EEE 412 - Project Report 1 - Tuna Şahin

1) Simulation Results:

My assigned project was an HGA at 1.01GHz. This results in a band of $[0.96, 1.06]GHz$ and a minimum gain of 12.44.

- $S_{11}, S_{22} <- 12dB$ in the band. The amplifier satisfies the return loss criteria.
- $S_{21} > 13.65 > 12.44$. So the amplifier also satisfies the gain criterion.
- $k > 1$ for all frequencies so the amplifier satisfies the stability criterion.
- Gain varies at most 0.795dB, which satisfies the gain variation criterion at most $\pm\ 0.5$dB in the band.

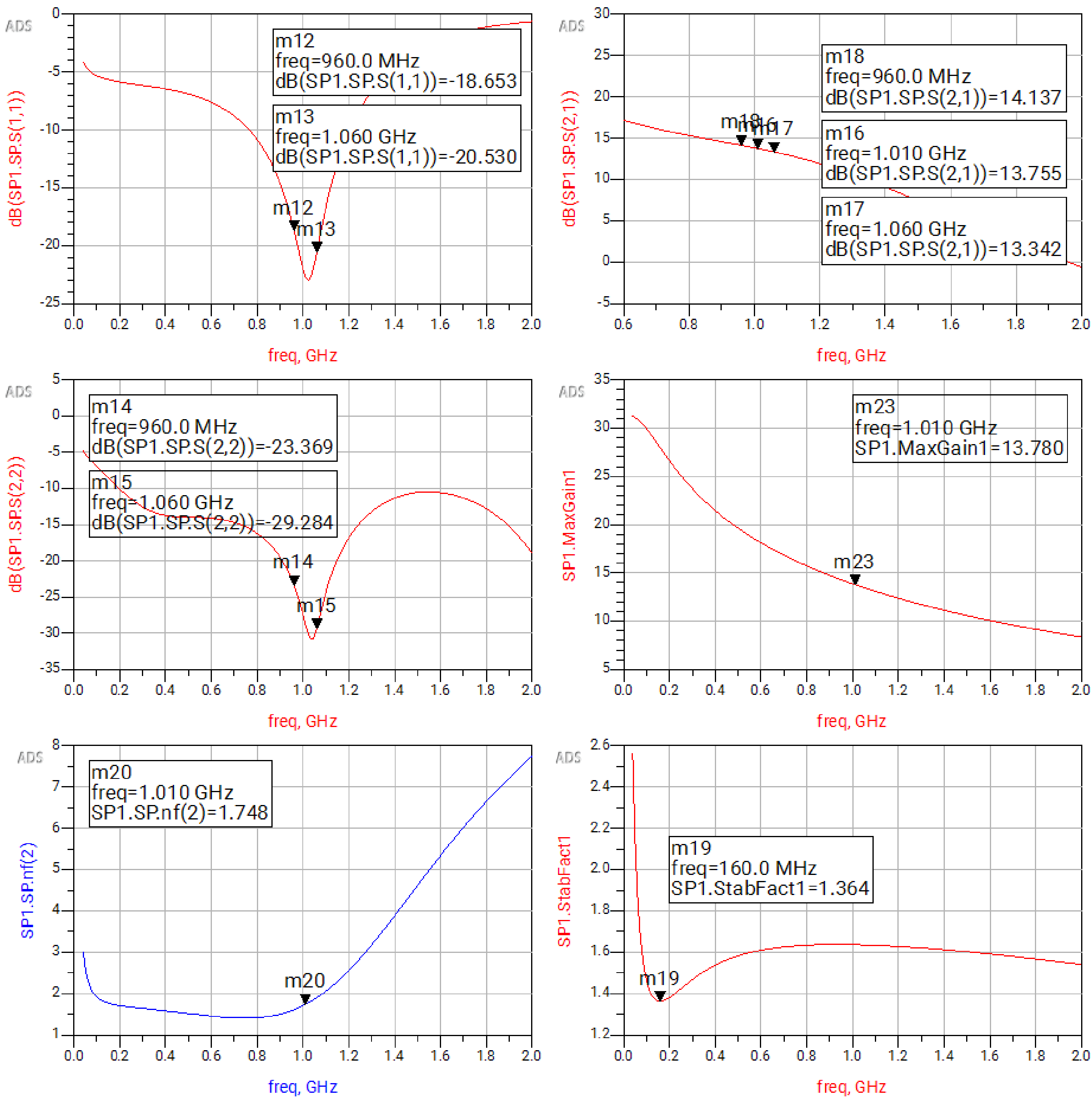


Figure 1: Simulation Results of the Amplifier

2) Design Process:

- The biasing circuit was constructed using biasing resistors, bypass capacitors, and a transmission line. The transmission line and bypass capacitors ensure that at 1.01 GHz, the biasing resistances do not affect the signal.

- Two DC-block capacitors are added to the input and output terminals of the system.

- No attenuators were necessary since the circuit was already unconditionally stable due to the construction of the biasing circuit.

- The input and output are then matched to 50Ω using two networks. The input matching network consists of an L-section featuring a shunt capacitor and a series inductor. The output matching network consists of a single transmission line.

