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

$cycle := 2\cdot\pi\cdot rad$

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

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

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

Part 1 : Thiele-Small Consistent Calculation

Cable Series Resistance

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

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

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

Driver Thiele / Small Parameters : Lowther DX3 Average Driver Properties

$f_d := 60.5\cdot Hz$ $V_{ad} := 41.1\cdot liter$

$R_e := 7.1\cdot\Omega + R_{add}$ $Q_{ed} := 0.26\cdot(R_e)\cdot(R_e - R_{add})^{-1}$

$L_{vc} := 0\cdot mHH$ $Q_{md} := 3.83$

$Bl := 10.27\cdot\frac{newton}{amp}$ $Q_{td} := \left(\frac{1}{Q_{ed}} + \frac{1}{Q_{md}}\right)^{-1}$

$S_d := 206\cdot cm^2$ $Q_{td} = 0.243$

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

$f_d := 41\cdot Hz$ $V_{ad} := 260\cdot liter$

$R_e := 5.88\cdot\Omega$ $Q_{ed} := 1.53$

$L_{vc} := 0.84\cdot mH$ $Q_{md} := 7.23$

$Bl := 7.7\cdot\frac{newton}{amp}$ $Q_{td} := \left(\frac{1}{Q_{ed}} + \frac{1}{Q_{md}}\right)^{-1}$

$S_d := 856.3\cdot cm^2$ $Q_{td} = 1.263$

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

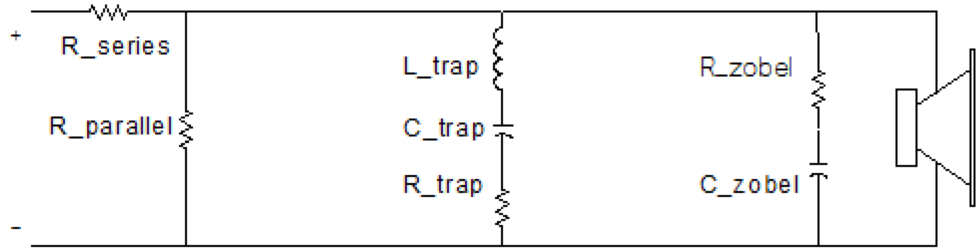
For Even Order Crossovers : Type 1 = Linkwitz-Riley
Type 2 = Bessel
Type 3 = BEC
Type 4 = Butterworth

Low Pass Filter	High Pass Filter	
$f_{LP} := 200 \cdot Hz$	$f_{HP} := 500 \cdot Hz$	(Filter Frequency)
$LP_{order} := 2$	$HP_{order} := 2$	(Filter Order : 0, 1, 2, 3, or 4)
$LP_{type} := 3$	$HP_{type} := 4$	(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)
	$L\_Pad := -3$ dB	(L Pad Attemuation 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 $R_{zobel} = 8.875\,\Omega$

