



Software : by Martin J. King  
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Line Configuration : Near End Closed -> Offset Driver -> Far End Open.

**Unit and Constant Definition**

cycle := 2·π·rad

Hz := cycle·sec<sup>-1</sup>

Air Density : ρ := 1.205·kg·m<sup>-3</sup>

Speed of Sound : c := 344·m·sec<sup>-1</sup>



**Part 1 : Thiele-Small Consistent Calculation**

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

Series Resistance

R<sub>add</sub> := 0.0·Ω

Driver Thiele / Small Parameters : Fostex FE-167E in a BIB Enclosure

f<sub>d</sub> := 51.5·Hz

V<sub>ad</sub> := 35.94·liter

Adjustments

R<sub>e</sub> := 7.1·Ω

Q<sub>ed</sub> := 0.33

R<sub>e</sub> := R<sub>e</sub> + R<sub>add</sub>

L<sub>vc</sub> := 0·mH

Q<sub>md</sub> := 4.63

Q<sub>ed</sub> := Q<sub>ed</sub>·R<sub>e</sub>·(R<sub>e</sub> - R<sub>add</sub>)<sup>-1</sup>

Bl := 6.92· $\frac{\text{newton}}{\text{amp}}$

Q<sub>td</sub> :=  $\left(\frac{1}{Q_{ed}} + \frac{1}{Q_{md}}\right)^{-1}$

S<sub>d</sub> := π·(65·mm)<sup>2</sup>

Q<sub>td</sub> = 0.308

Enclosure Geometry Definition

L := 136·in

(Length)

Driver Distance

ξ := 0.2

(Driver Position Ratio : 0.001 < ξ < 0.999)

ξ·L = 27.20 in

S<sub>0</sub> := 0.1·in<sup>2</sup>

(Area of the Closed End)

S<sub>L</sub> := 87.75·in<sup>2</sup>

(Area of the Open End)

Density := 0.25·lb·ft<sup>-3</sup>

(Stuffing density : 0 lb/ft<sup>3</sup> < D < 1 lb/ft<sup>3</sup>)

Power := 1·watt

(Input Power) Applied Voltage Reference ---> R<sub>ref</sub> := 8·Ω

**End of Abbreviated User Input**

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

**Transmission Line Definition** (0 lb/ft<sup>3</sup> < D < 1 lb/ft<sup>3</sup>)

$n_{closed} := 4$  (n\_closed > 1)

$n_{open} := 4$  (n\_open > 1)

**Geometry Definition**

$TR := (S_L - S_0) \cdot L^{-1}$  TR = 0.016 m

**Closed End of Transmission Line (Driver ----> Closed End)**

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

**Open End of Transmission Line (Driver ----> Open End)**

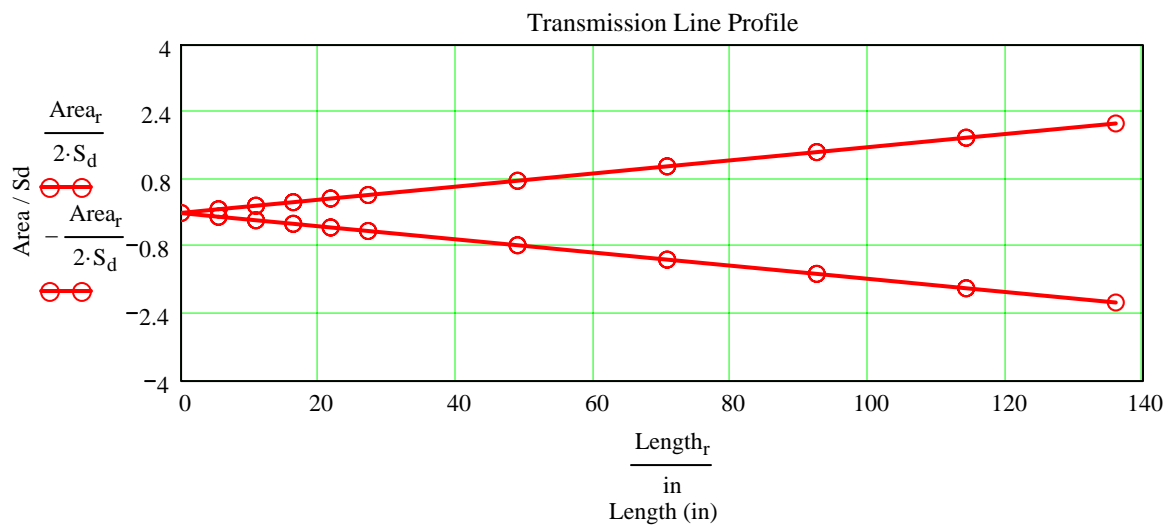
Section Length	Initial Area	Final Area	Stuffing Density
$L_{o_0} := L \cdot (1 - \xi) \cdot (n_{open} + 1)^{-1}$	$S_{o_{0,0}} := S_{c_{0,0}}$	$S_{o_{0,1}} := S_{o_{0,0}} + TR \cdot L_{o_0}$	$D_{o_0} := \text{Density}$
$L_{o_1} := L \cdot (1 - \xi) \cdot (n_{open} + 1)^{-1}$	$S_{o_{1,0}} := S_{o_{0,1}}$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

### Total Length of the Transmission Line

$$\sum_{i=0}^{n_{\text{closed}}} L_{c_i} + \sum_{i=0}^{n_{\text{open}}} L_{o_i} = 136.000 \text{ in}$$

### Total Amount of Stuffing

$$\sum_{r=0}^{n_{\text{closed}}} \left( \frac{S_{c_{r,0}} + S_{c_{r,1}}}{2} \cdot L_{c_r} \cdot D_{c_r} \right) + \sum_{r=0}^{n_{\text{open}}} \left( \frac{S_{o_{r,0}} + S_{o_{r,1}}}{2} \cdot L_{o_r} \cdot D_{o_r} \right) = 0.234 \text{ lb}$$

