Driver in a Ported Transmission Line - Acoustic and Electrical Response

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Unit and Constant Definition

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

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

Air Density : $\rho := 1.21\cdot kg\cdot m^{-3}$

Speed of Sound : $c := 342\cdot m\cdot sec^{-1}$

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

$R_{add} := 3\cdot\Omega$

Driver Thiele / Small Parameters : Lowther DX3 Average Driver Properties

$f_d := 60.5\cdot Hz$

$V_d := 41.1\cdot liter$

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

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

$L_{vc} := 0\cdot mH$

$Q_{md} := 3.83$

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

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

$S_d := 206\cdot cm^2$

$Q_{td} = 0.337$

Enclosure Geometry Definition

$L := 42\cdot in$	(Height)
$z_{driver} := 6\cdot in$	(Driver Distance From Top < Height)
$z_{port} := 38\cdot in$	(Port Distance From Top < Height)
$S_0 := 3.5\cdot S_d$	(Area of the Top End)
$S_L := 3.5\cdot S_d$	(Area of the Bottom End)
$Density := 0.25\cdot lb\cdot ft^{-3}$	(Stuffing density : 0 lb/ft^3 < D < 1 lb/ft^3)
$r_{port} := 2.0\cdot in$	(Radius of the port)
$L_{port} := 2.0\cdot in$	(Length of the port)

Ported Box Definition

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

$n\_top := 4$	$(n\_top > 1)$	$x_{top} := z_{driver}$
$n\_open := 4$	$(n\_open > 1)$	$x_{open} := z_{port} - z_{driver}$
$n\_bottom := 4$	$(n\_bottom > 1)$	$x_{bottom} := L - z_{port}$
$n\_port := 4$	$(n\_port > 1)$	$x_{port} := L_{port} + 0.6 \cdot r_{port}$

Geometry Definition

$TR := \left(S_L - S_0\right) \cdot L^{-1}$	$TR = 0\,m$
$S_D := S_0 + TR \cdot z_{driver}$	$S_D = 0.072\,m^2$
$S_P := S_0 + TR \cdot z_{port}$	$S_P = 0.072\,m^2$

Top Section of Enclosure

(Driver ---> Top of Enclosure)

Section Length	Initial Area	Final Area	Stuffing Density
$L_{c_0} := x_{top} \cdot (n\_top + 1)^{-1}$	$S_{c_{0,0}} := S_D$	$S_{c_{0,1}} := S_{c_{0,0}} - TR \cdot L_{c_0}$	$D_{c_0} := Density$
$L_{c_1} := x_{top} \cdot (n\_top + 1)^{-1}$	$S_{c_{1,0}} := S_{c_{0,1}}$	$S_{c_{1,1}} := S_{c_{1,0}} - TR \cdot L_{c_1}$	$D_{c_1} := Density$
$L_{c_2} := x_{top} \cdot (n\_top + 1)^{-1}$	$S_{c_{2,0}} := S_{c_{1,1}}$	$S_{c_{2,1}} := S_{c_{2,0}} - TR \cdot L_{c_2}$	$D_{c_2} := Density$
$L_{c_3} := x_{top} \cdot (n\_top + 1)^{-1}$	$S_{c_{3,0}} := S_{c_{2,1}}$	$S_{c_{3,1}} := S_{c_{3,0}} - TR \cdot L_{c_3}$	$D_{c_3} := Density$
$L_{c_4} := x_{top} \cdot (n\_top + 1)^{-1}$	$S_{c_{4,0}} := S_{c_{3,1}}$	$S_{c_{4,1}} := S_0$	$D_{c_4} := Density$

Open Section of Enclosure

(Driver ---> Port Position)

