A Design of Single Microstrip Directional Coupler with the High Directivity

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Outline

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Introduction

***Abstract*— Due to inhomogeneous structure of a microstrip directional couplers, i.e. partly dielectric substrate, partly air, they mostly present property of poor directivity and low coupling level. This method is easy to fabricate and incorporate another microwave device, and is validated via design and experimental results. The main goal was to obtain coupling around -30dB and it has a wide band, from around 3.5GHz to nearly 9GHz.**

Introduction

- Directional couplers with parallel-coupled microstrip transmission lines are easily fabricated which makes them widely used for various RF and microwave applications because they can be easily incorporated into and implemented with other circuits: designs of various balanced power amplifiers, mixers, modulators, measurement systems, circularly polarized antennas, beam-forming array antennas, etc
- In practical applications, the coupling level of microstrip coupled-line coupler is mainly limited by the narrow separation between two parallel edge-coupled transmission lines, usually 0.1 mm, in the printed circuit board (PCB) fabrication. However, due to inhomogeneous dielectric - partly dielectric substrate, partly air - odd phase velocities are unequal (the odd-mode phase velocity commonly faster) which, then, is cause of coupler's poor directivity. It also can be caused by increase in dielectric permittivity [1]. Therefore, the main limitations of the traditional coupled-line couplers are low coupling level and poor directivity in microstrip implementation.

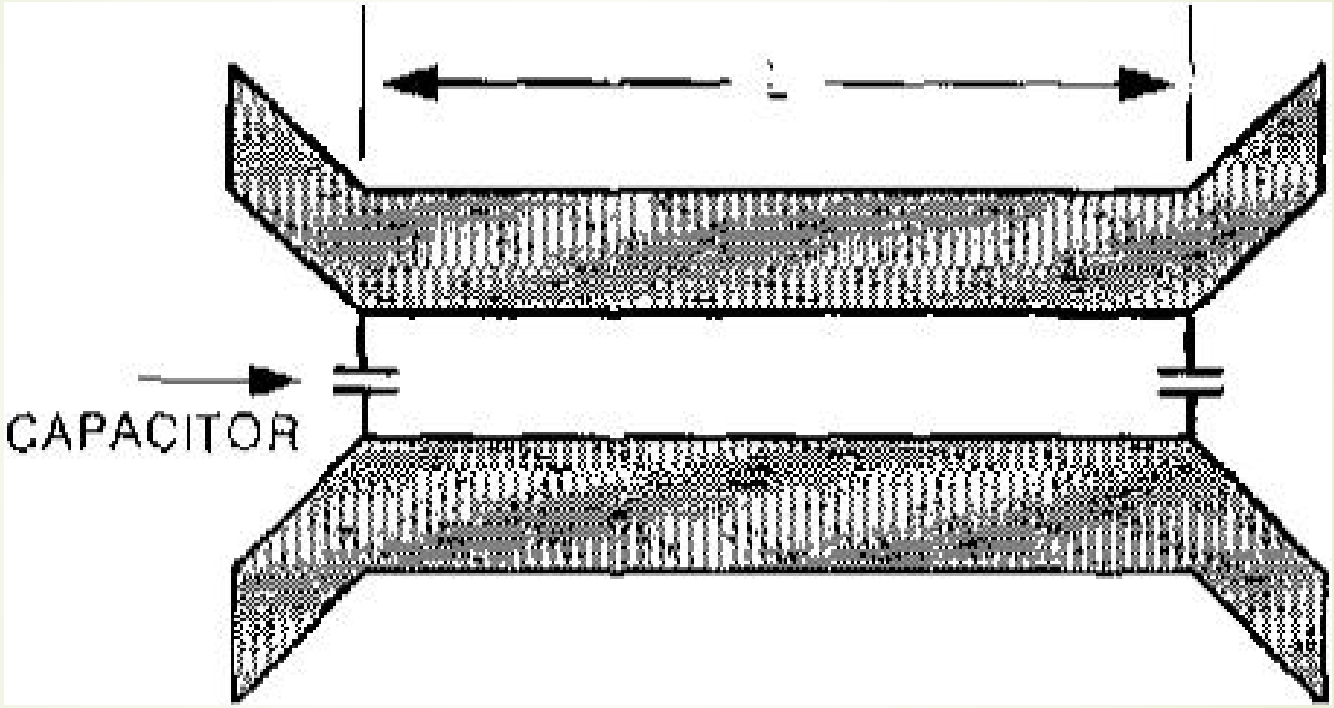
Introduction

- This paper will address how to take advantage of this method and apply it to the easy realization of a single microstrip directional coupler. This paper solves this issue by introducing capacitive compensation method by gap coupling of open stub formed in sub-coupled line

