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Design and Performance Assessment of Compact Microwave filter using Defected Ground Structures

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ABSTRACT

This paper analyses the effects of rectangular dumbbell shape defect in ground plane structure on performance of LowPass Filter. The bandstop filter has been incorporated in the ground plane substrate of the microstrip line using DGS phenomenon. The designed filter has stop band rejection of -31.2 db, stop bandwidth of 0.38 GHz and a resonating frequency of 4.38 GHz.

Keywords

Defected Ground Structure [DGS], Rectangular Dumbbell shape, Bandstop, Microstrip Filter, Rectangular slot, IE3D, Hyperlynx, ADS

INTRODUCTION

Conventional filters are known to occupy larger area than the Microstrip Line itself. In the modern communication system, miniaturisation of the circuit has become a key factor in any active and passive component design, due to which new and innovative techniques have been researched. Introducing defect in the ground plane suppresses harmonics and eliminates fallacious signals and reduces the area occupied significantly. The size, shape and orientation of a slot alters the performance of the filter. In this paper, 4 filter designs have been proposed.

A rectangular dumbbell shaped defect has been created in the ground plane structure. Height and width of defect have been varied and simulated to obtain optimum filter with reference to figures of merits considered. Software IE3D has been used to simulate the results and compare filters. ADS is the simulation software used to cross verify the results achieved. ADS simulation software was use to cross verify the results achieved.

Title and Authors

Design and Performance assessment of Compact Microwave filter using various defects in ground plane were analysed by ViranchеeLotia,Karan Shah under the guidance of Makarand Kulkarni

SECTIONS

In Section II we have studied the response of 4 similar slot geometries of the DGS slot and defined parameters to characterise them. The numerical experimentation was done on 3D EM simulator Mentor Graphics Hyperlynx 3D EM IE3D. In Section III, we analysed and found the variation in slot could improve performance in bandstop filter. Section IV compares the performance of the 4 simulated filters.

These are the defects

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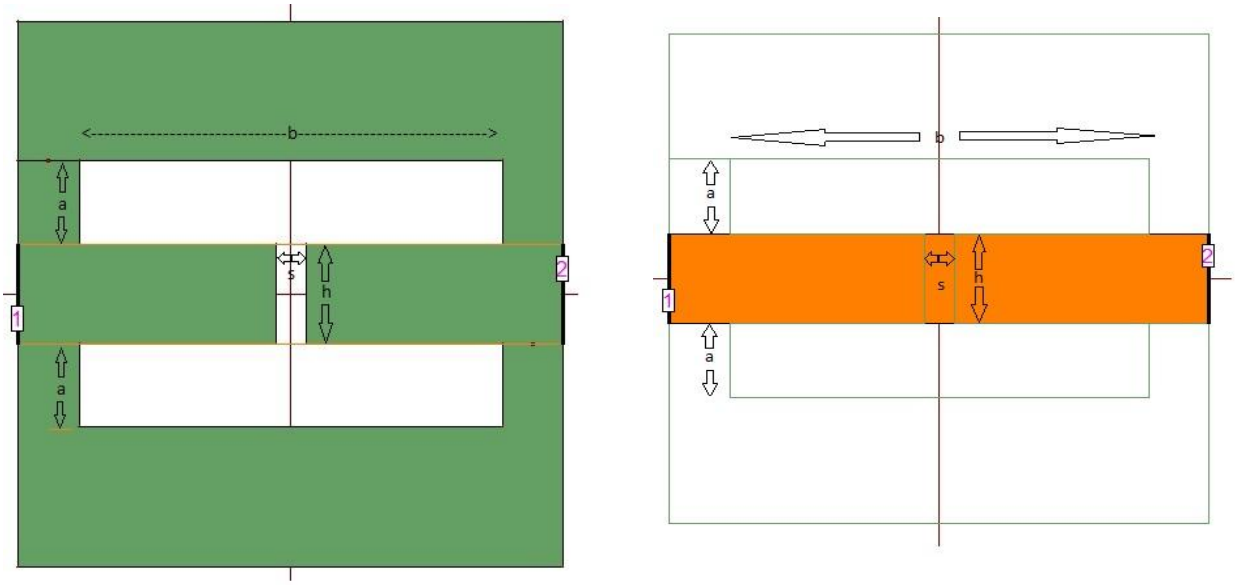
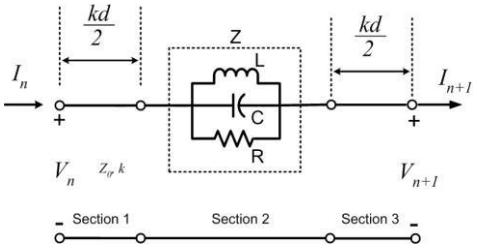


