6 dB Microstrip Coupler

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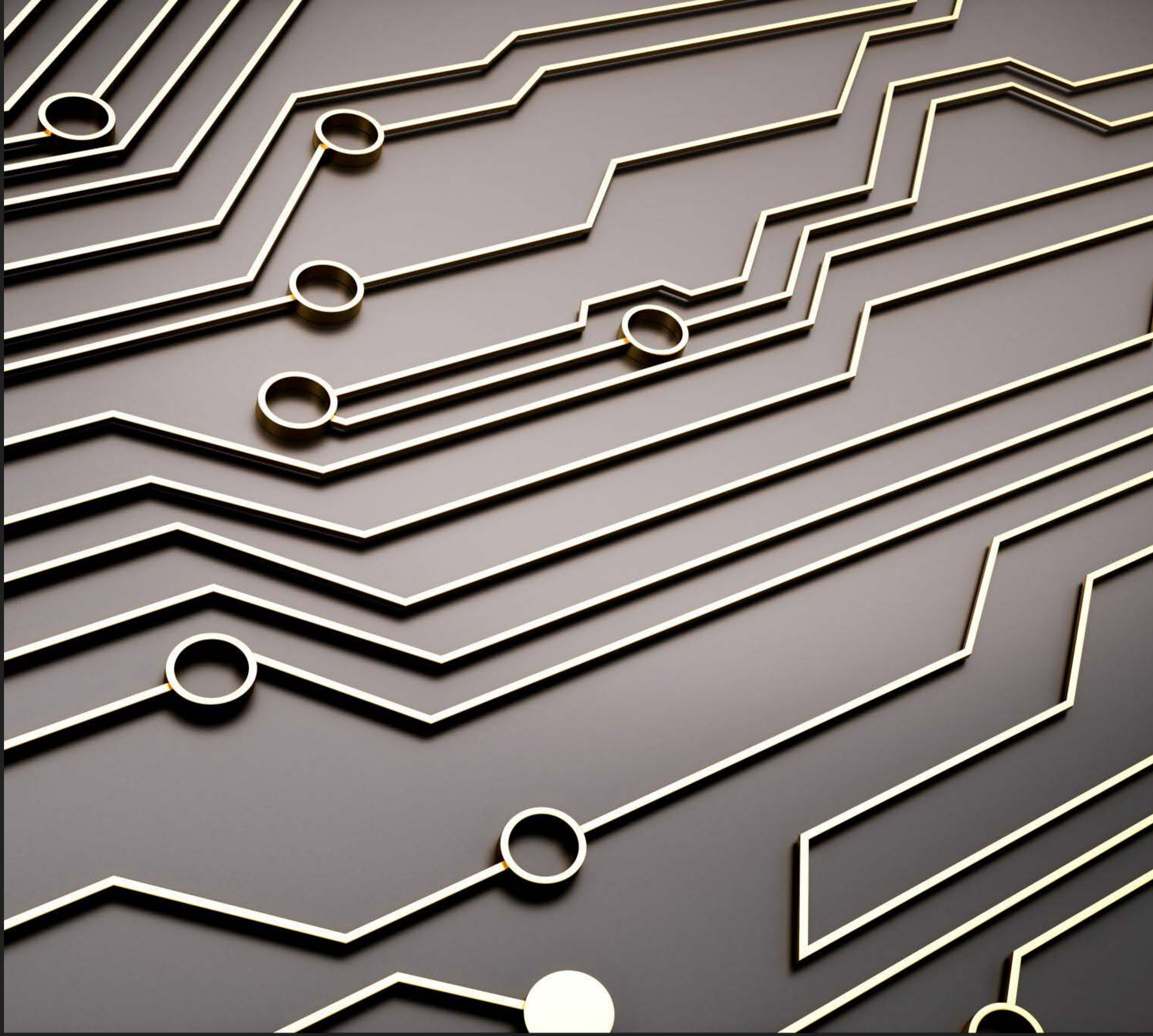