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

$C_{zobel} = 1\times 10^{-10}\,\mu F$

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

Resonance Trap Components

Suggested Values $R_{trap} = 7.582\,\Omega$

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

$C_{trap} = 1.425\times 10^{3}\,\mu F$

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

$L_{trap} = 4.856\,mH$

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

L-Pad Components

Suggested Values $R_{parallel} = 14.253\,\Omega$

Actual Values $R_{parallel} := 14\cdot\Omega$

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

$R_{series} := 2\cdot\Omega$

Woofer Circuit Elements

Zobel Components

Suggested Values

$R_{zobel} = 3.675\ \Omega$

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

User Specified Compensation Circuit Values

Actual Values

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

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

Resonance Trap Components

Suggested Values

$R_{trap} = 7.722\ \Omega$

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

$L_{trap} = 17.461\ mH$

Actual Values

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

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

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

L-Pad Components

Suggested Values

$R_{parallel} = 14.253\ \Omega$

$R_{series} = 1.717\ \Omega$

Actual Values

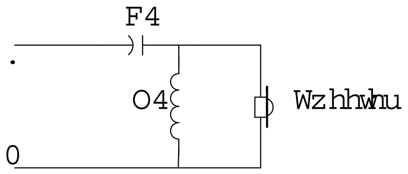
$R_{parallel} := 10^{10} \cdot \Omega$

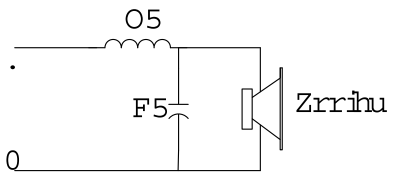
$R_{series} := 0 \cdot \Omega$

Crossover Definition - 1st Order High and Low Pass

Crossover Definition - 2nd Order High and Low Pass

Schematic





Theoretical Values

$C_1 = 31.696\,\mu F$

$L_1 = 3.197\,mH$

$L_2 = 4.006\,mH$

$C_2 = 158.072\,\mu F$

Enter Actual Component Values Below

High Pass

$C_1 := 33 \cdot \mu F$ $\quad R_{C1} := 0 \cdot \Omega$ PE Part # 027-592

$L_1 := 3.0 \cdot mH$ $\quad R_{L1} := 0.18 \cdot \Omega$ PE Part # 266-912

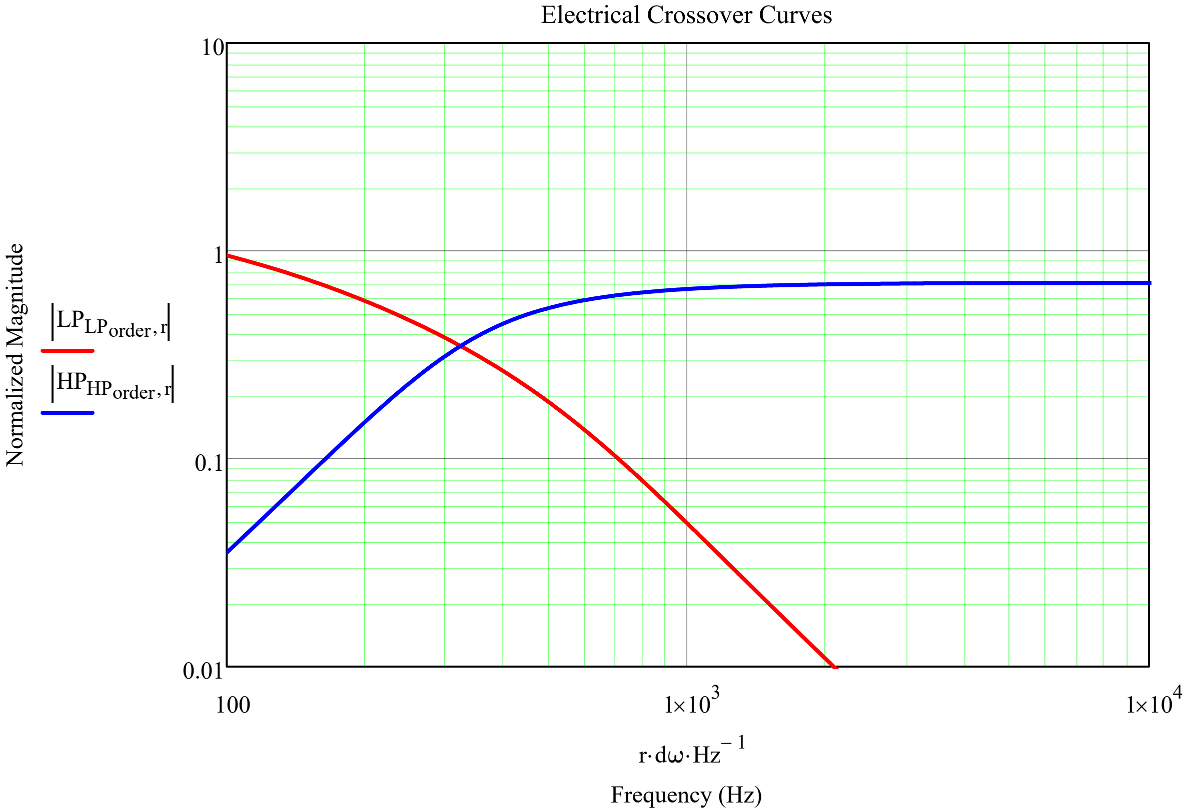
Low Pass

$L_2 := 4.0 \cdot mH$ $\quad R_{L2} := 0.22 \cdot \Omega$ PE Part # 266-922

$C_2 := 160 \cdot \mu F$ $\quad R_{C2} := 0 \cdot \Omega$ PE Part # 027-626

Crossover Definition - 3rd Order High and Low Pass

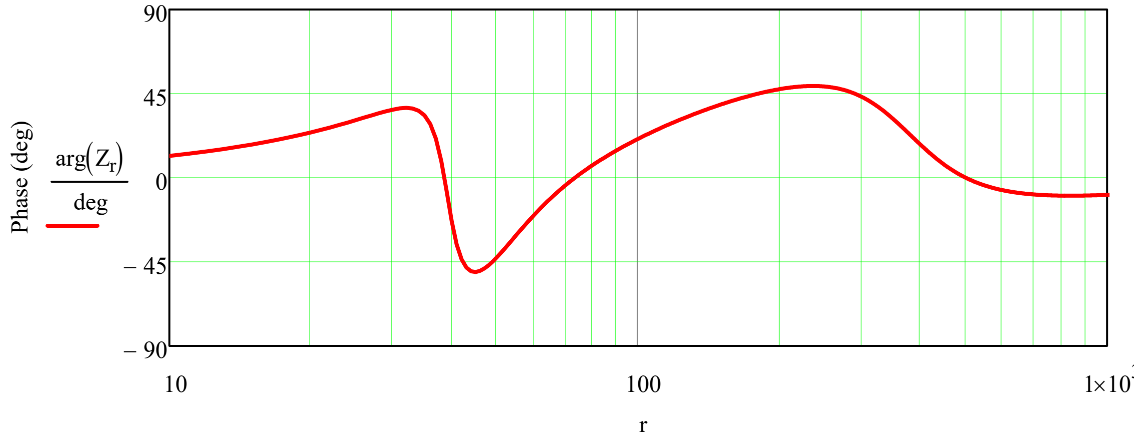
Crossover Definition - 4th Order High and Low Pass

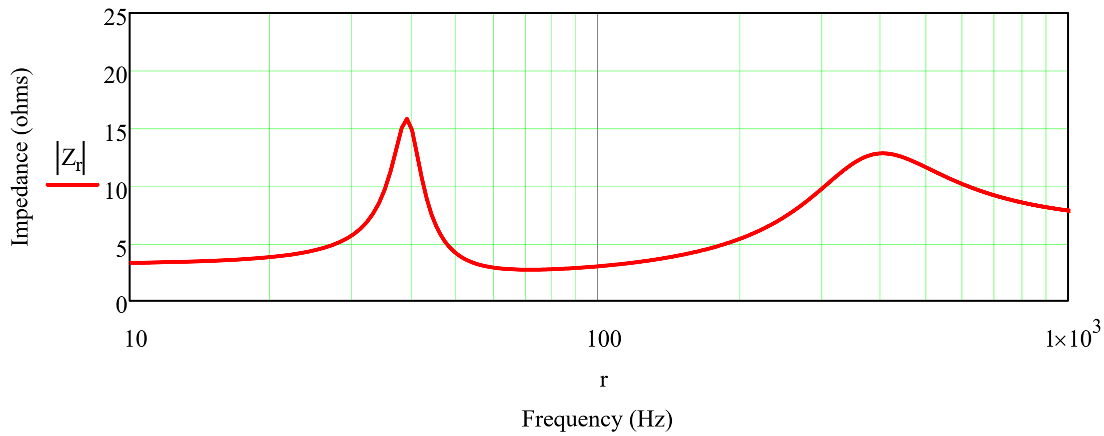


End of Detailed Input

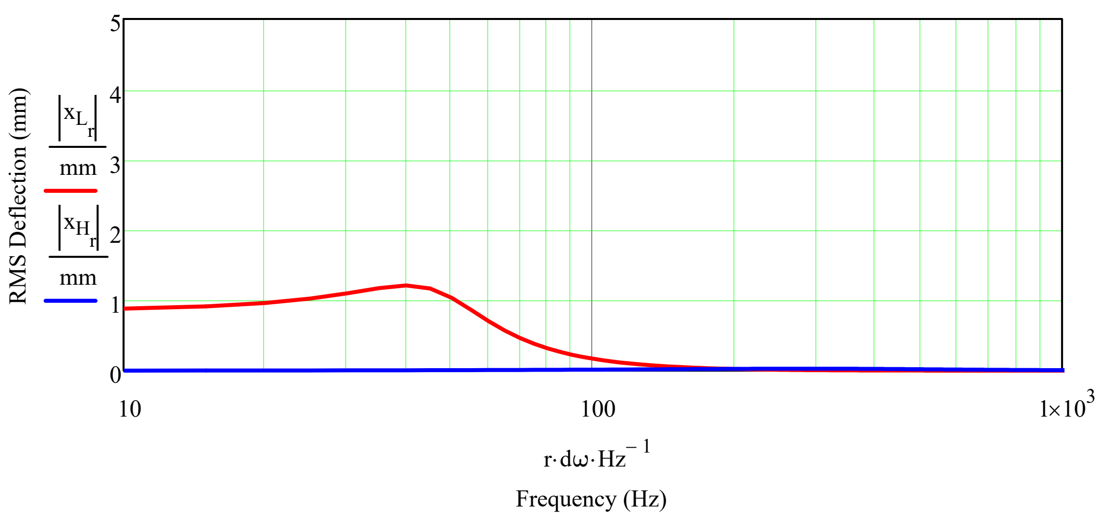
End of Part 1 Input

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

$X_0 := 2 \cdot ft$	(Front Baffle Distance from Rear Wall > Depth of Enclosure)
$Y_0 := 1.5 \cdot ft$	(Front Baffle Distance from Side Wall)
$\theta_0 := 45 \cdot deg$	(Rotation Towards Room Center)
$\theta_1 := 10 \cdot deg$	(Rotation Back of Baffle)
$Z_0 := 8 \cdot ft$	(Floor to Ceiling Distance)
$stand := 0 \cdot in$	(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	
$y_{o_0} := 20 \cdot in$		(Bottom Right Corner)
$y_{o_1} := 20 \cdot in$	$z_{o_1} := 46 \cdot in$	(Top Right Corner)
$y_{o_2} := 0 \cdot in$	$z_{o_2} := 46 \cdot in$	(Top Left Corner)
$y_{o_3} := 0 \cdot in$		(Bottom Left Corner)

Extended Range Driver Geometry Input

$y_{dc} := 14 \cdot in$	(Driver Center y Coordinate)
$z_{dc} := 23 \cdot in$	(Driver Center z Coordinate)
$n\_high := 8$	(Number of Points Across Diameter)