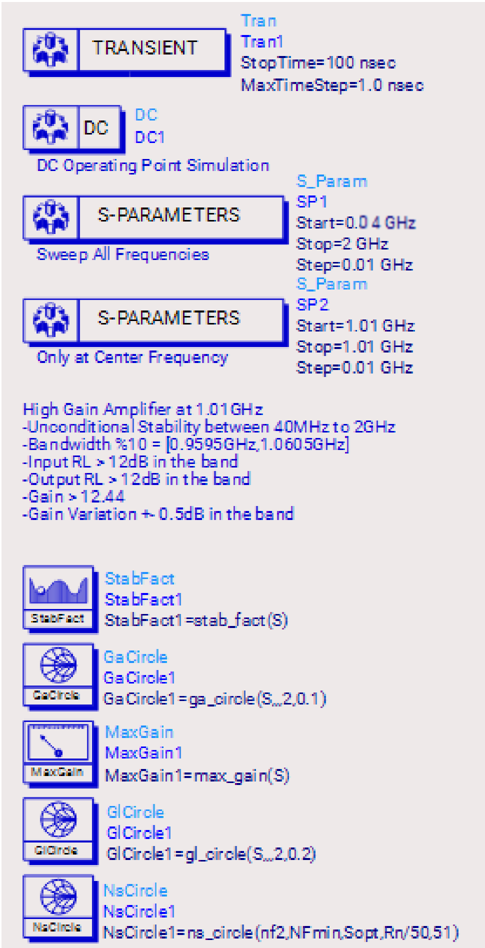


Figure 2: Simulation Conditions

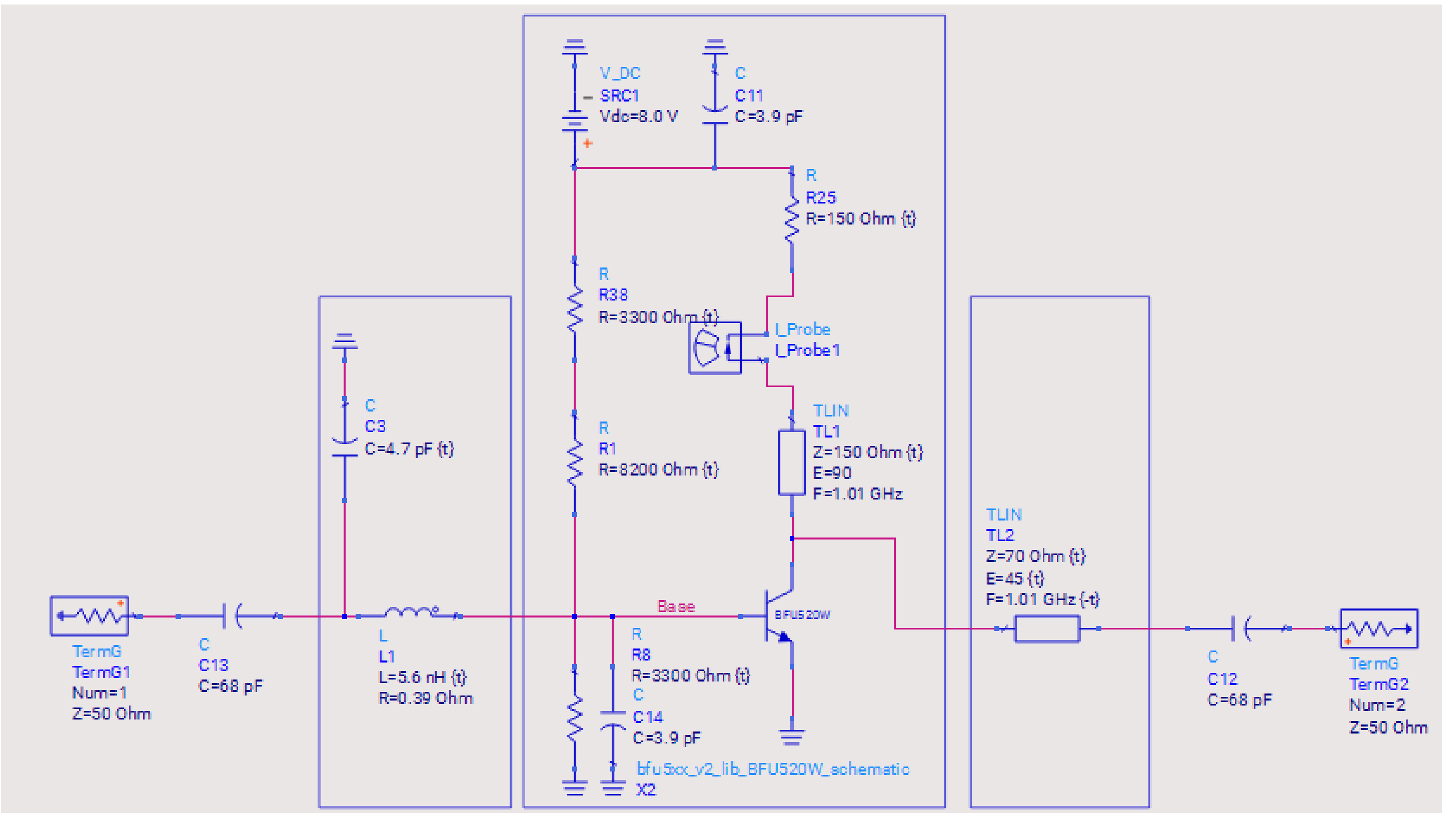


Figure 3: Amplifier Schematic

EEE 412 - Project Report 2 - Tuna Şahin

1) Schematic:

- The collector current was 30mA in the initial report. To lower this value, the base voltage was adjusted, and the final collector current was reduced to 18 mA.
- The supply voltage was 8V. The collector voltage was set at 3.2V at the middle of this range. So the supply is 2.5 times the collector-emitter voltage.
- The schematic from part 1 was adapted to be suitable for layouts. Transmission lines were replaced with microstrip lines. Lumped elements were replaced with their layout-compatible counterparts. Most importantly, every wire in the original schematic was replaced with microstrip lines, and nodes were replaced with intersections.
- To simplify the circuit even further, shunt capacitors were replaced with shunt open-circuit microstrip lines.
- The matching circuit was tweaked to compensate for the parasitic effects of the additional microstrip lines.
- Finally, to fit the circuit within the given area, the transmission lines were bent to accommodate their lengths.