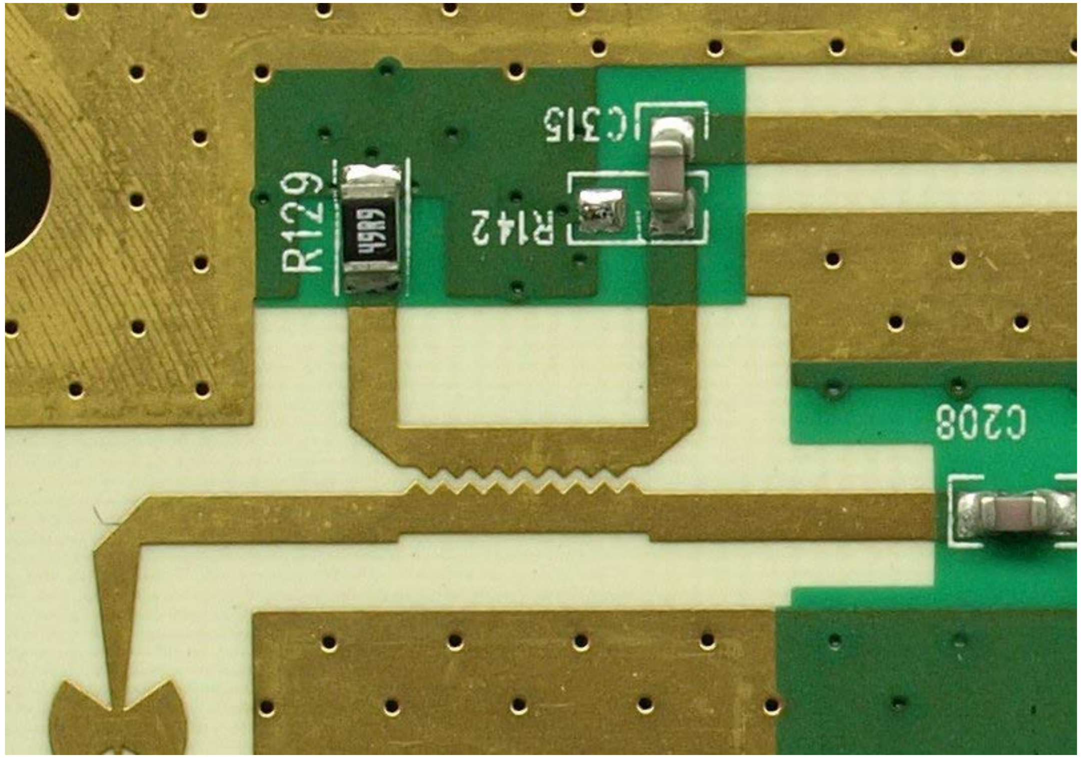
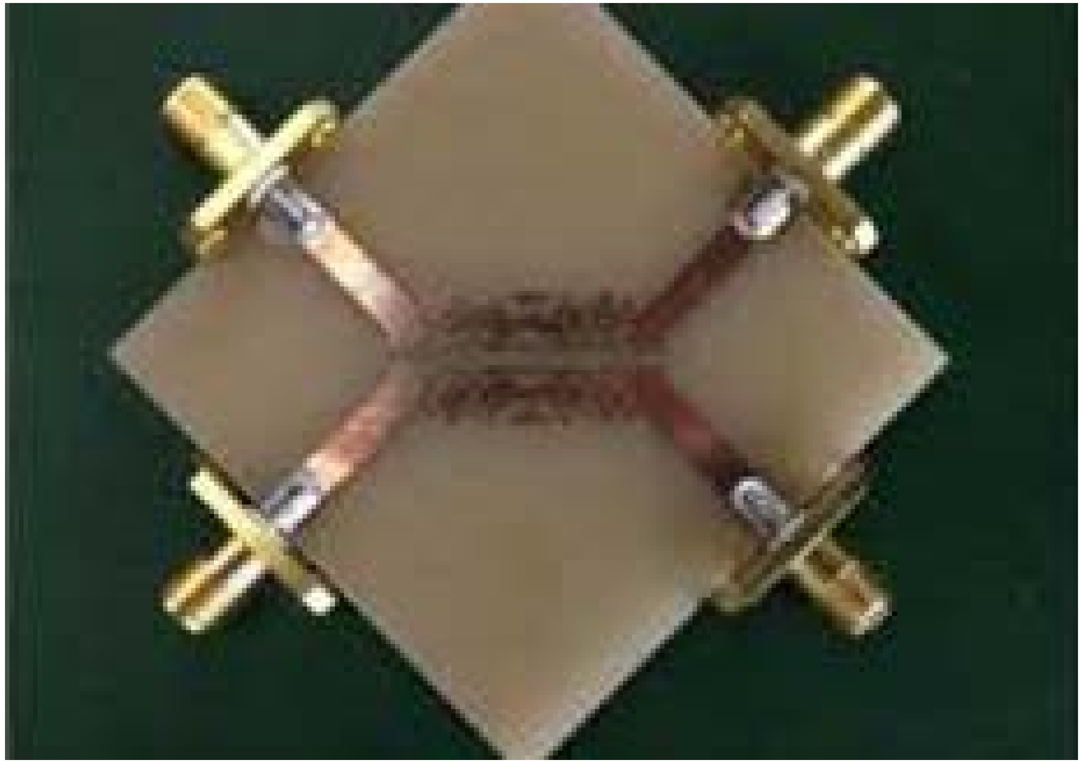






