3 dB Stripline Offset Coupler

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Abstract: In this work a 3dB stripline off-set coupler is designed and simulated. Various combinations were tried and final geometry is simulated with a 3-D planar electromagnetic simulation software. Simulation results are satisfactory and presented in figures. The coupler can be used in many wireless applications.

Keywords: Coupler, Stripline, 3dB, offset.

1. Introduction

Traditionally, the design of 3 dB coupler on microstrip is usually accomplished by the well-known Lange coupler. There are many 3dB coupler designes in previous works. Compared with the Lange coupler, the Wiggly line coupler has the better directivity, larger power capacity and better gain flatness. However, the site of the Wiggly coupler is larger than that of the Lange couple, and the requirement of the technology of the Wiggly line coupler is higher than that of Lange coupler[1] A quadrature 3-dB coupler, which combines the advantages of a coplanar waveguide and microstrip line structure suitable for single-layer substrate printed circuit board (PCB) circuit design is proposed. As compared to the conventional Lange coupler, the proposed coupler with the advantages of increasing the coupled linewidths and coupling spacing without using extra bonding wires can solve the drawbacks of Lange coupler. In addition, the proposed structure can easily be realized in a single-layer substrate by PCB manufacturing processes to eliminate the effects and uncertain factors from a multilayer substrate.[2] A 3-dB coupler by implementing microstrip-to-coplanar waveguide (CPW) via-hole transitions is proposed. The proposed coupler, with the advantages of wider coupled line widths and spacing without using any bonding wires, can eliminate the uncertain factors of conventional Lange couplers caused by the printed circuit board (PCB) manufacturing processes.[3] An effective quasi-TEM design method for 3 dB hybrid couplers using a semi-reentrant coupling section is presented.[4] Principle of operaiton and analysis of microstrip-slot-line-ring 3 db directional couplers featuring an ofset between the center frequencies of two coupling characteristics is presented.[5] Design of a broadband 3 db coupled-line directional coupler has been presented. The wide bandwidth has been achieved using symmetrical three-section coupled-line circuit.In order to achieve low losses of the designed coupler a suspended stripline technology has been chosen.[6] The design of a buried wideband 3 dB hybrid coupler in Low Temperature Co-fired Ceramics (LTCC) technology is presented. The LTCC process used is briefly described and the electromagnetic field simulation-based design is presented.[7]

2. Simulation Results

In this work, the main purpose was to design and simulate a 3 dB stripline coupler. The dielectric heights are 60-5.2-60 mils. Dielectric constant is 2, dielectric name is Rogers RT6002. Figure 1 shows the top view of the coupler. Figure 2 has the 3-D view. Figure 3, 4 and 5 has the S-parameter data.

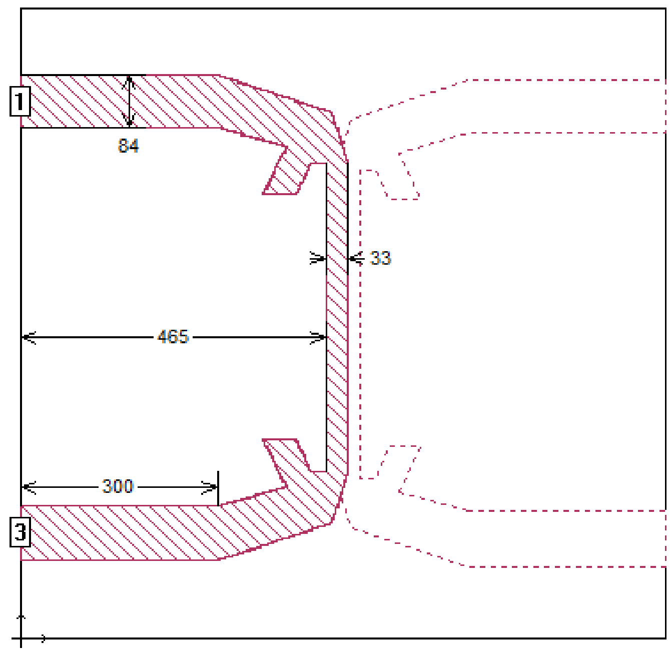

Fig. 1. Top view and dimensions of the coupler (mils)

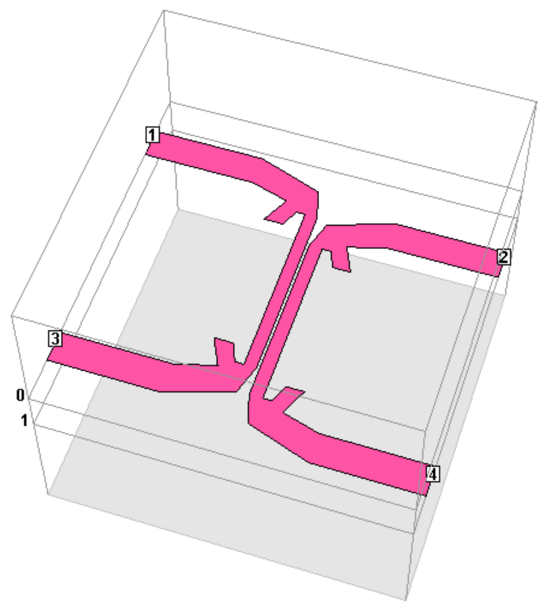

Fig. 2. 3-D view of the Coupler.

