ECE 545

Introductory Microwave Networks and Components

Final Report

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May 4, 2005

1. Hybrid Coupler

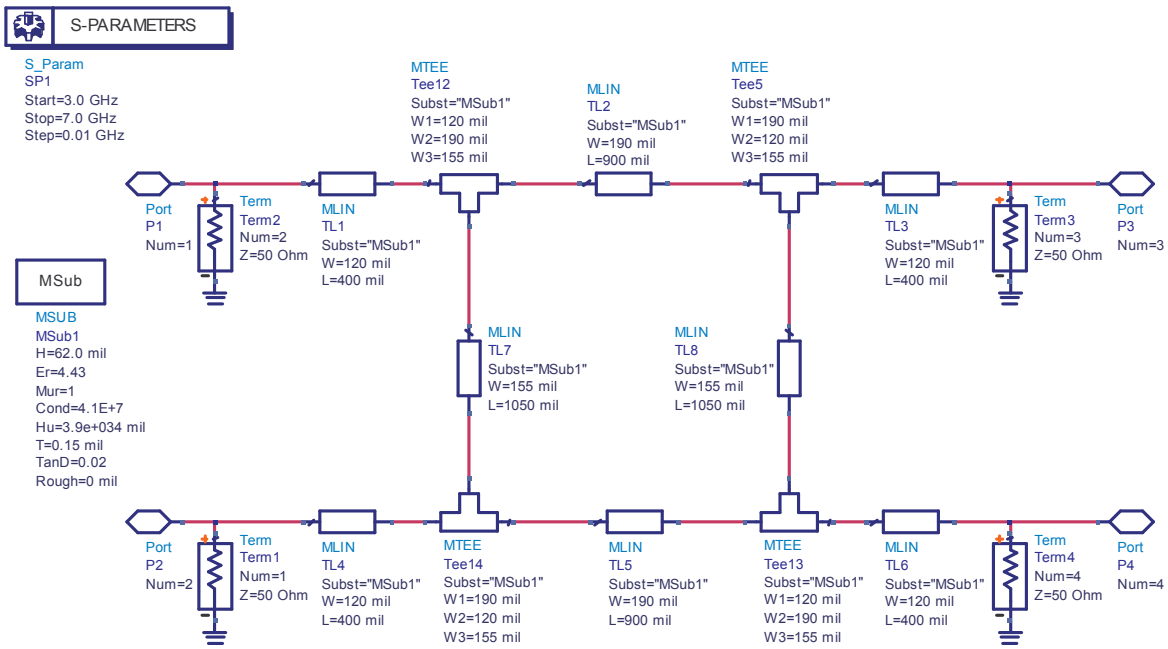


Figure 1.1 Schematic View of Hybrid Coupler

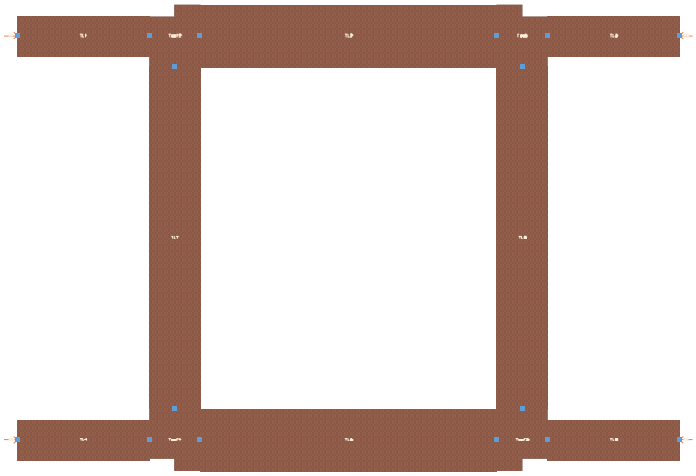


Figure 1.2 Layout of Hybrid Coupler

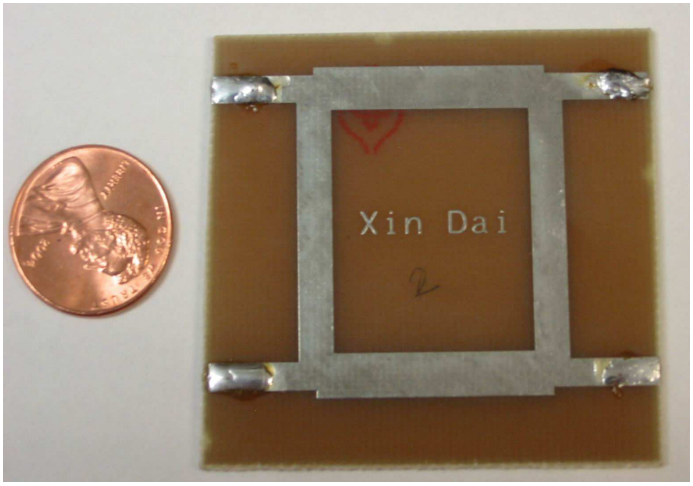


Figure 1.3 Picture of Hybrid Coupler

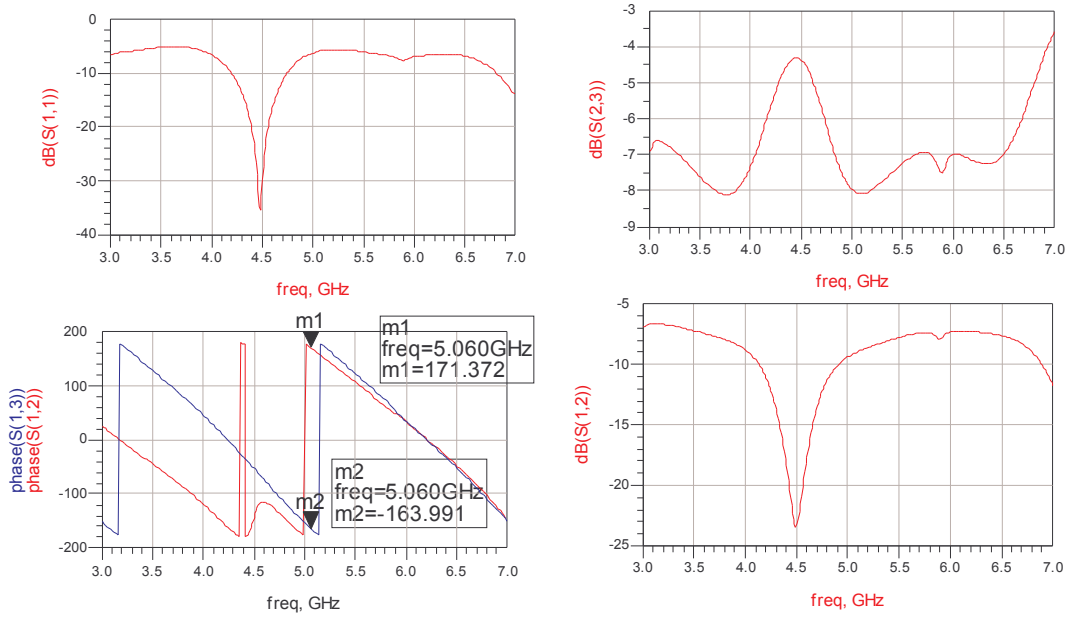


Figure 1.4 Schematic Simulation of Hybrid Coupler

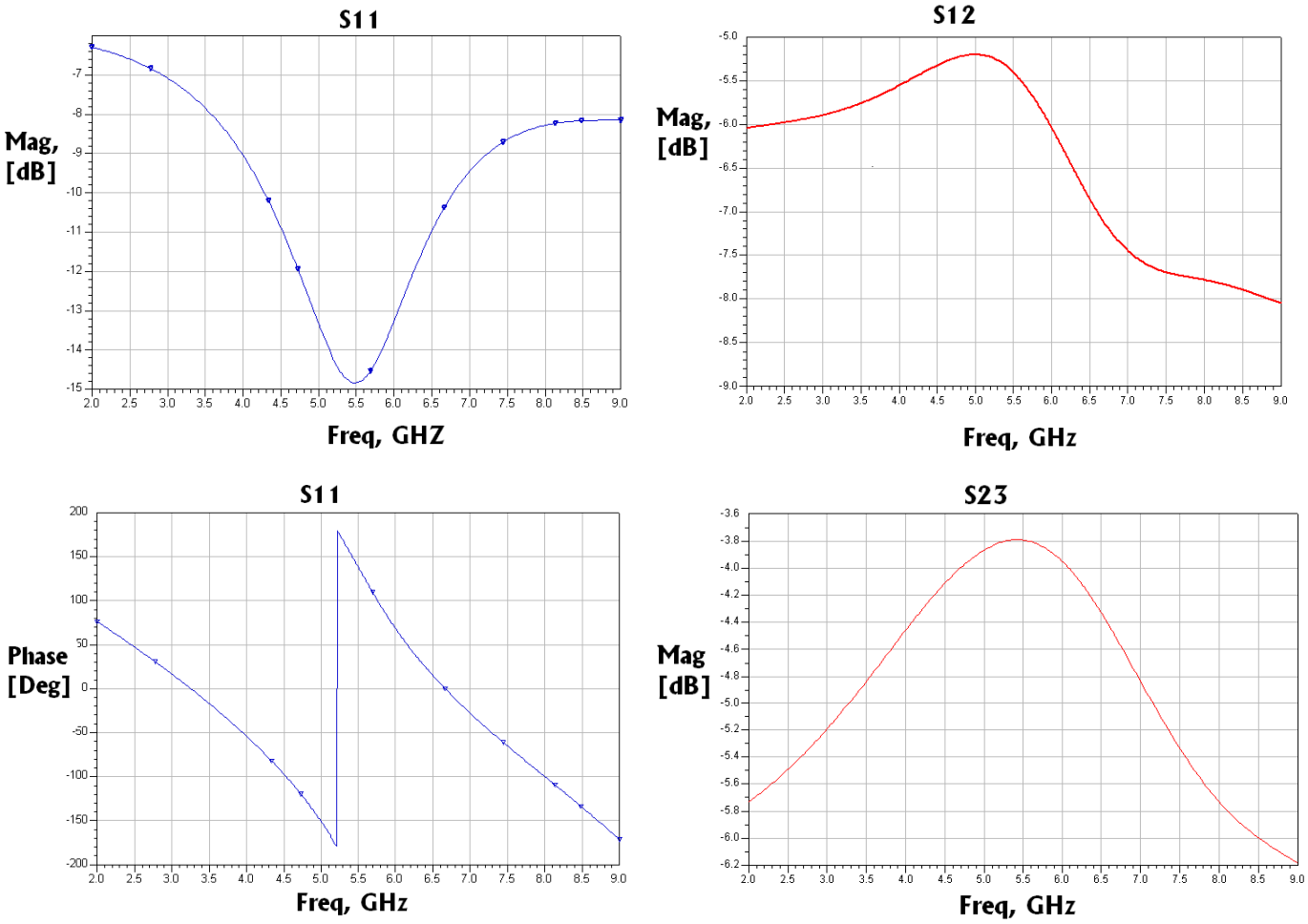


Figure 1.5 Momentum Simulation of Hybrid Coupler

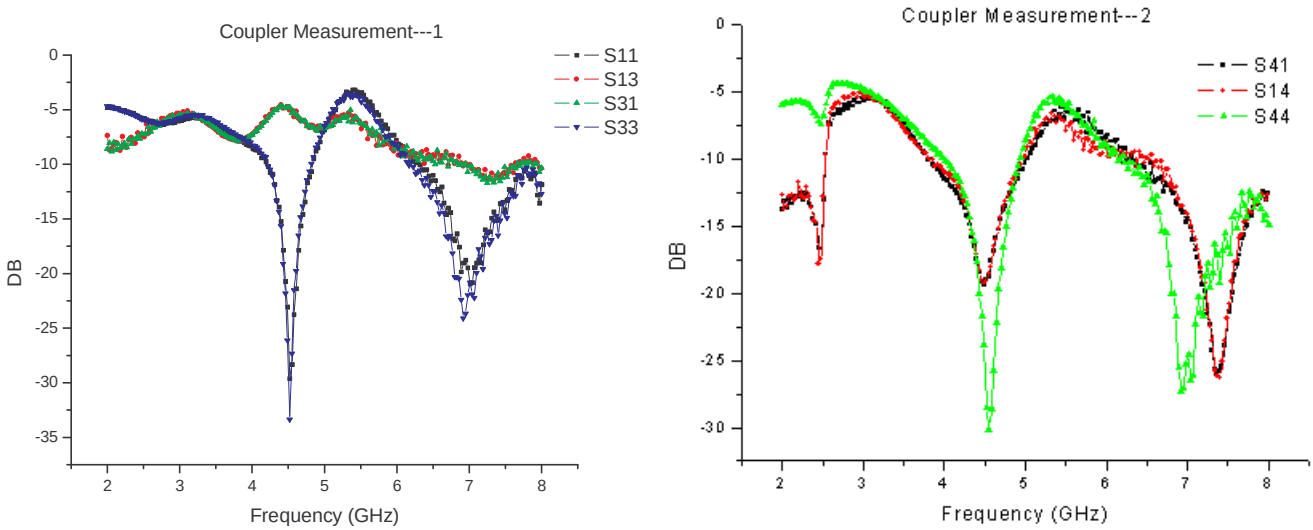


Figure 1.6 Measurements Result of Hybrid Coupler using Network Analyzer

Analysis:

On Momentum simulation, dB(S11) reaches lowest point of –15dB at 5.5GHz, dB(S12) gets the highest value of –5.2dB at 5GHz, the phase change of S11 appears at 5.2GHz.

While for the real measurement results, dB(S11) reaches lowest point of –32.5dB at 4.5GHz, dB(S12) gets the highest value of –5dB at 4.5GHz. dB(S41), dB(44) both reach lowest point at 4.5GHz to –20dB and –30dB respectively.

The measurement shows –0.5GHz difference to the expected. This is partially due to not taking the solder connection, loss along transmission line into consideration. Also, each edge of hybrid coupler is not exactly $\lambda/4$ length.

This project gives me a very good start to understand circuit design under microwave frequency. Due to unfamiliar with ADS software, I spend a lot of time in using and debugging the software. The measurement shows some difference with the design demand. But anyway, this project is still beneficial and helpful.