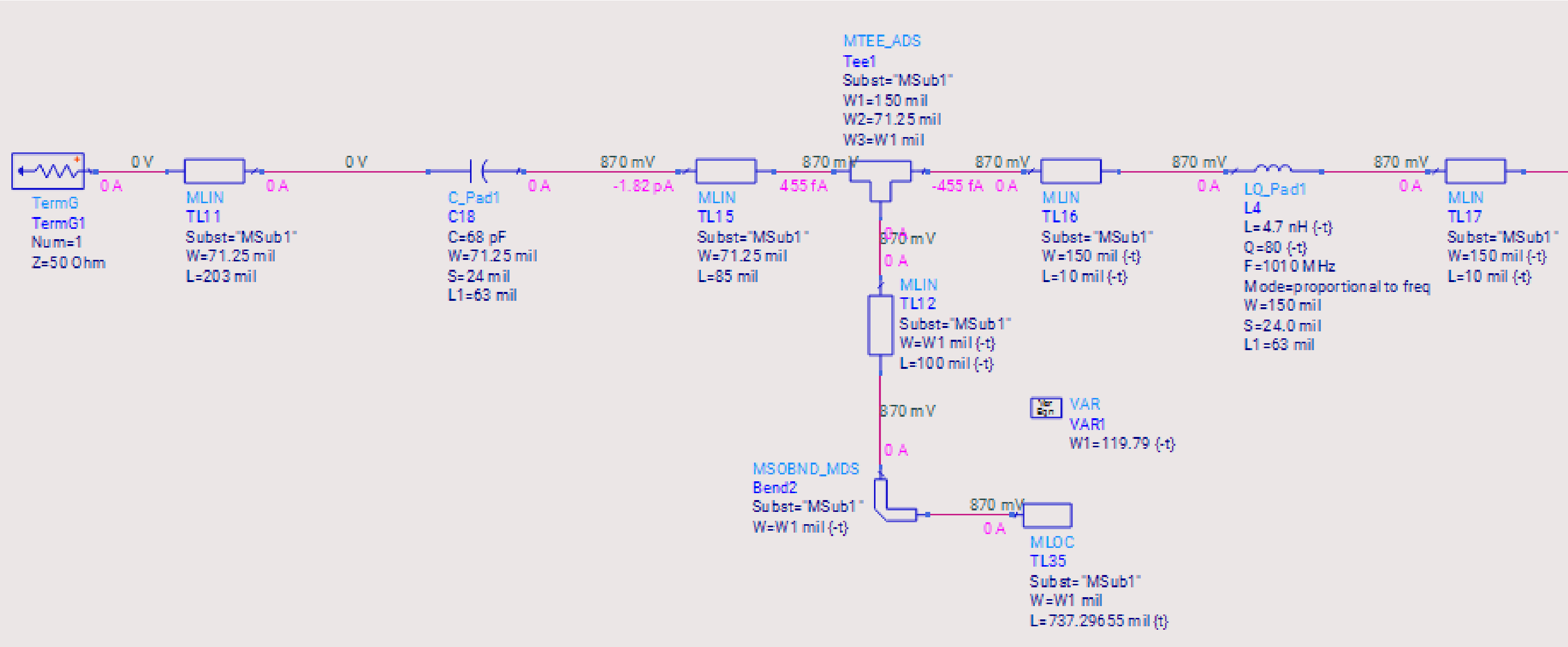


Figure 1.1: Input Matching Network,

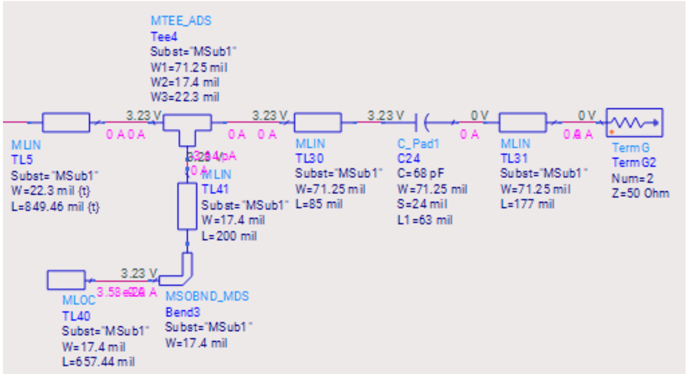


Figure 1.2: Output Matching Network

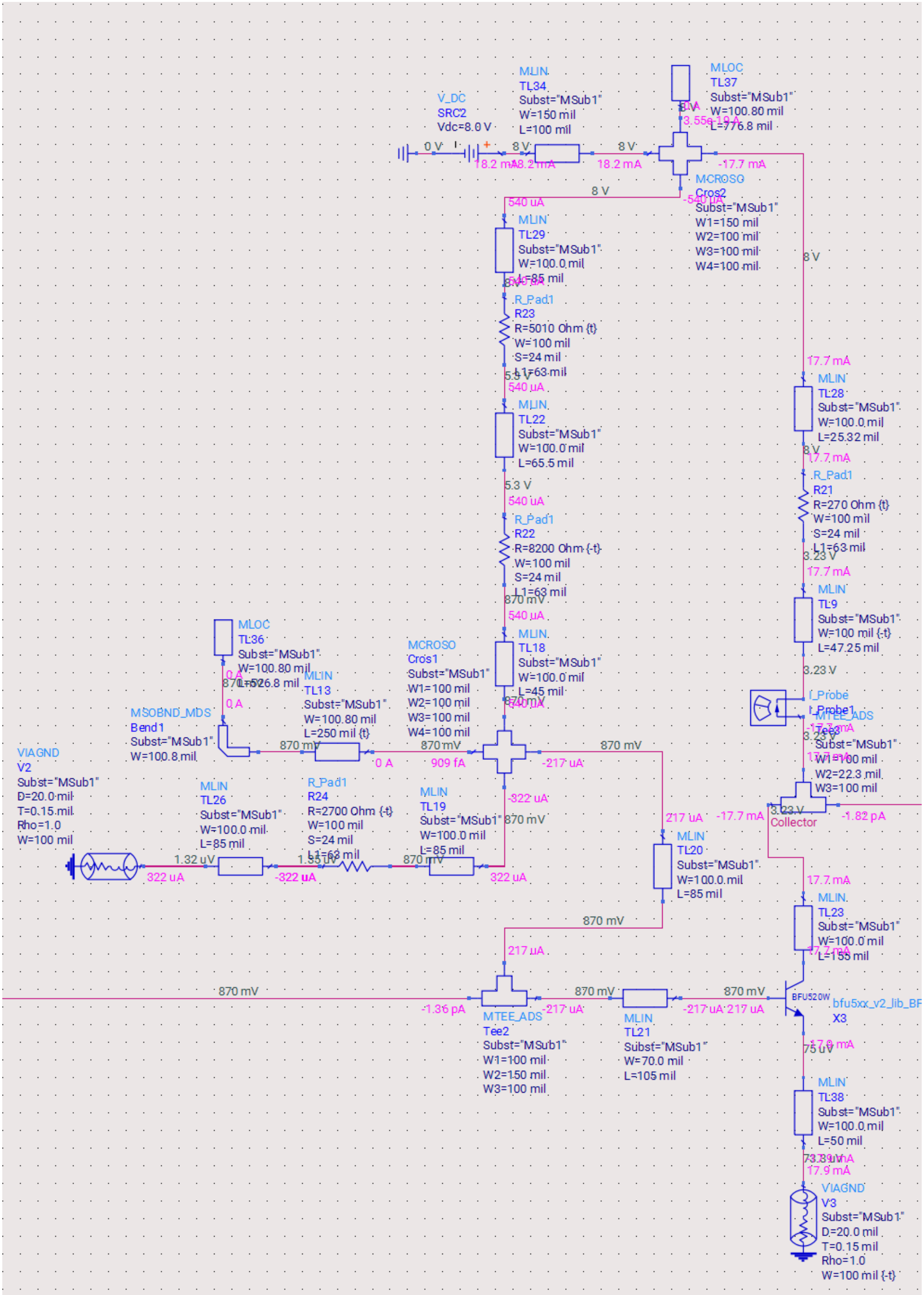


Figure 1.3: Biasing Circuit

2) Results of the Layout Compatible Circuit:

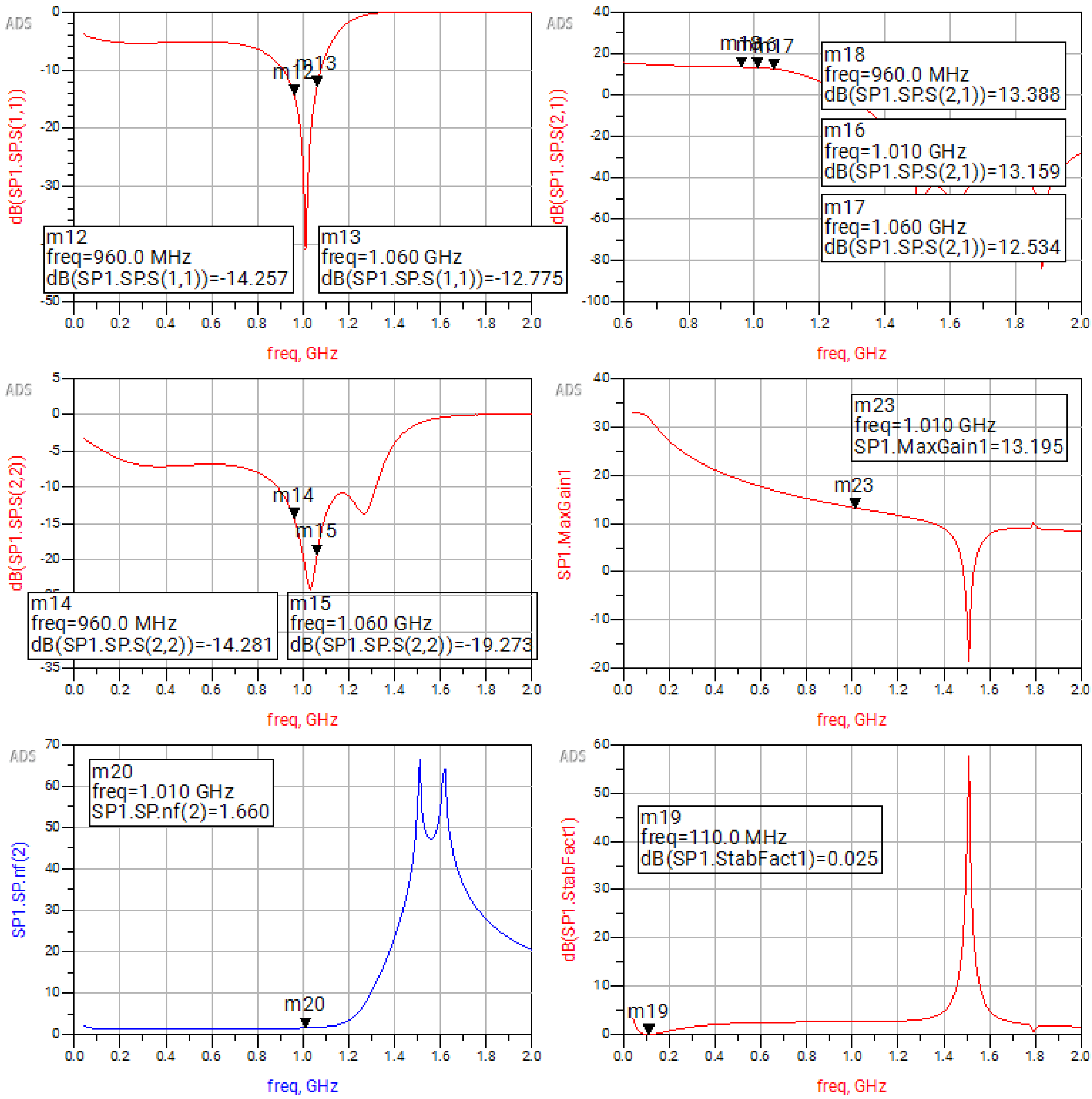


Figure 2: Simulation Results of the Layout-Compatible Circuit

- Both S_{11} and S_{22} < -12dB which satisfies the return loss criteria.

- Minimum stability factor value is 0.025dB = 1.005. The stability criterion is met.

- Maximum gain variation in the band is 0.854dB which is in the ±0.5dB range. In addition the gain is greater than 12.44dB so the gain criteria are satisfied.

- The collector current is 18mA and the collector voltage is 3.2V. The operating point is set within the desired range.

