4.77 dB Hybrid Stripline Coupler

Ş. Taha İmeci [1], İsmail Şişman [2] and Erdem Demircioğlu [3]

[1] Department of Electrical and Electronics Engineering
KTO Karatay University, Konya, TURKEY
taha.imeci@karatay.edu.tr

[2] Department of Electronics and Communication Engineering
Haliç University, İstanbul, TURKEY
ismailsisman@halic.edu.tr

[3] Türksat Satellite Communication and Cable TV A.S., Ankara, TURKEY
edemircioglu@turksat.com.tr

Abstract: In this work, a 4.77 dB, 90º hybrid stripline coupler is designed and simulated. The design covers a frequency range of 1.8 - 2.2 GHz and has an off-set, broadside coupled structure. The coupler is analized using Sonnet, a planar 3D electromagnetic simulation software [1]. The results taken from Sonnet are presented as, current distribution, smith chart, phase difference between the coupled and through ports, and S-parameters. Commercial application of the work is in wireless 3G networks.

Keywords: Coupler, Stripline, Hybrid, 4.77 dB, Off-set

1. Introduction

Directional couplers are fundamental and important passive components extensively used in the realization of a variety of microwave circuits, such as balanced amplifiers, balanced mixers, data modulators, and phase shifters. Among those, the most popular ones are starts with 3 dB, 4.77 dB, 6.02 dB, 10 dB, 20 dB [2] and 30 dB. There are different type of structures in the industry for different applications, [3], such as a 3-way power divider, can be achieved when a 4.8dB coupler and 3dB hybrids are cascaded. The 3 output signals will offer 1dB unbalance over an octave bandwidth. Meanwhile there are new developments on stripline broadside couplers in literature. One of them has the design methodology for a new type of alignment tolerant, broadside coupled, stripline directional coupler. The coupler uses an even number of cascaded, asymmetric, broadside coupled line stages that are electrically short (λ/8) and have been alternately inverted to achieve nearly symmetric coupling and return loss at all ports [4].

In this work, stripline off-set broadside coupled lines are used to design a 90º hybrid. Off-set structure of the lines give another degree of freedom, so that, the required design specifications are achieved. In order to do that a random 2D optimization scheme is applied for the structure. If the results are not satisfactory, the design is optimized and simulated again until the best results are obtained. Details of the work and the simulated results are discussed and figures presented in Section 2.

2. Simulation Results

In this work, the main purpose was to design and simulate a 4.77 dB stripline hybrid coupler. Figure 1 has the top view of the circuit pattern. Stubs near each port ensure sending less power to the isolation port. Figure 2 has the 3D view. Figure 3 shows the simulated scattering parameters and the amplitude balance is seen on Figure 4. The circuit is drawn on Rogers RT6002 substrate with dielectric constant of 1.6, and stripline layer thicknesses are 60 – 7 – 60 mils. The return loss and the isolation are around –16 dB at the low end of band, while they reduce to –16.7 and –17.7 dB, respectively, at the high and of the band.