2. Wilkison Power Coupler

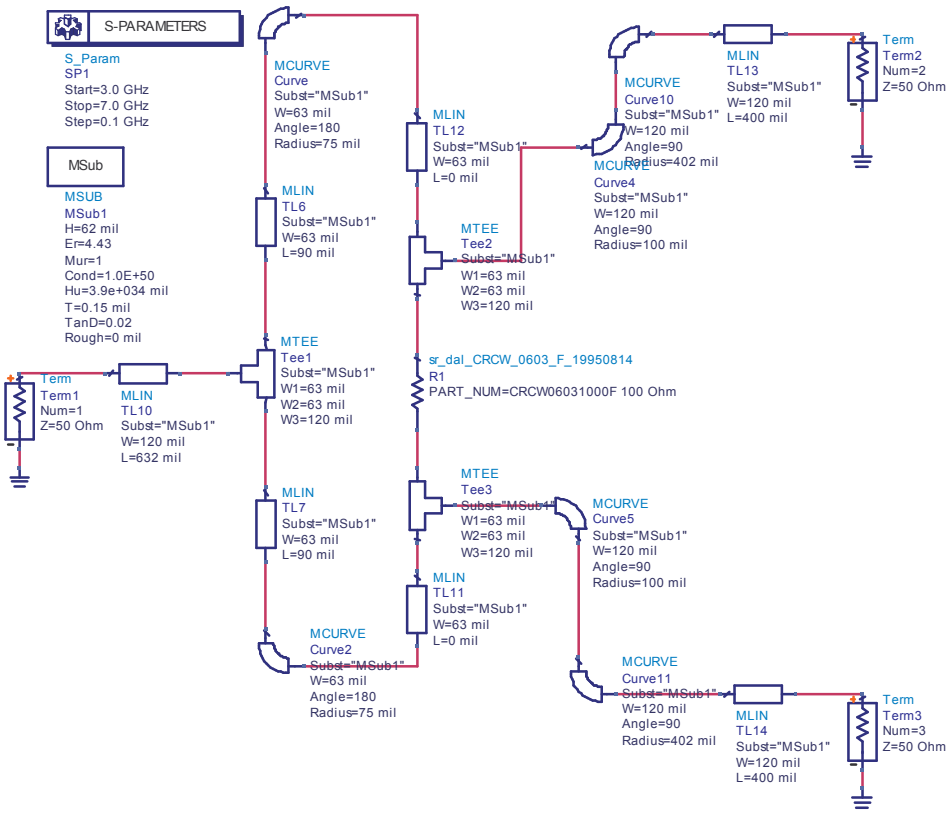


Figure 2.1 Schematic View of Wilkison Power Coupler

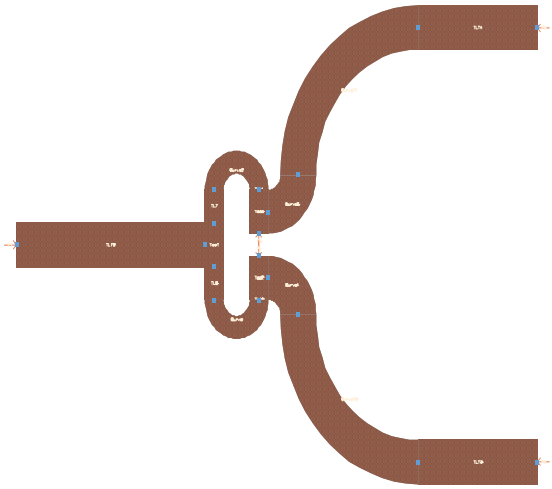


Figure 2.2 Wilkison Power Coupler Layout

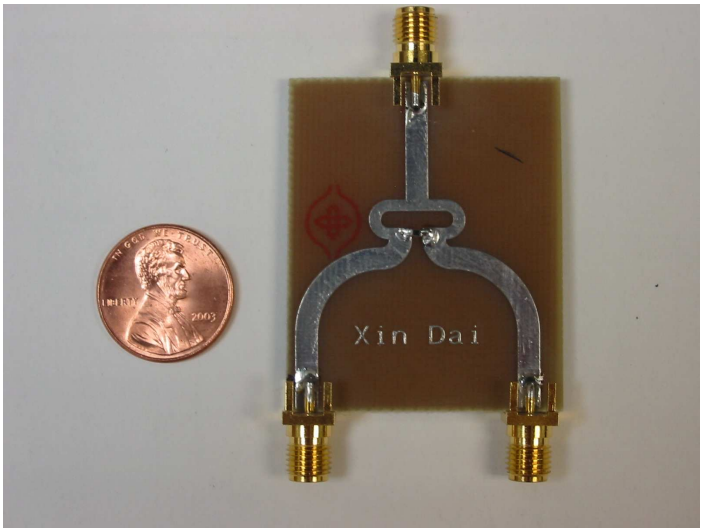


Figure 2.3 Wilkison Power Coupler Picture

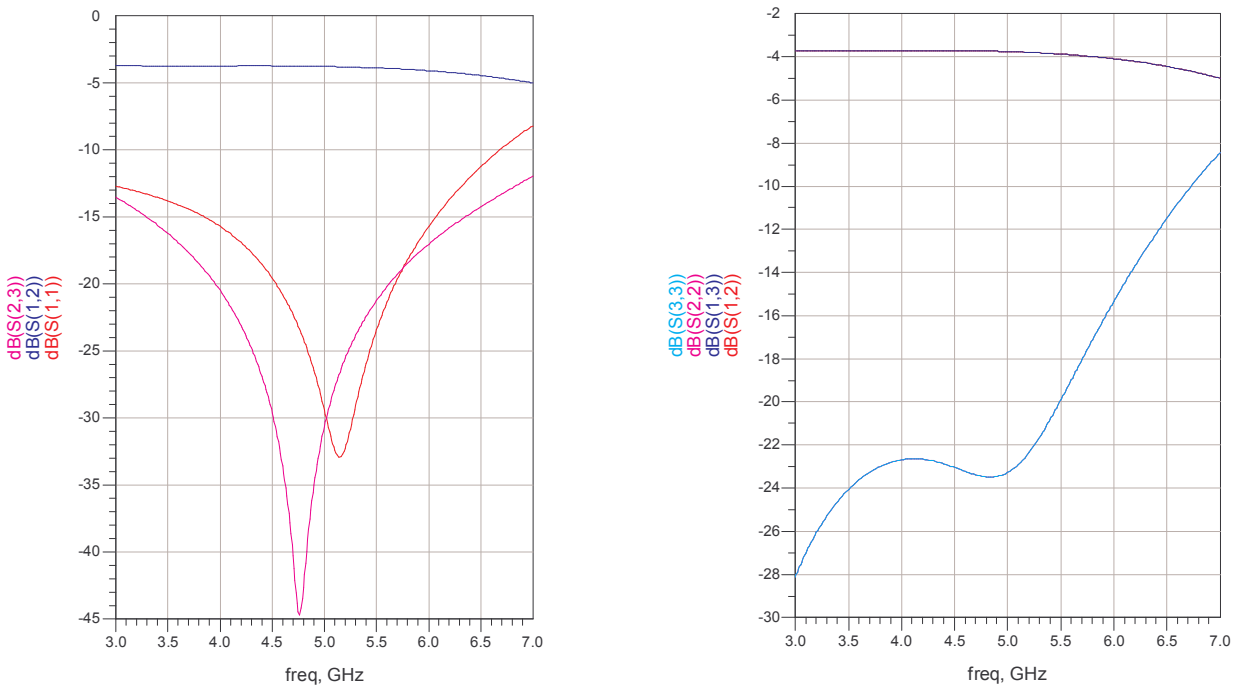


Figure 2.4 Schematic Simulation of Wilkison Power Coupler

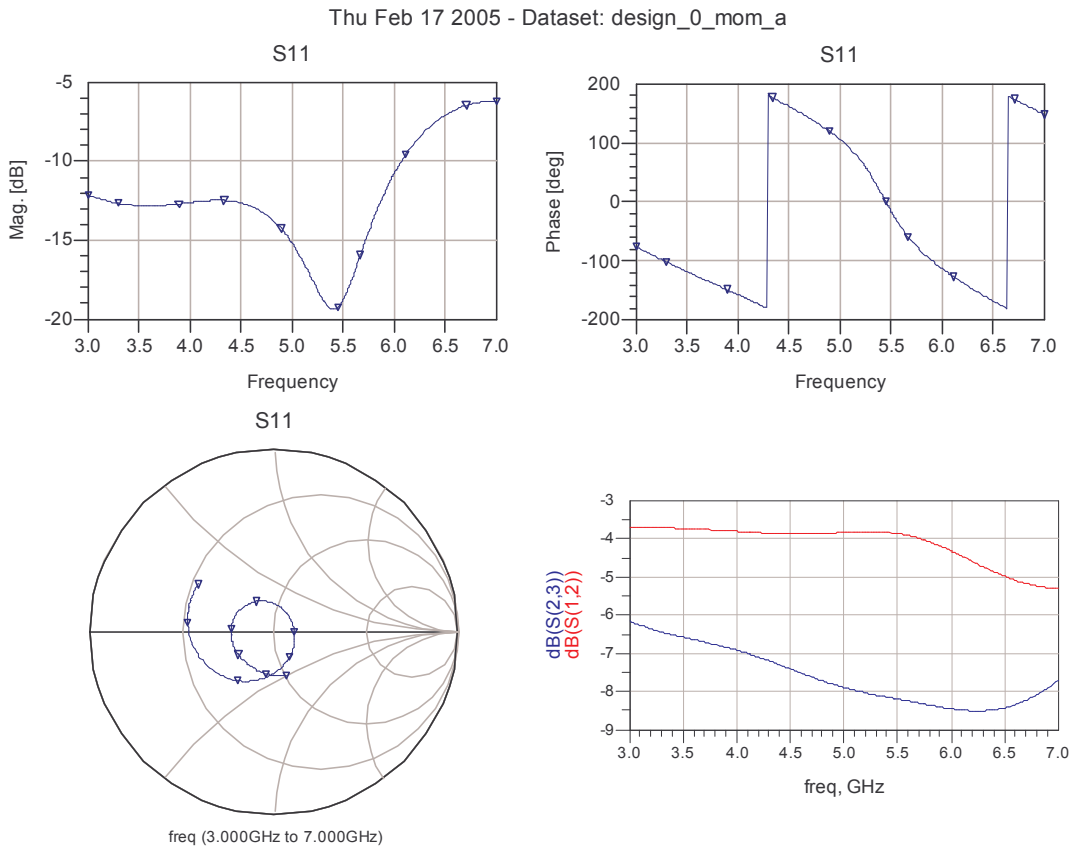


Figure 2.5 Momentum Simulation of Wilkison Power Coupler

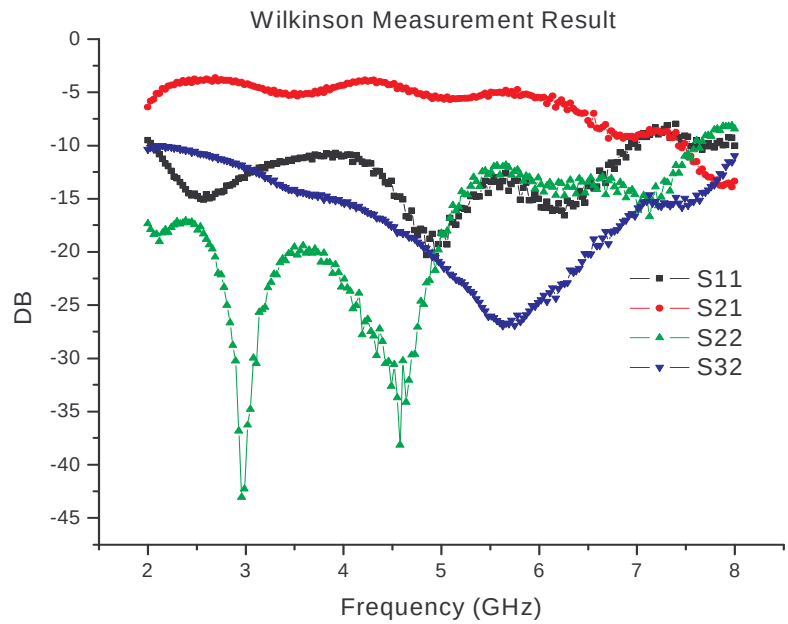


Figure 2.6 Measurement Result of Wilkison Power Coupler using Network Analyzer

Analysis:

On Momentum simulation, dB(S11) reaches lowest point of –20dB at 5.5GHz, dB(S12) remains above –4dB until the frequency is higher than 5.5GHz , the phase change of S11 appears at 4.2GHz and 6.7GHz.

While for the real measurement results, dB(S11) reaches lowest point of –20dB at 5GHz, dB(S21) gets the highest value of –5dB below 5.5GHz. dB(S32), dB(22) reach lowest point at 5.5GHz and –4.5GHz to –30dB and –40dB respectively.

The measurement shows –0.5GHz difference to design value. This is partially due to not taking the solder connection, loss along transmission line into consideration. Also, the position of SMT resistor has some influence to the measurement. The coupling between two branches also gives rise to additional errors.

This project gives me a further understanding to circuit design under microwave frequency. I had some problems in generate the proper layout due to the introduce of SMT resistor, but eventually solved this problem after long time of adjusting microstripe line dimension. The measurement shows some difference with the design demand. But anyway, this project is still beneficial and helpful.

