

3 dB Meander Line Coupler

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Abstract: A design for 0.3 - 0.8 GHz band for meander line 3dB, 90° hybrid broadside coupled stripline is presented in this work. An optimization of geometry, dielectric thickness, and the dielectric material is conducted using a planar 3D electromagnetic simulation software [1]. Simulation results are satisfactory and presented in graphs and figures which includes S-parameter data, Smith Chart, amplitude balance and the current on the runs.

Keywords: Coupler, Stripline, 90° Hybrid, 3dB, Offset

1. Introduction

A number of solutions to the 3-dB coupler design problem at microwave frequencies are available to researchers in previous works. Those almost require the construction of a tight coupled transmission line. 3 dB coupler has been continuously studied for smaller size, wider bandwidth, and easier circuit fabrication. A previous work of coupled-line coupler has a fully-planar structure by connecting two coupled-lines of quarter-wavelength in cascade by non coupled lines of quarter-wave long [2]. They applied this to the design of microstrip 3 dB couplers. Consequently, a 27% bandwidth is obtained for 0.5 dB amplitude balance tolerance and return loss and isolation are less than 20 dB. Another work is a novel tandem 3 dB directional coupler using a patterned ground plane [3]. Design is based on the concept that the even mode impedance of a coupler is mainly relevant to the capacitance of the microstrip conductor to ground and the ground plane as well as the capacitance between the two coupled conductors. Similar work is done by another researcher which has a wide bandwidth of 42%, an amplitude imbalance of 0.5-dB, a phase unbalance of 1.0 in [4]. Our design is based on broadside coupled meander lines in the UHF band. For this purpose, a random 2D optimization technic is conducted and the geometry is simulated continuously until the design goals are achieved.

2. Simulation Results

In this section, simulated results are presented for a stripline, offset, broadside coupled lines. Fig.1 has the top view of the circuit pattern. Stubs near the each port ensure sending less power to the isolation port. Rogers RT6002 substrate is used. Dielectirc constant is 2, dielectric stack up is 60-10-60 mils. Figure 2 has the 3D view. Figure 3 shows the simulated scattering parameters. It is clearly seen in Figure 3 that, coupling and thru port are -3.058. The isolation and the return losses are almost under -30 dB throughout

the frequency band. Figure 4 is a close-up on coupling and the through port. It shows the amplitude balance of the coupler, which is 0.8 dB.

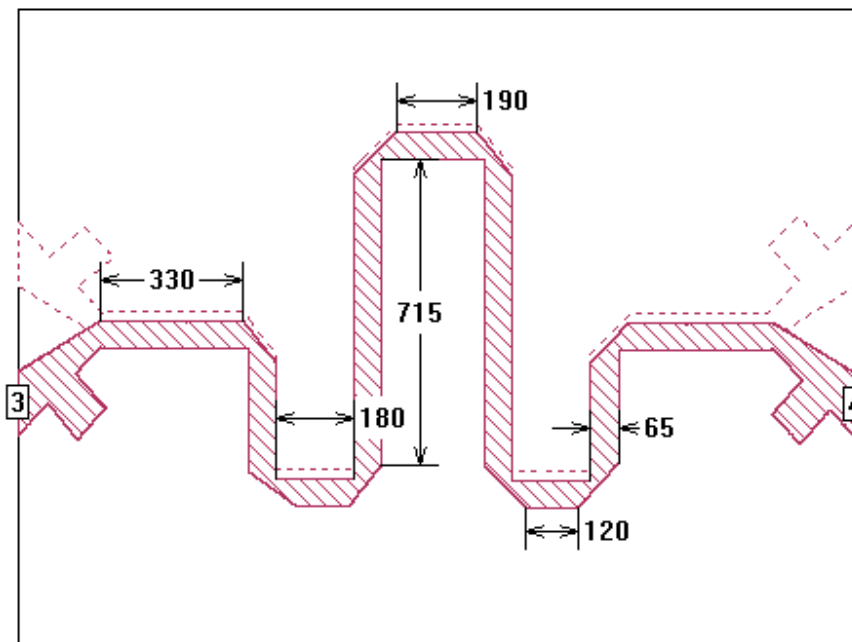


Fig. 1 Top view and dimensions of the coupler (mils).