Woofer Driver Geometry Input

$y_{w1} := 10 \cdot in$	(Lower Driver Center y Coordinate)
$z_{w1} := 9 \cdot in$	(Lower Driver Center z Coordinate)
$y_{w2} := 10 \cdot in$	(Upper Driver Center y Coordinate)
$z_{w2} := 37 \cdot in$	(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)
$\text{radius} := 3\cdot\text{m}$	(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, -80 deg < θ < 80 deg)
$z_p := 38\cdot\text{in}$	(Default Height is Equal to Driver Height)
n_listen = 1	(Listening Position Relative to the Room Corner)
$X_p := 10\text{ft}$	
$Y_p := 7\cdot\text{ft}$	
$Z_p := 38\cdot\text{in} + \text{stand}$	(Default Height is Equal to Driver Height)
n_listen := 0	(Method Selection)

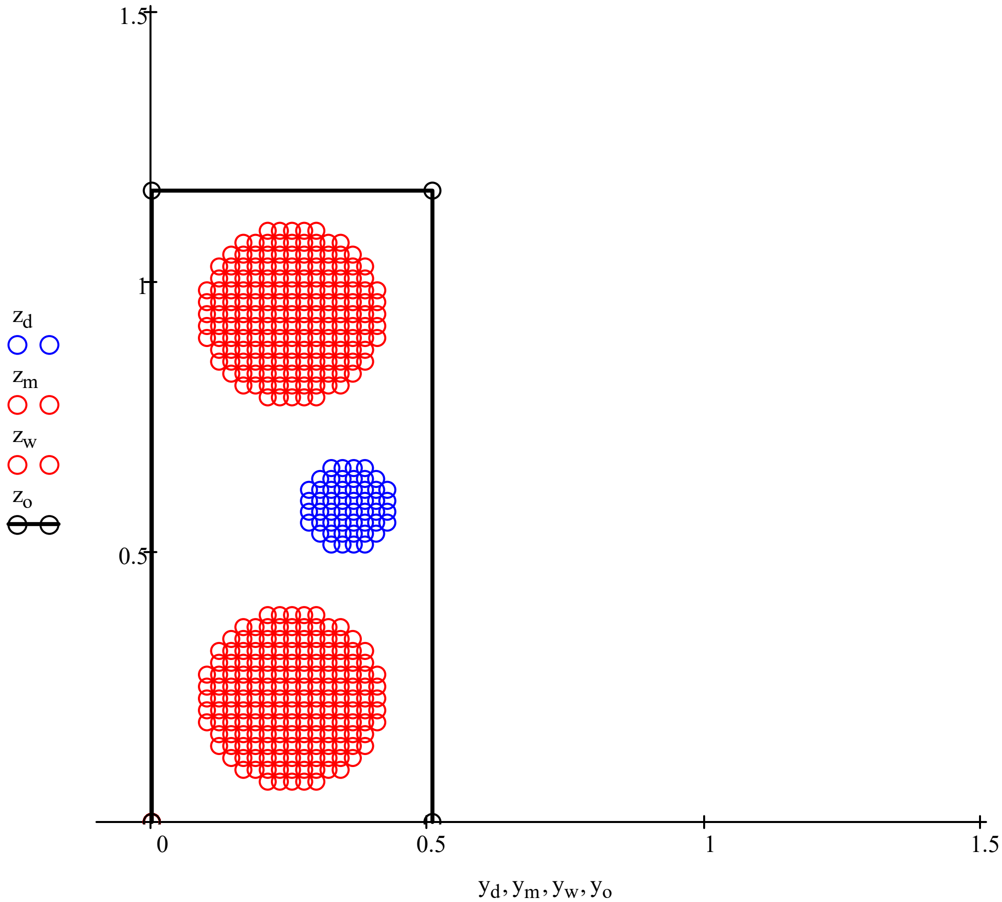
Floor Condition

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

