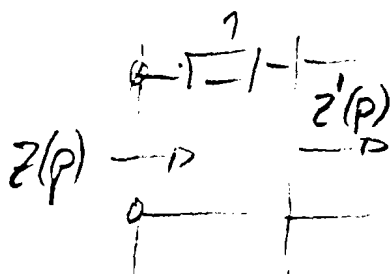


Lösungen zu Klausur Netzwerke (SS 1984)

Aufg. 1

a) $Z(p \rightarrow 0) = 1$ — p Widerst. = 1 1P $\Sigma = 15P$

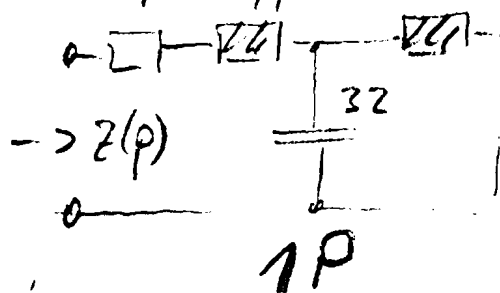


$Z'(p) = Z(p) - 1$

Übertragung: 1P

$Z' = \frac{6p^3 + 8p^2 + p + 1 - 8p^2 - 1}{8p^2 + 1} = \frac{6p^3 + p}{8p^2 + 1}$ 1P die 3. Polst. aufbau. bei diesem Wert

1.) $Z(p \rightarrow \infty) = \infty$ — p Zähler/Nenner:



1P

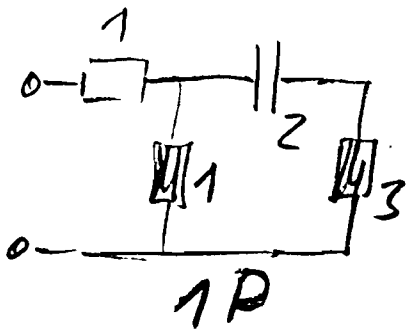
$$\begin{array}{r|l} 6p^3 + p & 8p^2 + 1 \\ \hline 6p^3 + \frac{3}{4}p & \frac{3}{4}p \leftarrow L \quad 1P \end{array}$$

$$\begin{array}{r|l} 8p^2 + 1 & \frac{1}{4}p \\ \hline 8p^2 & 32p \leftarrow C \quad 2P \end{array}$$

$$\begin{array}{r|l} 1 & 1 \\ \hline 4 & \frac{1}{4}p \leftarrow L \quad 2P \\ \hline 4 & \\ \hline 0 & \end{array}$$

bei Existenz + Schaltg. richtig bis weiches 9P
ohne R

2. $Z(p \rightarrow 0) = 0$



$\frac{1P}{1P}$ Numerator/Zähler : 1. Element = Indukt.

$$\frac{1+8p^2}{1+6p^2} \Bigg| \frac{p+6p^3}{\frac{1}{p} + \frac{1}{L_{max}p}} \quad 1P$$

$$\frac{p+6p^3}{2p^2} \Bigg| \frac{1}{2p} + \frac{1}{L_{max}p} \quad 1P$$

$$\frac{2p^2}{2p^2} \Bigg| \frac{6p^3}{\frac{1}{3p}} + \frac{1}{L_{max}p} \quad 1P$$

Aufg. 2

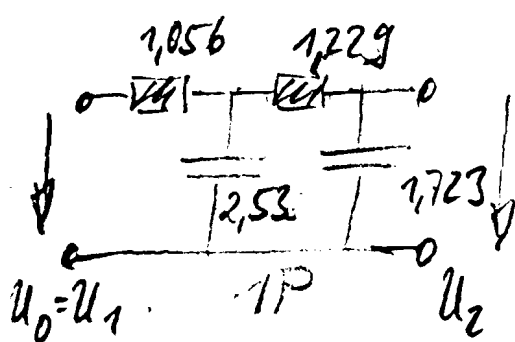
$\Sigma = 28P$

a) $D(p) = \frac{H(p)}{H(0)} = 1 + 2,285p + 6,609p^2 + 3,284p^3 + 5,657p^4$ 1P

b) $Z(p) = \frac{1}{R_2 Y_{22}(p)} = \frac{u(p)}{g(p)} = \frac{3,284p^3 + 2,285p}{5,657p^4 + 6,609p^2 + 1}$ 1P

