

Microstrip Hybrid Wideband 10 dB Coupler

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Introduction

- This paper presents the design, simulation and optimization of Microstrip Hybrid 10 dB Wideband Coupler.
- The coupler has 10 dB coupling and almost 4 GHz frequency band.
- The aim of the project was to introduce a new coupler design and to achieve stable operation for as wide bandwidth as possible.

Introduction

- For microwave engineering, the frequency range from 3 to 300 GHz is reserved.
- Couplers can be used in microwave applications, as well as in radio frequency through devices like power amplifiers, antenna feeders and balance mixers.
- Coupler can be a 3-port or 4-port device.
- Hybrid Coupler is a 4-port device.

Previous Work

- [1]K.C. Dalar, M. Yildirim, M. A. Aydin, Ş. T. Imeci, 3 dB Hybrid Coupler, 28th Annual Review of Progress in Applied Computational Electromagnetics, April 10-14, 2012 - Columbus, Ohio
 - The paper presents a 3dB stripline broadside coupler which can be applied to construct highly integrated WiFi/WiMAX RF applications. The design offered a very good coupler with high isolation, great amplitude balance and almost 2 GHz frequency band.

Previous Work

- [2]G. Sanna, G. Montisci, Z. Jin, A. Fanti, G. A. Casula, Design of a Low-Cost Microstrip Directional Coupler with High Coupling for a Motion Detection Sensor, Electronics 2018
- In this paper, coupled-line asymmetric coupler design for motion detection systems is shown and it is explained how it can be used in Doppler motion detection system due to its strong coupling and relatively high isolation. It's also compared to standard quarter-wave, coupled-line coupler which showed the increase in coupling factor of about 3 dB.

Previous Work

- [3]S..S. Pai, M. Kumar , K. Singh, Design and Performance Analysis of lumped and distributed 6-dB micro strip coupler topologies at S-band, International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE) Volume 6, Issue 5, May 2017
- This work presents various approaches for the realization of 6 dB coupler in planar configuration. Some topologies such as hybrid coupler, ring coupler, etc. are designed at S-band in microstrip configuration. Further, the design of a 6 dB coupler using lumped approach is carried out. Comparison between all topologies are presented and discussed.

Previous Work

- [4]Rezaei, A and Noori, L. Microstrip Hybrid Coupler with a Wide Stop-Band Using Symmetric Structure for Wireless Applications. J. Microw. Optoelectron. Electromagn. Appl., 2018, vol.17, n.1, pp.23-31
- A wide stop-band microstrip coupler is presented in this paper. It is designed to operate at 2.82 GHz for wireless applications.

