Comparative Analysis of Different Types of Planer EBG Structures

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***Abstract*—**In this paper three types of Electromagnetic Band Gap (EBG) structure is presented. This paper analyze the parametric performance of different factors that influence band gap properties of EBG structures. Planer Electromagnetic Band Gap (EBG) structures are considered very promising in microwave engineering. It is found that EBG structures used to reduce interference, surface wave and mutual coupling. This paper includes three designs of EBG structures including Fractal shaped, Fork shaped and Spiral shaped. The array of theses EBG structures has been also analyzed to investigate the Band Gap Properties of these structures. Finally the comparison of band gap properties of all three EBG structures has been compared, discussed and concluded.

***Keywords*—**Electromagnetic Band Gap Structures(EBG), Surface Wave, Mutual Coupling, Interference**.**

I. INTRODUCTION

Electromagnetic band gap structures are normally periodic in nature. EBG strctures are equivalent to magnetic surface at the resonance frequency and have very high impedance. These structures are extensively used in Band Gap phenomena for used in practical used both in optical domain and microwave areas. The EBG structures are also very compact in nature, this is because compactness is very much preferred in wireless communications. [1]

Surface wave propogation can be suppressed by using periodic structures called Electromagnetic Band Gap structures. EBG structures can be implemented as metallic-dielectric and purily dielectric. [2]

The band gap property of any EBG structure is dependent on the dielectric constant , thickness of the substrate as well as on the EBG structure geometry. During the early phases of research on EBG structure, it is mainly focused on the three dimensional geometries. These three dimensional EBG structures are very complex in designing and fabrication. Later on researchers have found planer types of EBG structures. The advantage of planer types of EBG structure is in its fabrication is very easy also the manufacturing cost is very less as compared to three dimensional EBG structures. [3]

In this paper we have designed three types of EBG structures which are planer in nature. The array contains the periodicity of dielectric structures designed on metal.

We proposed fractal type of EBG structure. The important property of fractal type of structure is that a long electrical length can be incorporated in a small area. The self similarity of fractal geometry generats multiple notch band and thus the wide band response is created. The second one is fork shaped EBG structure. This type of structure is very simple to design also the band gap is very large. The third structure is spiral shaped EBG structure. The design and band gap properties of all three structures are compared in the next sections.

II . DESIGN OF EBG STRUCTURES

In this paper purily dielectric planer types of EBG structures is designed to suppress surface waves. The EBG structures are designed on the FR-4 substrate having dielectric constant 4.4, thickness 1.6 mm and loss tangent 0.02. The unit cell of EBG structure in all three types is taken as 5mm x5mm.

A. FRACTAL TYPE EBG

Fractal EBG strcture is a two dimensional planer type EBG structure. The transmission characteristics depends on the size of patch and structure. The transmission characteristics also depends on the thickness and type of substrate material used. The single unit of fractal EBG is shown below.

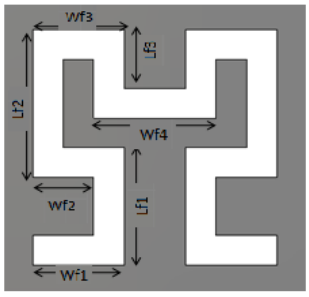

Fig-1: Unit cell of fractal EBG

The optimum parameters of the proposed fractal EBG are following: Wf1= 3 mm, Wf2= 2 mm , Wf3= 3 mm., Wf4=4mm,

Lf1= 4 mm, Lf2= 5 mm and Lf3= 2mm. The width fractal is 1 mm.
We take only left side of parameters because the structure is symmetric so right hand side parameters are same as left hand side.

B. FORK TYPE EBG

The fork type EBG structure is very eas to design as compared to fractal EBG. The unit cell of fork type EBG structure is shown below.

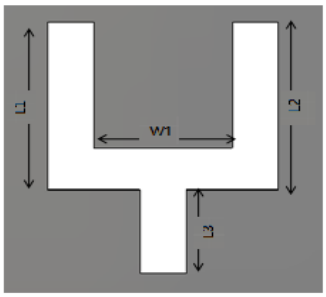

Fig- 2: Unit cell of Fork EBG

The parameters of the cell are given as : L1=7 mm, L2= 7 mm, L3= 4mm, W1=6 mm. the width of the structure is 1 mm.

