



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

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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 : Alpair 10 Properties

f<sub>d</sub> := 40·Hz

V<sub>ad</sub> := 19.5·liter

Adjustments

R<sub>e</sub> := 5.4·Ω

Q<sub>ed</sub> := 0.39

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

L<sub>vc</sub> := 70.23·10<sup>-3</sup>·mH

Q<sub>md</sub> := 2.24

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

Bl := 5.83· $\frac{\text{newton}}{\text{amp}}$

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

S<sub>d</sub> := 90·cm<sup>2</sup>

Q<sub>td</sub> = 0.332

Power := 1·watt

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

## Enclosure Geometry Definition - Half of the Enclosure (model only top half of coupling chamber)

### Coupling Chamber Geometry

$L := 13 \cdot \text{in}$	(Length)
$\xi := 0.999$	(Driver Position Ratio : $0.001 < \xi < 0.999$ )
$S_0 := 2.75 \cdot 8 \cdot \text{in}^2$	(Area of the Closed End : $S_0 > 0 \text{ m}^2$ )
$S_L := 2.75 \cdot 8 \cdot \text{in}^2$	(Area of the Throat End : $S_L > 0 \text{ m}^2$ )
Density := $0.5 \cdot \text{lb} \cdot \text{ft}^{-3}$	(Stuffing density : $0 \text{ lb/ft}^3 < D < 1 \text{ lb/ft}^3$ )

### BLH Enclosure Definition

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

$n_{\text{closed}} := 3$	( $n_{\text{closed}} > 1$ )
$n_{\text{open}} := 13$	( $n_{\text{open}} > 1$ )

### Coupling Chamber Geometry Definition

$$TR := (S_L - S_0) \cdot L^{-1} \quad TR = 0.000 \text{ m}$$

### Closed End of Coupling Chamber (Driver ----> Closed End)

Section Length	Initial Area	Final Area	Stuffing Density
$L_{c_0} := 0.25 \cdot \xi \cdot L$	$S_{c_{0,0}} := S_0 + TR \cdot \xi \cdot L$	$S_{c_{0,1}} := S_{c_{0,0}} - TR \cdot L_{c_0}$	$D_{c_0} := \text{Density}$
$L_{c_1} := 0.25 \cdot \xi \cdot L$	$S_{c_{1,0}} := S_{c_{0,1}}$	$S_{c_{1,1}} := S_{c_{1,0}} - TR \cdot L_{c_1}$	$D_{c_1} := \text{Density}$
$L_{c_2} := 0.25 \cdot \xi \cdot L$	$S_{c_{2,0}} := S_{c_{1,1}}$	$S_{c_{2,1}} := S_{c_{2,0}} - TR \cdot L_{c_2}$	$D_{c_2} := \text{Density}$
$L_{c_3} := 0.25 \cdot \xi \cdot L$	$S_{c_{3,0}} := S_{c_{2,1}}$	$S_{c_{3,1}} := S_0$	$D_{c_3} := \text{Density}$

### Open End of Coupling Chamber (Driver ----> Throat End)

Section Length	Initial Area	Final Area	Stuffing Density
$L_{o_0} := 0.25 \cdot (1 - \xi) \cdot L$	$S_{o_{0,0}} := S_{c_{0,0}}$	$S_{o_{0,1}} := S_{o_{0,0}} + TR \cdot L_{o_0}$	$D_{o_0} := \text{Density}$
$L_{o_1} := 0.25 \cdot (1 - \xi) \cdot L$	$S_{o_{1,0}} := S_{o_{0,1}}$	$S_{o_{1,1}} := S_{o_{1,0}} + TR \cdot L_{o_1}$	$D_{o_1} := \text{Density}$
$L_{o_2} := 0.25 \cdot (1 - \xi) \cdot L$	$S_{o_{2,0}} := S_{o_{1,1}}$	$S_{o_{2,1}} := S_{o_{2,0}} + TR \cdot L_{o_2}$	$D_{o_2} := \text{Density}$
$L_{o_3} := 0.25 \cdot (1 - \xi) \cdot L$	$S_{o_{3,0}} := S_{o_{2,1}}$	$S_{o_{3,1}} := S_L$	$D_{o_3} := \text{Density}$

## Horn Geometry Definition

(Throat ---> Mouth)

