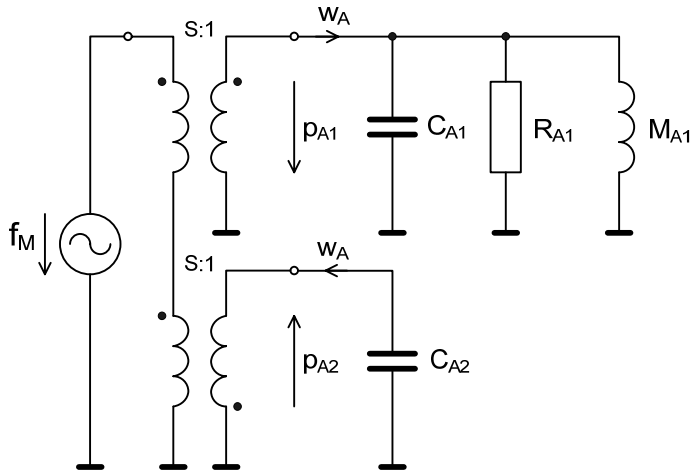


Náčrt riešenia úlohy na cvičenie v 5. týždni LS2007

1. Analogická schéma akustickej časti sústavy:



Hodnoty prvkov:

$$C_{A1} = \frac{V_{A1}}{c_0^2 \cdot \rho_0} = \frac{0.08}{344^2 \cdot 1.18} = 5.73 \cdot 10^{-7} \quad [\text{m}^3/\text{Pa}]$$

$$C_{A2} = \frac{V_{A2}}{c_0^2 \cdot \rho_0} = \frac{0.08}{344^2 \cdot 1.18} = 5.73 \cdot 10^{-7} \quad [\text{m}^3/\text{Pa}]$$

$$M_{A1} = \frac{\rho_0}{S_T} \cdot \left(l_T + \frac{8d_T}{3\pi} \right) = \frac{4\rho_0}{\pi d_T^2} \cdot \left(l_T + \frac{8d_T}{3\pi} \right) = \frac{4 \cdot 1.18}{\pi \cdot 0.08^2} \cdot \left(0.2 + \frac{8 \cdot 0.08}{3\pi} \right) = 62.89 \quad [\text{kg}/\text{m}^4]$$

$$R_{A1} = Q_A \sqrt{\frac{M_{A1}}{C_{A1}}} = 10 \sqrt{\frac{62.89}{5.73 \cdot 10^{-7}}} = 104764 \quad [\text{Pa} \cdot \text{s}/\text{m}^3]$$

Rezonančná frekvencia paralelného akustického rezonačného obvodu

$$f_{s2} = \frac{1}{2\pi \sqrt{M_{A1} \cdot C_{A1}}} = \frac{1}{2\pi \sqrt{62.89 \cdot 5.73 \cdot 10^{-7}}} = 26.5 \quad [\text{Hz}]$$

Skript obvodu v programe AkAbak

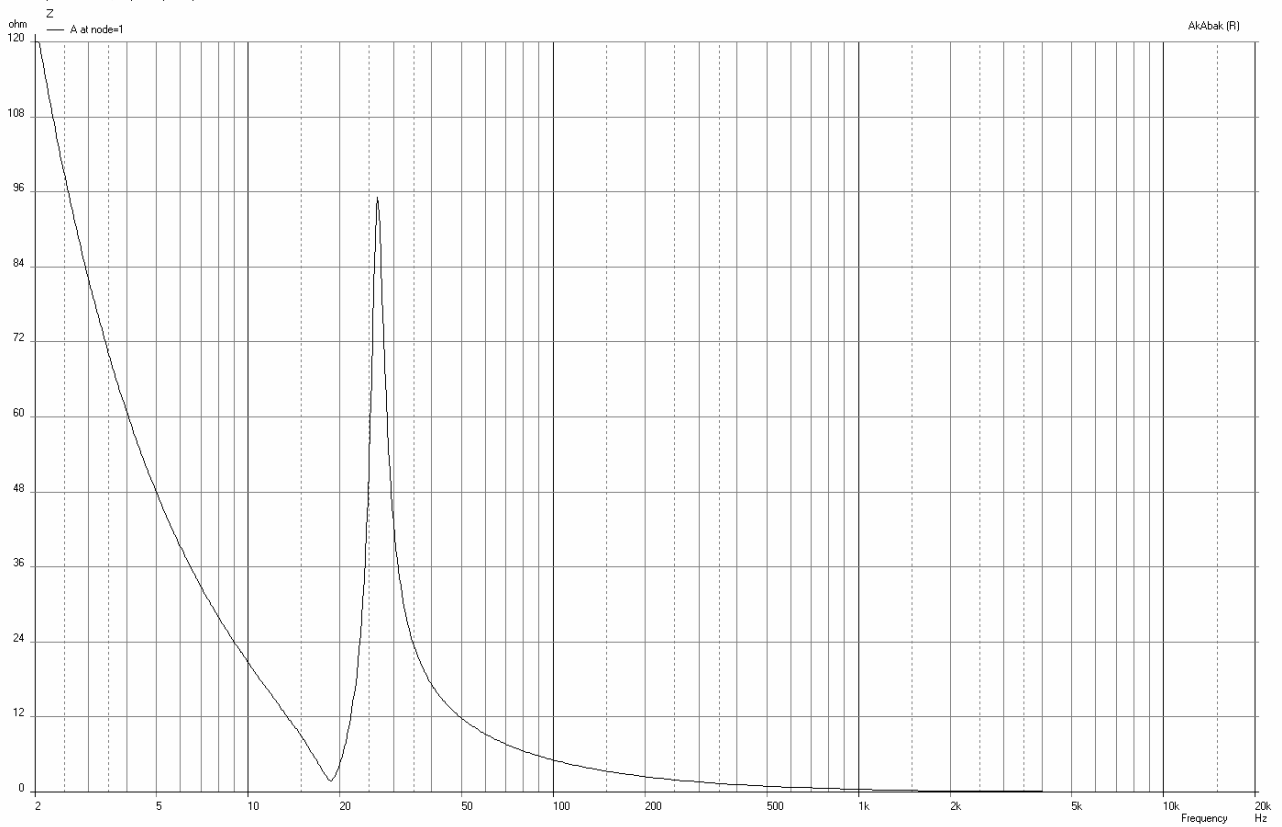
```
Def_Const
{roh=1.18; c0=344; Sd=300e-4; Rd=sqrt(Sd/pi);
 Rt=0.04; Lt=0.2; St=pi*Rt^2; Mat=(roh/St)*(Lt+(16*Rt)/(3*pi));
 V1=80e-3; Ca1=V1/(roh*c0^2); V2=80e-3; Ca2=V2/(roh*c0^2);
 Qa=10; Ra1=Qa*sqrt(Mat/Ca1);
}
```