Section Length	Initial Area	Final Area	Stuffing Density
$L_{o_0} := x_{open} \cdot (n\_open + 1)^{-1}$	$S_{o_{0,0}} := S_D$	$S_{o_{0,1}} := S_{o_{0,0}} + TR \cdot L_{o_0}$	$D_{o_0} := Density$
$L_{o_1} := x_{open} \cdot (n\_open + 1)^{-1}$	$S_{o_{1,0}} := S_{o_{0,1}}$	$S_{o_{1,1}} := S_{o_{1,0}} + TR \cdot L_{o_1}$	$D_{o_1} := Density$
$L_{o_2} := x_{open} \cdot (n\_open + 1)^{-1}$	$S_{o_{2,0}} := S_{o_{1,1}}$	$S_{o_{2,1}} := S_{o_{2,0}} + TR \cdot L_{o_2}$	$D_{o_2} := Density$
$L_{o_3} := x_{open} \cdot (n\_open + 1)^{-1}$	$S_{o_{3,0}} := S_{o_{2,1}}$	$S_{o_{3,1}} := S_{o_{3,0}} + TR \cdot L_{o_3}$	$D_{o_3} := 0.0 \cdot lb \cdot ft^{-3}$
$L_{o_4} := x_{open} \cdot (n\_open + 1)^{-1}$	$S_{o_{4,0}} := S_{o_{3,1}}$	$S_{o_{4,1}} := S_P$	$D_{o_4} := 0.0 \cdot lb \cdot ft^{-3}$

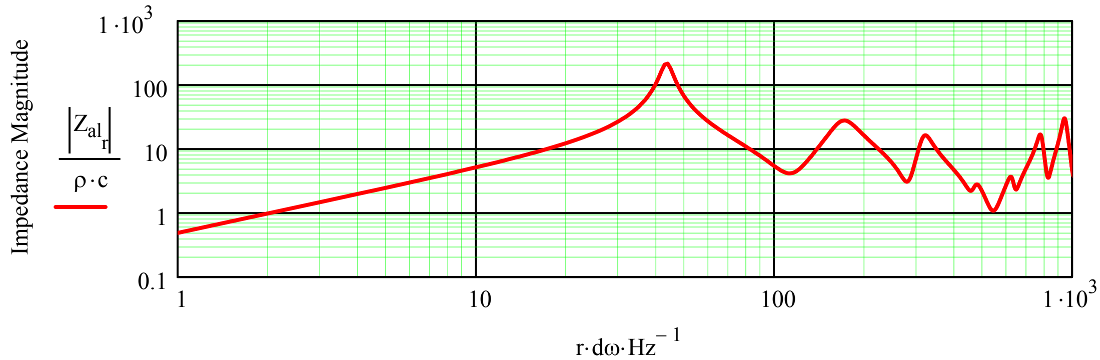
Bottom Section of Enclosure (Port Position ---> Bottom of Enclosure)

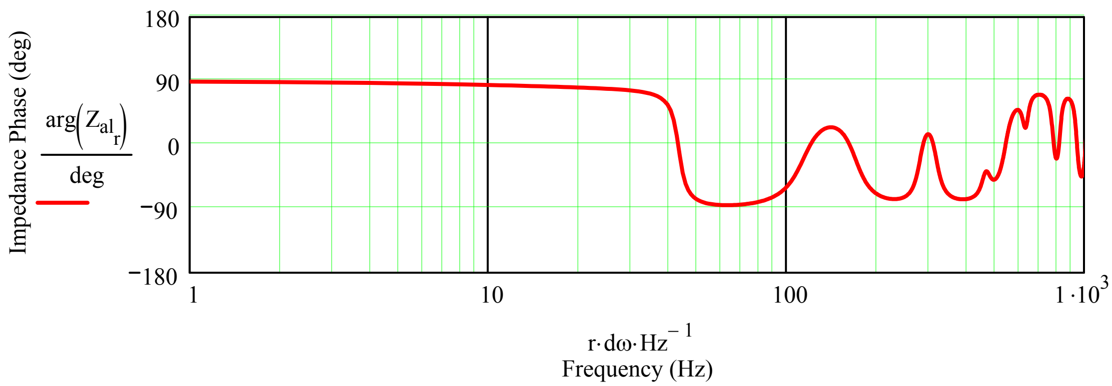
Section Length	Initial Area	Final Area	Stuffing Density
$L_{b_0} := x_{bottom} \cdot (n\_bottom + 1)^{-1}$	$S_{b_{0,0}} := S_P$	$S_{b_{0,1}} := S_{b_{0,0}} + TR \cdot L_{b_0}$	$D_{b_0} := 0.0 \cdot lb \cdot ft^{-3}$
$L_{b_1} := x_{bottom} \cdot (n\_bottom + 1)^{-1}$	$S_{b_{1,0}} := S_{b_{0,1}}$	$S_{b_{1,1}} := S_{b_{1,0}} + TR \cdot L_{b_1}$	$D_{b_1} := 0.0 \cdot lb \cdot ft^{-3}$
$L_{b_2} := x_{bottom} \cdot (n\_bottom + 1)^{-1}$	$S_{b_{2,0}} := S_{b_{1,1}}$	$S_{b_{2,1}} := S_{b_{2,0}} + TR \cdot L_{b_2}$	$D_{b_2} := 0.0 \cdot lb \cdot ft^{-3}$
$L_{b_3} := x_{bottom} \cdot (n\_bottom + 1)^{-1}$	$S_{b_{3,0}} := S_{b_{2,1}}$	$S_{b_{3,1}} := S_{b_{3,0}} + TR \cdot L_{b_3}$	$D_{b_3} := 0.0 \cdot lb \cdot ft^{-3}$
$L_{b_4} := x_{bottom} \cdot (n\_bottom + 1)^{-1}$	$S_{b_{4,0}} := S_{b_{3,1}}$	$S_{b_{4,1}} := S_L$	$D_{b_4} := 0.0 \cdot lb \cdot ft^{-3}$