### Section Length

$$L_{o_4} := 2.25 \cdot \text{in}$$

$$L_{o_5} := 13 \cdot \text{in}$$

$$L_{o_6} := 15.5 \cdot \text{in}$$

$$L_{o_7} := 4.5 \cdot \text{in}$$

$$L_{o_8} := 12 \cdot \text{in}$$

$$L_{o_9} := 6 \cdot \text{in}$$

$$L_{o_{10}} := 9.25 \cdot \text{in}$$

$$L_{o_{11}} := 9.25 \cdot \text{in}$$

$$L_{o_{12}} := 5 \cdot \text{in}$$

$$L_{o_{13}} := 5 \cdot \text{in}$$

### Initial Area

$$S_{o_{4,0}} := 2 \cdot \text{in} \cdot 3.4 \cdot \text{in}$$

$$S_{o_{5,0}} := 3 \cdot \text{in} \cdot 8 \cdot \text{in}$$

$$S_{o_{6,0}} := 4 \cdot \text{in} \cdot 8 \cdot \text{in}$$

$$S_{o_{7,0}} := 4.5 \cdot \text{in} \cdot 8 \cdot \text{in}$$

$$S_{o_{8,0}} := 5 \cdot \text{in} \cdot 8 \cdot \text{in}$$

$$S_{o_{9,0}} := 5.5 \cdot \text{in} \cdot 8 \cdot \text{in}$$

$$S_{o_{10,0}} := 6 \cdot \text{in} \cdot 8 \cdot \text{in}$$

$$S_{o_{11,0}} := 6 \cdot \text{in} \cdot 8 \cdot \text{in}$$

$$S_{o_{12,0}} := 8.5 \cdot \text{in} \cdot 8 \cdot \text{in}$$

$$S_{o_{13,0}} := 8.5 \cdot \text{in} \cdot 8 \cdot \text{in}$$

### Final Area

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

$$S_{o_{5,1}} := S_{o_{5,0}}$$

$$S_{o_{6,1}} := S_{o_{6,0}}$$

$$S_{o_{7,1}} := S_{o_{7,0}}$$

$$S_{o_{8,1}} := S_{o_{8,0}}$$

$$S_{o_{9,1}} := S_{o_{9,0}}$$

$$S_{o_{10,1}} := S_{o_{10,0}}$$

$$S_{o_{11,1}} := S_{o_{11,0}}$$

$$S_{o_{12,1}} := S_{o_{12,0}}$$

$$S_{o_{13,1}} := S_{o_{13,0}}$$

### Stuffing Density

$$D_{o_4} := 0.25 \cdot \text{lb} \cdot \text{ft}^{-3}$$

$$D_{o_5} := 0.25 \cdot \text{lb} \cdot \text{ft}^{-3}$$

$$D_{o_6} := 0.25 \cdot \text{lb} \cdot \text{ft}^{-3}$$

$$D_{o_7} := 0.25 \cdot \text{lb} \cdot \text{ft}^{-3}$$

$$D_{o_8} := 0.25 \cdot \text{lb} \cdot \text{ft}^{-3}$$

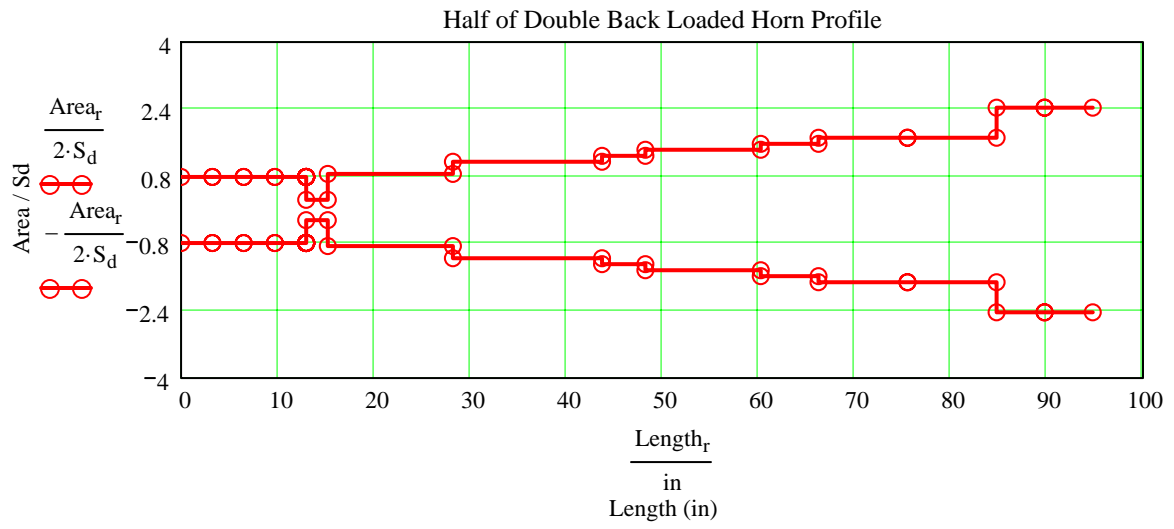
$$D_{o_9} := 0.25 \cdot \text{lb} \cdot \text{ft}^{-3}$$

