



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

Corrected
Offset and
Terminus
Position

Unit and Constant Definition

cycle := 2 · π · rad Hz := cycle · sec⁻¹

Air Density : ρ := 1.205 · kg · m⁻³

Speed of Sound : c := 344 · m · sec⁻¹

Active
Crossover

3 m SPL



Part 1 : Thiele-Small Consistent Calculation

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

Cable Series Resistance

R_{add} := 0.5 · Ω

Input Power

Power := 1 · watt (Input Power) Applied Voltage Reference ---> R_{ref} := 8 · Ω

Tweeter Thiele / Small Parameters : SB Acoustics Satori TW29R Updated

f_d := 671.7 · Hz

V_{ad} := 0.022 · liter

Adjustments

R_c := 3.05 · Ω

Q_{cd} := 1.375

R_c := R_c + R_{add}

L_{vc} := 0.02 · mH

Q_{md} := 2.214

Q_{cd} := Q_{cd} · R_c · (R_c - R_{add})⁻¹

Bl := 1.758 · $\frac{\text{newton}}{\text{amp}}$

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

S_d := 9.6 · cm²

Q_{td} = 0.929



Bass Driver Thiele / Small Parameters : Satori WO24P-4 Woofer

f_d := 32.81 · Hz

V_{ad} := 48.31 · liter

Adjustments

R_c := 3.3 · Ω

Q_{cd} := 0.545

R_c := R_c + R_{add}

L_{vc} := 0.372 · mH

Q_{md} := 7.637

Q_{cd} := Q_{cd} · R_c · (R_c - R_{add})⁻¹

R_p := 0.74 · Ω

L_p := 0.595 · mH

Bl := 7.524 · $\frac{\text{newton}}{\text{amp}}$

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

S_d := 255 · cm²

Q_{td} = 0.580

Enclosure Geometry Definition

$$0.71 \cdot \frac{\text{cycle} \cdot c}{4 \cdot f_d} = 73.268 \text{ in}$$

$$L := 74 \cdot \text{in}$$

(Length)

Driver Distance

$$\xi := 0.338285$$

(Driver Position Ratio : $0.001 < \xi < 0.999$)

$$\xi \cdot L = 25.033 \text{ in}$$

$$S_0 := 2.520 \cdot S_d$$

(Area of the Driver End)

$$1.5 \cdot V_{ad} = 72.465 \text{ liter}$$

$$S_L := 0.2 \cdot S_0$$

(Area of the Open End)

$$0.5 \cdot (S_0 + S_L) \cdot L = 72.470 \text{ liter}$$

$$S_T := 8 \cdot \text{in} \cdot 2.5 \cdot \text{in}$$

(Area of the Terminus)

$$\text{Density} := 0.5 \cdot \text{lb} \cdot \text{ft}^{-3}$$

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

Crossover Definition

For Even Order Crossovers :
Type 1 = Linkwitz-Riley
Type 2 = Bessel
Type 3 = BEC
Type 4 = Butterworth

Low Pass Filter

$$f_{LP} := 200 \cdot \text{Hz}$$

$$LP_{\text{order}} := 1$$

$$LP_{\text{type}} := 4$$

High Pass Filter

$$f_{HP} := 1600 \cdot \text{Hz}$$

$$HP_{\text{order}} := 2$$

$$HP_{\text{type}} := 4$$

(Filter Frequency)

(Filter Order : 0, 1, 2, 3, or 4)

(Filter Type : 1, 2, 3, or 4 for even order only,
for odd order this entry is ignored)

Crossover Phase Connection

$$LP_{\text{phase}} := 1$$

$$HP_{\text{phase}} := 1$$

(Phase : 1 = in phase, -1 = out of phase)

High Frequency Boost

$$HP_{\text{boost}} := -10 \text{ dB}$$

Sub High Pass Filter (Use to Limit Low Frequency Woofer Displacement)

$$f_{\text{sub}} := 20 \cdot \text{Hz}$$

$$SHP_{\text{order}} := 0$$

$$SHP_{\text{type}} := 4$$

(Filter Frequency)

(Filter Order : 0, 1, 2, 3, or 4)

(Filter Type : 1, 2, 3, or 4 for even order only,
for odd order this entry is ignored)



End of Abbreviated User Input

Internal Geometry Plot

$$242 \cdot \text{mm} = 9.528 \text{ in} \quad \text{driver OD}$$

$$\text{height} := 37.75 \cdot \text{in} \quad \text{exterior height}$$

$$210 \cdot \text{mm} = 8.268 \text{ in} \quad \text{hole OD}$$

$$\text{width} := 11 \cdot \text{in} \quad \text{exterior width}$$

$$\text{thick} := 0.5 \cdot \text{in} \quad \text{wood thickness}$$

$$0.5 \cdot (\text{width} - 2 \cdot \text{thick} - 210 \cdot \text{mm}) = 0.866 \text{ in} \quad \text{web}$$

$$\theta := \text{atan} \left[(S_0 - S_L) \cdot [(\text{width} - 2 \cdot \text{thick}) \cdot L]^{-1} \right] \quad \theta = 6.146 \text{ deg}$$

$$\text{depth} := (S_0 + S_L) \cdot (\text{width} - 2 \cdot \text{thick})^{-1} + 2 \cdot \text{thick} + \text{thick} \cdot (\cos(\theta))^{-1} \quad \text{exterior depth}$$

$$\text{depth} = 13.455 \text{ in}$$

$$\text{depth} := 13.5 \cdot \text{in}$$

$$L_1 := 30.5 \cdot \text{in} \quad \text{vertical height of divider}$$

$$(\text{height} - 2 \cdot \text{thick}) \cdot (\text{depth} - 2 \cdot \text{thick}) \cdot (\text{width} - 2 \cdot \text{thick}) - L_1 \cdot \cos(\theta)^{-1} \cdot (\text{width} - 2 \cdot \text{thick}) \cdot \text{thick} = 72.765 \text{ liter}$$



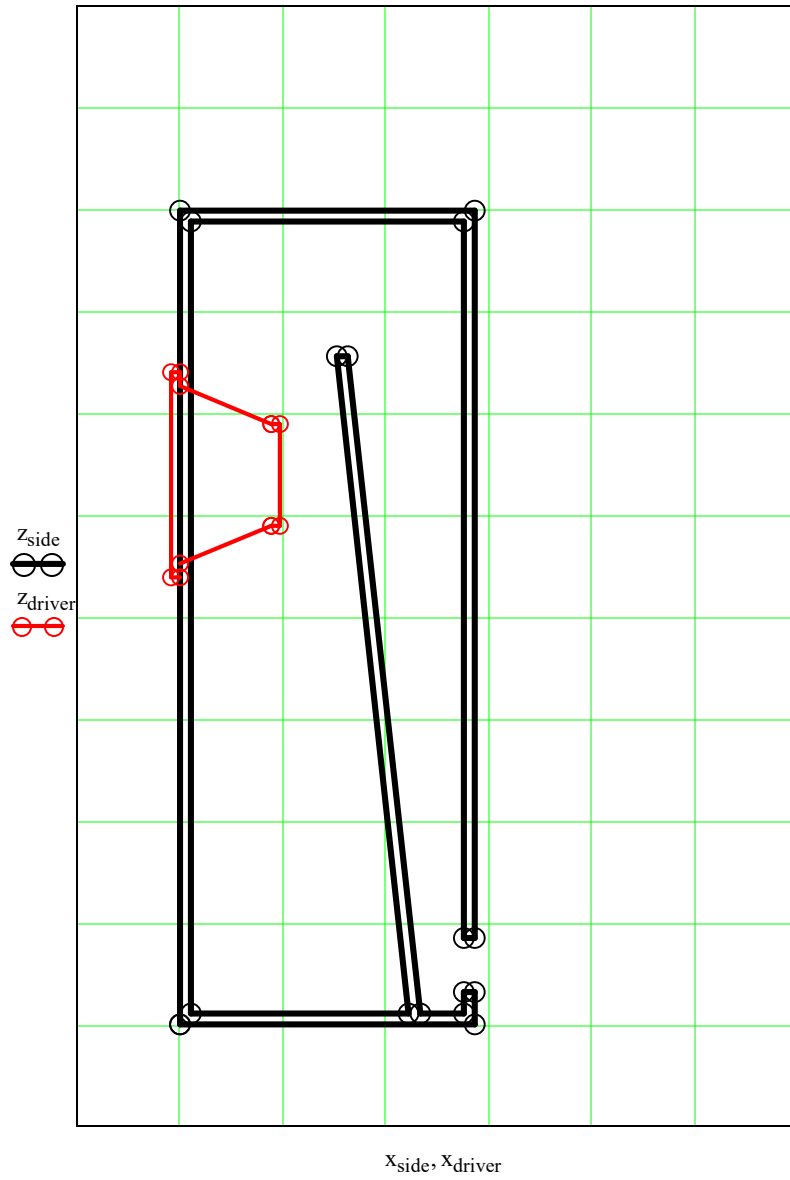
Checks

$$\frac{\sqrt{(x_{\text{side}_7} - x_{\text{side}_8})^2 + (z_{\text{side}_7} - z_{\text{side}_8})^2} \cdot (\text{width} - 2 \cdot \text{thick})}{S_0} = 1.000$$

$$\frac{(x_{\text{side}_{12}} - x_{\text{side}_{11}}) \cdot (\text{width} - 2 \cdot \text{thick})}{S_L} = 1.000$$

$$\frac{(z_{\text{side}_3} - z_{\text{side}_{13}}) \cdot (\text{width} - 2 \cdot \text{thick})}{S_T} = 1.250$$

