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THE DESIGN OF I-SHAPED DEFECTED GROUND STRUCTURE DIRECTIONAL COUPLER

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ABSTRACT

In the many microwave applications the directional couplers are highly useful for the good coupling. Here the model of the directional coupler is being presented to provide the better characteristics. The proposed structure has I–shaped defects in the ground which provide the coupling of 20.6db which is near to 20db (required) at the frequency of 1.7GHz.The return loss and the directivity are also one of the effective measures for the coupler which also shows the effectiveness of the coupler.

KEYWORDS: Directional Coupler, Directivity, Return Loss

INTRODUCTION

When two transmission lines are close to each other than electromagnetic field of each line interacts with one another and the power is coupled between the lines, now to design the coupler these two transmission lines are needed. In the conventional couplers, there are many techniques to improve the coupling level like maintaining the very small gaps between the microstrip lines. There are various approaches of Lange couplers proposed to show the good coupling and the directivity characteristics in [1]-[3], but these all couplers are very costly so it can not be considered for the general purposes.

The paper presents defects in the ground which is termed as defected ground structure (DGS), where the ground plane metal is intentionally modified to improve the performance of the coupler. The defects can be of many kinds as slots, dumbbell shapes; slot variations are shown in [4].Here I-shaped defects have been considered to improve coupling level. The coupling depends on the dimensions of the patterns in the ground and it can also be modified by changing the dimensions. The basic block diagram of the coupler is shown below. This structure of coupler has two transmission lines, at the first transmission line input is applied and at the second transmission line the output is coupled at port 3. For the design of the proposed coupler the transmission lines have been considered as microstrip lines of width ‘w’ each, the spacing between transmission lines are denoted by ‘s’.

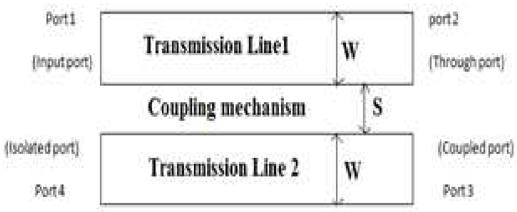


Figure 1: Basic Diagram of Coupler

PROPOSED STRUCTURE

The designing of coupler is always a very considerable aspect for designers, so that it could provide desired coupling level. Here all the calculation steps have been considered from [5].

The Figure 2 shows the structural hierarchy of the proposed structure where the top layer shows the upper part of the coupler and the bottom most layer shows the lower shape of the coupler and in the middle, the two substrate have been shown on either side of the ground level, the substrate has been chosen as Fr4 of height 1.6mm and between two substrates the ground has been prepared and on the ground the I-shaped structure have been formed to provide the desired coupling level. This structure can also be called as the five layered architecture of the coupler.

There is the parallel plate capacitance between microstrip and ground planes, fringe capacitance in between the edge of an uncoupled microstrip line, extra fringe capacitances across the gap between the inserted I-shaped signal strip and the ground plane in the air and dielectric regions.

In odd mode excitation the extra fringe capacitances exist between the signal strips on the top layer and between the inserted signal strips.

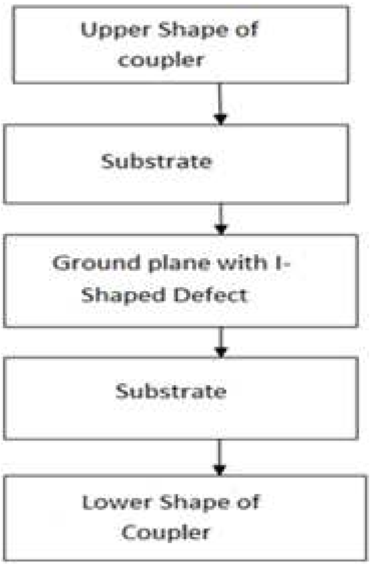
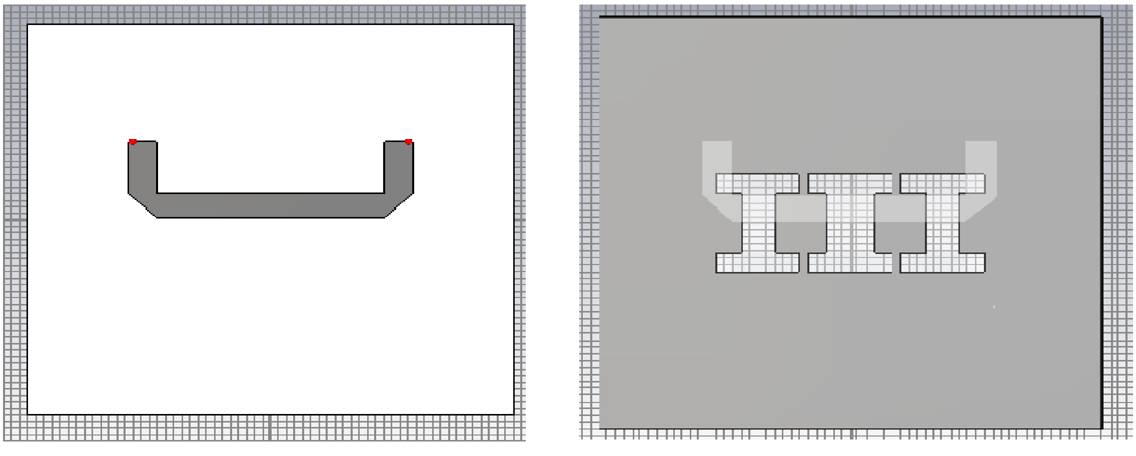


