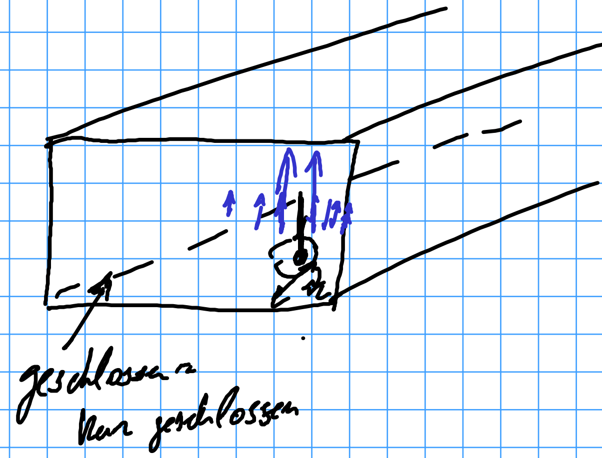
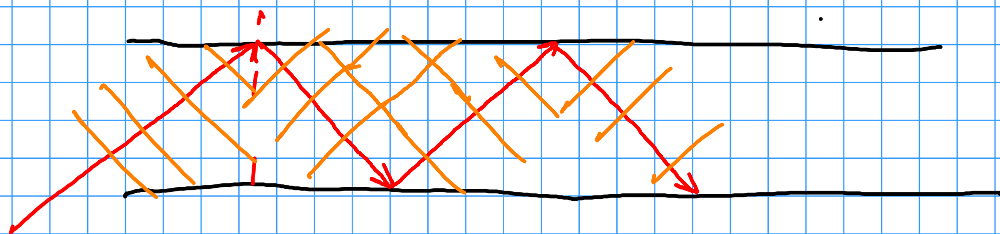
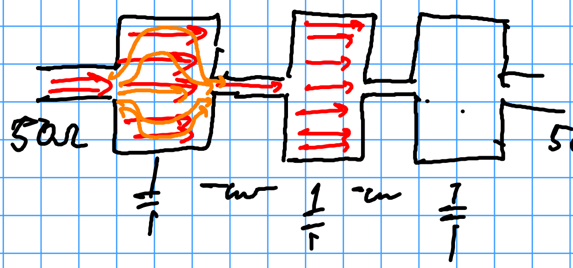

geschlossen
kurz geschlossen



Entwurf TP-Filter mit Leitungsstücken



FR4, 0,5 mm dick

$f_c = 1\,GHz$

Leiterbreiten & Impedanzen

50Ω: $w = 1mm$; $\lambda_{50} = 171\,mm$

99Ω (100Ω) $w_H = 0{,}25\,mm$ $\lambda_H = 180\,mm$ $Z_H = 100\,\Omega$

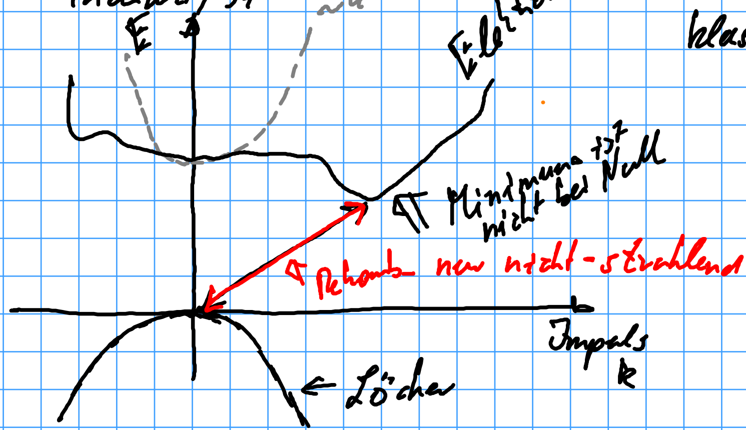
15Ω $w_L = 5\,mm$ $\lambda_L = 160\,mm$ $Z_L = 15\,\Omega$