$$D_{o_{10}} := 0.25 \cdot \text{lb} \cdot \text{ft}^{-3}$$

$$D_{o_{11}} := 0.25 \cdot \text{lb} \cdot \text{ft}^{-3}$$

$$D_{o_{12}} := 0.25 \cdot \text{lb} \cdot \text{ft}^{-3}$$

$$D_{o_{13}} := 0.25 \cdot \text{lb} \cdot \text{ft}^{-3}$$

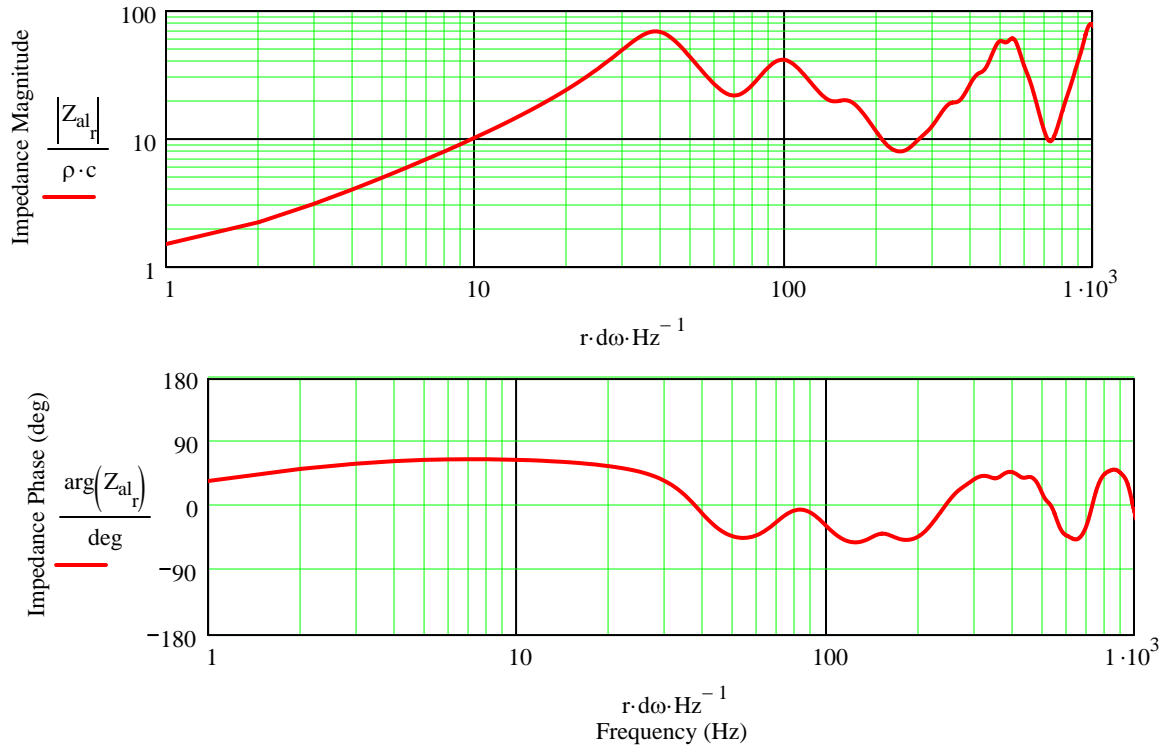


**End of Detailed Input**

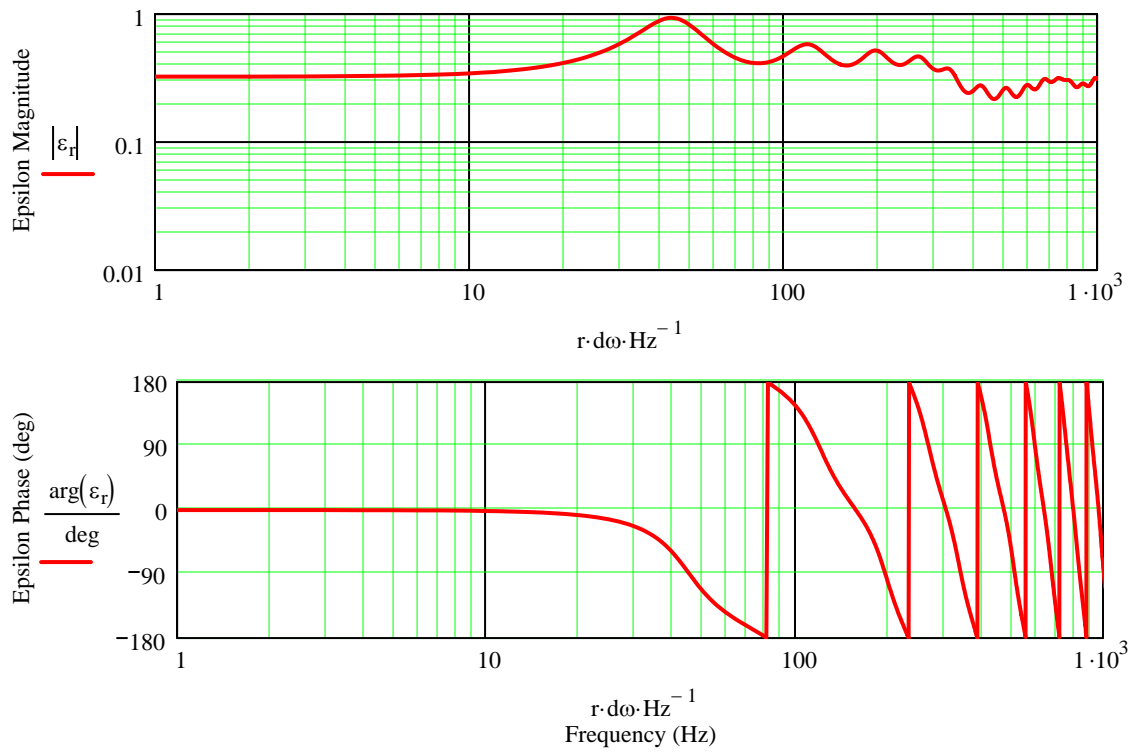
**End of Part 1 Input**



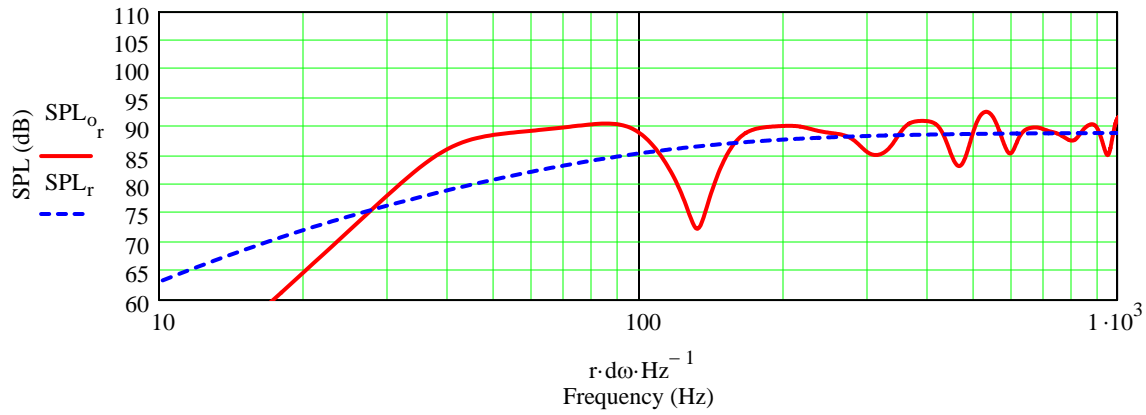
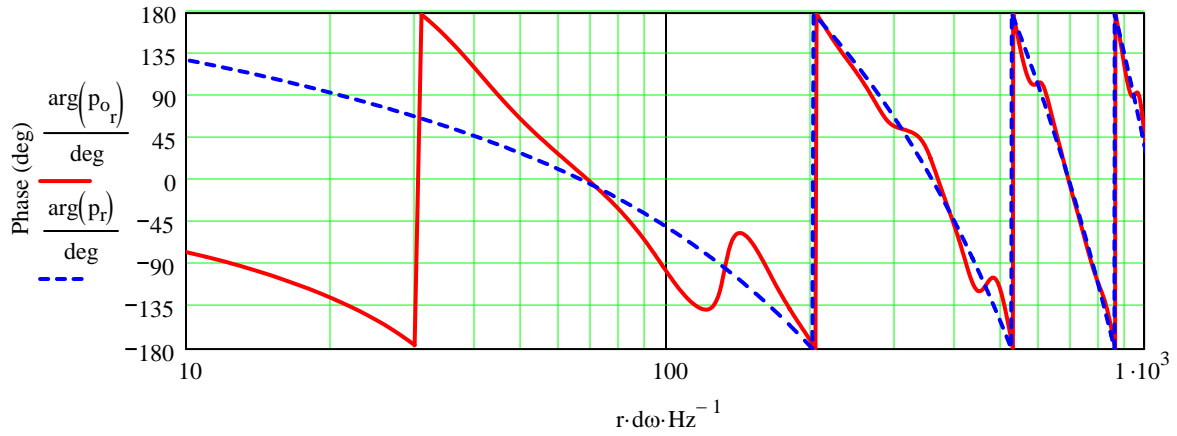
## Resulting Acoustic Impedance for the Back Loaded Horn



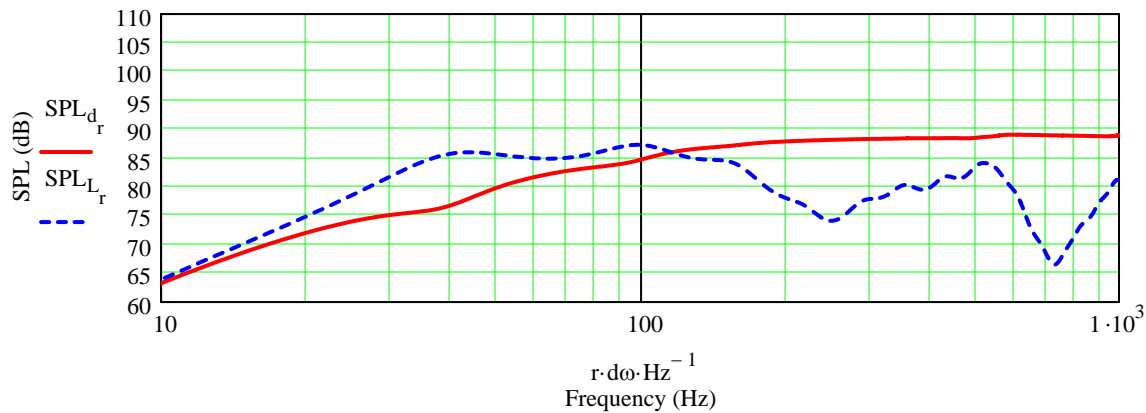
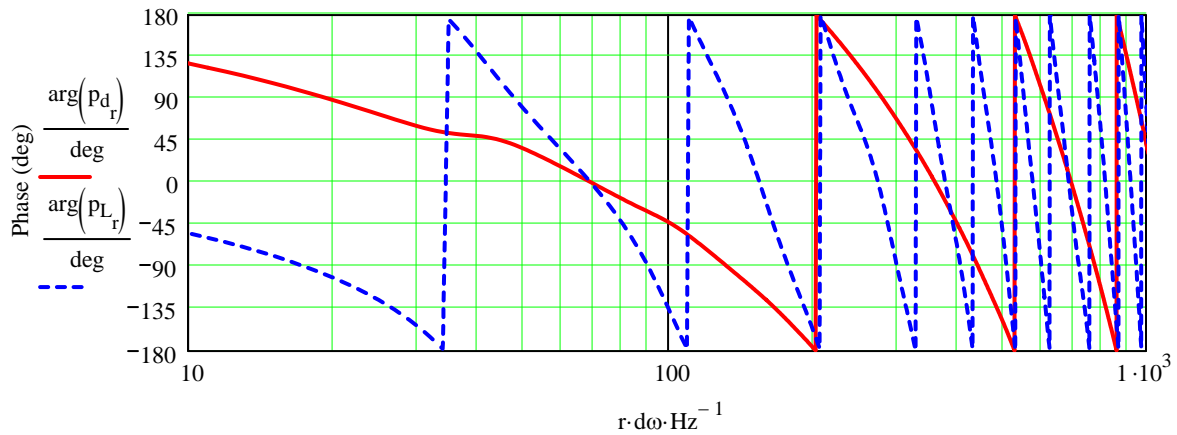
## Velocity at the Terminus of the Back Loaded Horn for a 1 m/sec Excitation at the Driver