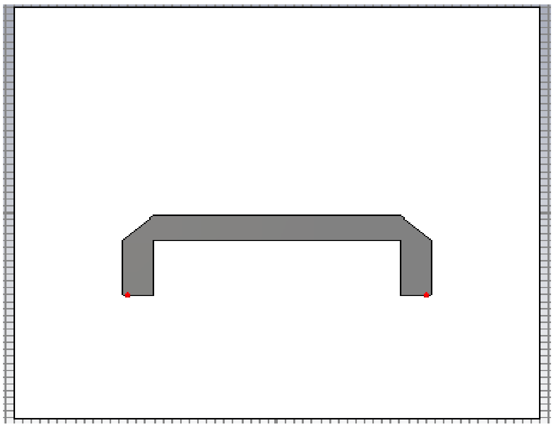
Figure 2: Structural Hierarchy of the Proposed Coupler Design where Arrow Indicating the Layer One below Another

SIMULATED DESIGN

After the analytical calculation of the design the simulation of the proposed structure has been done on the CST Studio Suite 2010 [6]. The simulated structure of the design is being shown in Figure 3 where the structure has been designed at the width (w) of 31mm and the spacing between the two microstrips is taken as 7mm at frequency of 1.7GHz.



(a) (b)



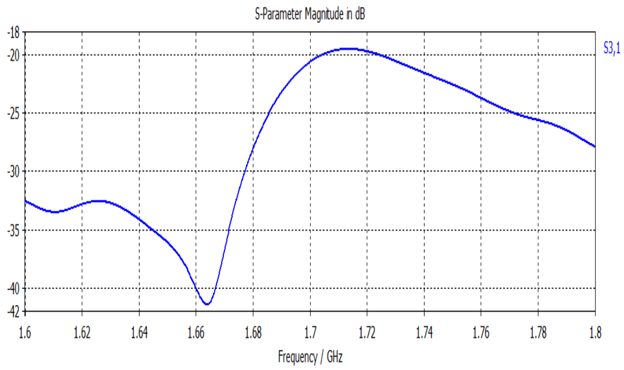
(c)

Figure 3: Simulated Diagram (a) Shows the Upper Shape of the Coupler, (b) Shows Ground Plane with I-Shaped Defects (c) Shows the Lower Shape of the Coupler

RESULTS

The return loss, coupling level and directivity are important characteristics of the coupler. For all these characteristics, results have been obtained by using the CST Studio suite 2010.

So the return loss is 14dB and the coupling level is obtained 20.6dB which is very close to the 20dB (i.e. analytical). % error between the simulated and analytic values of Coupling level is only 3%. The directivity is obtained 20dB. Figure 4 shows the simulated results for the proposed structure.



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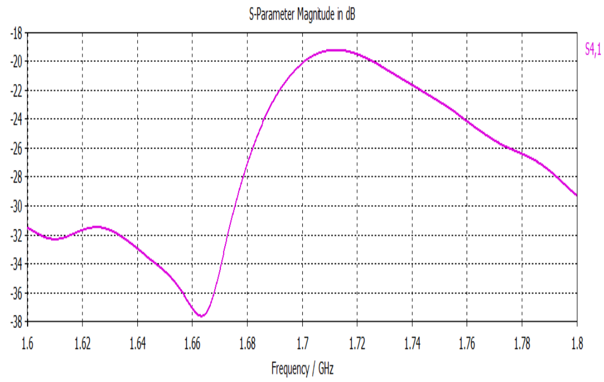

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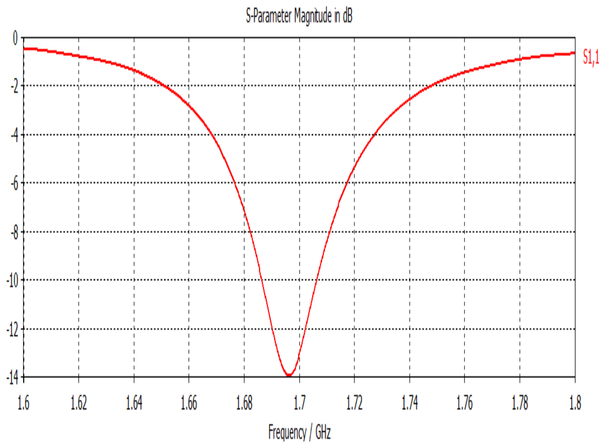

(c)

Figure 4: Shows Response at Frequency of 1.7GHz (a) Coupling (S_{31}), (b) Directivity (S_{41}), (c) Return Loss (S_{11})

CONCLUSIONS

The design of coupler by using analytical method have been presented to provide the improved coupling level with only 3% of error between analytical and simulated values of coupler. This proposed structure has I-shaped defected ground which shows the effectiveness of the coupler and provides the coupling very close to 20db. For the small microwave frequencies this structure of coupler is better and can be applied very efficiently.

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