



Open Baffle w/ 3 Drivers - Acoustic Response

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Configuration : Extended Range Driver w/ Bass Driver Mounted on an Open Baffle

Unit and Constant Definition

$$\text{cycle} := 2 \cdot \pi \cdot \text{rad}$$

$$\text{Hz} := \text{cycle} \cdot \text{sec}^{-1}$$

$$\text{Air Density : } \rho := 1.205 \cdot \text{kg} \cdot \text{m}^{-3}$$

$$\text{Speed of Sound : } c := 344 \cdot \text{m} \cdot \text{sec}^{-1}$$



Part 1 : Thiele-Small Consistent Calculation

Cable Series Resistance

$$R_{\text{add}} := 0.0 \cdot \Omega$$

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

$$\text{Power} := 1 \cdot \text{watt} \quad (\text{Input Power}) \quad \text{Applied Voltage Reference} \longrightarrow R_{\text{ref}} := 8 \cdot \Omega$$

Driver Thiele / Small Parameters : Lowther DX3 Average Driver Properties

$$f_d := 60.5 \cdot \text{Hz}$$

$$V_{\text{ad}} := 41.1 \cdot \text{liter}$$

$$R_e := 7.1 \cdot \Omega + R_{\text{add}}$$

$$Q_{\text{ed}} := 0.26 \cdot (R_e) \cdot (R_e - R_{\text{add}})^{-1}$$

$$L_{\text{ve}} := 0 \cdot \text{mH}$$

$$Q_{\text{md}} := 3.83$$

$$Bl := 10.27 \cdot \frac{\text{newton}}{\text{amp}}$$

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

$$S_d := 206 \cdot \text{cm}^2$$

$$Q_{\text{td}} = 0.243$$



Bass Driver Thiele / Small Parameters : Eminence Alpha 15" High Efficiency

$$f_d := 41 \cdot \text{Hz}$$

$$V_{\text{ad}} := 260 \cdot \text{liter}$$

$$R_e := 5.88 \cdot \Omega$$

$$Q_{\text{ed}} := 1.53$$

$$L_{\text{ve}} := 0.84 \cdot \text{mH}$$

$$Q_{\text{md}} := 7.23$$

$$Bl := 7.7 \cdot \frac{\text{newton}}{\text{amp}}$$

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

$$S_d := 856.3 \cdot \text{cm}^2$$

$$Q_{\text{td}} = 1.263$$



Instructions :

1. A Zobel, Trap, and L-Pad are available for adjusting the Extended Range Driver's SPL output.
2. Select the crossover frequencies, orders, and types below.
3. Scroll down to the applicable crossover sections below and fill in the values of the circuit components.
 - a. The theoretical values are shown to the right of each schematic.
 - b. Theoretical values are calculated using only the driver's DC resistance, a textbook solution.
 - c. Enter the actual component values, these should correspond to available components.
 - d. Iterate the actual component values to optimize the crossover responses.
 - e. You can mix the crossover orders and types by using only half of each pair of schematics.
4. Purchase the optimized actual component values and construct the crossover per the schematics.

Crossover Definition

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

Low Pass Filter

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

$LP_{order} := 2$

$LP_{type} := 1$

High Pass Filter

$f_{HP} := 350 \cdot \text{Hz}$

$HP_{order} := 2$

$HP_{type} := 3$

(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 and Extended Range Driver Attenuation

$LP_{phase} := 1$

$HP_{phase} := -1$

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

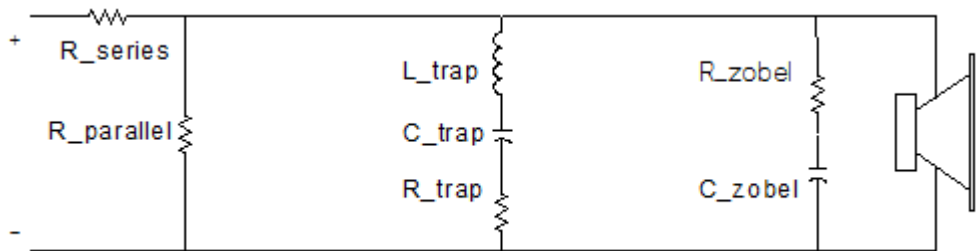
$L_Pad := -3 \text{ dB}$

(L Pad Attenuation of Extended Range Driver)



Compensation Circuits

(Default Actual Values **Remove** Circuits)



Extended Range Driver Circuit Elements

Zobel Components

User Specified Compensation Circuit Values

Suggested Values

$R_{\text{zobel}} = 8.875 \, \Omega$
 $C_{\text{zobel}} = 1 \times 10^{-10} \, \mu\text{F}$

Actual Values

$R_{\text{zobel}} := 10^{10} \cdot \Omega$
 $C_{\text{zobel}} := 10^{-10} \cdot \mu\text{F}$

Resonance Trap Components

Suggested Values

$R_{\text{trap}} = 7.582 \, \Omega$
 $C_{\text{trap}} = 1.425 \times 10^3 \, \mu\text{F}$
 $L_{\text{trap}} = 4.856 \, \text{mH}$

Actual Values

$R_{\text{trap}} := 10^{10} \cdot \Omega$
 $C_{\text{trap}} := 10^{-10} \cdot \mu\text{F}$
 $L_{\text{trap}} := 10^{10} \cdot \text{mH}$

L-Pad Components

Suggested Values

$R_{\text{parallel}} = 14.253 \, \Omega$
 $R_{\text{series}} = 1.717 \, \Omega$

Actual Values

$R_{\text{parallel}} := 14 \cdot \Omega$
 $R_{\text{series}} := 2 \cdot \Omega$





Woofer Circuit Elements

Zobel Components

Suggested Values

$$R_{\text{zobel}} = 3.675 \, \Omega$$

$$C_{\text{zobel}} = 62.196 \, \mu\text{F}$$

User Specified Compensation Circuit Values

Actual Values

$$R_{\text{zobel}} := 10^{10} \cdot \Omega$$

$$C_{\text{zobel}} := 10^{-10} \cdot \mu\text{F}$$

Resonance Trap Components

Suggested Values

$$R_{\text{trap}} = 7.722 \, \Omega$$

$$C_{\text{trap}} = 862.974 \, \mu\text{F}$$

$$L_{\text{trap}} = 17.461 \, \text{mH}$$

Actual Values

$$R_{\text{trap}} := 10^{10} \cdot \Omega$$

$$C_{\text{trap}} := 10^{-10} \cdot \mu\text{F}$$

$$L_{\text{trap}} := 10^{10} \cdot \text{mH}$$

L-Pad Components

Suggested Values

$$R_{\text{parallel}} = 14.253 \, \Omega$$

$$R_{\text{series}} = 1.717 \, \Omega$$

Actual Values

$$R_{\text{parallel}} := 10^{10} \cdot \Omega$$

$$R_{\text{series}} := 0 \cdot \Omega$$



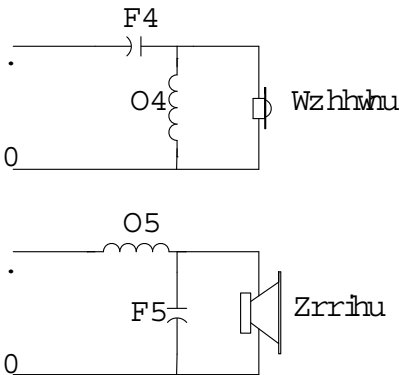
Crossover Definition - 1st Order High and Low Pass