Port Section of Enclosure (Port Inside ---> Port Outside)

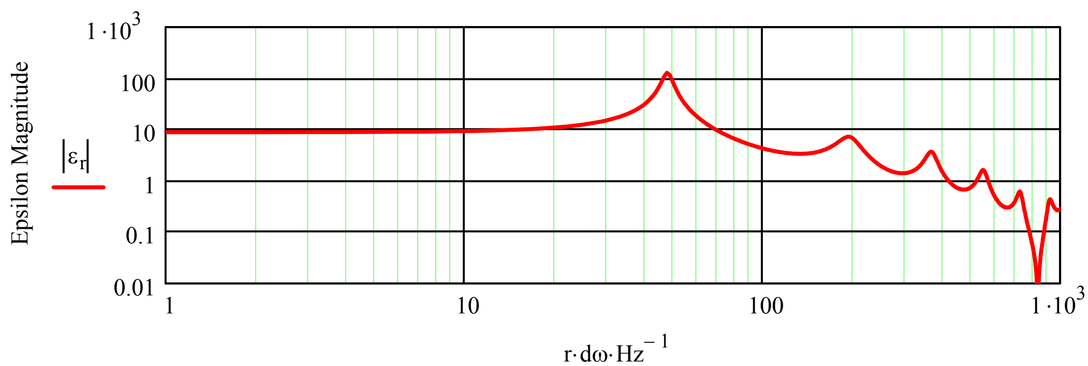
Section Length	Initial Area	Final Area	Stuffing Density
$L_{p_0} := x_{port} \cdot (n\_port + 1)^{-1}$	$S_{p_{0,0}} := \pi \cdot r_{port}^2$	$S_{p_{0,1}} := \pi \cdot r_{port}^2$	$D_{p_0} := 0.0 \cdot lb \cdot ft^{-3}$
$L_{p_1} := x_{port} \cdot (n\_port + 1)^{-1}$	$S_{p_{1,0}} := S_{p_{0,1}}$	$S_{p_{1,1}} := \pi \cdot r_{port}^2$	$D_{p_1} := 0.0 \cdot lb \cdot ft^{-3}$
$L_{p_2} := x_{port} \cdot (n\_port + 1)^{-1}$	$S_{p_{2,0}} := S_{p_{1,1}}$	$S_{p_{2,1}} := \pi \cdot r_{port}^2$	$D_{p_2} := 0.0 \cdot lb \cdot ft^{-3}$
$L_{p_3} := x_{port} \cdot (n\_port + 1)^{-1}$	$S_{p_{3,0}} := S_{p_{2,1}}$	$S_{p_{3,1}} := \pi \cdot r_{port}^2$	$D_{p_3} := 0.0 \cdot lb \cdot ft^{-3}$
$L_{p_4} := x_{port} \cdot (n\_port + 1)^{-1}$	$S_{p_{4,0}} := S_{p_{3,1}}$	$S_{p_{4,1}} := \pi \cdot r_{port}^2$	$D_{p_4} := 0.0 \cdot lb \cdot ft^{-3}$