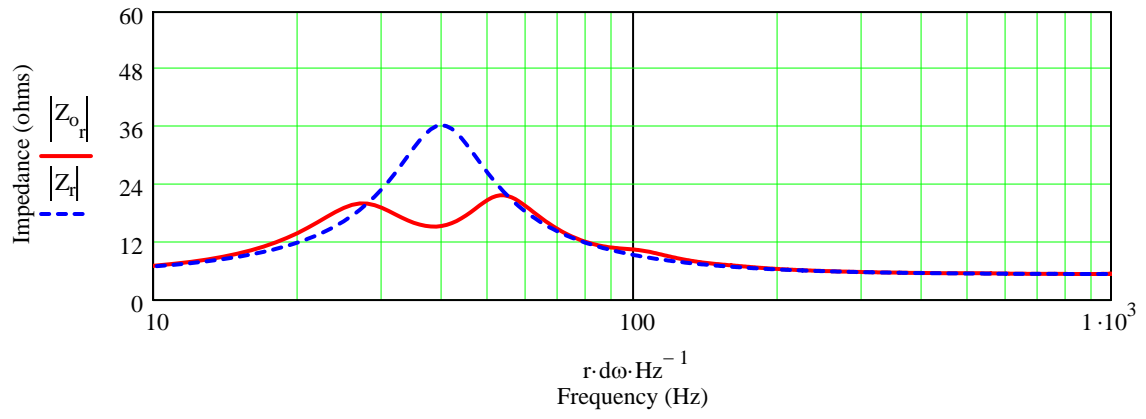
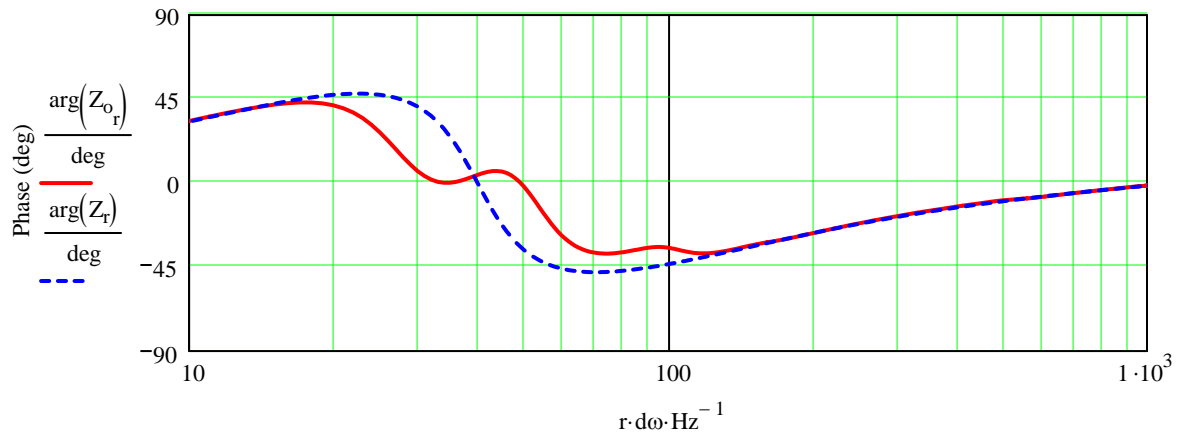
### Far Field Back Loaded Horn System and Infinite Baffle Sound Pressure Level Responses



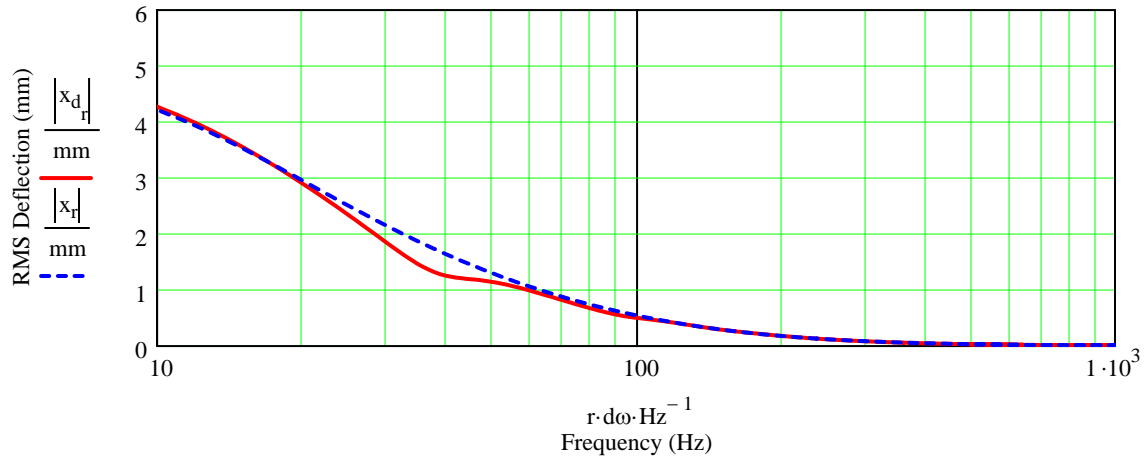
### Woofer and Terminus Far Field Sound Pressure Level Responses



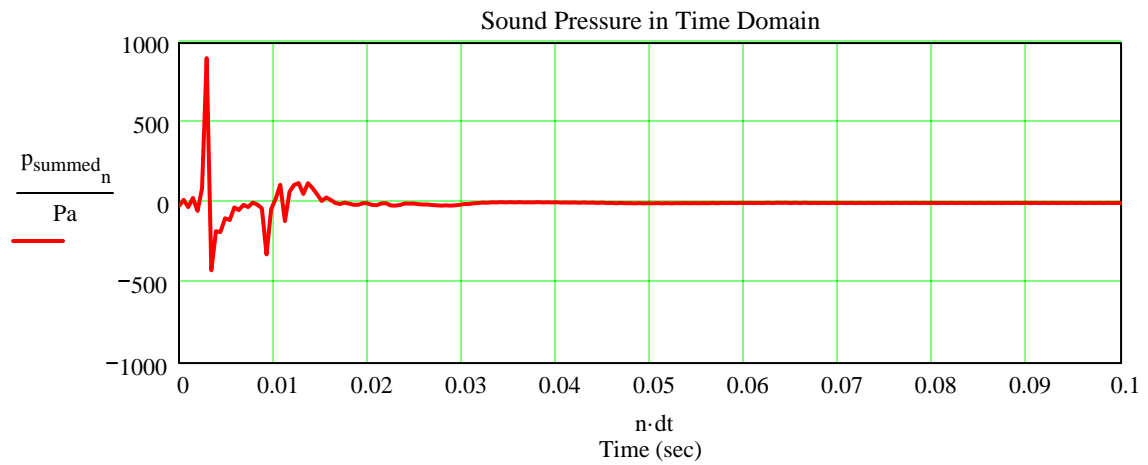
# Back Loaded Horn System and Infinite Baffle Impedance