Crossover Definition - 2nd Order High and Low Pass



Schematic



Theoretical Values

$C_1 = 37.403 \mu F$

$L_1 = 5.528 \text{ mH}$

$L_2 = 4.679 \text{ mH}$

$C_2 = 135.336 \mu F$

Enter Actual Component Values Below

High Pass

$C_1 := 36 \cdot \mu F$ $R_{C1} := 0 \cdot \Omega$ PE Part # 027-594

$L_1 := 5.5 \cdot \text{mH}$ $R_{L1} := 0.47 \cdot \Omega$ PE Part # 266-570

Low Pass

$L_2 := 4.7 \cdot \text{mH}$ $R_{L2} := 0.23 \cdot \Omega$ PE Part # 266-924

$C_2 := 130 \cdot \mu F$ $R_{C2} := 0 \cdot \Omega$ PE Part # 027-622

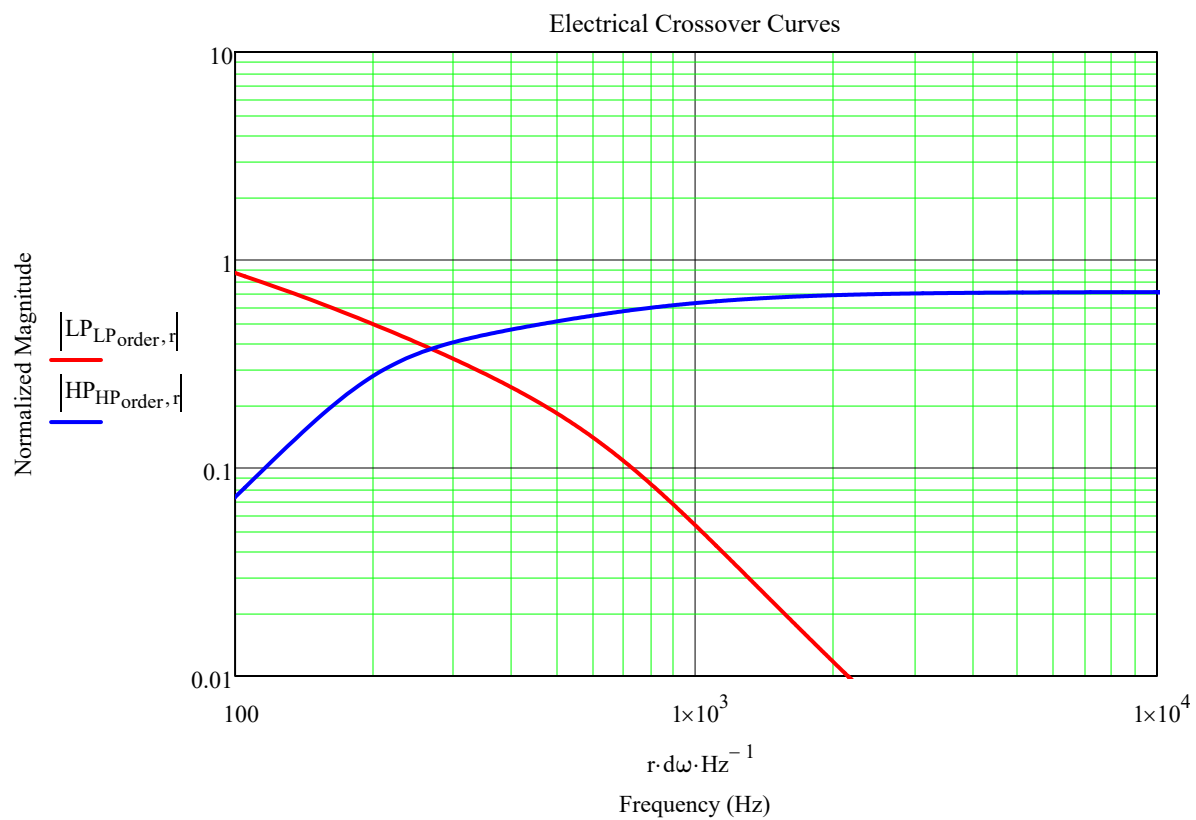


Crossover Definition - 3rd Order High and Low Pass



Crossover Definition - 4th Order High and Low Pass

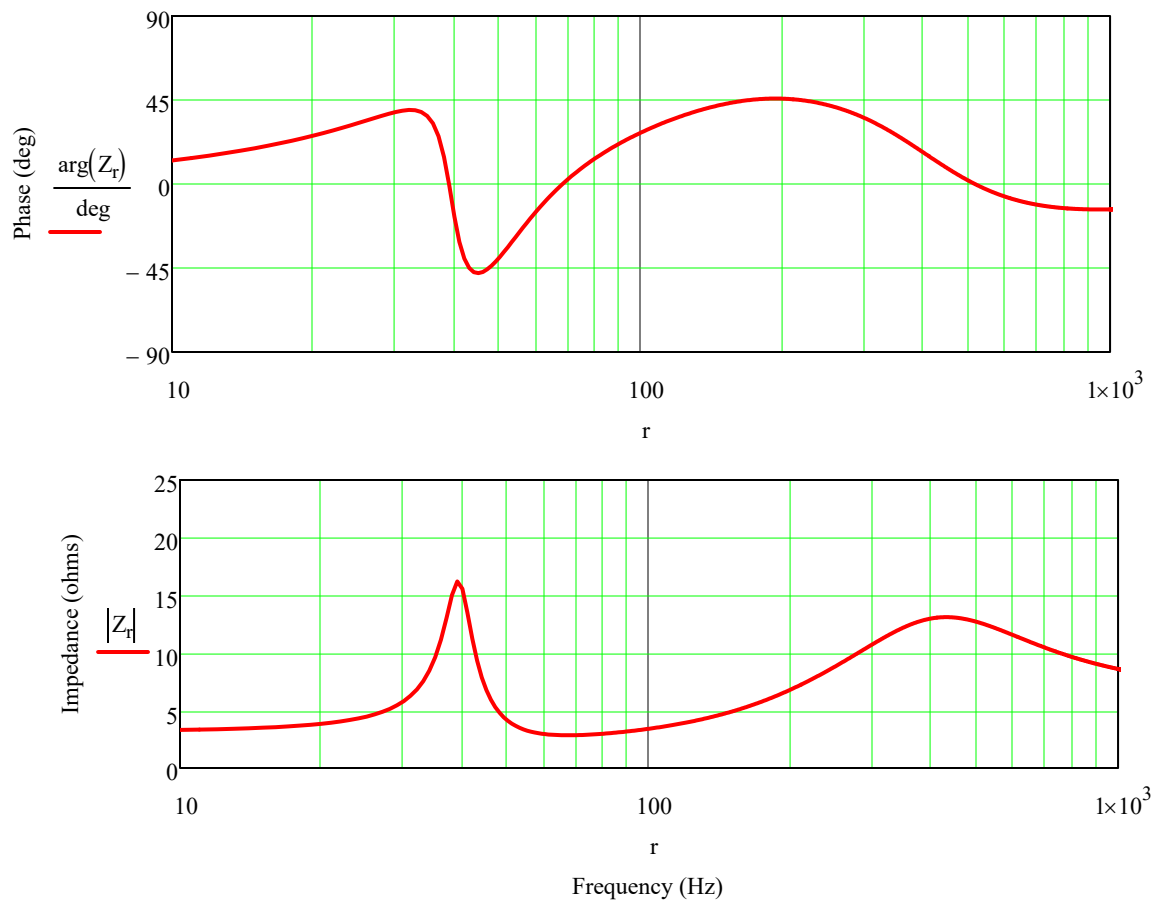




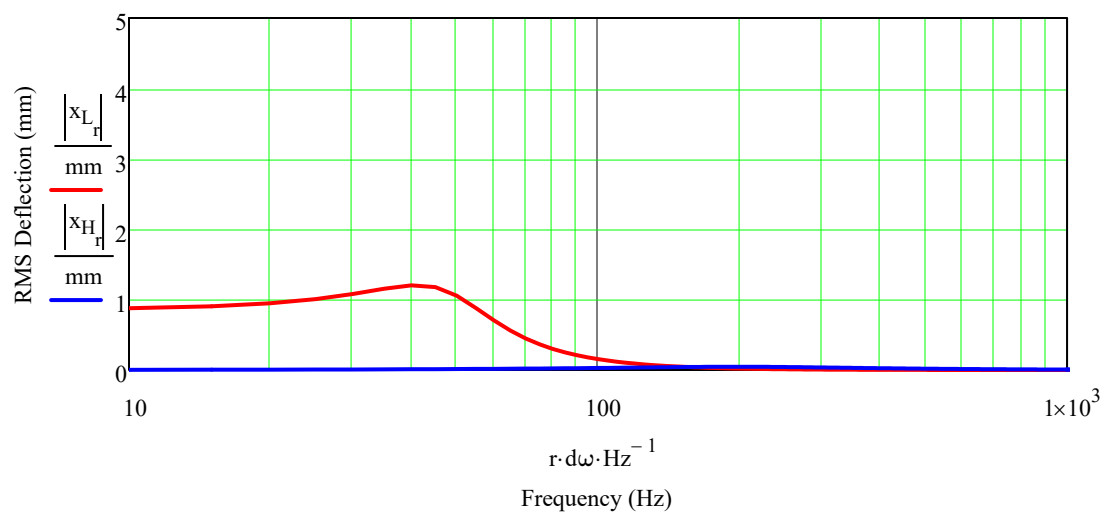
End of Detailed Input

End of Part 1 Input

OB Driver Impedance



Driver RMS Displacements (Red Curve - Woofers, Blue Curve - Extended Range Driver)



Part 2 : Detailed SPL Response Calculation

Calculation Includes :

- Position of Drivers on the Baffle.
- Open Baffle Defraction for the Drivers.
- Floor Reflection for the Drivers.

Geometry

Coordinate System :

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

The variables num_r, n_low, and n_high 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

$X_0 := 2 \cdot \text{ft}$	(Front Baffle Distance from Rear Wall > Depth of Enclosure)
$Y_0 := 1.5 \cdot \text{ft}$	(Front Baffle Distance from Side Wall)
$\theta_0 := 45 \cdot \text{deg}$	(Rotation Towards Room Center)
$\theta_1 := 0 \cdot \text{deg}$	(Rotation Back of Baffle)
$Z_0 := 8 \cdot \text{ft}$	(Floor to Ceiling Distance)