Realitätsf: $Z(p \rightarrow \infty) = 0$ $\frac{-101}{0} \leftarrow Z(p)$

Division $\frac{\text{Nenner}}{\text{Zähler}}$ bei $Z(p)$
richtiges Start 3P



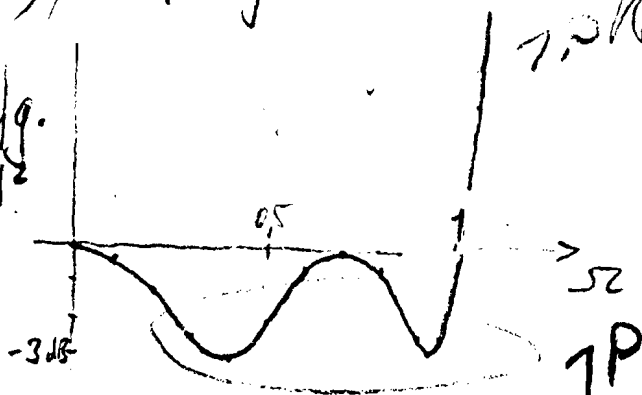
$$\begin{array}{r|l}
 5,657p^4 + 6,609p^2 + 1 & 3,284p^3 + 2,285p \\
 \hline
 5,657p^4 + 3,936p^2 & 1,723p \leftarrow C_{3P} \\
 \hline
 3,284p^3 + 2,285p & 2,673p^2 + 1 \\
 \hline
 3,276p^3 + 1,229p & 1,229p \leftarrow L_{1P} \\
 \hline
 2,673p^2 + 1 & 1,056p \\
 \hline
 2,673p^2 & 2,530p \leftarrow C_{1P} \\
 \hline
 1,056p & 1 \\
 \hline
 1,056p & 1,056p \leftarrow C_{2P} \\
 \hline
 0 &
 \end{array}$$

c) n. Weg

$|D|^2 = [1 - 6,609\Omega^2 + 5,657\Omega^4]^2 + (2,285\Omega - 3,284\Omega^3)^2$ 1P

$|D(0)| = 1$ und $|D(1)| = 1 \rightarrow$ jeweils 0 dB Dämpfung 1P

Dämpfung
10log |D|^2



anderes Uly: es gilt $|D|^2 = \frac{|H|^2}{H(0)^2} = \frac{1}{2} |H|^2$ (1P)

außerdem $(|H|^2 = 1 + \epsilon^2 \tan^2 \alpha = 1 + (85\Omega^4 - 85\Omega^2 + 1)^2$ (1P)
 " " $85\Omega^4 - 85\Omega^2 + 1$ (1P)