System 'A'

```
Coupler 'Cp1' Node=1=8=10
 Ratio={1/Sd}
Coupler 'Cp2' Node=8=0=0=11
 Ratio={1/Sd}
AcouCompliance 'Ca1' Node=10=0 Ca={Ca1}
AcouResistance 'Ra1' Node=10=0 Ra={Ra1}
AcouMass 'Ma1' Node=10=0 Ma={Mat}
AcouCompliance 'Ca2' Node=11=0 Ca={Ca2}
```

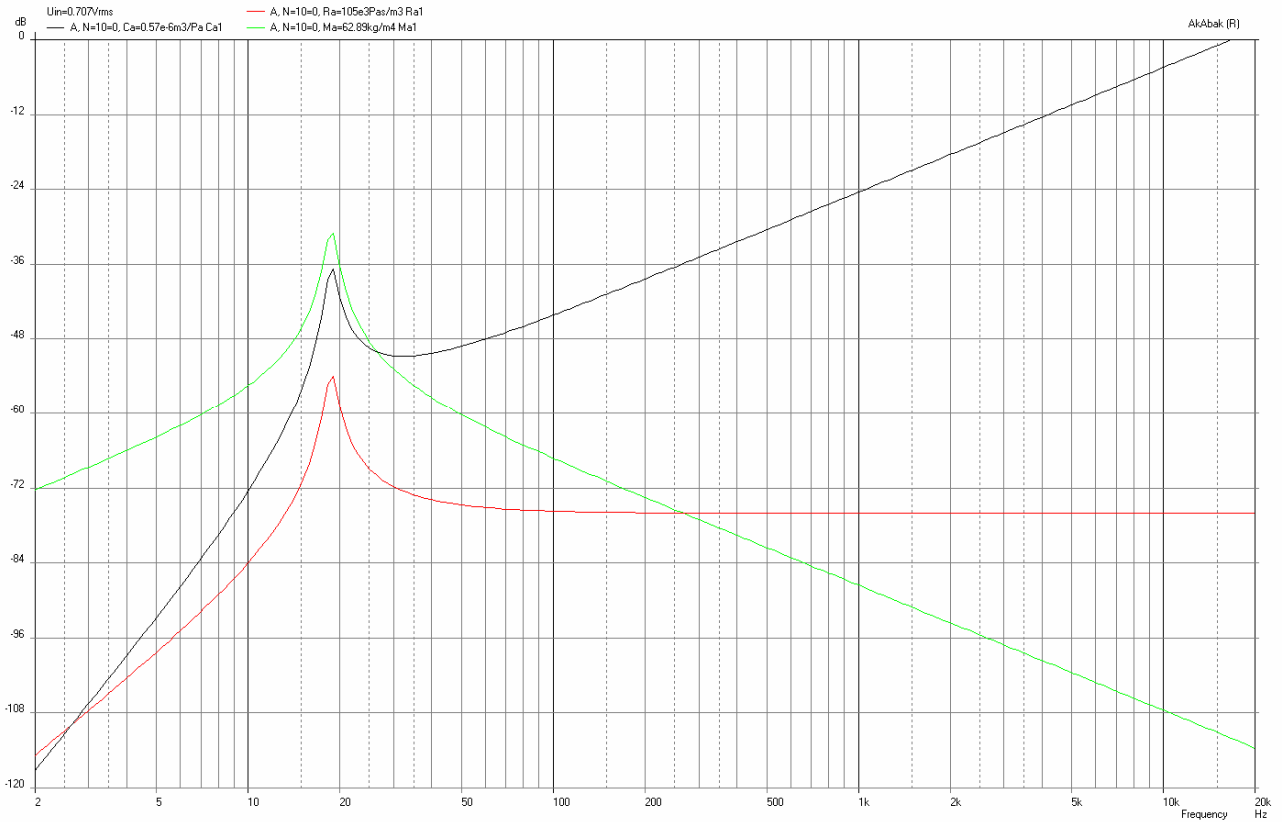
Vstupná impedancia obvodu

41. Impedance of U5, Amplitude (Phase)



Objemové rýchlosti v prednej komore ozvučnice:

42. Vol/Velocity of U5, Level (Phase)



Akustické tlaky v prednej komore:

43. Pressure of U5_Lp (Phase)

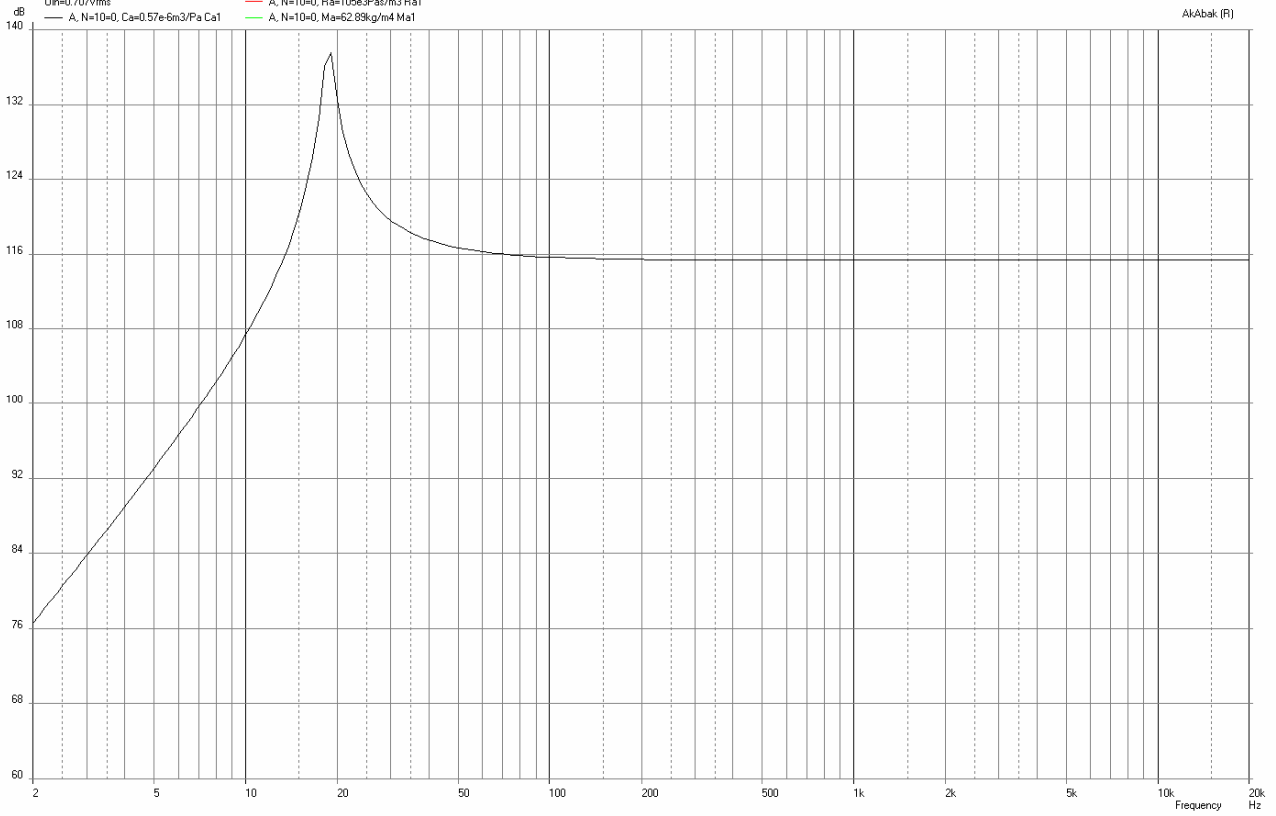
U_{in}=0.707Vrms

A, N=10=0, Ca=0.57e-6m3/Pa Ca1

A, N=10=0, Ra=105e3Pas/m3 Ra1

A, N=10=0, Ma=62.89kg/m4 Ma1

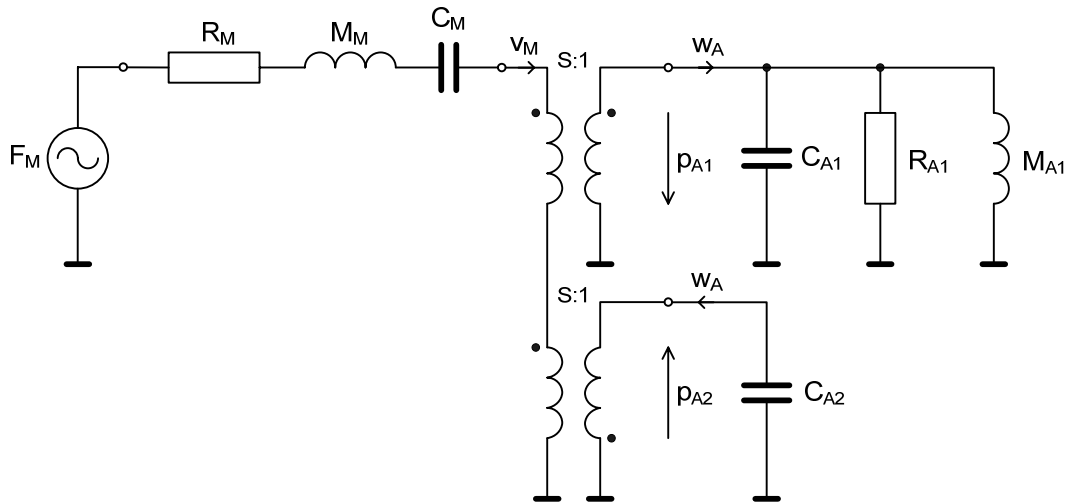
AKAbak (F)



Poznámka:

...

2. Analogická schéma mechanicko-akustickej sústavy



Mechanická rezonančná frekvencia I

$$f_{s1,I} = \frac{1}{2\pi\sqrt{M_M \cdot C_M}} = \frac{1}{2\pi\sqrt{0.038 \cdot 1.86 \cdot 10^{-3}}} = 18.9 \text{ [Hz]}$$

Mechanický činiteľ kvality:

$$Q_M = \frac{1}{R_M} \sqrt{\frac{M_M}{C_M}} = \frac{1}{0.88} \sqrt{\frac{0.038}{1.86 \cdot 10^{-3}}} = 5.14$$