stand := 0·m	(Height from Floor to Bottom Edge of Front Baffle)
num_r := 50	(Number of Points per Unit Length of Baffle Edge)

Corner Coordinates

Y coordinate	Z coordinate	
$y_{o_0} := 20 \cdot \text{in}$		(Bottom Right Corner)
$y_{o_1} := 20 \cdot \text{in}$	$z_{o_1} := 46 \cdot \text{in}$	(Top Right Corner)
$y_{o_2} := 0 \cdot \text{in}$	$z_{o_2} := 46 \cdot \text{in}$	(Top Left Corner)
$y_{o_3} := 0 \cdot \text{in}$		(Bottom Left Corner)

Extended Range Driver Geometry Input

$y_{dc} := 12 \cdot \text{in}$	(Driver Center y Coordinate)
$z_{dc} := 40 \cdot \text{in}$	(Driver Center z Coordinate)
n_high := 8	(Number of Points Across Diameter)

Woofer Driver Geometry Input

$y_{w1} := 10 \cdot \text{in}$	(Lower Driver Center y Coordinate)
$z_{w1} := 9 \cdot \text{in}$	(Lower Driver Center z Coordinate)
$y_{w2} := 10 \cdot \text{in}$	(Upper Driver Center y Coordinate)
$z_{w2} := 26 \cdot \text{in}$	(Upper Driver Center z Coordinate)
n_low := 15	(Number of Points Across Diameter)

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

$n_listen = 0$ (Listening Position Relative to Speaker)
 $radius := 3 \cdot m$ (Calculation Radius, Effective Radius is Greater if y_p is Changed from Default)
 $\theta := 0 \cdot deg$ (0 deg is along the Driver's Axis, $-80 \text{ deg} < \theta < 80 \text{ deg}$)
 $z_p := 38 \cdot in$ (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

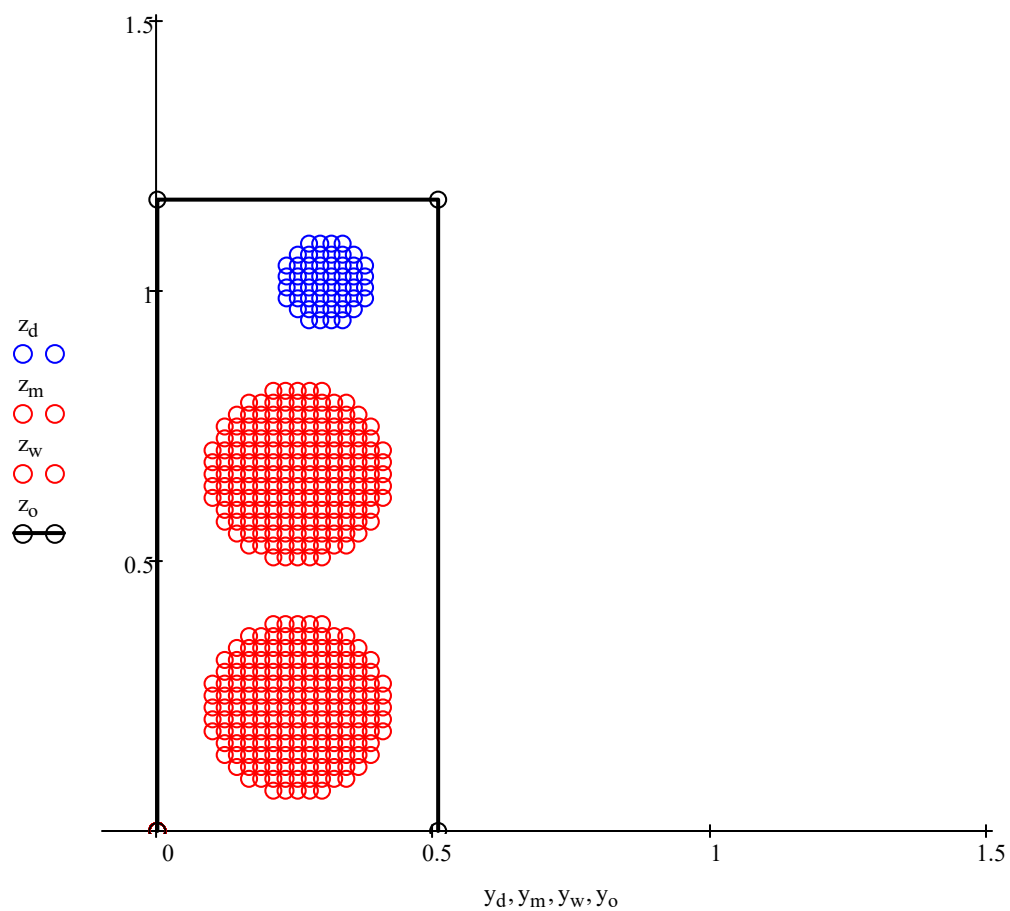
$Reflect := 1$ (0 = hardwood or concrete, 1 = carpeted)

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

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



Extended Range Driver and Two Woofer : Simple Source Pattern with Baffle Edge Outline

