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### Unit and Constant Definition

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

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

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

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



### Part 1 : Thiele-Small Consistent Calculation

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

Series Resistance

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

Driver Thiele / Small Parameters : Seas FA22RCZ H1507 Average Driver Properties

$$f_d := 30 \cdot \text{Hz}$$

$$V_{\text{ad}} := 134 \cdot \text{liter}$$

Adjustments

$$R_e := 8 \cdot \Omega$$

$$Q_{\text{ed}} := 0.38$$

$$R_{\text{av}} := R_e + R_{\text{add}}$$

$$L_{\text{vc}} := 0.09 \cdot \text{mH}$$

$$Q_{\text{md}} := 4.36$$

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

$$B_l := 6.4 \cdot \frac{\text{newton}}{\text{amp}}$$

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

$$S_d := 222 \cdot \text{cm}^2$$

$$Q_{\text{td}} = 0.35$$

Enclosure Geometry Definition : Model of Internal Air Volume

$$L := 1145 \cdot \text{mm}$$

(Internal Height)

$$z_{\text{driver}} := 191 \cdot \text{mm}$$

(Driver Internal Distance From Top < Height)

$$z_{\text{port}} := 960 \cdot \text{mm}$$

(Port Internal Distance From Top < Height)

$$S_0 := 255 \cdot \text{mm} \cdot 325 \cdot \text{mm}$$

(Internal Area of the Top End,  $z = 0$ )

$$S_L := S_0$$

(Internal Area of the Bottom End,  $z = L$ )

$$\text{Density} := 0.3 \cdot \text{lb} \cdot \text{ft}^{-3}$$

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

$$r_{\text{port}} := 50 \cdot \text{mm}$$

(Inside Radius of the Port)

$$L_{\text{port}} := 150 \cdot \text{mm}$$

(Length of the Port)

$$\text{Power} := 1 \cdot \text{watt}$$

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

**End of Abbreviated User Input**

## Pre Formated Geometry and Stuffing Location Input (Only Edit Details Below to Change Defaults)

### ML TL Definition

(0 lb/ft<sup>3</sup> < D < 1 lb/ft<sup>3</sup>)

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

### Geometry Definition

$TR := (S_L - S_0) \cdot L^{-1}$	$TR = 0 \text{ m}$
$S_D := S_0 + TR \cdot z_{driver}$	$S_D = 0.083 \text{ m}^2$
$S_P := S_0 + TR \cdot z_{port}$	$S_P = 0.083 \text{ m}^2$

### Top Section of Enclosure

(Driver ---> Top of Enclosure)

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

### Open Section of Enclosure

(Driver ---> Port Position)

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

## Bottom Section of Enclosure

(Port Position ---> Bottom of Enclosure)

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

## Port Section of Enclosure

(Port Inside ---> Port Outside)

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

## Total Amount of Stuffing

$$\sum_{r=0}^{n_{\text{top}}} \left[ \frac{(S_{c_{r,0}} + S_{c_{r,1}})}{2} \cdot L_{c_r} \cdot D_{c_r} \right] + \sum_{r=0}^{n_{\text{open}}} \left[ \frac{(S_{o_{r,0}} + S_{o_{r,1}})}{2} \cdot L_{o_r} \cdot D_{o_r} \right] \dots = 0.573 \cdot \text{lb}$$

