Driver in a U Frame Transmission Line - Acoustic and Electrical Response

8/10/13

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

Line Configuration : Near End Open -> Driver in the Line -> Far End Open

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

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

Woofer Series Resistance

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

Input Power

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

Extended Range Driver Thiele / Small Parameters : Peerless TC9FD18-08 Measured parameters

$f_d := 131 \cdot Hz$ $V_{ad} := 1.13 \cdot liter$

$R_e := 6.45 \cdot \Omega$ $Q_{ed} := 1.61$

$L_{vc} := 0.119 \cdot mH$ $Q_{md} := 2.45$

$Bl := 2.85 \cdot \frac{newton}{amp}$ $Q_{td} := \left(\frac{1}{Q_{ed}} + \frac{1}{Q_{md}} \right)^{-1}$

$S_d := 36.3 \cdot cm^2$ $Q_{td} = 0.972$

Bass Driver Thiele / Small Parameters : QTX 902-539 15" woofer (measured)

$f_d := 33.2 \cdot Hz$ $V_{ad} := 228 \cdot liter$

$R_e := 5.72 \cdot \Omega$ $Q_{ed} := 1.42$

$L_{vc} := 0.893 \cdot mH$ $Q_{md} := 4.01$

$Bl := 9.07 \cdot \frac{newton}{amp}$ $Q_{td} := \left(\frac{1}{Q_{ed}} + \frac{1}{Q_{md}} \right)^{-1}$

$S_d := 830 \cdot cm^2$ $Q_{td} = 1.049$

Adjustments

$R_e := R_e + R_{add}$

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

U Frame Enclosure Geometry Definition : Model of Internal Air Volume

$L := 180 \cdot mm$ (Total Length of the U Frame)

$S_0 := 437 \cdot mm \cdot 437 \cdot mm$ (Area of the Driver End)

$S_L := 437 \cdot mm \cdot 437 \cdot mm$ (Area of the Open End)

$Density := 0 \cdot lb \cdot ft^{-3}$ (Stuffing Density : 0 lb/ft^3 < D < 1 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

$f_{LP} := 110 \cdot Hz$ (Filter Frequency)

$LP_{order} := 2$ (Filter Order : 0, 1, 2, 3, or 4)

$LP_{type} := 1$ (Filter Type : 1, 2, 3, or 4 for even order only, for odd order this entry is ignored)

High Pass Filter

$f_{HP} := 285 \cdot Hz$ (Filter Frequency)

$HP_{order} := 3$ (Filter Order : 0, 1, 2, 3, or 4)

$HP_{type} := 1$ (Filter Type : 1, 2, 3, or 4 for even order only, for odd order this entry is ignored)

Crossover Phase Connection

$LP_{phase} := 1$ (Phase : 1 = in phase, -1 = out of phase)

$HP_{phase} := 1$ (Phase : 1 = in phase, -1 = out of phase)

Low Frequency Boost

$LP_{boost} := 4.0$ dB

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

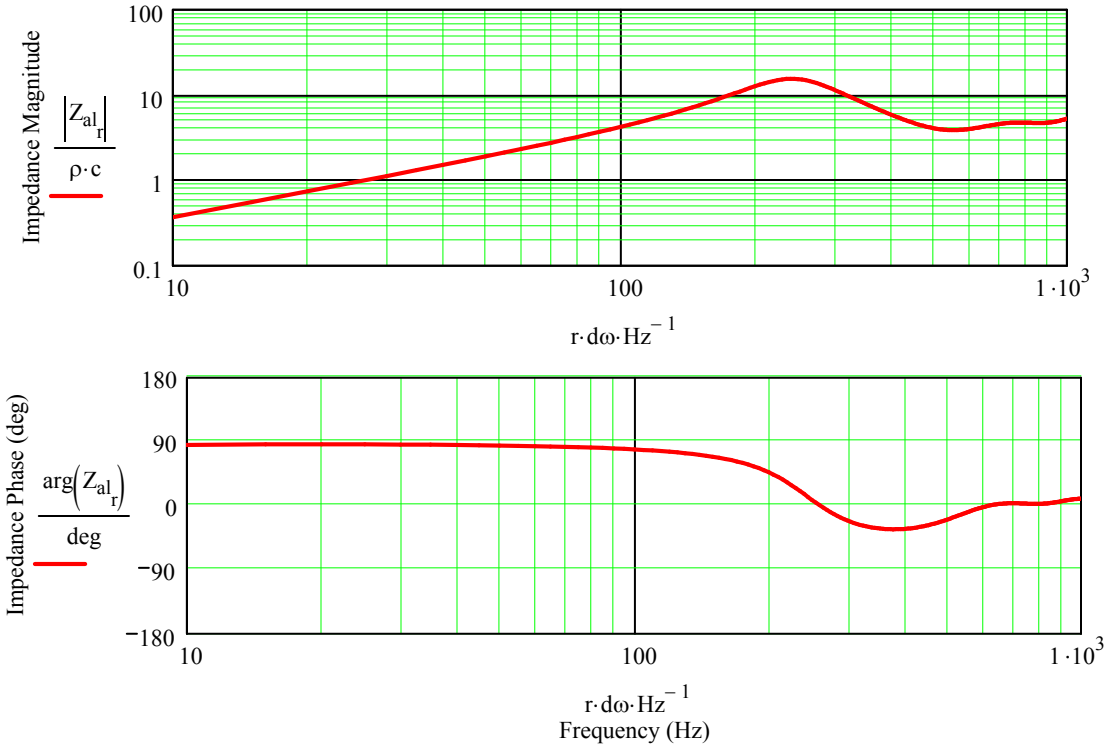
$f_{sub} := 20 \cdot Hz$ (Filter Frequency)