Figure 3 shows that coupling and thru ports are -3.02 dB and -3.04 dB at the start and the stop bands, respectively. The isolation and the return losses are less than -27 dB throughout the band.

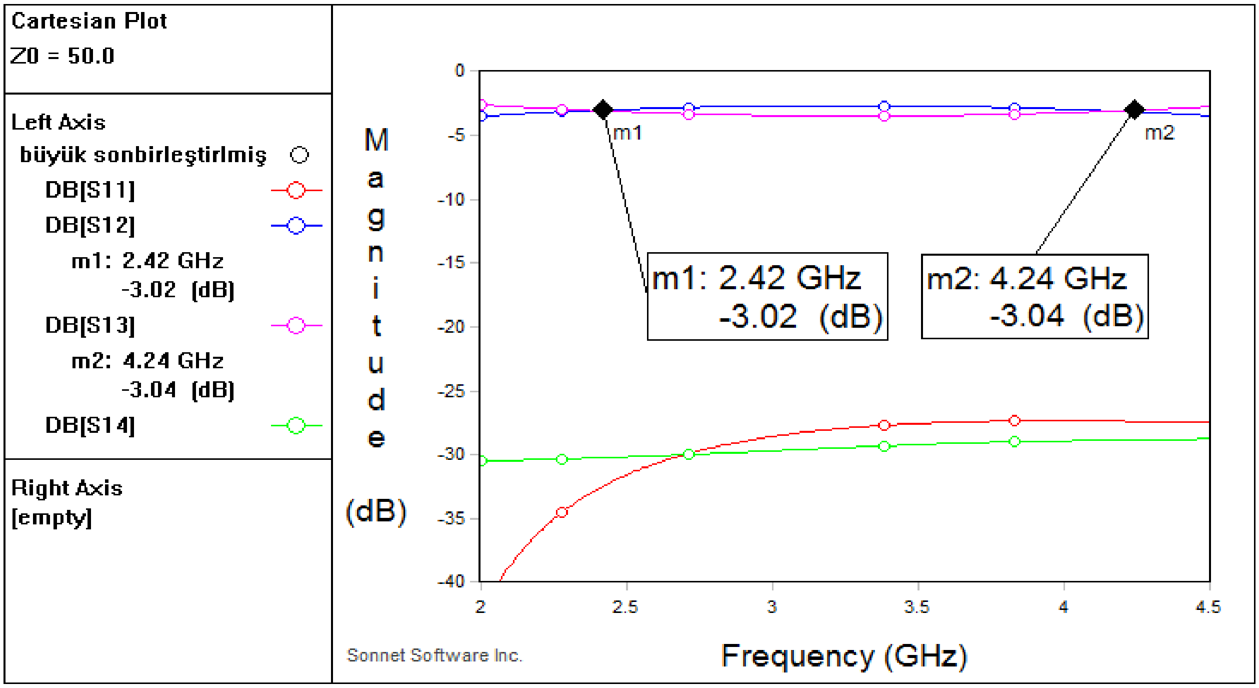

Fig. 3. S-parameters of the Coupler.

Figure 4 shows that the amplitude balance of the coupler is 0.8 dB.