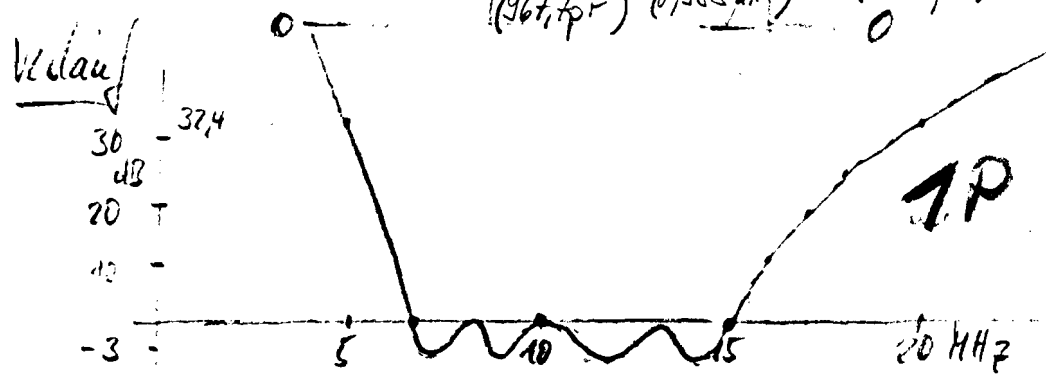
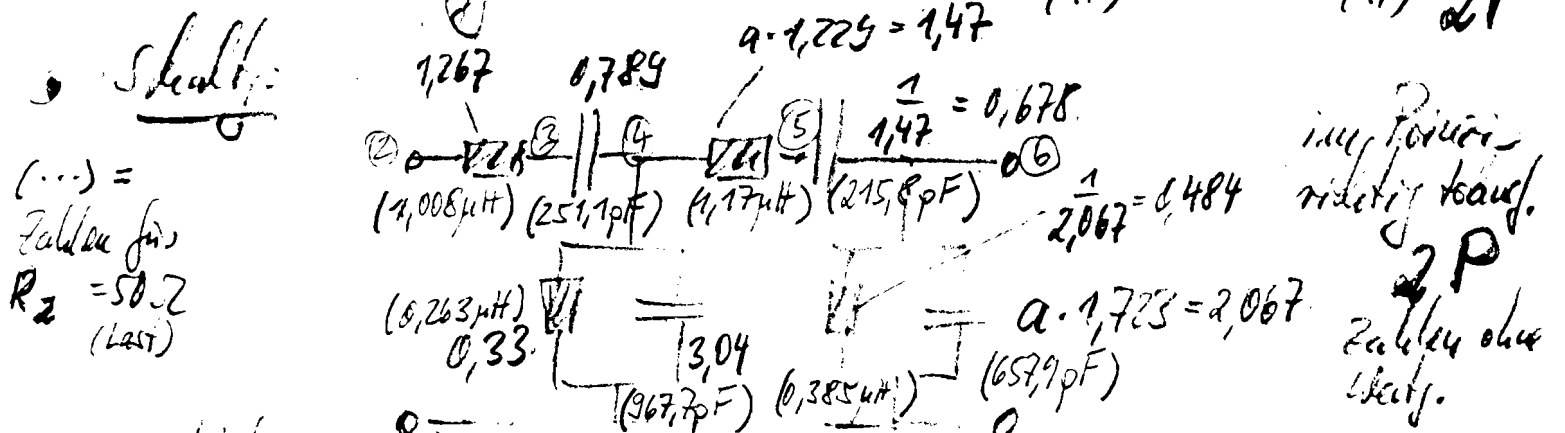
$|D|^2 = \frac{1}{2} [(85\Omega^4 - 85\Omega^2 + 1)^2 + 1]$ 4P (1P)

d) $f_B = \sqrt{f_{+S} f_{-S}} = \underline{10 \text{ MHz}}$ 1P

$f_{+D} f_{-D} = f_B^2 \rightarrow f_{-D} = \frac{f_B^2}{f_{+D}} = \underline{6,66 \text{ MHz}}$ 1P

$a = \frac{1}{\tilde{\omega}_{+D} - \tilde{\omega}_{-D}} = \frac{f_B}{f_{+D} - f_{-D}} = 1,2$ 1P
 $\sigma_S = \frac{f_{+S} - f_{-S}}{f_{+D} - f_{-D}} = 1,8$ 1P

Dämpfung: 1P-Dämpfung bei $\sigma = \sigma_S$ bestimmen $\rightarrow 10 \log |D|^2 = 37,4 \text{ dB}$ (1P) 2P
 $a \cdot 1,225 = 1,47$