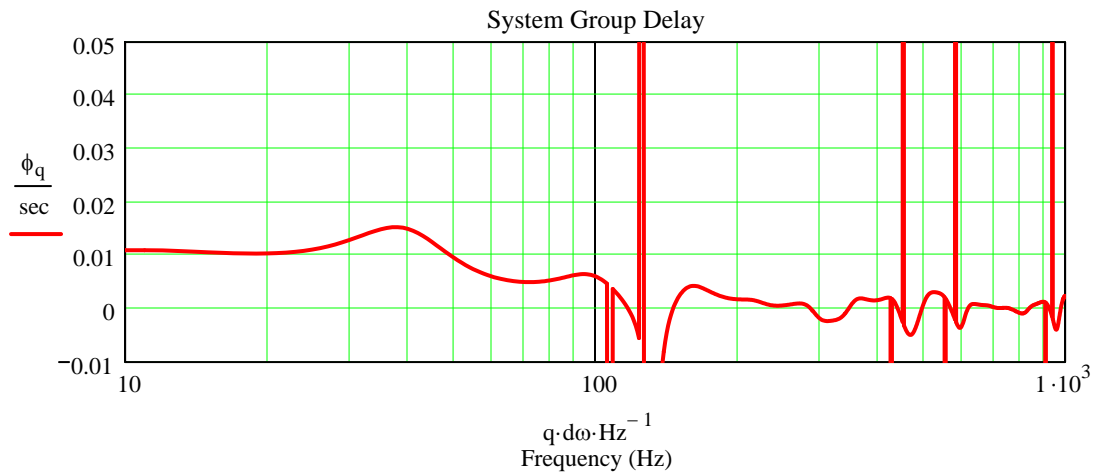
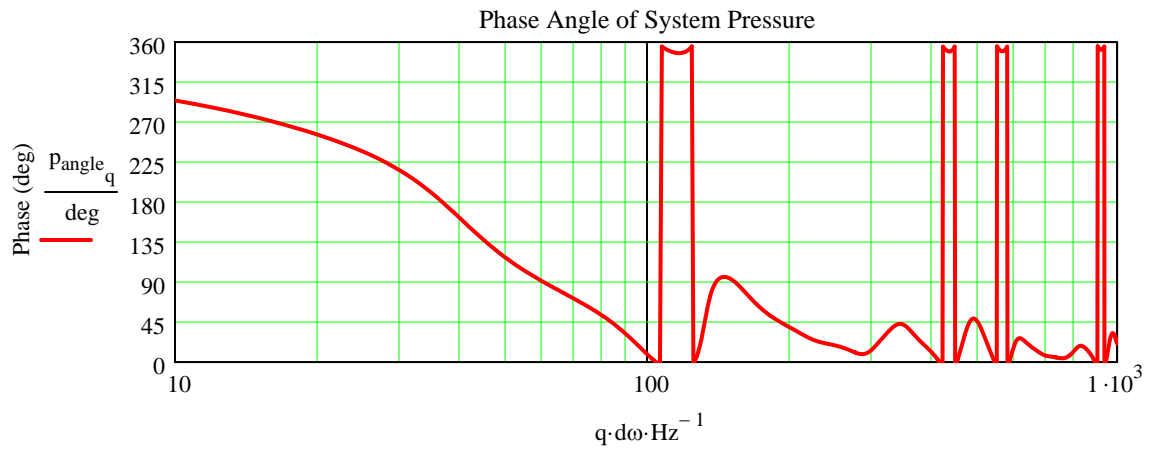
## Woofer RMS Displacement



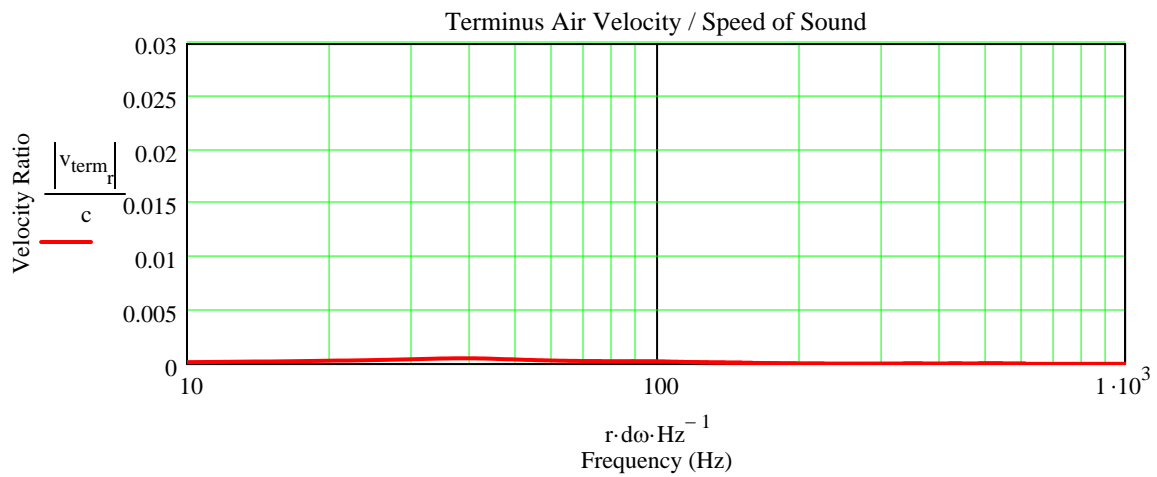
## System Time Response for an Impulse Input



## 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                  |                       |
|------------------------------|-------------------------------|-----------------------|
| $y_{o_0} := 9\cdot\text{in}$ |                               | (Bottom Right Corner) |
| $y_{o_1} := 9\cdot\text{in}$ | $z_{o_1} := 60\cdot\text{in}$ | (Top Right Corner)    |
| $y_{o_2} := 0\cdot\text{in}$ | $z_{o_2} := 60\cdot\text{in}$ | (Top Left Corner)     |
| $y_{o_3} := 0\cdot\text{in}$ |                               | (Bottom Left Corner)  |
| depth := 15·in               |                               | (Depth of Enclosure)  |

### Driver Geometry Input

$y_{dc} := 4.5\text{-in}$  (Driver Center x Coordinate)  
 $z_{dc} := 30\text{-in}$  (Driver Center y Coordinate)  
 $n_{dvr} := 5$  (Number of Points Across Diameter)

### Terminus Geometry Input

$y_{mc} := 4.5\text{-in}$  (Terminus Center y Coordinate)  
 $z_{mc\_t} := 55\text{-in}$  (Top Terminus Center z Coordinates)  
 $z_{mc\_b} := 5\text{-in}$  (Bottom Terminus Center z Coordinates)  
 $w_{mth} := 8\text{-in}$  (Terminus Width)  
 $n_{mth} := 7$  (Number of Points Across the Width)  
Locate := 1 (0 = Front Baffle Terminus, 1 = Rear Baffle Terminus)

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

$n_{listen} = 0$  (Listening Position Relative to Speaker)  
 $radius := 1\text{-m}$  (Calculation Radius, Effective Radius is Greater if  $y_p$  is Changed from Default)  
 $\theta := 0\text{-deg}$  (0 deg is along the Driver's Axis,  $-80\text{ deg} < \theta < 80\text{ deg}$ )  
 $z_p := z_{dc} + stand$  (Default Height is Equal to Driver Height)

$n_{listen} = 1$  (Listening Position Relative to the Room Corner)  
 $X_p := 10\text{ft}$   
 $Y_p := 7\text{-ft}$   
 $Z_p := z_{dc} + stand$  (Default Height is Equal to Driver Height)  
 $n_{listen} := 0$  (Method Selection)