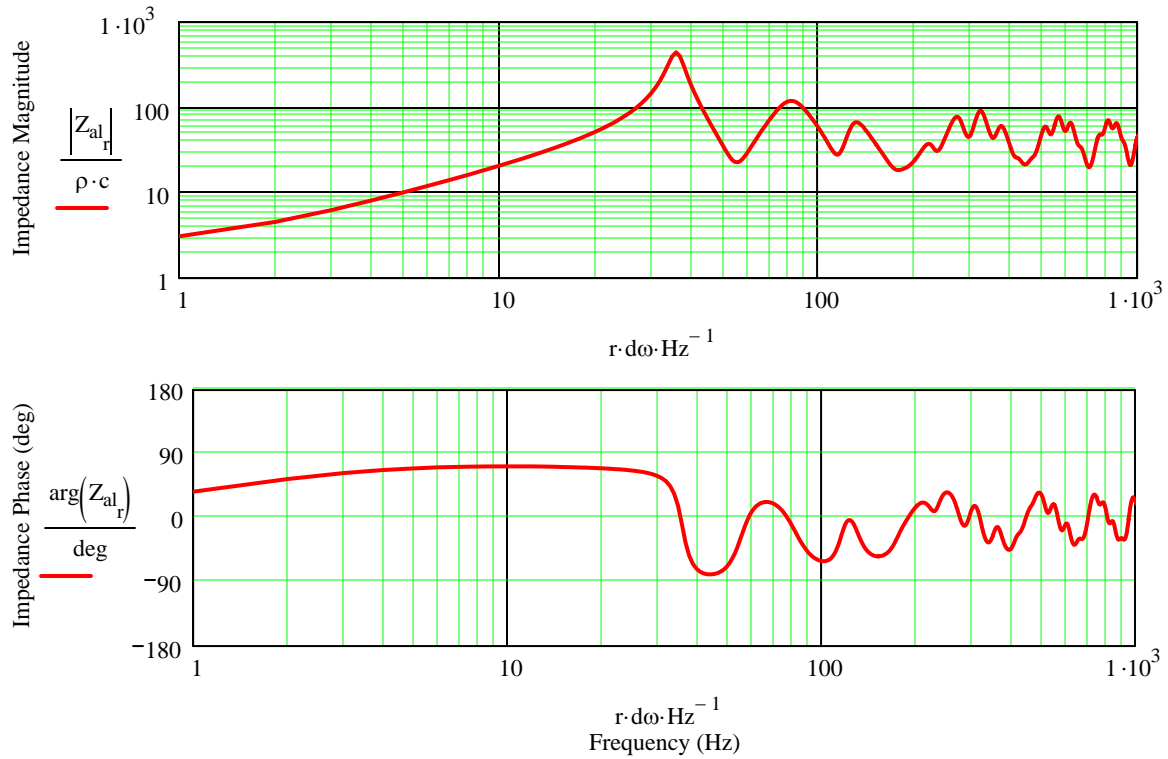


**End of Detailed Input**

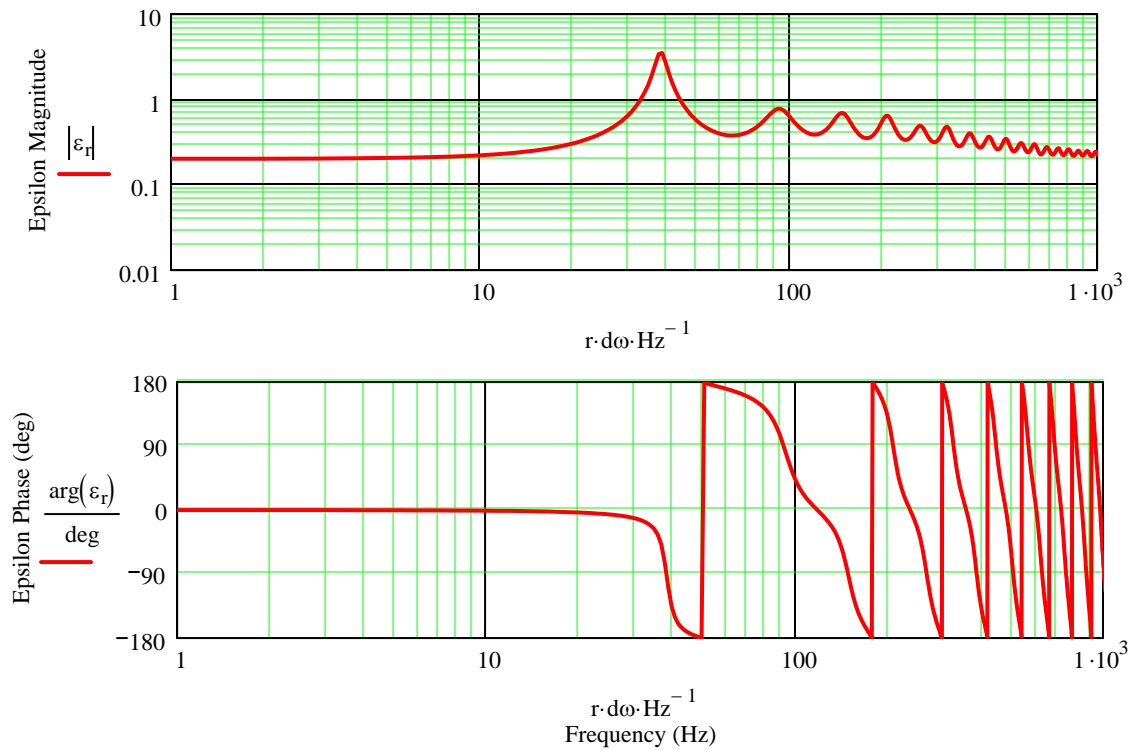
**End of Part 1 Input**



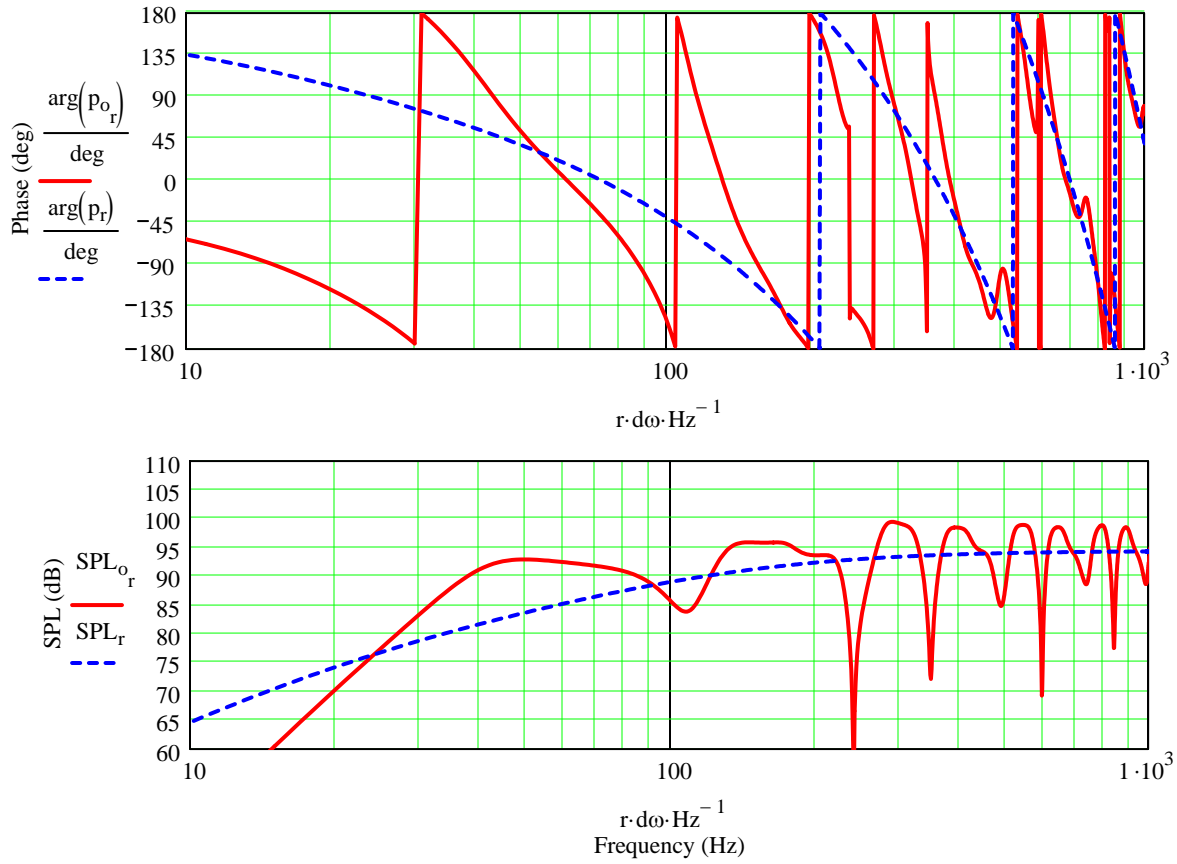
## Resulting Acoustic Impedance for the Transmission Line