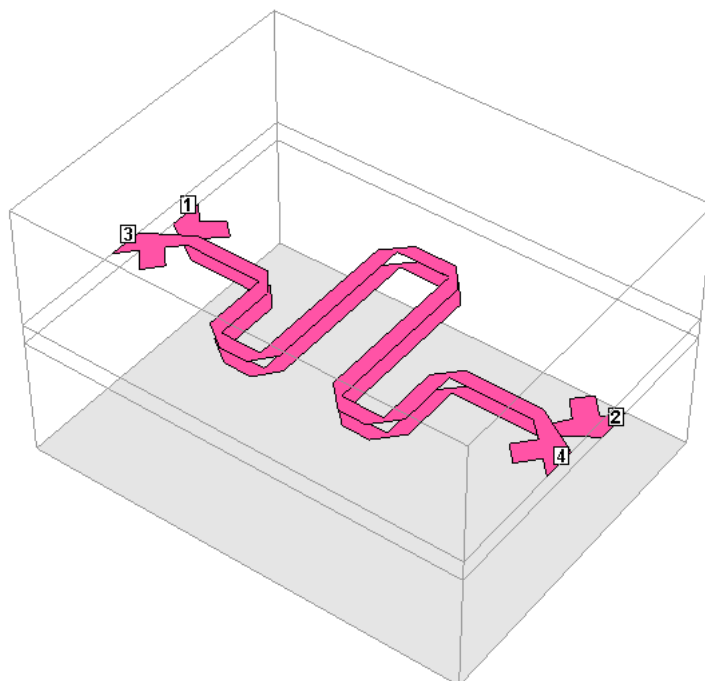


Fig. 2 3D view of the Coupler.

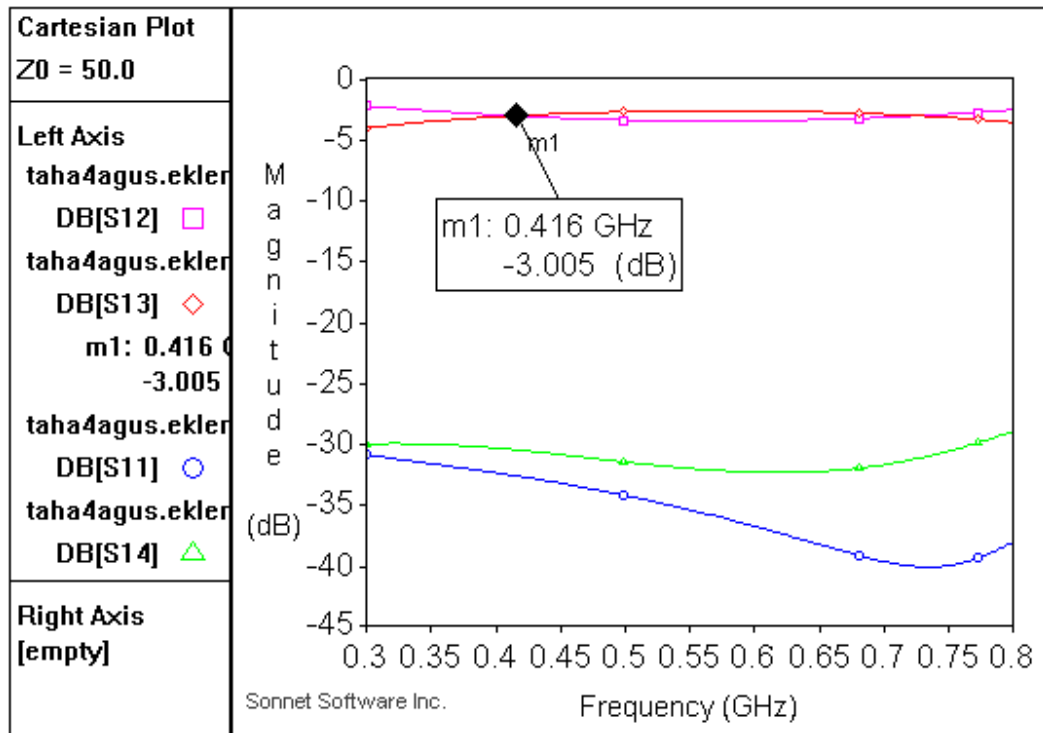


Fig. 3 S-parameters of the Coupler.

