Low Noise Amplifier (LNA) Design Report

1. Introduction

- **Objective**: The purpose of this project is to design, simulate, and optimize a Low Noise Amplifier (LNA) using Keysight ADS, achieving a low noise figure (NF), high gain, and good input/output matching at the target frequency.
- **Target frequency**: 10 GHz
- **Applications**: Wireless communication systems, RF receivers.

---

2. Design Specifications

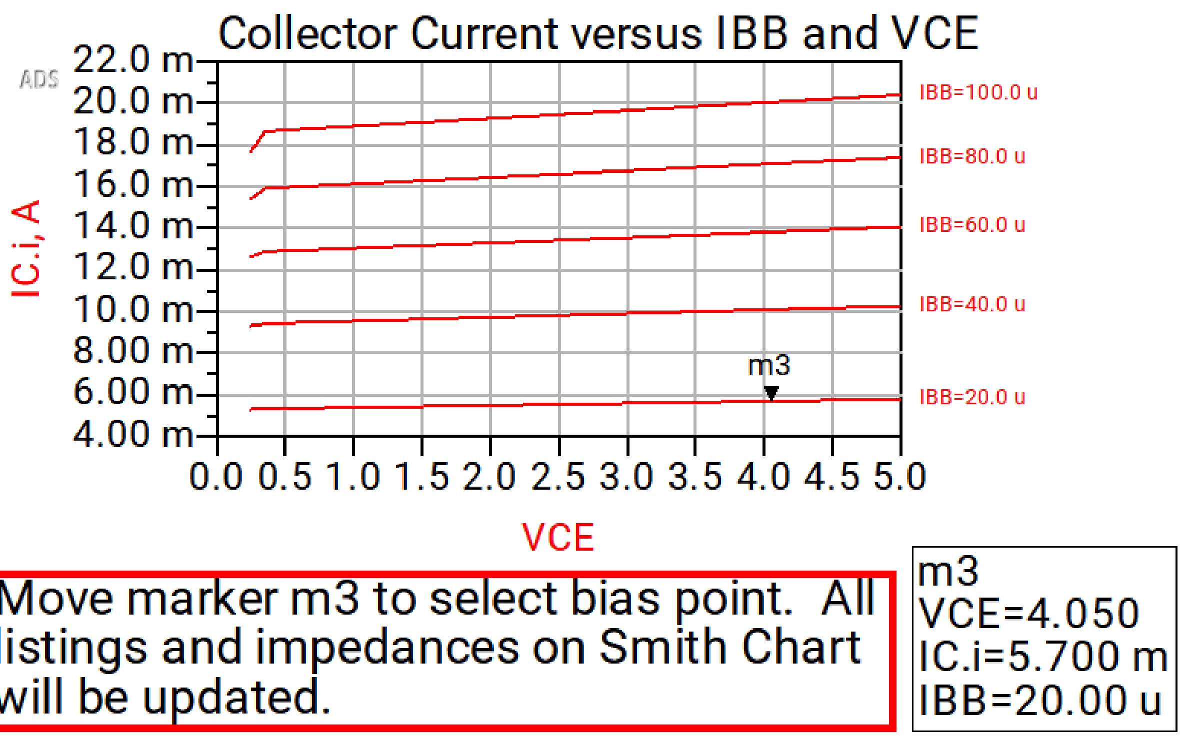
Parameter	Target Value
Center Frequency	[10 GHz]
Gain (S21)	[14 dB]
Noise Figure (NF)	[1.185 dB]
Input Matching (S11)	[-8.630 dB]
Output Matching (S22)	[-48.268 dB]
Stability (K-factor)	[K > 1 over all frequencies]
Technology	[NPN BJT]

---

3. Design Methodology

- **3.1 Device Selection**
  - Selected transistor/model: [Infineon BJT BFP720 from Infineon RF Library]
  - Key parameters: ft, noise figure, gain characteristics.

- **3.2 Topology**
    - **Single-stage common-emitter configuration**)
- **3.3 Matching Networks**
    - Input matching for noise optimization.
    - Output matching for maximum gain.
- **3.4 Biasing**
    - Bias point selection for optimal performance (V_CE, I_base values).



