3 dB Offset Wideband Coupler

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Abstract: In this work a 3dB stripline 90° off-set hybrid coupler is designed and simulated. The frequency band is relatively wide for this kind of tight couplers. Various combinations were tried and final geometry is simulated with a 3D planar electromagnetic simulation software [1]. Simulation results are satisfactory and presented detailly in figures. The coupler can be used in both GSM bands and 3G wireless network applications.

Keywords: Coupler, Stripline, 90º Hybrid, 3dB, Broadside.

1. Introduction

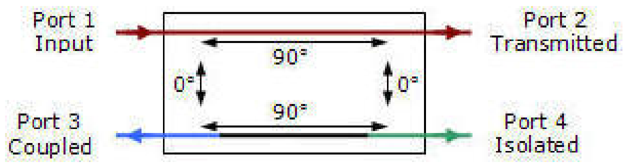

Fig.1. 3dB Hybrid multiplexer.

There are several 3dB couplers in literature. Some of them are ring type and microstrip as in [2], some of them are similar to the design in this work. In [3], a similar frequency band is used with the lumped-element microstrip type. There is another microstrip ring coupler in [4], which has 27% bandwidth. In this work, a stripline offset coupled lines are used to design a 3dB coupler. Figure 1 shows the general structure of those kind of couplers. The dielectric stack-up is 30-3-30 mils. Dielectric constant is 2, dielectric name is Rogers RT6002. Simulation results and the details of the work are presented in the next section.

2. Simulation Results

In this work, the main purpose was to design and simulate a 3 dB stripline 90º hybrid coupler. Figure 2 shows the top view of the coupler. Port 3 and port 4 are located at the other side of the wall in order to have fabrication easiness. Stubs near each port ensure sending less power to the isolation port. Figure 3 has the 3D view. Figure 4 has the S-parameter data.

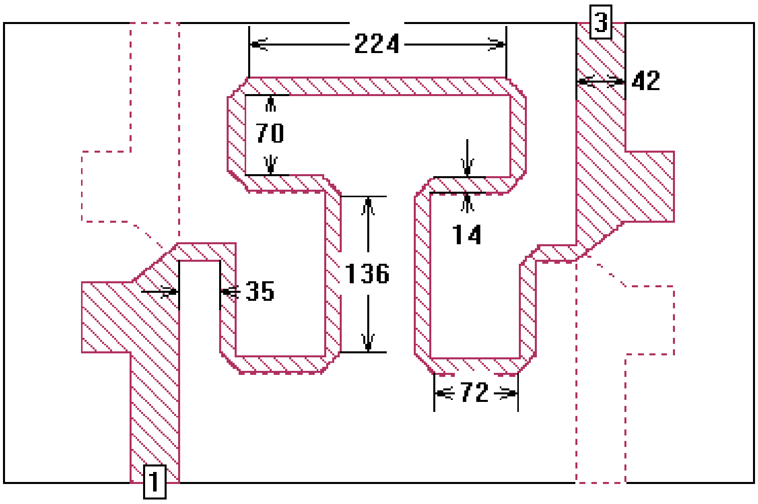

Fig. 2. Top view and dimensions of the coupler (mils).

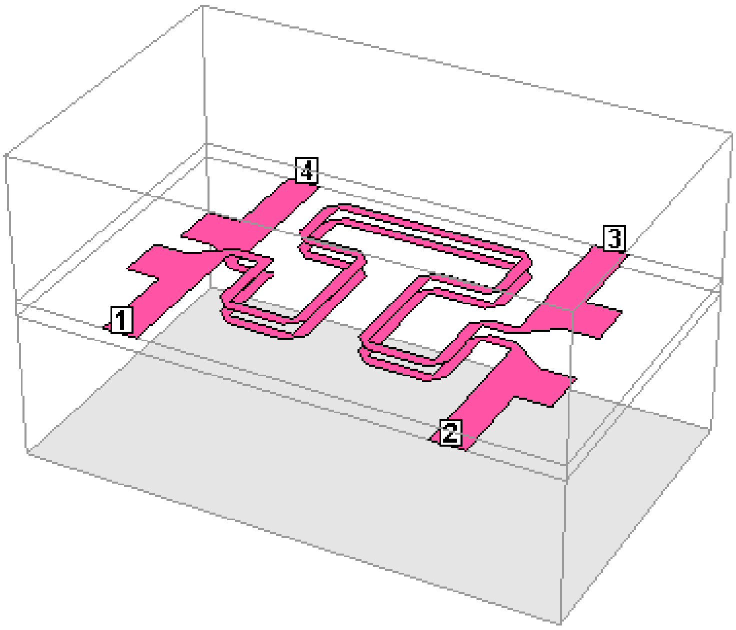

Fig. 3. 3D view of the Coupler.