II. STUDY and Characteristics of slots in ground plane

Figure 1 shows the layout of rectangular dumb bell DGS slot fed by 50-Ω micro strip line. The DGS slot is modelled by a parallel RLC resonant circuit [1], shown in fig. 2(a). RLC components are connected in series with transmission line of electrical length kd/2 on both sides. K is the propagation constant along the line without DGS and d is the physical length of transmission line of used. RLV parameters are calculated based on resonant frequency f_o, -3dB cut-off frequency f_c, and characteristic impedance Z_o which is 50-Ω



$$R = 2Z_0\left(\frac{1}{|S21|}-1\right) \quad (1)$$

$$C = \frac{\omega_c}{2Z_0}\cdot\frac{1}{\omega_0^2-\omega_c^2} = \frac{f_c}{200\pi}\cdot\frac{1}{f_0^2-f_c^2} \quad (2)$$

$$L = \frac{1}{\omega_0^2 C} = \frac{1}{4\pi f_0^2 C} \quad (3)$$

The lumped capacitance C in RLC equivalent model is gap capacitance, the inductance L is the magnetic flux generated by current passing through defect apertures in the ground plane. This radiation effect is explained in resistance R.

We have selected following parameters to characterisebandstop performance of the DGS slots

Pass Bandwidth, Stop Band Rejection, Stop Bandwidth, Resonant Frequency, Cutoff frequency VSWR and Radiation Loss.

Slot heads at both ends were created, with varying heights ‘a’ and widths ‘b’, simulated and analysed. First, height ‘a’ was kept fixed and width ‘b’ was varied by equal intervals. These simulation results were then analysed and height ‘a’ was increased by same interval. All possible rectangular defects with variation in ‘a’ and ‘b’ at fixed intervals were simulated. Variation in ‘b’ is given in fig. 3a to 3c.

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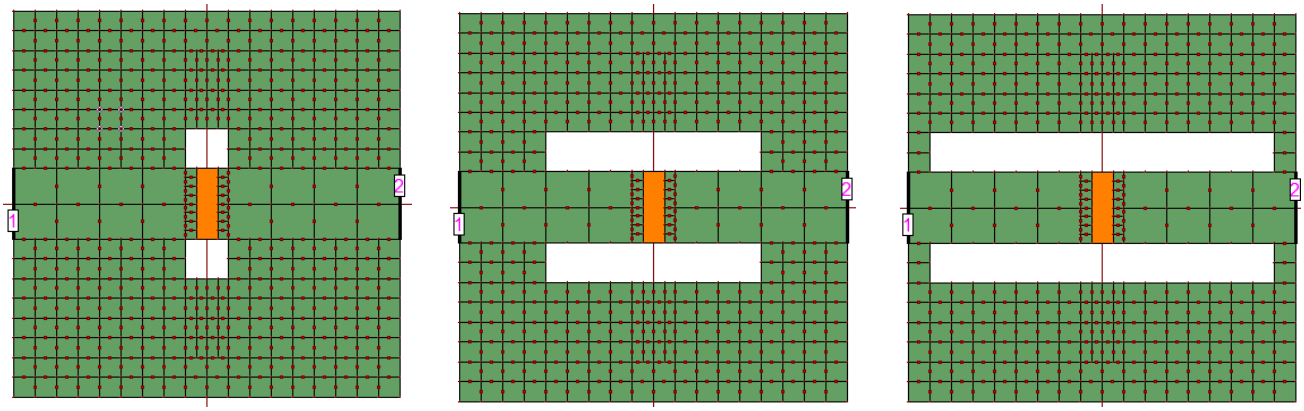