Skript obvodu v programe AkAbak

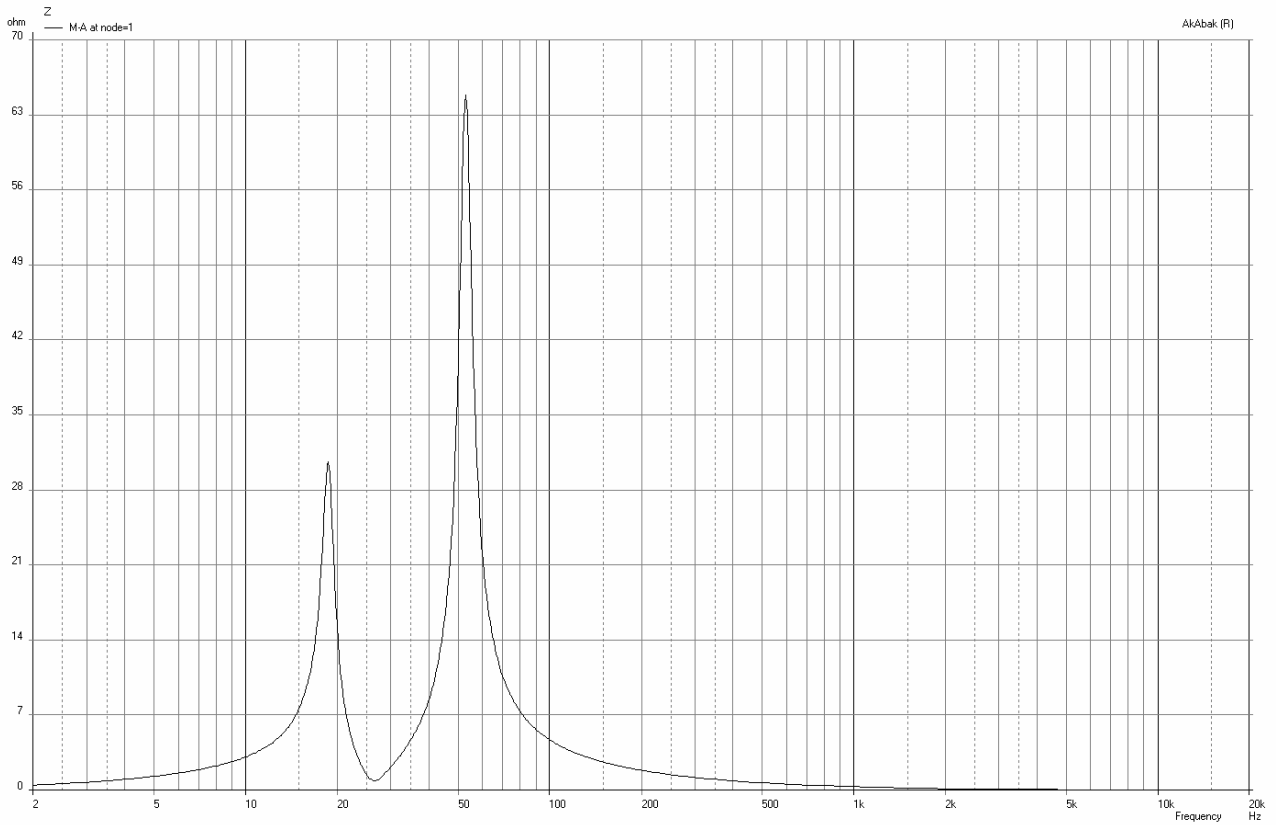
```
Def_Const
{roh=1.18; c0=344; Sd=300e-4; Rd=sqrt(Sd/pi);
Rt=0.04; Lt=0.2; St=pi*Rt^2; Mat=(roh/St)*(Lt+(16*Rt)/(3*pi));
V1=80e-3; Ca1=V1/(roh*c0^2); V2=80e-3; Ca2=V2/(roh*c0^2);
Qa=10; Ra1=Qa*sqrt(Mat/Ca1);
}
```

System 'M-A'

```
Gyator 'Gy1' Node=1=0=4=0 Bl=9.2Tm
MechResistance 'Rm' Node=4=5 Rm=0.88Ns/m
MechMass 'Mm' Node=5=6 Mm=38g
MechCompliance 'Cm' Node=6=7 Cm=1.86e-3m/N
Coupler 'Cp1' Node=7=8=10
Ratio={1/Sd}
Coupler 'Cp2' Node=8=0=0=11
Ratio={1/Sd}
AcouCompliance 'Ca1' Node=10=0 Ca={Ca1}
AcouResistance 'Ra1' Node=10=0 Ra={Ra1}
AcouMass 'Ma1' Node=10=0 Ma={Mat}
AcouCompliance 'Ca2' Node=11=0 Ca={Ca2}
```

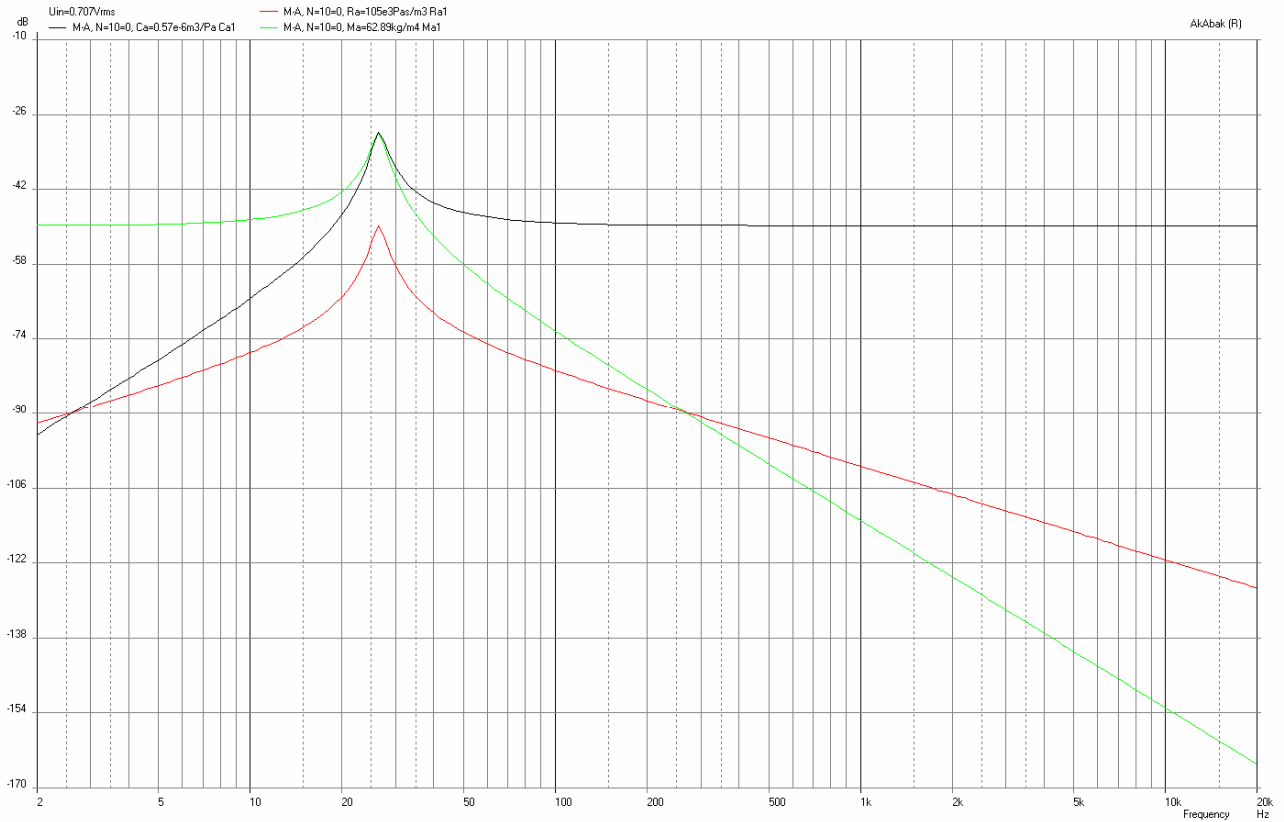
Vstupná impedancia mechanicko-akustickej sústavy