Previous Work

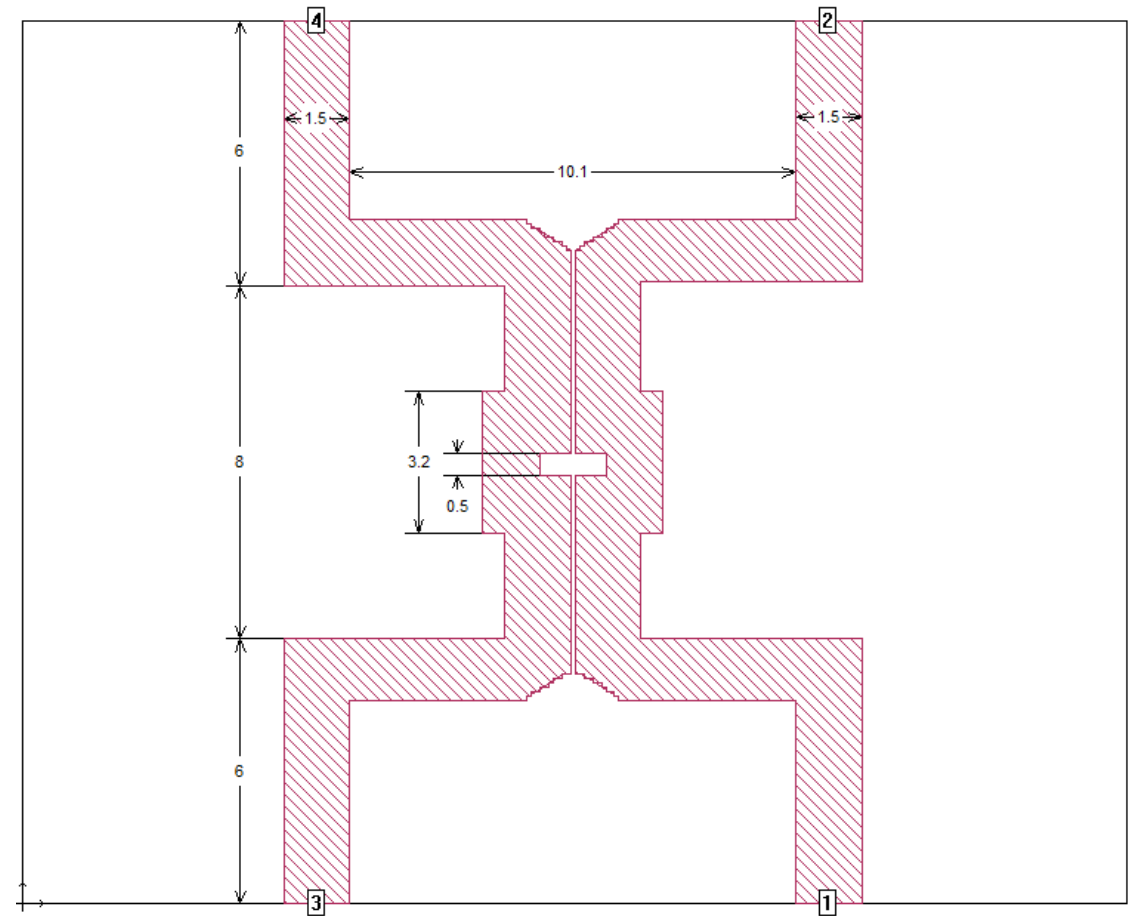
- [5]T.Jayachitra, V.K Pandey and A. Singh, Design and Development of Hybrid Coupler with FR4, International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE) Volume 2, Issue 12, December-2013
- Here, the design and development of hybrid coupler using FR4 substrate is explained and shown to work at 2.4 GHz with efficiency of 55%.

Design Steps

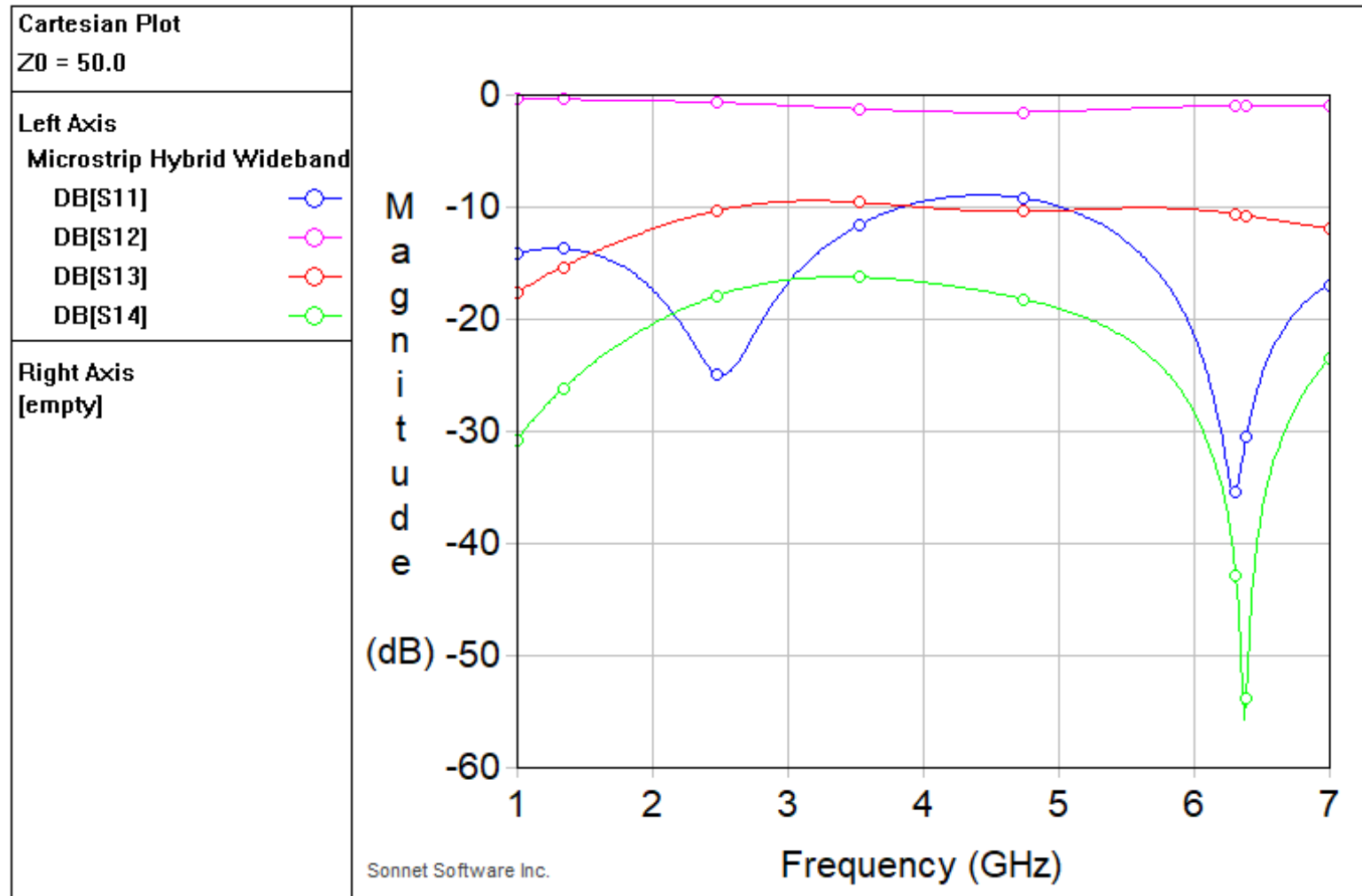
- In this work, a 4-port microstrip coupler is designed.
- The main material of the coupler is FR4 with thickness of the substrate 1.55 mm and dielectric constant is 4.4. The dimensions of coupler are 13.1 mm by 20 mm, and the air layer is 11.5 mm.

