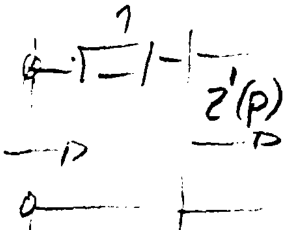
Lösungen zu Klausur Netzsynthese
(SS 1984)

Aufg. 1

a) $Z(p \to 0) = 1$ → Widerstand $= 1$ **1P** $\qquad \Sigma = 15P$



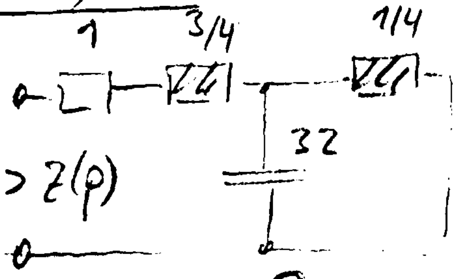
$Z'(p) = Z(p) - 1$

Überlegung: **1P**

$$Z' = \frac{6p^3+8p^2+p+1-8p^2-1}{8p^2+1} = \frac{6p^3+p}{8p^2+1} \quad \textbf{1P}$$

diese 3 Pkt autom. bei besserem Start

1.) $Z(p \to \infty) = \infty$ → Zähler/Nenner:



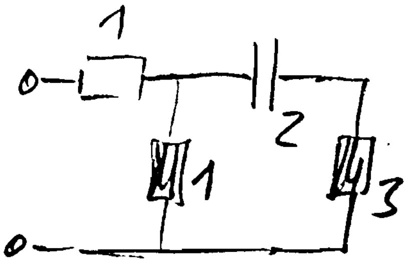
1P

$$\begin{array}{l|l}
6p^3+p & 8p^2+1 \\
6p^3+\frac{3}{4}p & \frac{3}{4}p \quad \leftarrow L \ \textbf{1P} \\
\hline
8p^2+1 & \frac{1}{4}p \\
8p^2 & 32p \quad \leftarrow C \ \textbf{2P} \\
\hline
\frac{1}{4}p & 1 \\
\frac{1}{4}p & \frac{1}{4}p \quad \leftarrow L \ \textbf{2P} \\
0 &
\end{array}$$

bei Division + Schaltg. ohne R richtig bis hierher 9P

$2.\ Z(p \to 0) = 0$ (1P) → Nenner/Zähler : 1. Element = Induktivität.