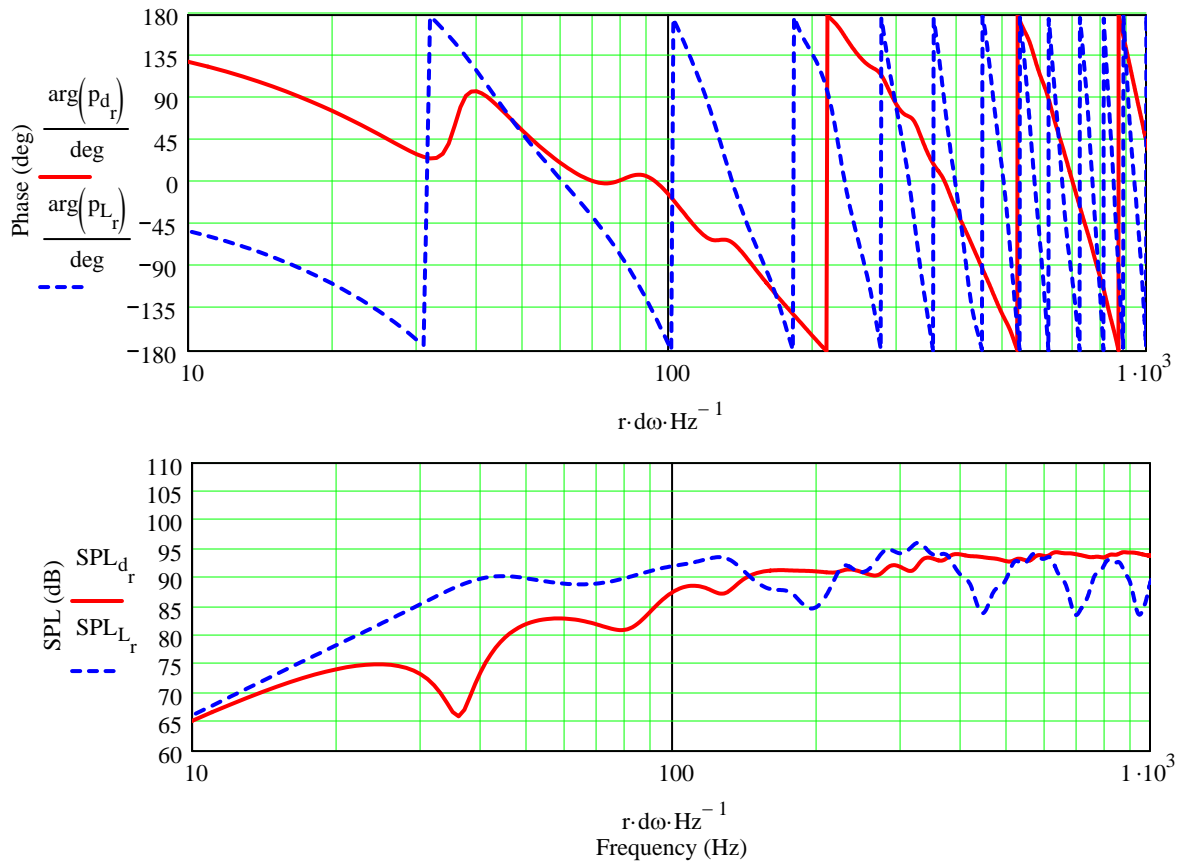
## Velocity at the Terminus of the Transmission Line for a 1 m/sec Excitation at the Driver



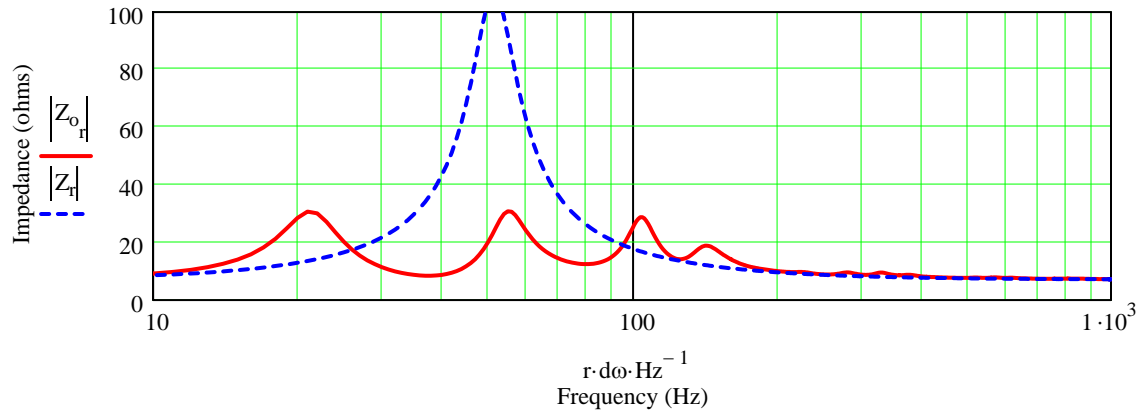
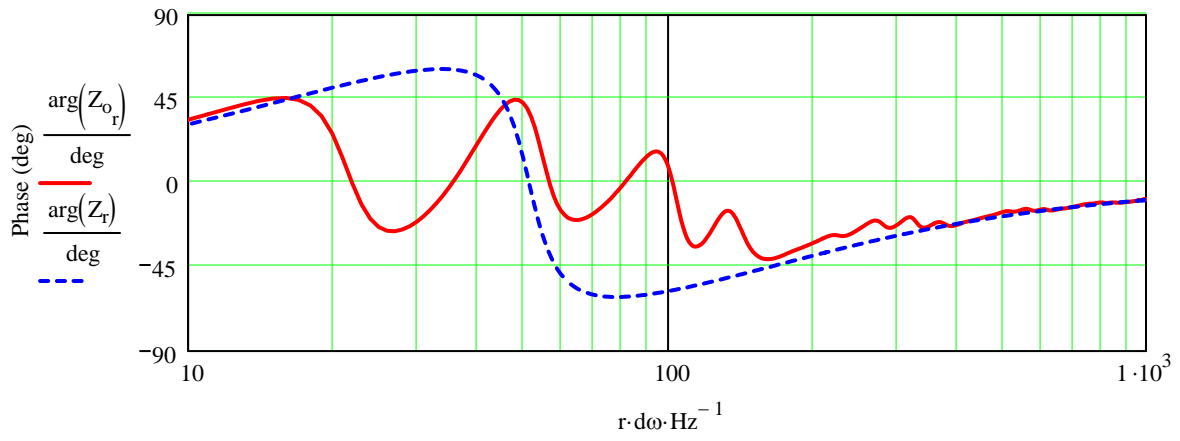
### Far Field Transmission Line System and Infinite Baffle Sound Pressure Level Responses