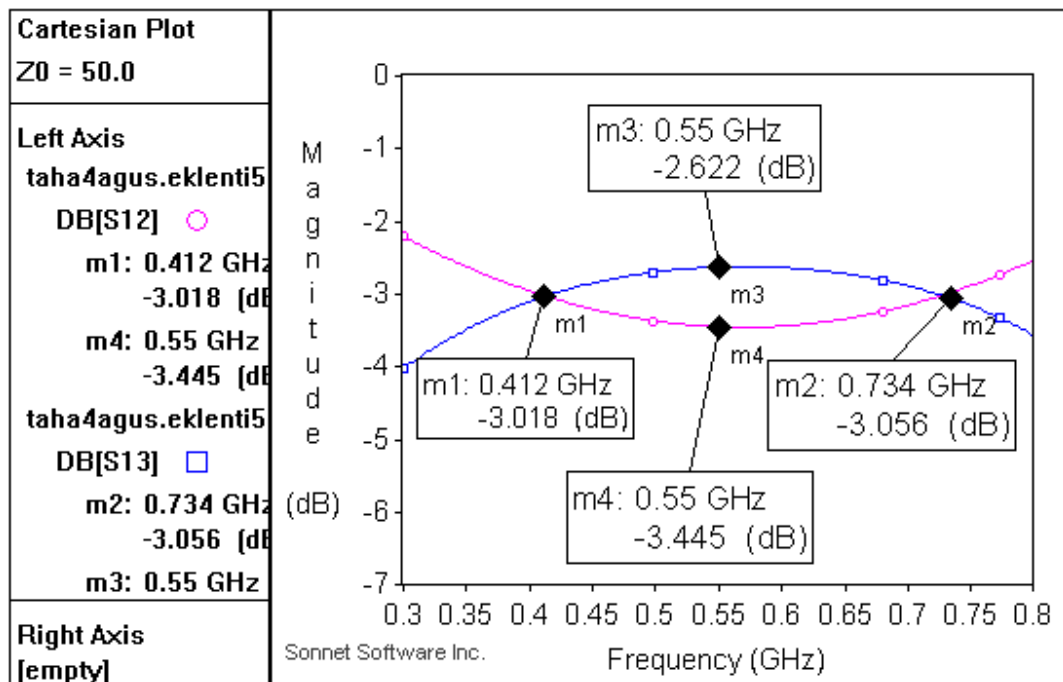


Fig. 4 A close-up view to show the Amplitude Balance.

Figure 5 shows that, input reflection coefficient (S11) and isolation (S14) are almost at the center of the smith chart as expected.