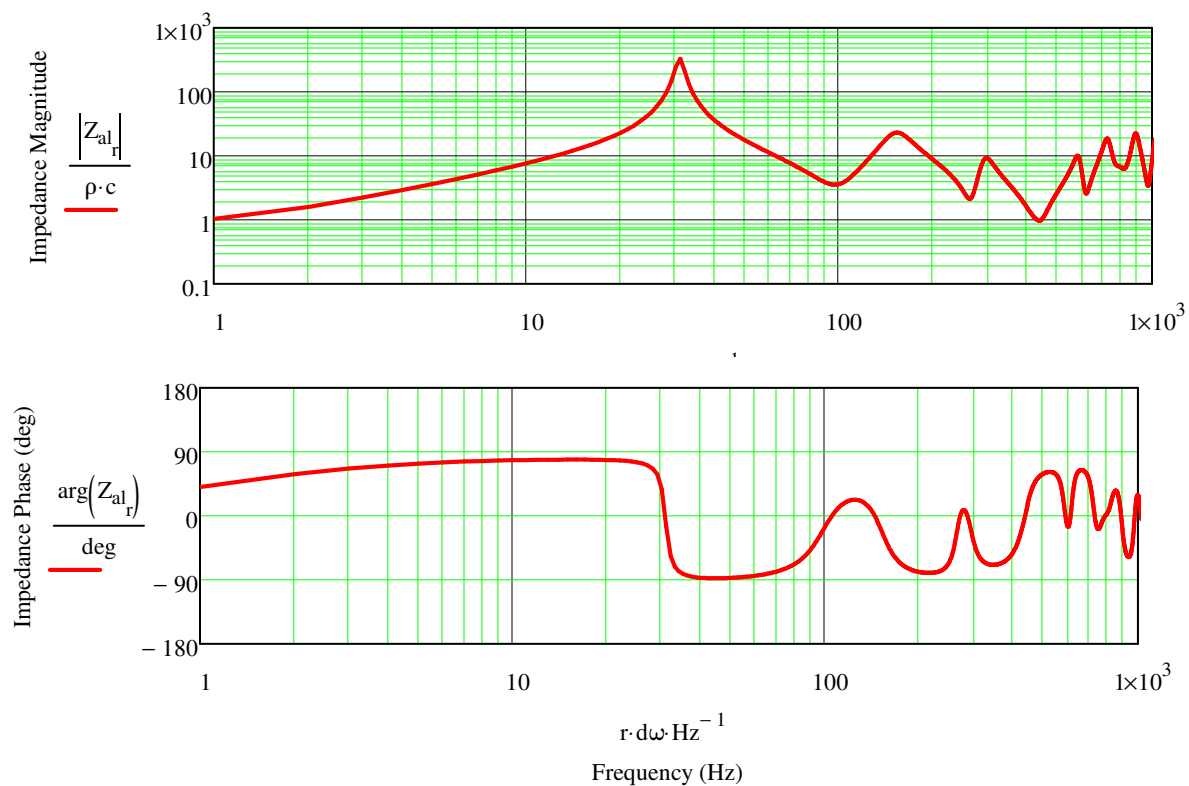
$$+ \sum_{r=0}^{n_{\text{bottom}}} \left[ \frac{(S_{b_{r,0}} + S_{b_{r,1}})}{2} \cdot L_{b_r} \cdot D_{b_r} \right] + \sum_{r=0}^{n_{\text{port}}} \left[ \frac{(S_{p_{r,0}} + S_{p_{r,1}})}{2} \cdot L_{p_r} \cdot D_{p_r} \right]$$