2P



1P

(1P) $1+8p^2 \;|\; p+6p^3$

$1+6p^2 \quad \frac{1}{p} \leftarrow \frac{1}{L_{ser}\,p}$ 1P

$p+6p^3 \;|\; 2p^2$

$p \quad \frac{1}{2p} \leftarrow \frac{1}{C_{ser}\,p}$ 1P

$2p^2 \;|\; 6p^3$

$2p^2 \quad \frac{1}{3p} \leftarrow \frac{1}{L_{ser}\,p}$ 1P

0

Aufg. 2 $\Sigma = 28P$

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

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

Realisierung: $Z(p \to \infty) = 0$ $\leftarrow Z(p)$

Division $\frac{\text{Nenner}}{\text{Zähler}}$ bei $Z(p)$

richtiger Start **3P**

$5{,}657\,p^4 + 6{,}609\,p^2 + 1 \;|\; 3{,}284\,p^3 + 2{,}285\,p$

$5{,}657\,p^4 + 3{,}936\,p^2 \;|\; 1{,}723\,p \leftarrow C$ **2P**

$3{,}284\,p^3 + 2{,}285\,p \;|\; 2{,}673\,p^2 + 1$

$3{,}276\,p^3 + 1{,}229\,p \;|\; 1{,}229\,p \leftarrow L$ **1P**

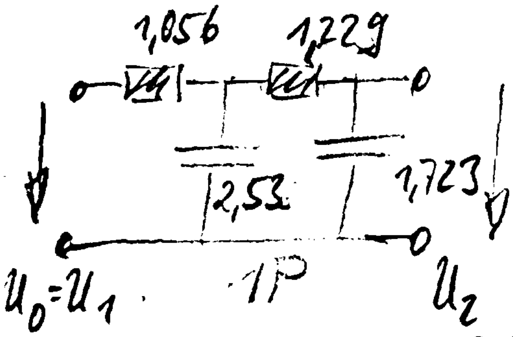
$2{,}673\,p^2 + 1 \;|\; 1{,}056\,p$

$2{,}673\,p^2 \;|\; 2{,}530\,p \leftarrow C$ **1P**

$1{,}056\,p \;|\; 1$

$1{,}056\,p \;|\; 1{,}056\,p \leftarrow C$ **2P**

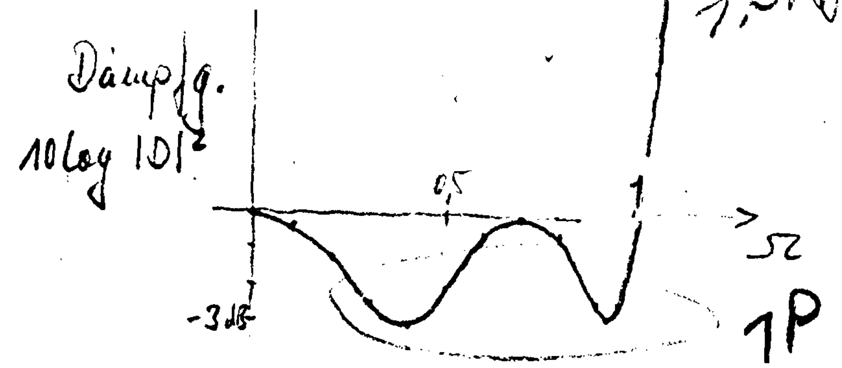
0



c) **1. Weg**

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

$|D(0)| = 1$ und $|D(1)| = 1 \Rightarrow$ jeweils 0 dB Dämpfg. **1P**



1P

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

außerdem $|H|^2 = 1+\epsilon^2 T_4^2 = 1 + (8\Omega^4-8\Omega^2+1)^2$

(1P) $\epsilon = 1$, $T_4 = 8\Omega^4-8\Omega^2+1$ (1P)

$\Rightarrow |D|^2 = \frac{1}{2}\left[\underbrace{(8\Omega^4-8\Omega^2+1)^2+1}_{(1P)}\right]$ 4P

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

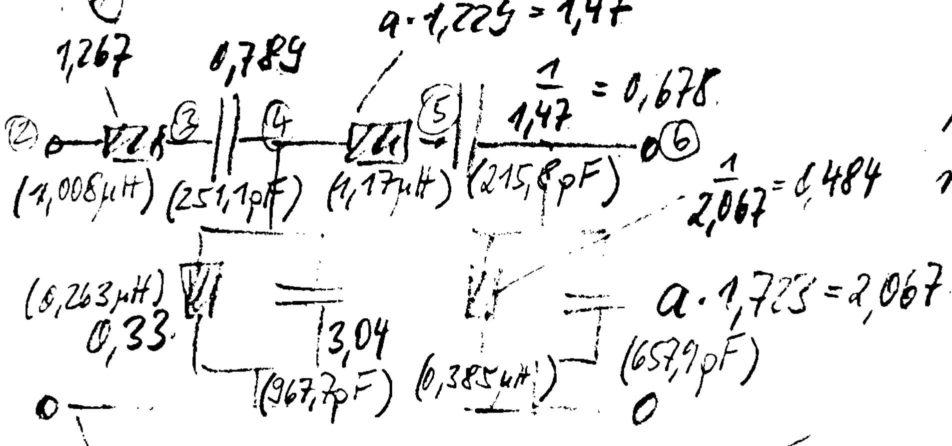
$f_{+D} f_{-D} = f_B^2 \Rightarrow f_{-D} = \frac{f_B^2}{f_{+D}} = \underline{6{,}66 \text{ MHz}}$ 1P

$a = \frac{1}{\hat\Omega_{+D} - \hat\Omega_{-D}} = \frac{f_B}{f_{+D}-f_{-D}} = \underline{1{,}2}$ 1P $\Omega_S = \frac{f_{+S}-f_{-S}}{f_{+D}-f_{-D}} = \underline{\underline{1{,}8}}$ 1P

Dämpf.: TP-Dämpf. bei $\Omega = \Omega_S$ bestimmen (1P) c) $\Rightarrow 10\log|D|^2 = 37{,}4$ dB (1P) 2P

Schalt.:

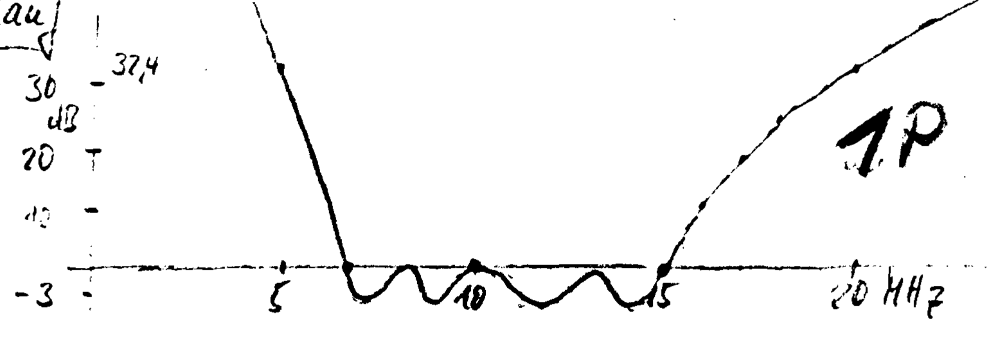
(...) = Zahlen für $R_Z = 50\,\Omega$ (Last)



im Prinzip richtig kaum. 2P

Zahlen ohne Skalg.