3. Modified Wilkison Power Coupler

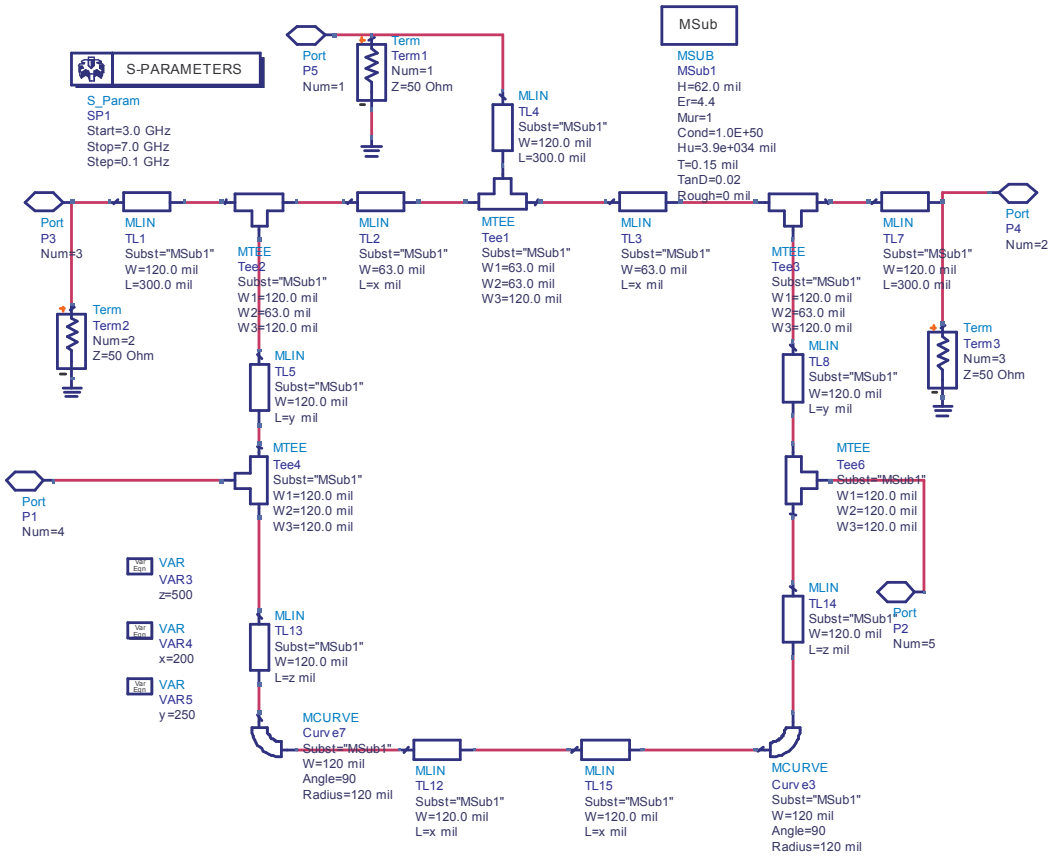


Figure 3.1 Schematic view of Modified Wilkison Power Coupler

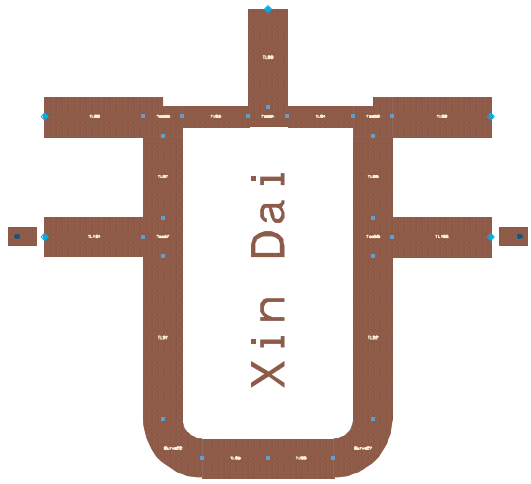


Figure 3.2 Modified Wilkison Power Coupler Layout

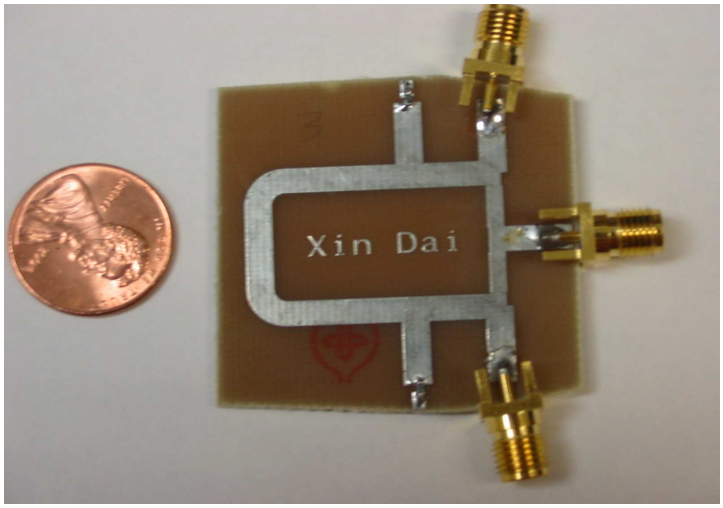


Figure 3.3 Modified Wilkison Power Coupler Picture

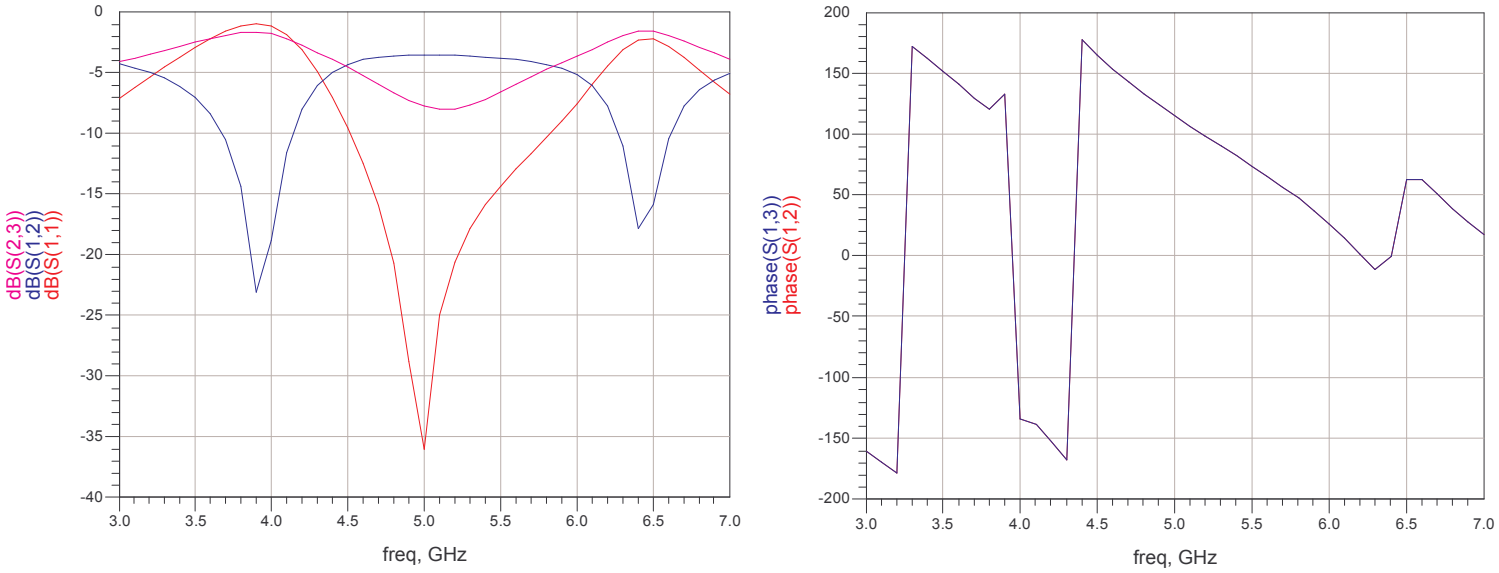


Figure 3.4 Simulation Result of Modified Wilkison Power Coupler

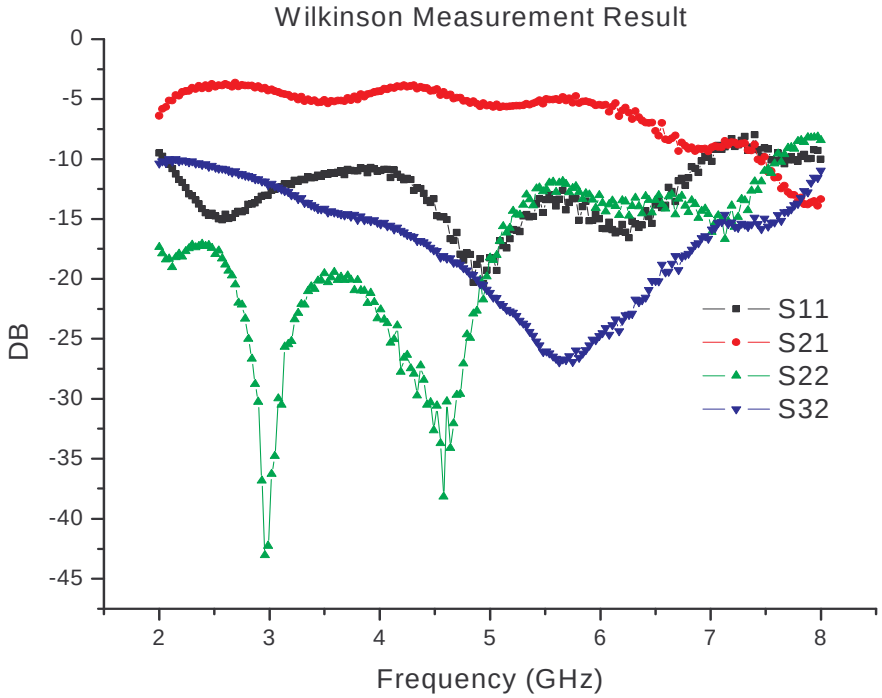


Figure 3.5 Measurement Result of Modified Wilkison Power Coupler

4. 5GHz Amplifier

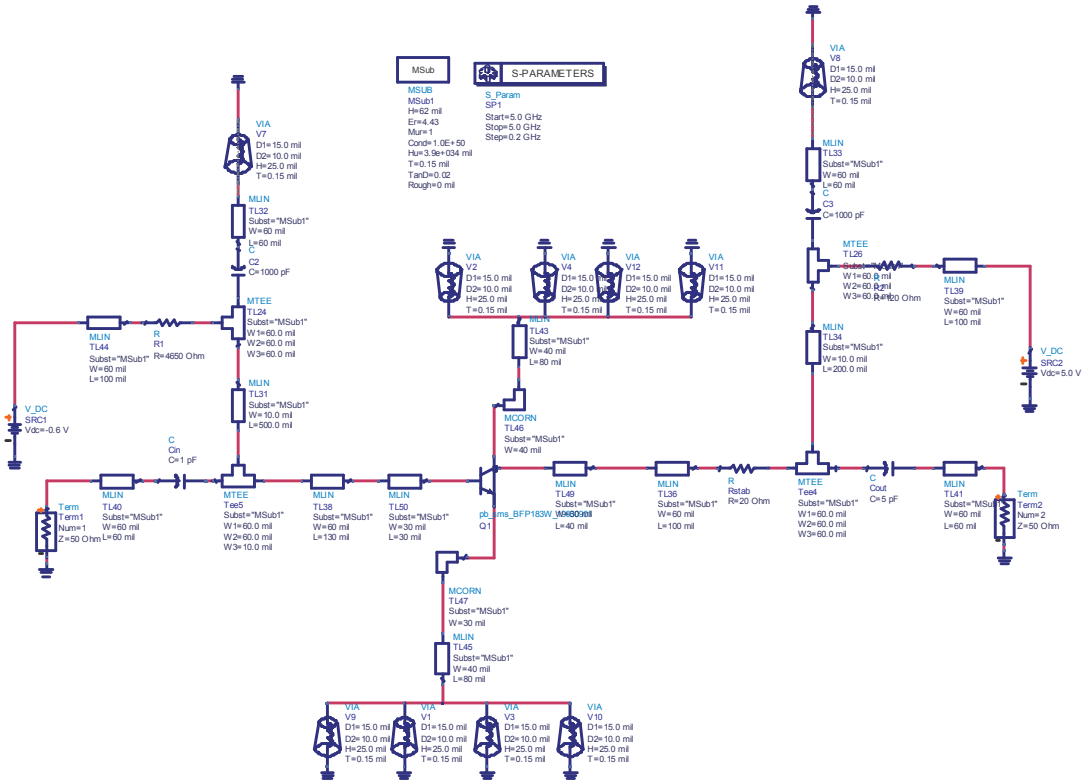


Figure 4.1 Schematic View of 5GHz Amplifier

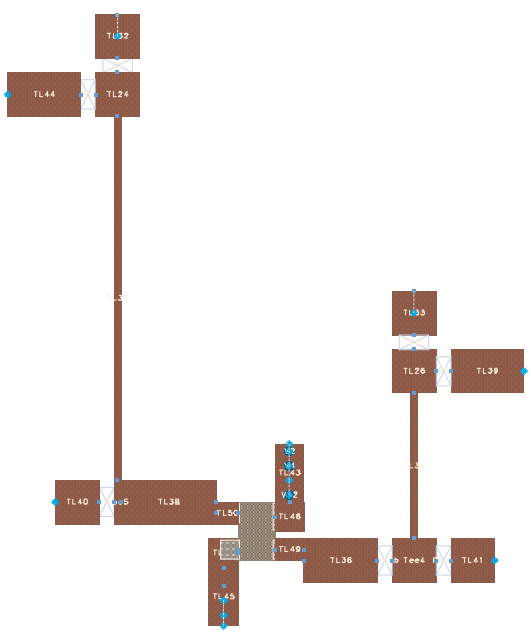


Figure 4.2 Layout of 5GHz Amplifier

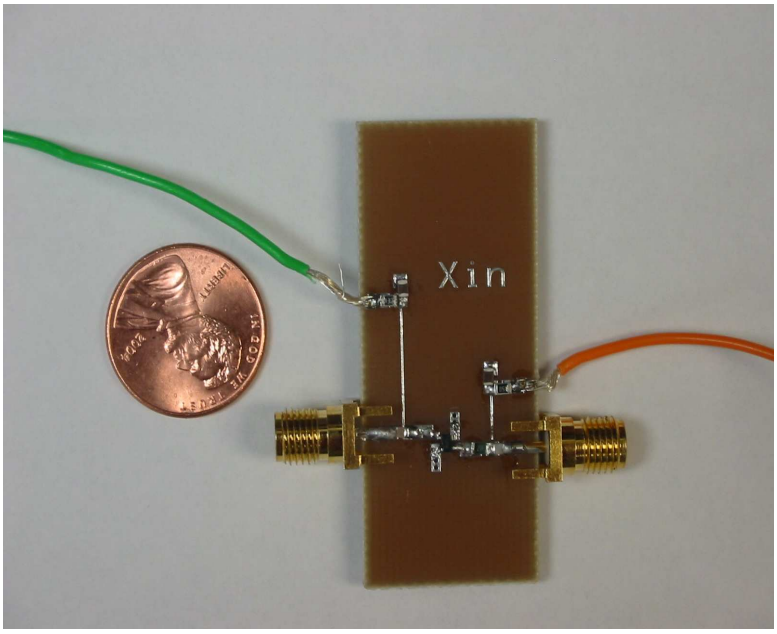


Figure 4.3 Picture of 5GHz Amplifier

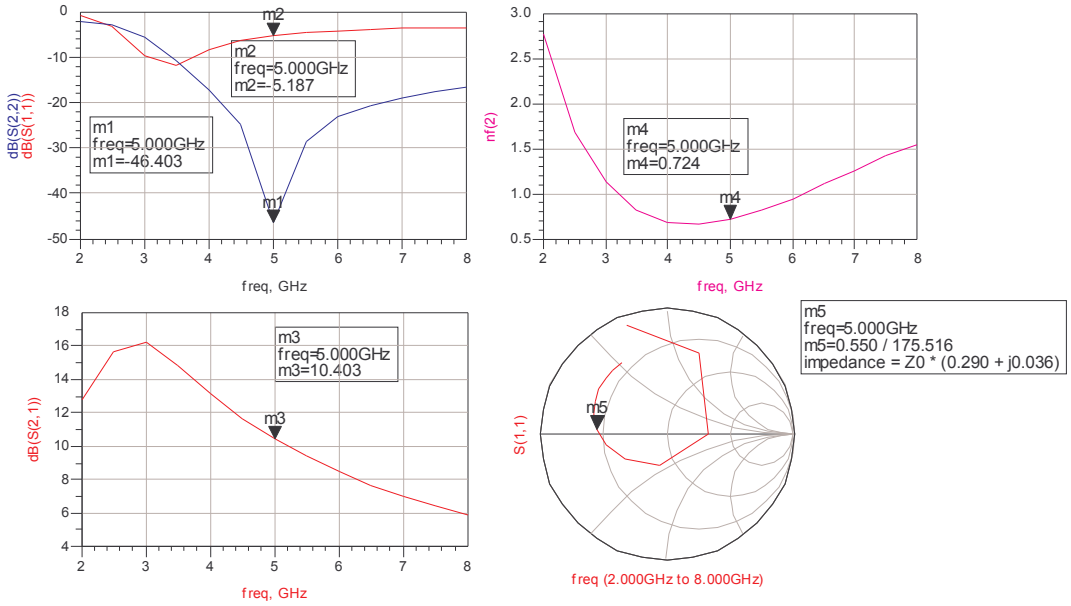


Figure 4.4 Simulation Result of 5GHz Amplifier

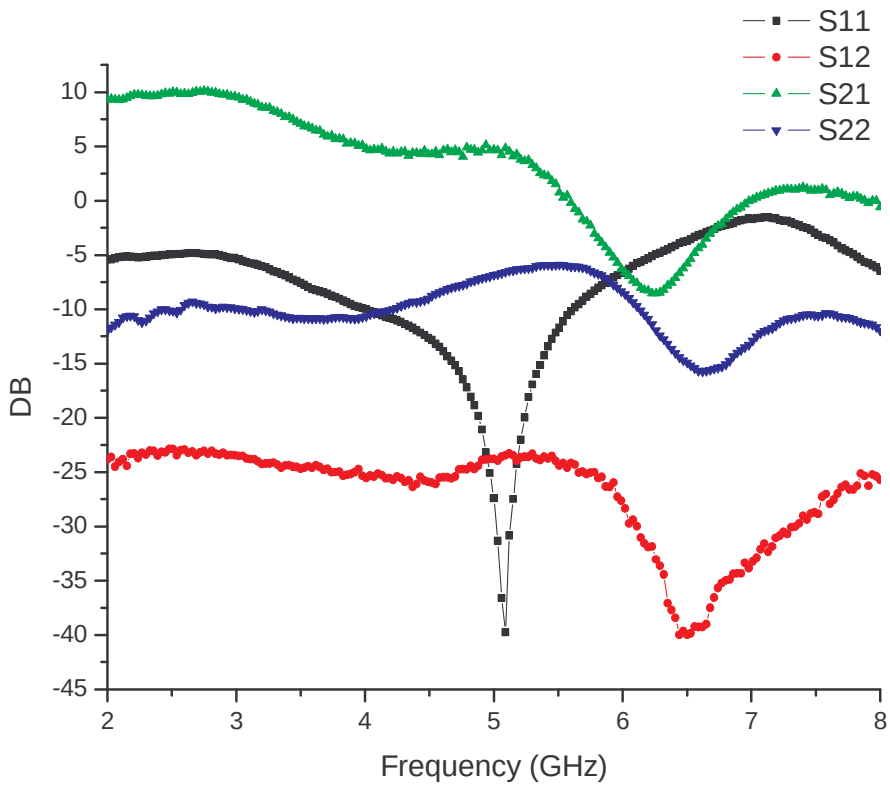


Figure 4.5 Measurement Result of 5GHz Amplifier

Analysis:

This project gave me more challenge. It requires a lot of procedures, including DC-bias setup, stability calculation, input/output impedance match. But after I got familiar with some ADS example, the design is just a time process, although this process is still long and energy consuming. On simulation, all the index are good. dB(S11)is -5dB at 5GHz, dB(S22) remains reaches lowest point of –46dB at 5GHz , db(s21) at 5GHz is 10.4dB.

While for the real measurement results, dB(S11) reaches lowest point of –40dB at 5GHz, which is good. dB(S12) and db(S22) get –25dB and –8dB at 5GHz. dB(21) gets only 5dB at 5GHz, which is not satisfactory.

This project gives me a further understanding to Microwave circuit design with power source. I had some problems in DC-bias setup due to using S-parameter mode instead of Spice model. The design of power amplifier needs a lot of experience and is really not a easy job for beginners like me. But anyway, this project is still helpful and gives me a very good start point.