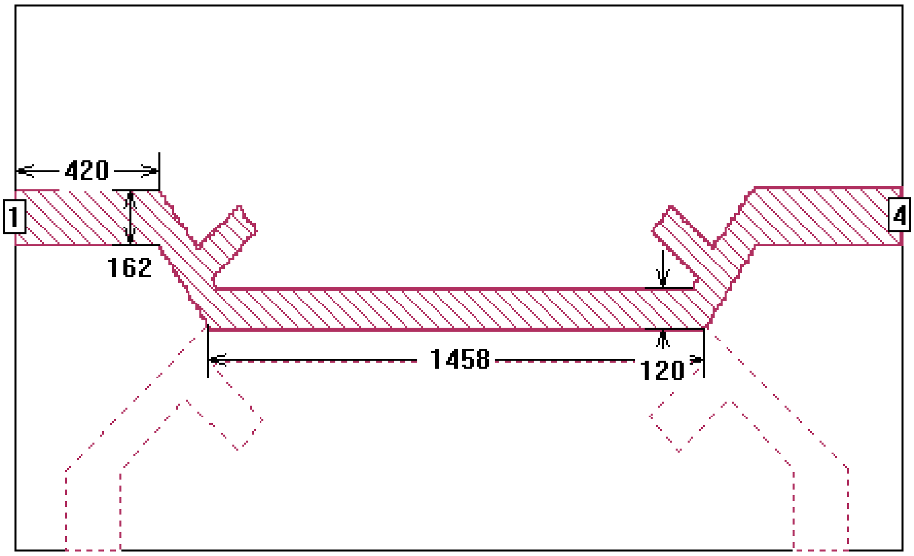

Fig. 1. Top view and dimensions of the coupler (mils).

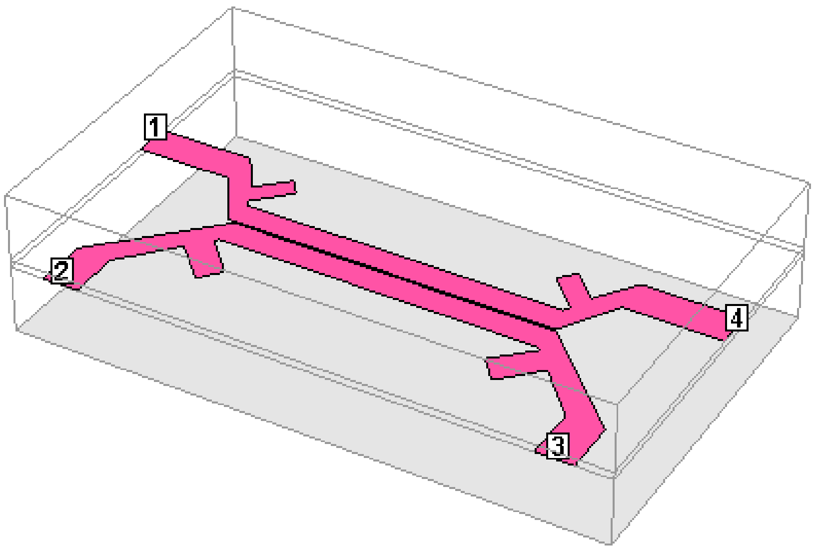

Fig. 2. 3-D view of the Coupler.