    -

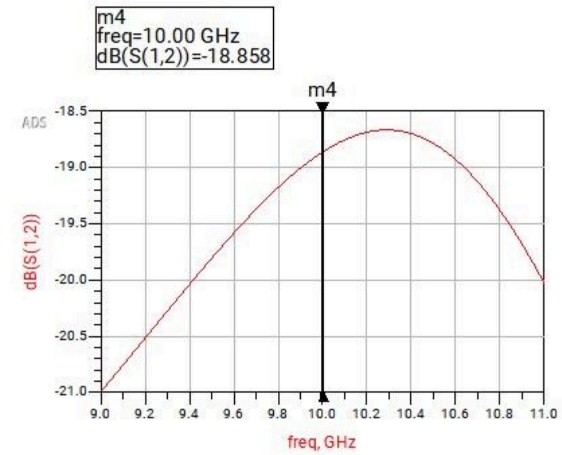
4. Simulation Setup

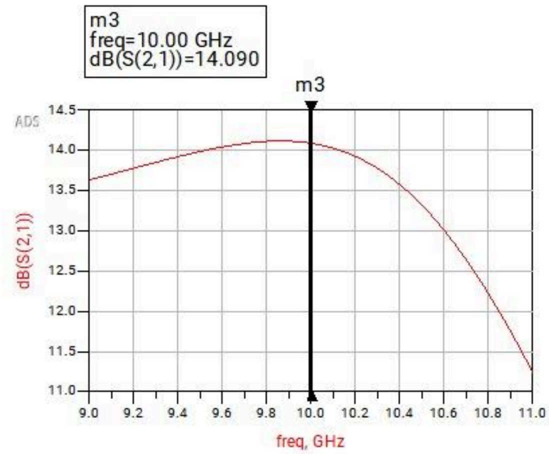
- **4.1 S-Parameter Simulation**
  - Setup details (frequency sweep range- **9GHz to 11 GHZ**).
- **4.2 Noise Figure Simulation**
  - Setup to measure NF vs frequency.
- **4.3 Stability Analysis**
  - K-factor, Mu-factor calculations.

---

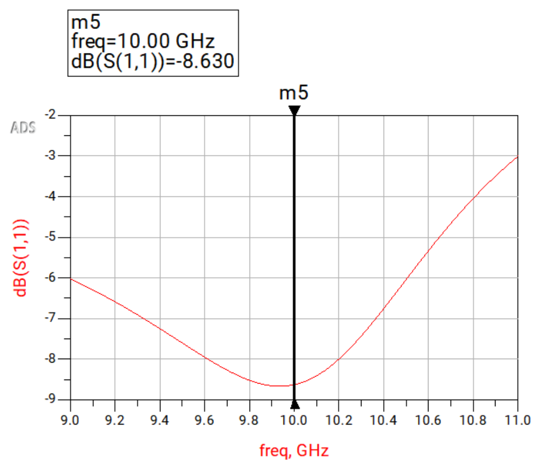
5. Results

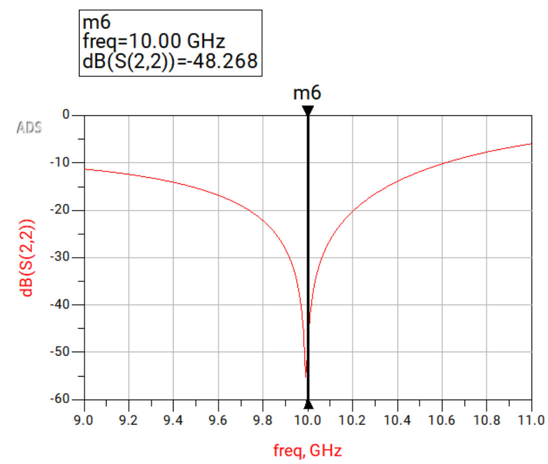
- **5.1 S-Parameters**
  - Plot and discussion of S11, S21, S12, S22.





