

Task-5 Maximum Gain Amplifier Design

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Objective

- Designing a Maximum gain Amplifier for specified operating frequency ($f_0=4.5\text{GHz}$) using given transistor
- S2p file in the rar-zip file is used for producing operation of transistor.
- The amplifier is designed and simulated.
- Analysing the performance, is later performed with graph.

Procedure

- Calculate F_s and F_l using the equations.
- Plot the F_s and F_l in a smith chart and find respective values for series and shunt stub.
- Find the respective values of W and L for the series and shunt stub using transmission line calculator.
- Design the circuit
- Simulate the circuit.
- Analyze the results.

Design and calculations

Microwave Amplifier
calculations

Given: $f_0 = 4.5 \text{ GHz}$

$S_{11} = 0.58717 / 150.7^\circ$
 $S_{22} = 0.6381 / 23.474^\circ$
 $S_{12} = 0.021803 / -38.893^\circ$
 $S_{21} = 0.45097 / 146.13^\circ$

$K \Delta$ Test

$$K = \frac{1 - |S_{11}|^2 - |S_{22}|^2 + |\Delta|^2}{2 |S_{12} S_{21}|} > 1$$

$$\Delta = |S_{11} S_{22} - S_{12} S_{21}| < 1$$

$$\Delta = 0.34461$$

$$K = \frac{1 - 0.34461^2}{2 \cdot 0.021803 \cdot 0.45097} = 1.06633$$

μ -test

$$\mu = \frac{1 - |S_{11}|^2}{|S_{22} - \Delta S_{11}| + |S_{12} S_{21}|}$$

$$\mu = \frac{0.212929}{0.148249 + 0.009601} = 1.0211$$

Design and calculations

$$F_1 = \frac{Q_1 + \sqrt{Q_1^2 - 4V_1}}{2C_1}$$

$$F_2 = \frac{Q_2 + \sqrt{Q_2^2 - 4V_2}}{2C_2}$$

$$F_3 = \frac{1 + 4V_3 - 4V_3}{2} = 0.5$$

$$F_4 = \frac{1 + 4V_4 - 4V_4}{2} = 0.5$$

$$F_5 = \frac{201 - 201}{2} = 0$$

$$F_6 = \frac{202 - 202}{2} = 0$$

$$F_7 = \frac{Q_7 + \sqrt{Q_7^2 - 4V_7}}{2C_7} = \frac{14.4121 + \sqrt{14.4121^2 - 4 \cdot 1.9521}}{2 \cdot 1.9521} = 1.9521$$

$$F_8 = \frac{Q_8 + \sqrt{Q_8^2 - 4V_8}}{2C_8} = \frac{0.2152 + \sqrt{0.2152^2 - 4 \cdot 0.0001}}{2 \cdot 0.0001} = 0.0001$$

$$F_9 = \frac{0.2152 + \sqrt{0.2152^2 - 4 \cdot 0.0001}}{2 \cdot 0.0001} = 0.0001$$

$$F_{10} = \frac{0.2152 + \sqrt{0.2152^2 - 4 \cdot 0.0001}}{2 \cdot 0.0001} = 0.0001$$

$$F_{11} = \frac{0.2152 + \sqrt{0.2152^2 - 4 \cdot 0.0001}}{2 \cdot 0.0001} = 0.0001$$

$$F_{12} = \frac{0.2152 + \sqrt{0.2152^2 - 4 \cdot 0.0001}}{2 \cdot 0.0001} = 0.0001$$

$$F_{13} = \frac{0.2152 + \sqrt{0.2152^2 - 4 \cdot 0.0001}}{2 \cdot 0.0001} = 0.0001$$

$$F_{14} = \frac{0.2152 + \sqrt{0.2152^2 - 4 \cdot 0.0001}}{2 \cdot 0.0001} = 0.0001$$

$$F_{15} = \frac{0.2152 + \sqrt{0.2152^2 - 4 \cdot 0.0001}}{2 \cdot 0.0001} = 0.0001$$