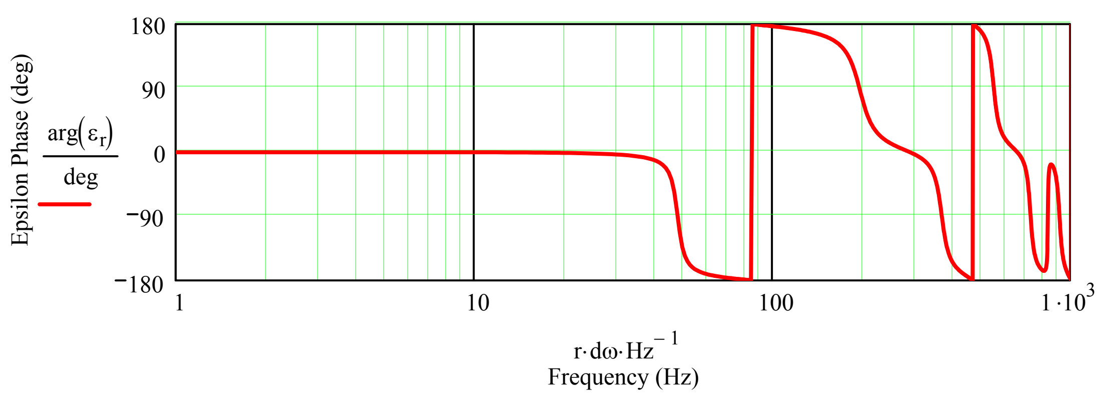
Resulting Acoustic Impedance for the Enclosure