Cut-away Side View



Total Length of the Transmission Line

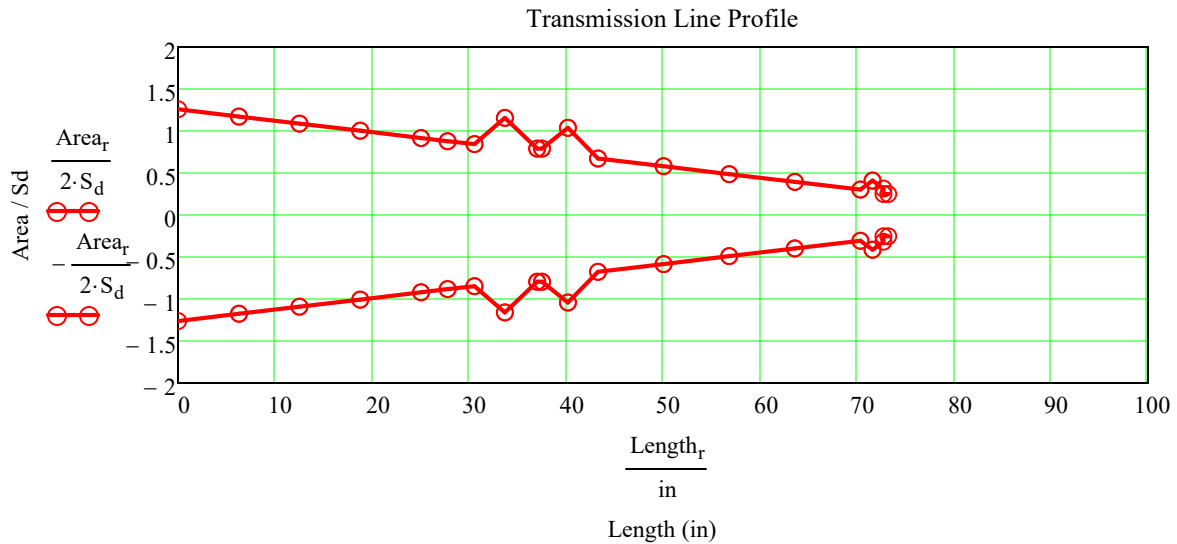
$$\sum_{i=0}^{n_closed} L_{c_i} + \sum_{i=0}^{n_open} L_{o_i} = 73.203 \text{ in} \quad L = 74.000 \text{ in} \quad \text{checks}$$

Total Amount of Stuffing

$$\sum_{r=0}^{n_closed} \left(\frac{S_{c_{r,0}} + S_{c_{r,1}}}{2} \cdot L_{c_r} \cdot D_{c_r} \right) + \sum_{r=0}^{n_open} \left(\frac{S_{o_{r,0}} + S_{o_{r,1}}}{2} \cdot L_{o_r} \cdot D_{o_r} \right) = 538.141 \text{ gm}$$

Total Volume

$$\sum_{r=0}^{n_closed} \left(\frac{S_{c_{r,0}} + S_{c_{r,1}}}{2} \cdot L_{c_r} \right) + \sum_{r=0}^{n_open} \left(\frac{S_{o_{r,0}} + S_{o_{r,1}}}{2} \cdot L_{o_r} \right) = 75.414 \text{ liter} \quad 1.5 \cdot V_{ad} = 72.465 \text{ liter}$$

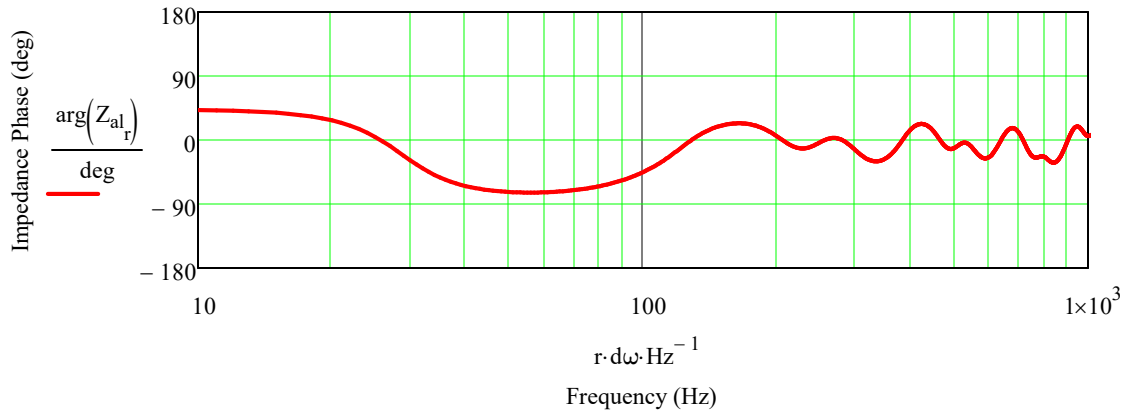
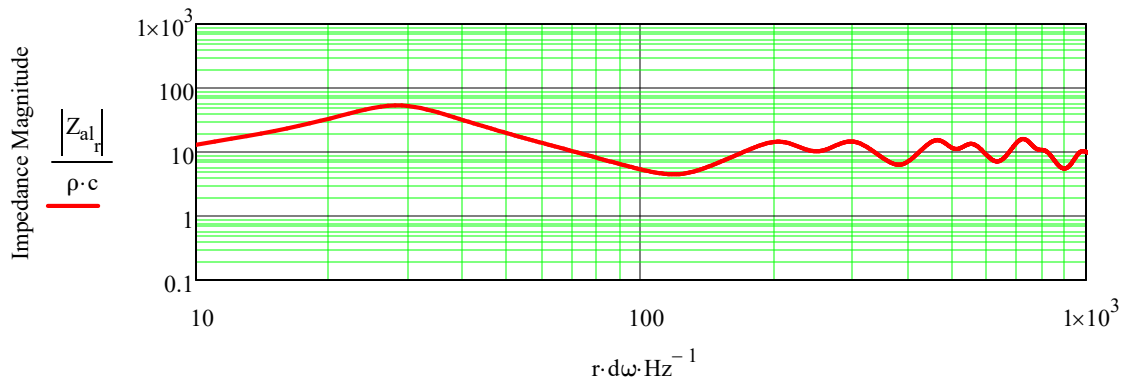


End of Detailed Input

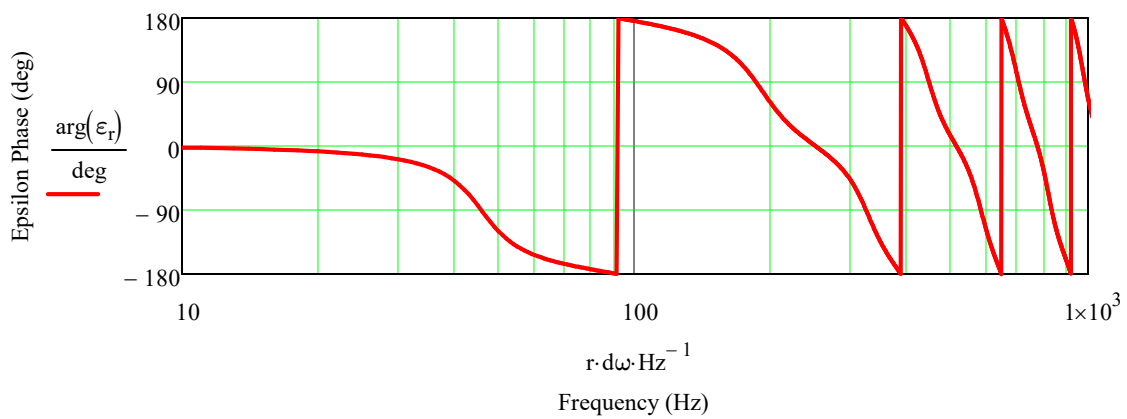
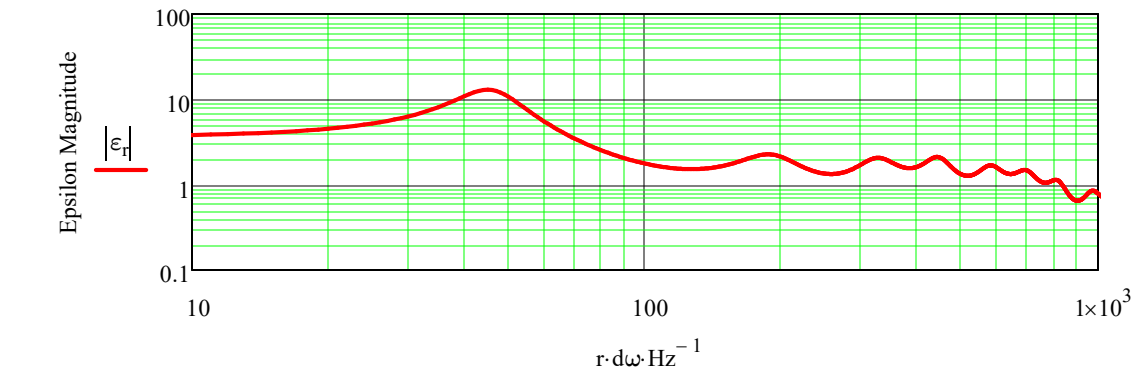
End of Part 1 Input