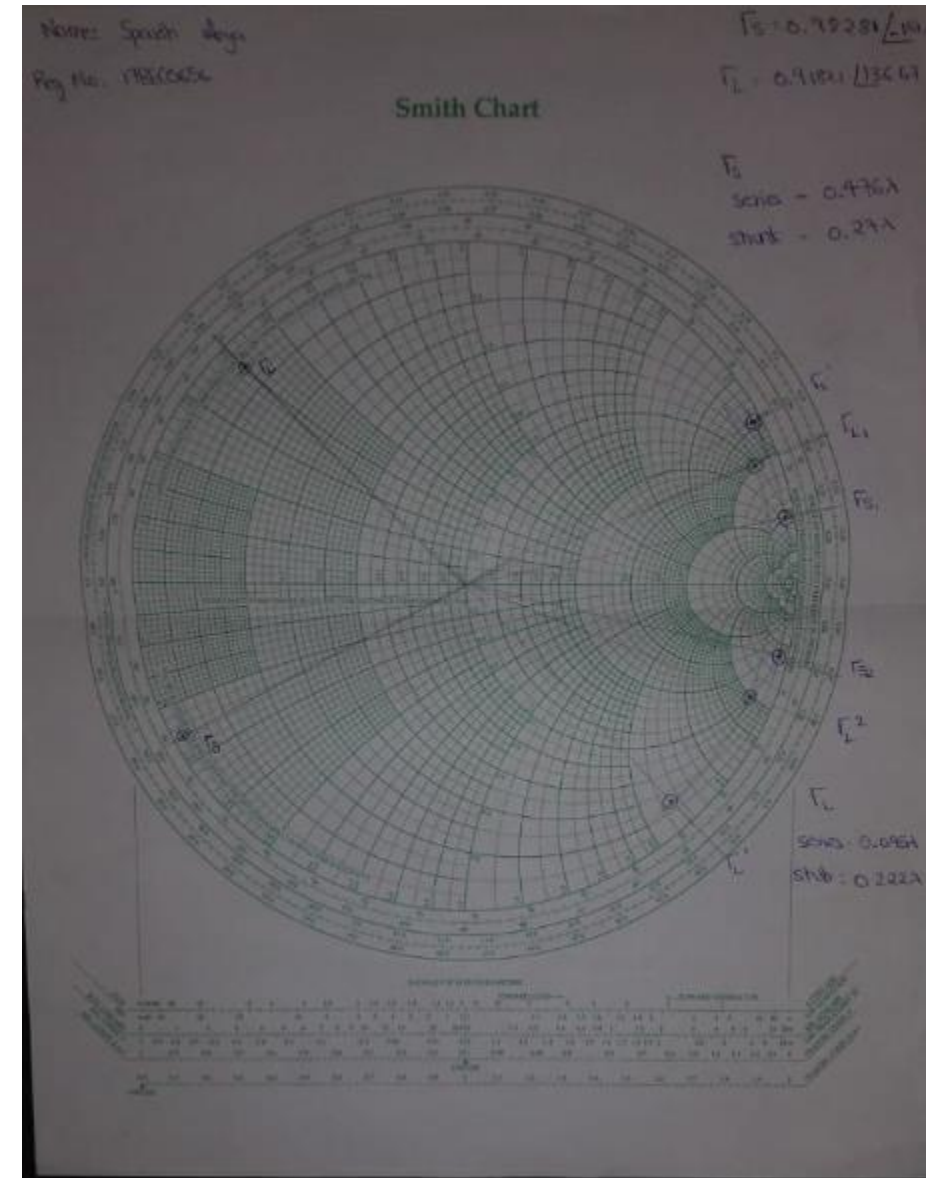
$$F_{16} = \frac{0.2152 + \sqrt{0.2152^2 - 4 \cdot 0.0001}}{2 \cdot 0.0001} = 0.0001$$

$$F_{17} = \frac{0.2152 + \sqrt{0.2152^2 - 4 \cdot 0.0001}}{2 \cdot 0.0001} = 0.0001$$