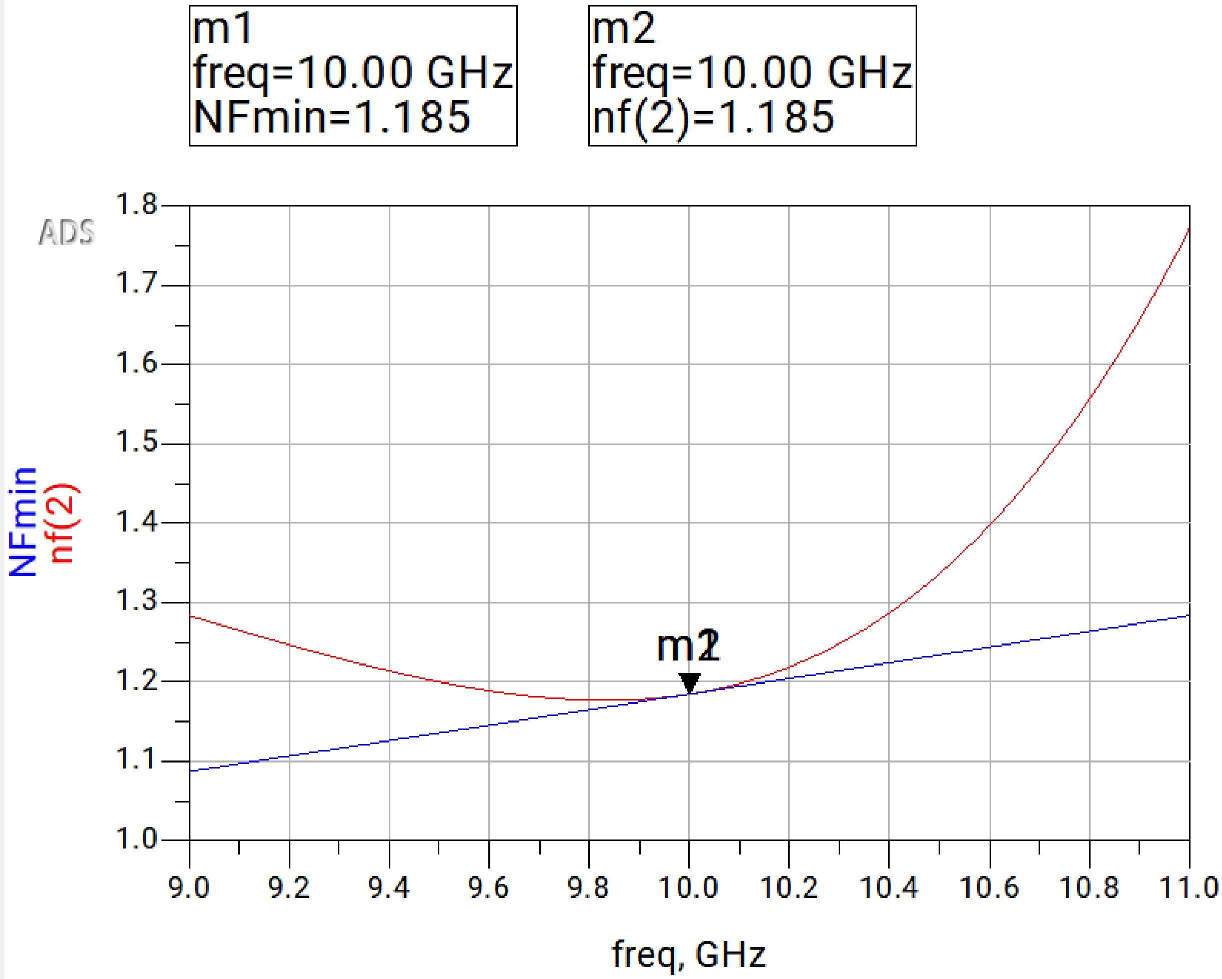
  -



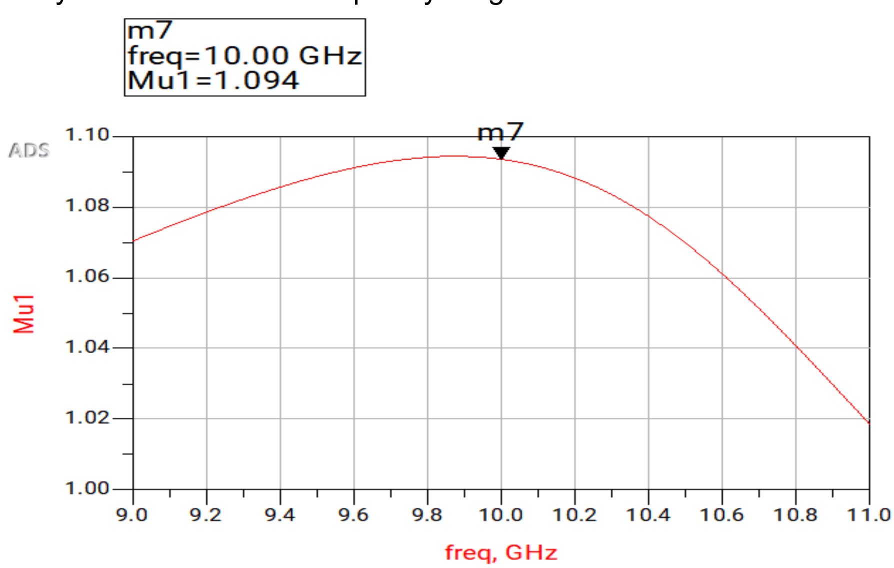


  - Check input/output matching and gain.

- **5.2 Noise Figure**
  - NF vs frequency plot.
  - Noise figure at center frequency: 1.185 at 10 GHz.