It is clearly seen in Figure 4 that, coupling and thru ports are -3.1 dB and -3.33 dB at the start and the stop bands, respectively. The isolation and the return losses are almost -20 dB at the start band, while they reduce to -15 dB at the stop band.

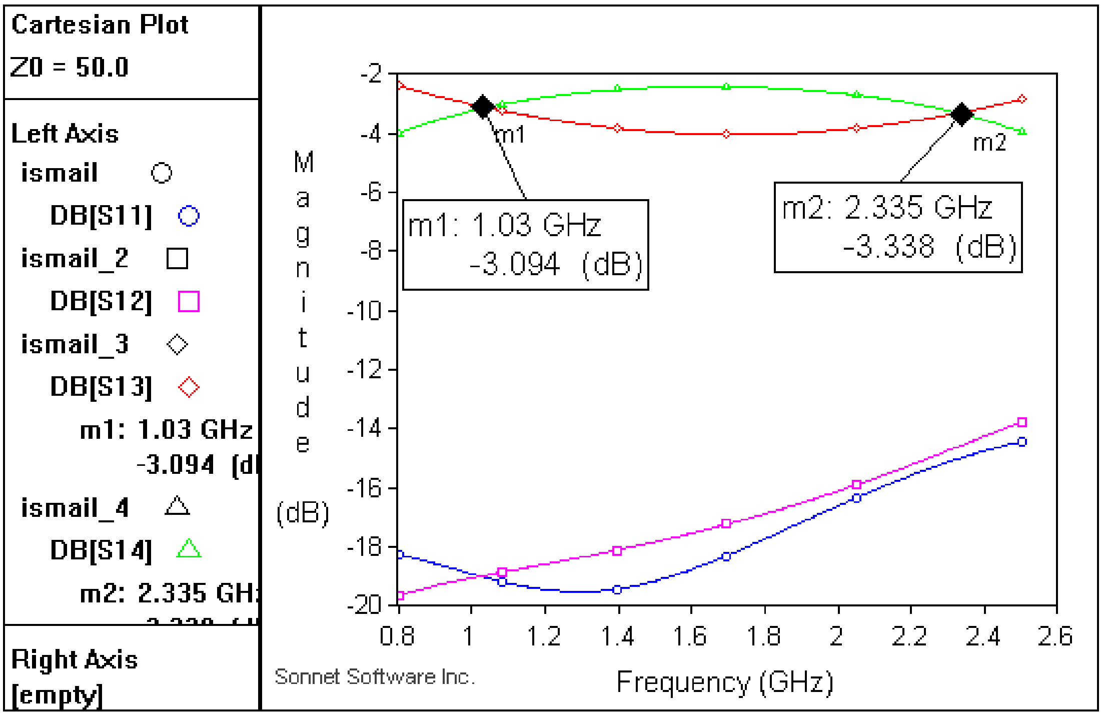

Fig. 4. S-parameters of the Coupler.

Figure 5 is a close-up on coupling and the through port. It shows the amplitude balance of the coupling, which is 1.7 dB.