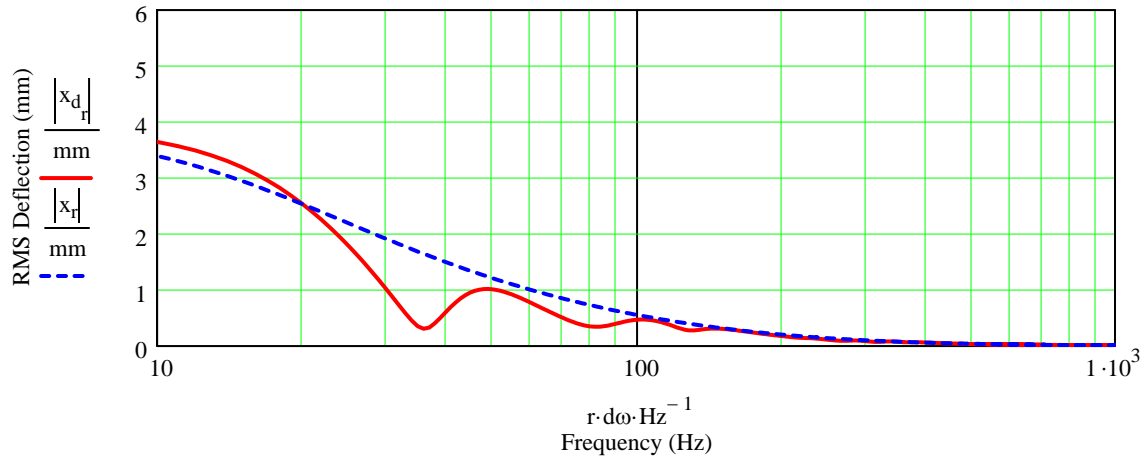
### Woofer and Terminus Far Field Sound Pressure Level Responses



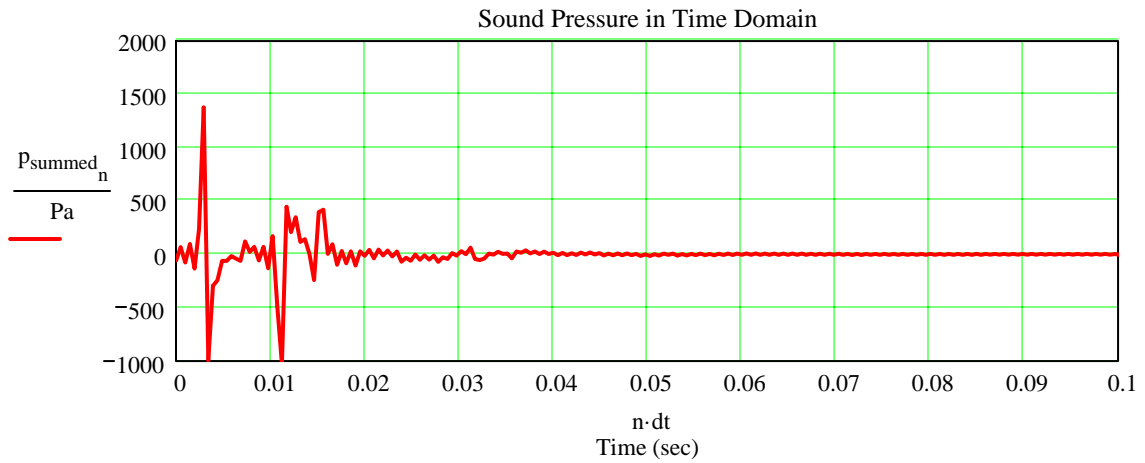
# Transmission Line System and Infinite Baffle Impedance



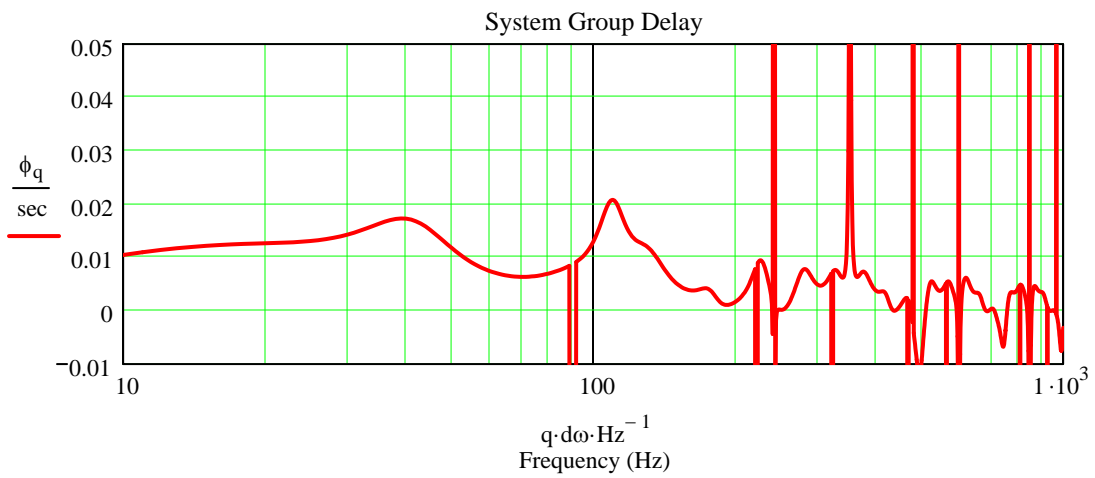
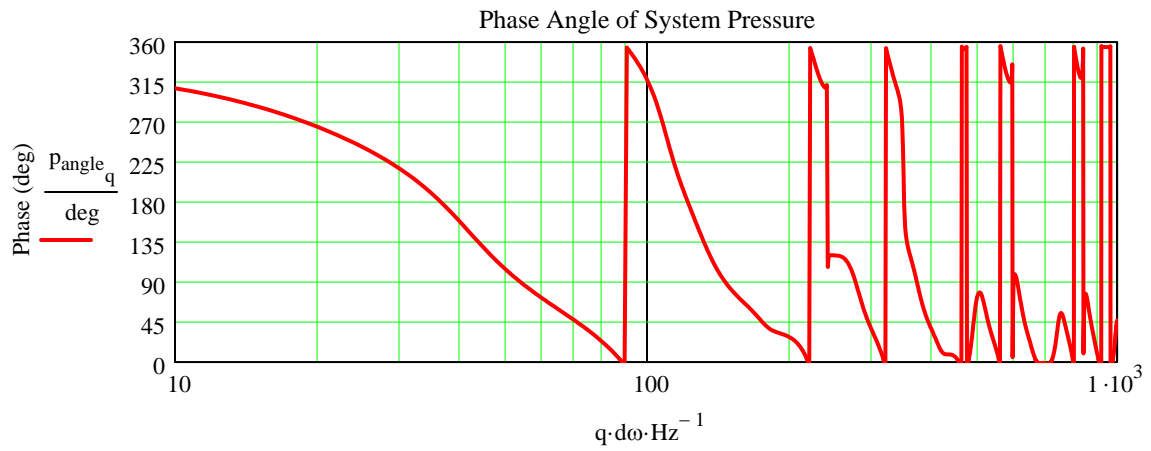
## Woofer RMS Displacement