Design details

- Figure 1 shows the capacitative compensated microstrio directional coupler consisted of two symmetrical lumped capacitors between coupled lines for high directivity characteristics. The capaitance in Figure 1 is implemented by gap coupling between main line and open stub formed in sub-coupled line to compensate the phase difference of each mode

DESIGN DETAILS



- FIGURE I MICROSTRIP DIRECTIONAL COUPLER WITH SYMMETRIC COMPENSATING CAPACITORS

Simulation and Measurments

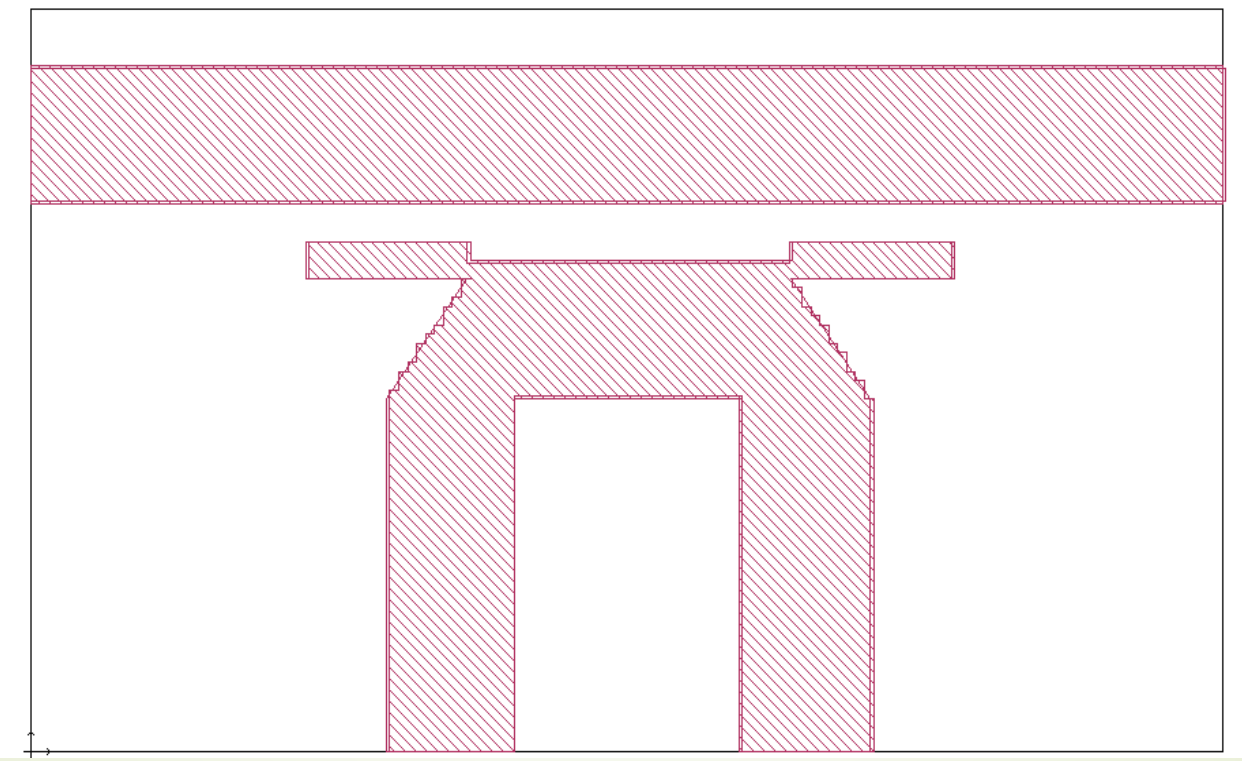
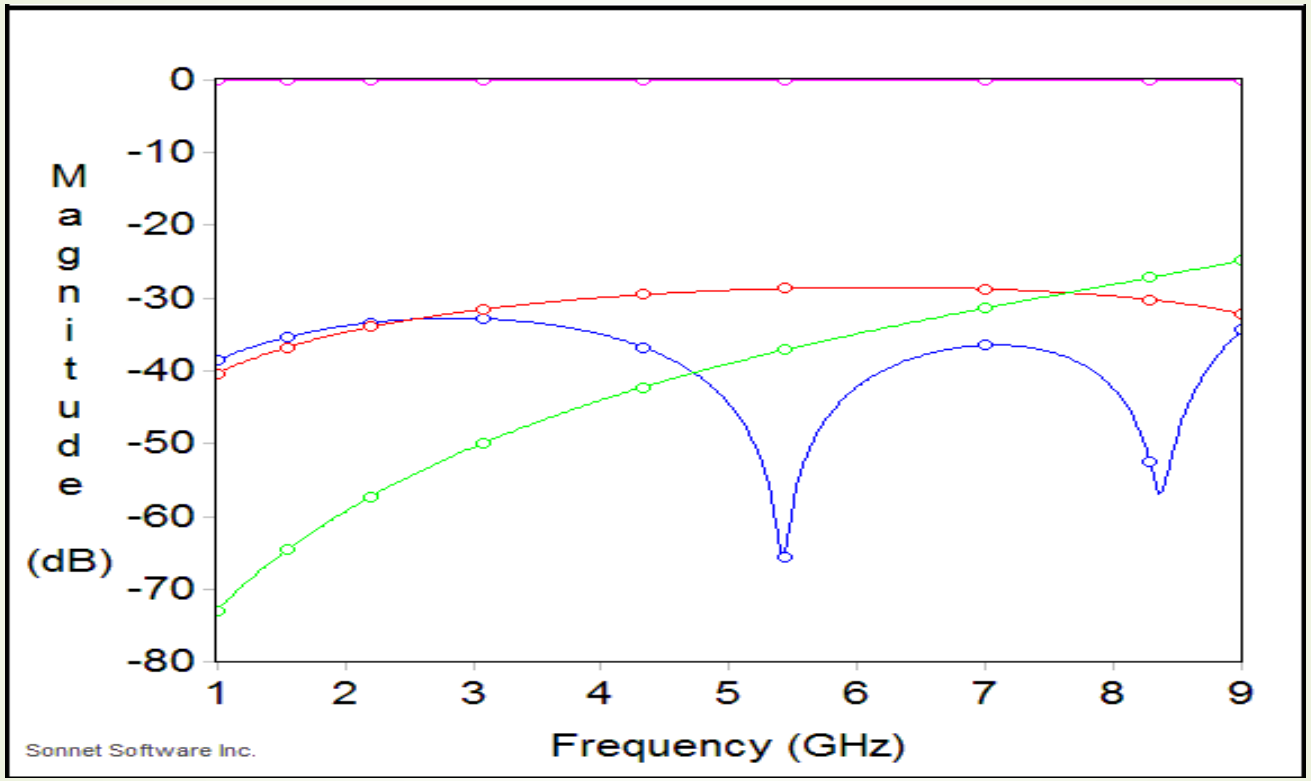