### Floor Condition

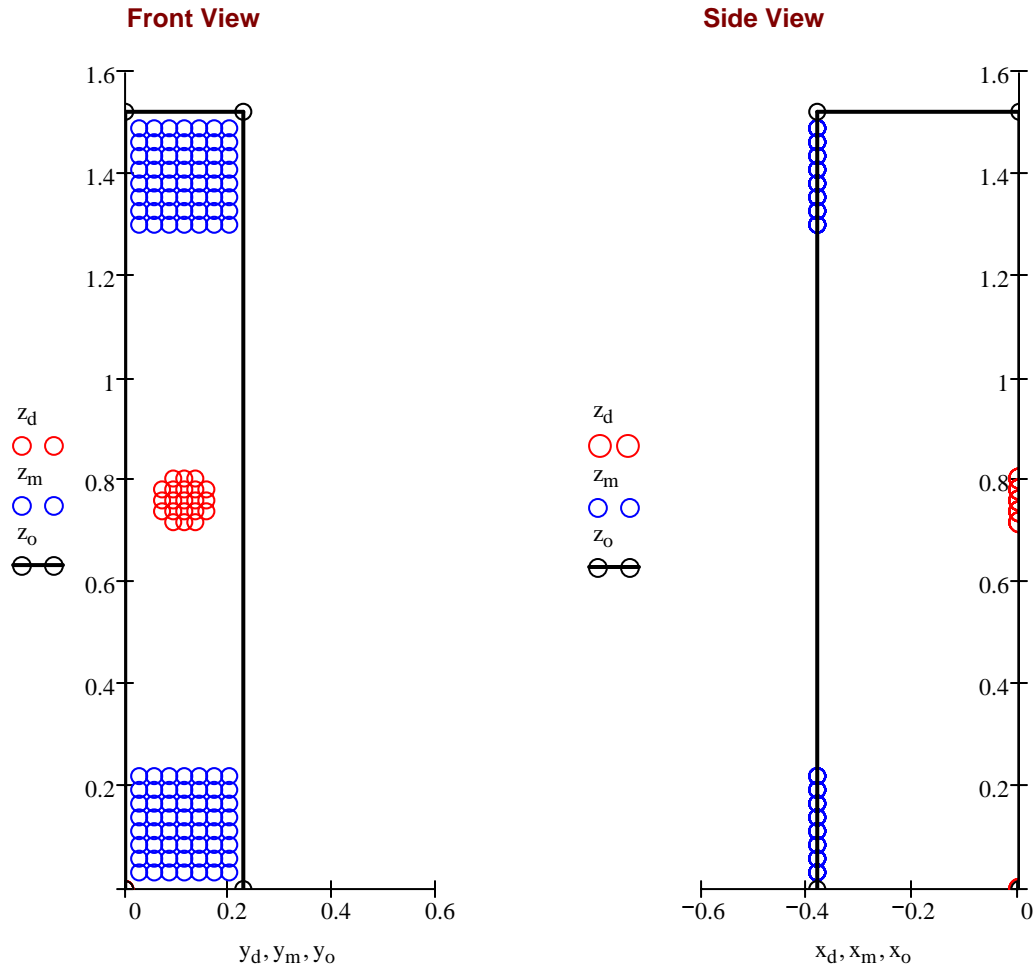
Reflect := 1 (0 = hardwood or concrete, 1 = carpeted)

### 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 Terminus Simple Source Pattern with Baffle Edge Outline



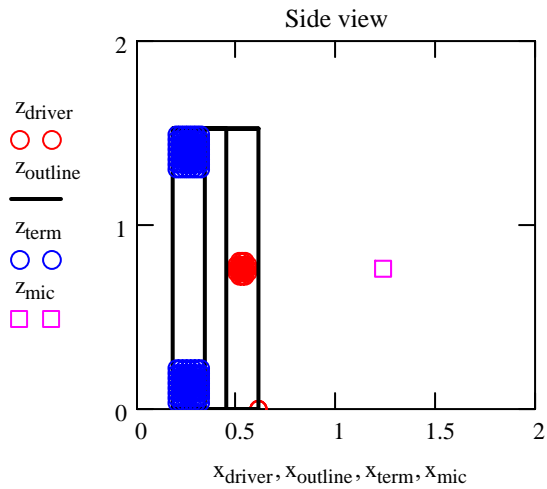
Red sources represent the driver.  
Blue sources represent the terminus.  
Black outline represents the baffle edge.  
Origin is at the bottom front left corner of the enclosure.



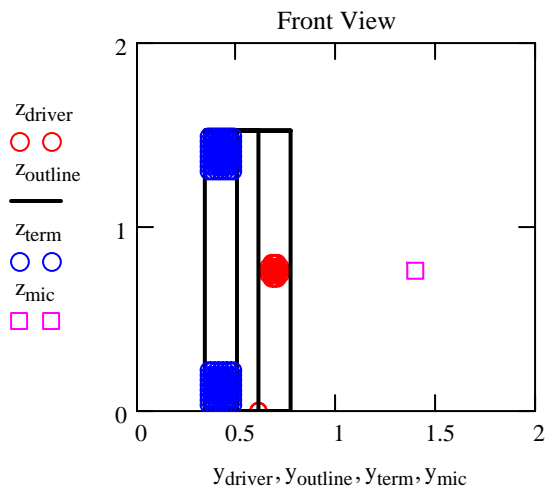
### Three Dimensional View

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

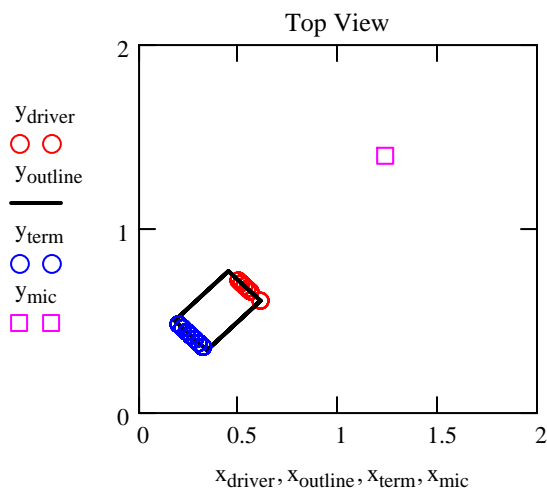
Room Corner is the Origin



Side View - looking out from side wall



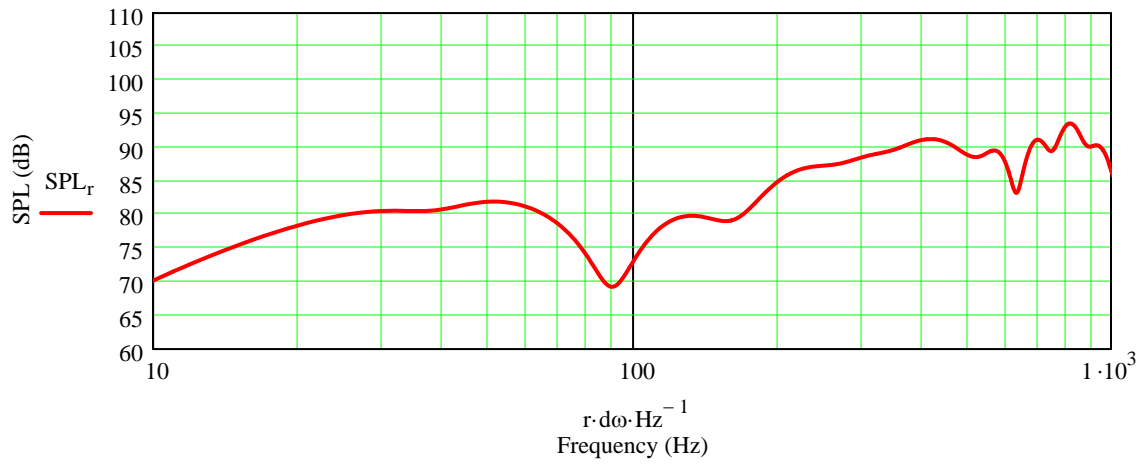
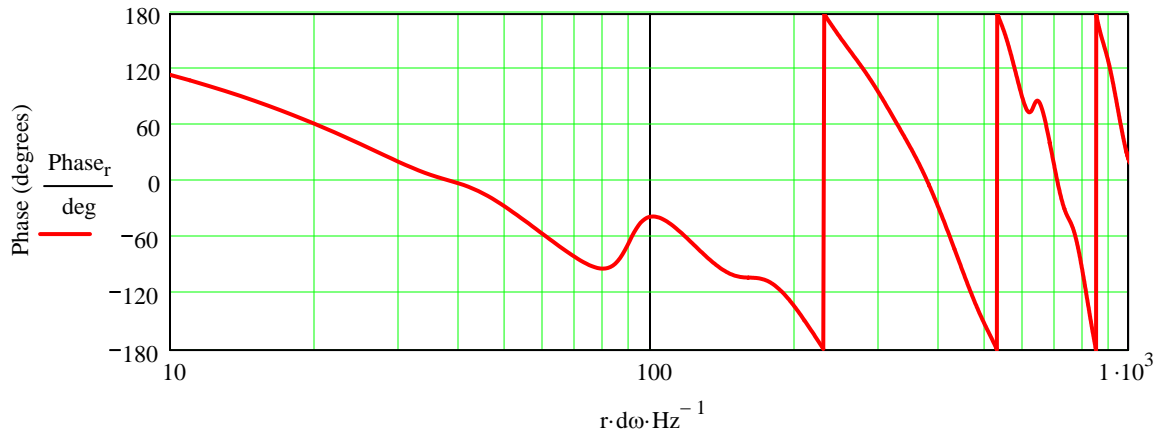
Front View - looking towards rear wall