$SHP_{order} := 0$ (Filter Order : 0, 1, 2, 3, or 4)

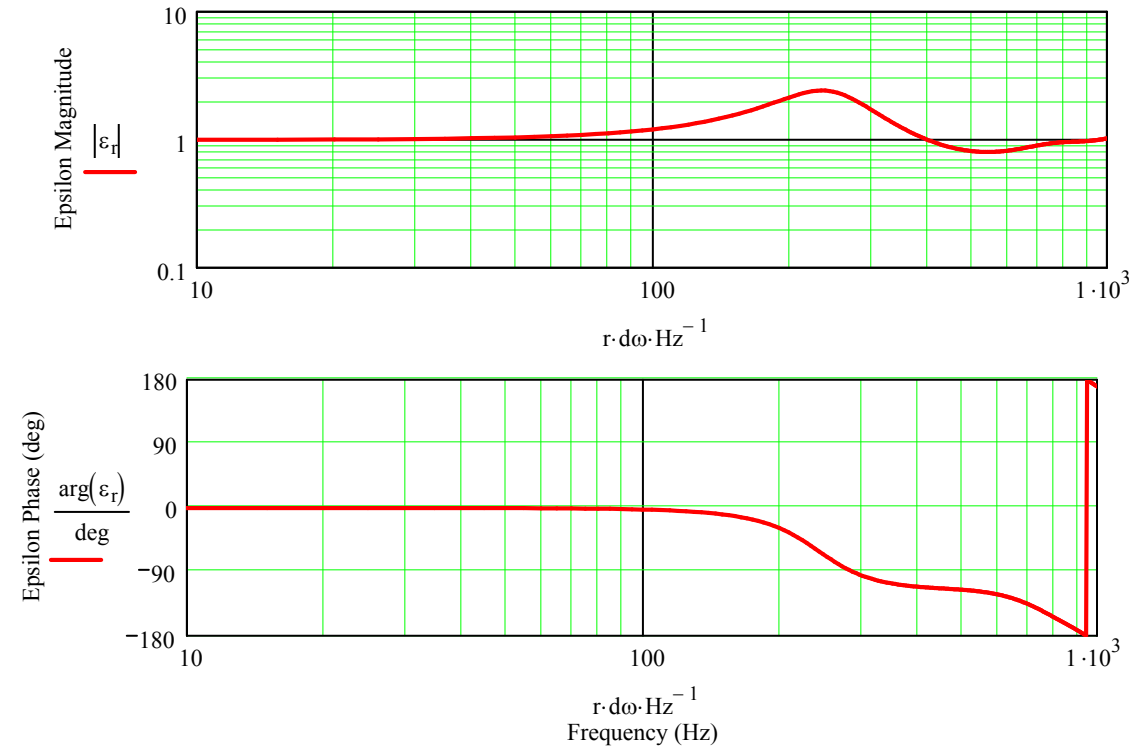
$SHP_{type} := 4$ (Filter Type : 1, 2, 3, or 4 for even order only, for odd order this entry is ignored)