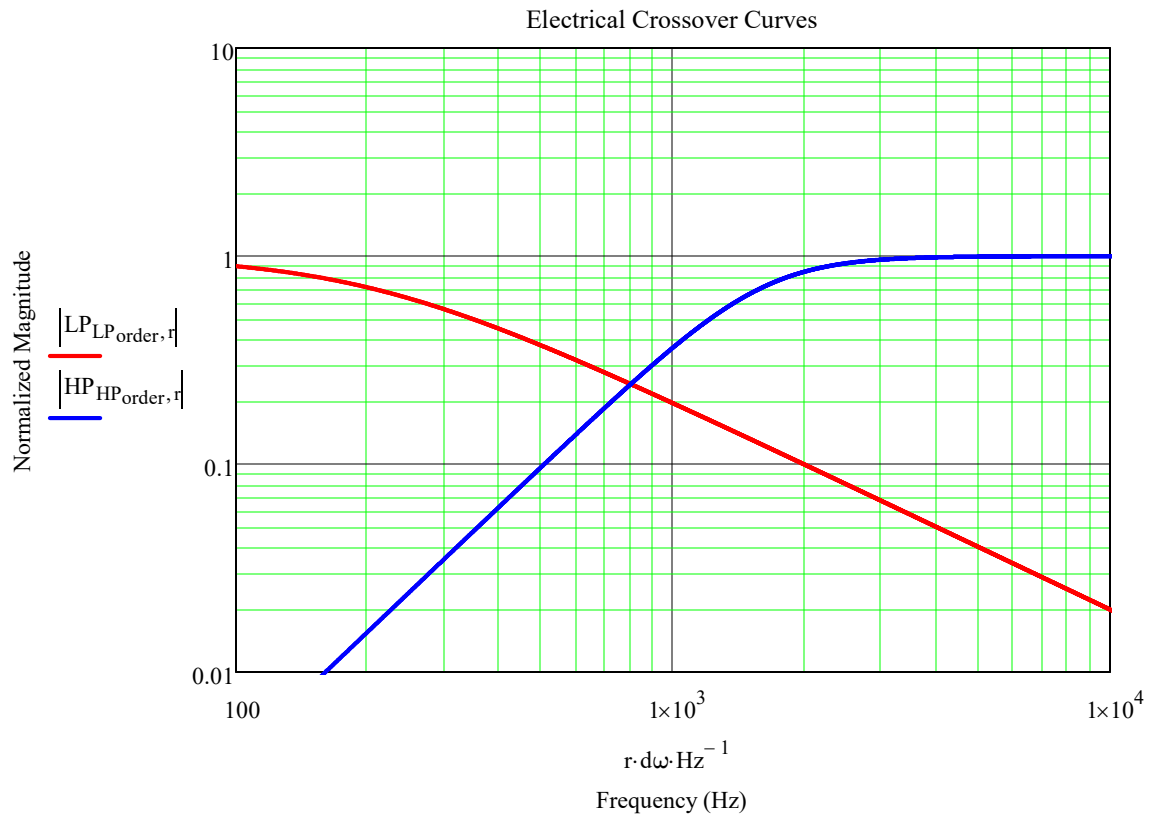


Resulting Acoustic Impedance for the Transmission Line



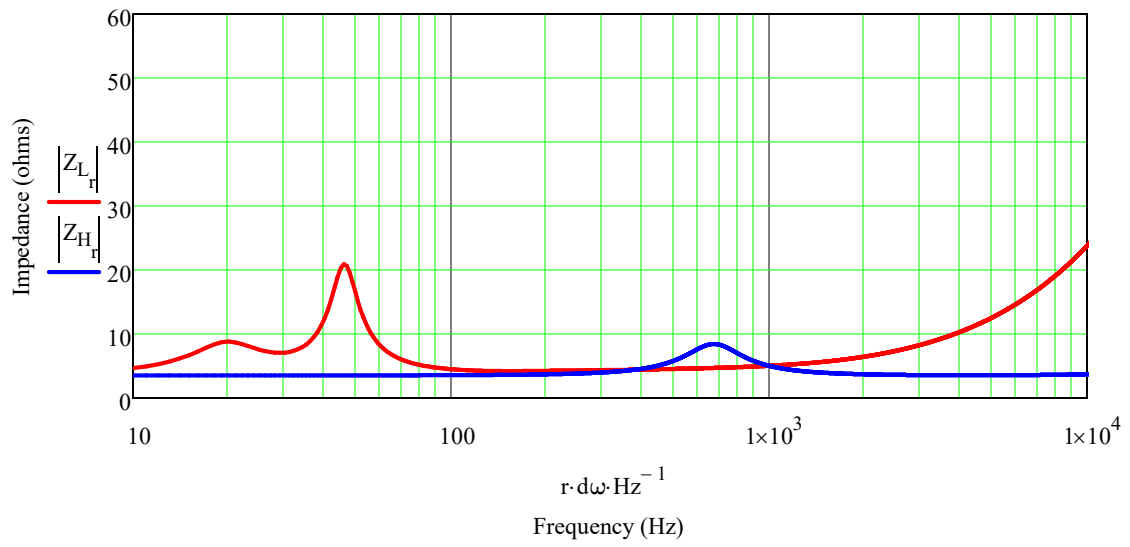
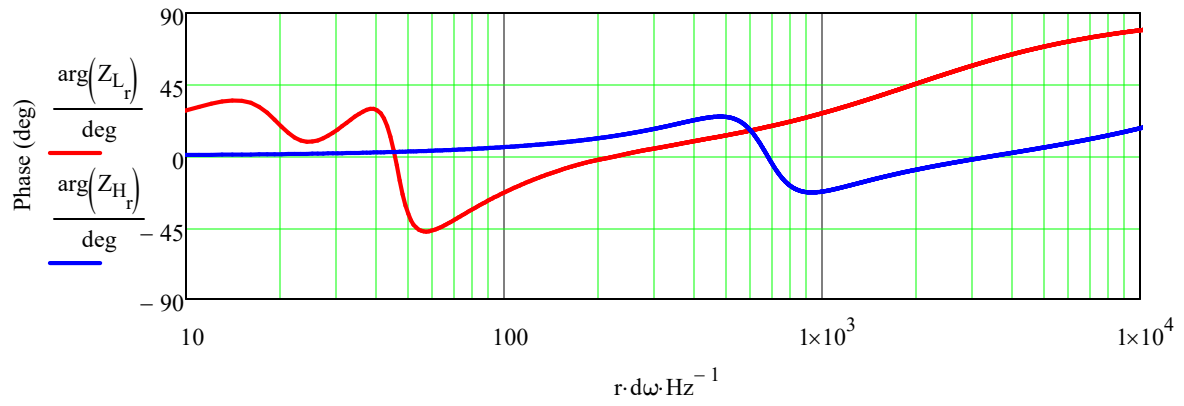
Velocity at the Terminus of the Transmission Line for a 1 m/sec Excitation at the Driver