38. Impedance of U5, Amplitude (Phase)

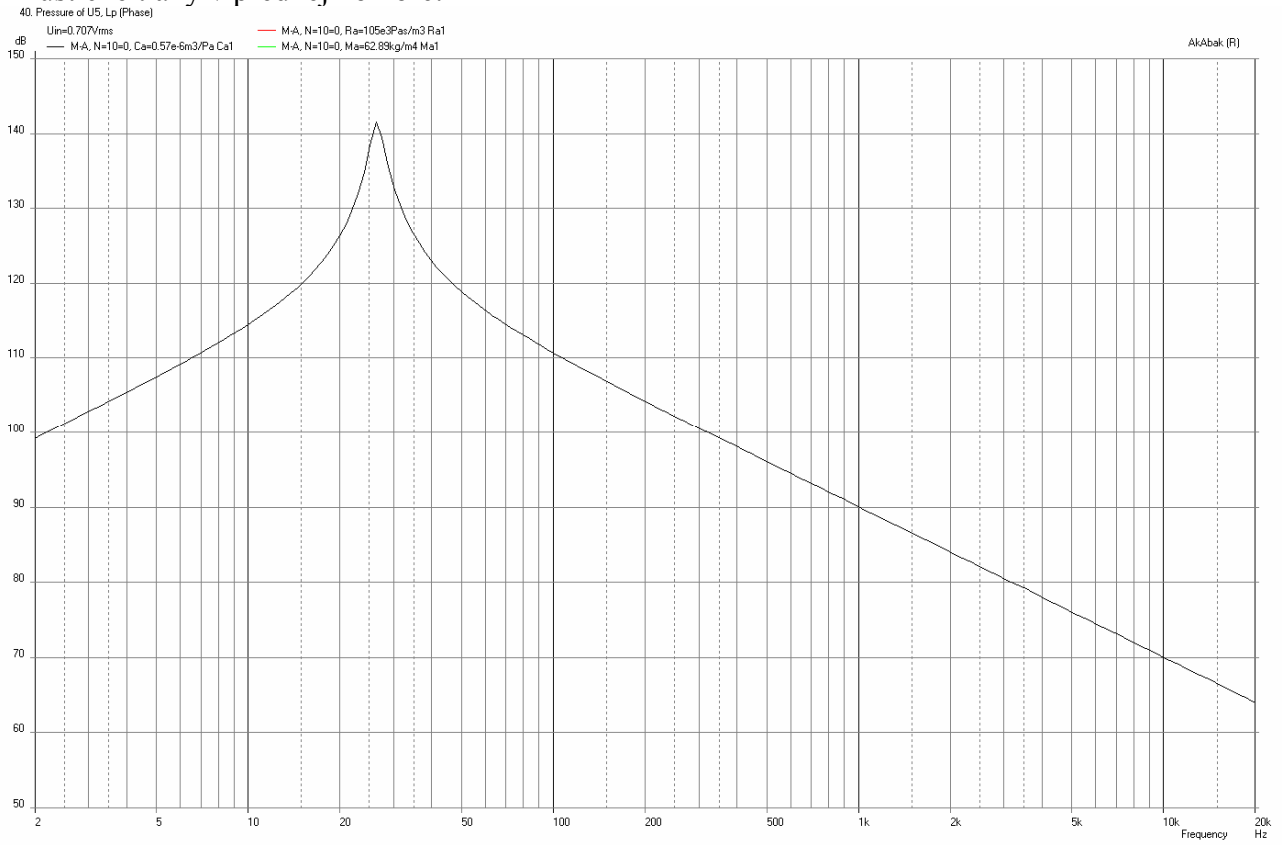


Objemové rýchlosti v prednej komore:

39. Vol/Velocity of U5, Level (Phase)



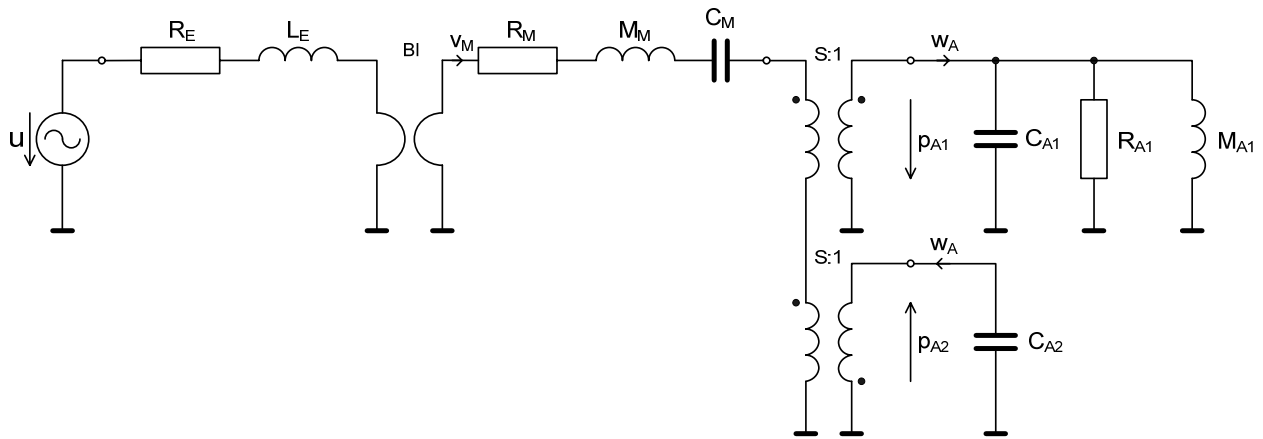
Akustické tlaky v prednej komore:



Poznámka:

...