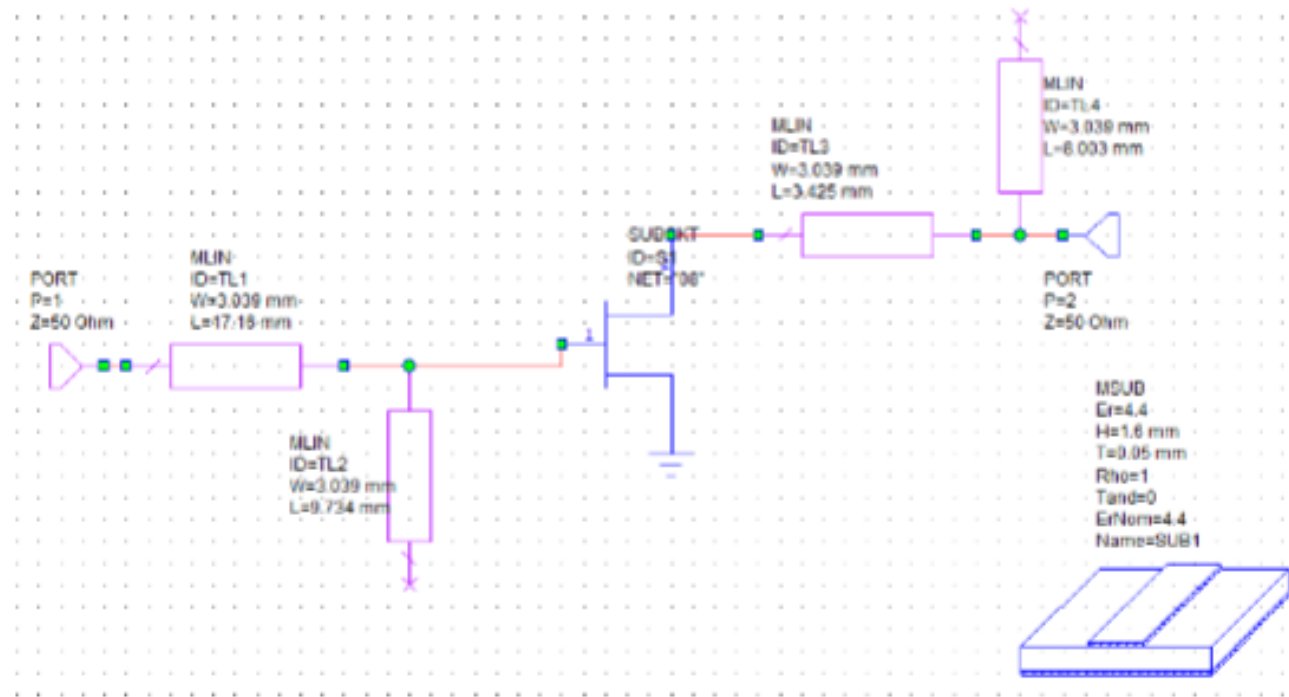
$$F_{18} = \frac{0.2152 + \sqrt{0.2152^2 - 4 \cdot 0.0001}}{2 \cdot 0.0001} = 0.0001$$

$$F_{19} = \frac{0.2152 + \sqrt{0.2152^2 - 4 \cdot 0.0001}}{2 \cdot 0.0001} = 0.0001$$