5. 2.35GHz Oscillator

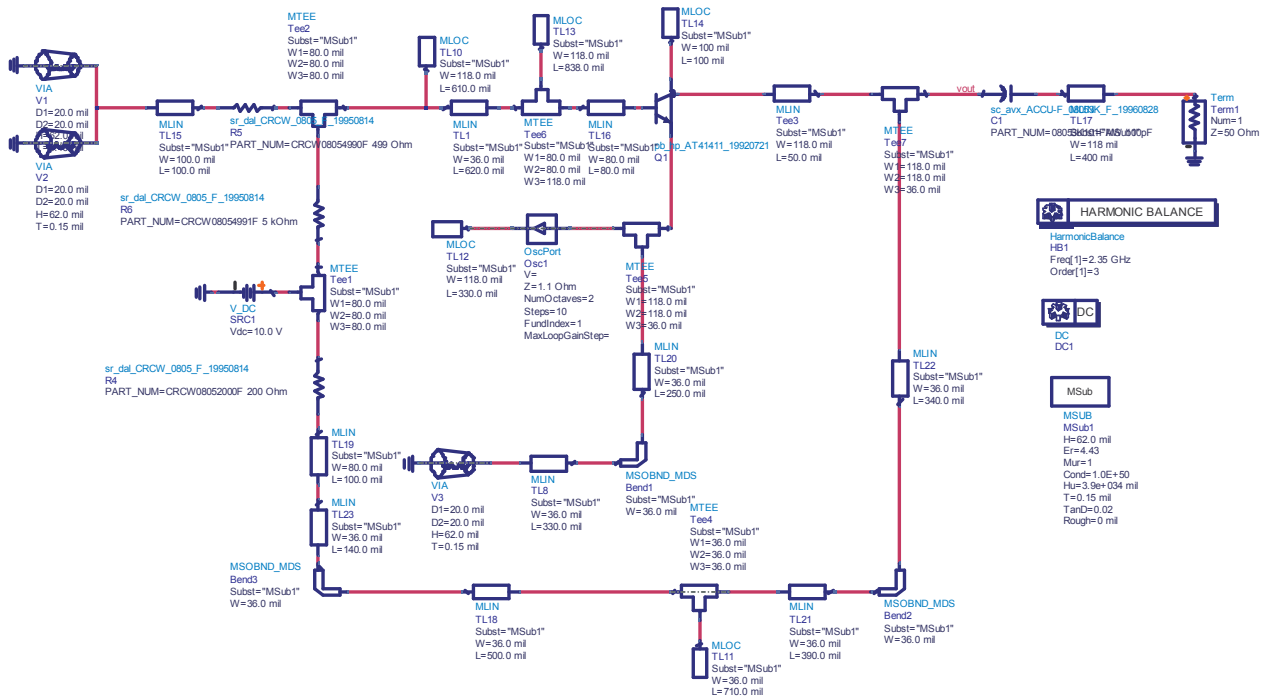


Figure 5.1 Schematic View of 2.35GHz Oscillator

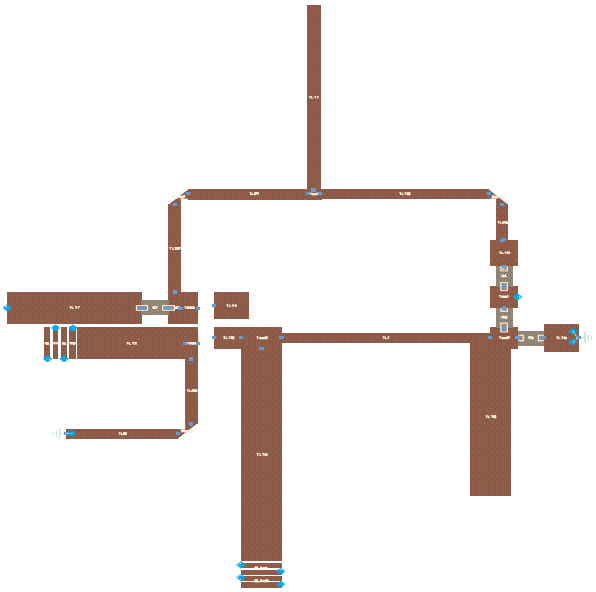


Figure 5.2 Layout of 2.35GHz Oscillator

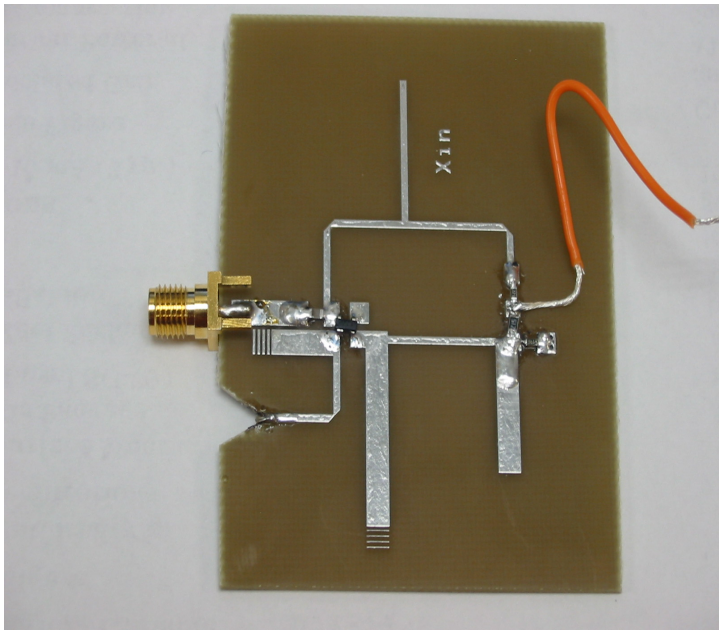


Figure 5.3 Picture of 2.35GHz Oscillator

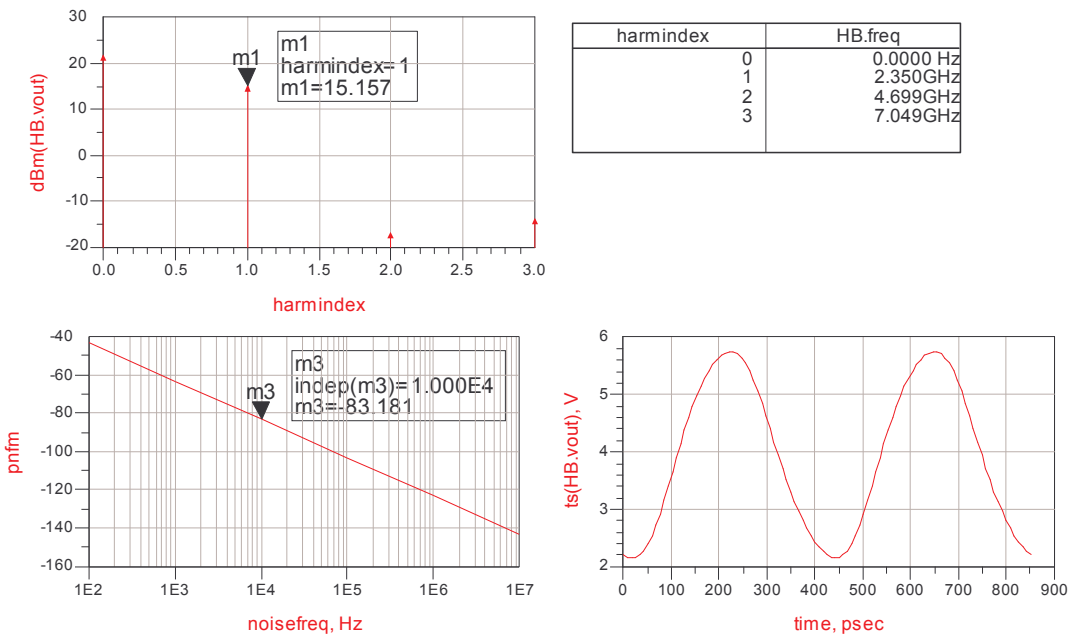


Figure 5.4 Simulation result of 2.35GHz Oscillator

Analysis:

I felt much better in this project. Perhaps this is because I am becoming more and more familiar with ADS and interested in Microwave circuit design. I got the best Simulation result so far. I got perfect 2.35GHz base frequency and very little harmonics. The waveform shown on above figure is very smooth.

Since we need equipment from EM lab under Dr. Race to test the oscillator, I did not test it because Dr. Pace is not available so far. What's a pity.

This project gives me a further understanding to Microwave circuit design with power source. I begin to like Microwave circuit design. The design of oscillator still needs a lot of experience and some more stuff like buffer and feedback control parts, which we are not required to design. But anyway, this project is still helpful.