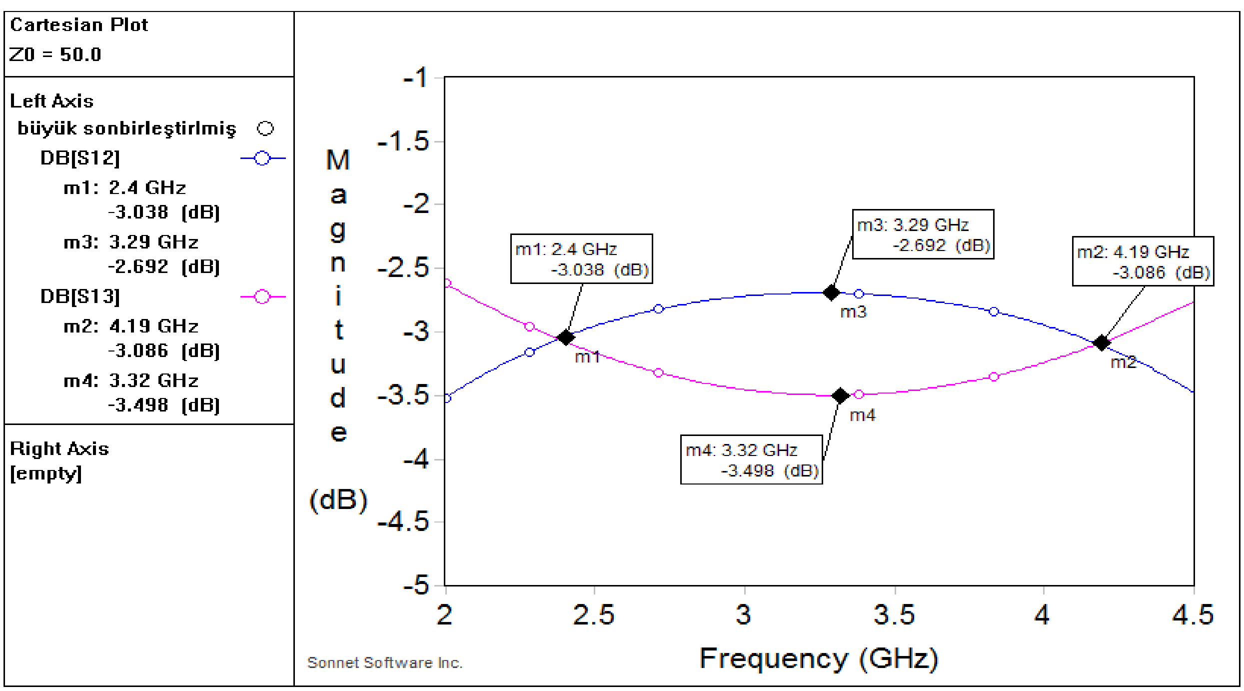

Fig. 4. Amplitude Balance on Close-up (S12 and S13)

Figure 5 shows that, the isolation and the return losses are at the center of the Smith Chart as expected.

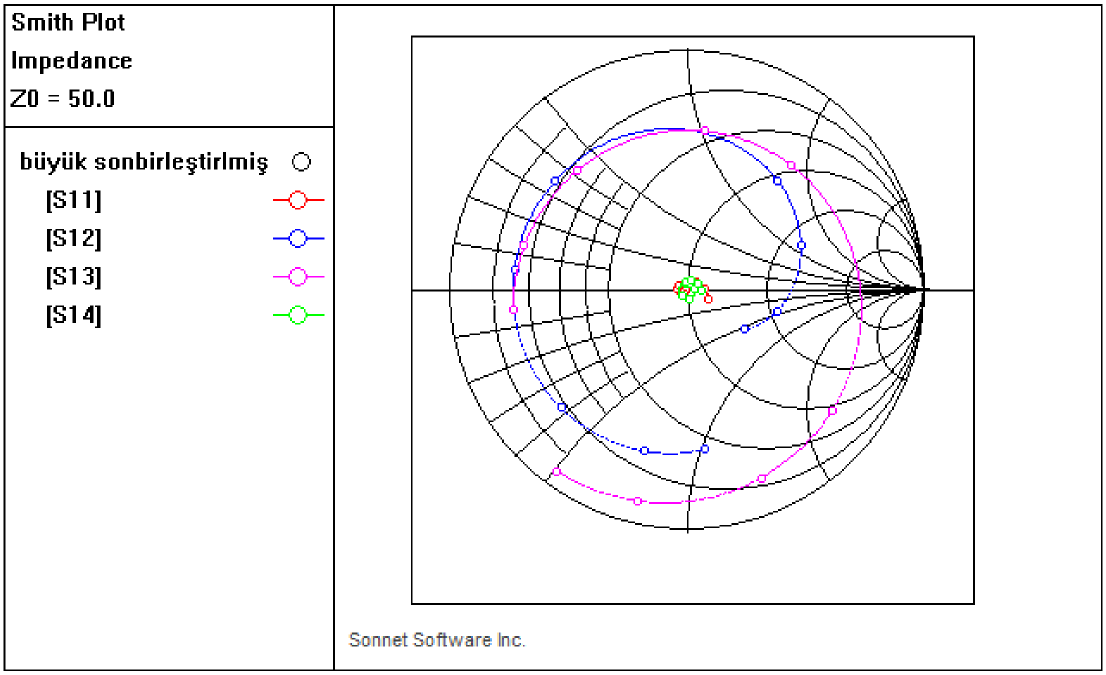

Fig. 5. S-parameters on the Smith Chart

The phase difference of the coupled port and the thru port is 90º along the frequency band as seen in Figure 6.