FIGURE II SCHEMATIC OF THE MICROSTRIP COUPLER WITH COMPENSATING CAPACITANCE

Simulation and Measurments



- FIGURE III MICROSTRIP COUPLER COMPENSATED BY GAP CAPACITANCE WITH 30DB COUPLING

TABLE I COUPLER PERFORMANCE VS WIDTH OF A GAP

S [mm]	Coupling BW [GHz]	Coupling Amplitude Balance [dB]
1.22	5.35	2.38
1.26	5.25	2.29
1.28	5.1	2.26
1.3	4.85	2.05

TABLE II COUPLER PERFORMANCE VS. DIELECTRIC THICKNESS

DT [mm]	Coupling BW [GHz]	Coupling Amplitude Balance [dB]
0.36	2.575	2.13
0.6	3.375	1.50
0.78	4.7	1.86
1	5.175	1.91
1.6	3.1	1.9

Table III coupler performace vs an oblique stub

W [mm]	Coupling BW [GHz]	Coupling Amplitude Balance [dB
0.6007	4.55	1.77
0.6321	4.8	1.94
0.6674	4.75	1-90
0.7059	4.825	1.98
0.7337	4.825	1.95

Conclusion

- Due to inhomogeneous dielectric of microstrip directional couplers, i.e. partly dielectric substrate, partly air, coupler suffer from poor directivity and low coupling level. And for this, odd phase velocities are unequal, meaning that the odd-mode phase velocity commonly faster than the even-mode.
- This paper compensates for this inequality by introducing the distributed capacitive compensation which is performed by gap coupling between main coupled line and the open stub formed in sub-coupled line. The main goal was to obtain coupling around -30dB and it has a wide band, from around 3.5GHz to nearly 9GHz.

References

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