Microstrip coupler

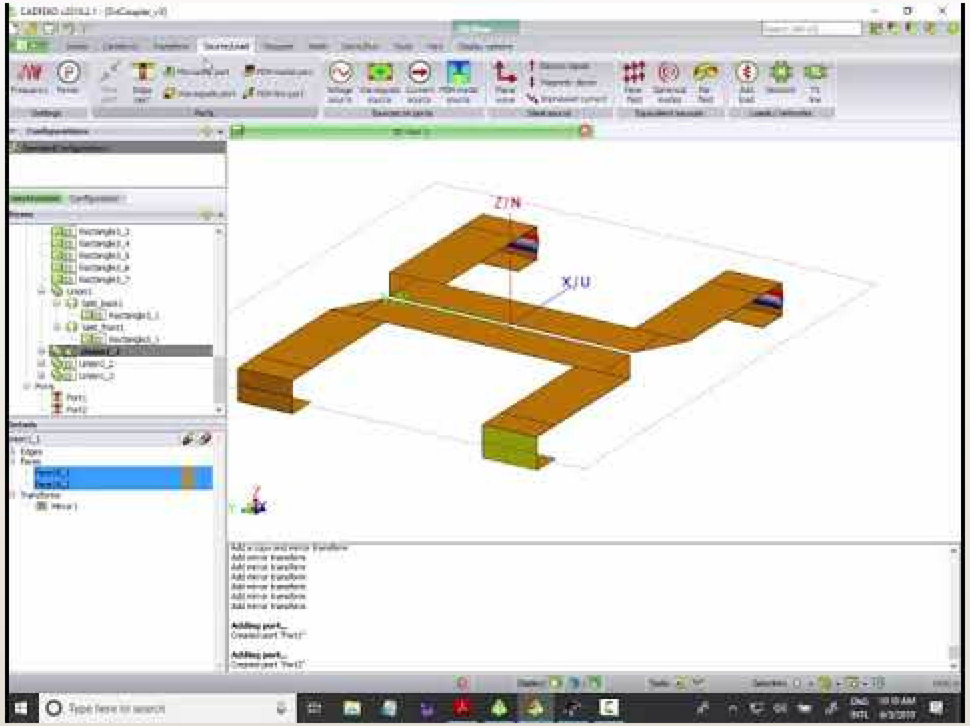
Introduction

This presentation introduces a new configuration of the microstrip 6 dB coupler with a new design. In the following slides we examine and study a coupler which operates on high frequencies which are between 9GHz to 11GHz. The results of the following experiment are shown using Sonnet software with excellent performance of the coupler with great isolation characteristics.