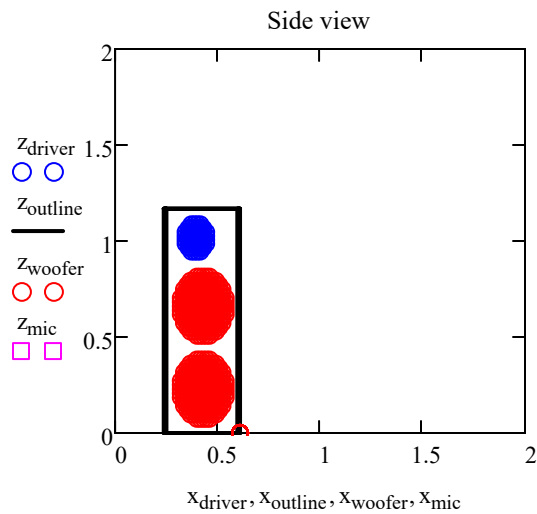




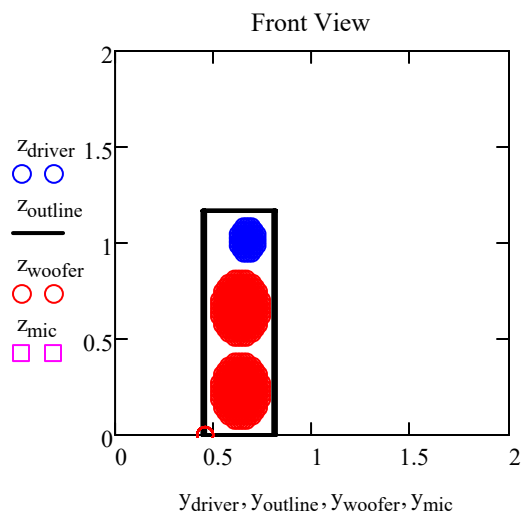
Three Dimensional View

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

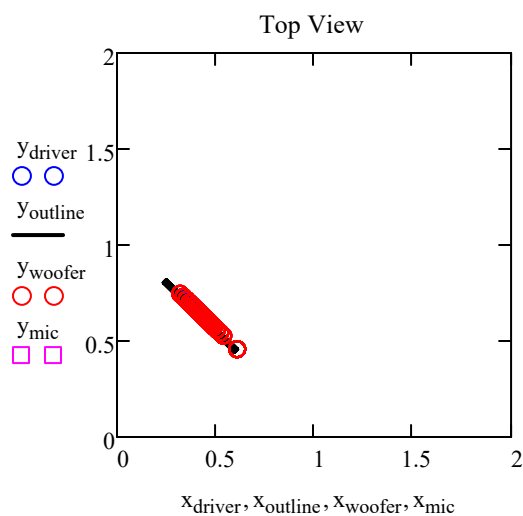
Room Corner is the Origin



Side View - looking out from side wall



Front View - looking towards rear wall



Top View - looking down from ceiling



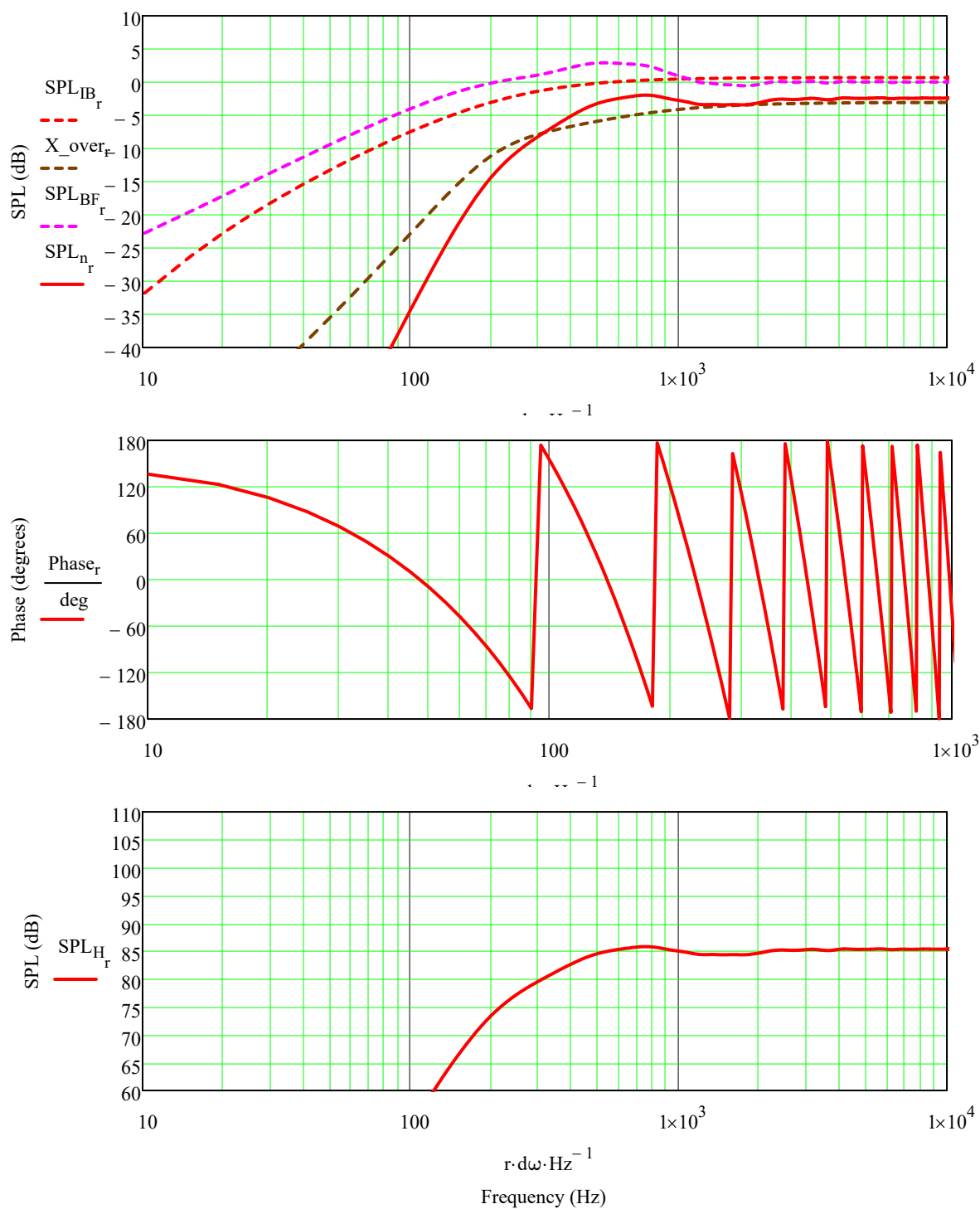
Plotted Response for the Extended Range Driver