- **5.3 Stability**
  - Stability check over entire frequency range.

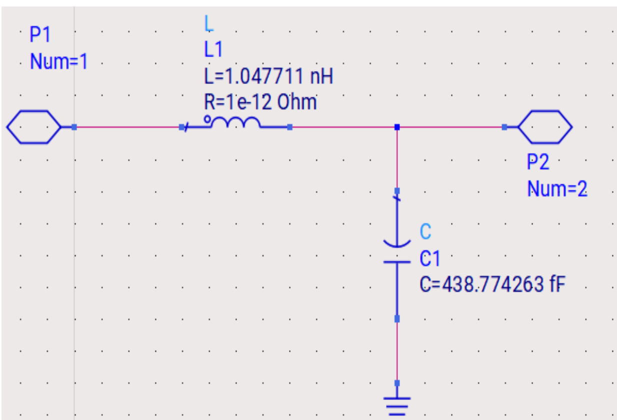


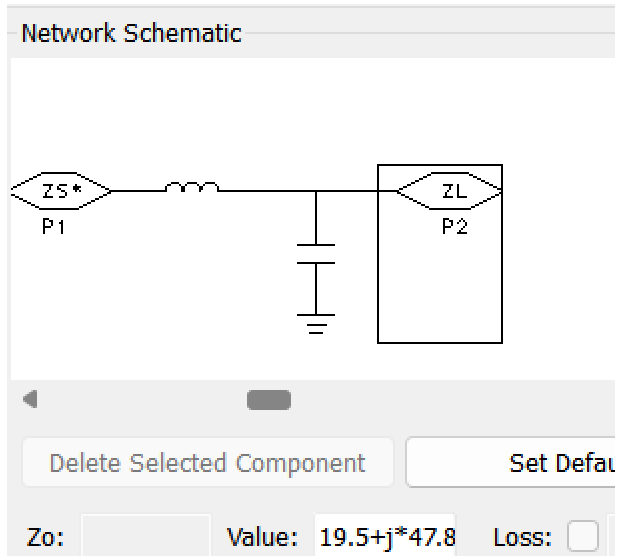
- **5.4 Input and Output Matching Networks**