Refective 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

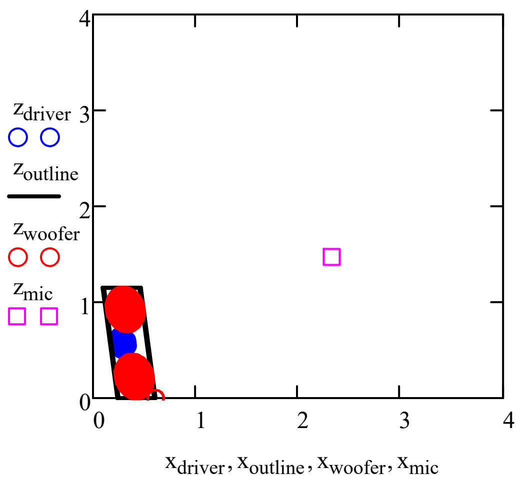


Three Dimensional View

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

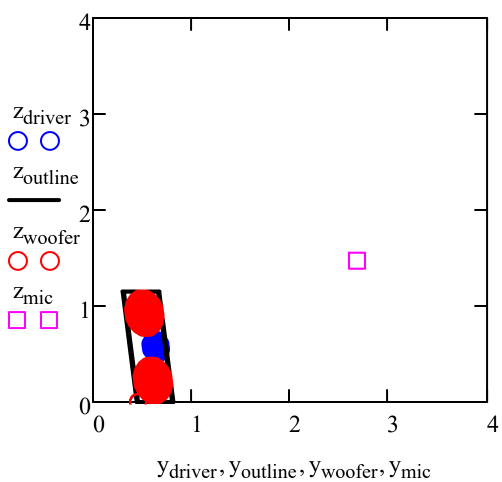
Room Corner is the Origin

Side view



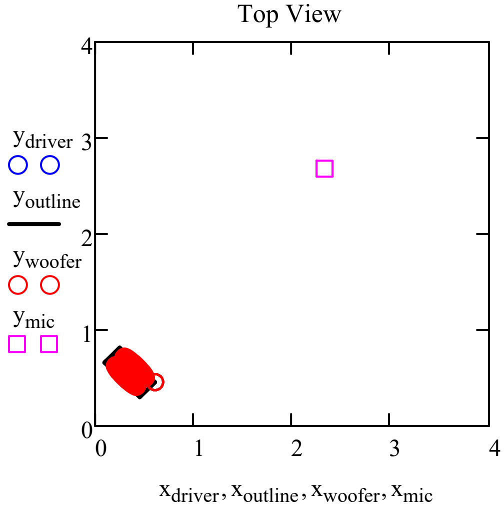
Side View - looking out from side wall

Front View



Front View - looking towards rear wall

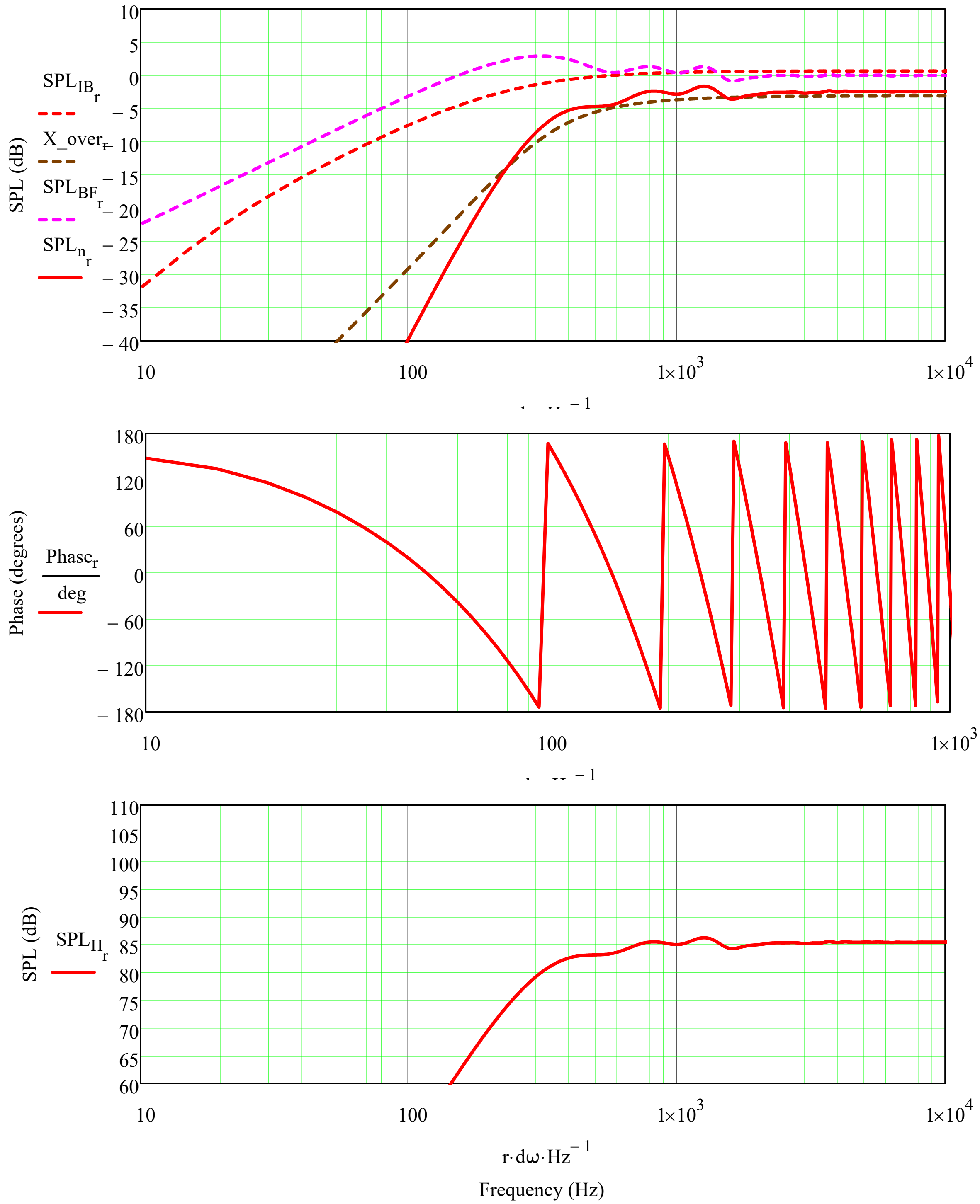
Top View



Top View - looking down from ceiling

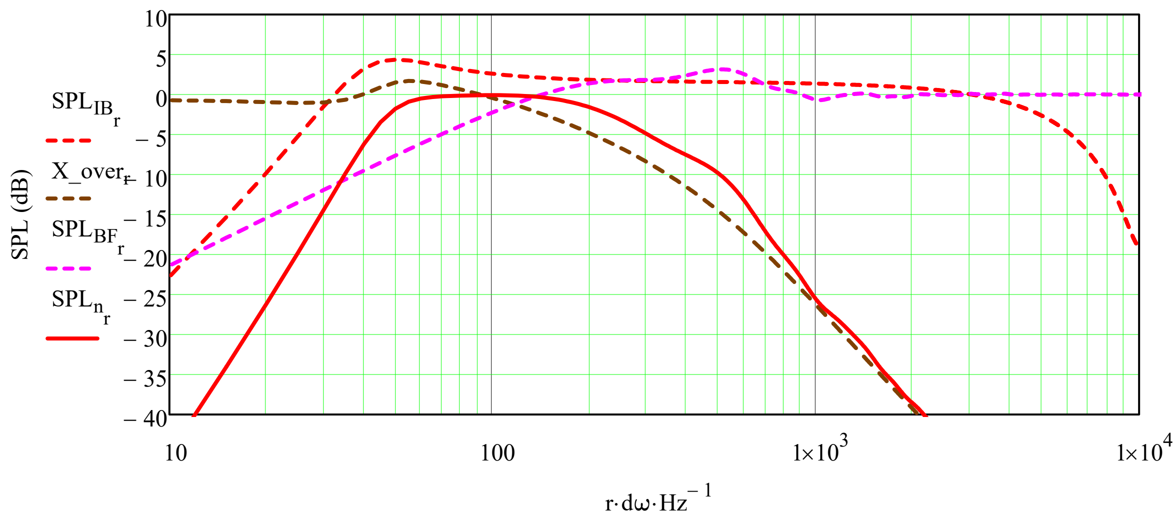
Plotted Response for the Extended Range Driver

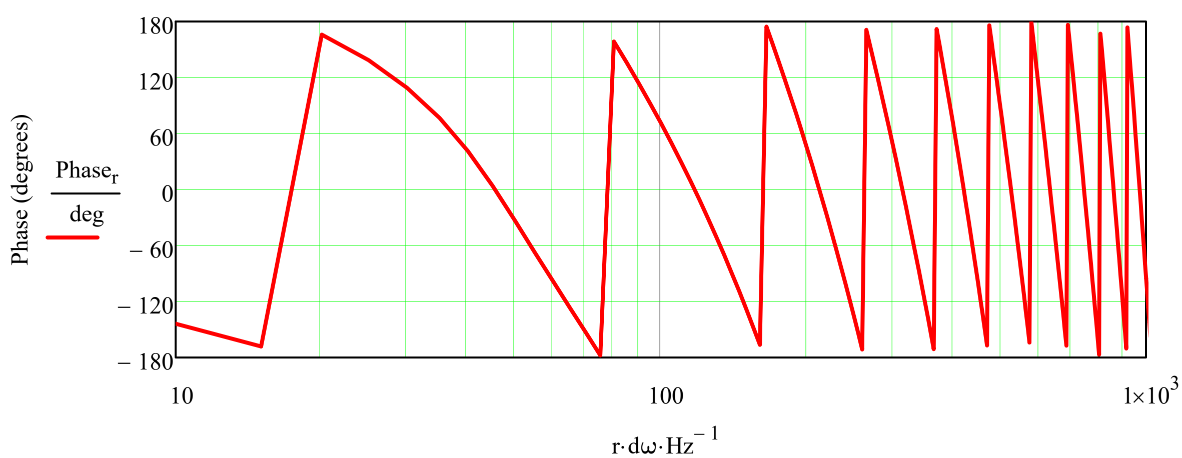
Dashed Red - Infinite Baffle Response
Dashed Magenta - Baffle Response
Dashed Brown - Crossover Response
Solid Red - Combined Response