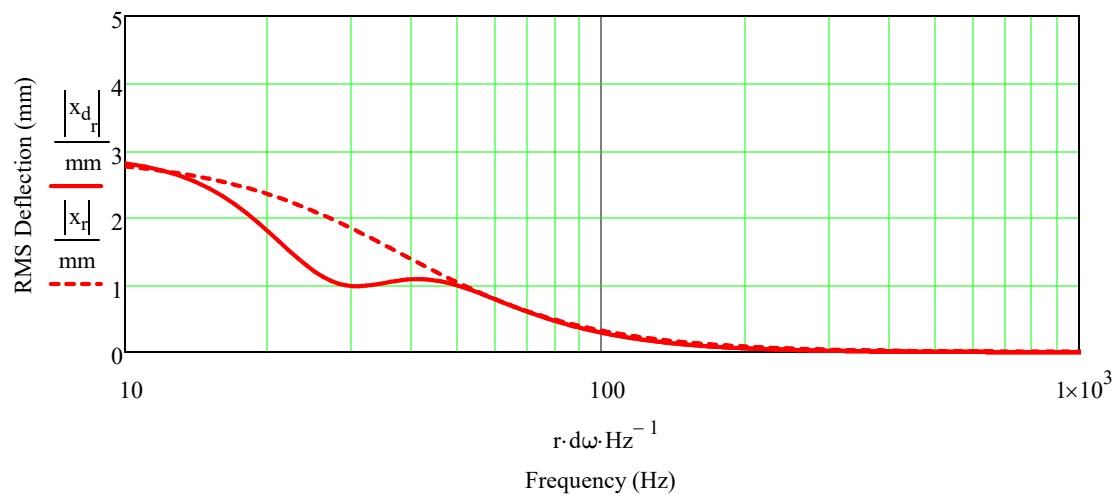




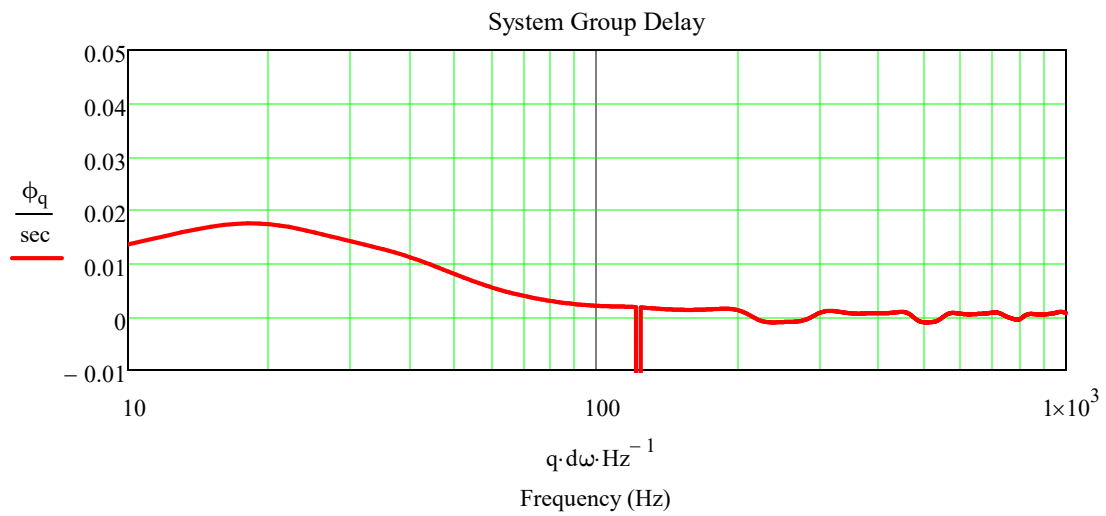
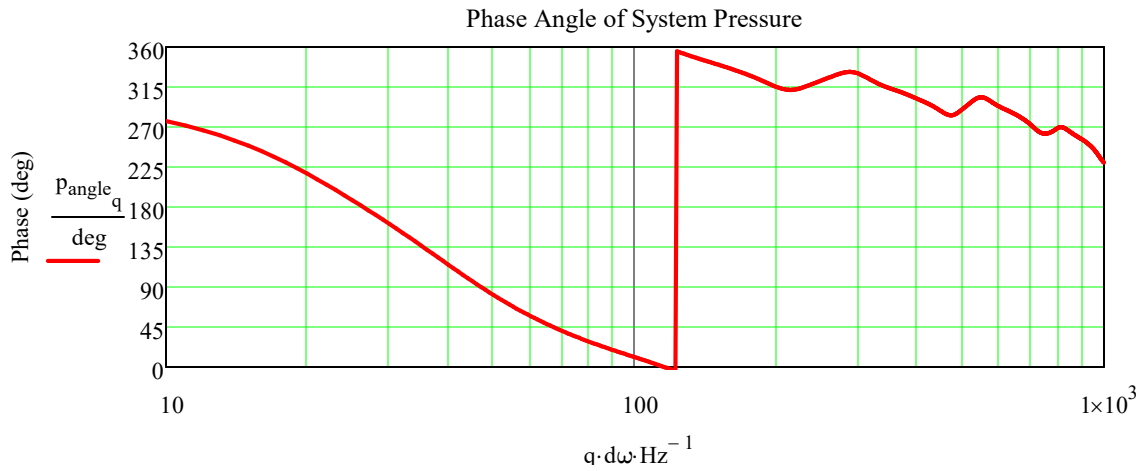
Transmission Line System and Infinite Baffle Impedance



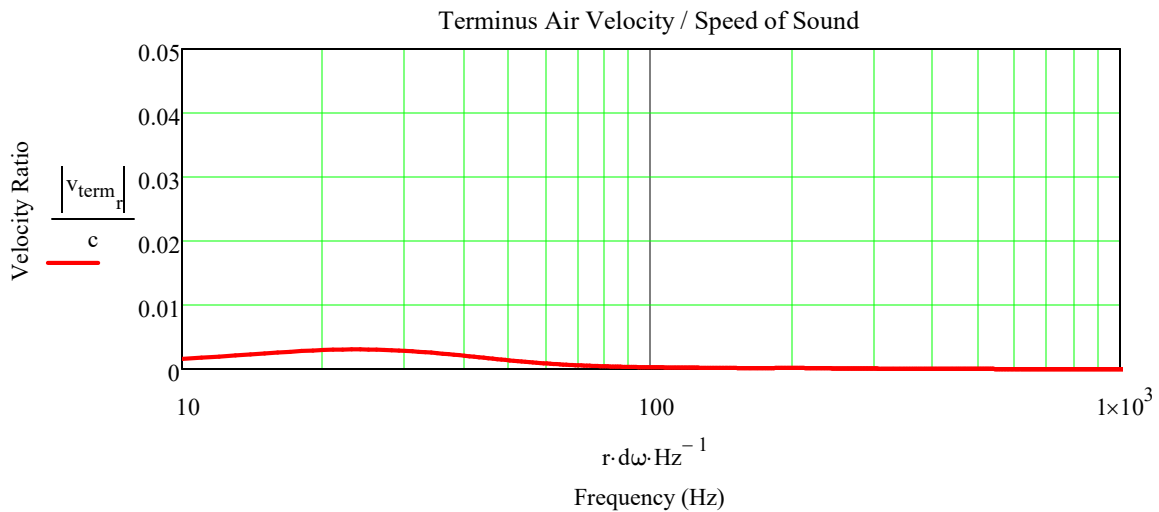
Woofer RMS Displacement



System Group Delay



Terminus Air Velocity (should be $< 17 \text{ m/sec} / 344 \text{ m/sec} = 0.05$)



Part 2 : Detailed SPL Response Calculation

Calculation Includes :

Position of the Drivers and the Terminus on the Baffle.

Baffle Step of the Drivers and the Terminus.

Room Reflections for the Drivers and the Rear Terminus.

Geometry

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 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

$X_0 := 3 \cdot \text{ft}$ (Front Baffle Distance from Rear Wall > Depth of Enclosure)

$Y_0 := 2 \cdot \text{ft}$ (Front Baffle Distance from Side Wall)

$\theta_0 := 30 \cdot \text{deg}$ (Rotation Towards Room Center)

$Z_0 := 8 \cdot \text{ft}$ (Floor to Ceiling Distance)

stand := 0.001-in (Height from Floor to Bottom Edge of Front Baffle)

num_r := 60 (Number of Points per Unit Length of Baffle Edge)

Corner Coordinates

Y coordinate

Z coordinate

$y_{o_0} := \text{width}$ (Bottom Right Corner)

$y_{o_1} := \text{width}$ $z_{o_1} := \text{height}$ (Top Right Corner)

$y_{o_2} := 0 \cdot \text{in}$ $z_{o_2} := \text{height}$ (Top Left Corner)

$y_{o_3} := 0 \cdot \text{in}$ (Bottom Left Corner)

depth = 13.500 in (Depth of Enclosure)

Driver Geometry Input

$y_{wc} := 0.5 \cdot \text{width}$	(Woofers Center y Coordinate)	
$z_{wc} := z_{\text{woofer}}$	(Woofers Center z Coordinate)	$z_{wc} + \text{stand} = 25.498 \text{ in}$
$w_{\text{dvr}} := 12$	(Number of Points Across Diameter)	$\xi \cdot L \cdot \cos(0.5 \cdot \theta) + \text{thick} = 25.497 \text{ in}$
$y_{tc} := 0.5 \cdot \text{width} + 1 \cdot \text{in}$	(Tweeters Center y Coordinate)	
$z_{tc} := z_{\text{woofer}} + 8 \cdot \text{in}$	(Tweeters Center z Coordinate)	$z_{tc} + \text{stand} = 33.498 \text{ in}$
$t_{\text{dvr}} := 5$	(Number of Points Across Diameter)	$\text{height} - z_{tc} = 4.253 \text{ in}$
$\Delta_{\text{centers}} := -42 \cdot \text{mm}$	(Acoustic Center Offset, Negative is Woofers Behind Tweeters)	