6. Mixer (RF:2.45GHz, LO:2.35GHz, IF:100MHz)

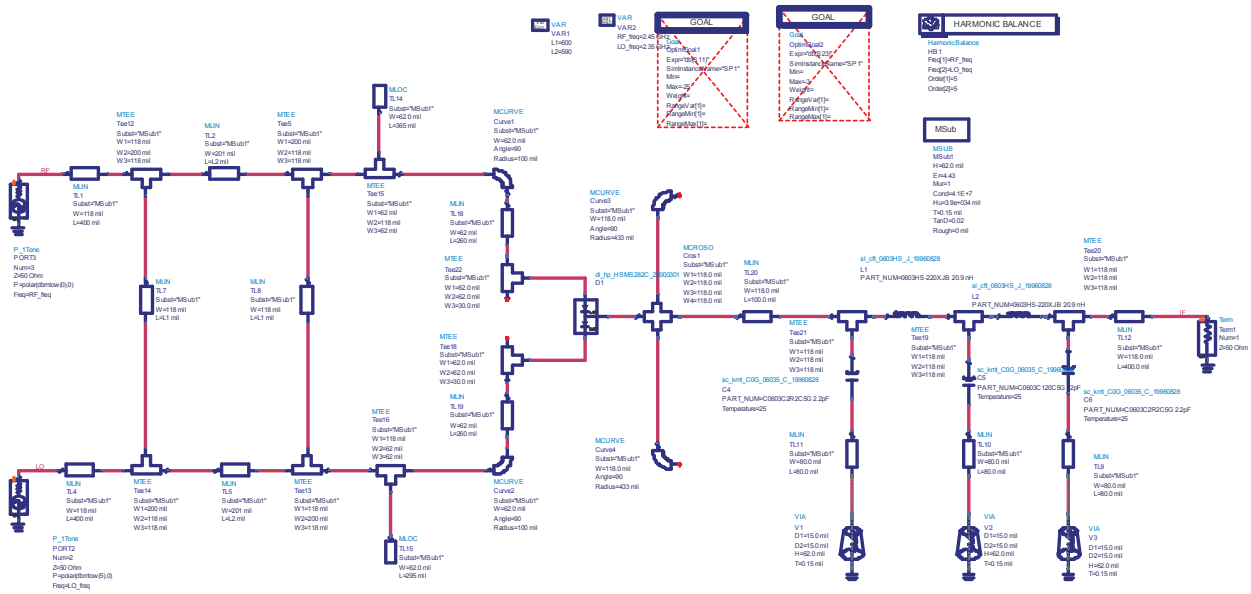


Figure 6.1 Schematic view of mixer

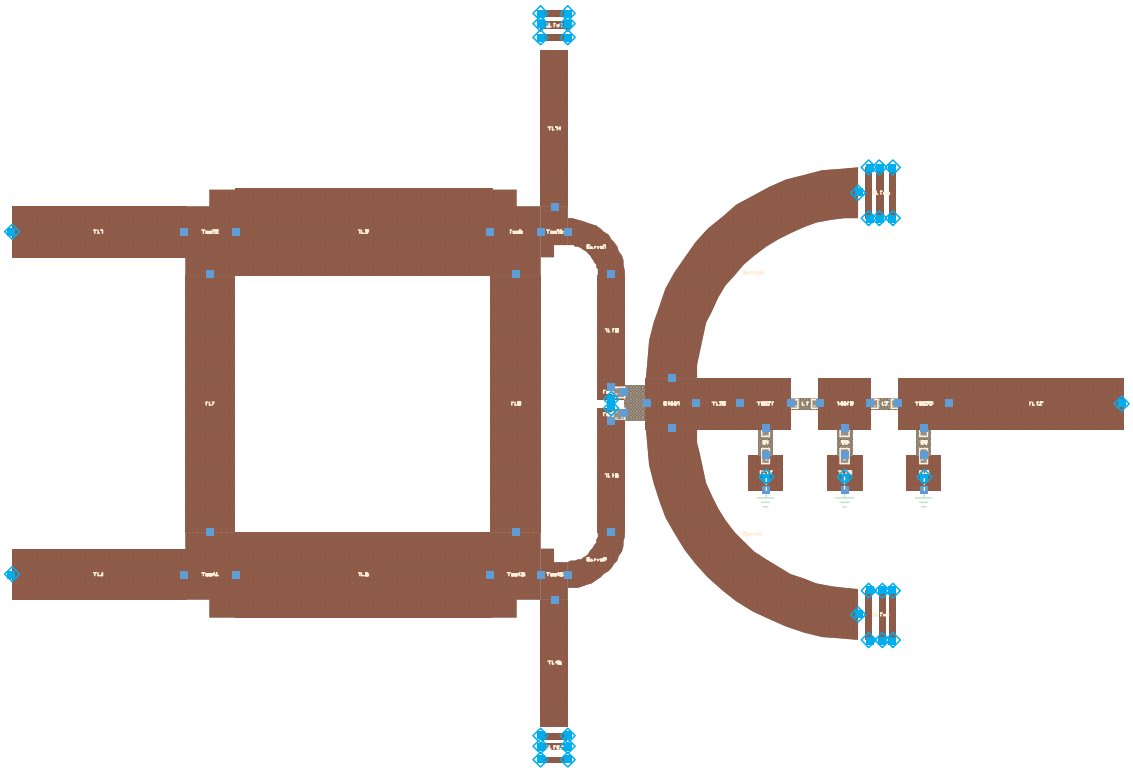
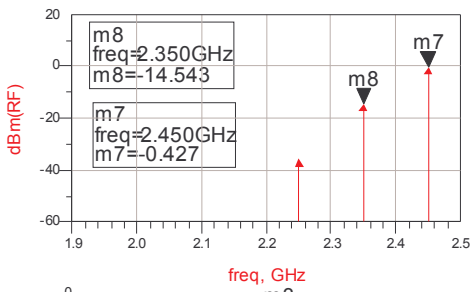
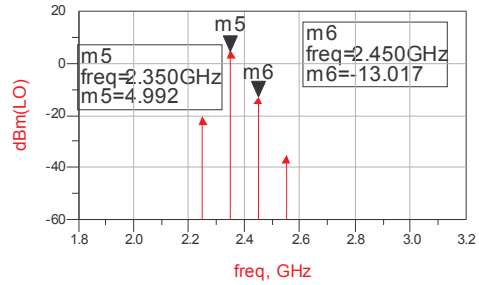
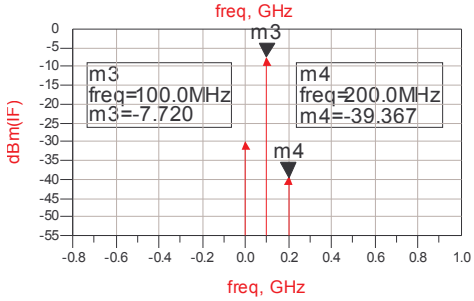


Figure 6.2 Layout of mixer







freq	IF	LO	RF
0.0000 Hz	0.010 / 0.000	0.005 / 180.000	0.005 / 180.000
100.0MHz	0.130 / 26.788	0.066 / -125.239	0.065 / -125.390
200.0MHz	0.003 / -11.771	0.002 / -132.736	0.002 / -137.334
2.250GHz	1.344E-6 / 66.689	0.029 / -22.354	0.005 / 107.939
2.350GHz	1.118E-5 / 136....	0.562 / -2.955	0.059 / -47.809
2.450GHz	3.376E-6 / 150....	0.071 / -91.693	0.301 / -7.034
2.550GHz	5.920E-8 / 31.850	0.005 / 18.418	0.014 / -168.822
4.600GHz	1.948E-4 / -94.1...	0.012 / -24.402	0.020 / 168.762
4.700GHz	0.002 / 126.152	0.003 / 52.741	0.005 / -75.701
4.800GHz	8.319E-4 / -167....	0.024 / -73.970	0.036 / 99.469
4.900GHz	0.002 / -97.513	0.003 / 153.735	0.004 / -25.214
5.000GHz	3.095E-4 / -38.7...	1.622E-4 / 25.492	1.648E-4 / -151....

Figure 6.3 Simulation result of mixer

Analysis:

For the last class project, I was assigned to design a mixer with 2.45GHz RF, 2.35GHz LO and 100MHz IF.

Since we have not received actual board yet, I can only provide the schematic view, layout and simulation result.

On RF port, dBm(RF) is –0.427, dBm(LO) is –14.54;
On LO port, dBm(LO) is 4.992, dBm(RF) is –13.017;
On IF port, dBm(IF) is –7.720, dBm(200MHz) is –39.367, RF and LO signal can be omitted.

Just from simulation result, this design basically satisfies the demand for mixer. Hopefully, after we got the board, the real measurement is still OK. The real measurement can be provided can we got the board.

This final project gives me a very good understanding to Microwave circuit system design and integration. I benefit a lot from the study of this course. Although I am not specified in Microwave design for my own research, this course will definitely give me a lot of help for my research and career.