End of Pre Formatted Default Input

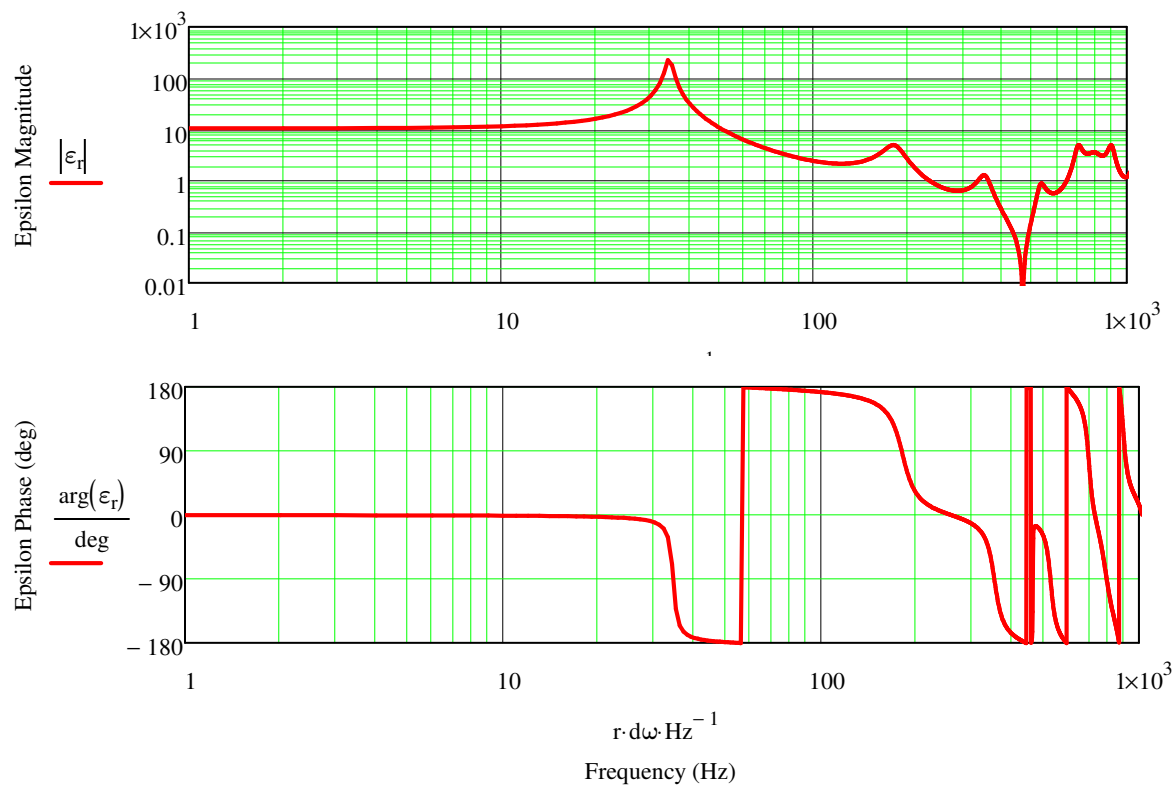
End of Part 1 Input



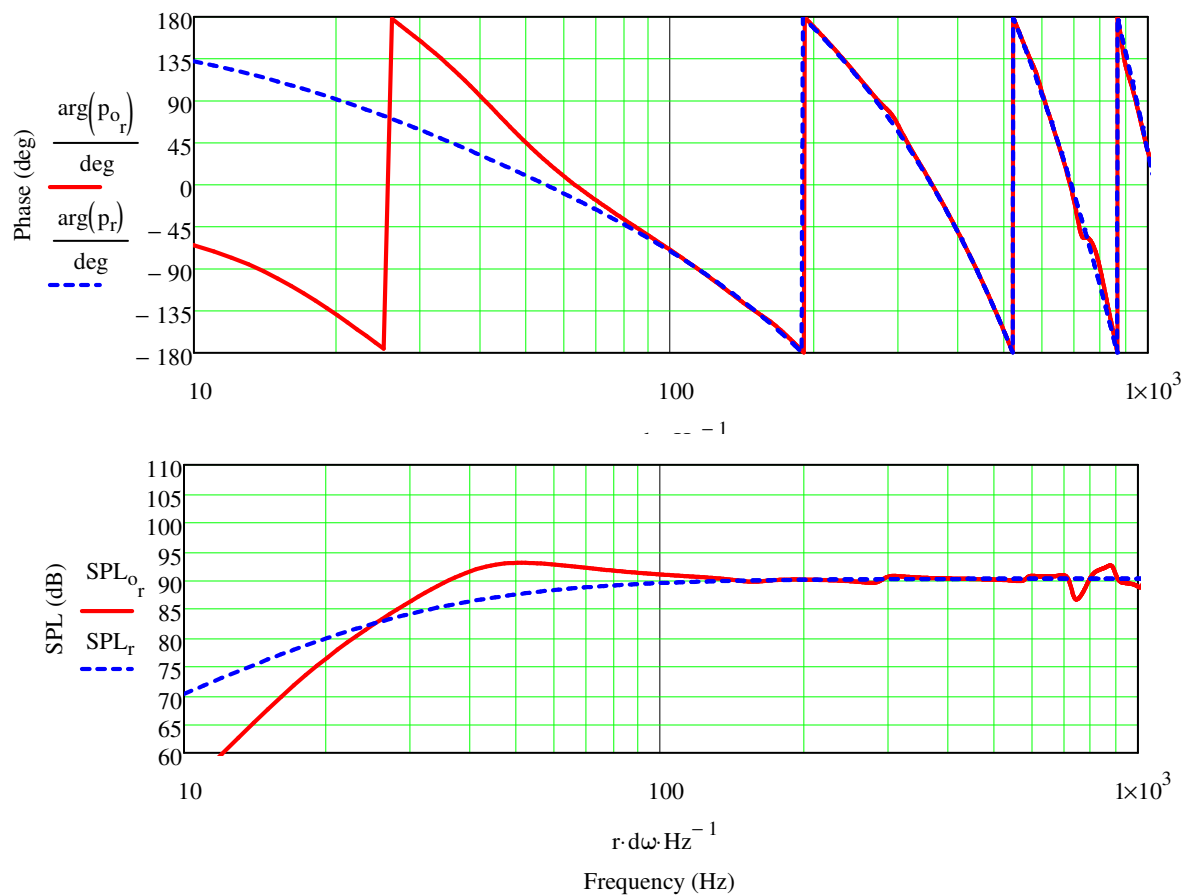
## Resulting Acoustic Impedance for the Enclosure