The coupler is usually used to split the input signal and the distributed power, and they are made up of four ports, each port has its own functions in the coupler. In this presentation, we show the response of a 6 dB coupler which works with the frequencies of 9GHz to 10.5GHz on sonnet.

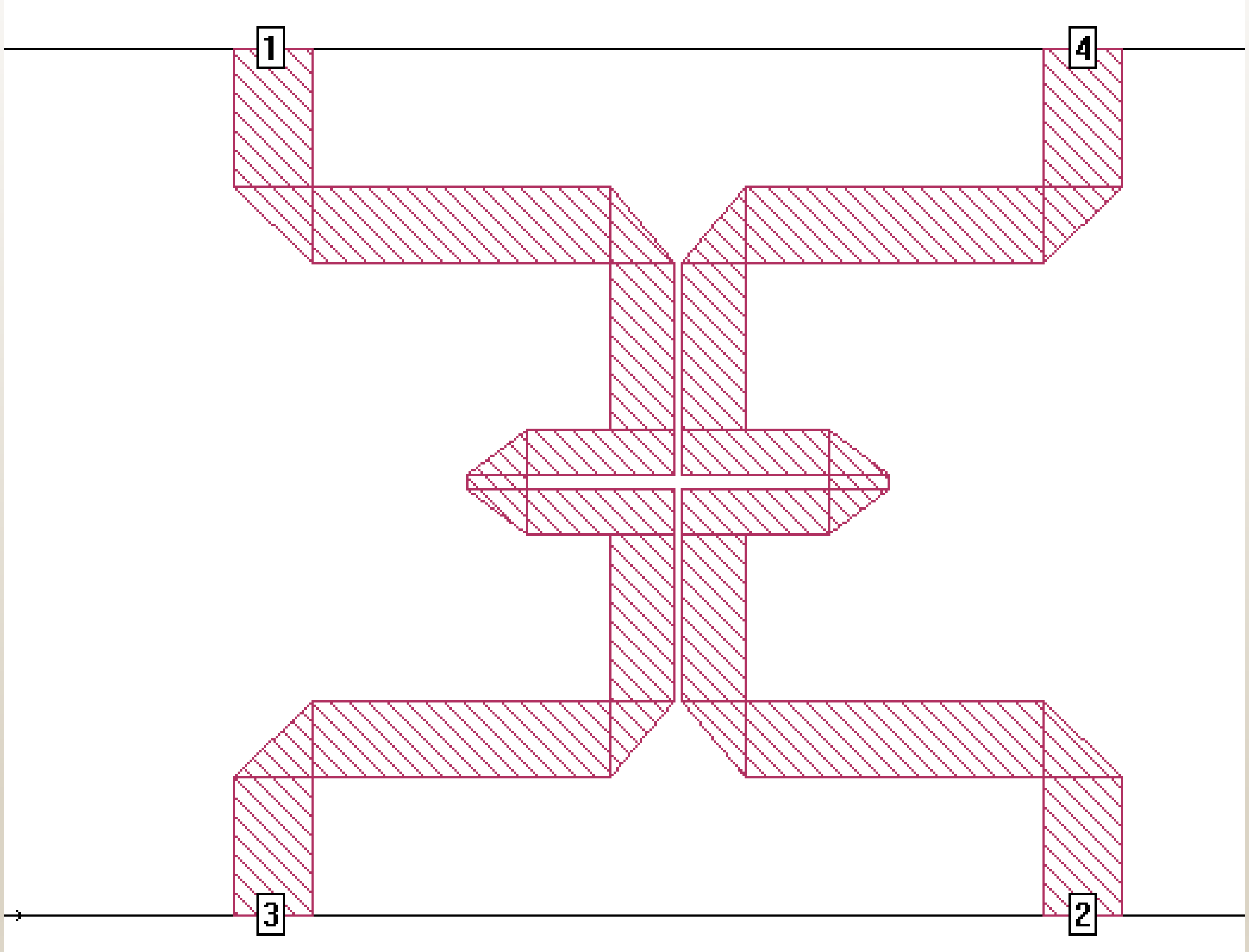
However, the microstrip directional couplers suffer from poor directivity due to characteristic of the inhomogeneous dielectric including both dielectric substrate and air in microstrip transmission lines. In addition, it is difficult to achieve tight coupling owing to impractical spacing between the coupled lines in conventional edge coupled microstrip couplers.