Design Steps

- Metal width: 1.5 mm
- Separation between lines: 0.1 mm
- Center part width: 1.5 mm
- Center part height: 0.5 mm
- Indentation width: 0.5 mm
- Indentation height: 3.2 mm



Simulation Results



Parametric study

Sep. (mm)	Center sep. (mm)	Center width (mm)	Amplitude balance (dB)	Bandwidth (GHz)
0.1	2.1	0.7	0.91	1.78
0.1	1.7	0.7	0.95	3.34
0.1	1.5	0.5	1.02	3.78
0.2	1.8	0.7	2.44	2.66
0.3	1.7	0.3	3.16	2.78

Parametric Study

Metal width (mm)	Amplitude balance (dB)	Bandwidth (GHz)
1.5	1.02	3.78
1.3	1.48	4.02
1.1	2.21	4.56
1.6	1.08	3.76
1.8	1.19	3.8
2.0	1.7	4.22

Conclusions

- In this paper, Microstrip Hybrid Wideband 10 dB Coupler is designed, simulated and optimized, and its behavior is observed while changing geometry and some other parameters.
- In parametric study conducted, it can be seen that changes in separation between two metal lines affect the results the most, as well as the width of the metal, as well as center part separation and width, while angles of cut corners didn't affect results at all.
- This design has very good simulated coupling of 10 dB in a quite wide bandwidth of almost 4 GHz frequency band.

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References

- [1] K.C. Dalar, M. Yildirim, M. A. Aydin, Ş. T. Imeci, 3 dB Hybrid Coupler, 28th Annual Review of Progress in Applied Computational Electromagnetics, April 10-14, 2012 - Columbus, Ohio
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- [4] Rezaei, A and Noori, L. Microstrip Hybrid Coupler with a Wide Stop-Band Using Symmetric Structure for Wireless Applications. J. Microw. Optoelectron. Electromagn. Appl., 2018, vol.17, n.1, pp.23-31
- [5] T.Jayachitra, V.K Pandey and A. Singh, Design and Development of Hybrid Coupler with FR4, International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE) Volume 2, Issue 12, December- 2013
- [6] Sonnet suites, version 16.54, www.sonnetsoftware.com

Thank you for your time!

Any questions ?