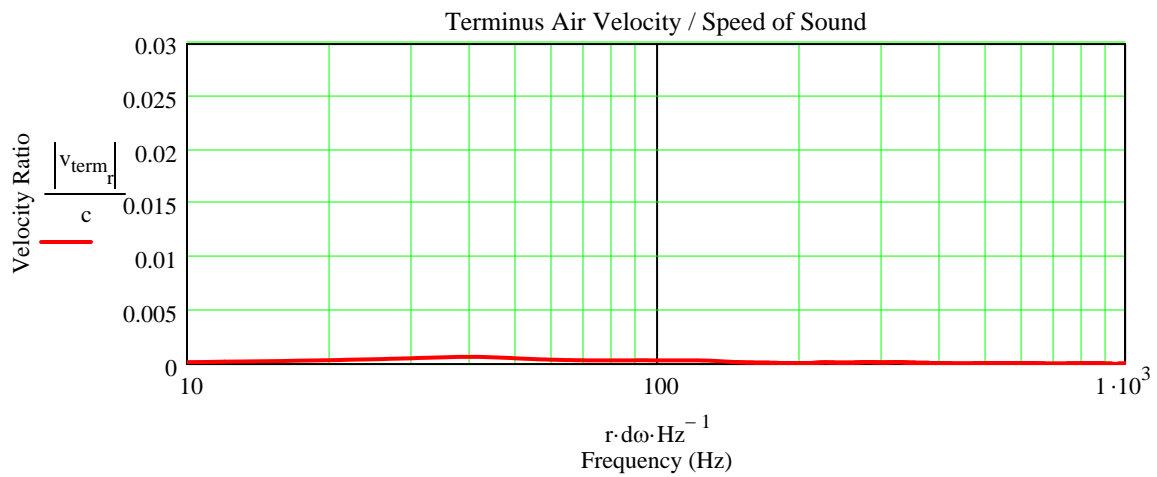
## System Time Response for an Impulse Input



## System Group Delay



Terminus Air Velocity (should be  $< 10 \text{ m/sec} / 344 \text{ m/sec} = 0.03$ )



## **Part 2 : Detailed SPL Response Calculation**

Calculation Includes :

- Position of Driver and Terminus on the Baffle.
- Baffle Step Defraction for the Driver and the Terminus.
- Room Reflections for the Driver and the Terminus.

### **Geometry**

Baffle Coordinate System :

- Origin is the lower left corner of the front baffle
- y = horizontal direction
- z = vertical direction

The variables num\_r, n\_drv, and n\_mth control the number of simple sources that are used in the calculations. Increasing each will improve accuracy at the expense of longer calculation times. Increase each variable until plotted SPL stops changing at which point the solution has converged.

### Enclosure Geometry Input

- $X_0 := 2 \cdot \text{ft}$  (Front Baffle Distance from Rear Wall > Depth of Enclosure)
- $Y_0 := 2 \cdot \text{ft}$  (Front Baffle Distance from Side Wall)
- $\theta_0 := 45 \cdot \text{deg}$  (Rotation Towards Room Center)
- $Z_0 := 8 \cdot \text{ft}$  (Floor to Ceiling Distance)
  
- stand := 0·m (Height from Floor to Bottom Edge of Front Baffle)
- num\_r := 10 (Number of Points per Unit Length of Baffle Edge)

### Corner Coordinates

- | Y coordinate                         | Z coordinate                    |                       |
|--------------------------------------|---------------------------------|-----------------------|
| $y_{o_0} := 10.0625 \cdot \text{in}$ |                                 | (Bottom Right Corner) |
| $y_{o_1} := 10.0625 \cdot \text{in}$ | $z_{o_1} := 68 \cdot \text{in}$ | (Top Right Corner)    |
| $y_{o_2} := 0 \cdot \text{in}$       | $z_{o_2} := 68 \cdot \text{in}$ | (Top Left Corner)     |
| $y_{o_3} := 0 \cdot \text{in}$       |                                 | (Bottom Left Corner)  |
| depth := 11.75·in                    |                                 | (Depth of Enclosure)  |

### Driver Geometry Input

$y_{dc} := 5.03125 \cdot \text{in}$  (Driver Center x Coordinate)  
 $z_{dc} := 40.5 \cdot \text{in}$  (Driver Center z Coordinate)  
 $n_{dvr} := 5$  (Number of Points Across Diameter)

### Terminus Geometry Input

$x_{mc} := -5.875 \cdot \text{in}$  (Terminus Center x Coordinate)  
 $y_{mc} := 5.03125 \cdot \text{in}$  (Terminus Center y Coordinate)  
 $w_{mth} := 8.5625 \cdot \text{in}$  (Terminus Width)  
 $n_{mth} := 5$  (Number of Points Across the Width)  
Locate := 1 (0 = Bottom Baffle Terminus, 1 = Top Baffle Terminus)

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

$n_{listen} = 0$  (Listening Position Relative to Speaker)  
 $radius := 1 \cdot \text{m}$  (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,  $-80 \text{ deg} < \theta < 80 \text{ deg}$ )  
 $z_p := z_{dc} + \text{stand}$  (Default Height is Equal to Driver Height)

$n_{listen} = 1$  (Listening Position Relative to the Room Corner)

$X_p := 10 \text{ft}$   
 $Y_p := 7 \cdot \text{ft}$   
 $Z_p := z_{dc} + \text{stand}$  (Default Height is Equal to Driver Height)  
 $n_{listen} := 0$  (Method Selection)

### Floor Condition

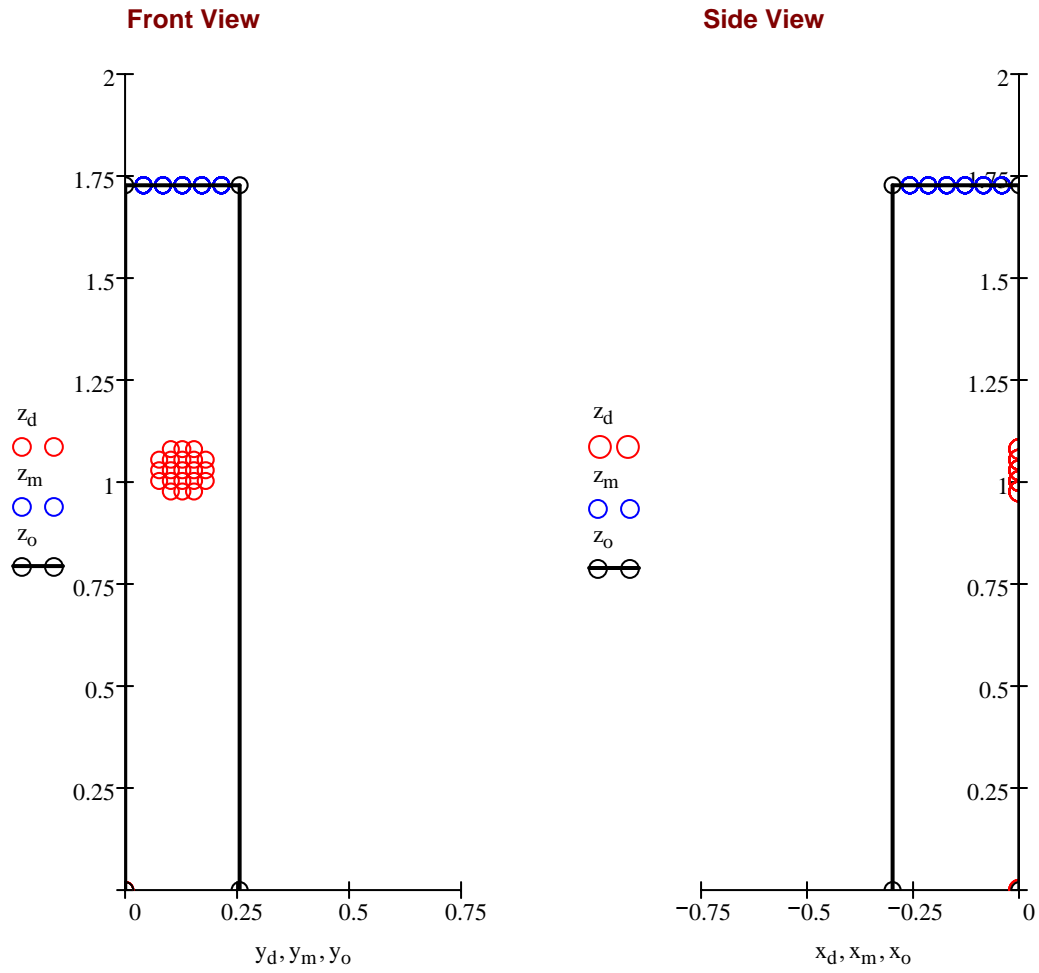
Reflect := 1 (0 = hardwood or concrete, 1 = carpeted)