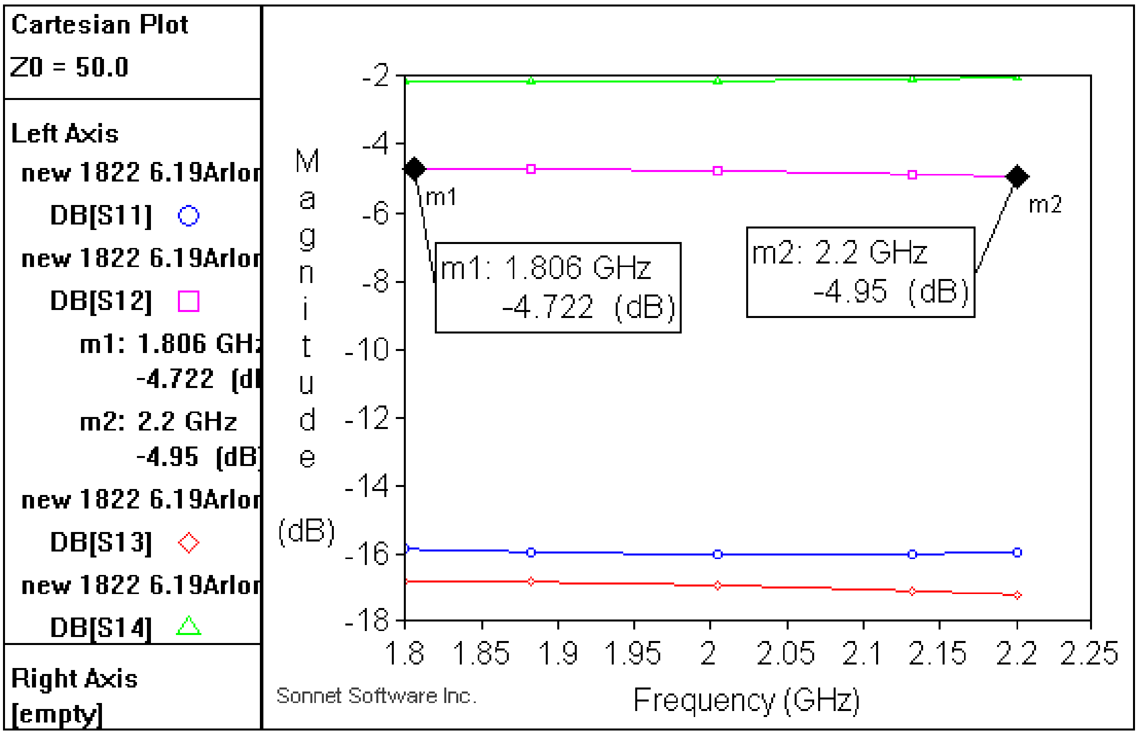

Fig. 3. S-parameters of the Coupler.

It is clearly seen in Figure 4 that, coupling is – 4.72 dB and – 4.95 dB at the lowend and highend of the band, respectively. It shows the amplitude balance of the coupling, which is 0.23 dB.

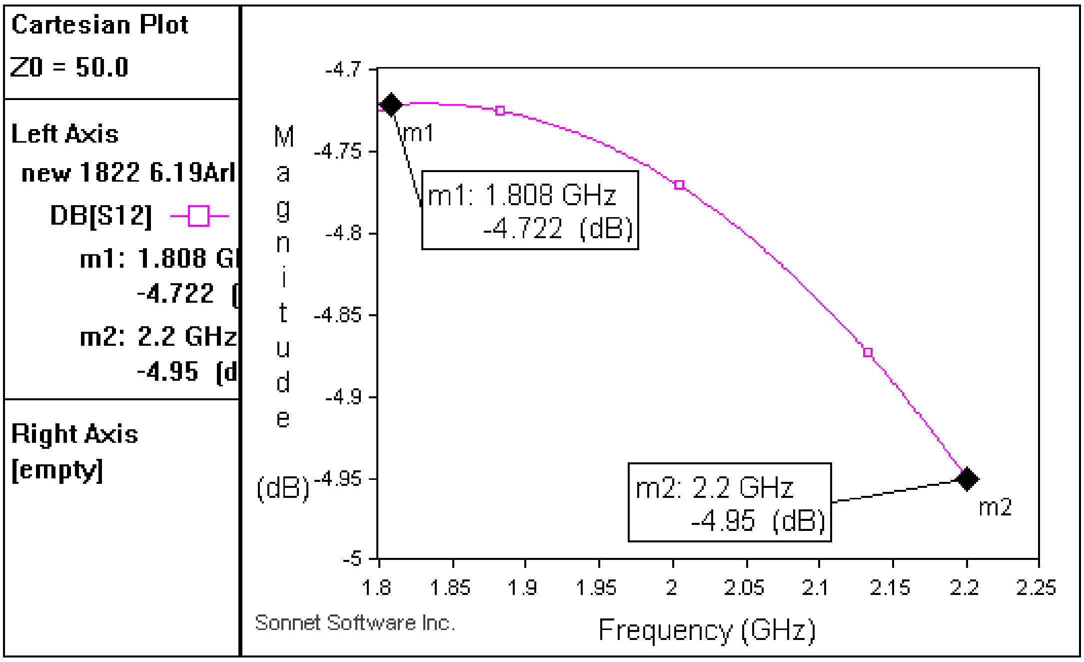

Fig. 4. Amplitude Balance.

