HSB
Hochschule Bremen
City University of Applied Sciences

Laboratory of Microwave Circuits and Systems

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LAB REPORT

Lab Exercise: **Designing a Low Noise Amplifier (LNA) Microwave Circuit.**

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Milestone 1:

Task: Theoretical design for maximum gain for transistor BFP640

Procedure:

1. Specifications:

Transistor: – BFP640 $V_{CE} = 2.0V$ $I_{CE} = 20.0mA$ $f = 4.0\ GHz$

2. Reading S – Parameters from the data sheet:

$S_{11} = 0.3820\angle 136.6°$ $\Rightarrow -0.28 + j\ 0.26$ $|S_{11}| = 0.38$

$S_{12} = 0.096\angle 37.0°$ $\Rightarrow 0.08 + j\ 0.06$ $|S_{12}| = 0.1$

$S_{21} = 5.694\angle 48.5°$ $\Rightarrow 3.77 + j4.26$ $|S_{21}| = 5.69$

$S_{22} = 0.0730\angle -81.2°$ $\Rightarrow 0.01 - j0.07$ $|S_{22}| = 0.07$

$\Delta = |S_{11}S_{22} - S_{12}S_{21}|$ $\Delta = 0.53$

3. Calculation:

Reflection Coefficients (Γ_S, Γ_L):

$$\Gamma_S = \frac{B_1 \pm \sqrt{B_1^2 - 4|C_1|^2}}{2C_1}$$

$$\Gamma_L = \frac{B_2 \pm \sqrt{B_2^2 - 4|C_2|^2}}{2C_2}$$

Where B_1, B_2 , C_1, C_2 can be calculated from the following equations:

$$B_1 = 1 + |S_{11}|^2 - |S_{22}|^2 - |\Delta|^2$$

$$B_1 = 1 + (0.38)^2 - (0.07)^2 - (0.53)^2 \qquad B_1 = 0.8586$$

$$B_2 = 1 + |S_{22}|^2 - |S_{11}|^2 - |\Delta|^2$$

$$B_2 = 1 + (0.07)^2 - (0.38)^2 - (0.53)^2 \qquad B_2 = 0.5796$$

$$C_1 = S_{11} - \Delta S_{22}^*$$

$$C_1 = -0.2853 + j\,0.2229 \Rightarrow 0.36\angle 142.0° \qquad |C_1| = 0.36$$

$$C_2 = S_{22} - \Delta S_{11}^*$$

$$C_2 = 0.1584 + j\,0.0678 \Rightarrow 0.17\angle 23.17° \qquad |C_2| = 0.1$$

$$\Gamma_S = -0.5089 - j0.4386 \Rightarrow 0.67\angle -139.243° \qquad |\Gamma_S| = 0.57$$

$$\Gamma_L = 0.2837 + j0.4565 \Rightarrow 0.54\angle 58.67° \qquad |\Gamma_L| = 0.32$$

Maximum Gain ($G_{T,max}$):

The Overall Transducer gain,

$$G_T = G_S + G_O + G_L$$

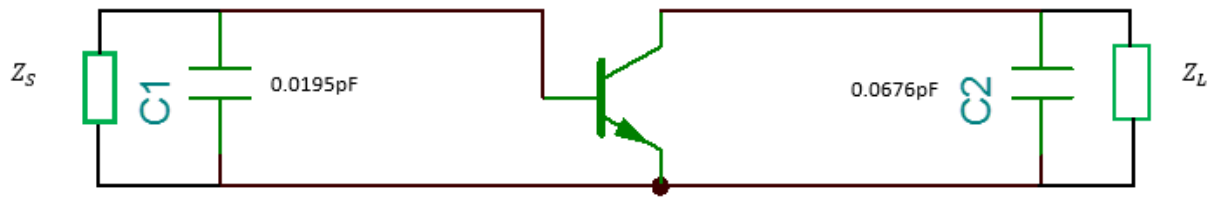
$$G_S = \frac{1}{1 - |\Gamma_S|^2}$$

$$G_O = |S_{21}|^2$$

$$G_L = \frac{1 - |\Gamma_L|^2}{|1 - S_{22}\Gamma_L|^2}$$

$$G_T = 16.5534\ dB$$

Circuit diagram with lumped elements:



The final amplifier circuit is designed as shown in the below figure:

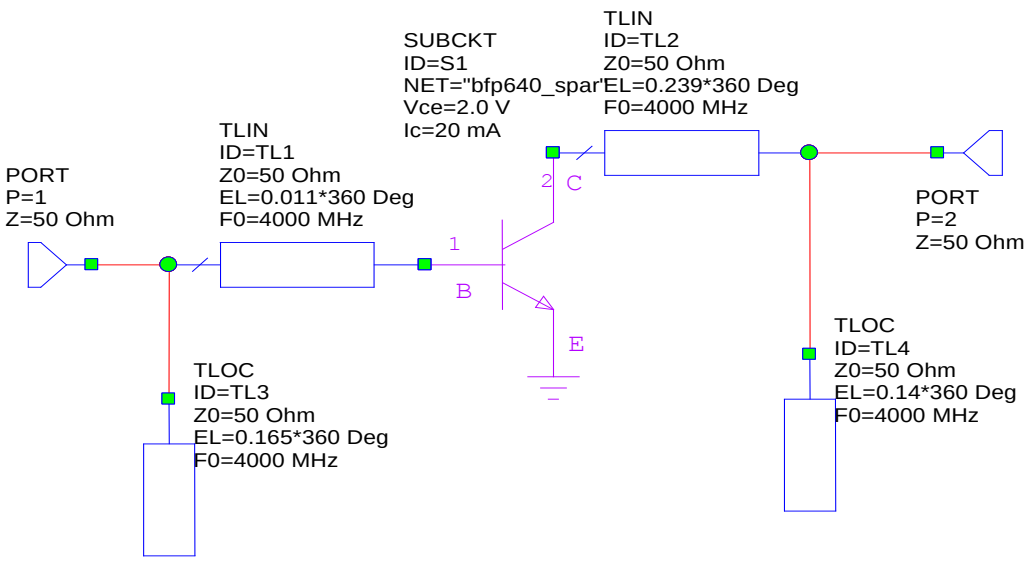


Figure 1: Transmission Line Circuit

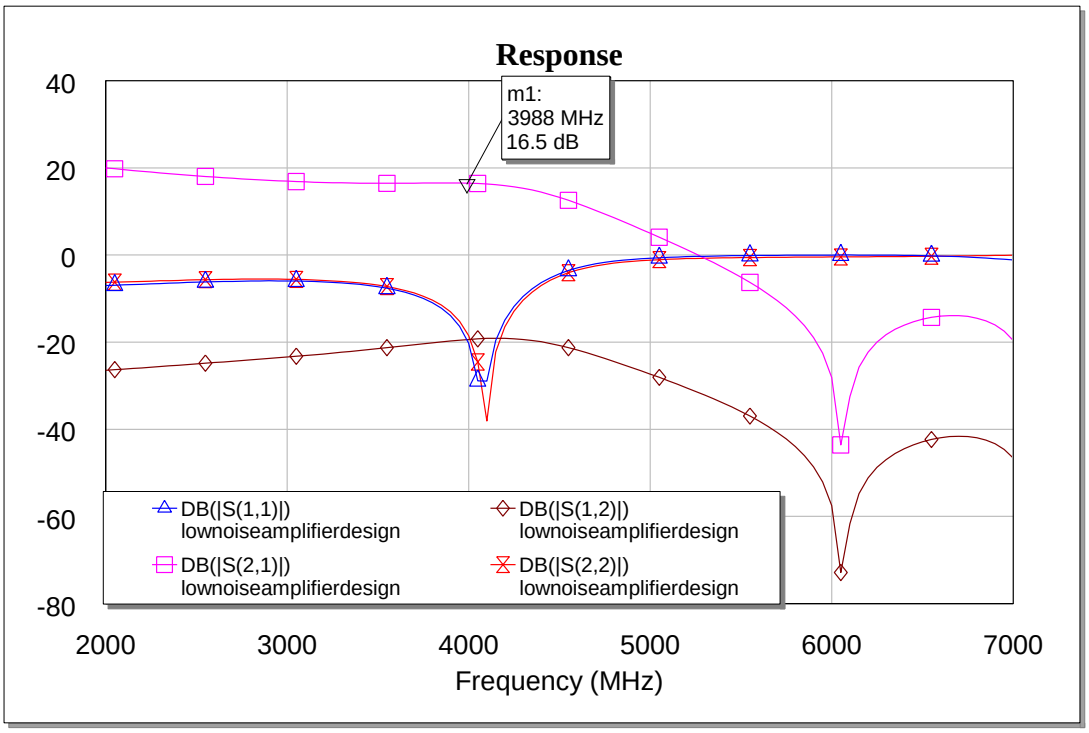


Figure 2: Transmission Line Response