End of Abbreviated User Input

Resulting Acoustic Impedance for the U Frame

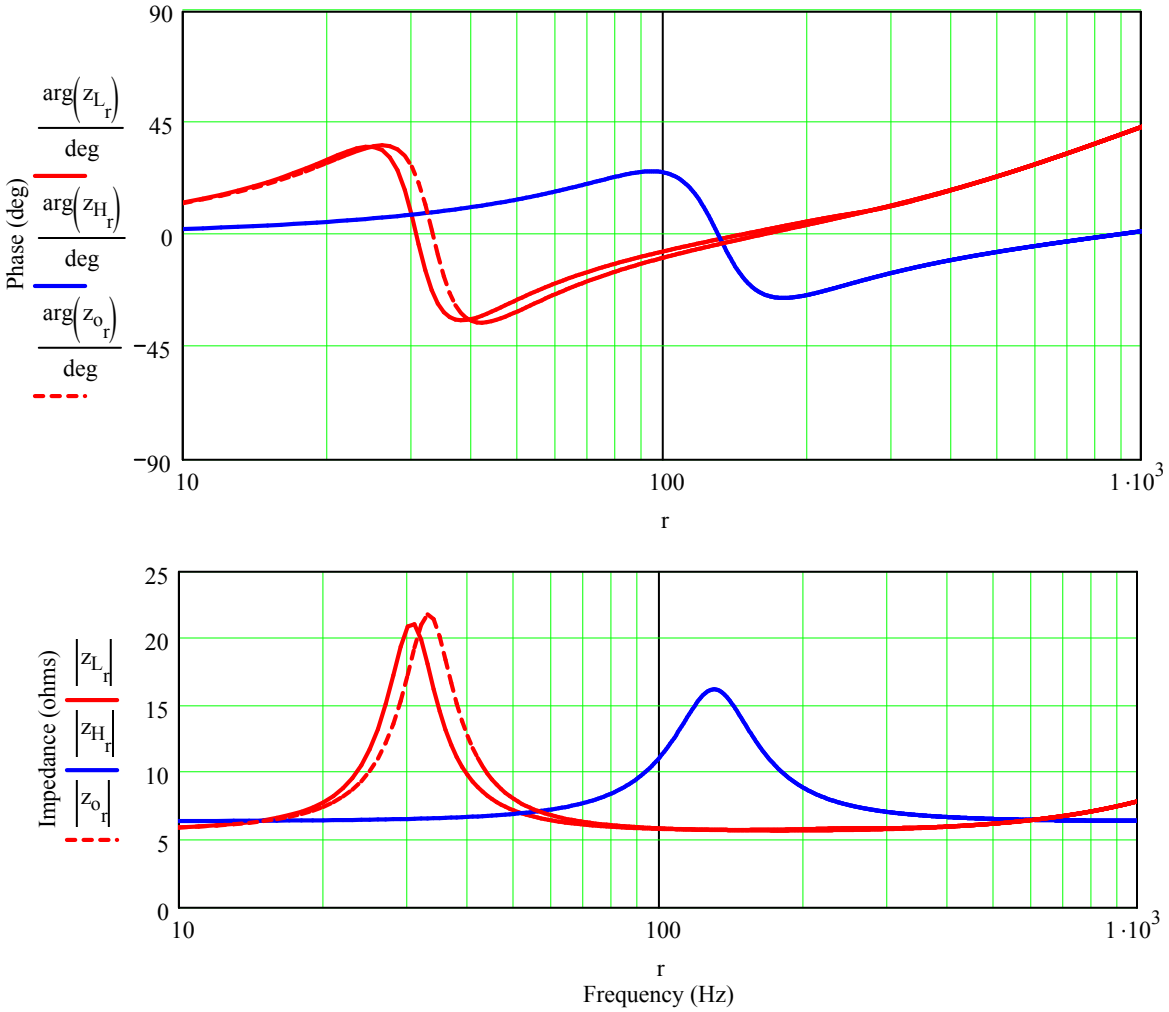


Velocity at the Terminus of the U Frame for a 1 m/sec Excitation at the Driver



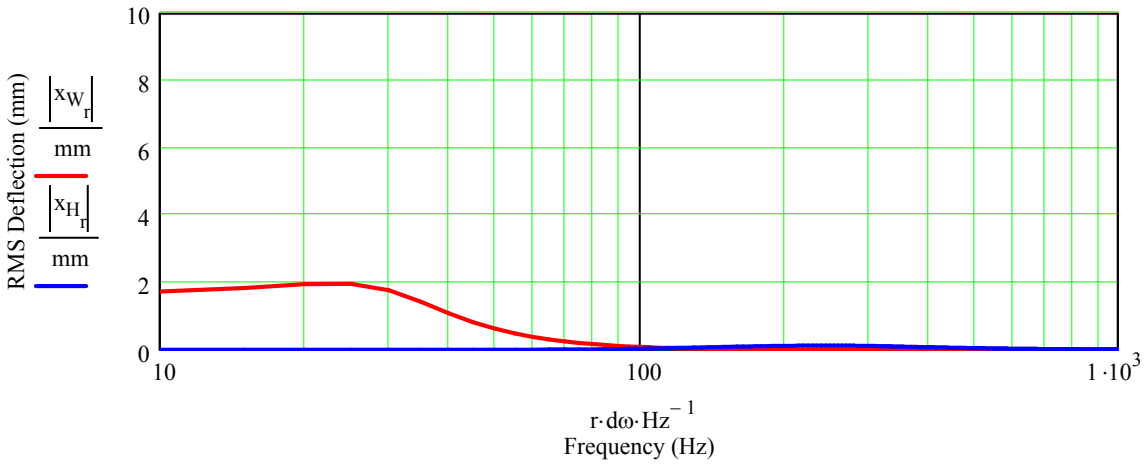
U Frame and Extended Range Driver Impedance

Solid Red is the U Frame Impedance
Solid Blue is the Extended Range Driver Impedance
Dashed Red is the Woofer Infinite Baffle Impedance



Driver RMS Displacements

Solid Red is the U Frame Woofer Response
Solid Blue is the OB Driver Response



Part 2 : Detailed SPL Response Calculation

Calculation Includes :
Position of the Driver and the Terminus on the Baffle.
Baffle Step of the Driver and the Terminus.
Room Reflections for the Driver and the Rear Terminus.

Geometry

Coordinate System :
Origin is the lower left corner of the U Frame
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

$X_0 := 2.5 \cdot ft$ (Front Baffle Distance from Rear Wall > Depth of Enclosure)

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

$\theta_0 := 0 \cdot deg$ (Rotation Towards Room Center)

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

$stand := 30 \cdot mm$ (Height from Floor to Bottom Edge of Front Baffle)

$num\_r := 20$ (Number of Points per Unit Length of Baffle Edge)

U Frame Geometry Input

$U_{width} := 472 \cdot mm$ (U Frame External Width)

$U_{height} := 472 \cdot mm$ (U Hrame External Height)

$depth := L + 18 \cdot mm$ (U Frame External Depth)

$y_c := 236 \cdot mm$ (Terminus Center y Coordinate)

$z_c := 236 \cdot mm$ (Terminus Center z Coordinate)