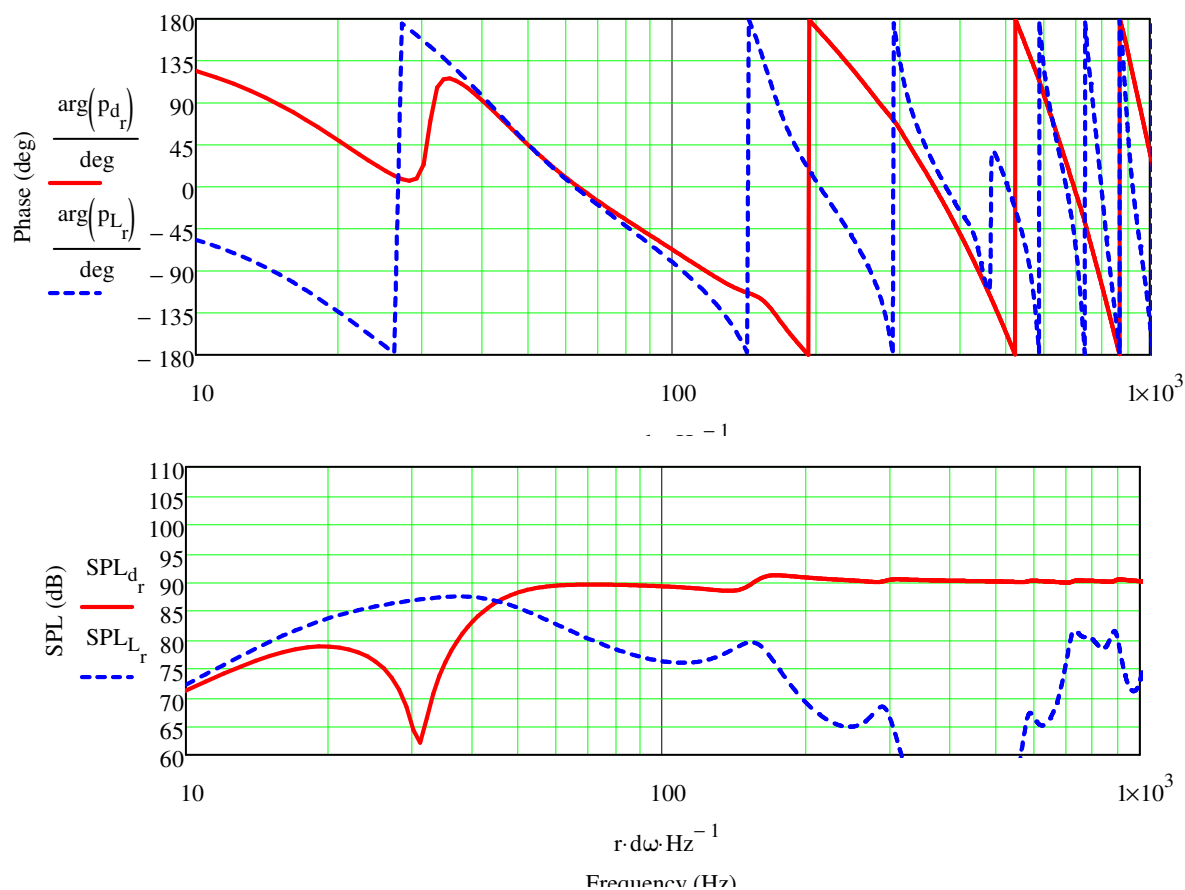
## Velocity at the Terminus of the ML TL for a 1 m/sec Excitation at the Driver Position