3) Layout

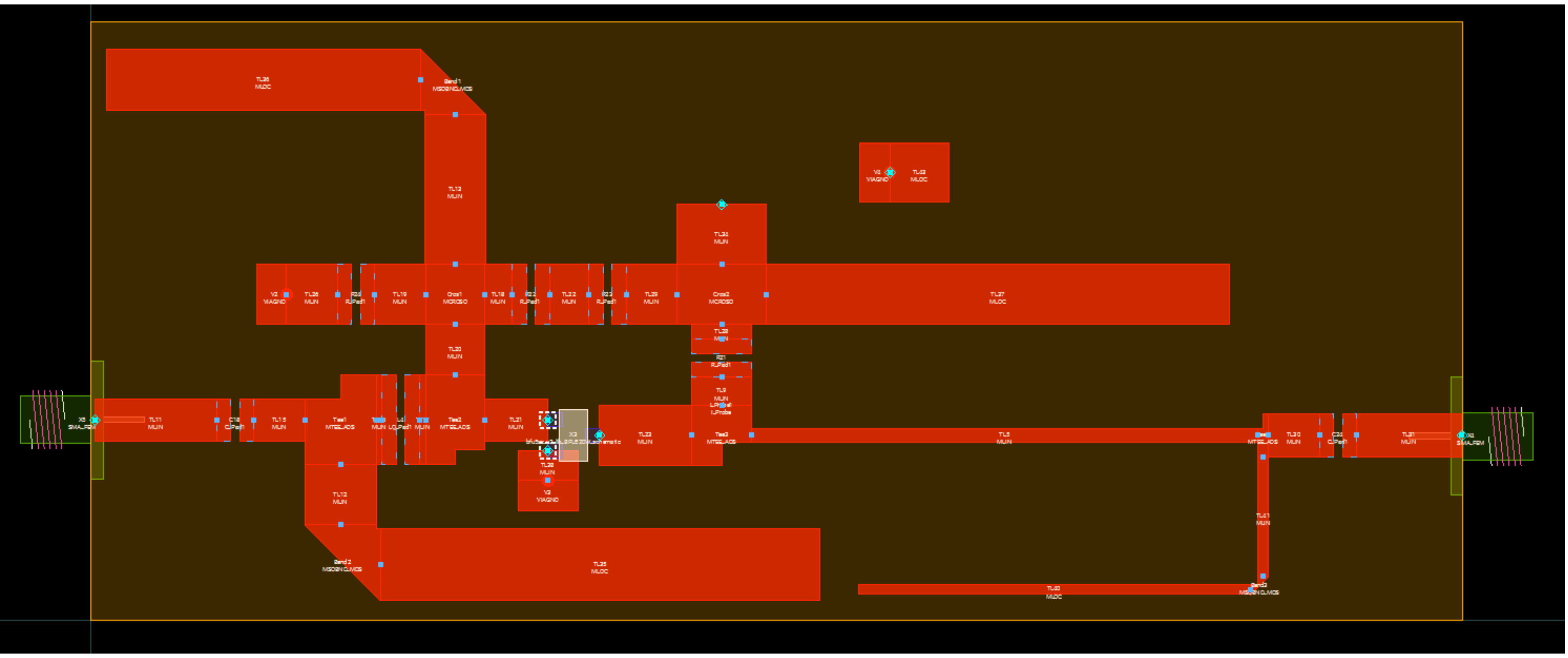


Figure 3.1: Layout of the circuit

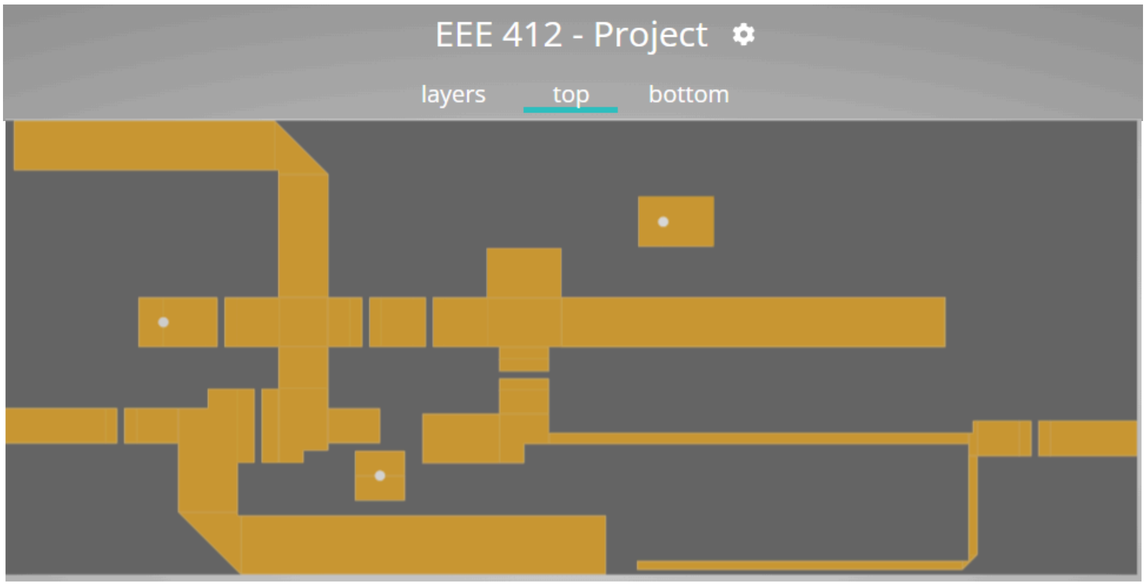


Figure 3.2: Top-side of the Gerber File Showing the Circuit

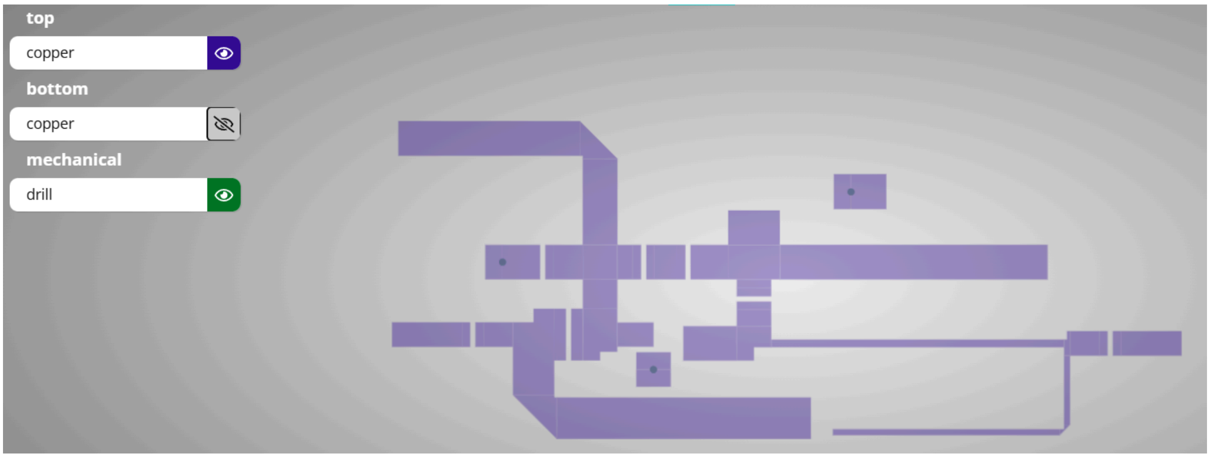


Figure 3.3: Drill Locations of the PCB

EE 412/512 Project Part 3 and 4

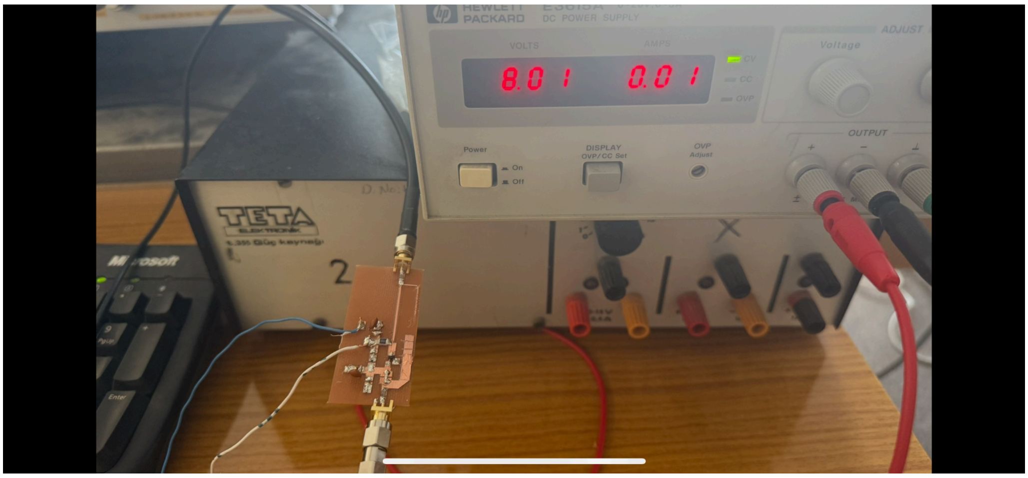
Due January 4, 2026

Measure your amplifier's response and fill in the following tables.

Requirements:

LNA/HKA	f_0 (MHz)	0.9 f_0 (MHz)	1.1 f_0 (MHz)	Gain (dB)	Noise figure (dB)	Input return loss (dB)
HGA	1.01GHz	960MHz	1060MHz	12.44dB (required) 13.57dB (result)		-13.39dB

Measurements (use one of the network analyzers for S-parameter measurements. Set the input power level of the network analyzer to −30 dBm for linear measurements. Use the noise figure meter for noise figure measurement. Refer to the "Noise Figure Measurement" document in Moodle.)