### Reflective Surface Selections (if 1 reflective surface is included, if 0 reflective surface is removed)

$Inc_{floor} := 1$  (Floor,  $Z = 0$ )  
 $Inc_{rear} := 1$  (Rear Wall,  $X = 0$ )  
 $Inc_{side} := 1$  (Left Side Wall,  $Y = 0$ )  
 $Inc_{ceiling} := 1$  (Ceiling)



### Circular Driver and TL Terminus Simple Source Pattern with Baffle Edge Outline



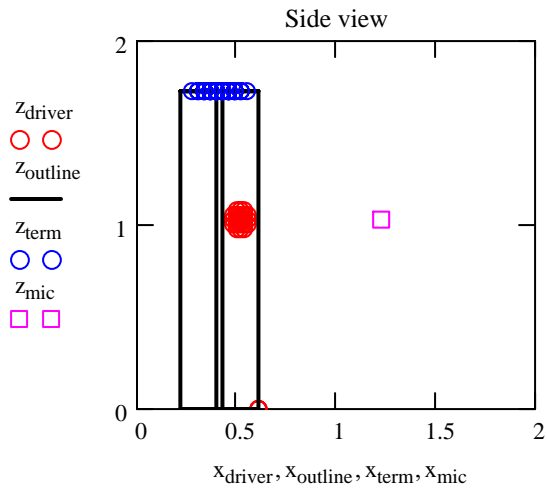
Red sources represent the driver.  
Blue sources represent the terminus.  
Black outline represents the baffle edge.  
Origin is at the bottom front left corner of the enclosure.



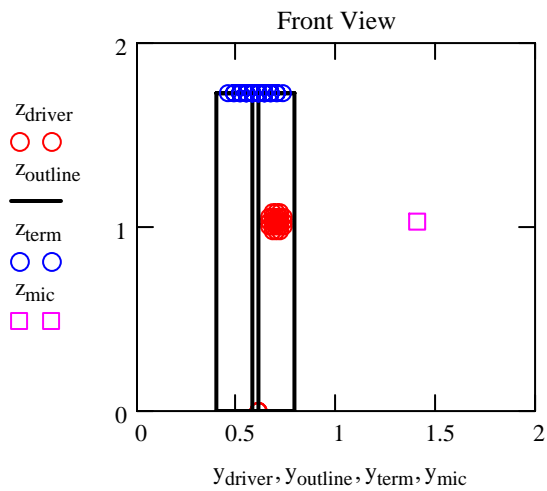
### Three Dimensional View

Axis Length (m) axis := 2 <---- Change value of "axis" to rescale plots

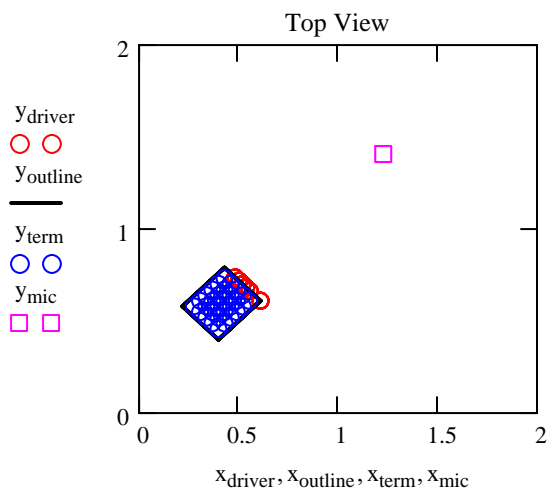
Room Corner is the Origin



Side View - looking out from side wall



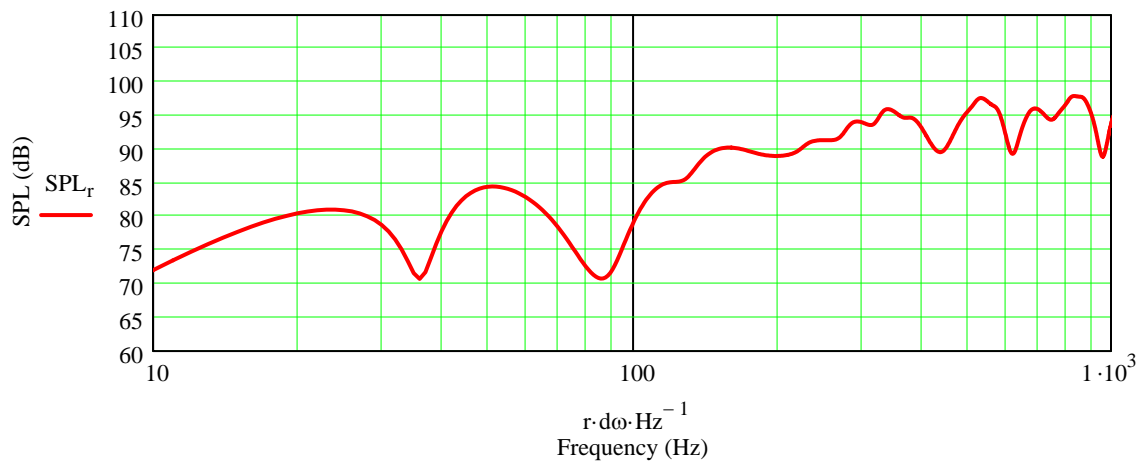
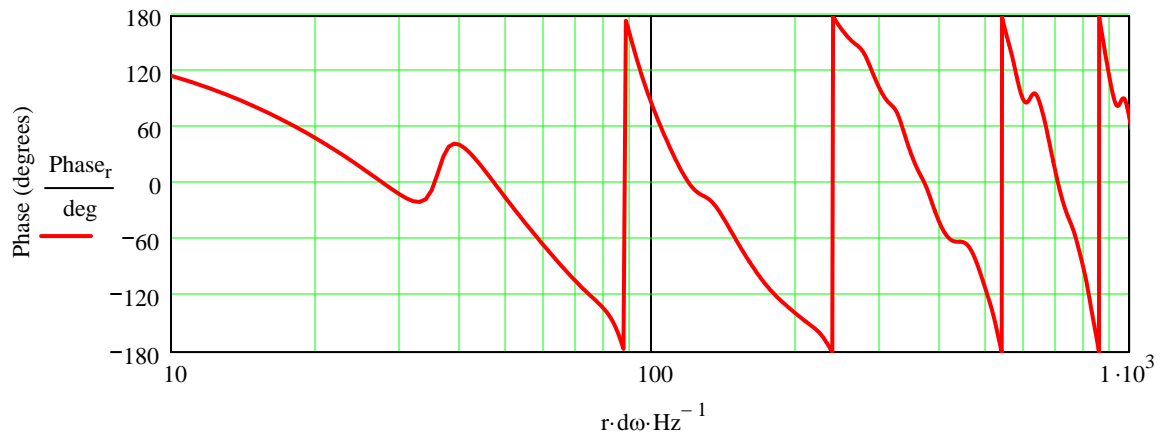
Front View - looking towards rear wall