Figure 5 shows that, the input reflection coefficient (S11) and isolation (S13) are close to the center of the smith chart as expected.

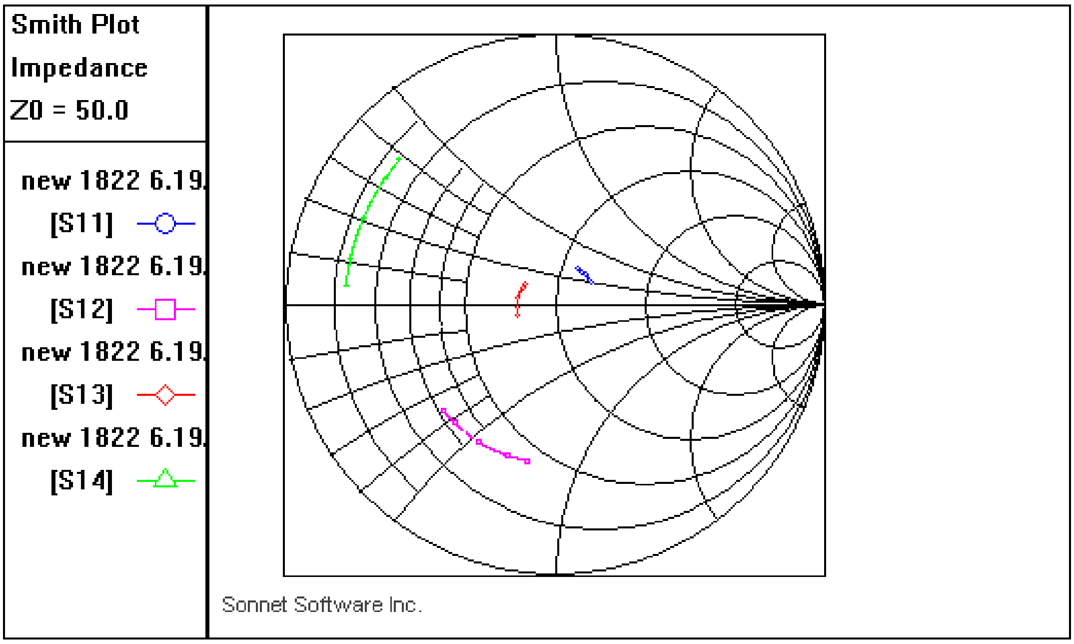

Fig. 5. S-parameters on the Smith Chart.

The phase difference between the coupled port and the thru port is 90º along the frequency band as it is seen on Figure 6.