Supply voltage (V)	
Supply current (mA)	

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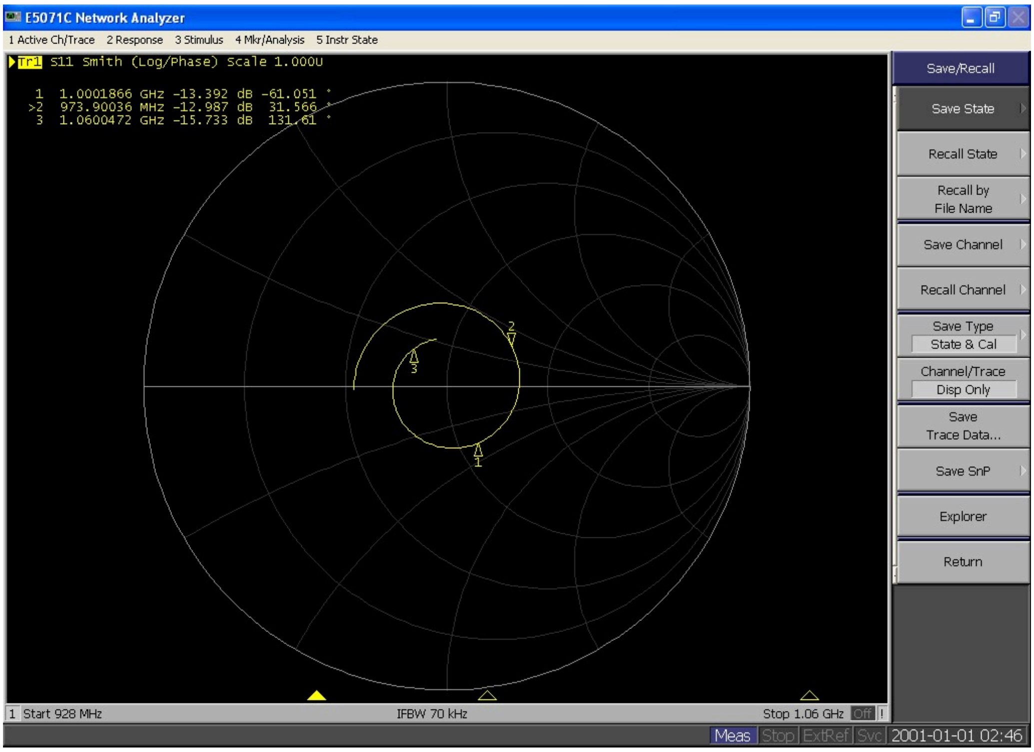
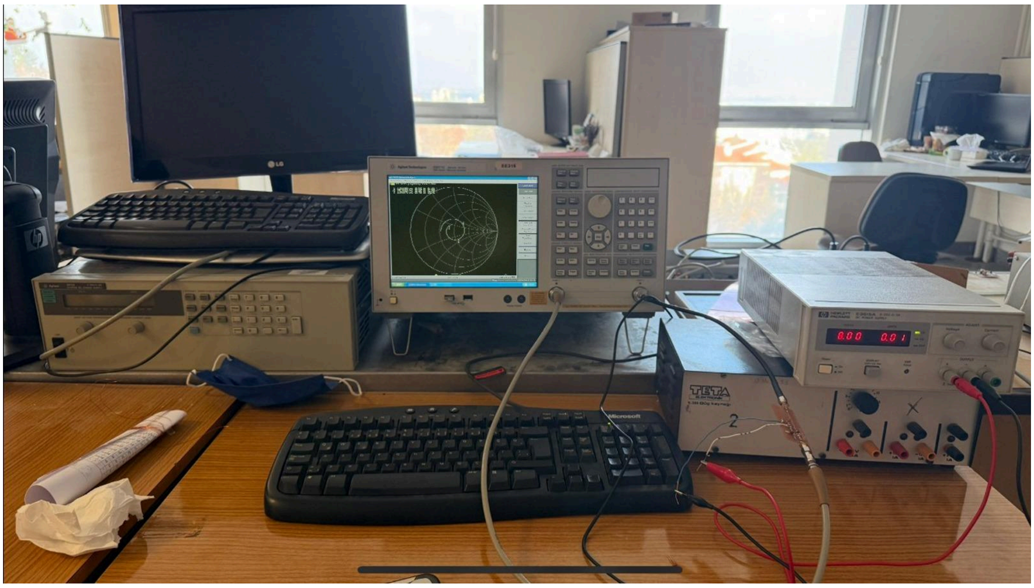
<td>Worst input return loss $-\lvert S_{11}\rvert_{dB}$ (dB)</td>
<td>
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<tr>
<td>Worst output return loss $-|S_{22}|_{dB}$ (dB)</td>
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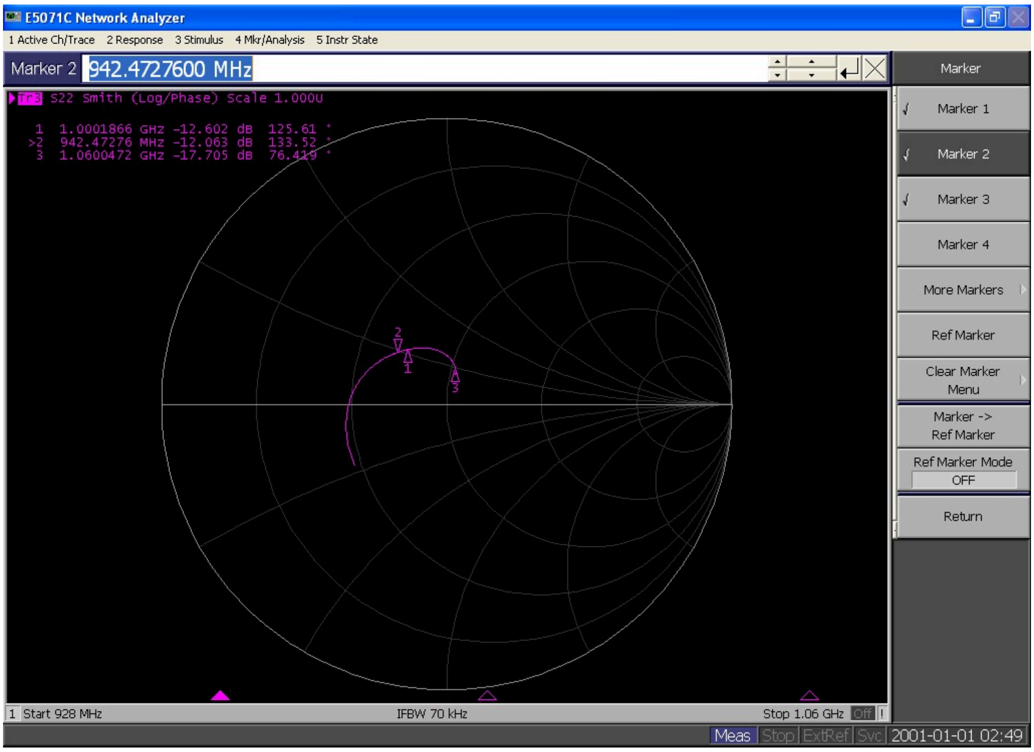