a=2,b=2 a=2,b=4 a=2,b=8

Figures 3a 3b & 3c

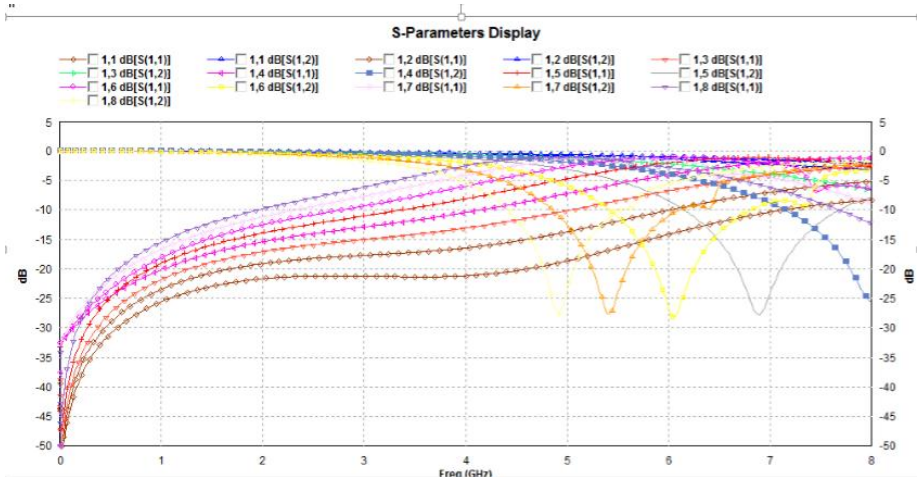


Figure 4a a=1, variation in b

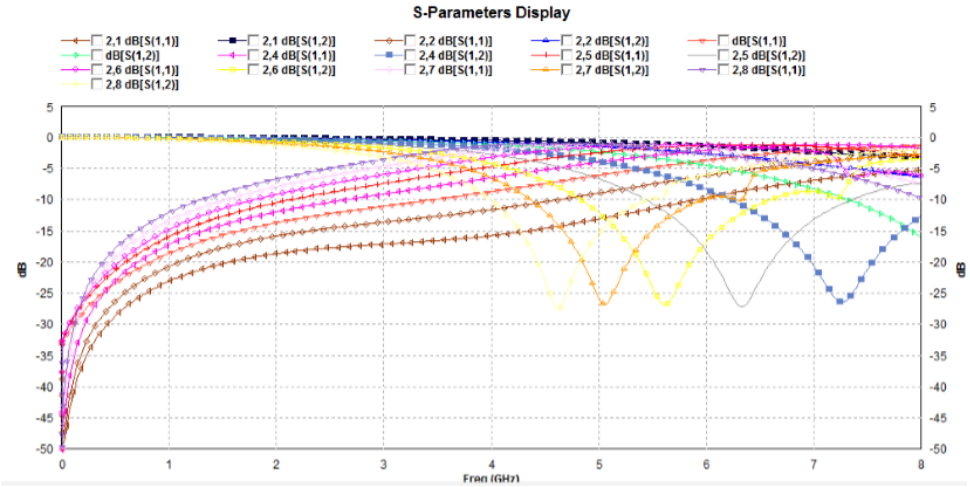
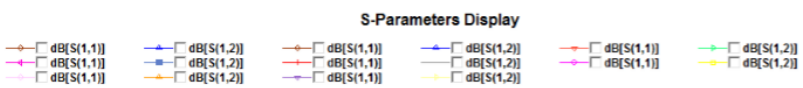


Figure 4b a=2 variation in b



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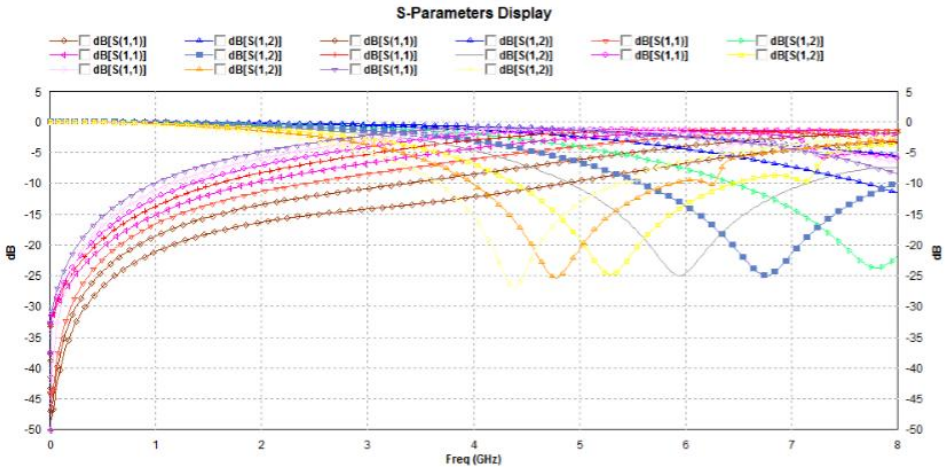