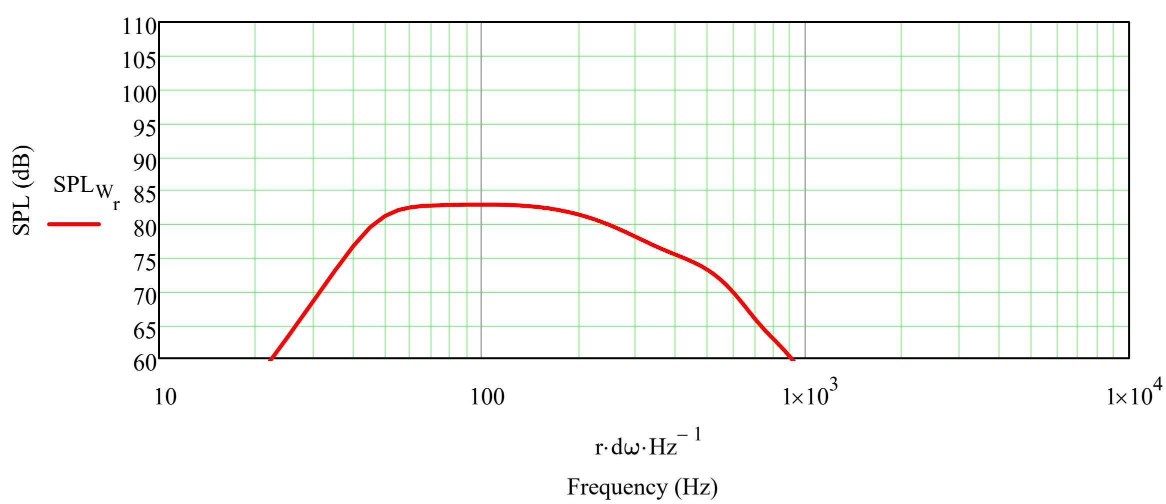


Plotted Response for the Lower Woofer Driver

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

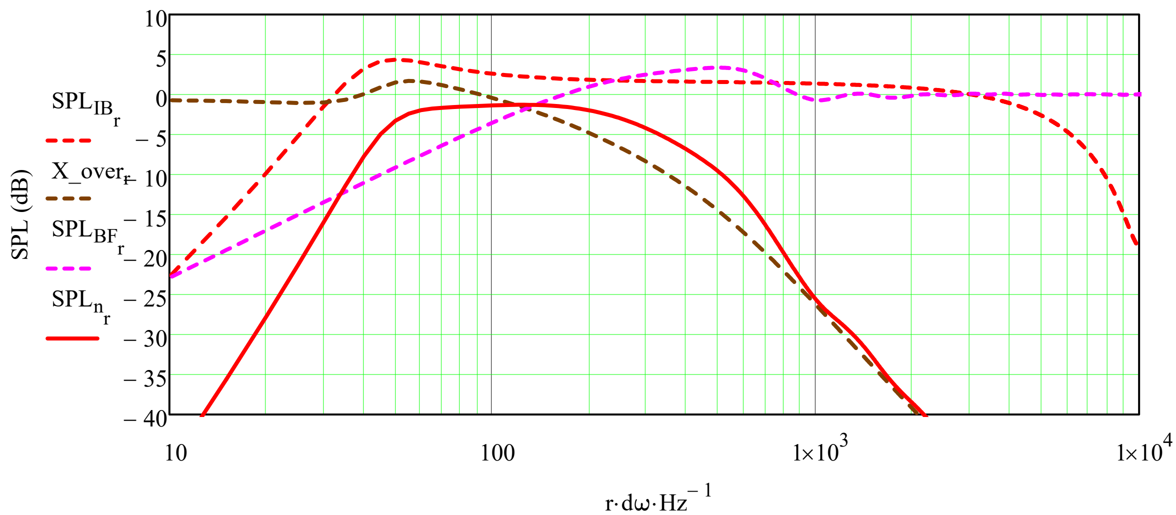


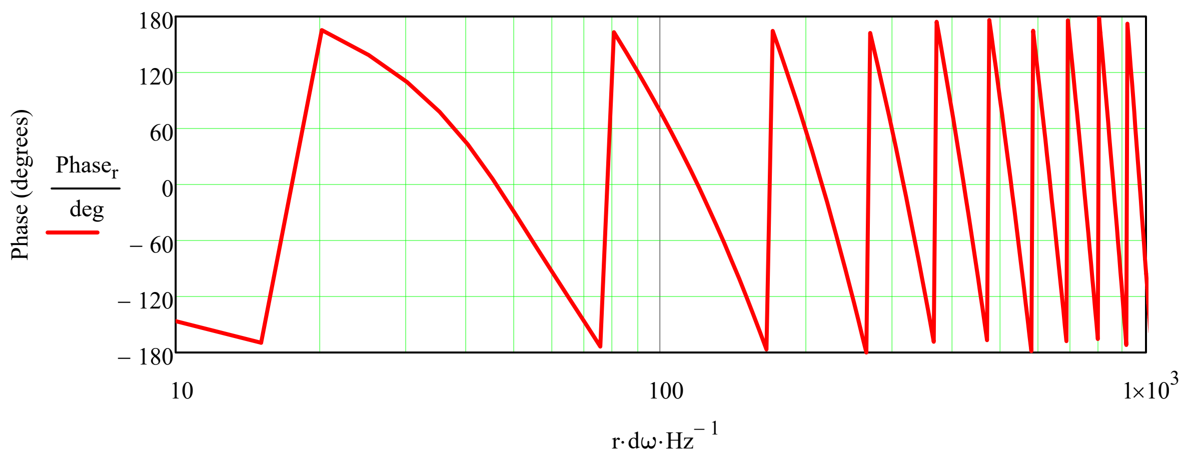


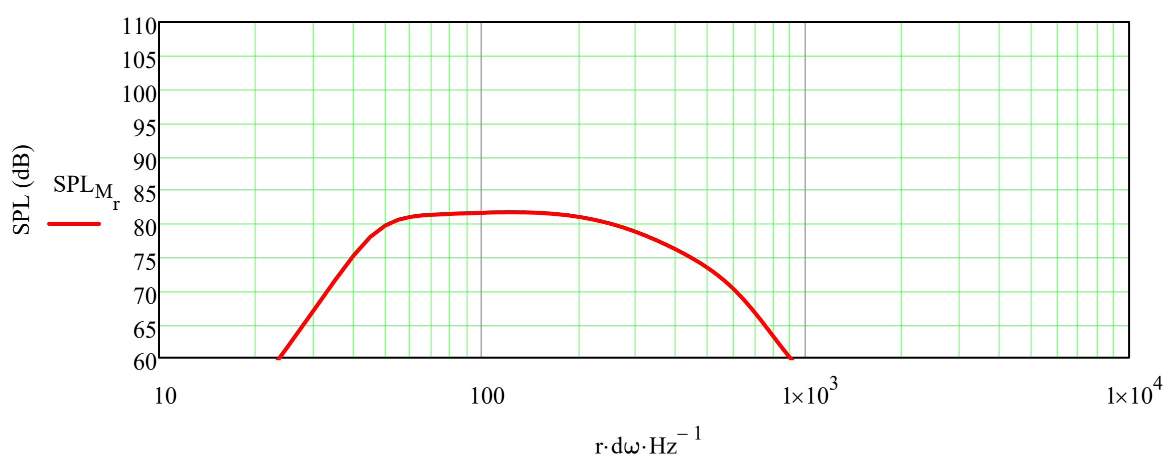


Plotted Response for the Upper Woofer Driver