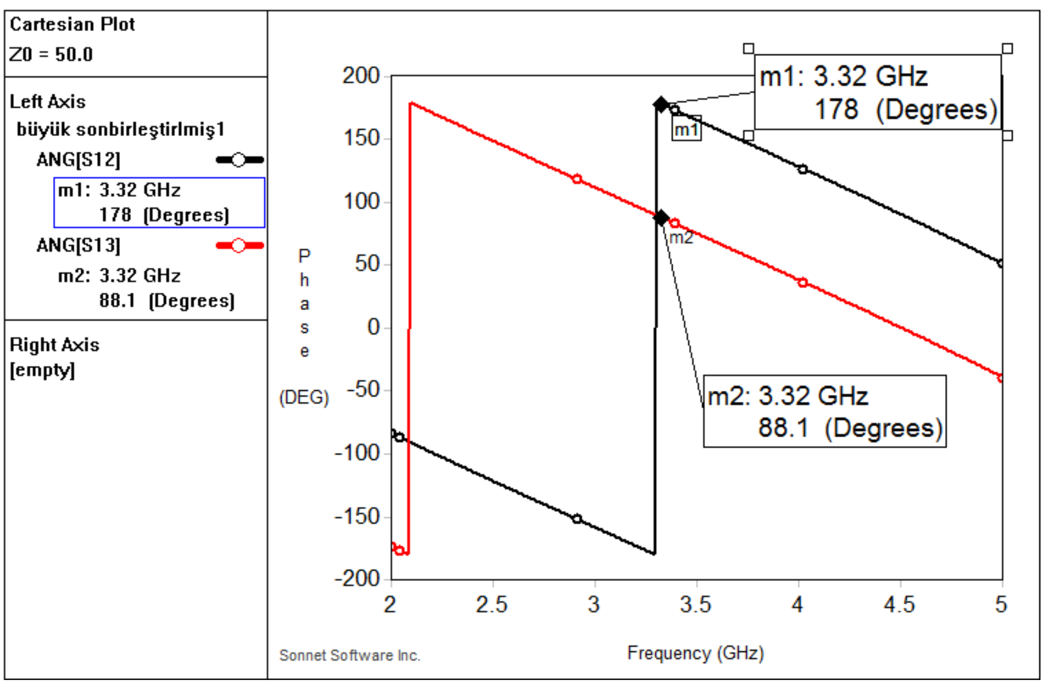

Fig. 6. Phase difference between the coupled and thru port

Tables 1, 2 and 3 shows the tolerance analysis of the coupler in terms of coupler length, offset spacing and substrate thicknesses.

Table 1. Tolerance analysis changing the coupler lenght

Coupler Length	S11 (dB)	S14 (dB)	S13 (dB) center freq.	S12 (dB) center freq.	Amplitude Balance (dB)	Bandwidth (GHz)
487	-30.3	-28.9	-3.55	-2.85	0.7	1.4
489	**-32.3**	**-28.5**	**-3.49**	**-2.69**	**0.8**	**1.81**
491	-29.5	-27.9	-3.40	-2.55	0.95	1.25

Table 2. Tolerance analysis changing the offset spacing

Offset Spacing	S11 (dB)	S14 (dB)	S13 (dB) center freq	S12 (dB) Center freq	Amplitude Balance (dB)	Bandwidth (GHz)
16	-30.3	-27.7	-3.53	-2.61	0.7	1.62
18	**-32.3**	**-28.5**	**-3.49**	**-2.69**	**0.8**	**1.81**
20	-33.2	-31.4	-3.57	-2.73	0.9	1.55

Table 3. Tolerance analysis changing the dielectric thicknesses

Dielectric thickness(mils)	S11 (dB)	S14 (dB)	S13 (dB) center freq	S12 (dB) Center freq	Amplitude Balance (dB)	Band Width (GHz)
50,5.2,50	-15.3	-21.6	-3.23	-2.34	0.9	1.42
	-15.5	-16.1				
60,5.2,60	**-32.3**	**-28.5**	**-3.49**	**-2.69**	**0.8**	**1.81**
	-30.5	**-27.5**				
70,5.2,70	-27.5	-26.5	-3.58	-2.74	0.8	1.2
	-25.8	25.3				

3. Conclusion

In this paper, we have presented a 3 dB offset stripline 90º hybrid broadside coupler. According to the simulation results of Sonnet Suites [8], all results are satisfactory. Especially simulation results of the coupled and thru ports are exactly 3 dB at the start and the stop bands. Isolation and the return loss levels are also very low, around -30 dB.

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