3. Analogická schéma mechanicko-akustickej sústavy



Skript obvodu v programe AkAbak

Def_Const

```
{roh=1.18; c0=344; Sd=300e-4; Rd=sqrt(Sd/pi);
Rt=0.04; Lt=0.2; St=pi*Rt^2; Mat=(roh/St)*(Lt+(16*Rt)/(3*pi));
V1=80e-3; Ca1=V1/(roh*c0^2); V2=80e-3; Ca2=V2/(roh*c0^2);
Qa=10; Ra1=Qa*sqrt(Mat/Ca1);
}
```

System 'E-M-A'

Resistor 'Re' Node=1=2 R=6.2ohm

Coil 'Le' Node=2=3 L=1.2mH

Gyrator 'Gy1' Node=3=0=4=0 Bl=9.2Tm

MechResistance 'Rm' Node=4=5 Rm=0.88Ns/m

MechMass 'Mm' Node=5=6 Mm=38g

MechCompliance 'Cm' Node=6=7 Cm=1.86e-3m/N

Coupler 'Cp1' Node=7=8=10

Ratio={1/Sd}

Coupler 'Cp2' Node=8=0=0=11

Ratio={1/Sd}

AcouCompliance 'Ca1' Node=10=0 Ca={Ca1}

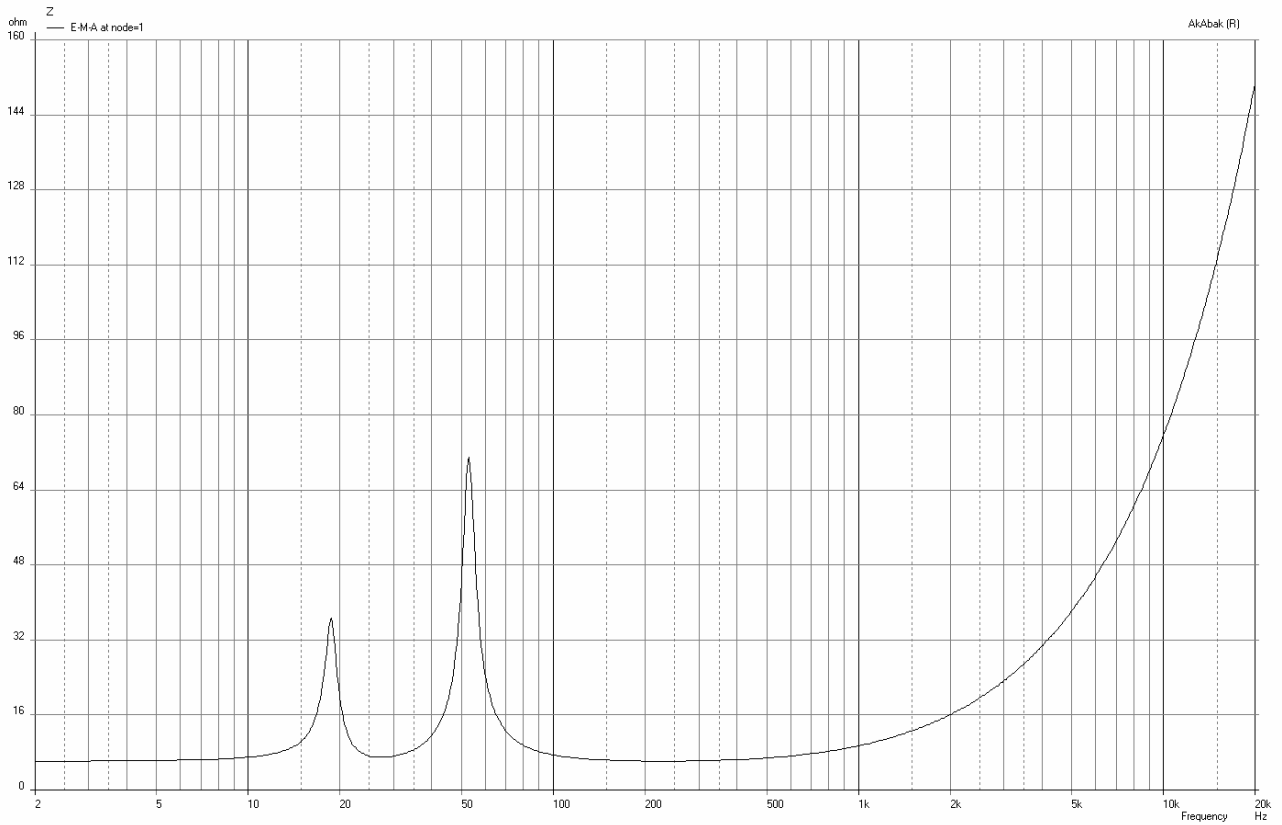
AcouResistance 'Ra1' Node=10=0 Ra={Ra1}

AcouMass 'Ma1' Node=10=0 Ma={Mat}

AcouCompliance 'Ca2' Node=11=0 Ca={Ca2}

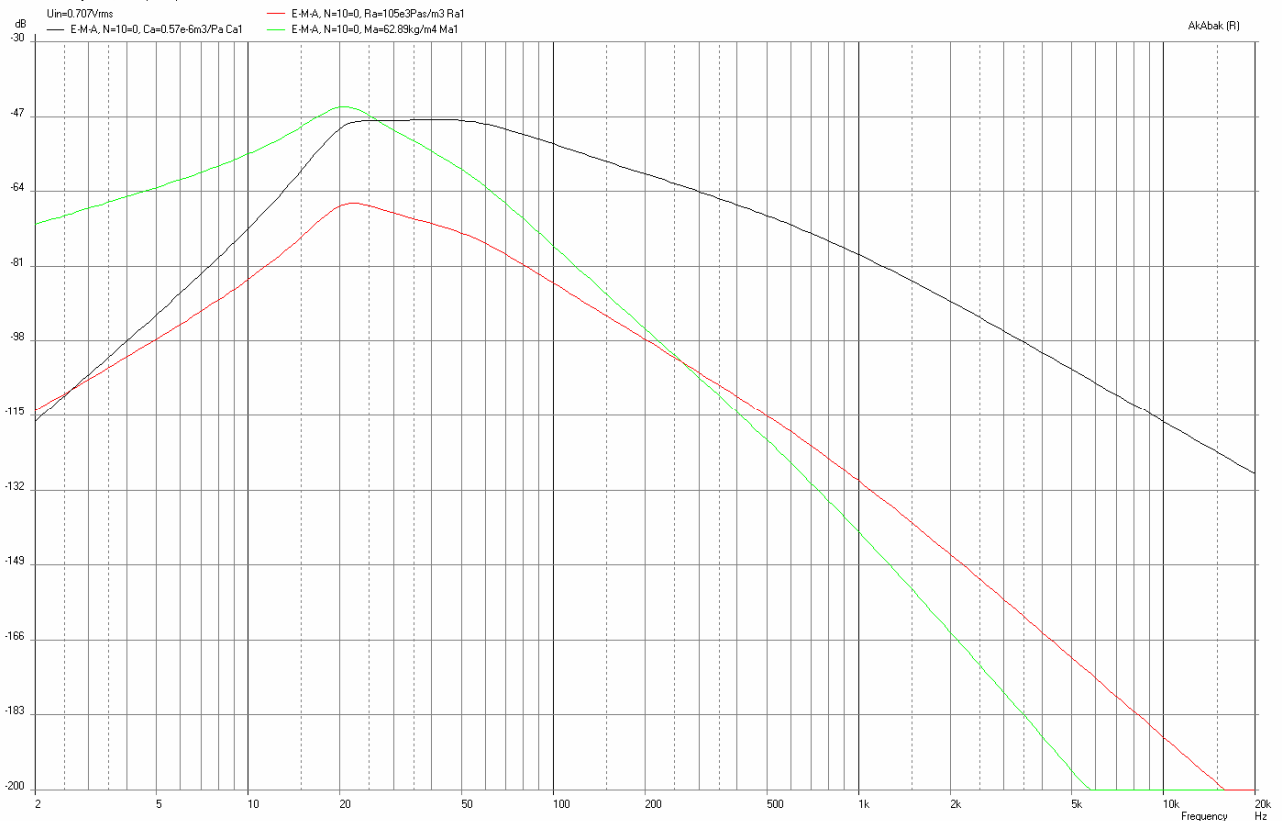
Vstupná impedancia

35. Impedance of U5, Amplitude (Phase)

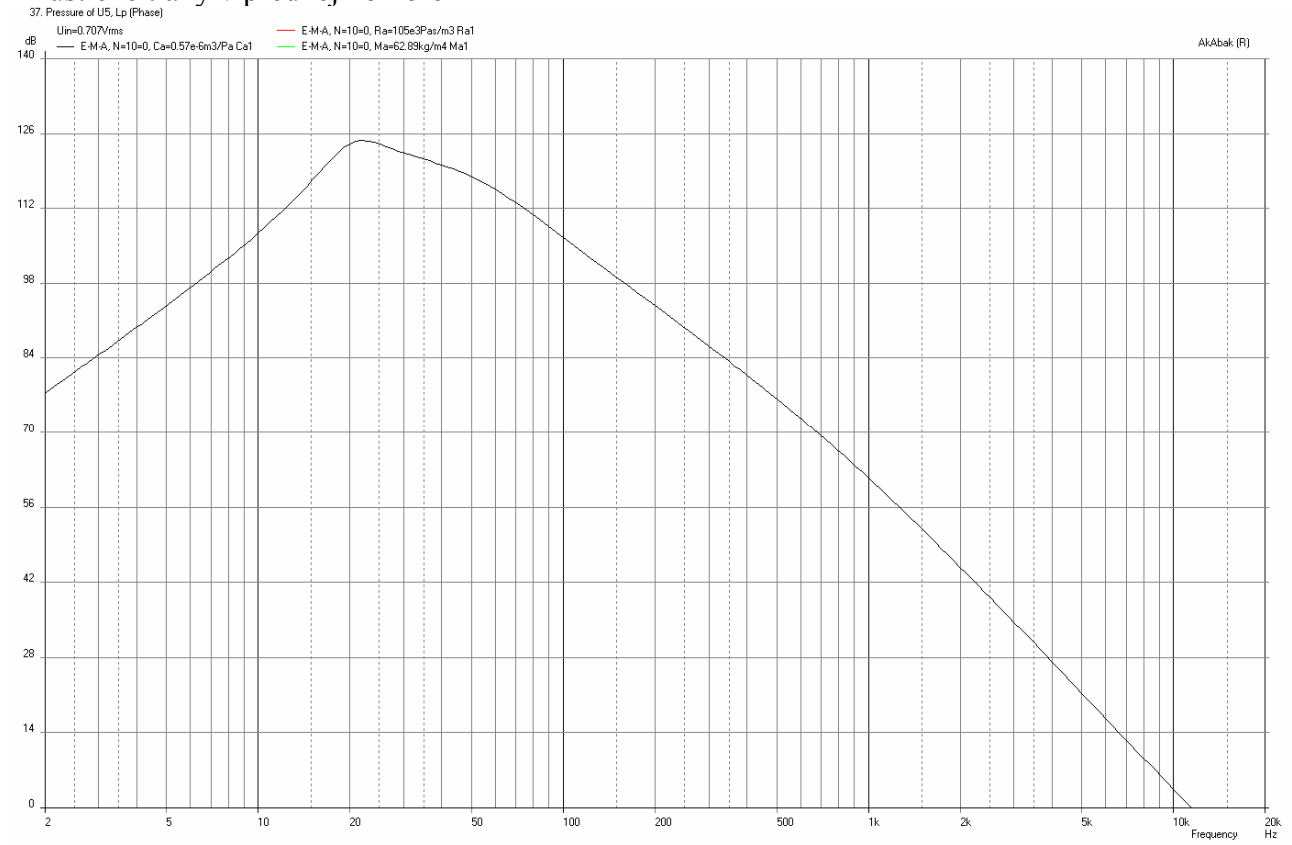


Objemové rýchlosti v prednej komore

36. Vol/Velocity of U5, Level (Phase)



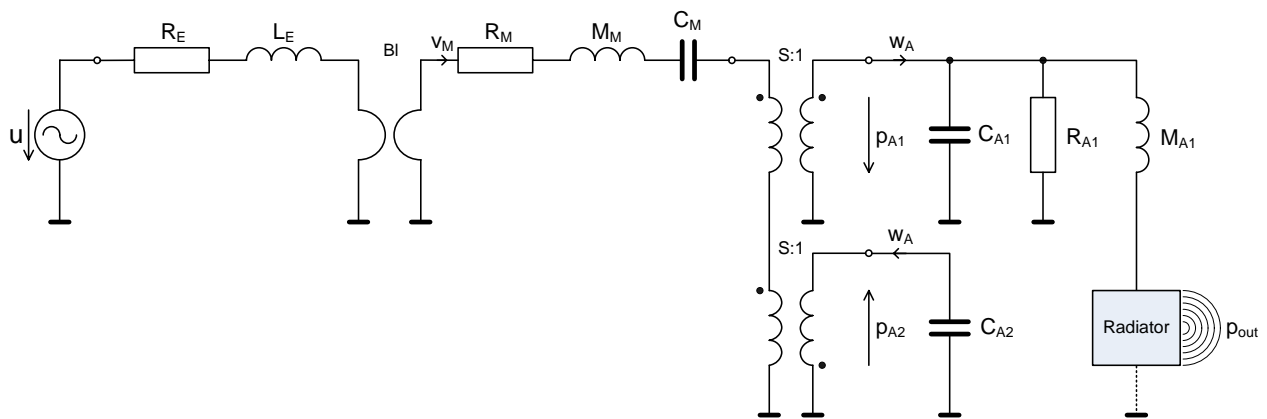
Akustické tlaky v prednej komore



Poznámka:

...