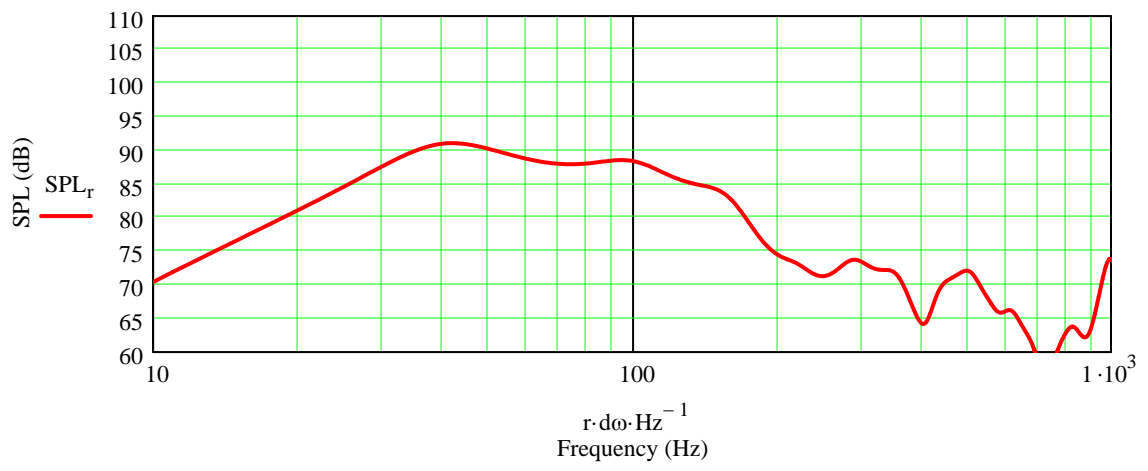
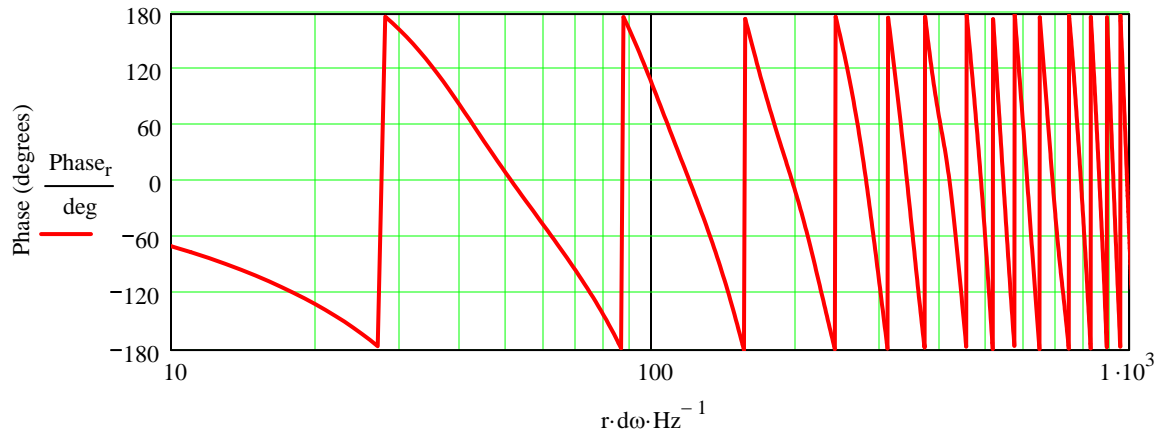
Top View - looking down from ceiling



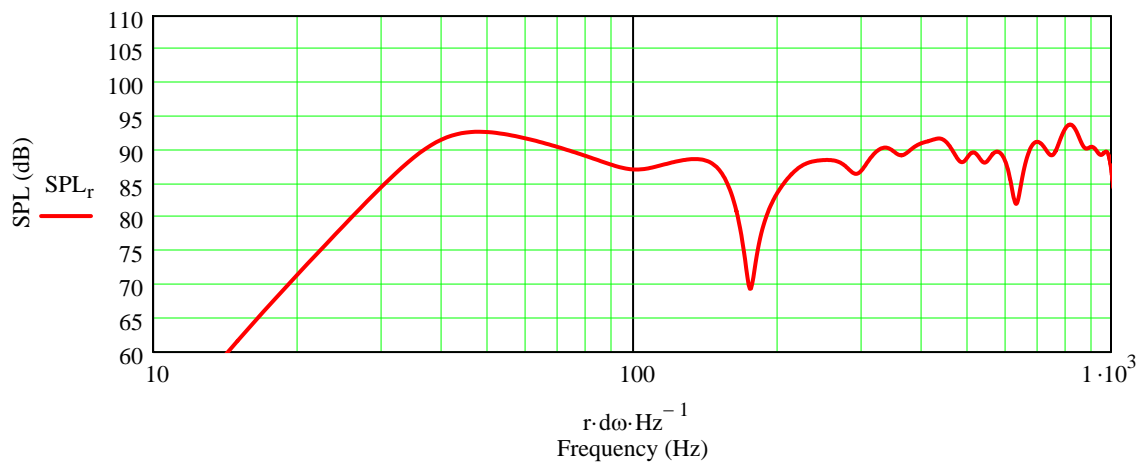
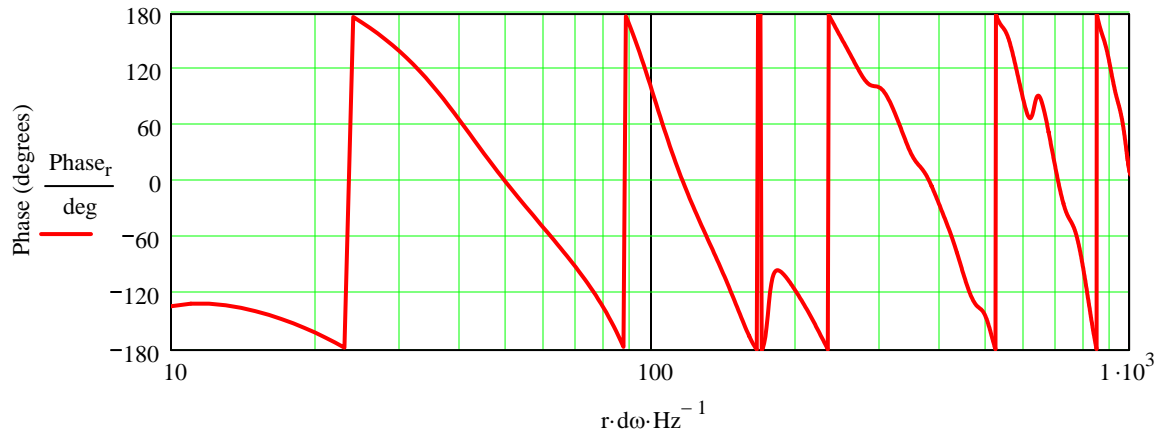
### Plotted Baffle Step and Reflection SPL Response for the Circular Driver Source