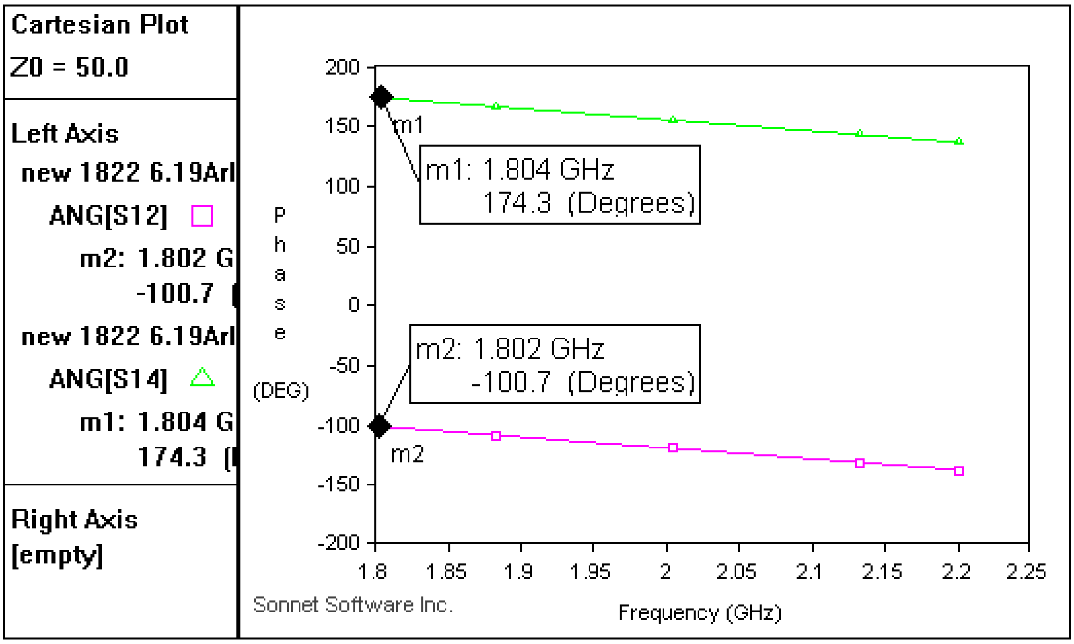

Fig. 6. Phase difference between the coupled and thru ports.

Current distribution on Figure 7 and Figure 8 clearly shows that the current is crowded on the main line (between ports 1 and 4), coupled port (2) color is darker than the thru port and almost no current goes to the isolation port (3).

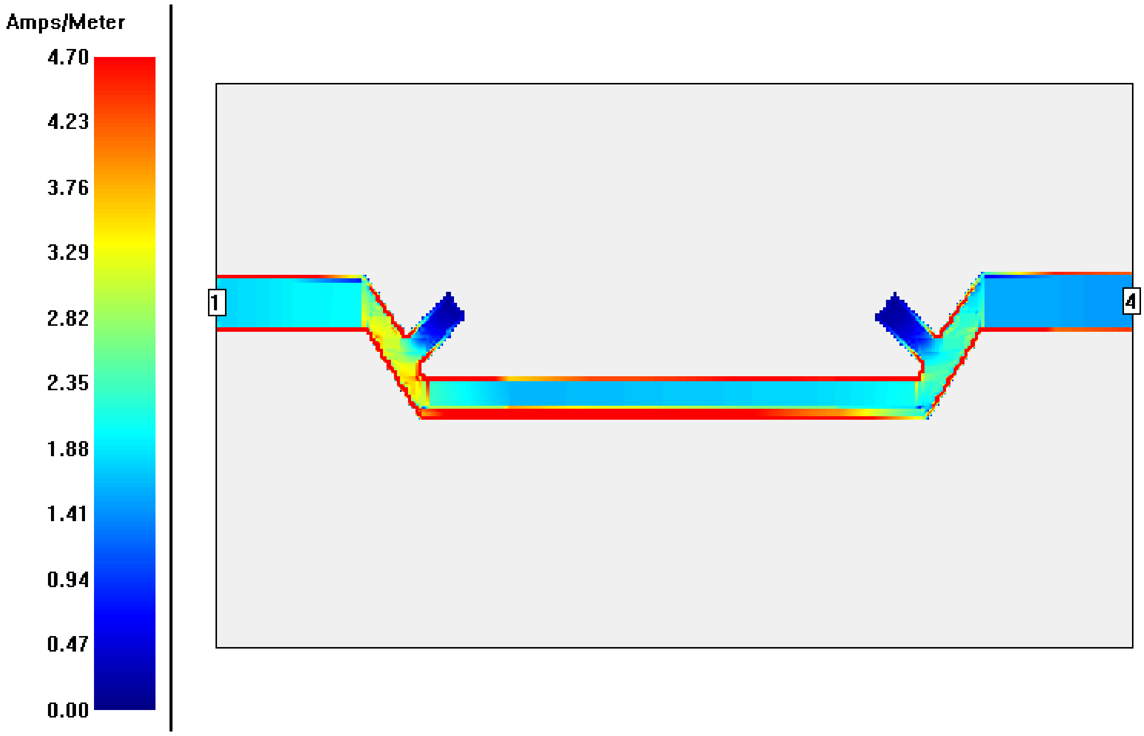

Fig. 7. Current distribution on the coupler (port1 and port4).