Terminus Geometry Input

$y_{mc} := 0.5 \cdot \text{width}$	(Terminus Center y Coordinate)	
$z_{mc} := 2.75 \cdot \text{in}$	(Terminus Center z Coordinate)	
$w_{\text{mth}} := 8 \cdot \text{in}$	(Terminus Width)	$\text{thick} + 1 \cdot \text{in} + \frac{1}{2} \cdot \frac{S_T}{\text{width} - 6 \cdot \text{thick}} = 2.750 \text{ in}$
$n_{\text{mth}} := 15$	(Number of Points Across the Width)	$\text{width} - 6 \cdot \text{thick} = 8.000 \text{ in}$
Locate := 1	(0 = Front Baffle Terminus, 1 = Rear Baffle Terminus)	

Listening Position

$n_listen = 0$ (Listening Position Relative to Speaker)
 $radius := 3 \cdot m$ (Calculation Radius Along Axis of the Extended Range Driver)
 $\theta := 0 \cdot deg$ (0 deg is along the Driver's Axis, $-80 \text{ deg} < \theta < 80 \text{ deg}$)
 $z_p := 33 \cdot in$ (Default Height is Equal to Seated Height)

$n_listen = 1$ (Listening Position Relative to the Room Corner)
 $X_p := 10 \text{ ft}$
 $Y_p := 7 \cdot \text{ft}$
 $Z_p := 33 \cdot in$ (Default Height is Equal to Seated Height)
 $n_listen := 0$ (Method Selection)

Floor Condition

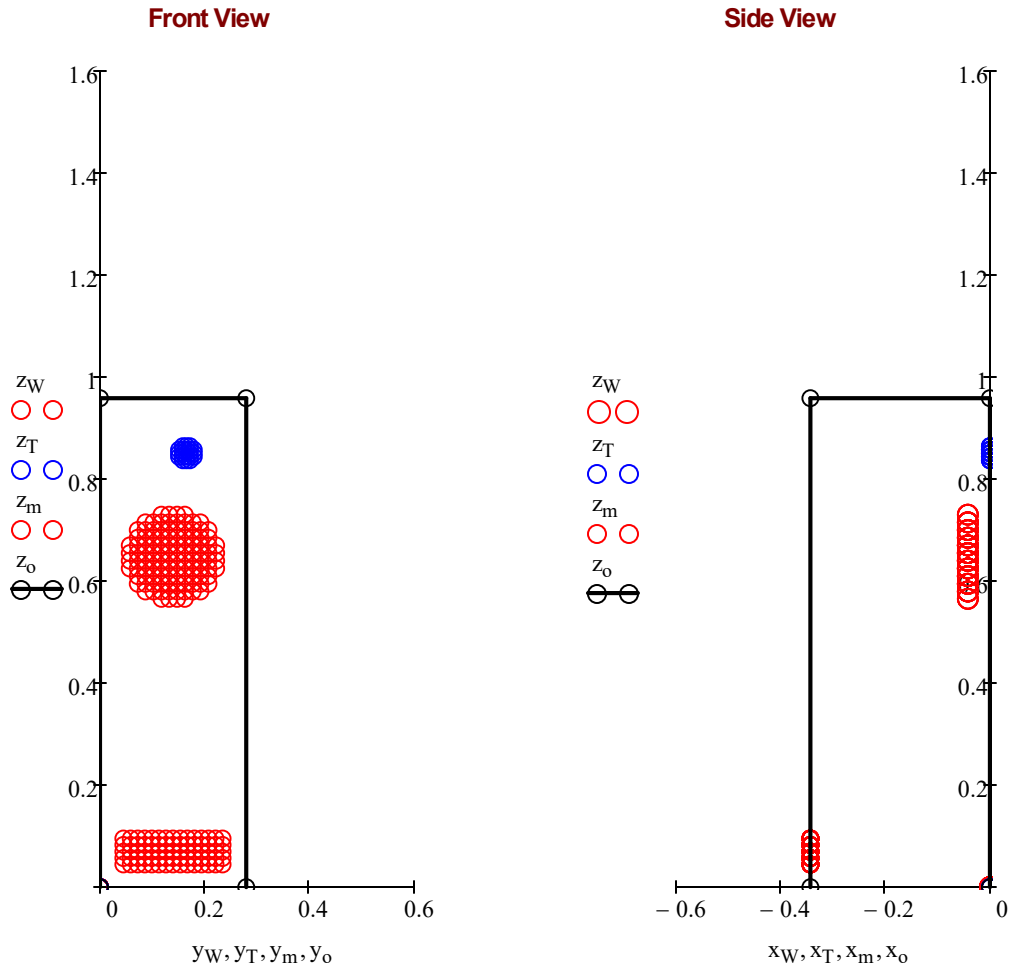
Reflect := 1 (0 = hardwood or concrete, 1 = carpeted)

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

Inc_floor := 0 (Floor, $Z = 0$)
Inc_rear := 0 (Rear Wall, $X = 0$)
Inc_side := 0 (Left Side Wall, $Y = 0$)
Inc_ceiling := 0 (Ceiling)



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



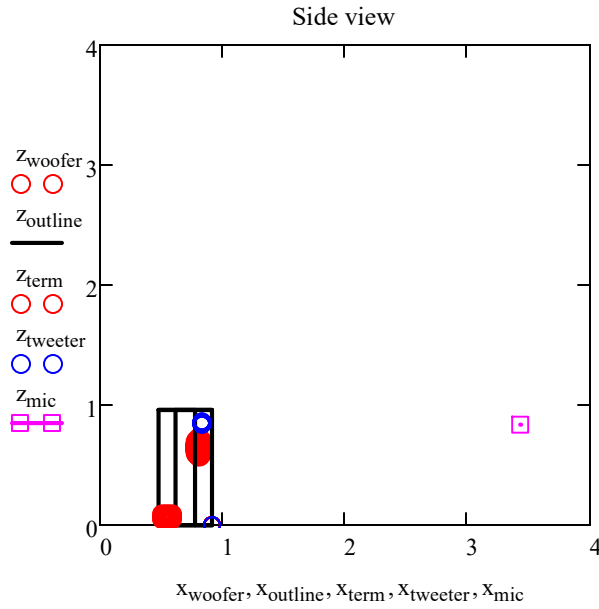
Red sources represent the woofer and terminus.
Blue sources represent the tweeter.
Black outline represents the baffle edge.
Origin is at the bottom front left corner of the enclosure.