But in real life it is not as easy as the calculation work to achieve the aimed goals, when it goes to the fabrication part, it will not be as accurate as wished, therefor, some actions need to be made in order to have our coupler work as close as wished, some tables are made with small changes of design parameters to make sure that the coupler performs its functions as it supposed to do so. This performance is then enhanced by subsequent signal processing which, after amplification, is digitized using an analogue/digital convertor.

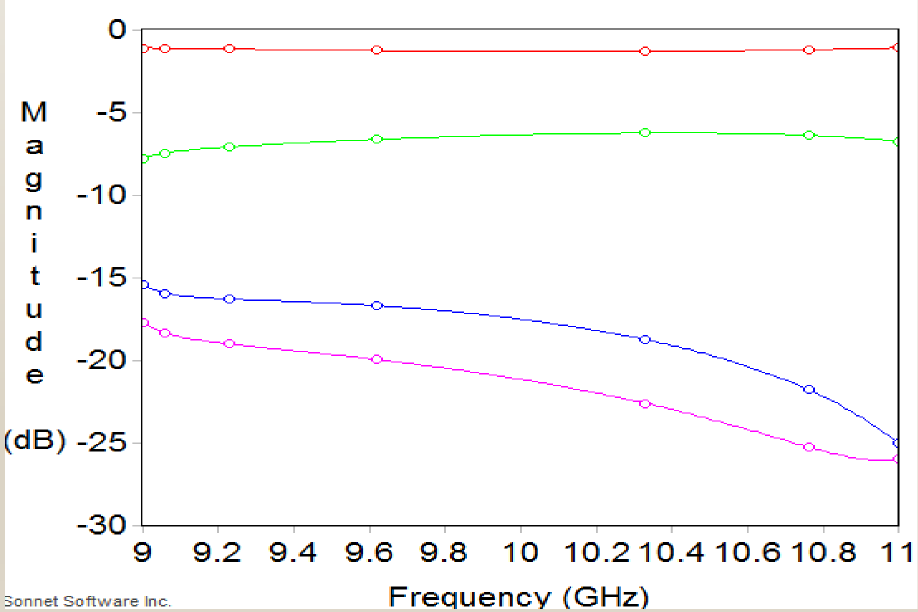


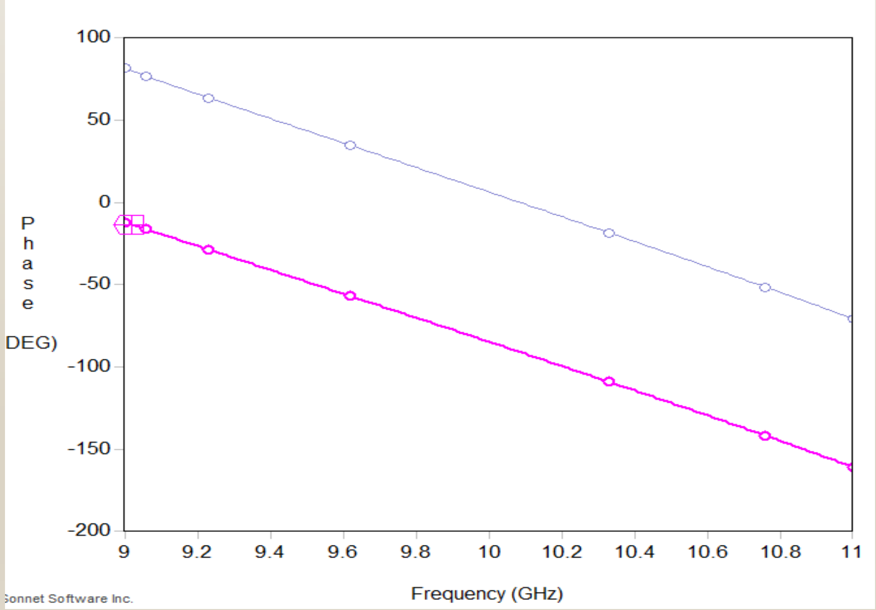
Design and simulation results

The 6 dB coupler design in this study is designed in Sonnet software which is made up of 4 ports with each port with its own function, port 1 works as the input work in the coupler, port 2 behaves as the transmitted port, while port 3 is the coupled port, and the final port does the isolation part in the coupler.