Dashed Red - Infinite Baffle Response

Dashed Magenta - Baffle Response

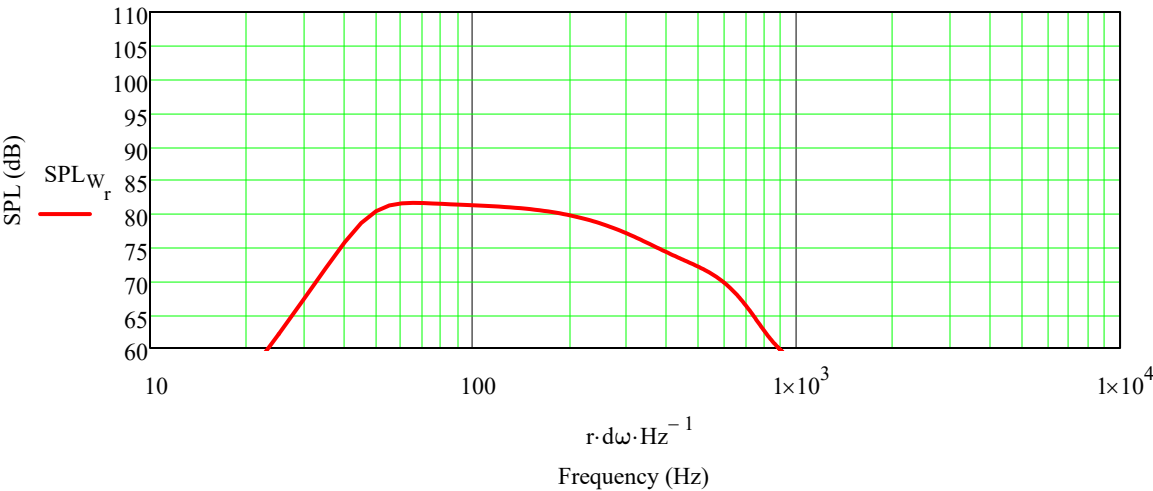
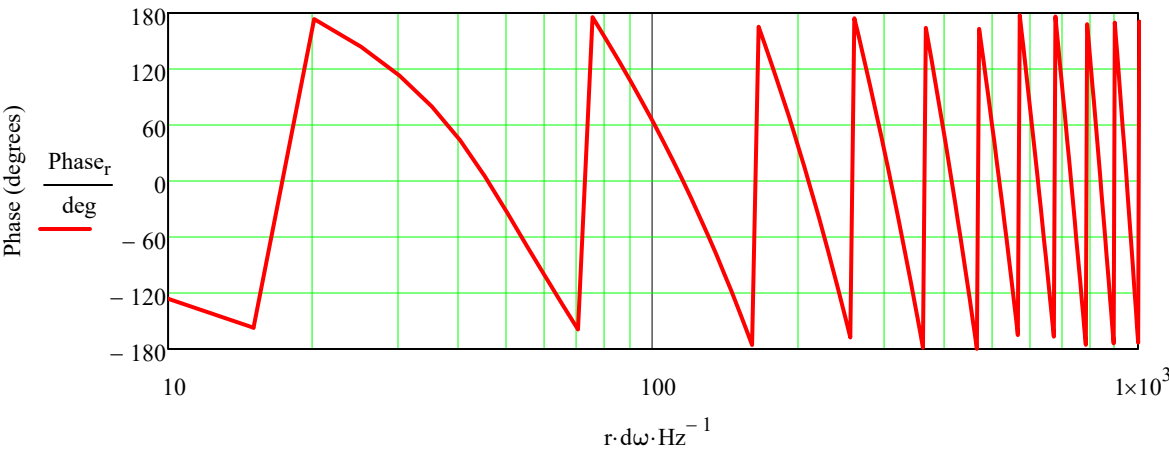
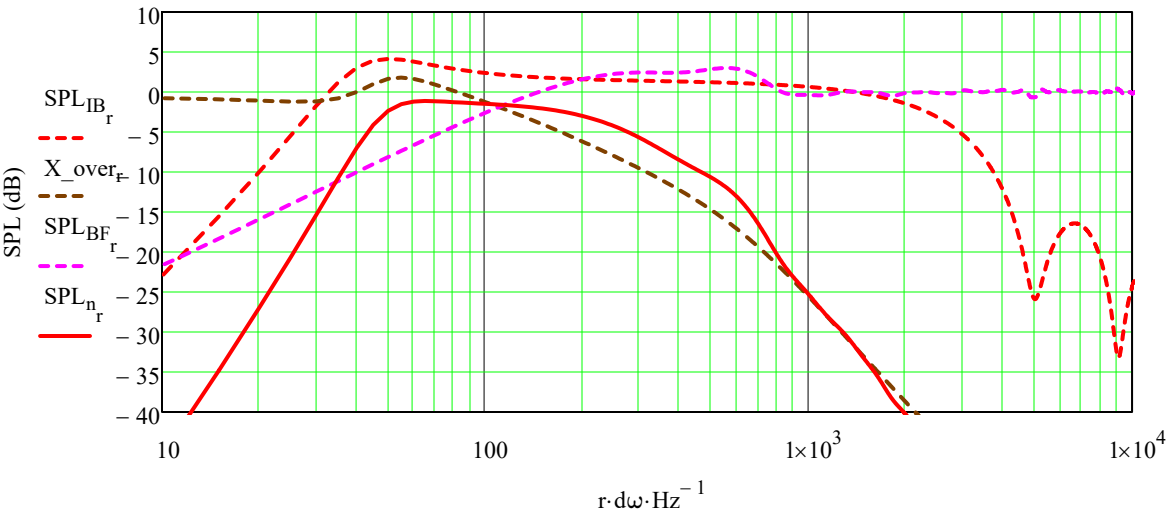
Dashed Brown - Crossover Response