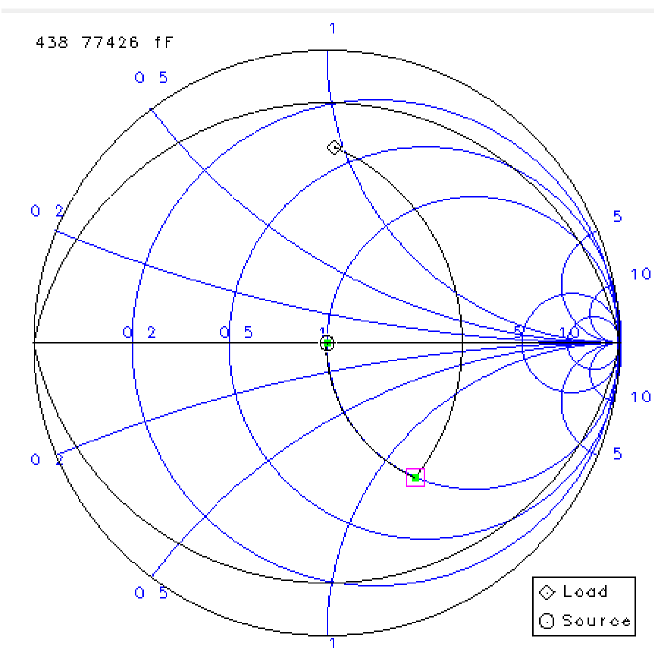
NFmin,dB	Source Impedance, Zopt, for Minimum NF	Optimal load impedance for power transfer when source impedance is Zopt	Transducer Power Gain, dB when these source and load impedances are used
1.185	19.521 - j47.822	17.820 - j11.037	14.103