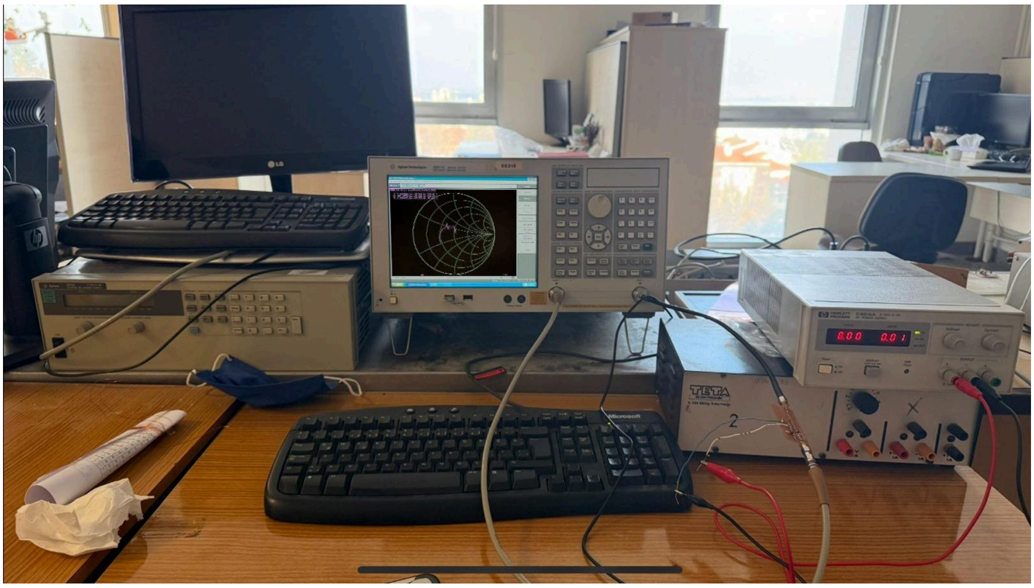
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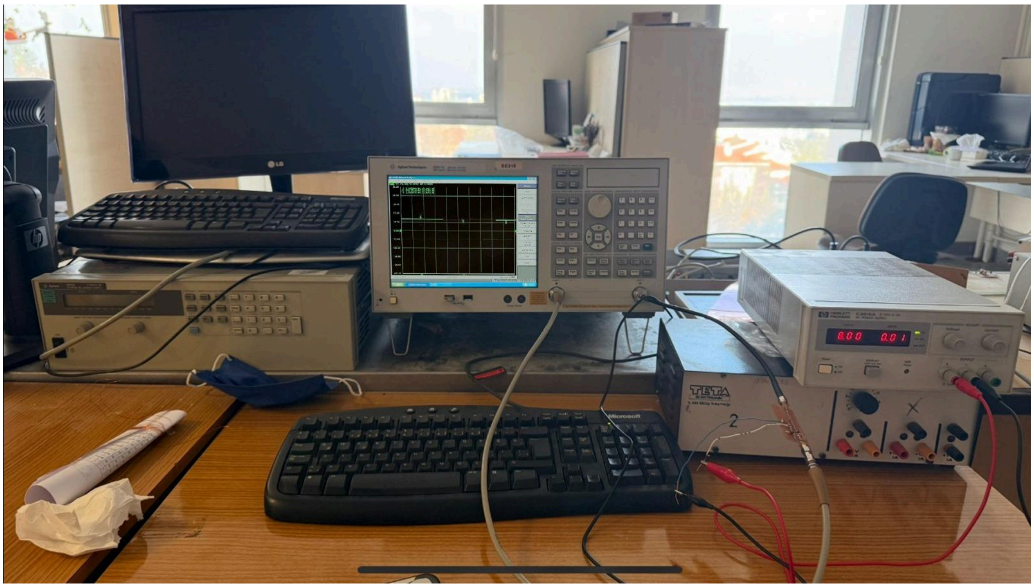
Minimum $\lvert S_{21}\rvert_{dB}$ in the band (dB)	
Maximum $\lvert S_{21}\rvert_{dB}$ in the band (dB)	