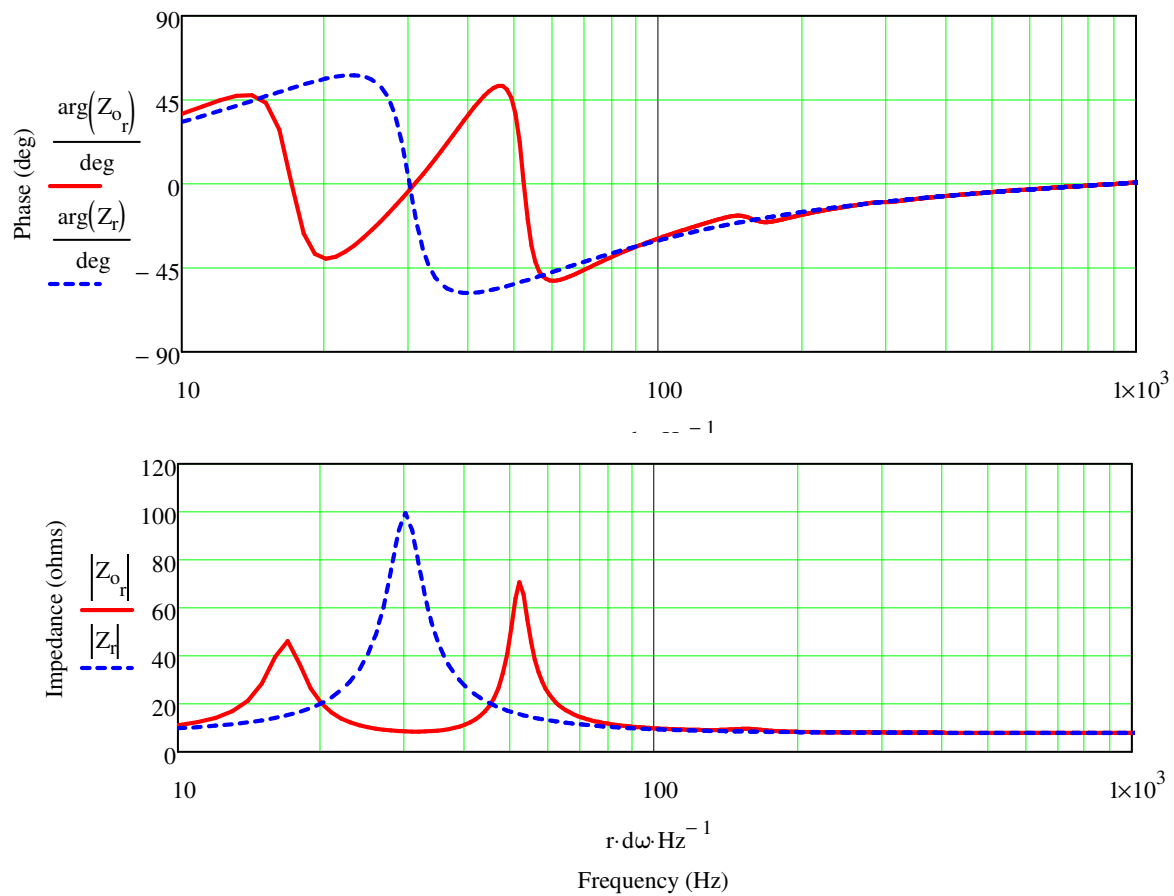
## Far Field ML TL System and Infinite Baffle Sound Pressure Level Responses