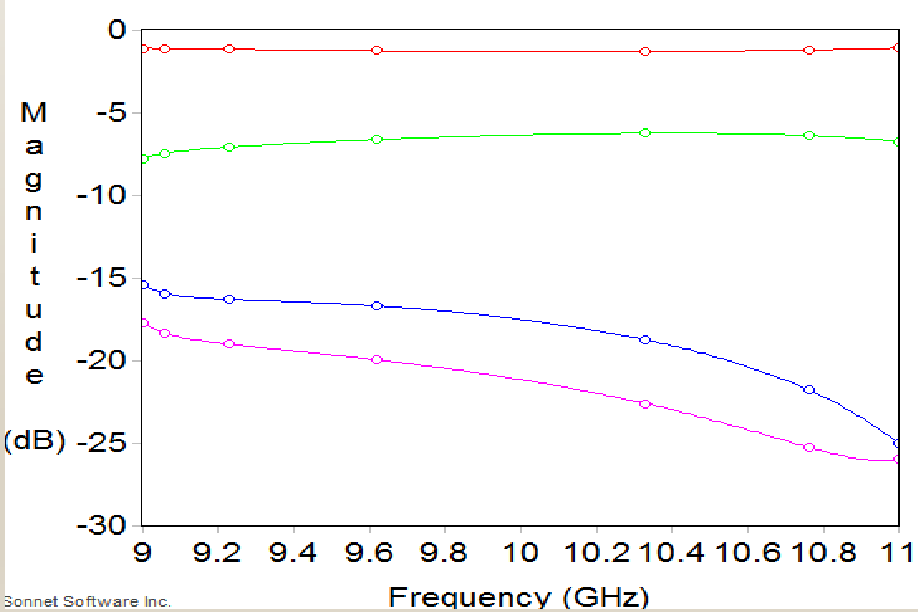


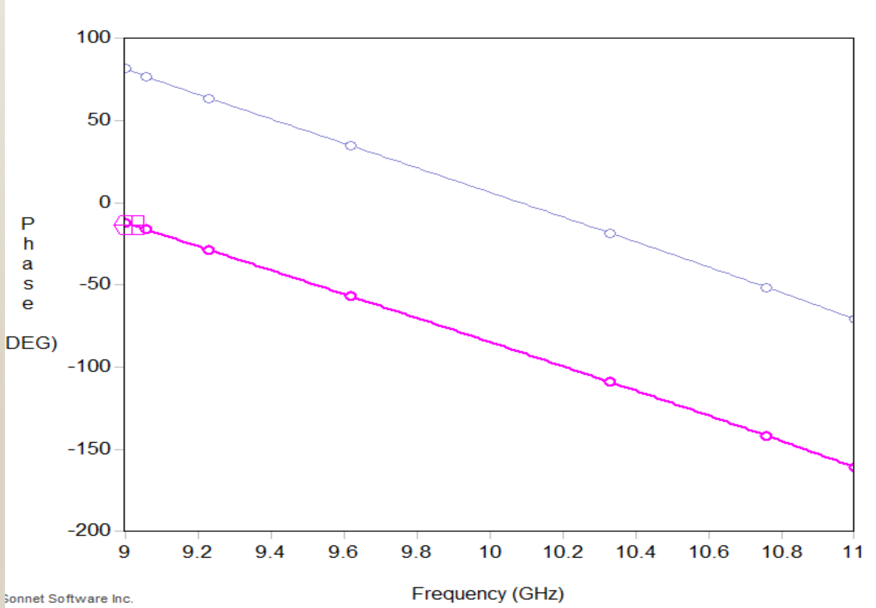
In the picture it is easy to see that coupling is about 6dB, more precisely it varies between 6.35dB to 6.25dB, where 6.35dB is the result of the measurement at the beginning or 6.25dB at the end of the graph. In the picture you can also see that the isolation generated by four ports of our coupler is around 25dB. At the beginning it is around 15dB, with the increase of the GHz also the value of the isolation increases. In our simulation we analyzed S11, S12, S13 and S14, as shown down in the figure. The green linear line corresponds to S13, which is stable through the analyzed range. S11 is represented by the blue line, and S12 by the purple line.





Those lines are steeply declining as the inductance is increasing. S14, which is red line, is stable. If the impedance is increasing a shift of the center frequencies will occur, which is not shown in the previous figure. Relative phase difference in the coupler plays an important role in the design of a microstrip coupler as it shows the importance of achieving dimension extraction in order to accomplish a great network performance using the microstrip coupler. In our case, ports s11 and s14 were used as the output ports and the relative phase difference is approximately 90° as it is shown in the figure below.





Parametric Study

One of the most important components to take into consideration while designing the coupler is the dielectric both its thickness and density as we have the thickness shown in Table II with 0.76mm as our main value and density of the dielectric is shown in Table III with 3.5 as our main density, which plays a big role in our study, the dielectric is the electrical insulator which is being polarized by the applied electrical field.