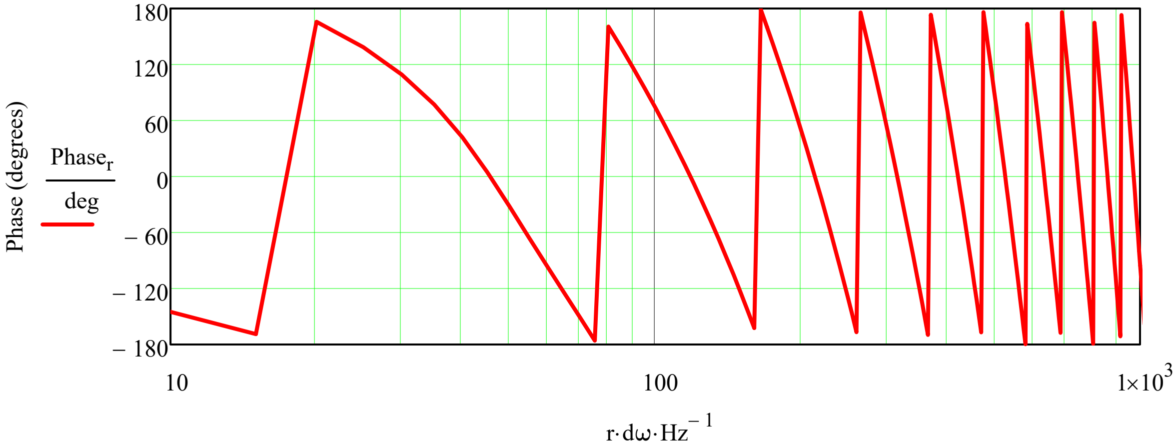
Dashed Red - Infinite Baffle Response
Dashed Magenta - Baffle Response
Dashed Brown - Crossover Response
Solid Red - Combined Response

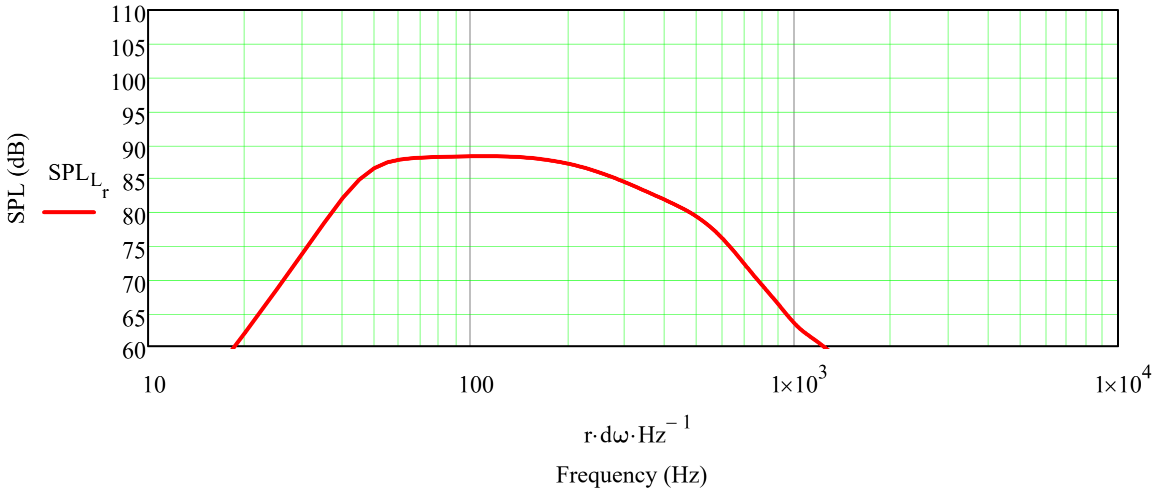




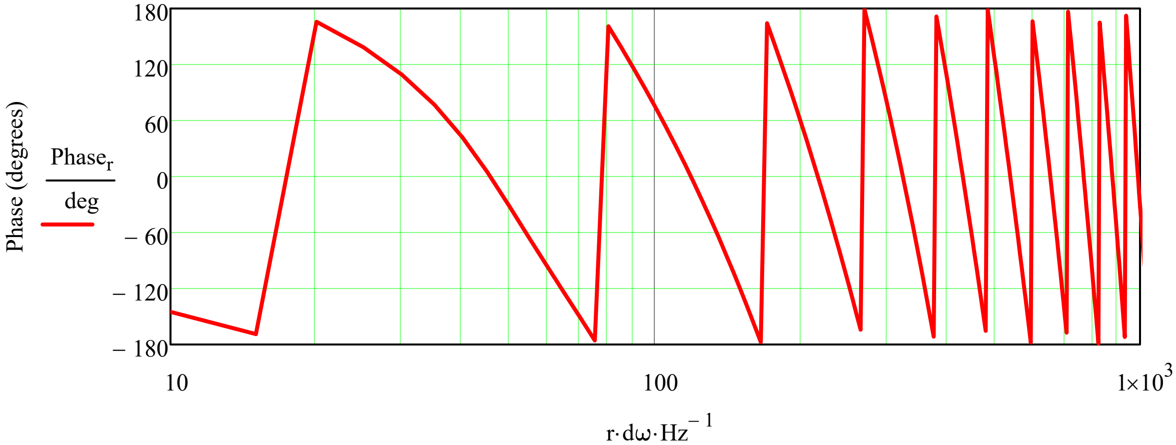


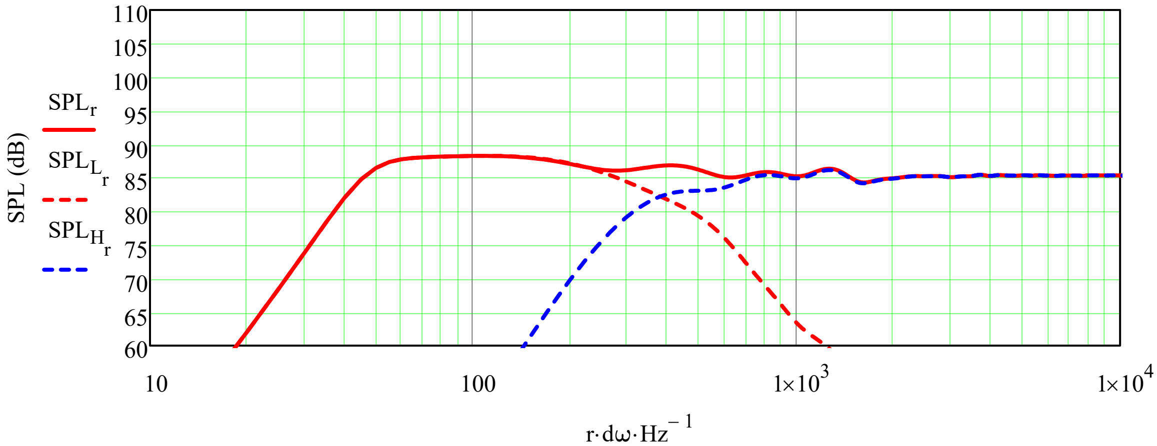
Plotted Combined Response for the Woofer Drivers