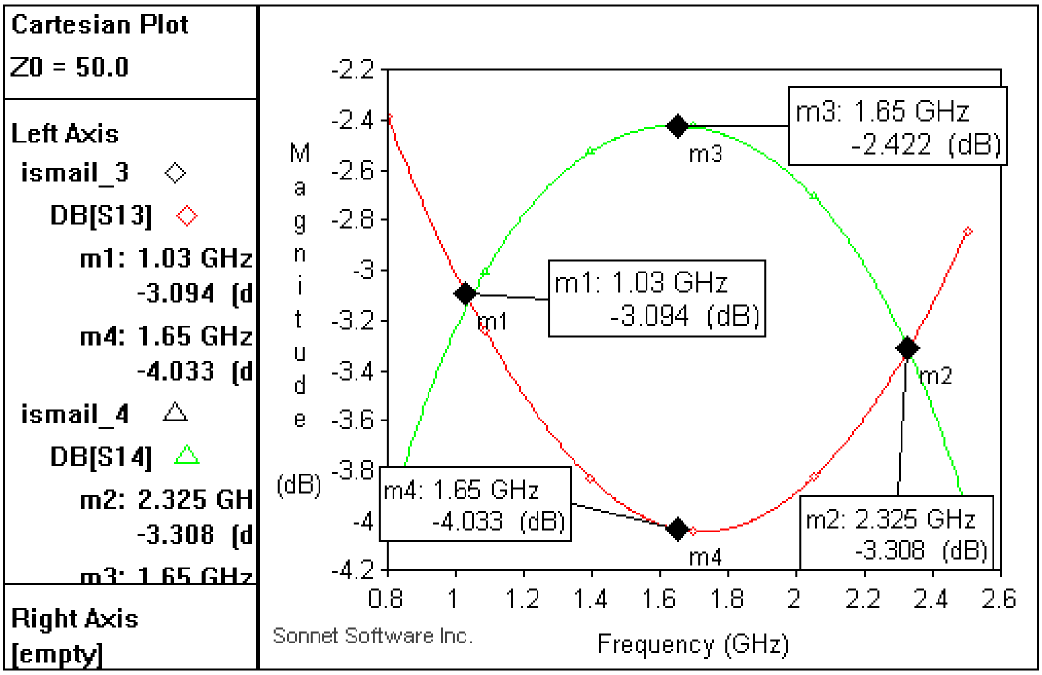

Fig. 5. Amplitude Balance.

Figure 6 shows that, return loss and isolation are almost at the center of the smith chart as expected. The phase difference between the coupled port and the thru port is 90º along the frequency band as it is seen on Figure 7.

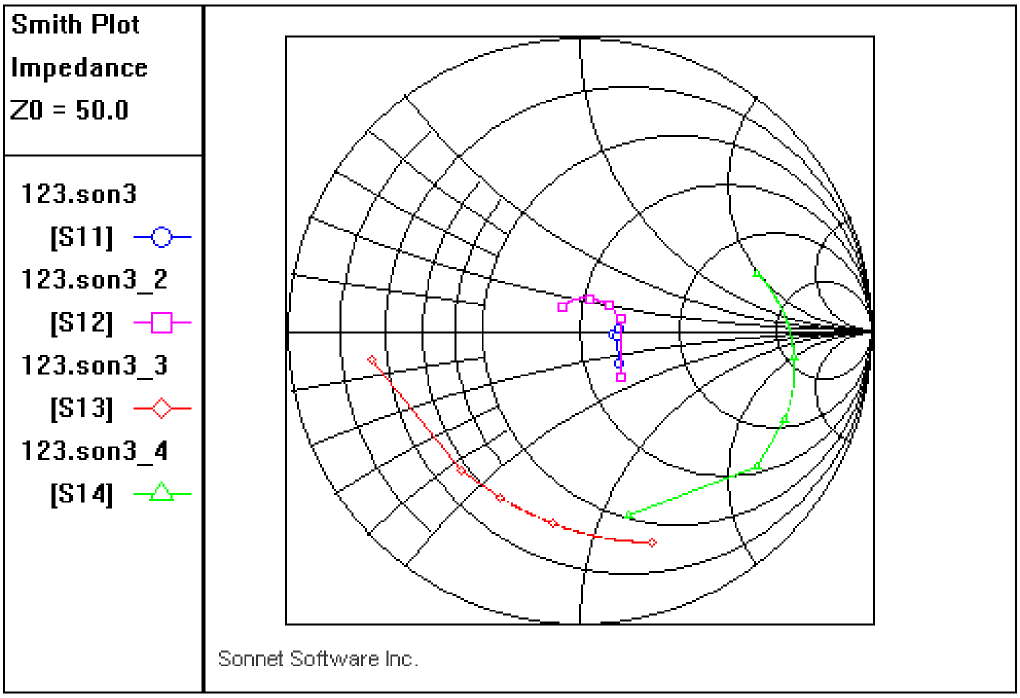

Fig. 6. S-parameters on the Smith Chart.