$w_{mth} := 436 \cdot mm$ (Terminus Width)

$n\_mth := 10$ (Number of Points Across the Width)

Extended Range Driver OB Geometry Input

$OB_{width} := 436 \cdot mm$ (OB panel width)

$OB_{height} := 450 \cdot mm$ (OB panel height)

$y_{dc} := 245 \cdot mm$ (Driver Center y Coordinate w.r.t. lower left corner of OB)

$z_{dc} := 400 \cdot mm$ (Driver Center z Coordinate w.r.t. lower left corner of OB)

$\xi_{ob} := 0.001$ (Fraction of the Total Depth of the H Frame : 0.001 < ξ < 0.999)

$n\_high := 4$ (Number of Points Across Diameter)

Listening Position

n_listen = 0 (Listening Position Relative to Speaker)

$radius := 1 \cdot m$ (Calculation Radius Along Axis of the Extended Range Driver)

$\theta := 15 \cdot deg$ (0 deg is along the Driver's Axis, -80 deg < θ < 80 deg)

$z_p := 0.9 \cdot m$ (Default Height is Equal to Seated Height)

n_listen = 1 (Listening Position Relative to the Room Corner)

$X_p := 10ft$

$Y_p := 7 \cdot ft$

$Z_p := 33 \cdot in$ (Default Height is Equal to Seated Height)

$n\_listen := 0$ (Method Selection)

Floor Condition

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

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

$Inc\_floor := 1$ (Floor, Z = 0)

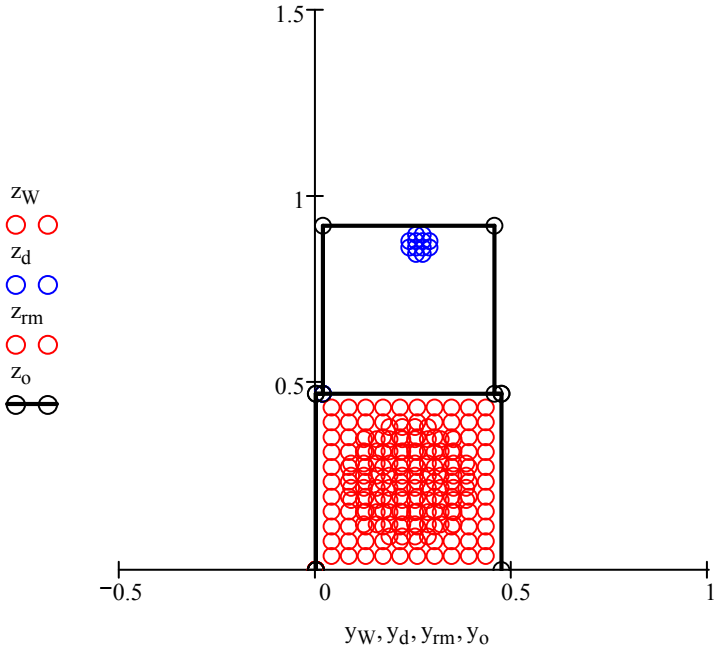
$Inc\_rear := 0$ (Rear Wall, X = 0)

$Inc\_side := 0$ (Left Side Wall, Y = 0)

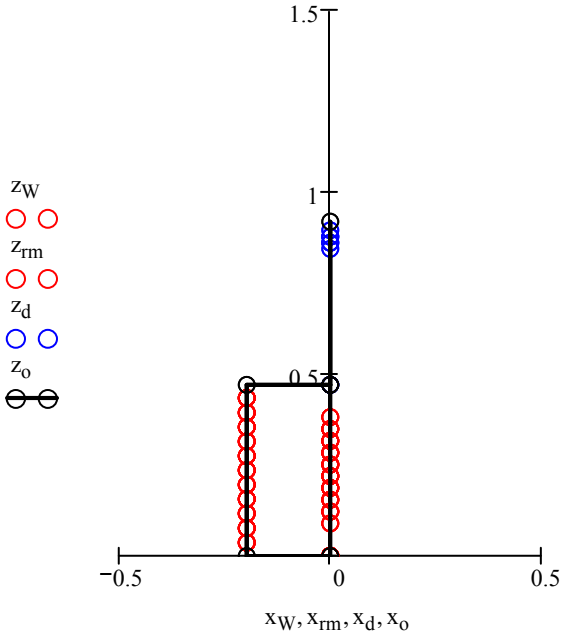
$Inc\_ceiling := 0$ (Ceiling)

U Frame and Extended Range Driver Simple Source Pattern with Baffle Edge Outline

Front View



Side View

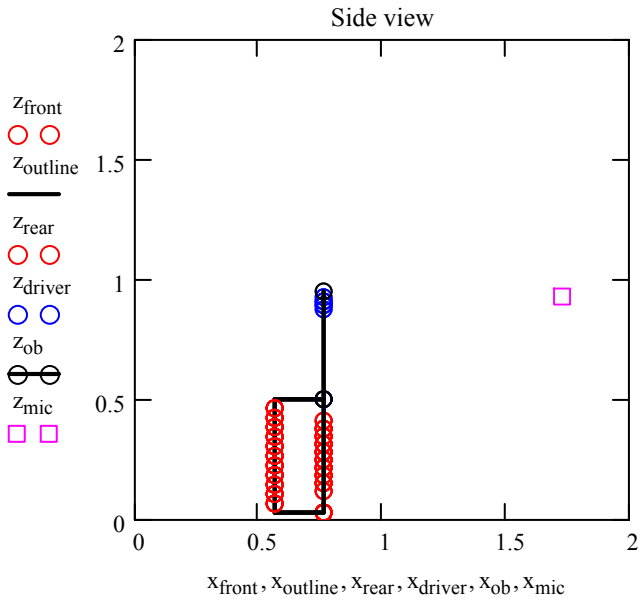


Blue sources represent extended range driver.
Red sources represent U frame driver.
Red sources represent the rear terminus.
Black outline represents the baffle edge.
Origin is at the bottom front left corner of the enclosure.