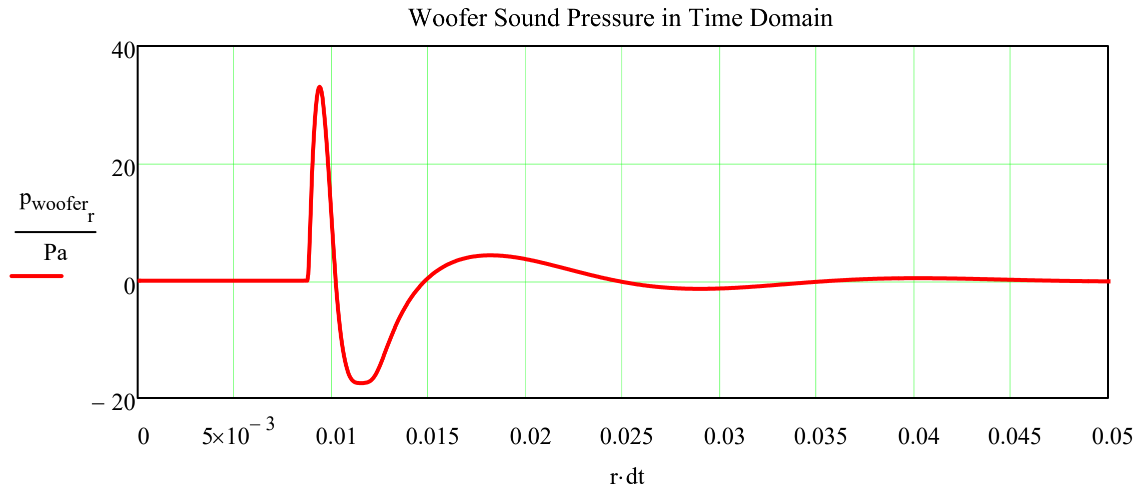


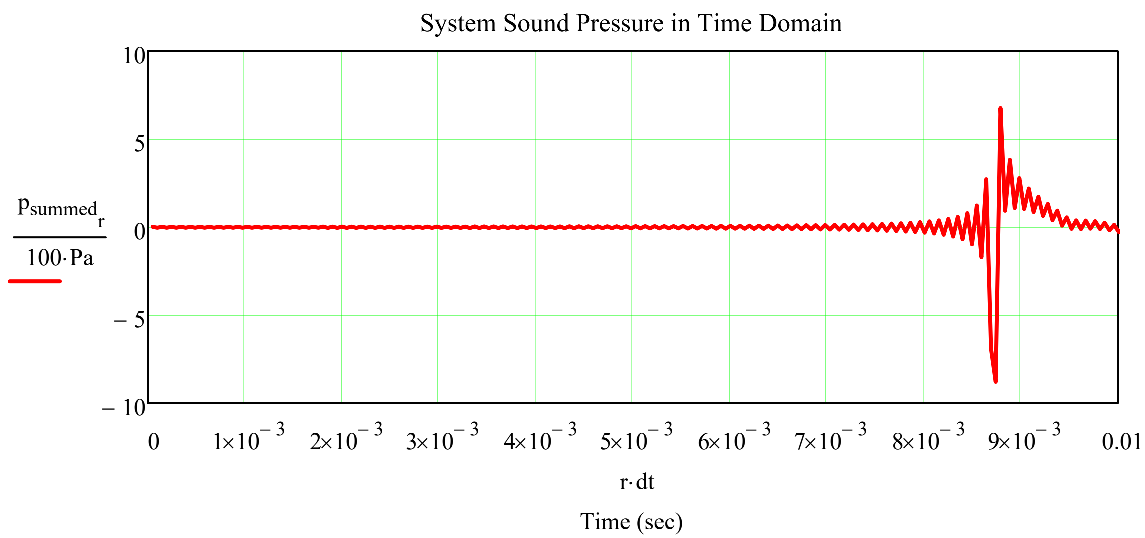
Plotted System Response for the Extended Range/Dual Woofer Open Baffle Design





System Time Response for an Impulse Input





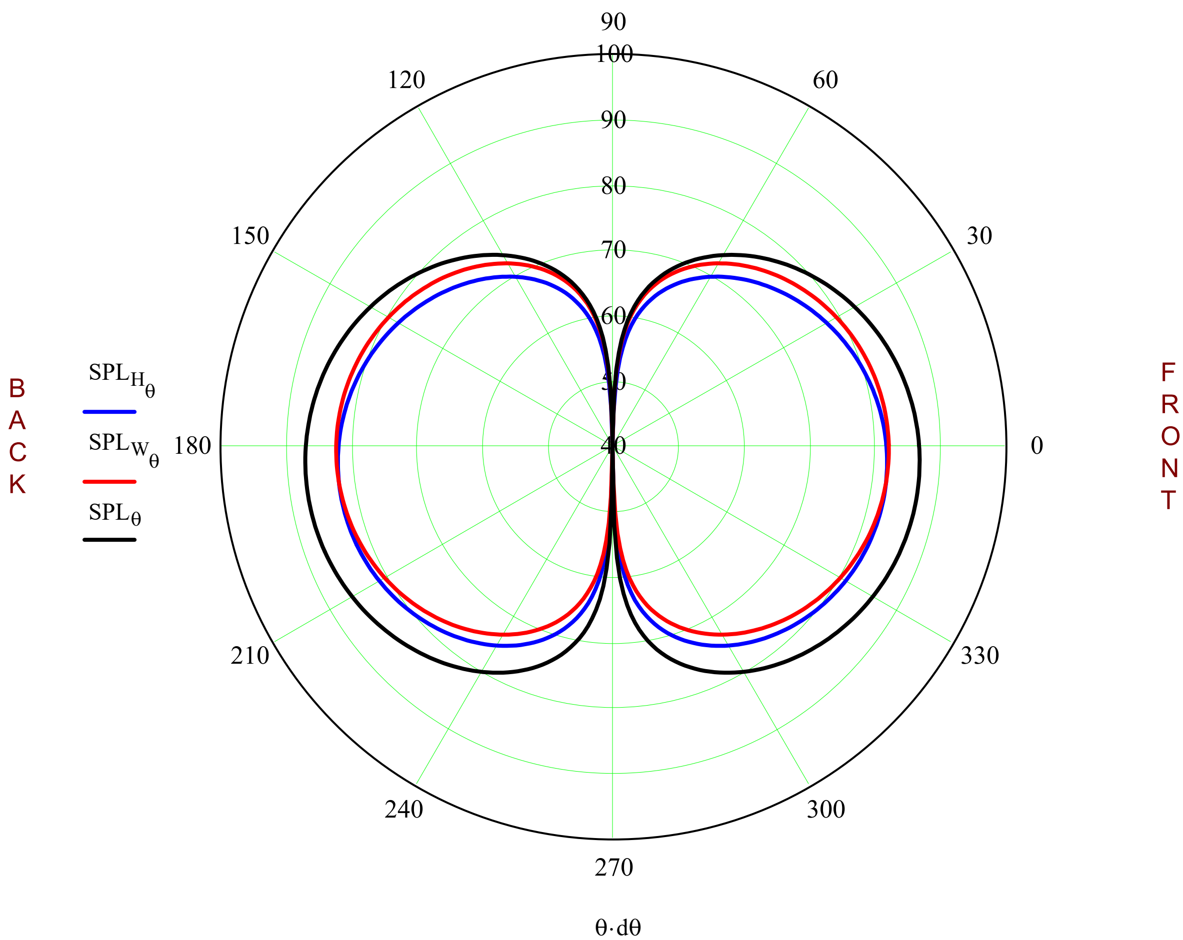
Anechoic Horizontal Polar Response - Free Space

Radius and Frequency Inputs

$radius := 3 \cdot m$ (Calculation Radius Along the Driver's Axis)

$\omega := 375 \cdot Hz$ (Calculation Frequency : 10 Hz < ω < 10000 Hz where ω must be an Integer Value)