4. Analogická schéma s vysielačou impedanciou, realizovanou makromodelom „Driver“ :



Skript obvodu v programe AkAbak

```

Def_Const
{roh=1.18; c0=344; Sd=300e-4; Rd=sqrt(Sd/pi);
 Rt=0.04; Lt=0.2; St=pi*Rt^2; Mat=(roh/St)*(Lt+(16*Rt)/(3*pi));
 V1=80e-3; Ca1=V1/(roh*c0^2); V2=80e-3; Ca2=V2/(roh*c0^2);
 Qa=10; Ra1=Qa*sqrt(Mat/Ca1);
}

```

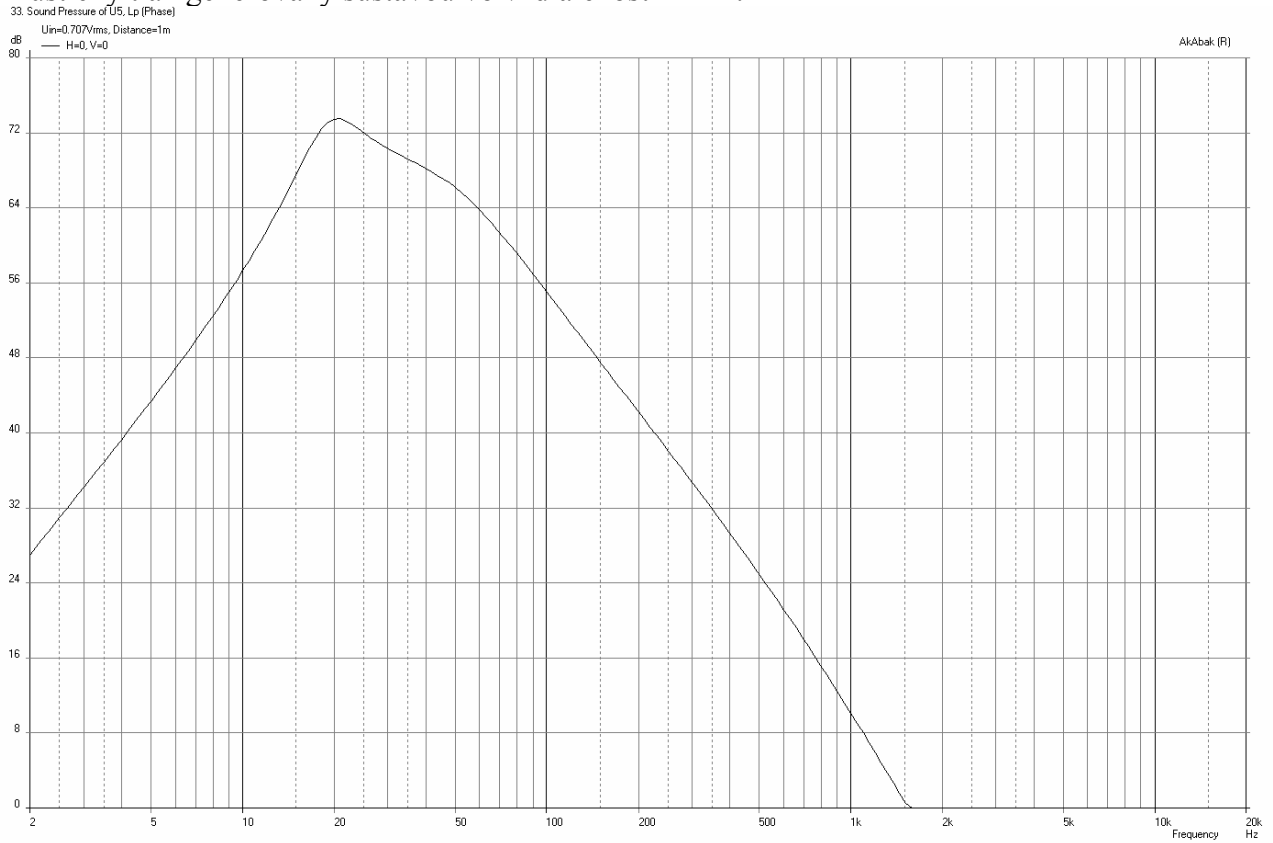
System 'E-M-A-Rad'

```

Resistor 'Re' Node=1=2 R=6.2ohm
Coil 'Le' Node=2=3 L=1.2mH
Gyrator 'Gy1' Node=3=0=4=0 Bl=9.2Tm
MechResistance 'Rm' Node=4=5 Rm=0.88Ns/m
MechMass 'Mm' Node=5=6 Mm=38g
MechCompliance 'Cm' Node=6=7 Cm=1.86e-3m/N
Coupler 'Cp1' Node=7=8=10
Ratio={1/Sd}
Coupler 'Cp2' Node=8=0=0=12
Ratio={1/Sd}
AcouCompliance 'Ca1' Node=10=0 Ca={Ca1}
AcouResistance 'Ra1' Node=10=0 Ra={Ra1}
AcouMass 'Ma1' Node=10=11 Ma={Mat}
Radiator 'Rad1' Node=11
SD={St} |Piston
x=0 y=0 z=0 HAngle=0 VAngle=0
AcouCompliance 'Ca2' Node=12=0 Ca={Ca2}

```

Akustický tlak generovaný sústavou vo vzdialenosti $r=1m$:



Akustický tlak v trubici a v akustickom poli - porovnanie