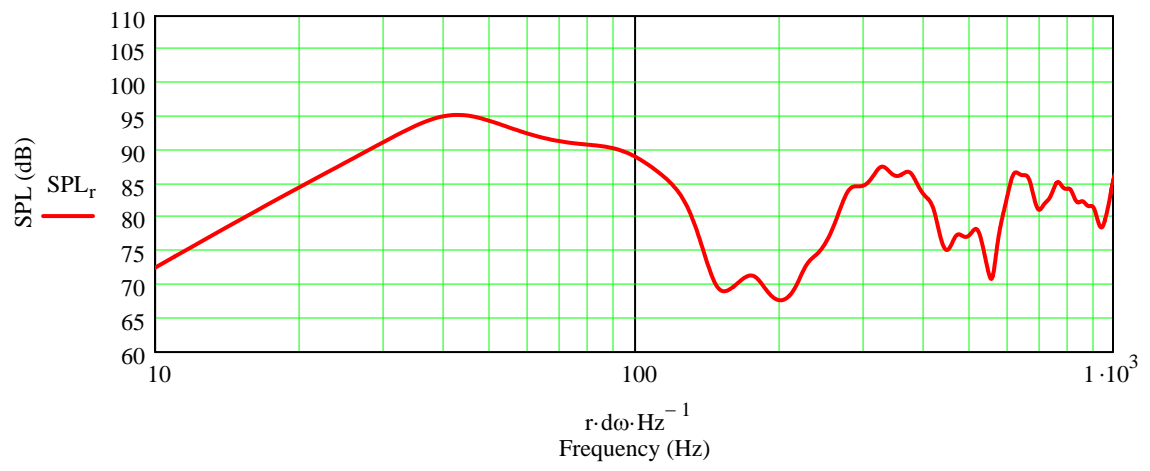
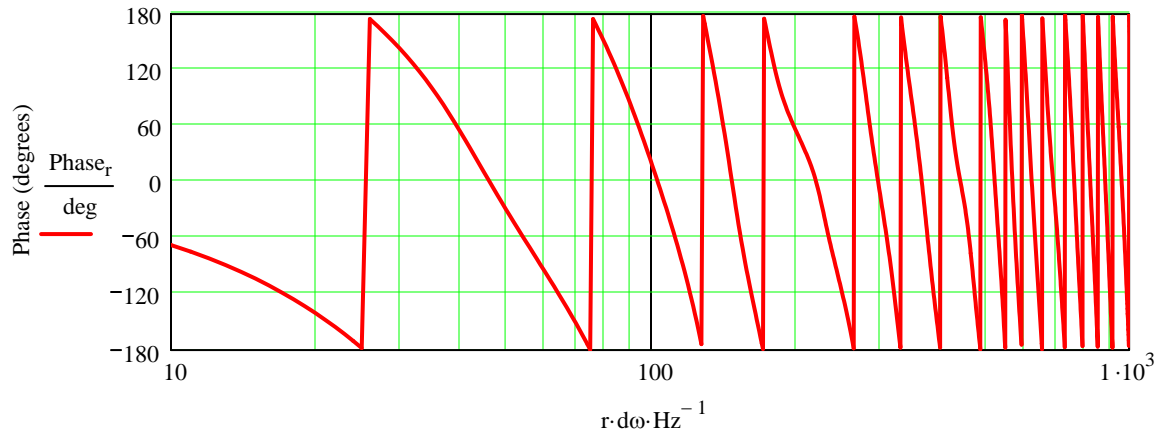
Top View - looking down from ceiling



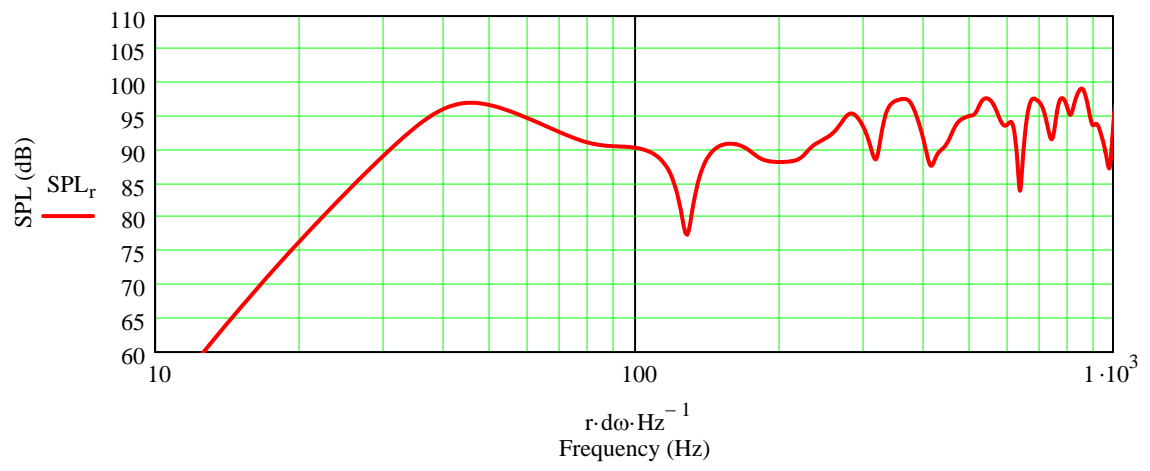
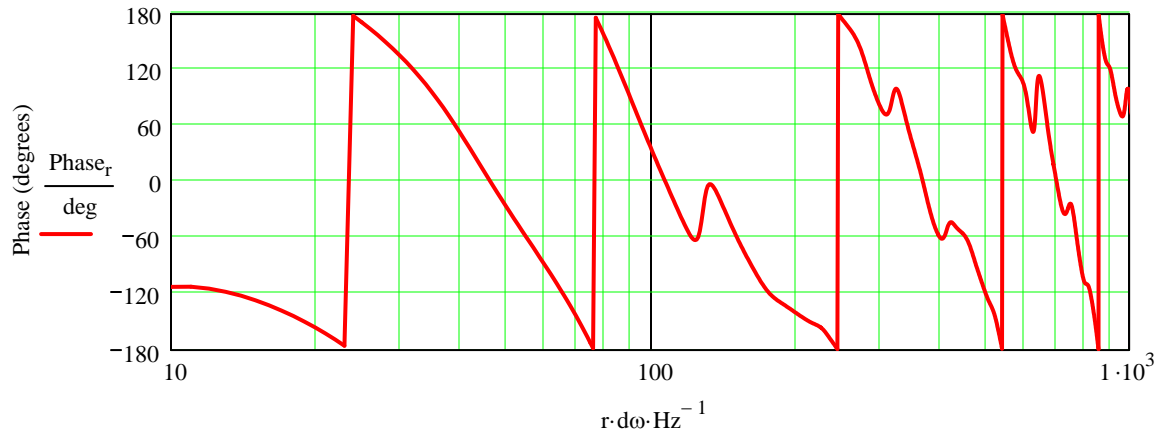
### Plotted Baffle Step and Reflection SPL Response for the Circular Driver Source