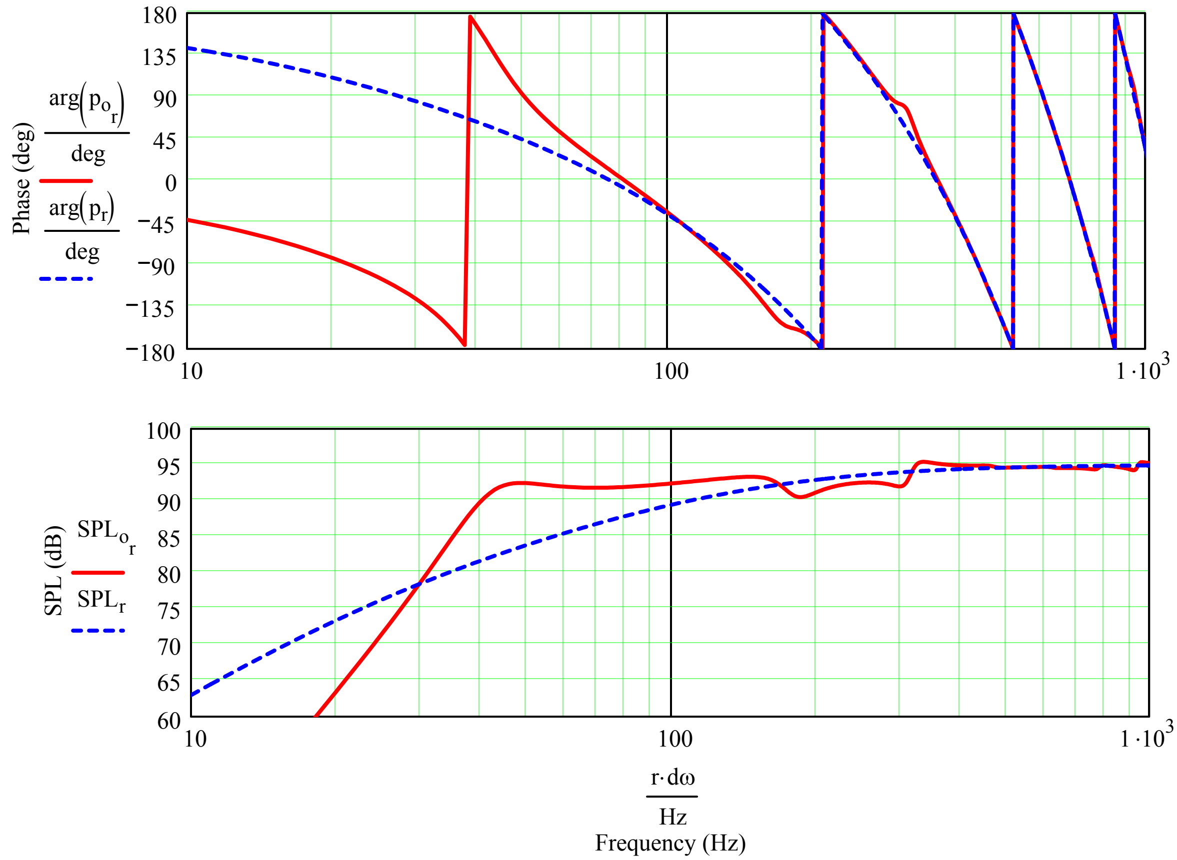


Velocity at the Terminus of the Ported Box for a 1 m/sec Driver Excitation

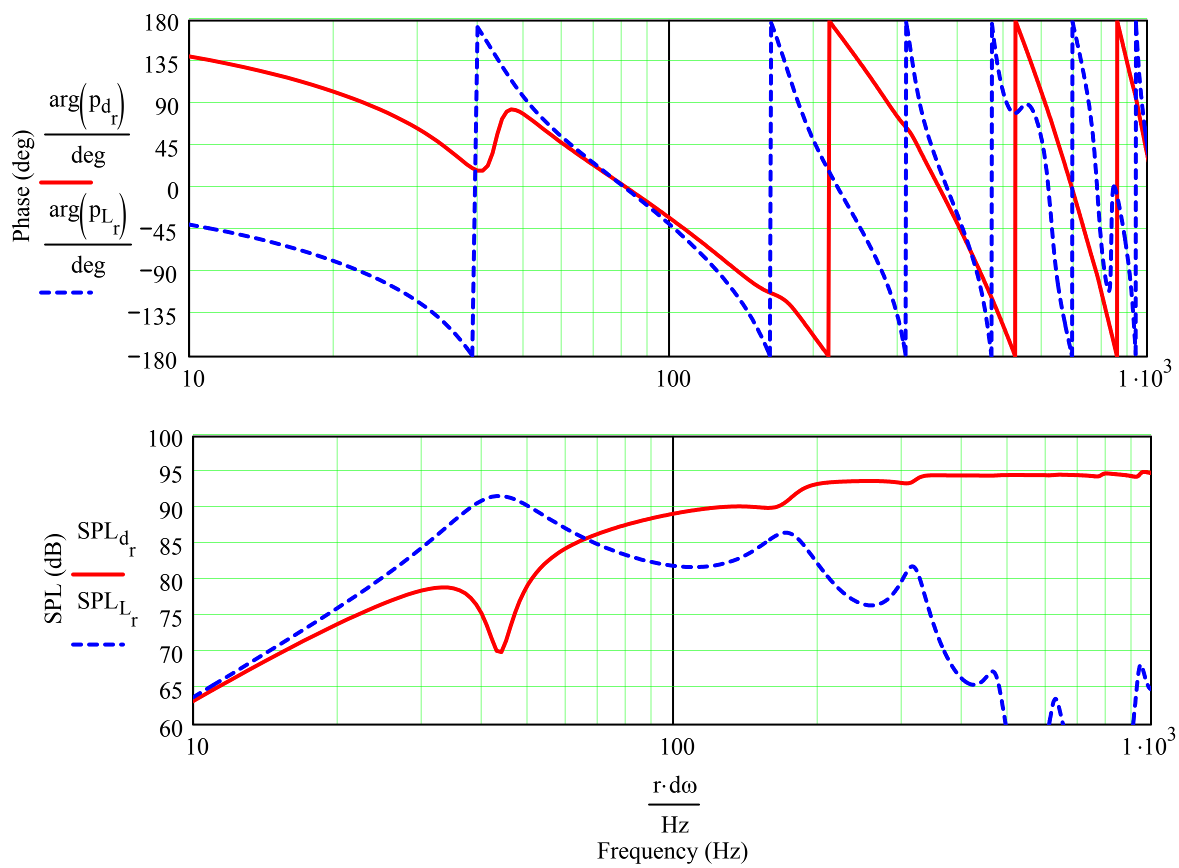