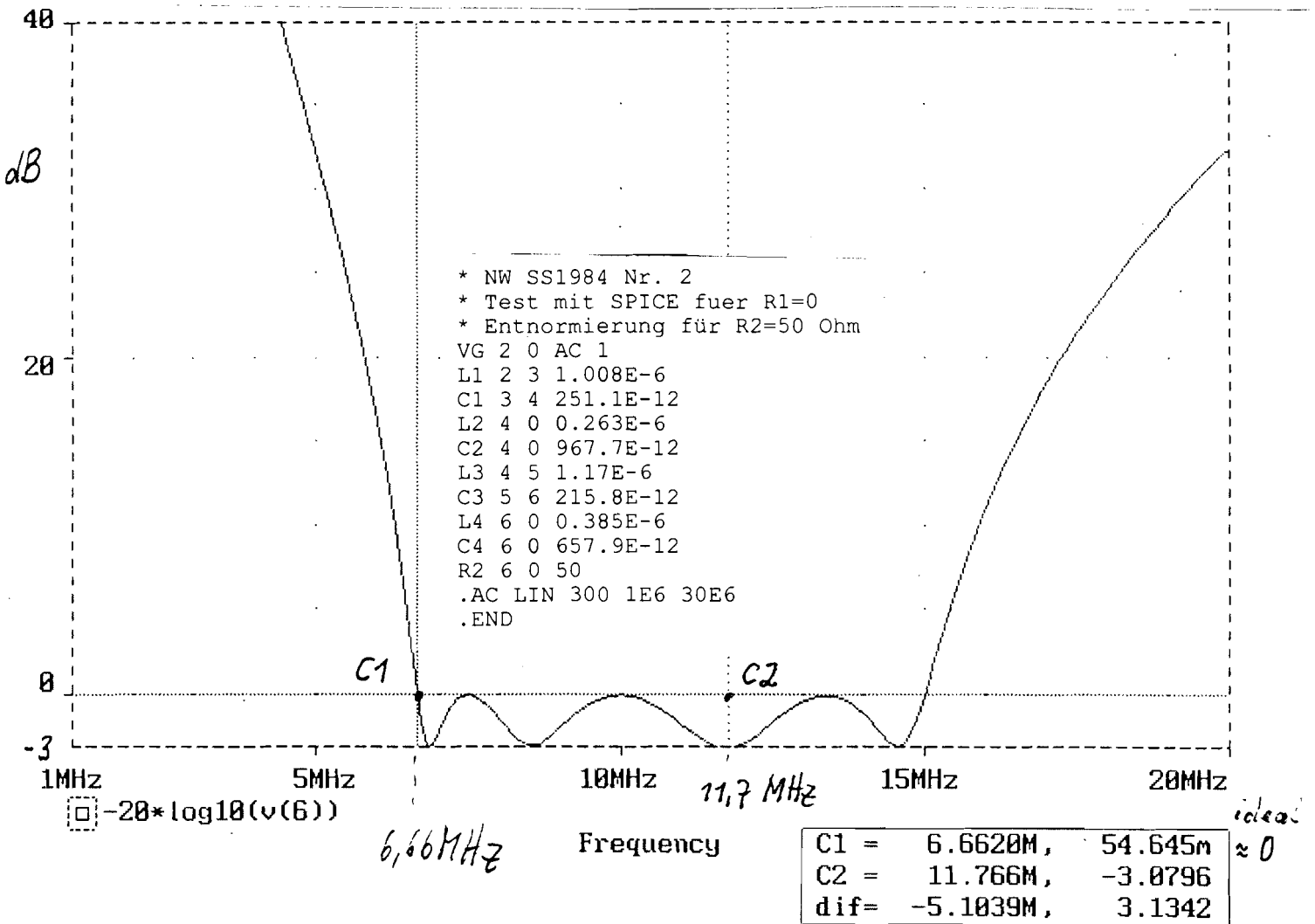
falls keine bei 1P fehlt, sonst ist richtig: 2P

SPICE-

Test zu Aufg. 2

Entnormierung willkürlich für $R_2 = 50 \Omega = R_B$

$$L = R_B \frac{L_{nor}}{\omega_B} ; C = \frac{C_{nor}}{\omega_B R_B}$$



Aufg. 3

$$\Sigma = 17P$$

a) $T(p) = \frac{1}{p+1}$ (1P) ; $p = \frac{s}{\omega_{BT}} \rightarrow \frac{2}{\omega_{BT} \tau} = f^e$ $\frac{1-z^{-1}}{1+z^{-1}}$

$$\Rightarrow T(z) = \frac{1}{f^e \frac{1-z^{-1}}{1+z^{-1}} + 1} = \frac{1+z^{-1}}{f(1-z^{-1}) + 1+z^{-1}} = \frac{1+z^{-1}}{1+f+z^{-1}(1-f)}$$

$$T(z) = \frac{1}{1+f} \frac{1+z^{-1}}{1 + \frac{1-f}{1+f} z^{-1}}$$

$A = \frac{-1}{1+f}$; $b_1 = 1$ (1P)
 $a_1 = \frac{1-f}{1+f}$ (1P)

b) Stabilität:

Nullstelle aus $z + \frac{1-f}{1+f} = 0 \rightarrow z_0 = \frac{f-1}{f+1}$

Bedingung $|z_0| < 1$ (1P) $\rightarrow |f-1| < f+1$

$\Leftrightarrow f^2 - 2f + 1 < f^2 + 2f + 1 \rightarrow 0 < 4f \rightarrow f > 0$ (1P)
 immer stabil! (2P)
 oder $|a_2| < 1$

c) Transformation

$$\omega \rightarrow \frac{z}{\tau} \tan \frac{\omega \tau}{2}$$

1. Polstelle bei $\frac{\omega \tau}{2} = \frac{\pi}{2} \rightarrow \omega_{\infty} = 2\pi f_{\infty} = \frac{\pi}{\tau} \rightarrow$