### Plotted Baffle Step and Reflection SPL Response for the TL Terminus



### 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.

$f_{\text{center}} := 400 \cdot \text{Hz}$  <--- Input Center Frequency

$\text{dB} := 1$  <--- Input dB of Attenuation

Calculated Component Values

User Assigned Component Values  
Based on Calculated Values at Left

$$R_e \cdot \left( 10^{\frac{\text{dB}}{20}} - 1 \right) = 0.866 \Omega$$

Parallel Resistor

Input Value --->

$$R_{\text{parallel}} := 1 \cdot \Omega$$

$$\frac{R_{\text{parallel}}}{f_{\text{center}}} = 0.398 \text{ mH}$$

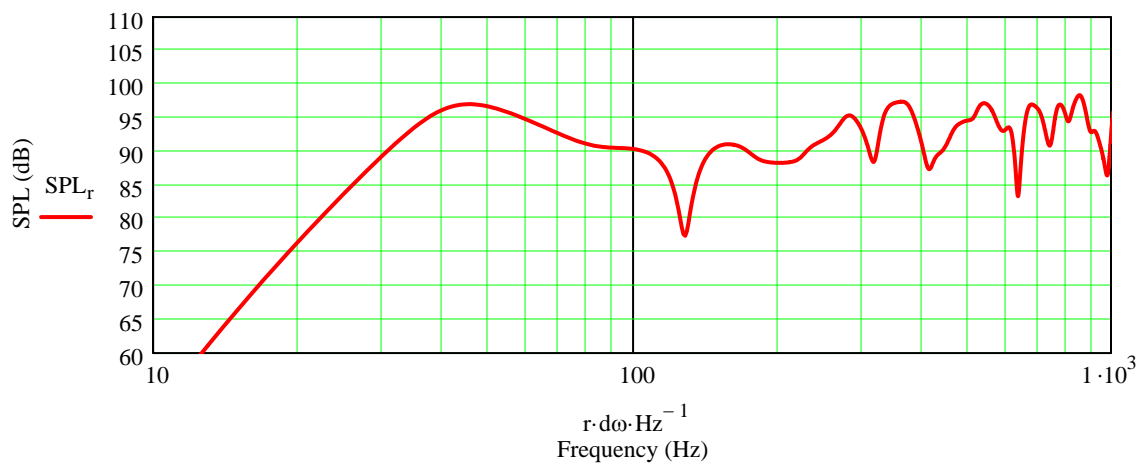
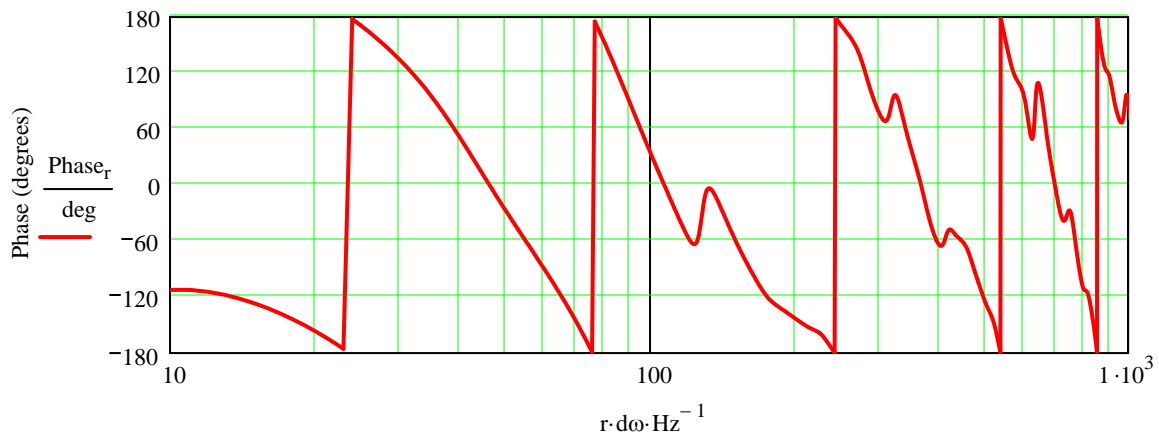
BSC Inductor

Input Value --->

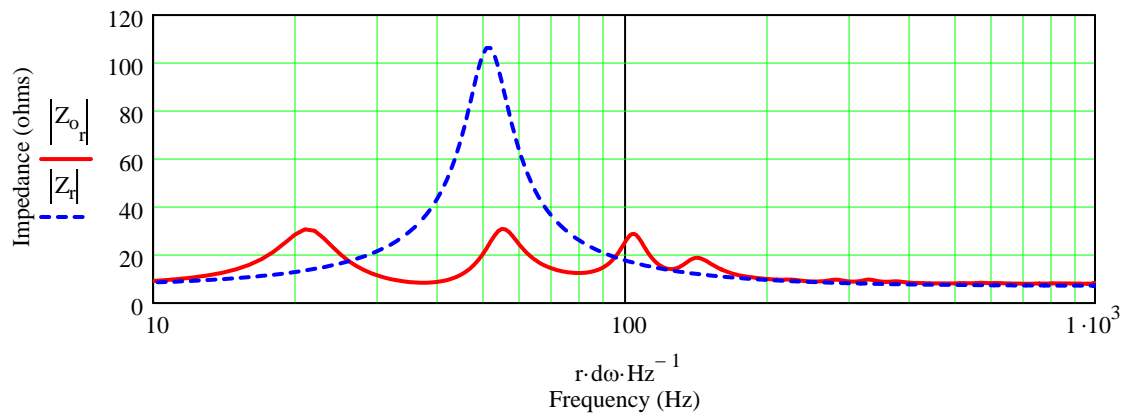
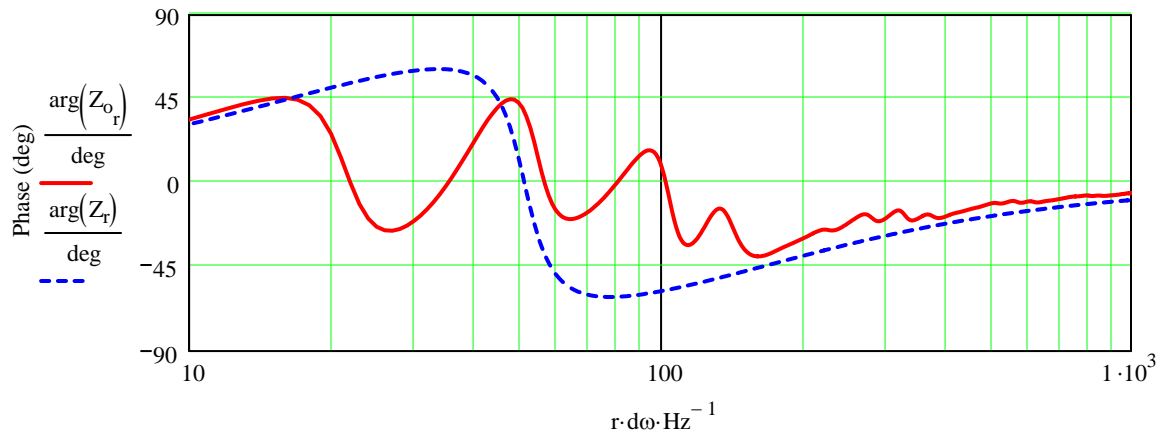
$$L_{\text{BSC}} := 0.4 \cdot \text{mH}$$



### Plotted Corrected SPL Response for the System



## Transmission Line Corrected System and Infinite Baffle Impedance



## System Time Response for an Impulse Input