C. SPIRAL TYPE EBG

The schematic proposed spiral EBG unit cell is shown in figure 3. The gray part in the structure is metal, which is etched on the dielectric substrate. The planer spiral EBG is simple to design as there is no vias connected.

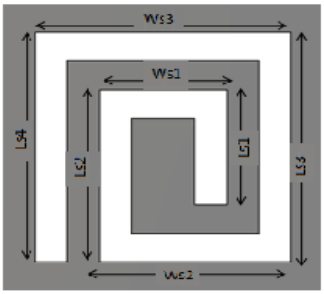

Fig-3: Unit cell of spiral EBG

The optimized parameters of the EBG cell are as follows: Ls1= 4 mm, Ls2= 6 mm, Ls3= 8 mm, Ls4= 8 mm, Ws1= 4 mm, Ws2= 6 mm, Ws3= 8 mm. the width of spiral is 1 mm.

III . BAND GAP CHARACTERIZATION OF SINGLE EBG STRUCTURE

The designed EBG structures are simulated using the CST microwave studio. Only the transmission coefficient (S21) is calculated to characterized the band gap behavior of EBG structure.
From the figure 4 it can be shown that the maximum band gap is provided by fork like EBG structure.
The frok like EBG structure have -10 dB band gap from 7.7 Ghz to 15 Ghz, fractal shaped EBG strcuture have -10 dB band gap from 8 Ghz to 15 Ghz, spiral shaped EBG structure does not have wide band gap as fractal and fork shaped.

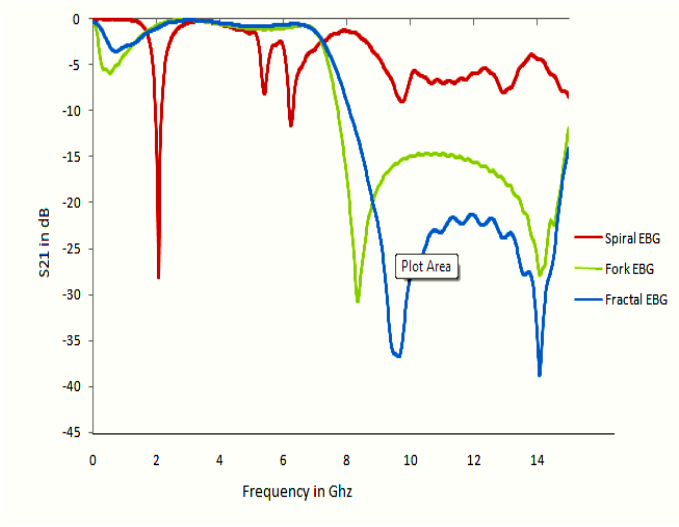

Fig-4: Comparision of Band gap behavior of Unit cell Spiral, Fractal and fork shaped EBG

IV . DESIGN OF ARRAY OF EBG STRUCTURE AND CHARACTERIZATION OF THEIR BAND GAP BEHAVIOUR

Now we will design and compare the array of EBG structure. In the array of EBG structure the single unit is same as designed above. We have designed 6 x6 array and 7 x7 array of fractal, fork and spiral EBG structures.
The simulation is done in CST microwave studio.

A. DESIGN AND CHARACTERIZATION OF 6X6 ARRAY EBG STRUCTURES

First we will design 6x6 array of EBG structure of fork, fractal and spiral types of EBG structures and simultaneously show their transmission characteristics.