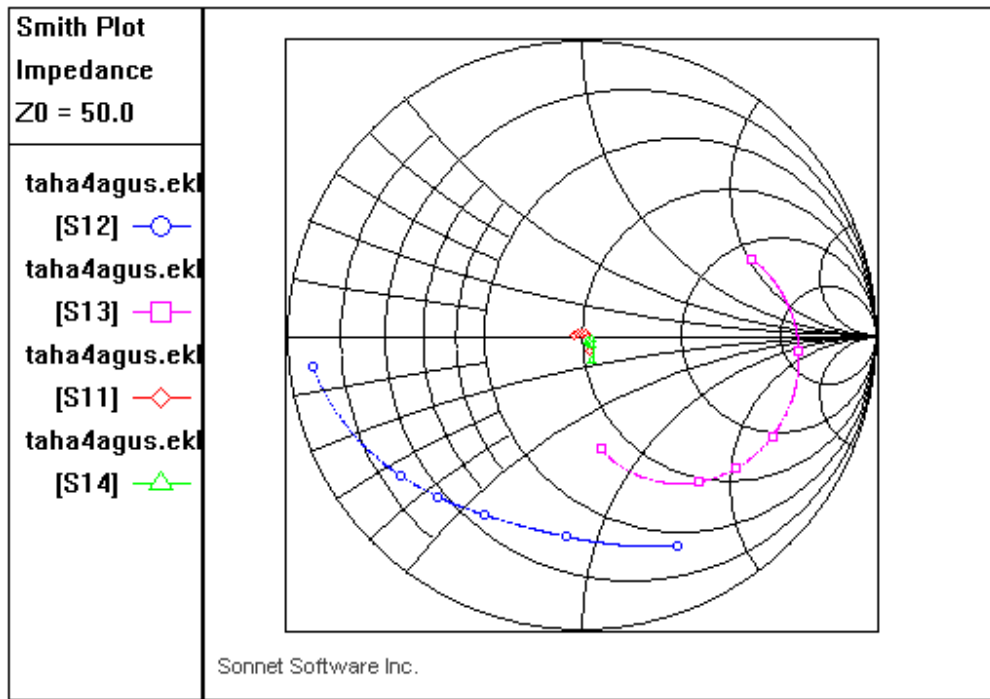


Fig. 5 S-parameters on the Smith Chart.

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

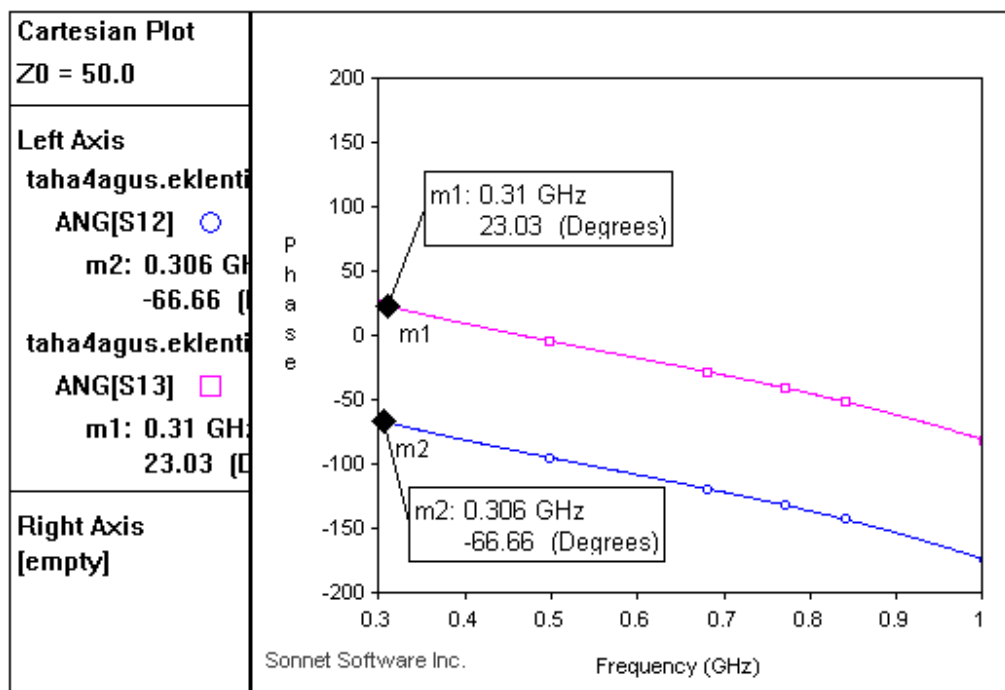


Fig. 6 Phase difference of the coupled and the thru port.

Current distribution is on Figure 7 and Figure 8, which clearly shows that the current is crowded on the main line (between the ports 1 and 2), and on the first half of the coupled line (3) and almost no current goes to the isolation port (4). Coupled and thru port currents have same color since same power goes to those two ports.