Solid Red - Combined Response



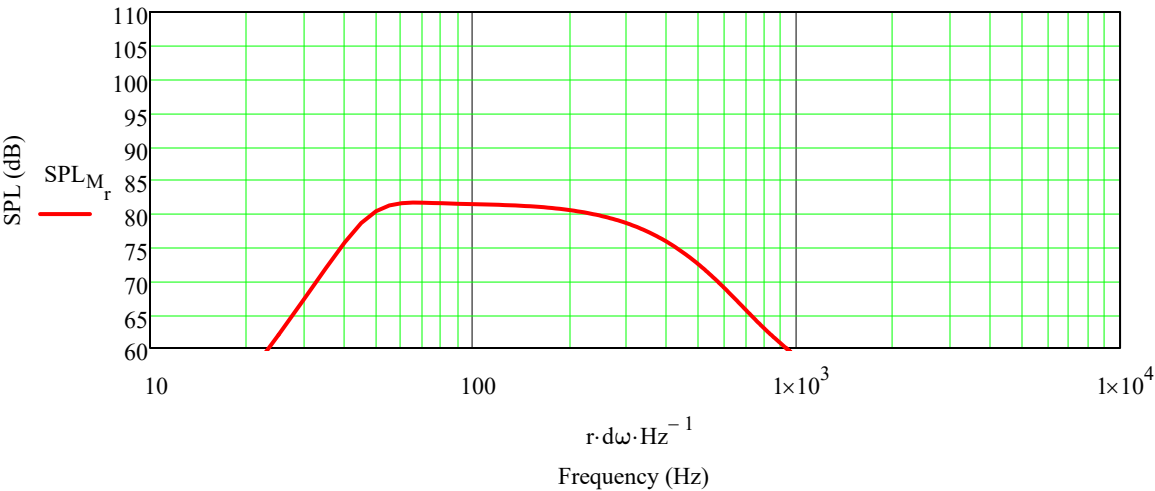
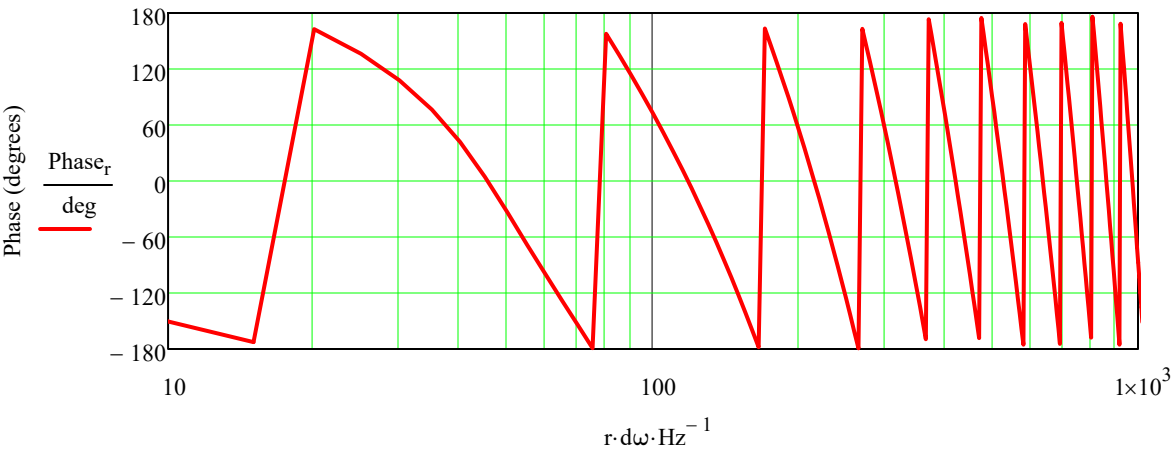
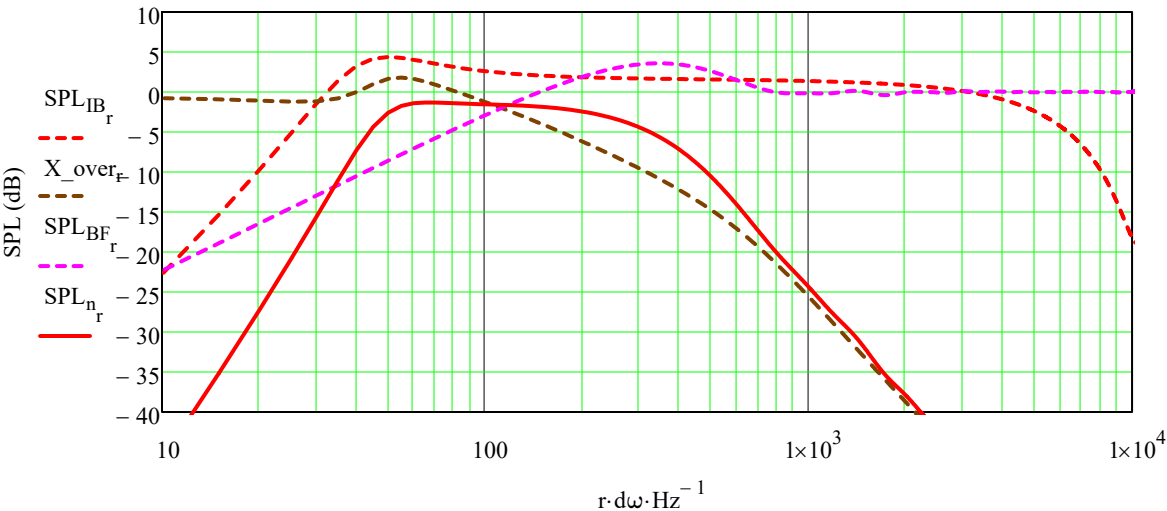
Plotted Response for the Lower Woofer Driver

- Dashed Red - Infinite Baffle Response
- Dashed Magenta - Baffle Response
- Dashed Brown - Crossover Response
- Solid Red - Combined Response

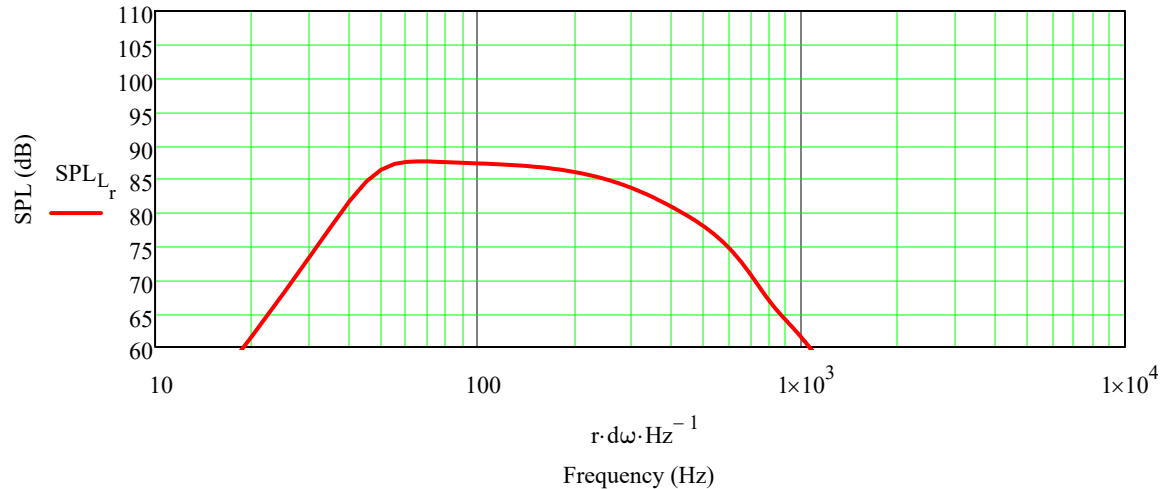
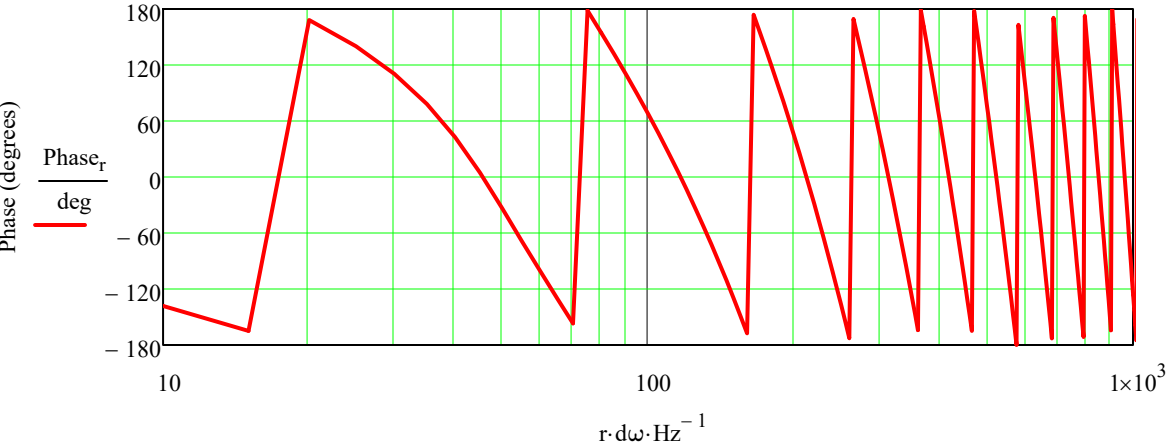