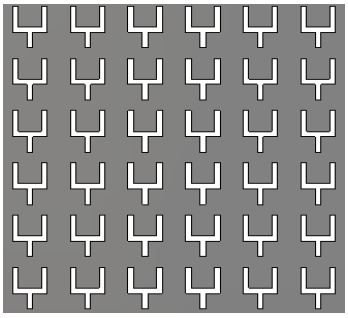

Fig-5: Front view of Array of Fork EBG structure

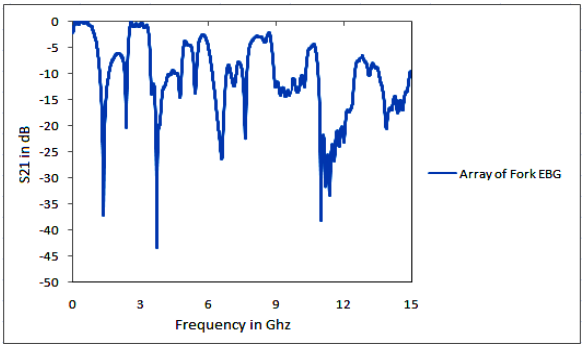

Fig-6: Tansmission coefficient of 6x6 array of Fork EBG Structure

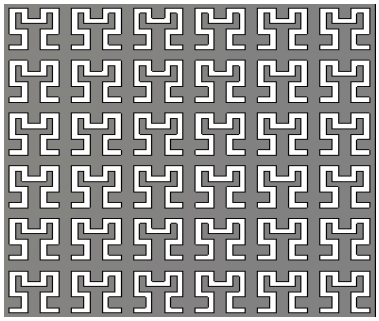

Fig-7: Front view of Array of Fractal EBG structure

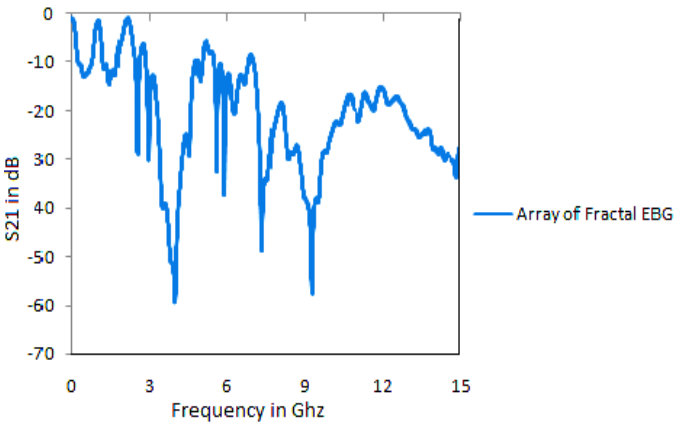

Fig-8: Transmission coefficient of 6x6 array of Fractal EBG strcture

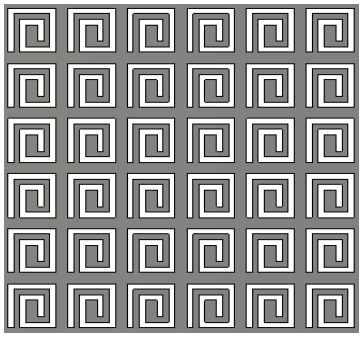

Fig-9: Front view of Array of Spiral EBG structure

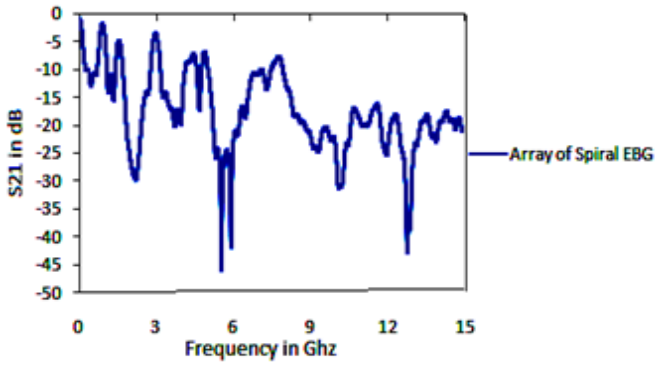

Fig-10: Transmission coefficient of 6x6 Array of Spiral EBG Structure

Now we will see the comparision between all three 6x6 array EBG structures.

