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Antenna Design with EBG Structure for S-band.

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Abstract- *In wireless communication microstrip antenna play an essential role in the system So In this project a microstrip has been designed to operate from 2 GHz to 4GHz.To improve the efficiency an Electromagnetic band gap structure has been .Electromagnetic band gap structures work as a stopband to the frequencies for which the antenna is designed. A substrate FR-4 has been used with the thickness of 1.6mm.The paper is proposed for the S band frequency. The electromagnetic band gap structure shape proposed for this antenna is fork like structure. The fork like structure possesses small size with easy to design as compared to the other structures. The Electromagnetic band gap structures enhances the performance of the microstrip patch antenna. The EBG structure will reduce the return loss and improve the bandwidth for S band application. In terms of bandwidth and return loss we simulated the proposed antenna design*

Keywords- **Antenna bandwidth, Electromagnetic band gap structure, microsrip patch antenna, return loss**

1. INTRODUCTION

In the recent years the communication system has become vital in the in the technology and electronics. This communication is done by the wireless communication due to which a large number of Antennas are introduced in the universe. These large number of Antennas create noise and Electromagnetic interference. So reduce this Electromagnetic Interference Electromagnetic Bad gap structures are introduced in the microstrip antenna.

1.1 Microstrip Patch Antenna

Microstrip antenna are planar antennas which resonate at a proposed frequency. The resonant frequency antennas which the widely used antenna due to the various applications In addition to that its increasing demand is due to its fabrication as it can be directly printed on the circuit board .A slot is introduced to increase the bandwidth of the antenna. The microstrip patch antenna have become demanding based on the various advantages like small in size ,low fabrication cost, light in weight. Along with the wide range of advantages it does have disadvantages like narrow bandwidth and low gain.

The basic microstrip antenna has a substrate of dielectric Flame Retardant-4 and a patch and ground below substrate. The feeding that will be used is coaxial feeding which comprise benefit of easy fabrication and optimization of the required output to the correct position.

Advantages

- Low profile and weight
- Can be used at various frequency
- Low fabrication cost
- Have Linear and circular polarisation
- Can design different feeding

Disadvantages

- Narrow bandwidth
- Can only work at low power
- Lower efficiency
- Low gain

1.2 Antenna Dimensions of Slotted patch

The antenna is designed at 2.4 GHz with a vertical slot as shown in the figure. the antenna is designed on FR-4 substrate with a tan of 0.02 ,thickness of 1.6mm and relative permittivity of 4.4.The measured dimensions of the sotted patch are W=39 , L=43 , Ws=36.2 and Ls=12.5.

Design Equations for a Patch

$$W=C/2\, f_o(\sqrt{(\varepsilon_r+1)/2})$$

$$\varepsilon_{eff} = ((\varepsilon_r+1)/2)+((\varepsilon_r-1)/2)[1+12(h/W)]^{-1/2}$$

$$L_{eff}= C / (2f_o\sqrt{\varepsilon_{eff}})$$

$$\Delta L= 0.412h [(\varepsilon_{eff}+0.3) ((W/h)+0.264)/(\varepsilon_{eff}-0.258)((W/h)+0.8)]$$

$$L=L_{eff}-2\Delta L$$

2. ELETROMAGNETIC BAND GAP STRUCTURE

2.1 EBG in Microstrip Antenna.

In this paper, we have proposed an antenna with an Electromagnetic band gap structure. This are introduced to increase the bandwidth of the microsrip antenna. This structure will increase the bandwidth and educe the return loss. Electromagnetic band gap structures are normally periodic which possesses very high impedance. These structures basically create a stopband which blocks electromagnetic waves of certain frequencies. In the world of electromagnetics, these structures are considered to be the fastest moving fields. The S parameter of the microtrip patch antenna is compared with the proposed antenna with EBG structure.

The EBG main benefit which includes its potential to supress the surface wave .The surface waves decreases the antenna efficiency and gain, in addition to that it also gives rise to mutual coupling .The mutual coupling is present between the slotted antenna and EBG structure which change the phase and magnitude of the current.