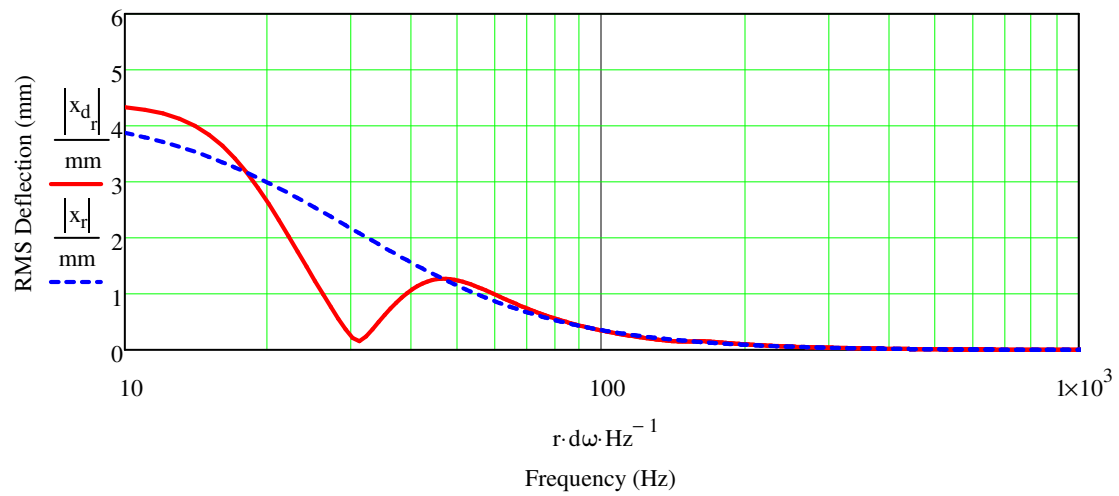
## Woofer and Terminus Far Field Sound Pressure Level Responses



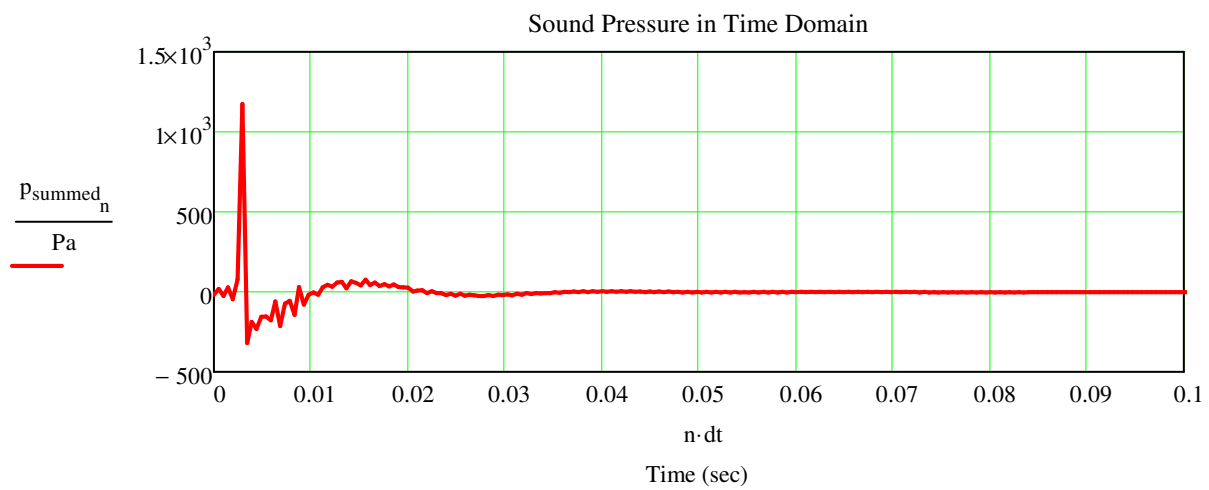
## ML TL System and Infinite Baffle Impedance