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

$\text{dB} := 0.1$  <--- Input dB of Attenuation

Calculated Component Values

User Assigned Component Values  
Based on Calculated Values at Left

$$R_e \cdot \left( 10^{\frac{\text{dB}}{20}} - 1 \right) = 0.063 \Omega$$

Parallel Resistor

Input Value --->

$$R_{\text{parallel}} := 0.1 \cdot \Omega$$

$$\frac{R_{\text{parallel}}}{f_{\text{center}}} = 0.040 \text{ mH}$$

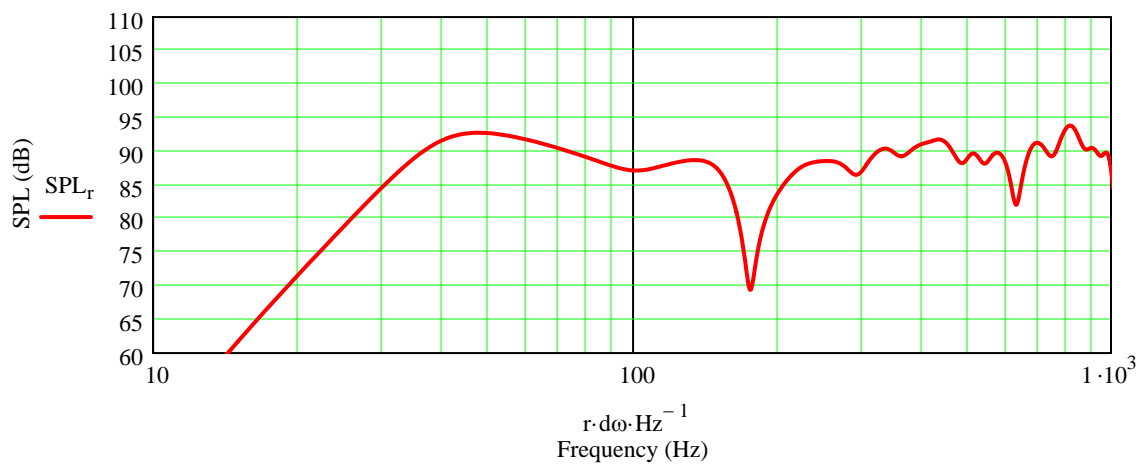
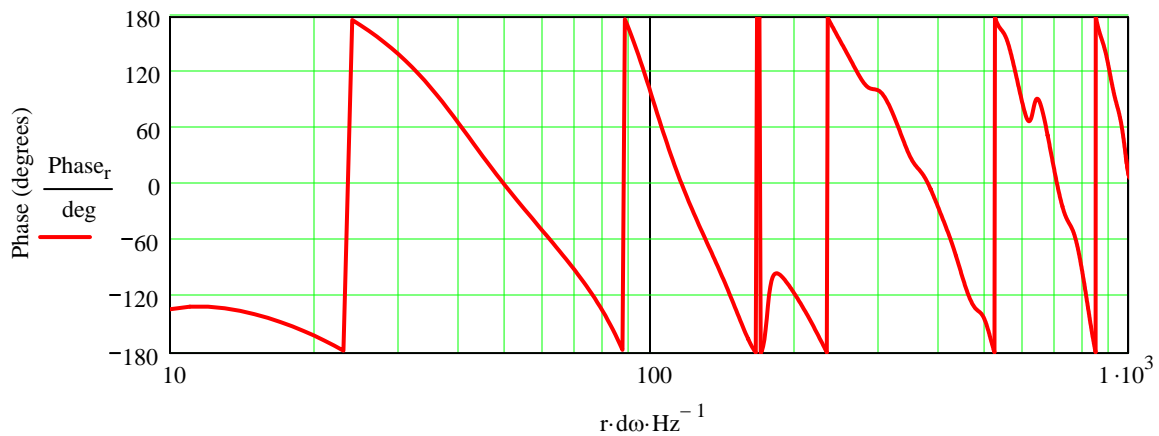
BSC Inductor

Input Value --->

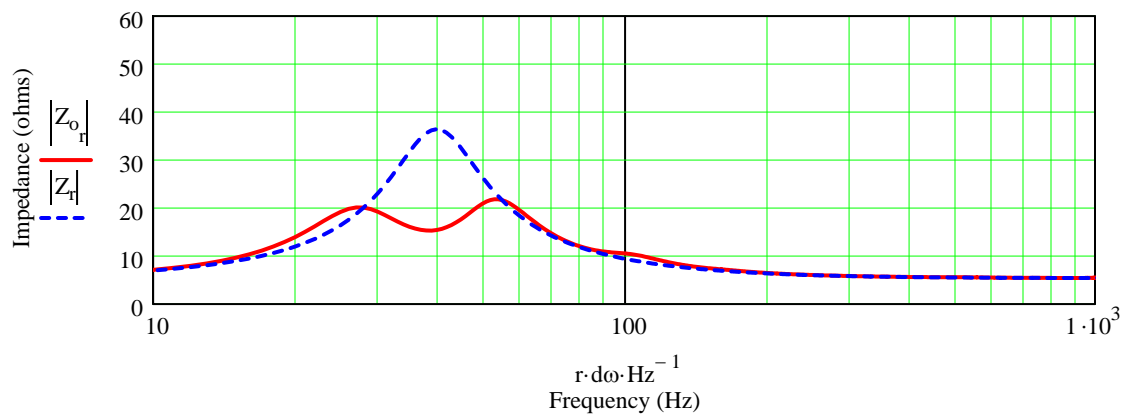
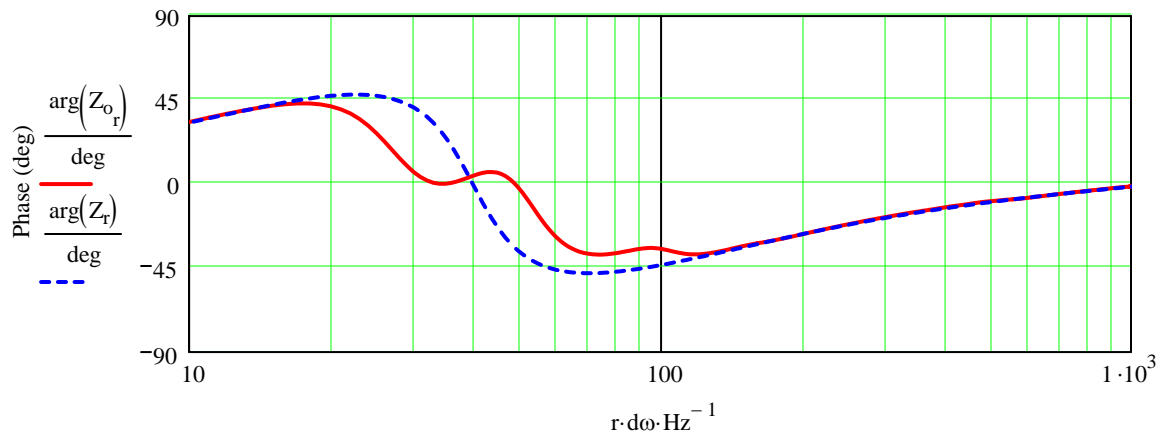
$$L_{\text{BSC}} := 0.001 \cdot \text{mH}$$



### Plotted Corrected SPL Response for the System



## Back Loaded Horn Corrected System and Infinite Baffle Impedance



## System Time Response for an Impulse Input