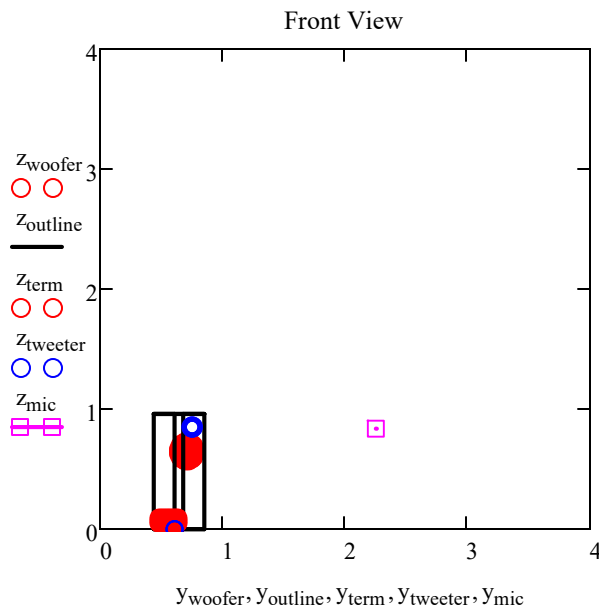
Three Dimensional View

Axis Length (m) axis := 4 <---- Change value of "axis" to rescale plots

Room Corner is the Origin

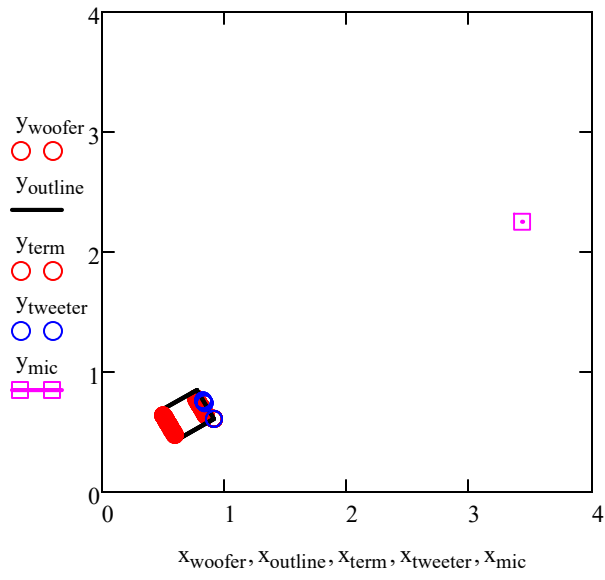


Side View - looking out from side wall



Front View - looking towards rear wall

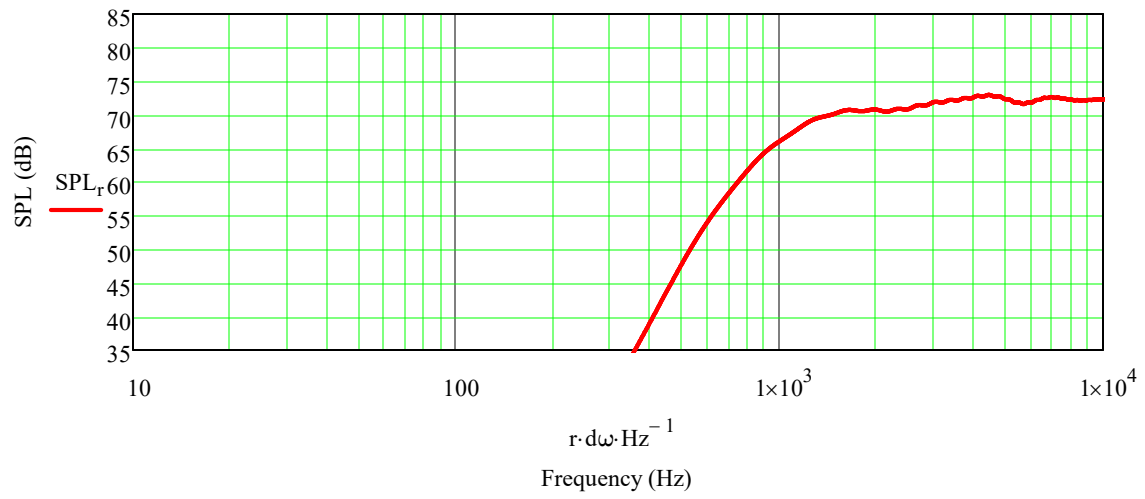
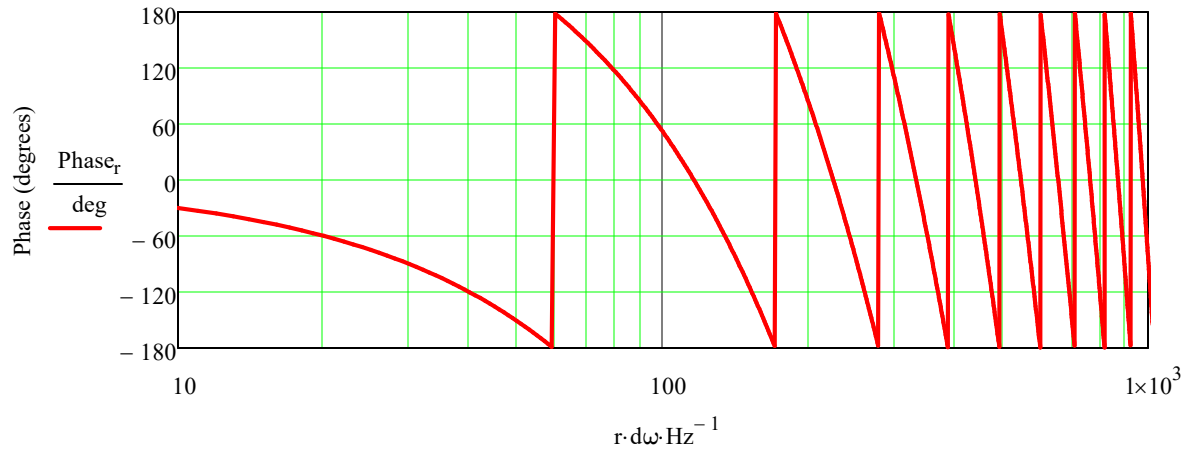
Top View



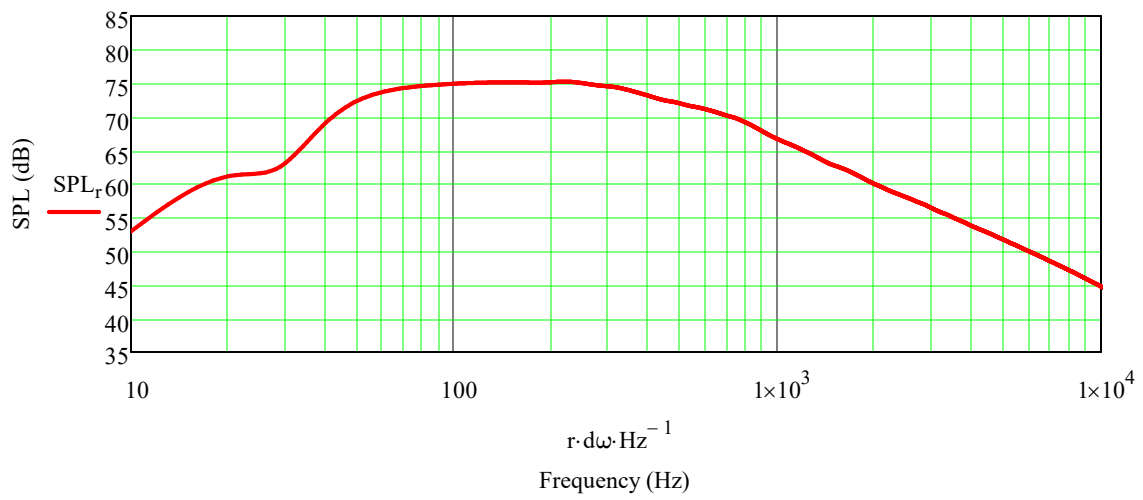
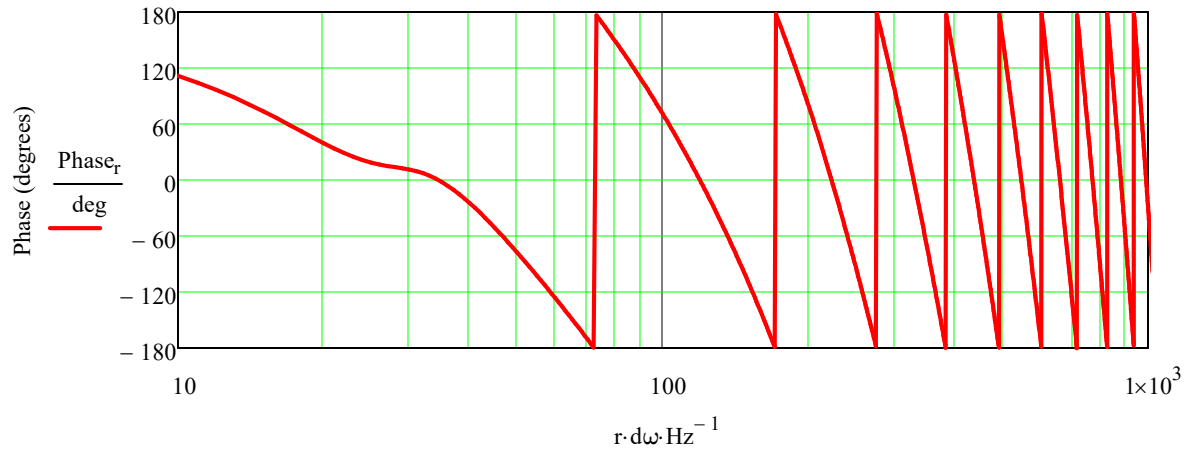
Top View - looking down from ceiling