TOP VIEW



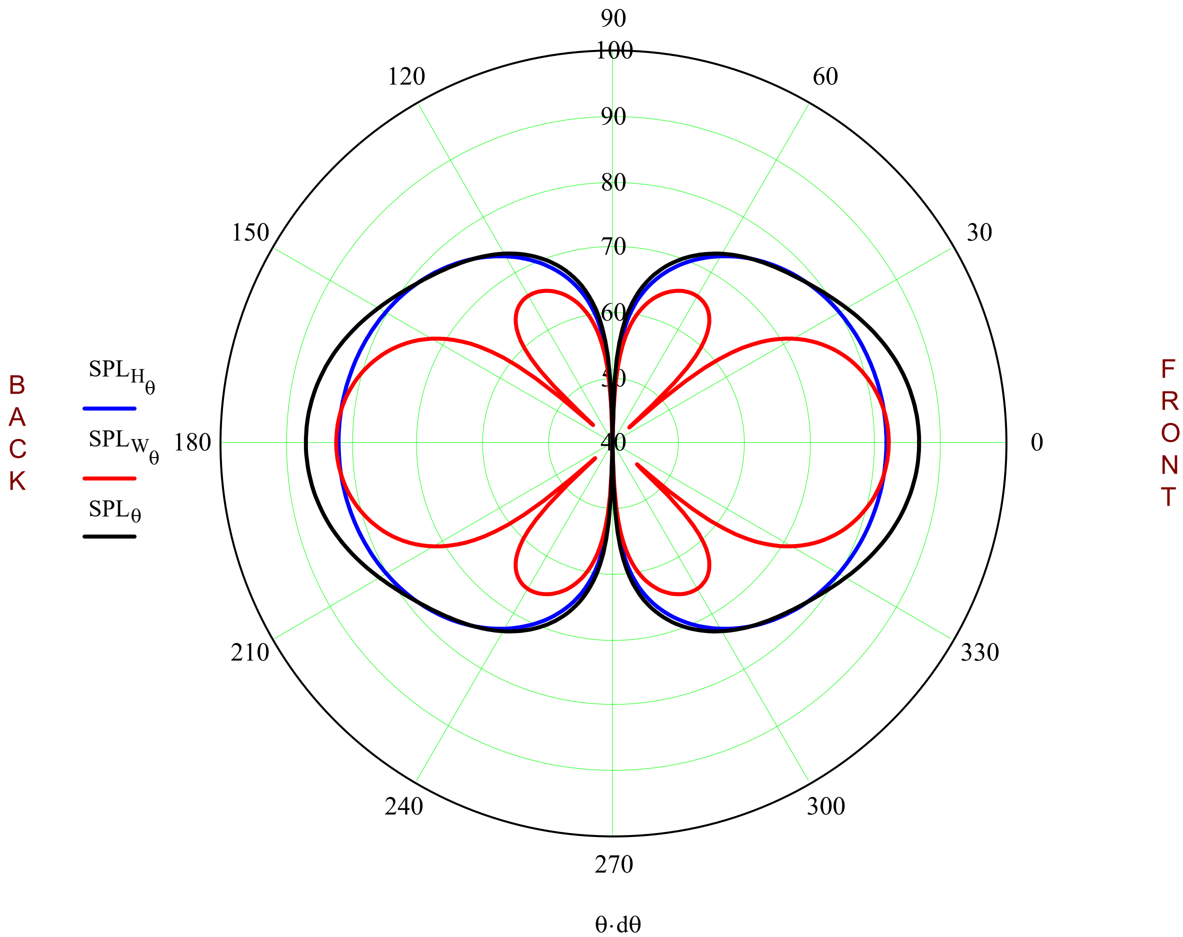
Anechoic Vertical Polar Response - Free Space

Radius and Frequency Inputs

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

ω := 375·Hz (Calculation Frequency : 10 Hz < ω < 10000 Hz where ω must be an Integer Value)

SIDE VIEW

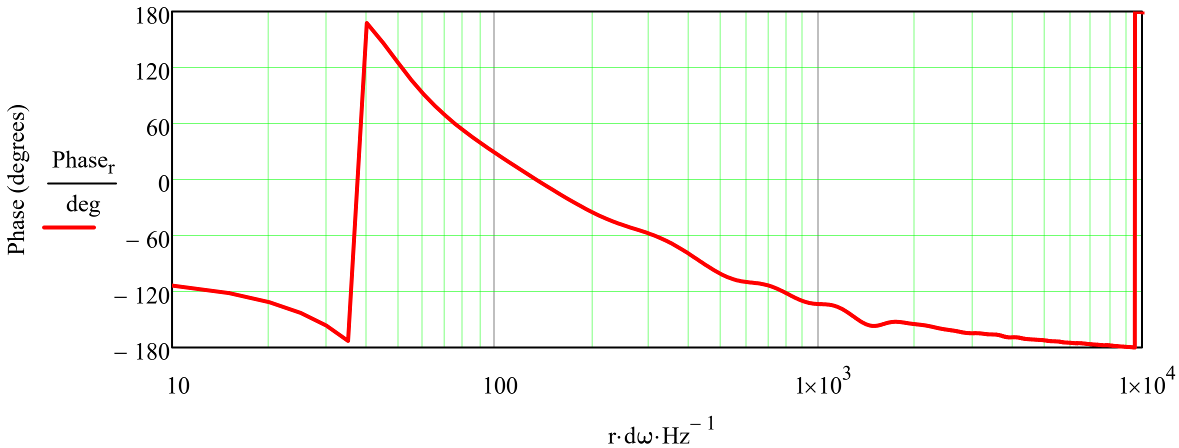


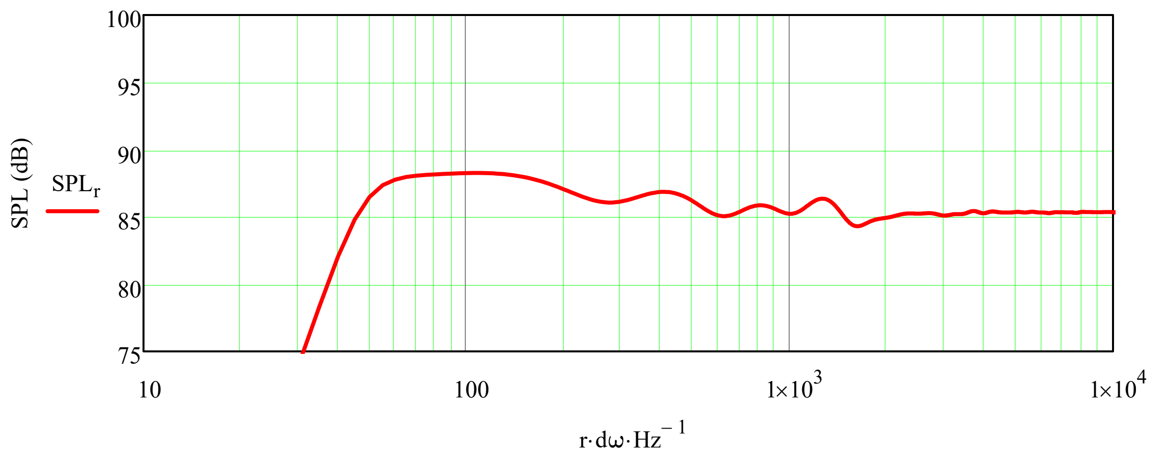
System (no subscript)

$$radius := 3.0 \cdot m$$

$$System_r := \left(Driver_r + Midrange_r + Woofer_r\right) \cdot \exp\left(j \cdot \frac{r \cdot d\omega}{c} \cdot radius\right)$$

$$SPL_r := 20 \cdot \log\left(\left|\frac{System_r}{2 \cdot 10^{-5} \cdot Pa}\right|\right) \qquad Phase_r := \arg\left(System_r\right)$$





Frequency (Hz)