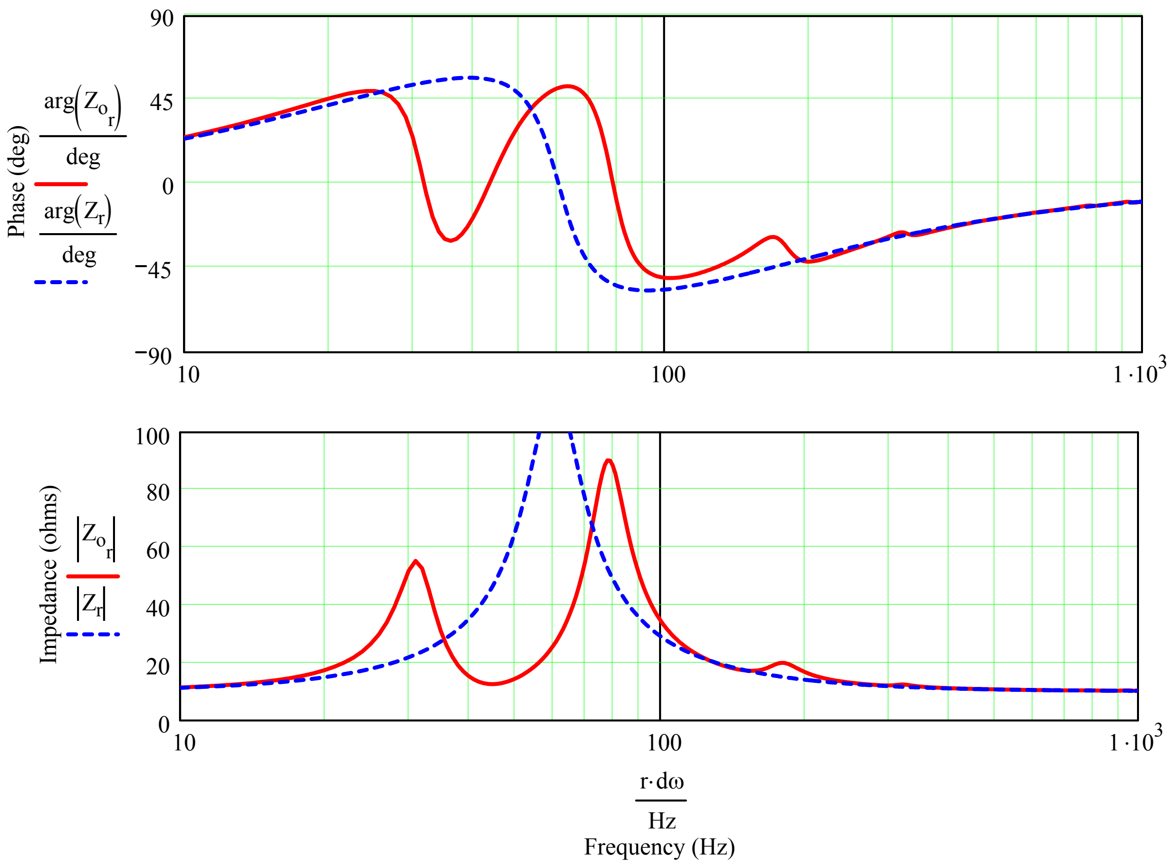
Far Field Ported Box System and Infinite Baffle Sound Pressure Level Responses



