International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 06 Issue: 06 | June - 2022 Impact Factor: 7.185 ISSN: 2582-3930

A NOVEL COUPLED LINE COUPLER WITH DEFECTIVE GROUND STRUCTURE (DGS)

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Abstract - This paper examines the development of a 10 dB directionally coupled line coupler with defective ground structure (DGS) using HFSS design tool. The coupler operates in the 4 GHz to 6 GHz frequency range with a high directivity of 46 dB. compared to conventional coupled line coupler and S parameters are calculated. Design optimization is performed in HFSS to meet required specifications.

Key Words: Branch Line Coupler, DGS, S parameters

1.INTRODUCTION

A transmission line structure with defects etched into the metal ground plane, such as the two-dimensional photonic band gap (PBG) and the one-dimensional defective basic structure (DGS), has been studied in microwave and millimeter wave frequency ranges. Applications of ground etched microstrip line include slow wave structure, harmonic suppression with compact size and low loss characteristics, various circuit design, etc. Transmission lines [1][6]. Microstrip line with DGS leads to an increased group rate delay due to the steep phase characteristic. Group rate delay reduces the dimension of distributed components in RF and microwave integrated circuits.

In order to apply the proposed DGS section to practical circuit design, the modeling technique is needed. This document shows the equivalent circuit of proposed DGS section of microstrip line, which has higher impedance level and shorter electrical length than conventional ones. To extract design parameters such as characteristic impedance and electrical length, S-parameters for an DGS section microstrip line are calculated using the finite element method (FEM). From the calculated S-parameters, the characteristic impedance and the electrical length for the DGS line section are extracted based on the theory of simple circuit analysis. The proposed DGS section can be easily implemented by a simple etch process on the back metal ground plane. To examine the usefulness For the proposed DGS section, we designed and manufactured a stub coupler with 10dB coupling. The 10dB stub coupler has many manufacturing limitations with the traditional microstrip configuration..

2. Proposed Design

The configuration of the proposed directional coupler is shown in Figure 1. The top layer contains the two coupled microstrip lines, while the ground plane is in the bottom layer. There is a Defected ground structure on the ground plane below the coupled lines. The 10 dB coupled branch coupler requires quarter-wave transmission lines with 150 ohms and 47.7 ohms characteristic impedance. The structure shown in Figure 1 can be fully analyzed using odd and even modes. The distribution of the electric field lines between the coupled lines is observed. According to the characteristics of reverse directional couplers, the input port (port 1) and port 4 are isolated, see Figure 1. Therefore, the following discussion focuses only on the calculation of the coupling between the input port and the coupled output (port 2). The output power of port 3 can becalculated from the value of the input power and the coupled output power.