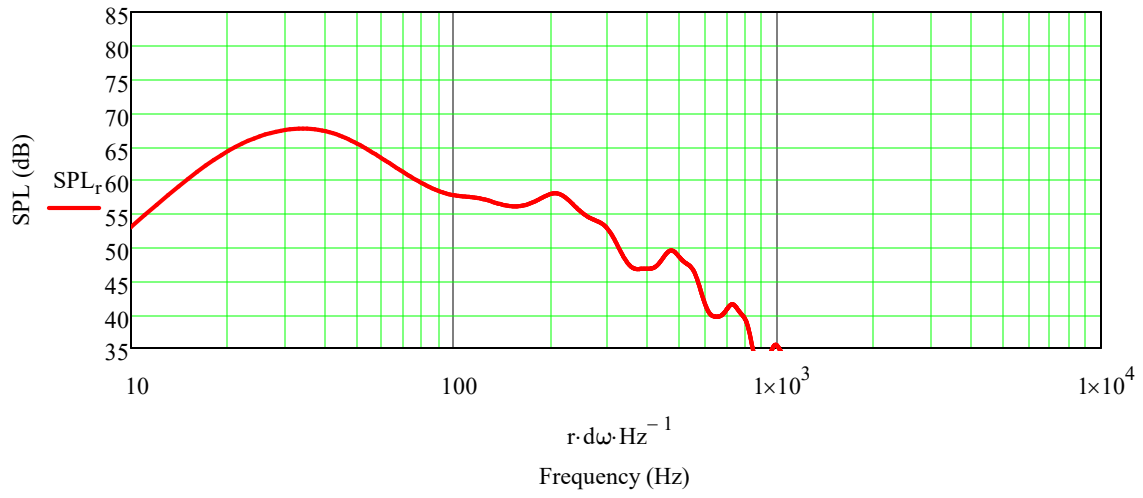
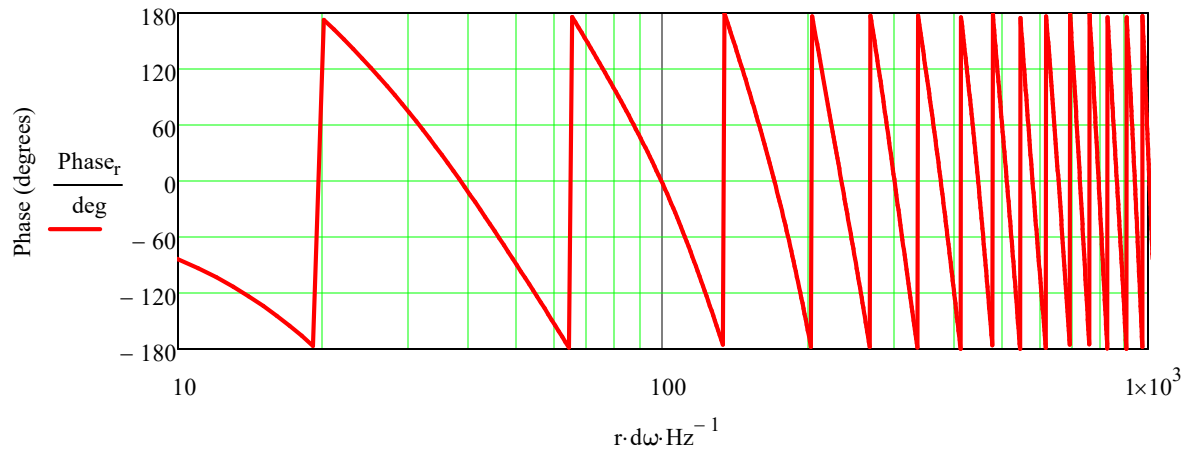
Plotted Baffle Step and Reflection SPL Response for the Tweeter



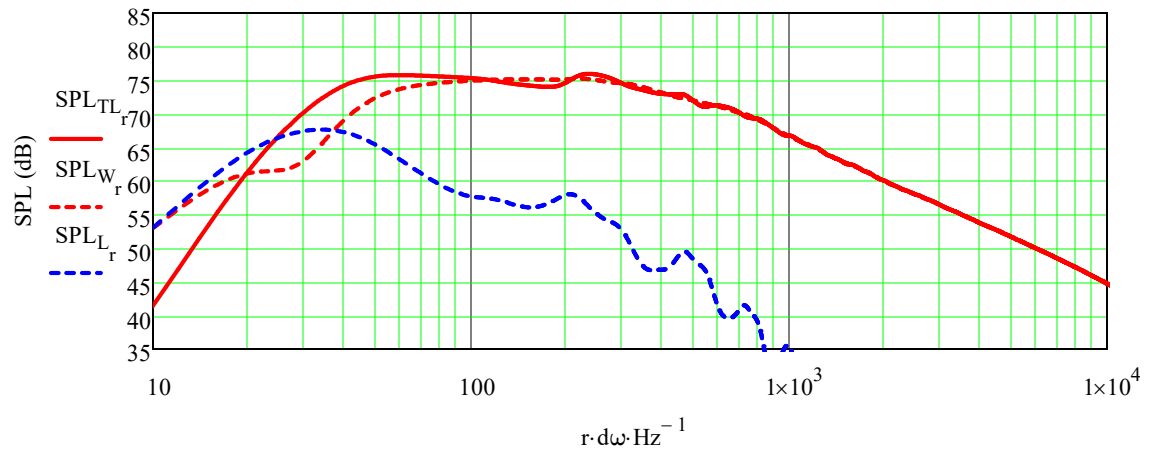
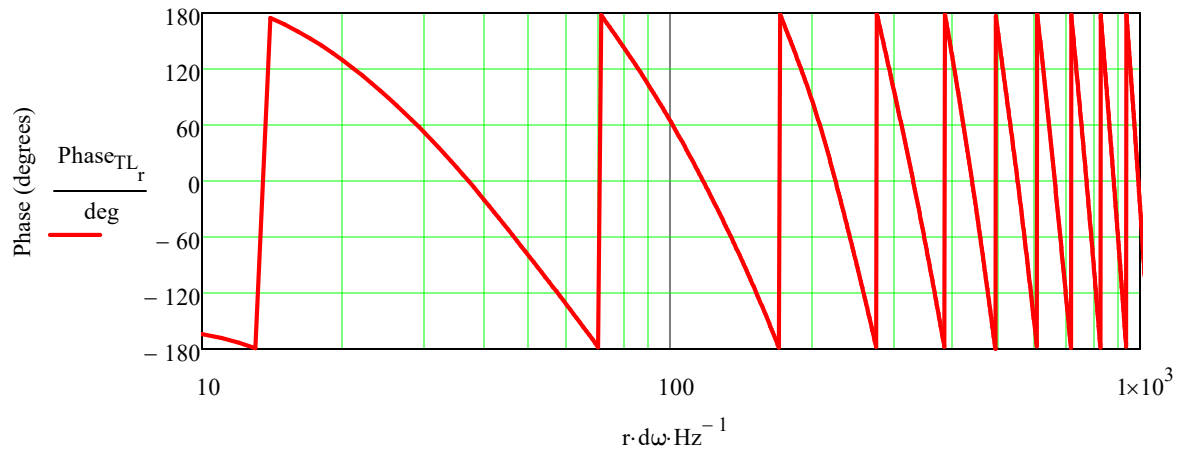
Plotted Baffle Step and Reflection SPL Response for the Woofer



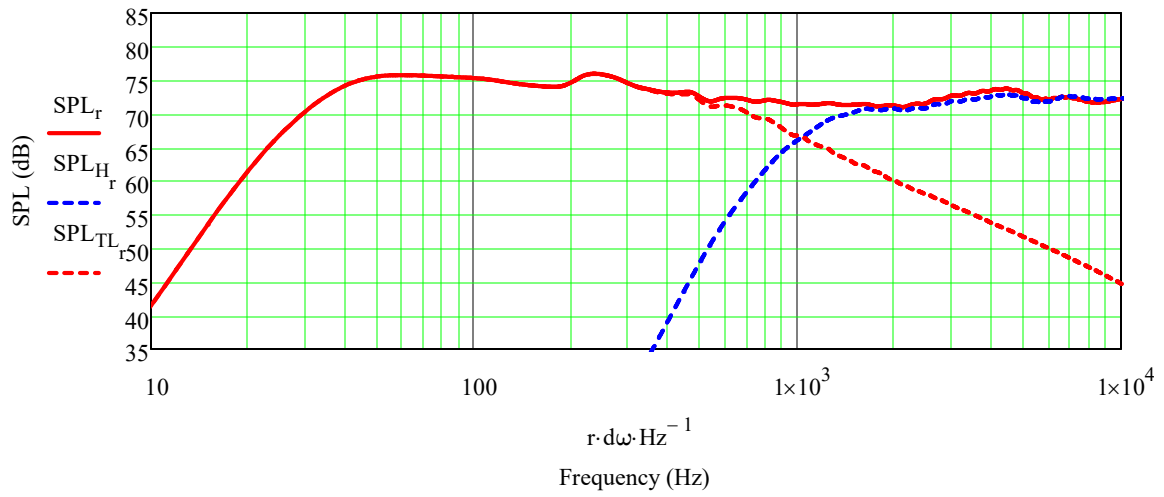
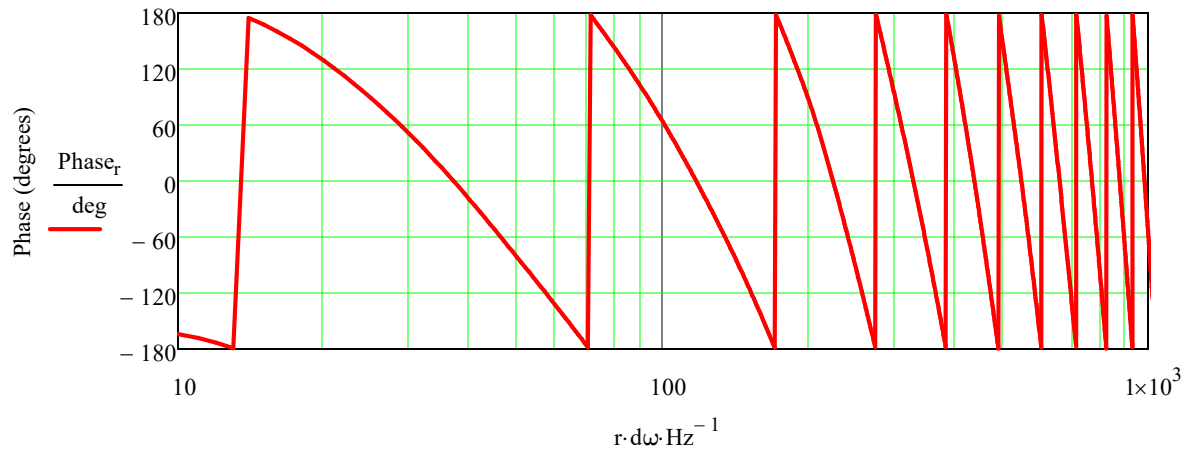
Plotted Baffle Step and Reflection SPL Response for the Terminus