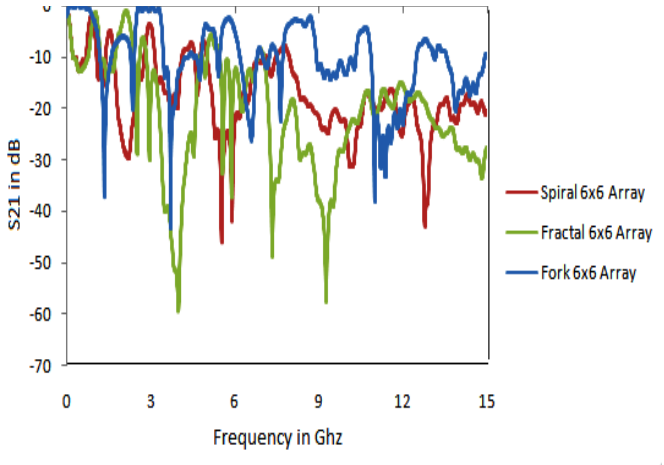

Fig-11: Comparision of Band Gap behavior of Array of Different EBG structures

B . DESIGN AND CHARACTERIZATION OF 7X7 ARRAY EBG STRUCTURES

Array of 7x7 EBG structures has been designed. It can be shown from the results in this section that 7x7 array E BG structures gives more Band Gap than 6x6 Array of EBG structure.