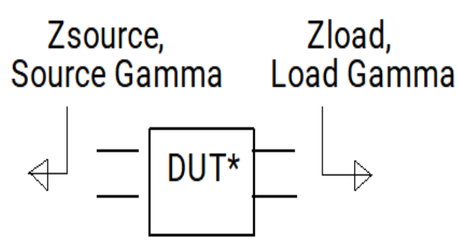
-

Input Matching



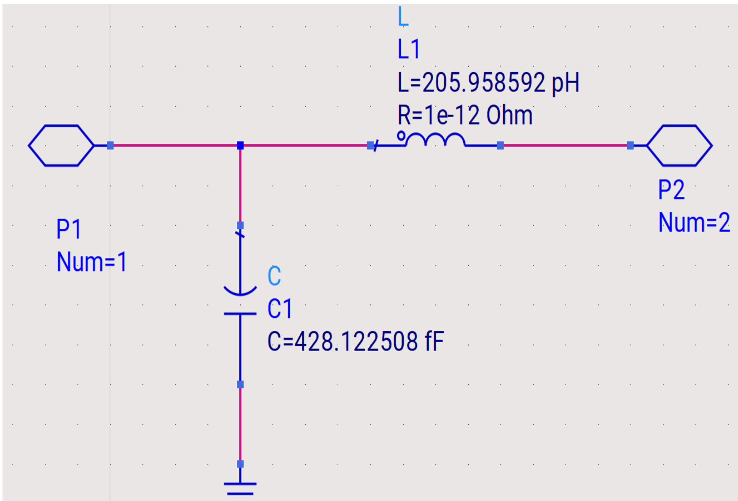


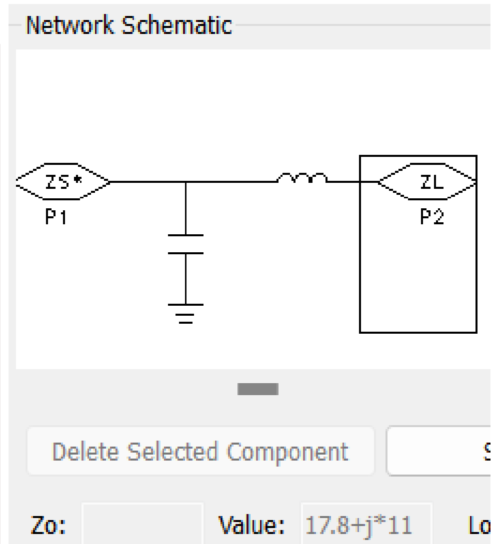


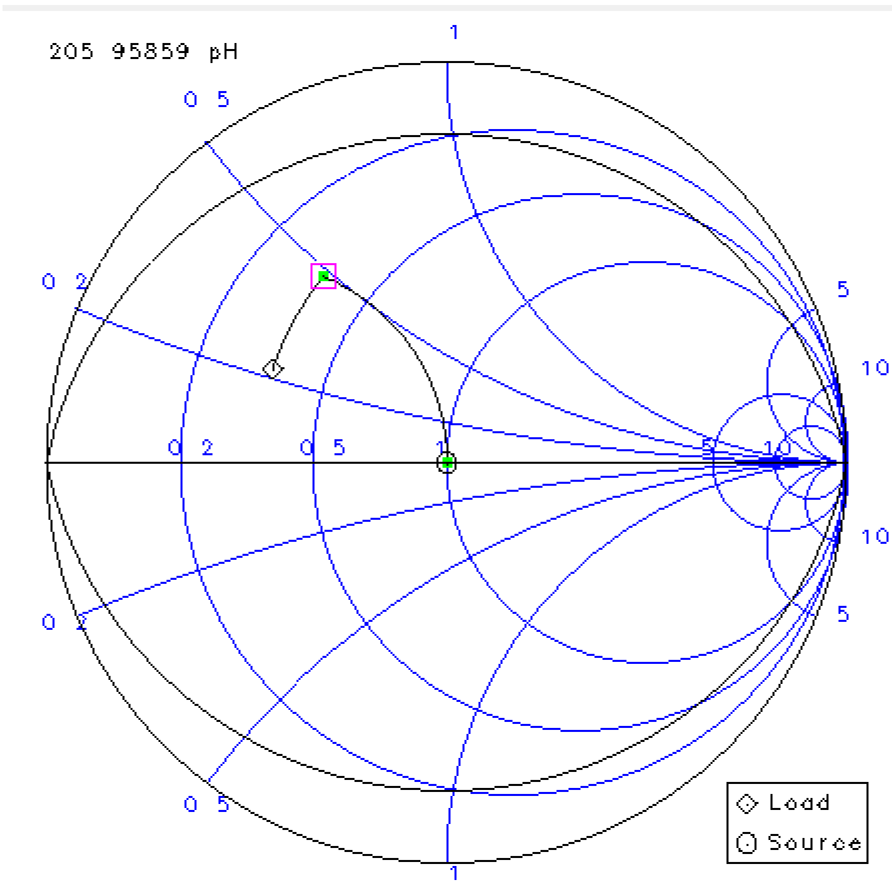


*DUT= Device Under Test
(simulated circuit or device)