Figure 4c a=3 variation in b

Figure 4d a=4 variation in b

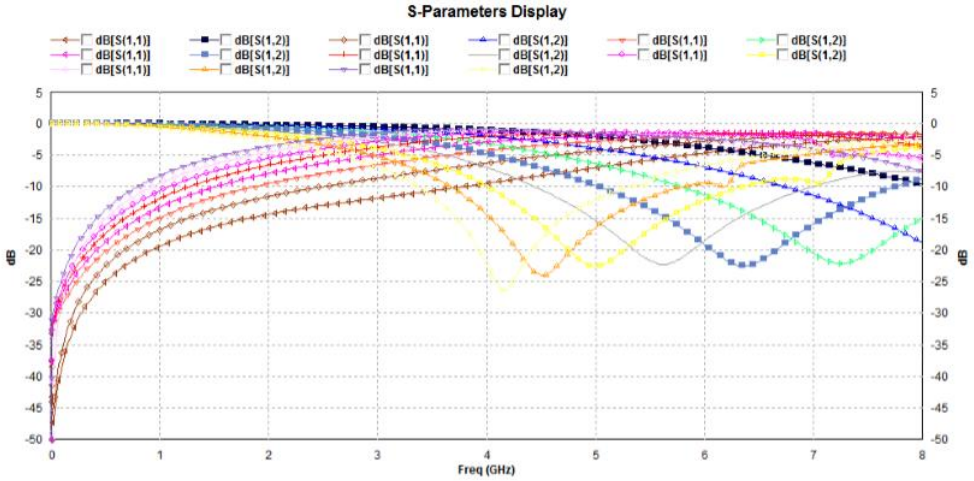

Figure 4e a=5 variation in b

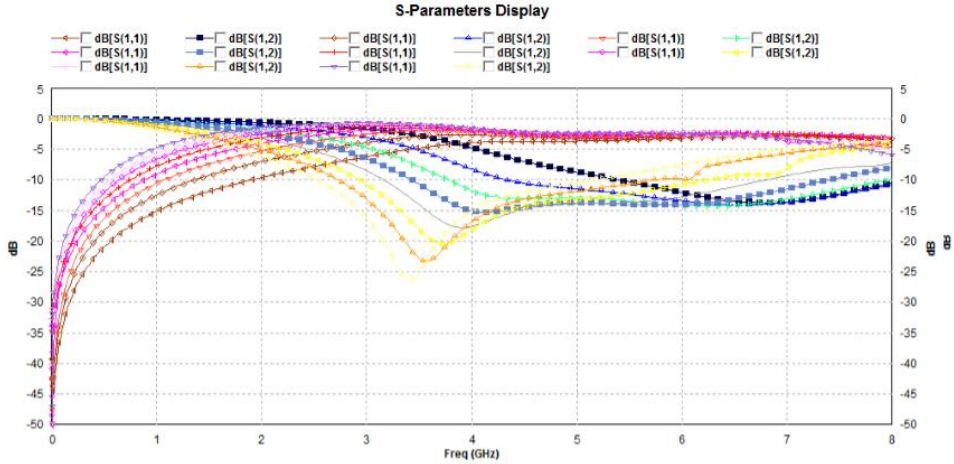

Figure 4f a=6 variation in b

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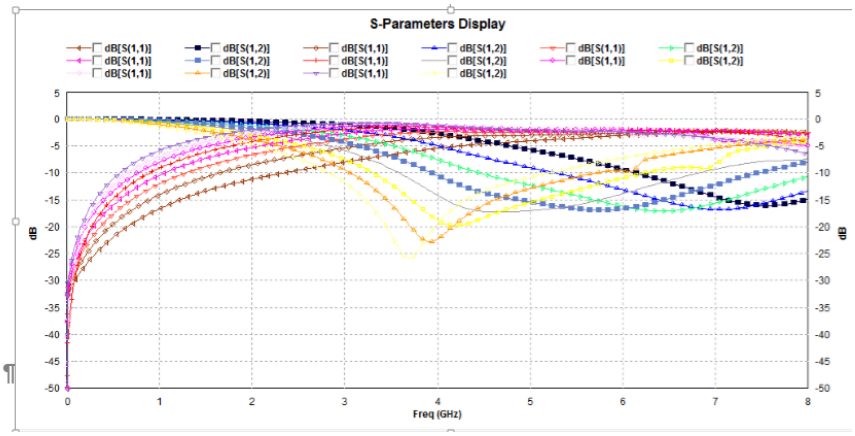

Figure 4g a=7 variation in b

Results and Conclusion

The simulations were verified on both IE3D and ADS, and

REFERENCES

1. Makarand G. Kulkarni, A N Cheeran, "Design of a Novel CPW Filter using Asymmetric DGS" IEEE papers