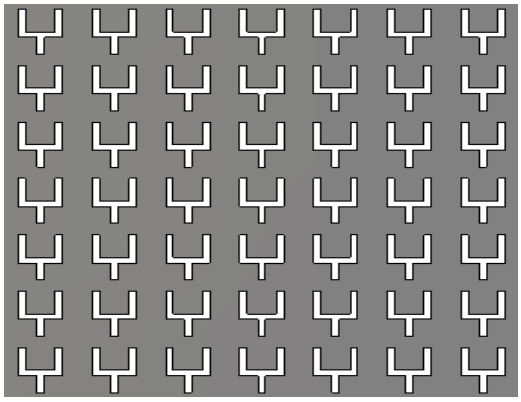

Fig-12: Front view of 7x7 Fork EBG structure

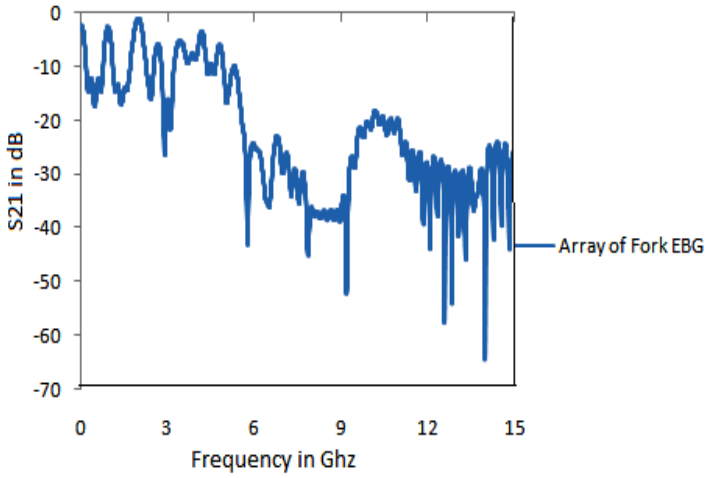

Fig-13: Transmission coefficient of 7x7 Array of Fork EBG Structure

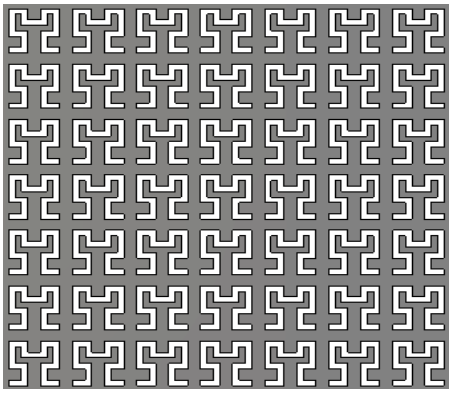

Fig-14: Front view of 7x7 Array of Fractal EBG structure

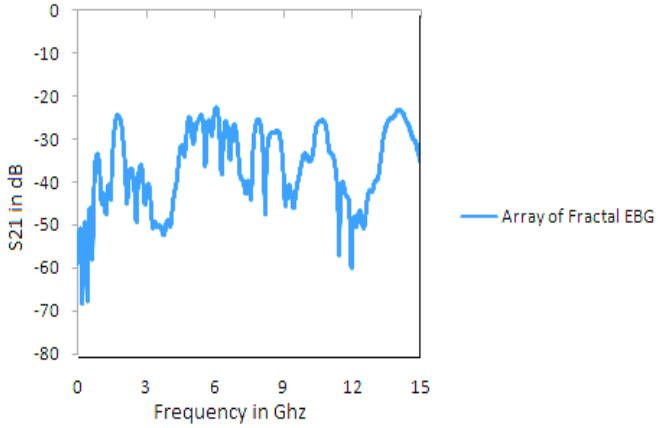

Fig-15:Transmission coefficient of 7x7 Array of Fractal EBG structure

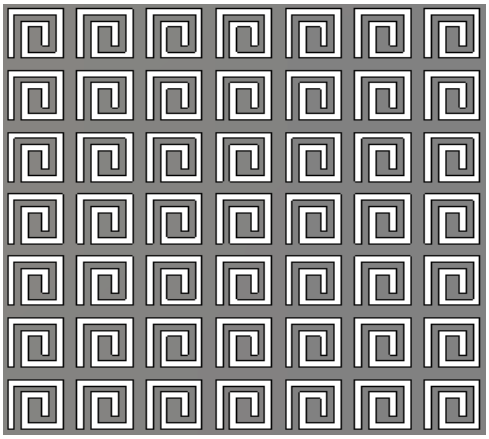

Fig-16: Front view of 7x7 Array of Spiral EBG structure

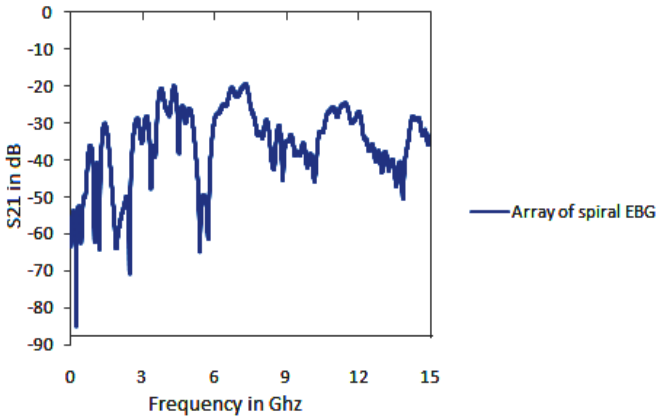

Fig-17: Transmission coefficient of 7x7 Array of Spiral EBG Structure

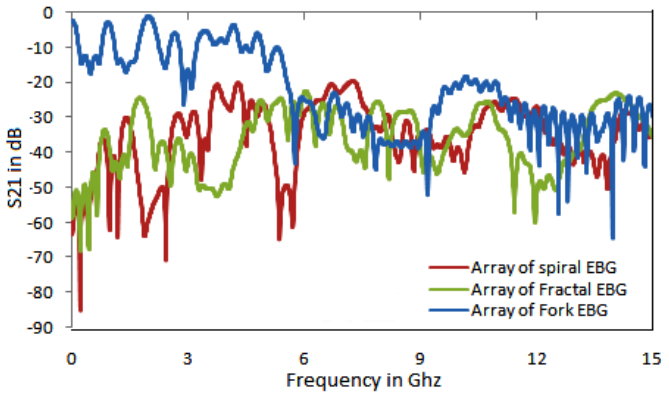

Fig-18: Comparative Analysis of Band Gap behavior of 7x7 Array of Different EBG structures

V. CONCLUSION

A comparative analysis of planer types of EBG structures has been presented in this paper. The band gap characteristics along with physical dimensions of the structure have been determined and simulated using CST microwave studio 2010. Three types of electromagnetic band gap structures are investigated. The effect of number of array in an EBG structure is studied. As the number of element increases the band gap increases also the band gap shifts to the lower frequency region. Among three EBG structures the fork type EBG structure gives better performance in terms of simplicity, compactness and band gap. The proposed EBG structures can be used for microstrip patch antennas in terms of bandwidth, gain, reduction of mutual coupling and surface wave. Hence the antenna performance can be enhanced.

VI . REFERENCES

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