TABLE I SEPARATION LINES

S1 values(mm)	Coupling (dB)	
	9 Hz	10Hz
0.4	-6.41	-6.36
0.3	-6.41	-6.32
0.3	-6.35	-6.25
0.25	-6.30	-6.18
0.20	-6.29	-6.16

TABLE II DIELECTRIC THICKNESS

Eth values(mm)	Coupling (dB)	
	9 Hz	10Hz
0.8	-6.09	-5.99
0.78	-6.21	-6.11
0.76	-6.35	-6.25
0.74	-6.45	-6.39
0.72	-6.64	-6.54

TABLE III DIELECTRIC DENSITY

Er values(density)	Coupling (dB)	
	9 Hz	10Hz
3.6	-6.32	-6.30
3.55	-6.33	-6.27
3.50	-6.35	-6.25
3.45	-6.37	-6.23
3.40	-6.39	-6.22

TABLE IV LENGTH OF MEANDER LINES

S3 values(mm)	Coupling (dB)	
	9 Hz	10Hz
3.4	-6.48	-6.73
3.3	-6.29	-6.32
3.2	-6.35	-6.25
3.1	-6.36	-6.14
3.0	-6.42	-6.07

Parametric Study

We have also taken into consideration separation of lines at the center which separates the upper and the lower ports between each other by changing their dimensions with 0.5mm each time as we have 0.3mm as our main dimension which is shown in Table I as S1. Lastly, we took the length of the meander lines at the center into account as well by moving it 1mm each time as we standardize 3.2mm as our main length which is shown in Table IV as S3.

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Conclusion

The 6 dB coupler which we have constructed meets the requirements for a coupler which has great performance, low losses, economical with its low costs. The region which this coupler operates is from 9GHz to 11GHz which results in a magnitude of 6 dB which could be used in several future projects in fields such as radio technology.

Acknowledgement

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