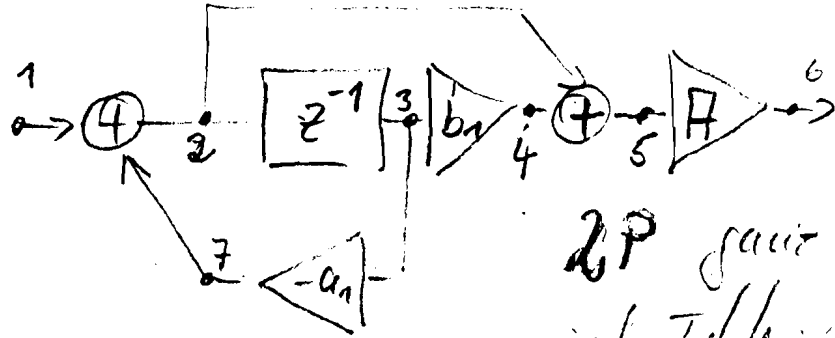
Verzögerzeit: $\tau = \frac{1}{2 f_{\infty}} = \underline{\underline{116,279 \mu s}}$ (1P)

$\omega_{BT} = \frac{z}{\tau} \tan \frac{\omega_{BT} \tau}{2} \Rightarrow f_{BT} = \underline{\underline{5,3244 \text{ MHz}}}$ (1P)
 $f_{BK} = 3 \text{ MHz}$

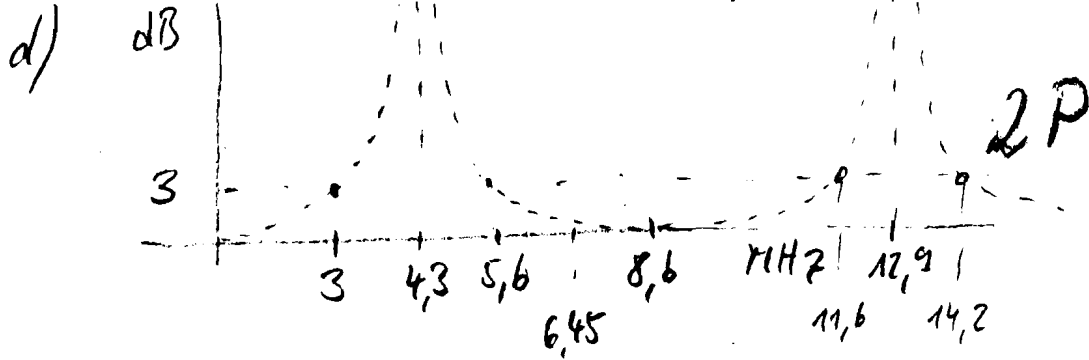
$C \Rightarrow f = \frac{z}{\omega_{BT} \tau} = \underline{\underline{0,51474}}$ (1P)

$C \Rightarrow A = 0,66044$ (1P) ; $a_1 = 0,320885$ (1P)

Schaltf:

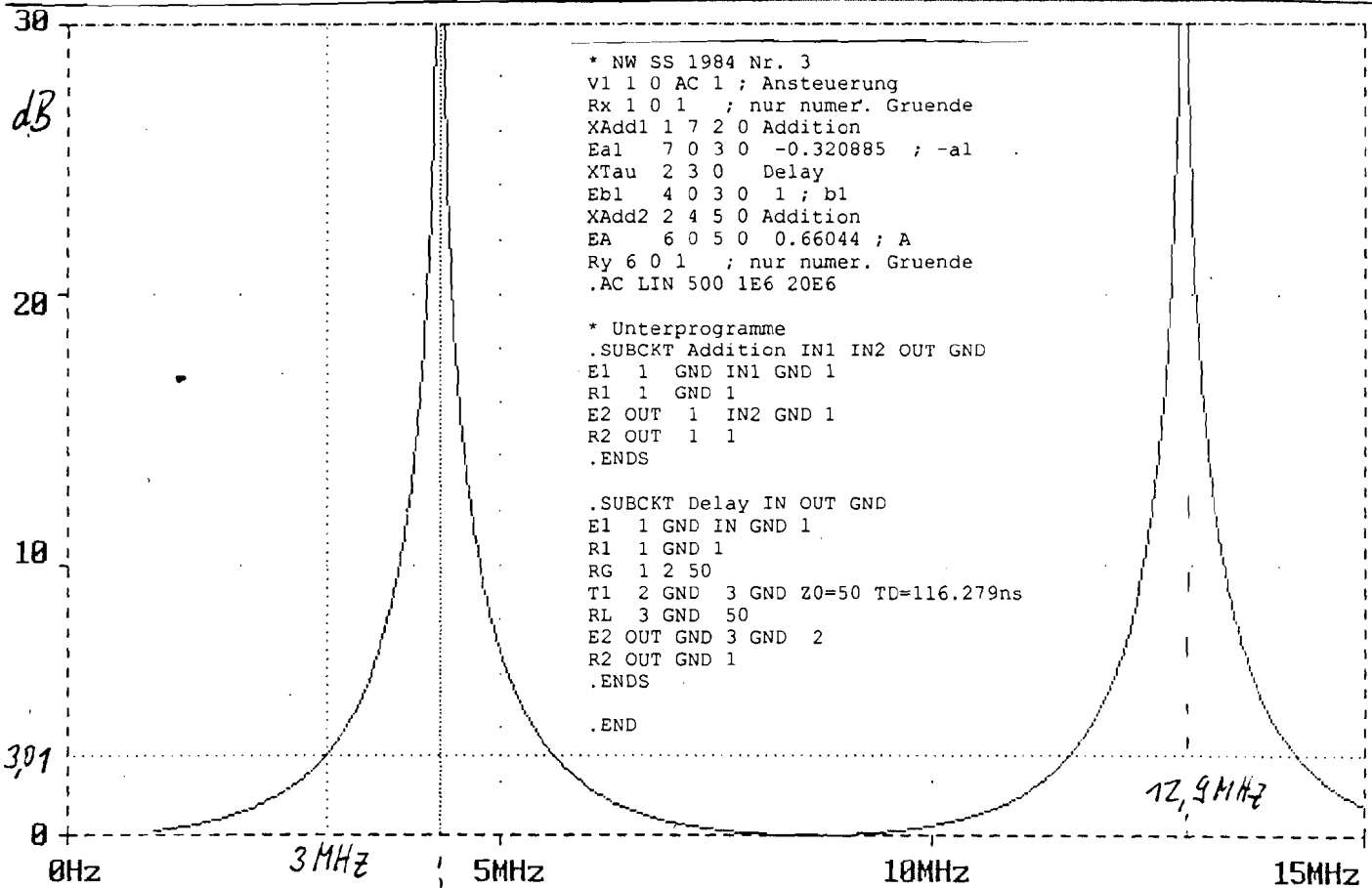


2P ganz richtig
jedes Filter: 1 Pol 1 Nullstelle



Test →

Probe mit Nachbildung der Schaltung in SPICE:



```
* NW SS 1984 Nr. 3
V1 1 0 AC 1 ; Ansteuerung
Rx 1 0 1 ; nur numer. Gruende
XAdd1 1 7 2 0 Addition
Ea1 7 0 3 0 -0.320885 ; -a1
XTau 2 3 0 Delay
Eb1 4 0 3 0 1 ; b1
XAdd2 2 4 5 0 Addition
EA 6 0 5 0 0.66044 ; A
Ry 6 0 1 ; nur numer. Gruende
.AC LIN 500 1E6 20E6

* Unterprogramme
.SUBCKT Addition IN1 IN2 OUT GND
E1 1 GND IN1 GND 1
R1 1 GND 1
E2 OUT 1 IN2 GND 1
R2 OUT 1 1
.ENDS

.SUBCKT Delay IN OUT GND
E1 1 GND IN GND 1
R1 1 GND 1
RG 1 2 50
T1 2 GND 3 GND ZO=50 TD=116.279ns
RL 3 GND 50
E2 OUT GND 3 GND 2
R2 OUT GND 1
.ENDS

.END
```

$-20 \cdot \log_{10}(v(6)/v(1))$

$f_{00} = 4,3 \text{ MHz}$

Frequency

C1 =	4.3077M,	40.157
C2 =	3.0000M,	3.0113
dif=	1.3077M,	37.145