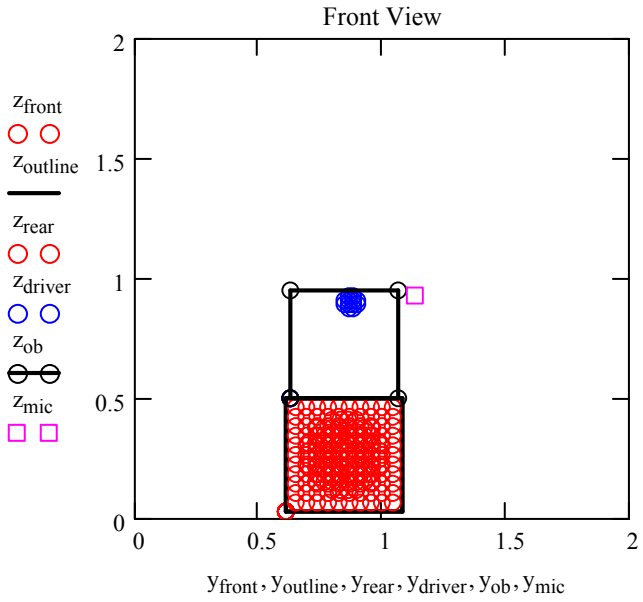
Three Dimensional View

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

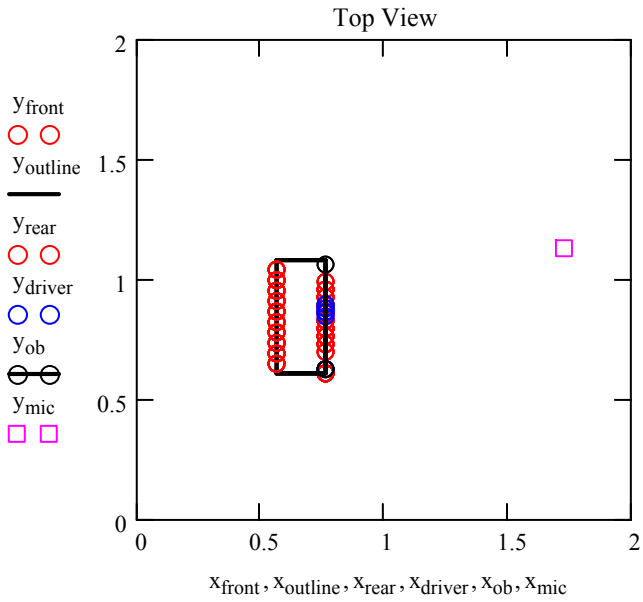
Room Corner is the Origin



