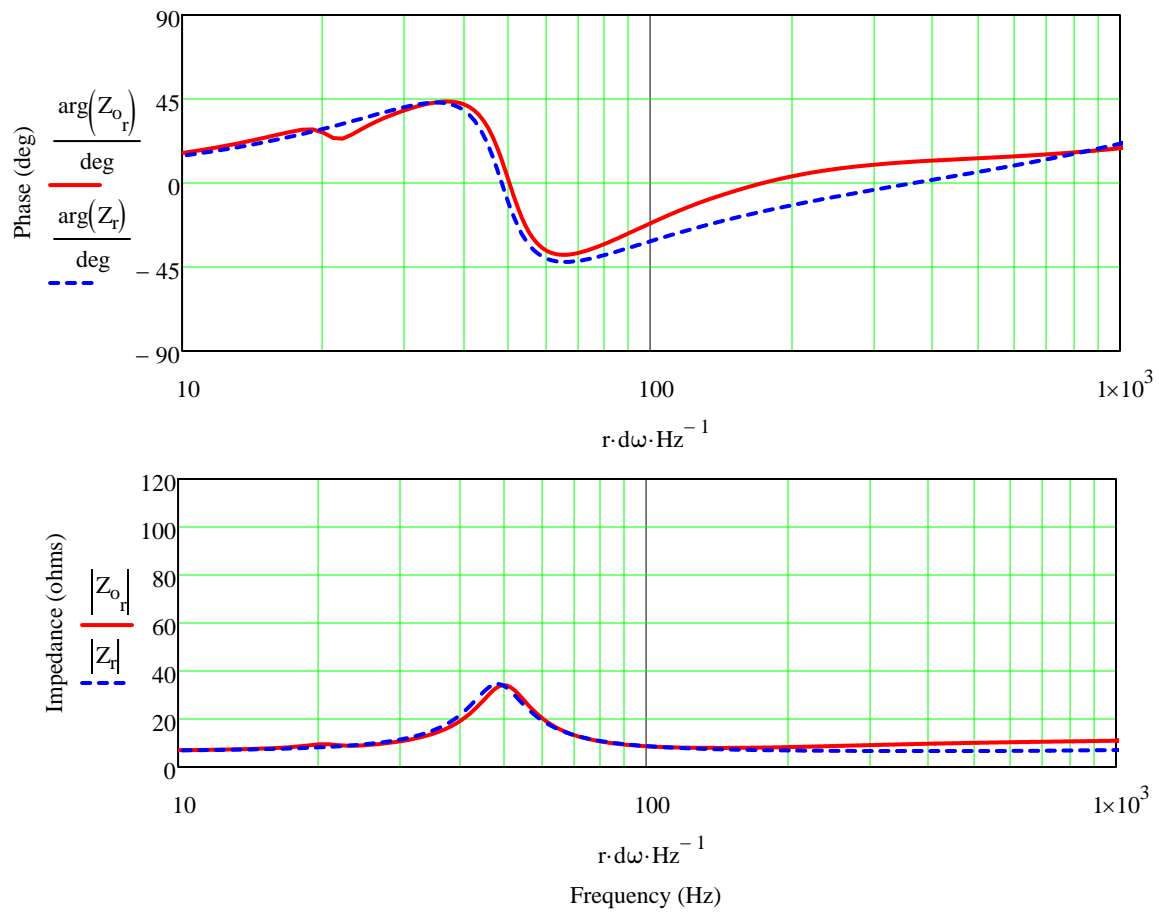
$$L_{\text{BSC}} := 2.5 \cdot \text{mH}$$



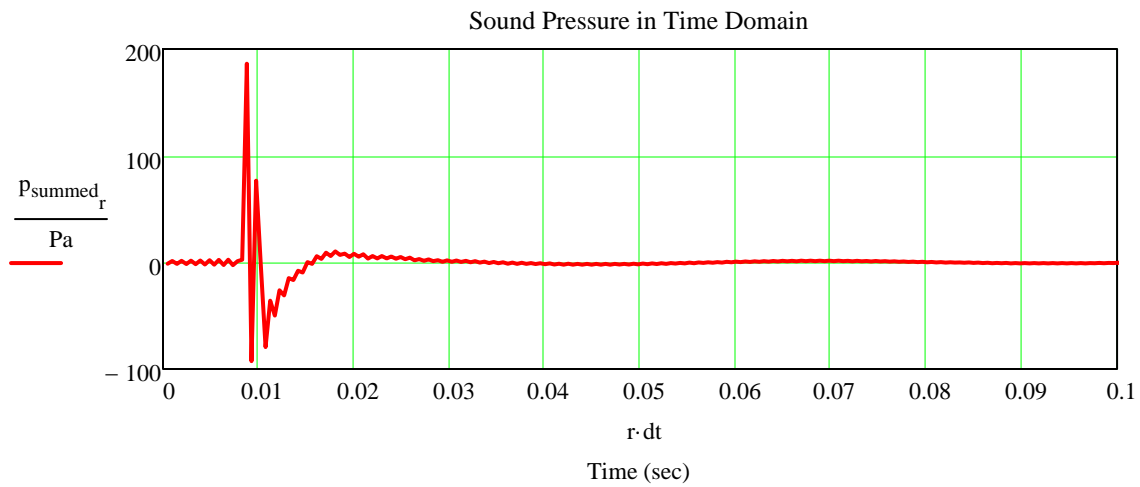
Plotted Corrected SPL Response for the System



Ported Box Corrected System and Infinite Baffle Impedance



System Time Response for an Impulse Input



Anechoic Polar Response - Free Space

Radius and Frequency Inputs

radius := 1·m (Calculation Radius Along the Driver's Axis)

$V_m := y_{dc}$ (Default Height is Equal to Driver Height)

$\omega := 500 \cdot \text{Hz}$ (Calculation Frequency : 10 Hz < ω < 1000 Hz where ω must be an Integer Value)