Output Matching

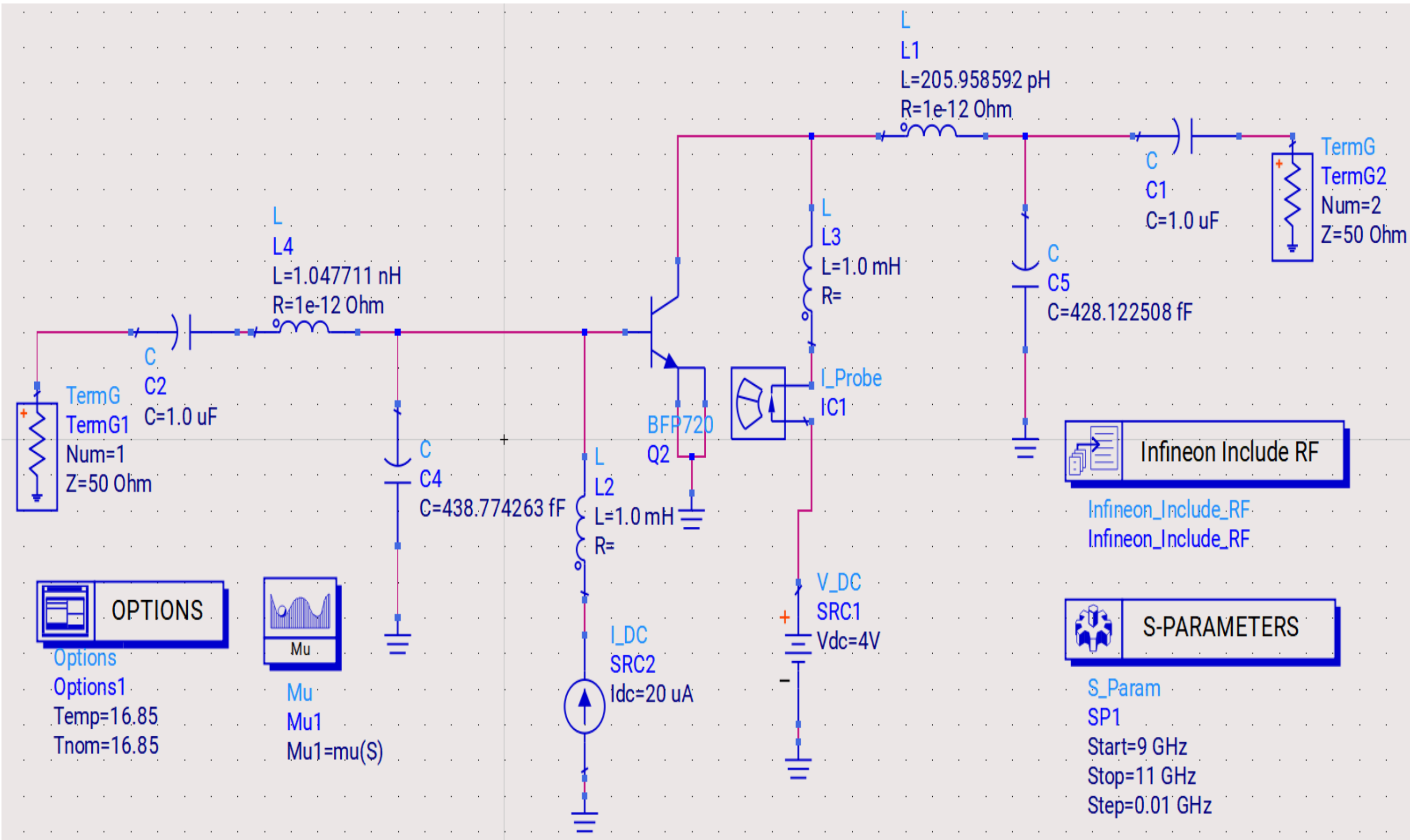






Input and output impedance matching shown on Smith Chart.

6. Layout



7. Discussion

The designed Low Noise Amplifier (LNA) operating at 10 GHz successfully meets the primary design specifications. The achieved gain (S21 ≈ 14 dB) is close to the targeted value, ensuring adequate amplification for the intended RF applications. The noise figure achieved (1.185 dB) is within an acceptable range for high-performance communication systems, although slightly higher optimization could further reduce it.

Input matching (S11 ≈ -8.63 dB) shows acceptable performance but could be improved for better return loss, while output matching (S22 ≈ -48.26 dB) indicates excellent output isolation.

The amplifier remains stable across the entire frequency sweep (9 GHz–11 GHz) with a stability factor (K > 1), confirming unconditional stability.

Minor improvements in input matching could enhance performance, and layout parasitics should be considered in the final fabrication phase to ensure the simulated performance closely matches measured results.

---

8. Conclusion

A Low Noise Amplifier (LNA) was successfully designed and simulated at 10 GHz using the BFP720 transistor in a common-emitter configuration. The amplifier achieved the desired performance targets of gain, low noise figure, good matching, and stability. The design was validated through extensive S-parameter, noise figure, and stability simulations.

Future improvements could include layout optimization using EM simulations to account for parasitic effects and slight tuning of the input matching network for even better noise and reflection characteristics. Overall, the designed LNA is suitable for high-frequency wireless communication applications.