Wähle Tschebyscheff-Filter mit $g_{rss} = 1dB$ $N = 5$

K	C oder L	l
2,135	6,8 pF	17,7 mm
1,091	8,68 nH	16,5 mm
3,001	9,55 pF	28,5 mm

Halbleiter

indirekt / Si

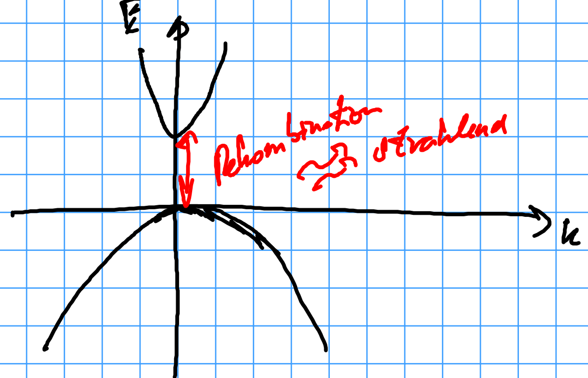


klassisch

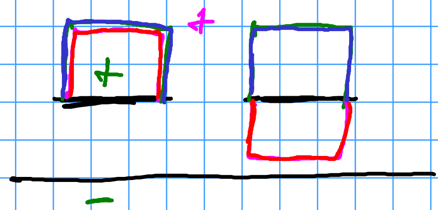
$E \sim p^2$

$\sim k^2$

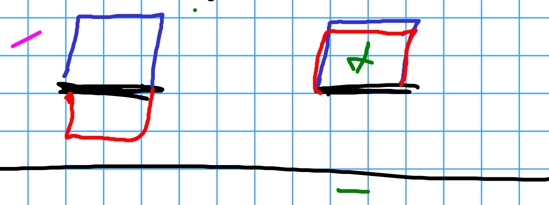
direkter HL / GaAs



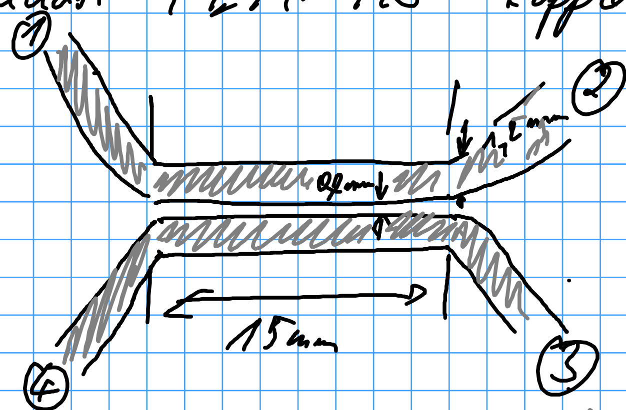
Gleich- & Gegentaktwelle



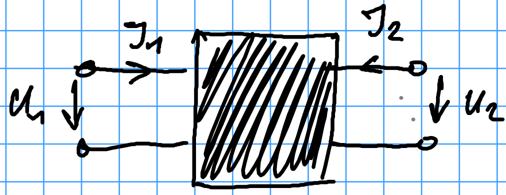
nach etwas Distanz und rot hat andere Geschwindigkeit/ Wellenlänge als blau



Quasi-TEM-MS-Koppler



4 Pol bzw. 2-Tor Parameter



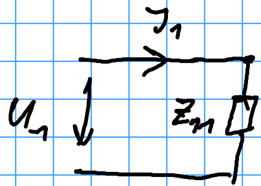
$U = R \cdot I$

$= Z \cdot I$

$$\begin{pmatrix} U_1 \\ U_2 \end{pmatrix} = \begin{pmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{pmatrix} \begin{pmatrix} I_1 \\ I_2 \end{pmatrix}$$

Annahme: $I_2 = 0$ (Leerlauf rechts) & I_1 eingeprägt

$U_1 = Z_{11} \cdot I_1$; $U_2 = Z_{21} \cdot I_1$

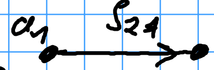


geht auch anders herum

Signalflussgrafen

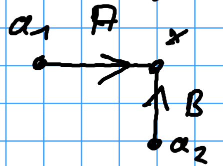
Knoten • hat Wert bzgw. a_1 oder a_2 ...