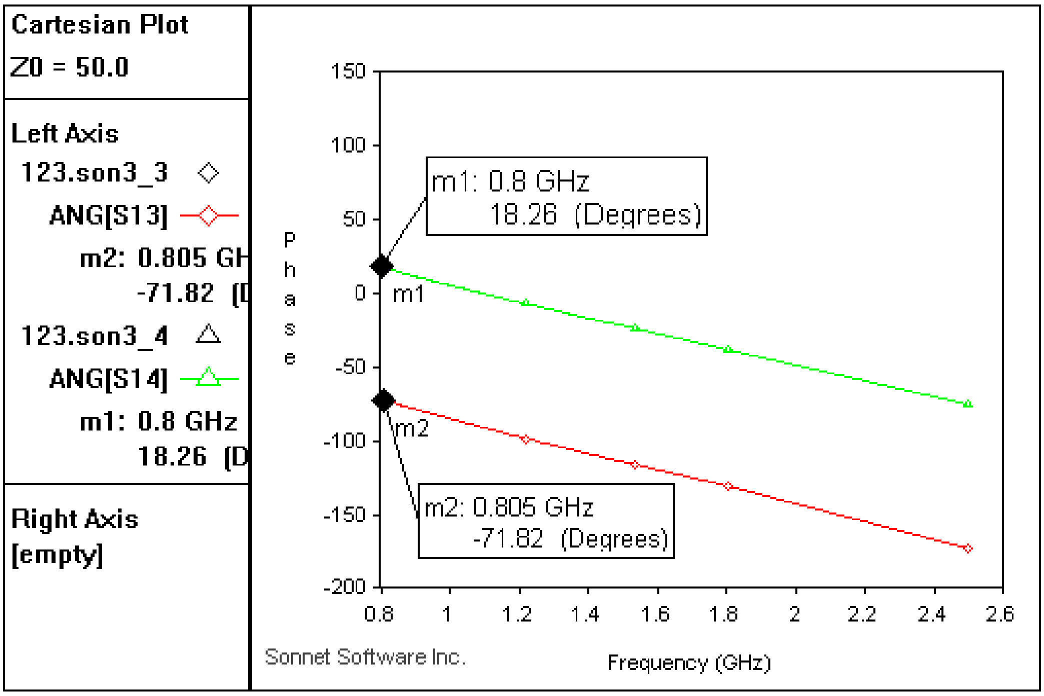

Fig. 7. Phase difference between the coupled and thru port.

Current distribution on Figure 8 and Figure 9 clearly shows that the current is crowded on the main line (between 1 and 3) and on the first half of the coupled ports (4) line. Almost no current goes to the isolation port (2). Coupled and thru port currents have same color since same power goes to those two ports.