Side View - looking out from side wall

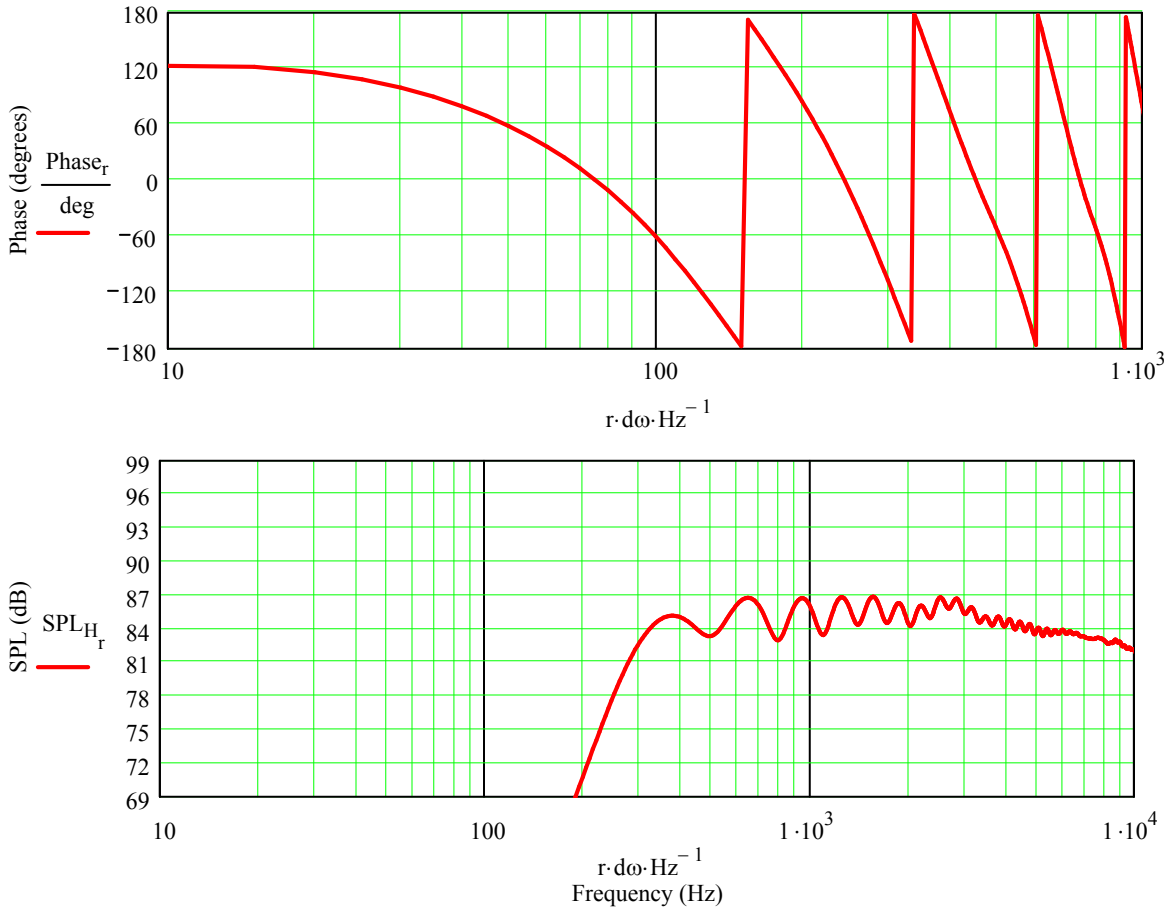


Front View - looking towards rear wall

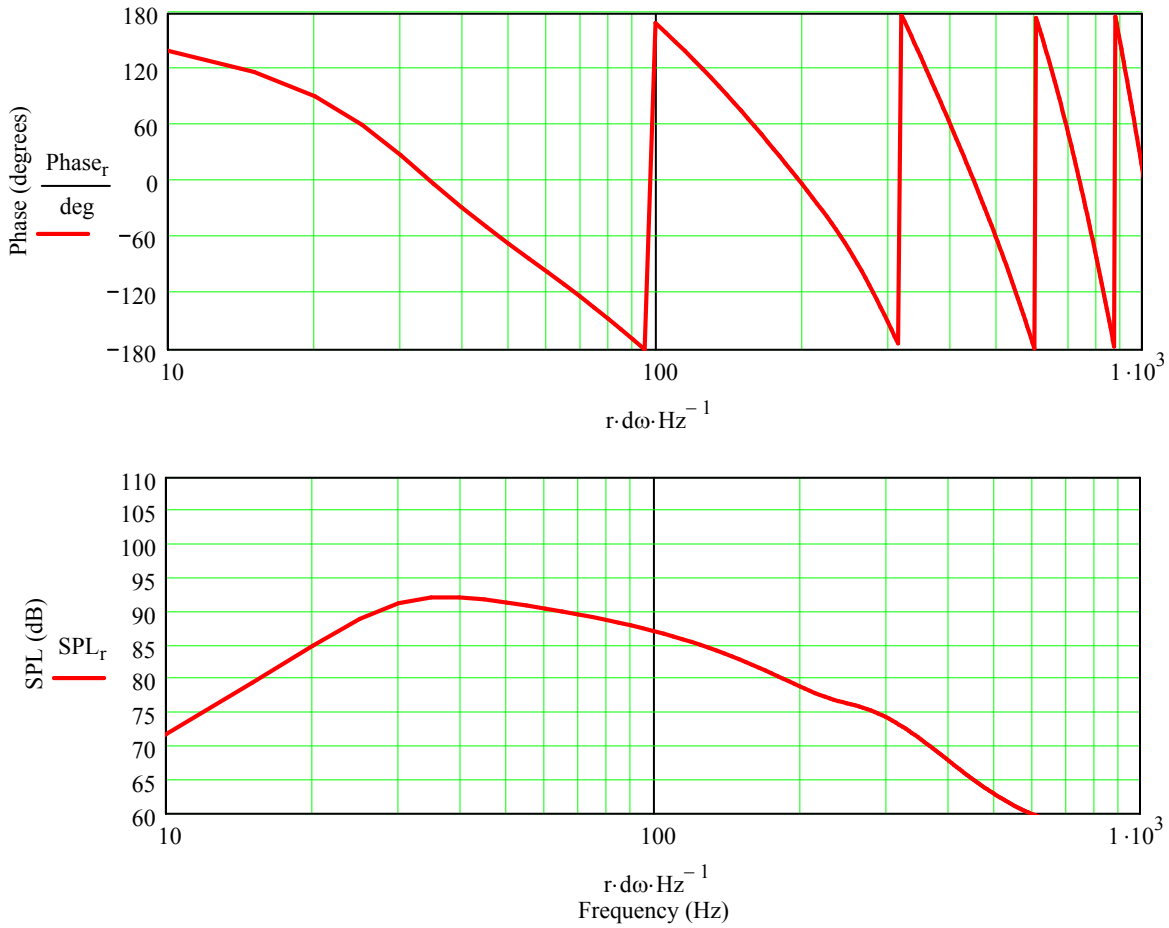


Top View - looking down from ceiling