Grafen $\xrightarrow{S_{21}}$ hat auch Wert bzgw. S_{21}



$x = S_{21} \cdot a_1$

Lineare Beziehung

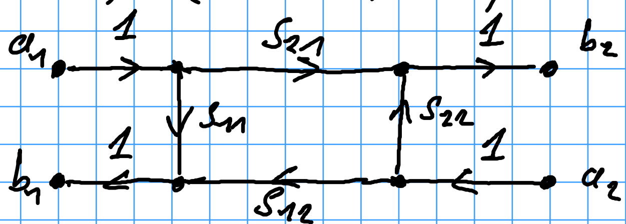


Wenn an einem Knoten zwei Grafen zusammen treffen werden ihre Ergebnisse addiert

$x = A \cdot a_1 + B \cdot a_2$

=> Damit hat man die Möglichkeit sämtliche linearen Beziehungen auszudrücken.

$$\begin{pmatrix} b_1 \\ b_2 \end{pmatrix} = \begin{pmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{pmatrix} \begin{pmatrix} a_1 \\ a_2 \end{pmatrix}$$

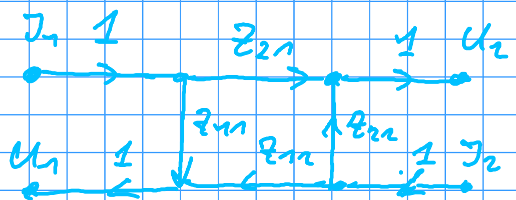


$b_2 = S_{22} \cdot a_2 + S_{21} \cdot a_1$

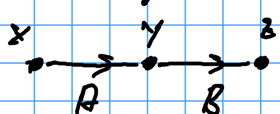
$b_1 = S_{11} \cdot a_1 + S_{12} \cdot a_2$

Bei Z-Parameter 4-Pol

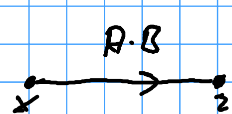
$$\begin{pmatrix} U_1 \\ U_2 \end{pmatrix} = \begin{pmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{pmatrix} \begin{pmatrix} I_1 \\ I_2 \end{pmatrix}$$

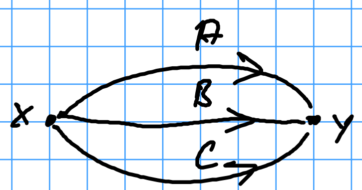


Rechenregeln

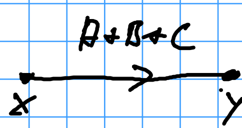


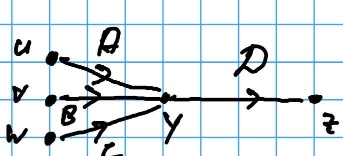
$z = B \cdot y = B \cdot A \cdot x$

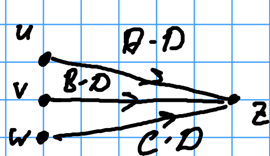




$y = (A+B+C) \cdot x$

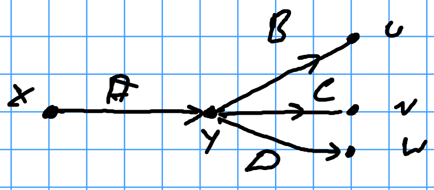


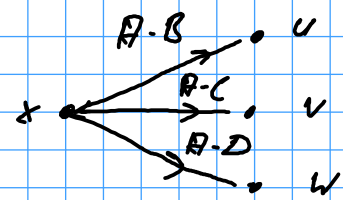




$z = A \cdot D\, u + B \cdot D \cdot v + C D \cdot w$

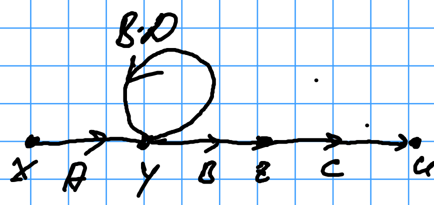
Knoten y wurde aufgespalten und ist damit zerstört worden.





Rückkoppelschleife

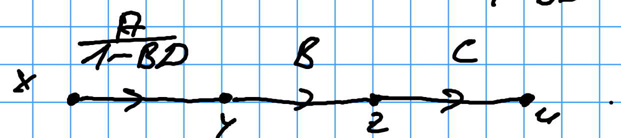
$$y = A\cdot x + D\cdot z$$



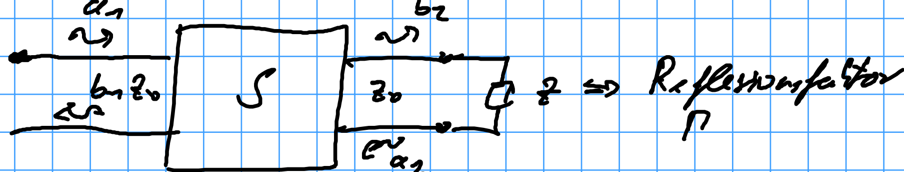
$$y = A\cdot x + B\cdot D\cdot y$$

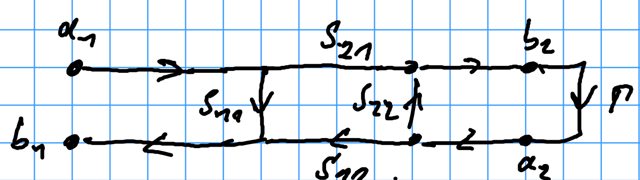
$$\Leftrightarrow y\cdot(1-BD) = A\cdot x$$