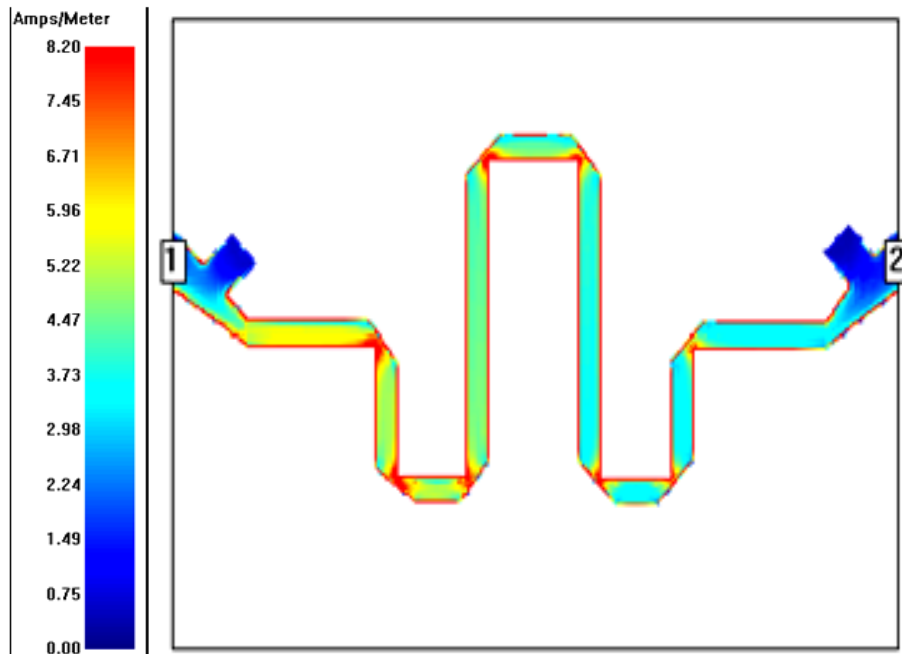


Fig. 7 Current distribution on the coupler (port1 and port2).

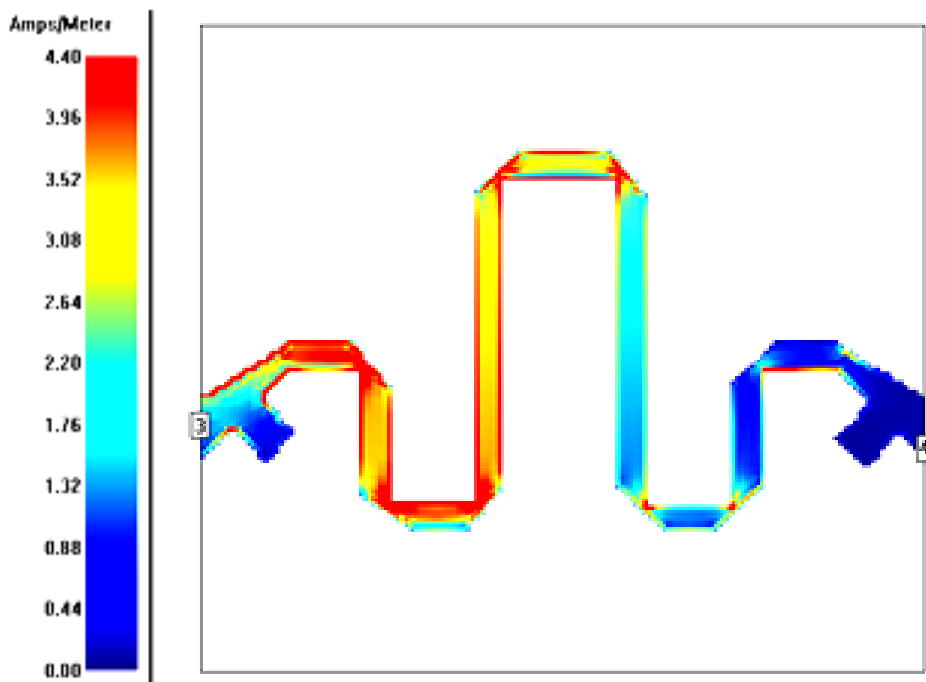


Fig. 8 Current distribution on the coupler (port3 and port4).

3. Conclusion

In this work, we have presented a 3 dB 90° hybrid offset and broadside coupled stripline coupler. The design covers a frequency range of 0.3 – 0.8 GHz. The simulated results are an input return loss of 30 dB, an isolation of 31 dB, and phase difference of 90°, with a maximum amplitude imbalance of 0.8 dB. According to the simulation results of Sonnet software, all results are satisfactory. Design started with a little error (a slight deviation from 3 dB at first) but, after reducing the cell size and the distance between the lines a better result of coupling is achieved.

References

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