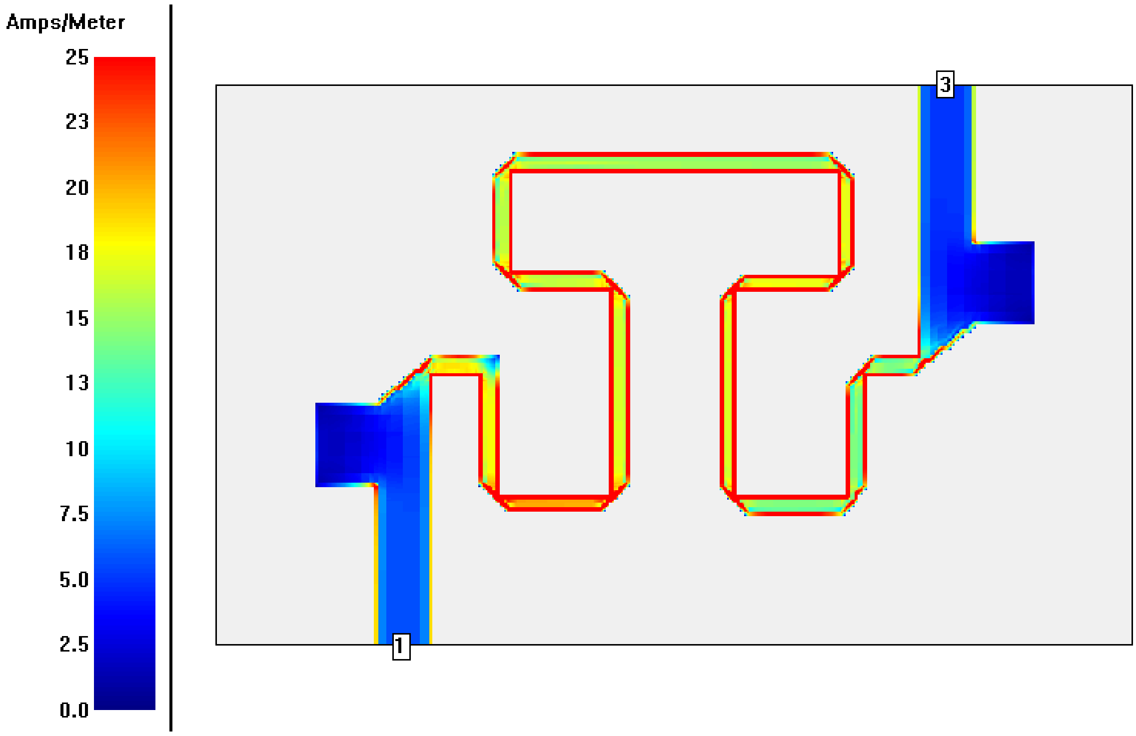

Fig. 8. Current distribution on the coupler (port1 and port3).

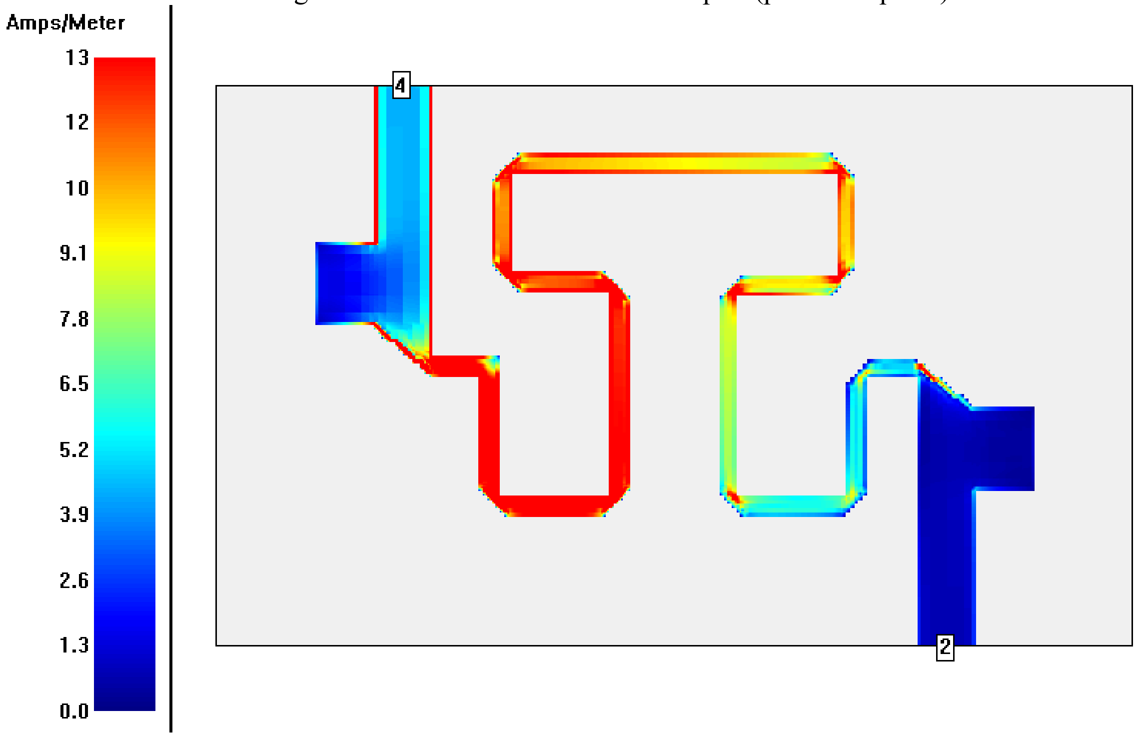

Fig. 9. Current distribution on the coupler (port2 and port4),

3. Conclusion

In this paper, we have presented a 3 dB 90 hybrid coupler. Broadside of the lines are coupled in order to achieve tight coupling of 3 dB, offset geometry gave a degree of freedom while making optimization on the geometry. The proposed design offers a wide operation bandwidth with acceptable return loss, isolation, and phase imbalance. According to the simulation results of Sonnet software, all results are satisfactory.

References

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