$$\Leftrightarrow y = \frac{A}{1-BD}\cdot x$$



Praktisch für 4-Pol

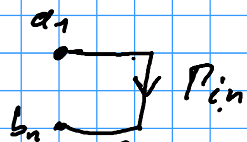


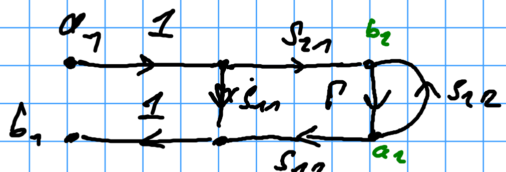


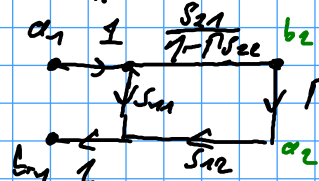
$$\begin{pmatrix} b_1 \\ b_2 \end{pmatrix} = \begin{pmatrix} S_{11} & S_{12} \\ S_{21} & S_{21} \end{pmatrix} \begin{pmatrix} a_1 \\ a_1 \end{pmatrix} \quad \text{und } a_2 = \Gamma\cdot b_2$$

a_1 gegeben

Ich will b_1 ausrechnen, also







$$b_1 = S_{11}\cdot a_1 + \frac{S_{21}\cdot\Gamma\cdot S_{12}}{1-\Gamma\cdot S_{22}}\cdot a_1$$

$$= \underbrace{\left(S_{11} + \frac{S_{21}\,\Gamma\cdot S_{12}}{1-\Gamma\cdot S_{22}}\right)}_{\Gamma_{in}}\cdot a_1$$

$\Gamma = 0$; $b_1 = S_{11} \cdot a_1$

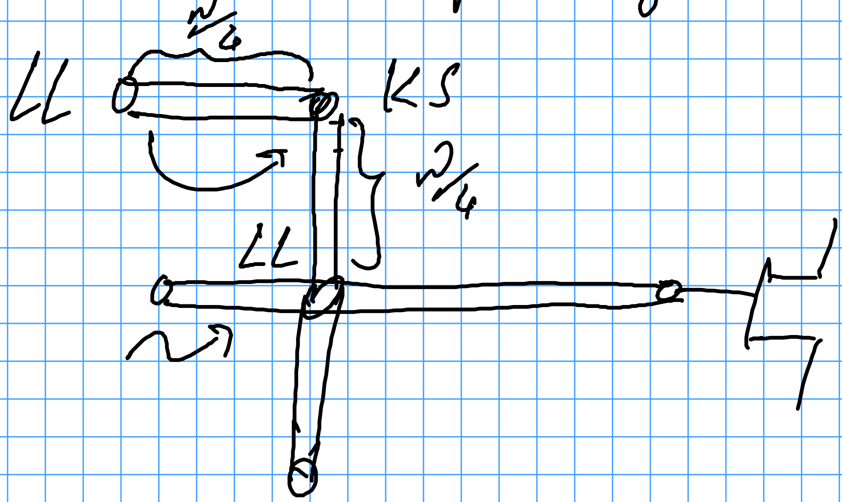
$S_{22} = 0$ $\quad b_1 = (S_{11} + S_{21} \Gamma \cdot S_{12})\, a_1$ Keine Rückkopplung

$S_{21} \approx 1,\ \Gamma \approx 1$ $\quad b_1 = \left(S_{11} + \frac{S_{21} \Gamma S_{12}}{\text{was kleines}}\right) a_1$

Wie groß ist b_2?

hier ist $\quad b_2 = \frac{S_{21}}{1 - \Gamma S_{22}} \cdot a_1$ Aktiv Anregung kann nur über a_1

Vorspannungs-NW mit Leitungen



λ @ 12 GHz

Verstärker

$f = 1250$ MHz

entweder mit BFP 450 → low-Noise

BFU 590 → mittl. Leistung