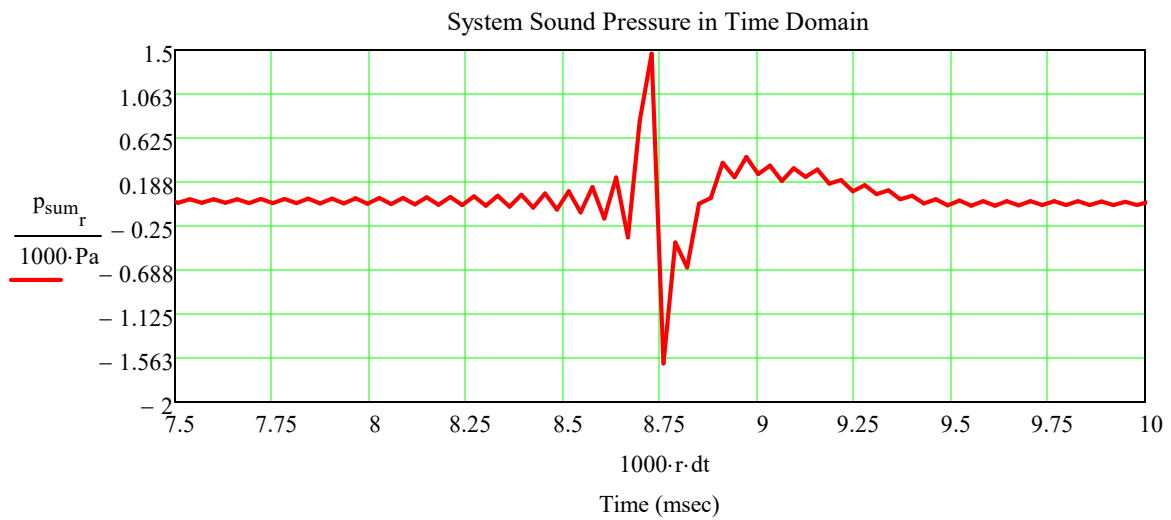
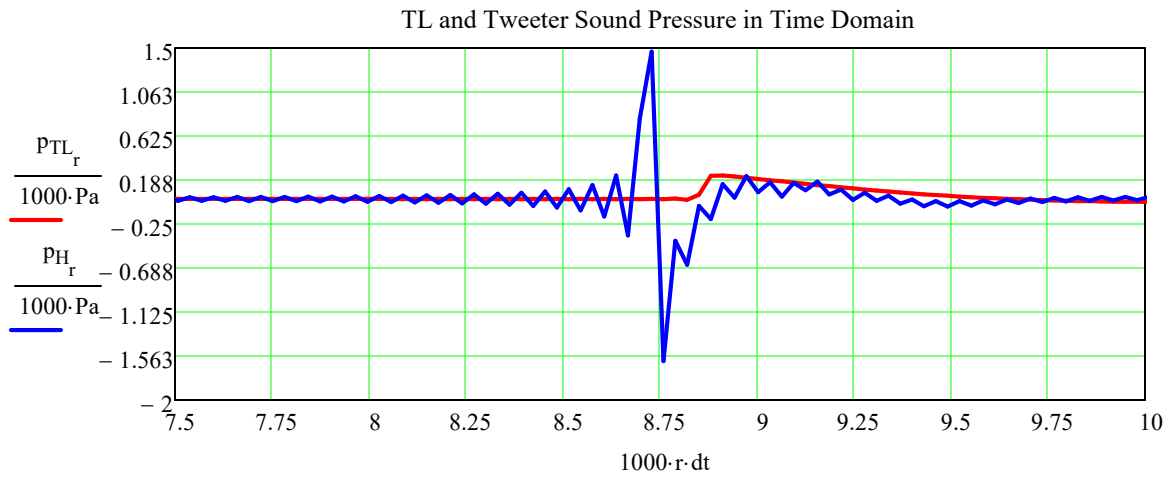
Plotted SPL Response for the Woofer in the TL



Plotted SPL Response for the System



System Time Response for an Impulse Input

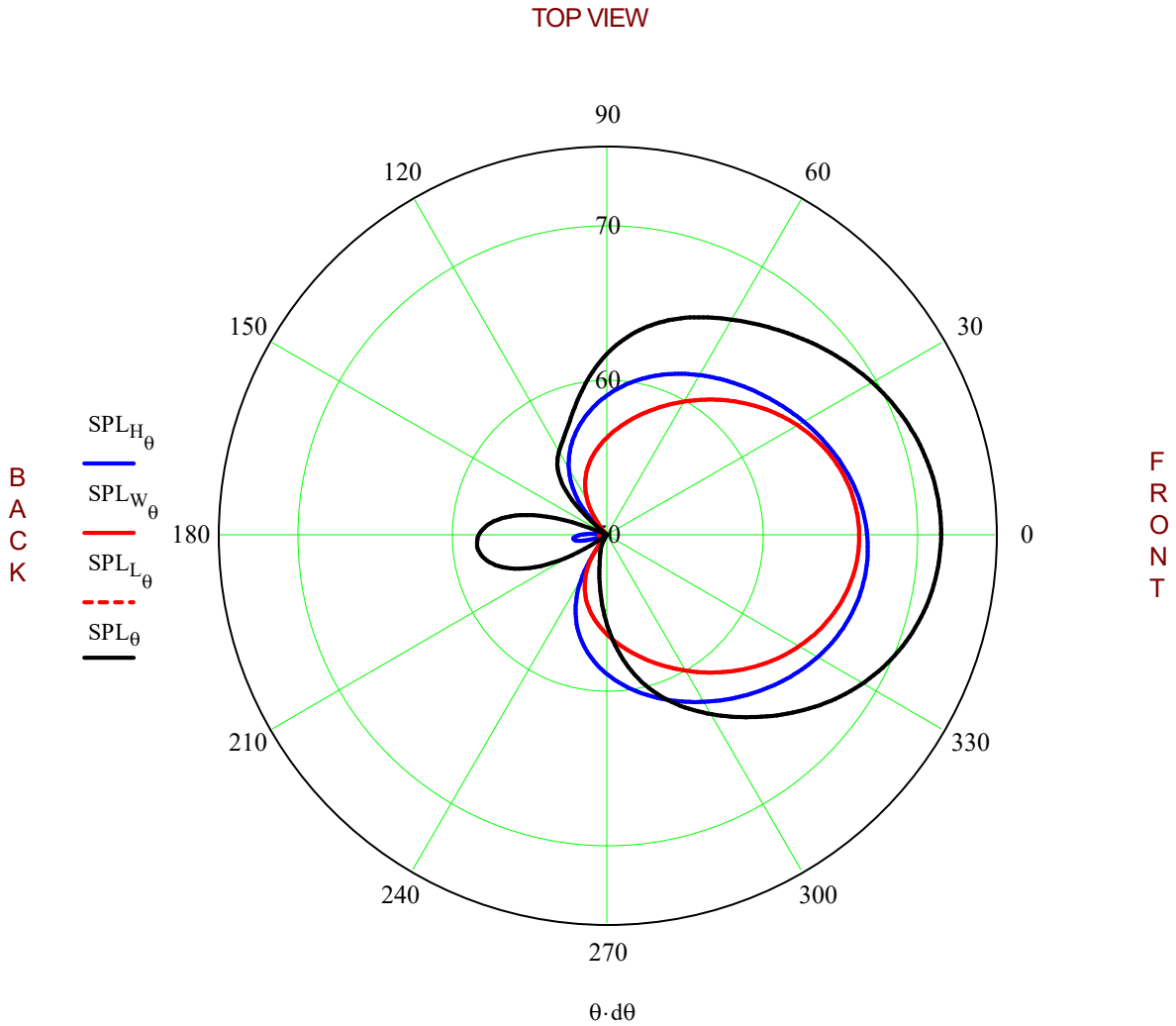


Anechoic Horizontal Polar Response - Free Space

Radius and Frequency Inputs

radius := 3·m (Calculation Radius Along the Driver's Axis)

ω := 1050·Hz (Calculation Frequency : 10 Hz < ω < 10000 Hz where ω must be an Integer Value)



Anechoic Vertical Polar Response - Free Space

Radius and Frequency Inputs

radius := 3·m (Calculation Radius Along the Driver's Axis)

ω := 1050·Hz (Calculation Frequency : 10 Hz < ω < 10000 Hz where ω must be an Integer Value)