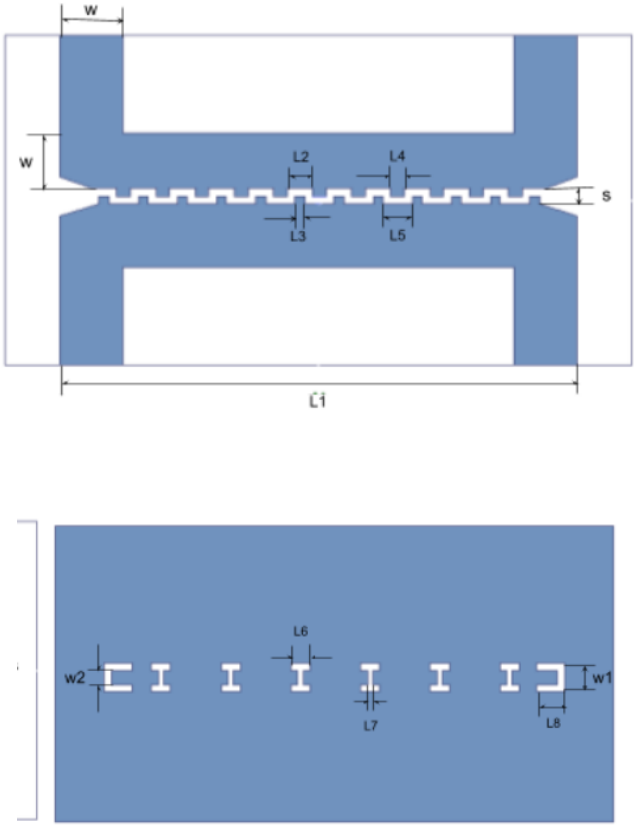

Figure.1 Proposed Coupled Line Coupler with Defected Ground Structure (DGS)

Table 1 Shows the parameters of Proposed Coupled Line Coupler with Defected Ground Structure (DGS), the width of the coupler line is 1.6 mm, the space between the two branch line is 0.2 mm. L parameters are shows the stub dimensions of the branch line couplers. The defected ground plane is dimensioned as a parameter of L6, L7, L8 and width is mentioned as W2.

Table 1 Parameters of Proposed Design

Parameter	Value (mm)	Parameter	Value (mm)
w	1.6	L5	0.75
s	0.2	w1	0.8
L1	13.2	w2	0.4
L2	0.65	L6	0.55
L3	0.25	L7	0.15
L4	0.35	L8	0.6

3. Simulated Result

To see the performance of the proposed design ,the return loss,inertion losses and isolation are evaluated in Ansoft HFSS Tool. The substrate and electrical characteristics are given below

Substrate characteristics:
Dielectric constant εr = 4.4 ; Height H = 1.6mm ; Loss tangent δ = 0.001;
Electrical characteristics:
Characteristic impedance Z0 = 50Ω
Frequency Range f = 4 GHz to 6 GHz

Figure 2 shows the Results of proposed Coupled Line Coupler with Defected Ground Structure (DGS). From the figure we can observe that return loss is nearly 50 dB in the frequency of 4.7 GHz, the same frequency the insertion loss is less than 1 dB its shows that better transmission has happed with the proposed design. The proposed design gives the high directivity of 46 dB at the frequency of 4.7 GHz.

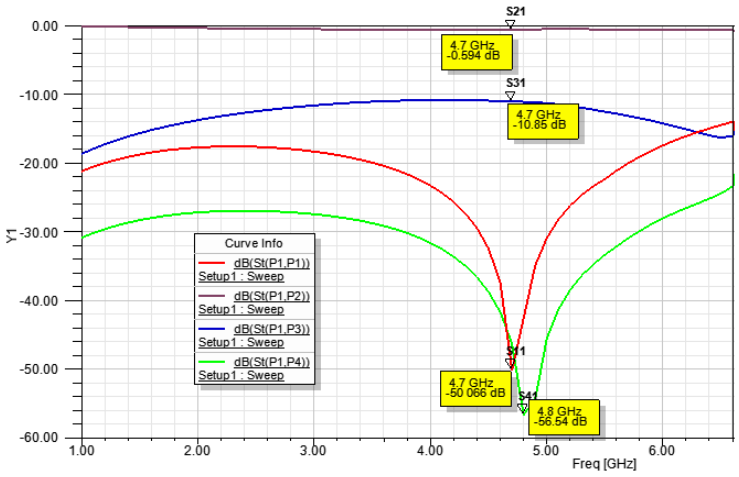

Figure 2. Simulation Results of proposed Coupled Line Coupler with Defected Ground Structure (DGS)

3. CONCLUSIONS

In this article, we implement a new branch coupler with the proposed DGS (Defective Ground Structure) to implement the high-impedance line sections. In addition, we observe the performance through electromagnetic simulations. The widening of the conductor width was achieved with the proposed DGS profile. to conventional microstrip. Simulation performances for the proposed trace coupler showed good directivity and return and insertion loss. This newly proposed DGS section and the design process can have various applications, such as Bandpass filters, unequal power dividers, etc..

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