Verlauf



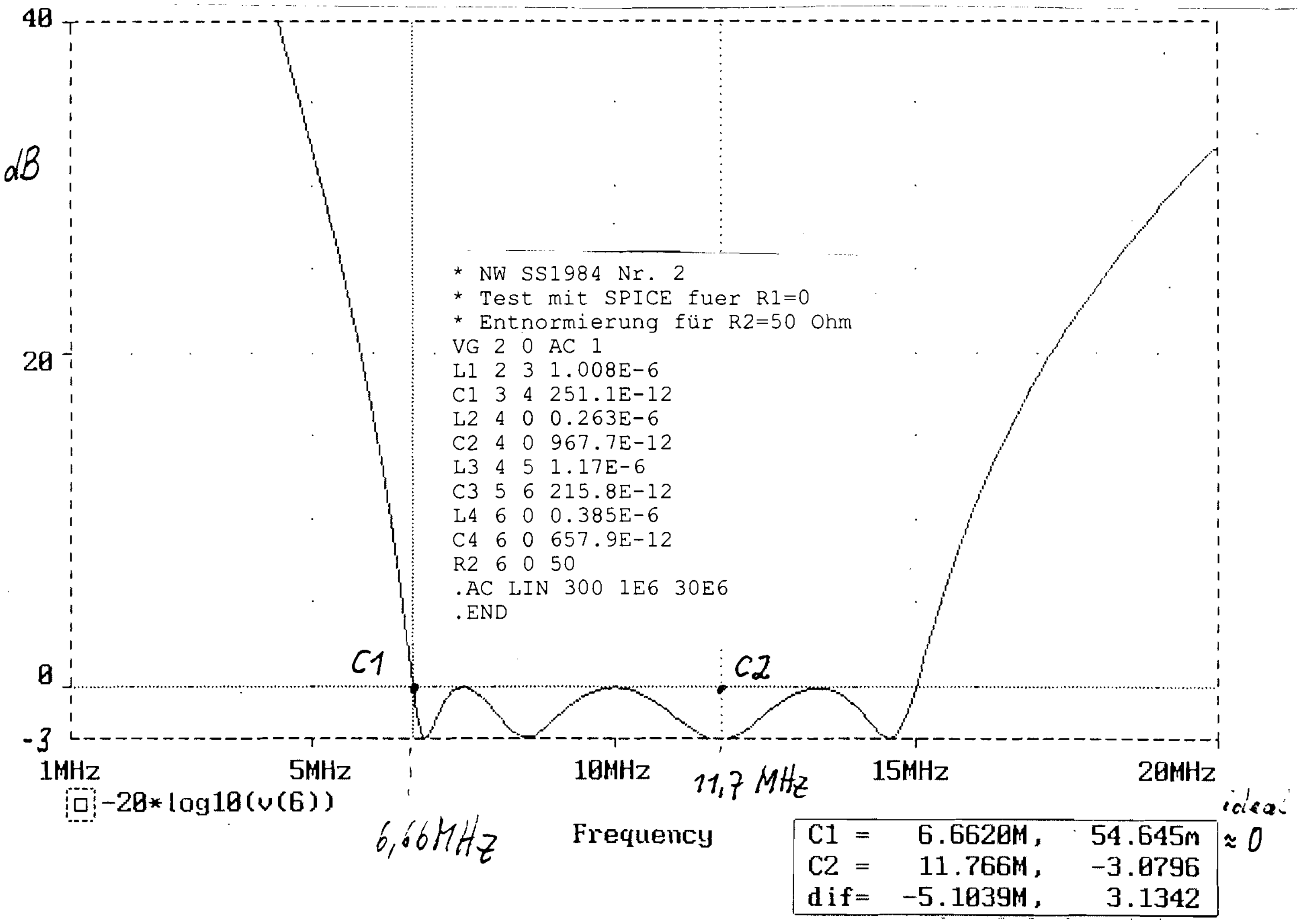
1P

falls Kurve bei TP fehlt, sonst alles richtig: 2P

SPICE-Test zu Aufg. 2

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

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



Aufg. 3 $\quad \Sigma = 17P$

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

$$\Rightarrow T(z) = \frac{1}{\gamma \frac{1-z^{-1}}{1+z^{-1}} + 1} \text{ (1P)} = \frac{1+z^{-1}}{\gamma(1-z^{-1}) + 1 + z^{-1}} = \frac{1+z^{-1}}{1+\gamma + z^{-1}(1-\gamma)}$$

$$T(z) = \frac{1}{1+\gamma} \; \frac{1+z^{-1}}{1 + \frac{1-\gamma}{1+\gamma} z^{-1}} \text{ (1P) } \mathbf{3P} \rightarrow$$

$\underline{A = \frac{1}{1+\gamma}}$ **1P** ; $\underline{b_1 = 1}$ **1P**

$\underline{a_1 = \frac{1-\gamma}{1+\gamma}}$ **1P**

b) Stabilität:

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

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

$\Leftrightarrow \gamma^2 - 2\gamma + 1 < \gamma^2 + 2\gamma + 1 \rightarrow 0 < 4\gamma \rightarrow \gamma > 0$ (1P)

immer stabil! **2P**

oder $|a_2| < 1$

c) Transformation

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

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

Verzögerungszeit: $\tau = \frac{1}{2 f_\infty} = \underline{116{,}279\,ns}$ **1P**

$\omega_{BT} = \frac{2}{\tau} \tan \frac{\omega_{BK}\tau}{2} \Rightarrow f_{BT} = \underline{5{,}3244\,MHz}$ **1P**

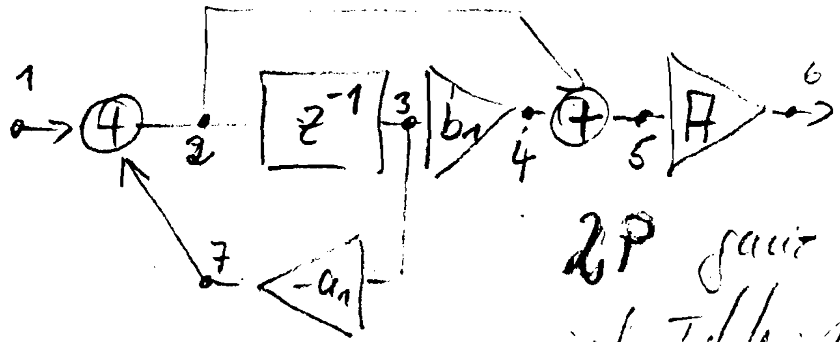
$f_{BK} = 3\,MHz$

$\Leftrightarrow \gamma = \frac{2}{\omega_{BT}\tau} = \underline{0{,}51414}$ **1P**

$\Leftrightarrow A = \underline{0{,}66044}$; $a_1 = \underline{0{,}320885}$

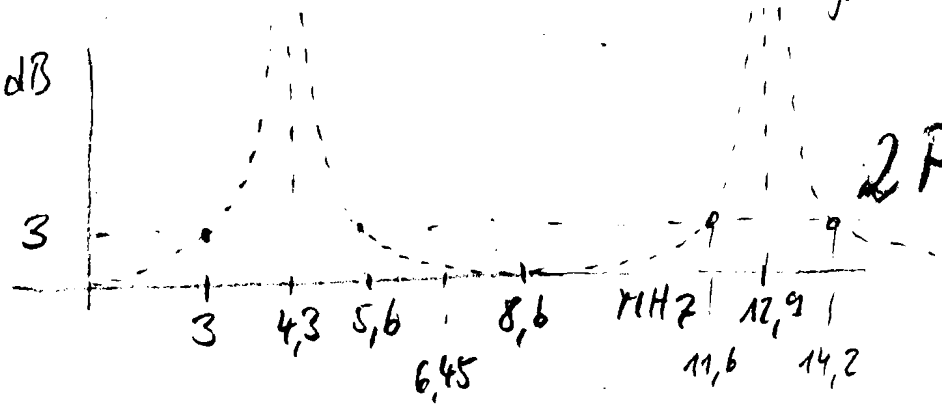
1P **1P**

Schaltung:



2P ganz richtig
jede Fehler: 1 Pkt Abzug

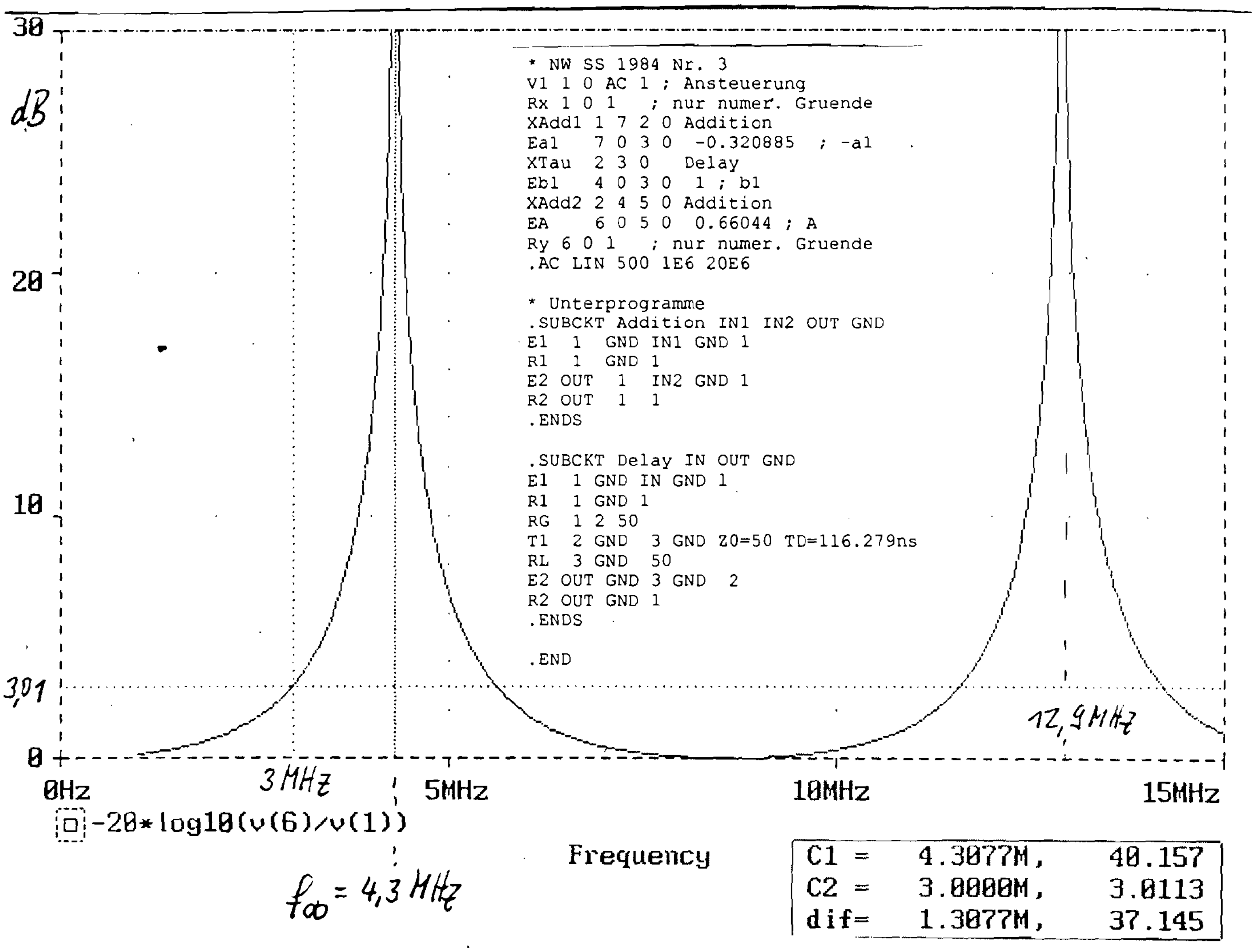
d)



2P

Test →

Probe mit Nachbildung der Schaltung in SPICE:



$f_{\infty} = 4{,}3$ MHz