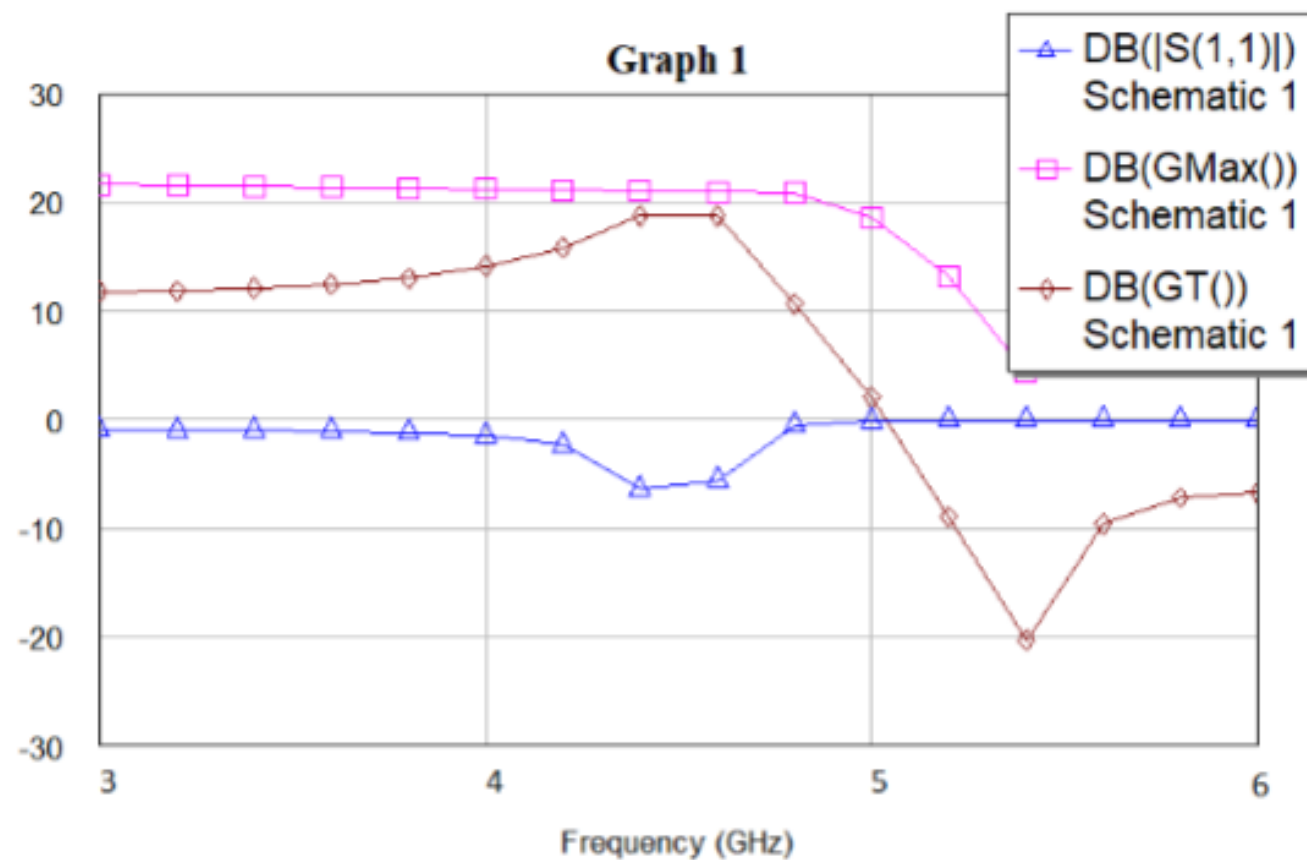
$$F_{20} = \frac{0.2152 + \sqrt{0.2152^2 - 4 \cdot 0.0001}}{2 \cdot 0.0001} = 0.0001$$



Schematic



Results and Graph



Inference

- The output waveform is produced and the results are in accordance with the theoretical values.
- Thus a maximum gain amplifier has been designed for maximum gain at 4.5 Ghz frequency.

References

- Microwave Engineering- David M. Pozar
- https://www.tutorialspoint.com/microwave_engineering/microwave_engineering_introduction.htm
- <https://www.microwaves101.com/encyclopedias/waveguide-mathematics>
- [https://en.wikipedia.org › wiki › Microwave_engineering](https://en.wikipedia.org/wiki/Microwave_engineering)