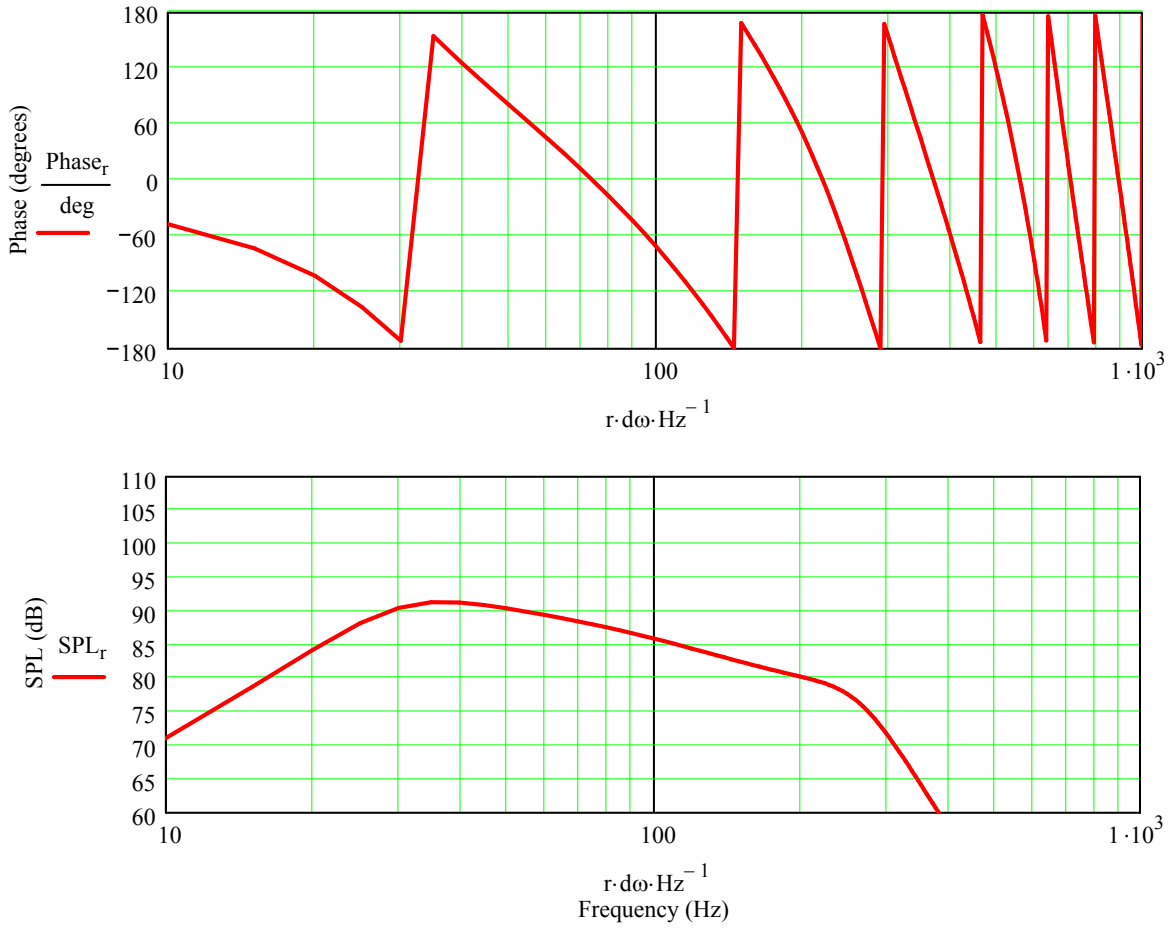
Plotted Response for the Extended Range Driver



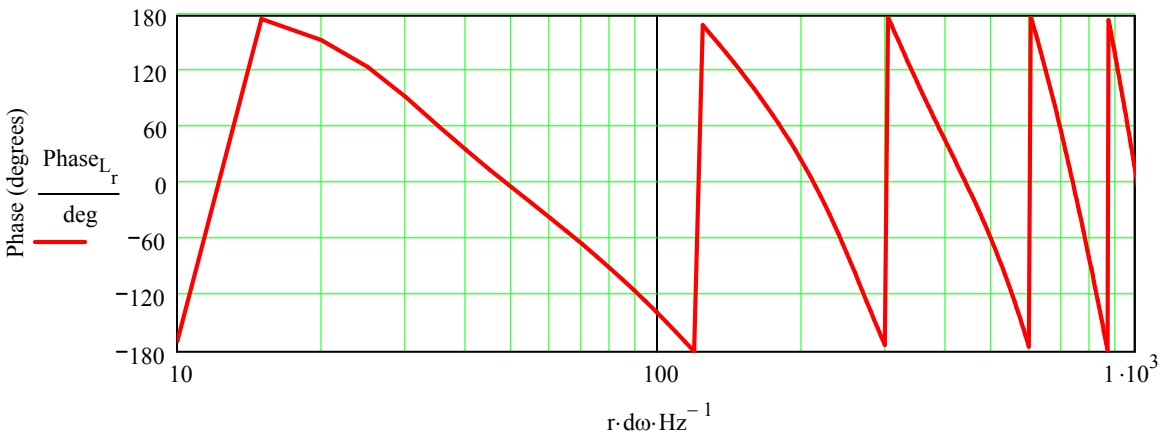
Plotted Baffle Step and Reflection SPL Response for the U Frame Driver