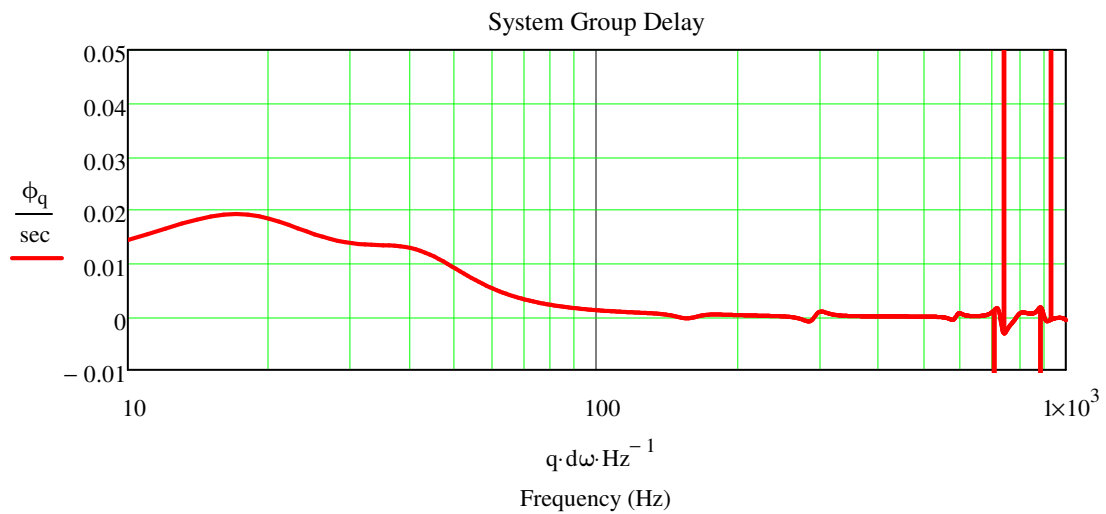
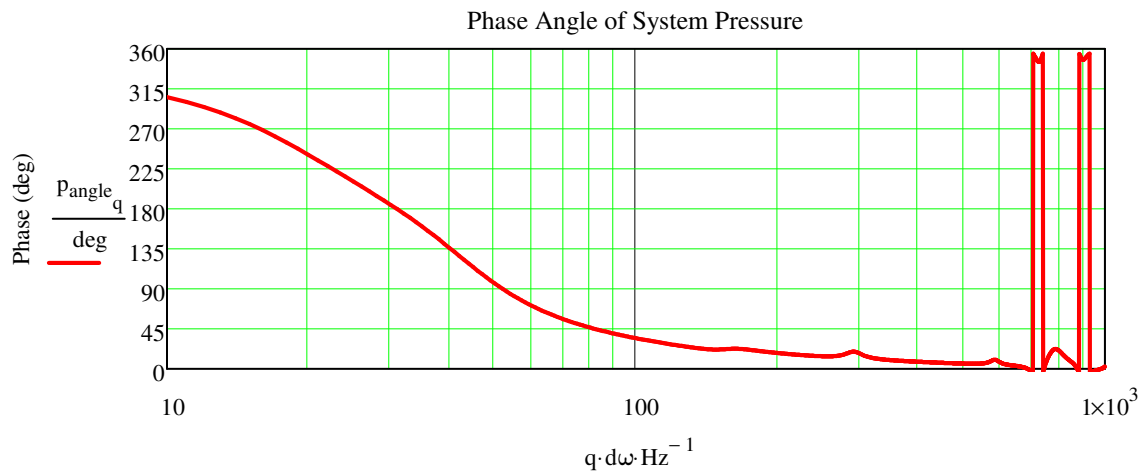
## Woofer RMS Displacement



## System Time Response for an Impulse Input



## System Group Delay



Port Air Velocity (should be  $< 10 \text{ m/sec} / 344 \text{ m/sec} = 0.03$ )