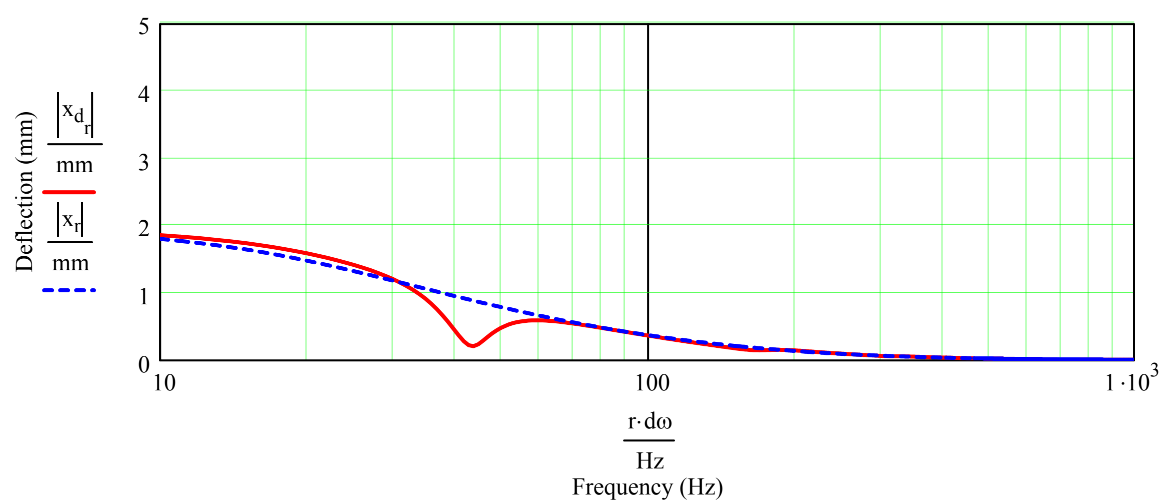
Woofer and Terminus Far Field Sound Pressure Level Responses



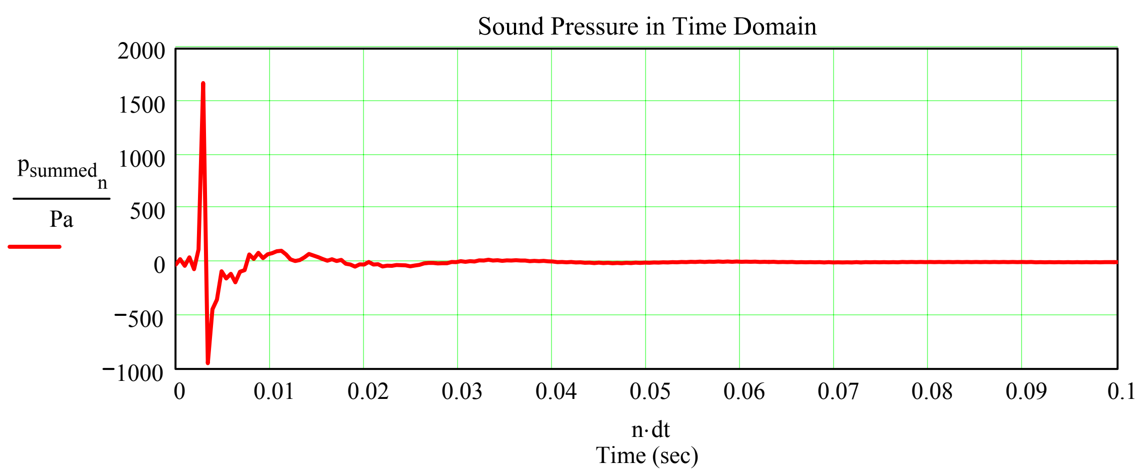
Ported Box System and Infinite Baffle Impedance