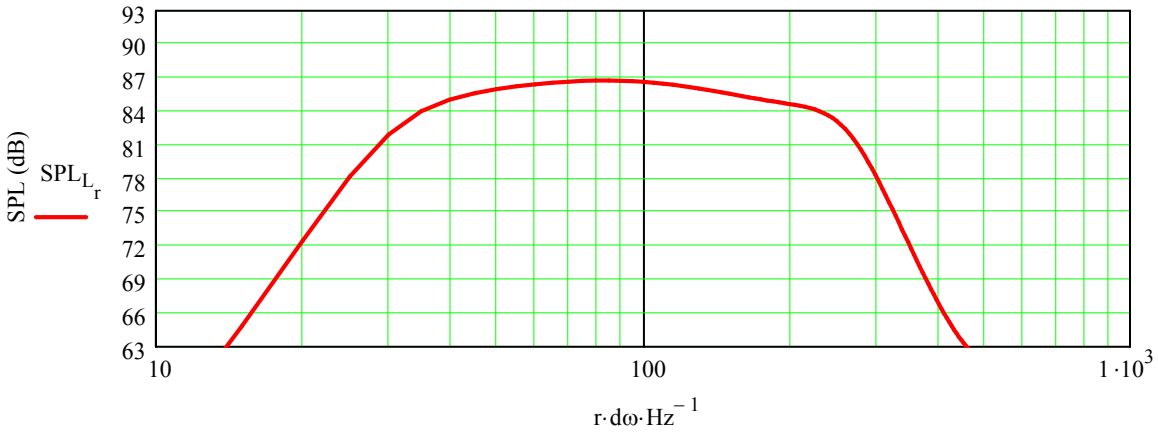


Plotted Baffle Step and Reflection SPL Response for the Rear Terminus

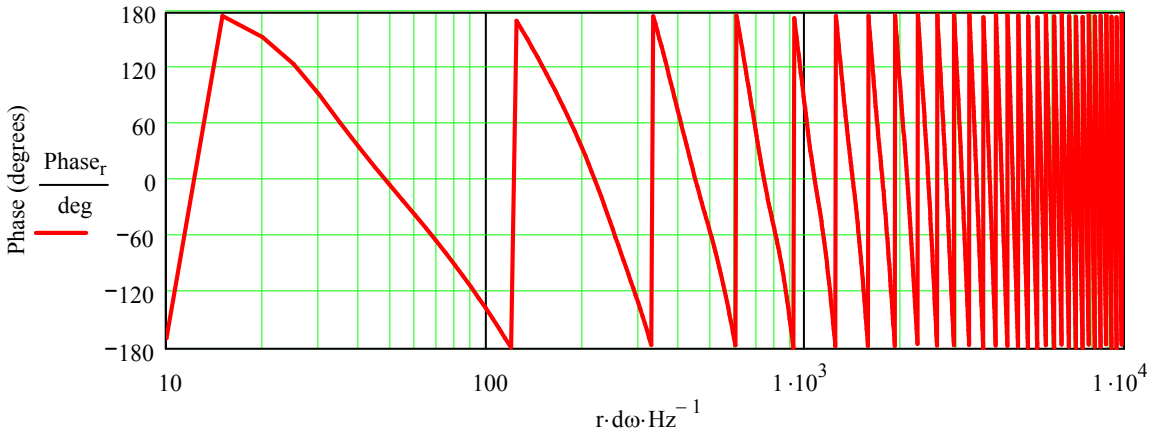


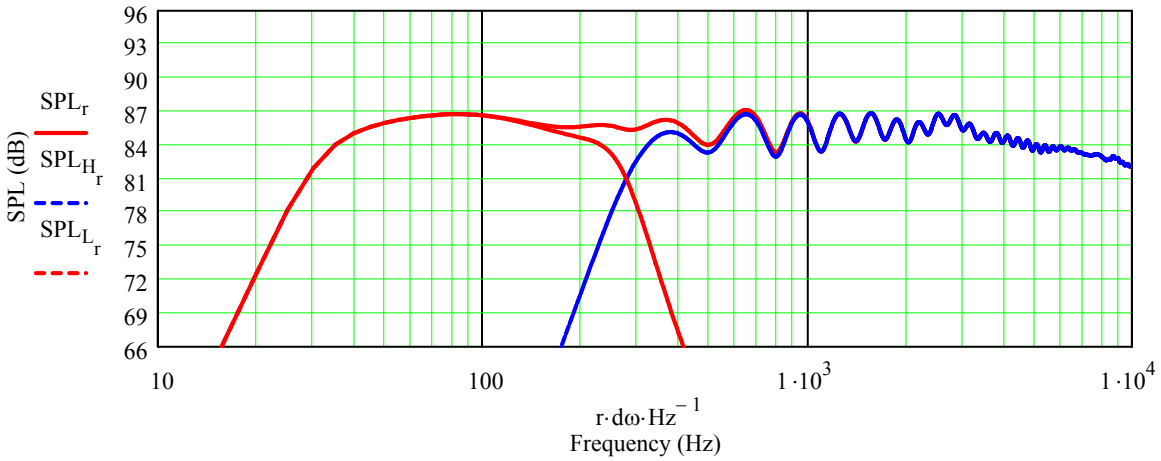
Plotted SPL Response for the U Frame





Plotted SPL Response for the System





System Time Response for an Impulse Input