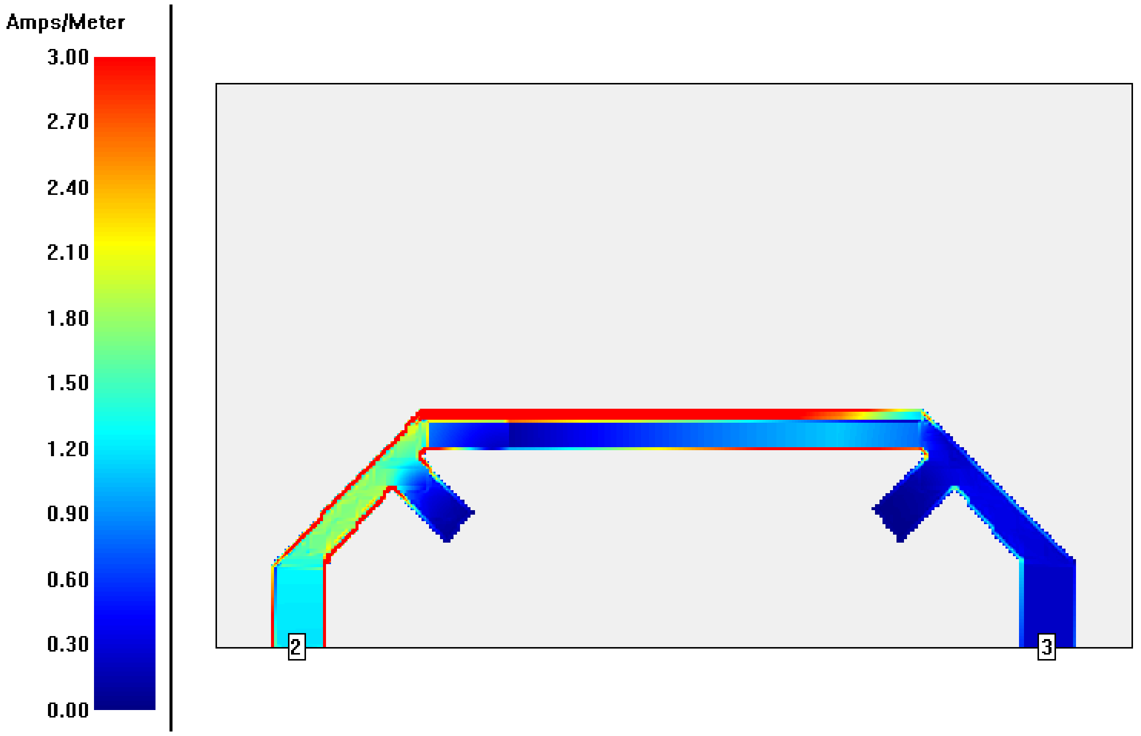

Fig. 8. Current distribution on the coupler (port2 and port3).

4. Conclusion

In this work, a 4.77 dB hybrid, 90º off-set and broadside coupled stripline coupler is designed and simulated. The design covers a frequency range of 1.8 – 2.2 GHz . The simulated results are input return loss of 16.7 dB, isolation of 17.7 dB, and phase of 90º between the coupled and thru ports, with a maximum amplitude balance of 0.23 dB. According to the simulation results of Sonnet software, all results are satisfactory.

References

1 Sonnet Software, version 12.56, www.sonnetsoftware.com, 2009
2 S. T. İmeci, K. S. Bayram, A. Z. Zeytinoglu, "20-dB hybrid stripline coupler", ACES Conference Finland, April 2010.
3 Hybridline and couplerline. http://www.responsemicrowave.com/Products_Services/hybrids_couplers.php
4 T. P. Budka, and R. A. Flynt, "Alignment tolerant stripline directional couplers", IEEE MTT-S Digest, 1997.