Plotted Response for the Upper Woofer Driver

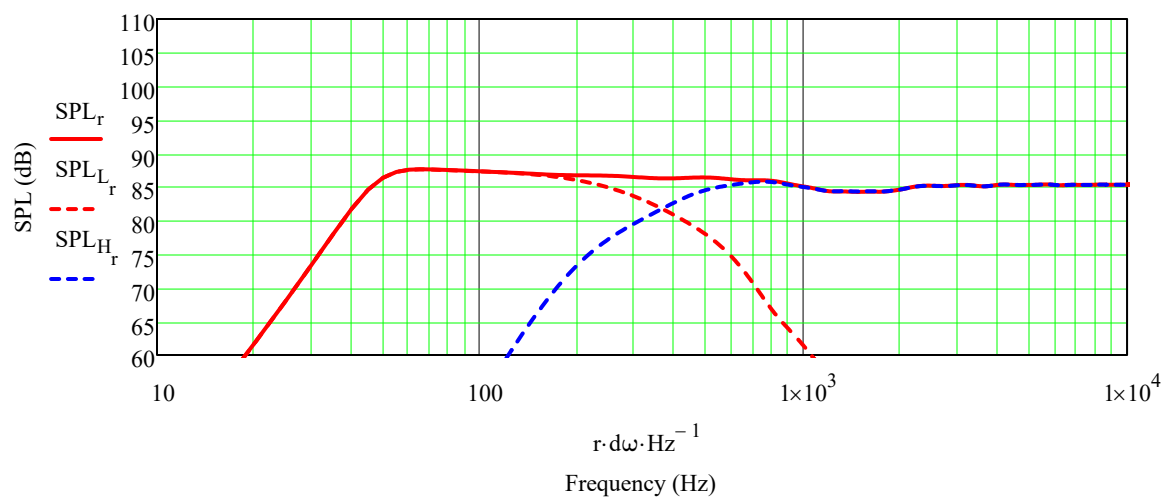
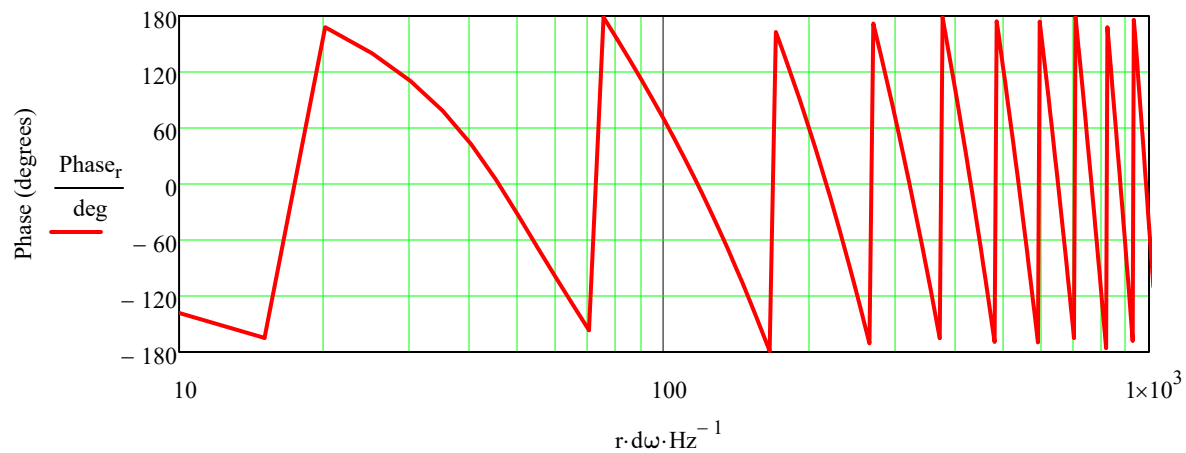
- Dashed Red - Infinite Baffle Response
- Dashed Magenta - Baffle Response
- Dashed Brown - Crossover Response
- Solid Red - Combined Response



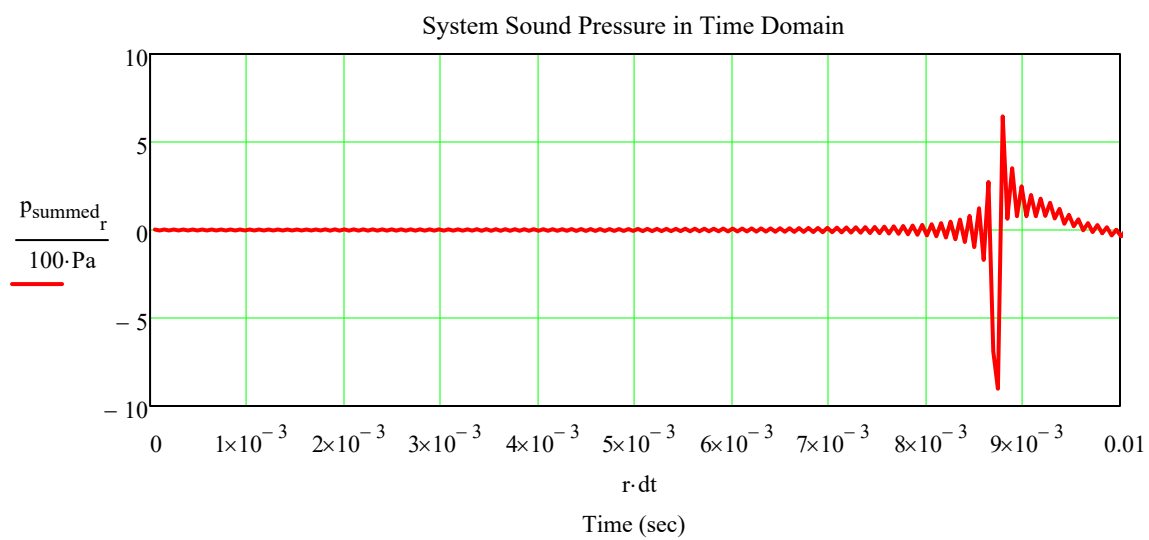
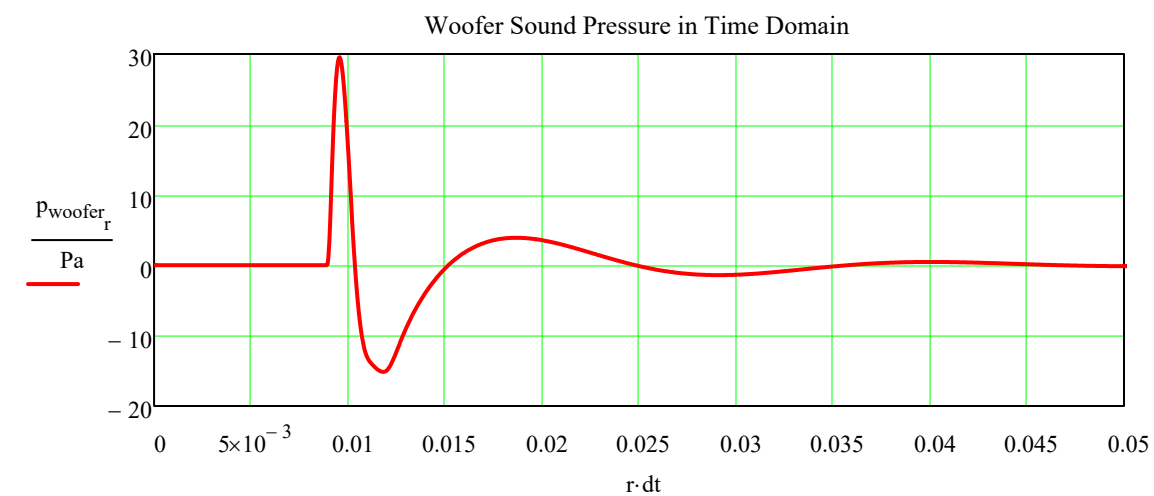
Plotted Combined Response for the Woofer Drivers