Woofer Displacement



System Time Response for an Impulse Input



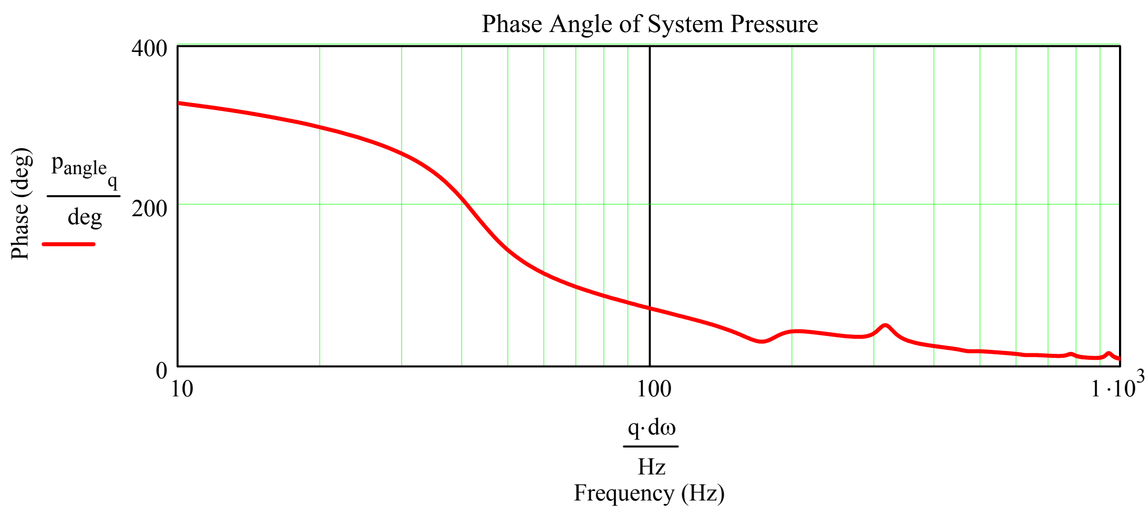
TL System Group Delay Calculation

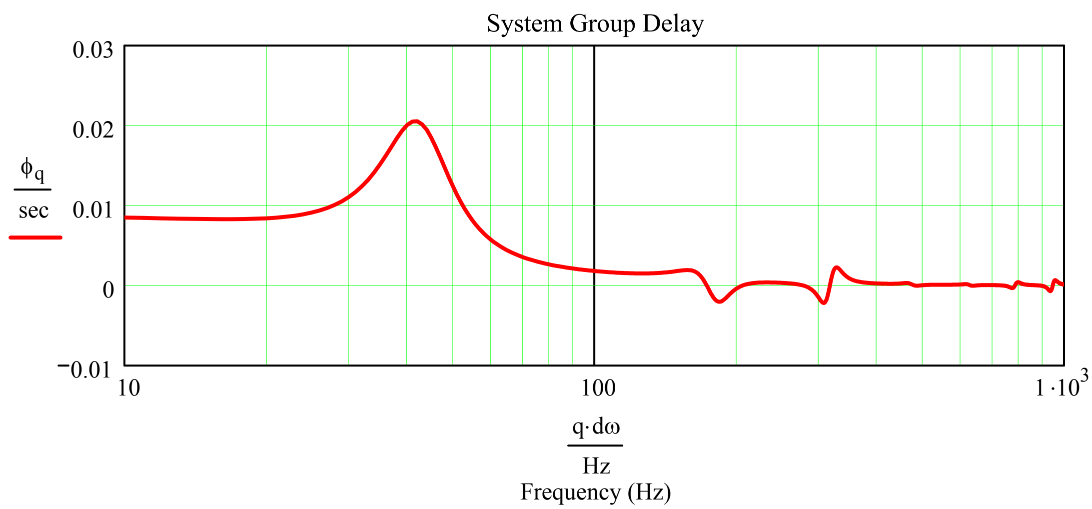
$q := 2, 3 .. 1000$

Removing the Phase Change Associated with the 1 meter Measurement Distance.

$$p_{angle_r} := \text{if}\left(\arg\left(p_{o_r} \cdot \exp\left(j \cdot \frac{r \cdot d\omega}{c} \cdot 1 \cdot m\right)\right) < 0, \arg\left(p_{o_r} \cdot \exp\left(j \cdot \frac{r \cdot d\omega}{c} \cdot 1 \cdot m\right)\right) + 2 \cdot \pi, \arg\left(p_{o_r} \cdot \exp\left(j \cdot \frac{r \cdot d\omega}{c} \cdot 1 \cdot m\right)\right)\right)$$

$$\phi_q := -\frac{p_{angle_{q+1}} - p_{angle_{q-1}}}{2 \cdot d\omega}$$





Port Air Velocity (< 10 m/sec / 342 m/sec = 0.03)

$$v_{port_r} := \frac{U_{L_r}}{\pi \cdot r_{port}^2}$$

$$\left| v_{port_{42}} \right| = 1.852 \, \frac{m}{sec}$$