Plotted System Response for the Extended Range/Dual Woofer Open Baffle Design



System Time Response for an Impulse Input



Anechoic Horizontal Polar Response - Free Space

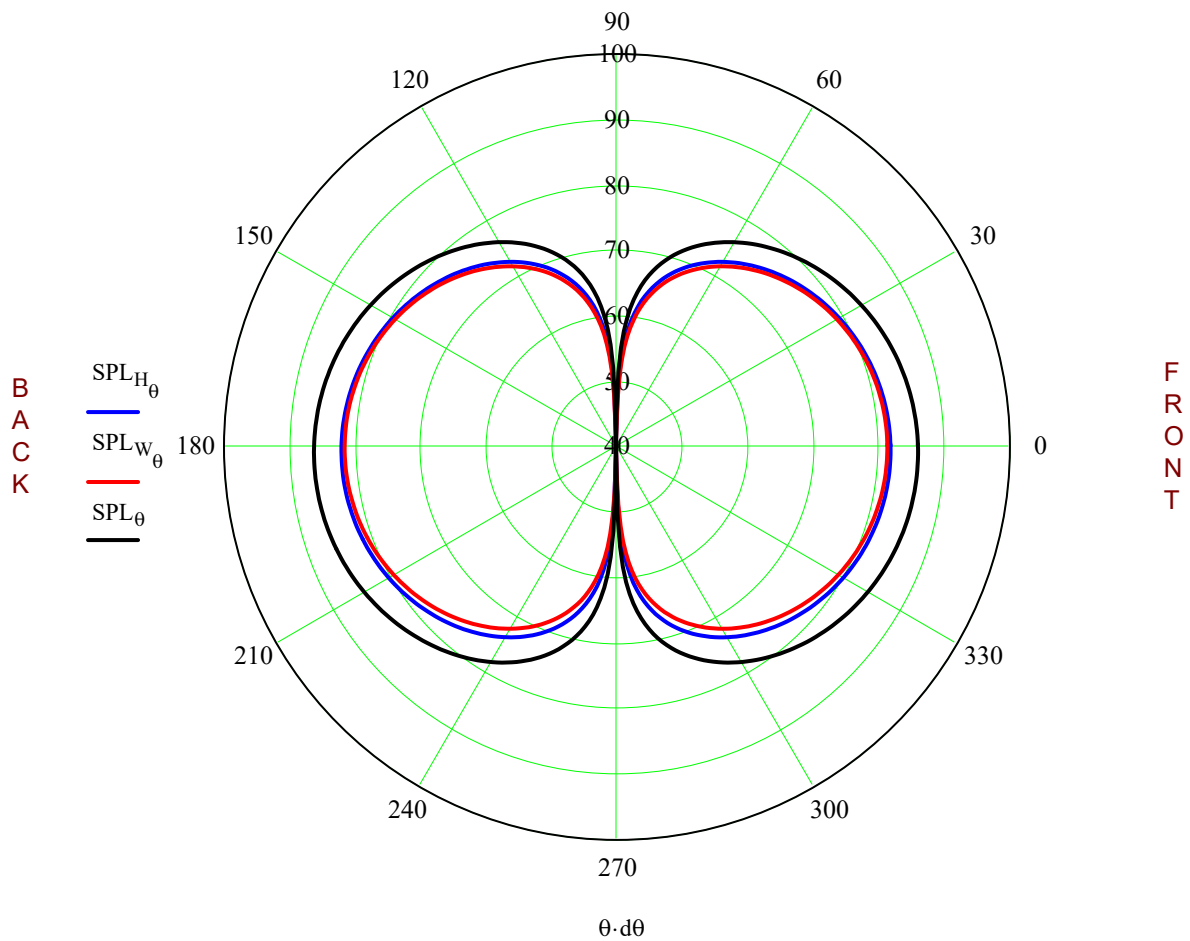
Radius and Frequency Inputs

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

ω := 370·Hz (Calculation Frequency : 10 Hz < ω < 10000 Hz where ω must be an Integer Value)



TOP VIEW



Anechoic Vertical Polar Response - Free Space

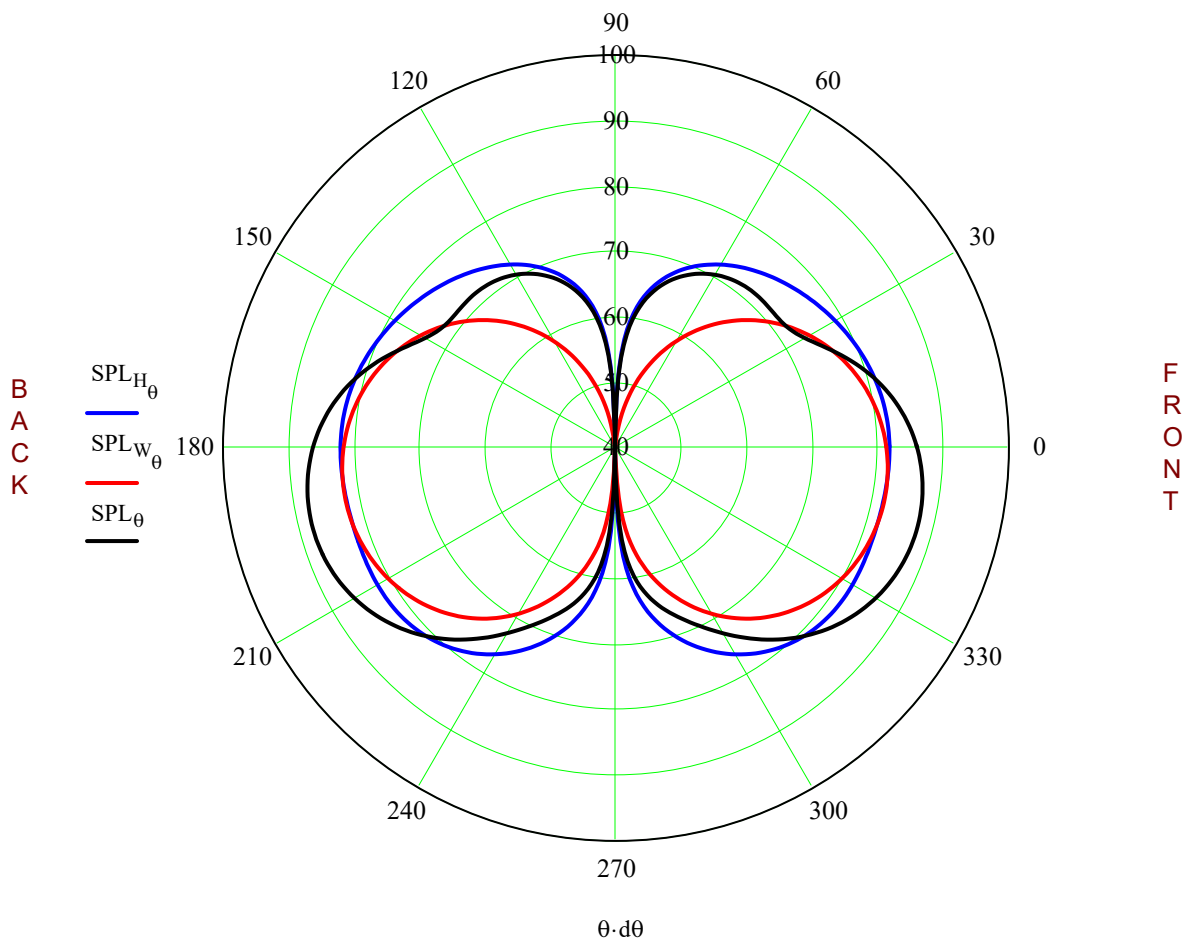
Radius and Frequency Inputs

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

$\omega := 370 \cdot \text{Hz}$ (Calculation Frequency : 10 Hz < ω < 10000 Hz where ω must be an Integer Value)



SIDE VIEW



System (no subscript) radius := 3.0·m

$$\text{System}_r := \left(\text{Driver}_r + \text{Midrange}_r + \text{Woofer}_r \right) \cdot \exp\left(j \cdot \frac{r \cdot d\omega}{c} \cdot \text{radius}\right)$$

$$\text{SPL}_r := 20 \cdot \log\left(\left| \frac{\text{System}_r}{2 \cdot 10^{-5} \cdot \text{Pa}} \right|\right) \quad \text{Phase}_r := \arg(\text{System}_r)$$