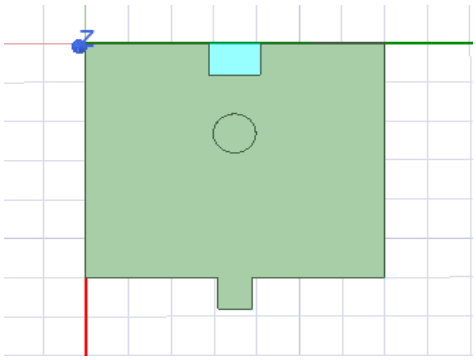

Fig.2.Fork EBG structure

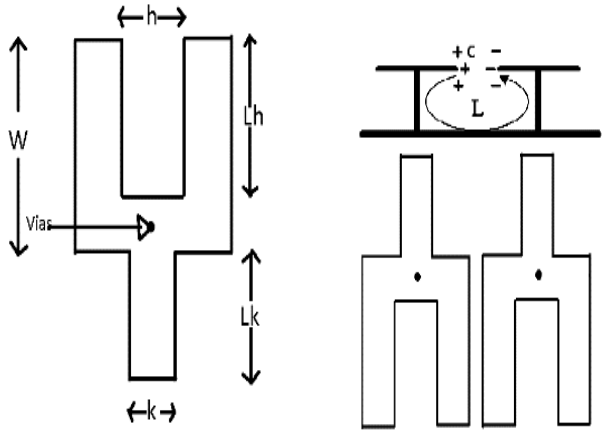

Fig.1. Fork like EBG

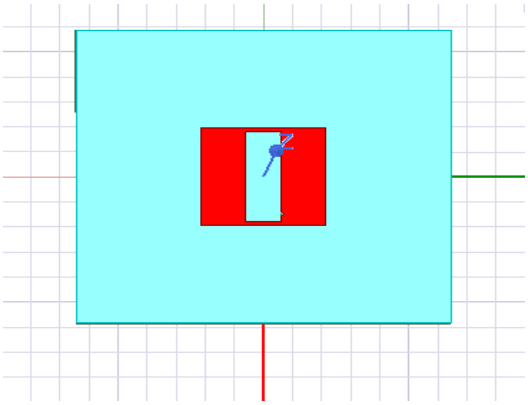

Fig.3. Microstrip patch antenna

2.2 Fork shape Electromagnetic band gap structure

This EBG for structure helps to reduce the antenna size which is a necessary scaling parameter in designing the antenna. If the size of the EBG shape is not scaled then the antenna will be enlarged which in turn will increase the fabrication cost at lower frequency. In comparison to other types of EBG structure like mushroom shape, this fork structure gives higher benefits of size this structure solves the difficulties in the traditional microstrip antenna. The surface impedance is very high for the structure with the frequency range. The surface waves are blocked by the frequencies by the LC filter which acts as 2 dimensional electric filter.

The Equation for the centre frequency is given by

$$f= 1/2\pi\sqrt{(LC)}$$

The inductance L is the current that flows through via to the substrate and the capacitance arises from the spacing between the patches. Thus when we increase the inductance and capacitance we normally decrease the bandgap in the antenna.

An EBG structure is incorporated on the patch antenna surrounding. The figure above depicts the same. It is promising structure that enhances the gain, efficiency and antenna bandwidth. HFFS software is used to designed structure of EBG.

3. DESIGN AND CONSTRUCTION

A single band Electromagnetic band gap structure is simulated for the s band frequency. It's designed on FR-4 substrate with relative permittivity of 4.4 and loss tangent of 0.02.The frequency chosen from the S band is 2.4 GHz at which the EBG structure will show its parameters. The EBG is designed with number of cells surrounding the patch antenna.

The microstrip patch antenna with EBG structure is simulated using HFSS .The result is successfully achieved for the specified frequency of single band. The fork like EBG structure is examined in this paper. The designed is 2.4 GHz but in the numeric result it is slightly shifted to 2.5 GHz.

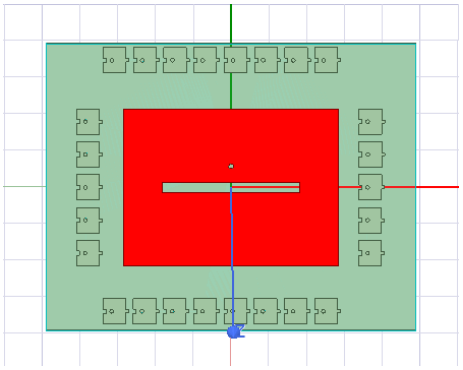

Fig 4.Antenna with EBG structure

4. RESULTS

The result shown above shows that at different frequency different return loss is obtained. The negative values of return loss depicts that it has fewer losses at that specified frequency. The return loss of the proposed antenna at 2.5 GHz is -20.79 and of the traditional antenna is at 2.5 GHz is -11.53 dB. The wideband also shows that the higher frequency at 4.5GHz and 5 GHz the return loss of the antenna with EBG structure is -2.61 dB and -18.51 dB.Also of the traditional antenna at 4.5GHz and 5GHz the return loss observed is -0.80 dB and -8.27dB.

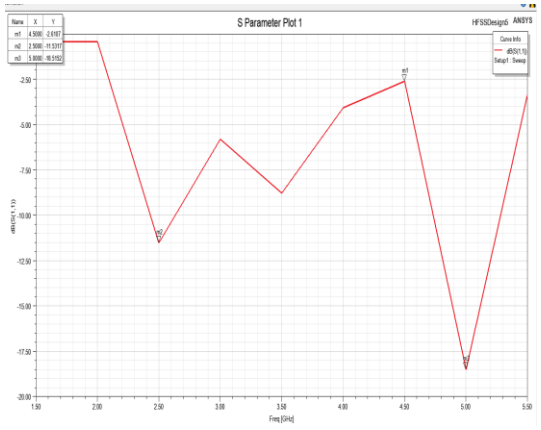

Fig .5, The traditional antenna without EBG structure shows the S11 parameter.

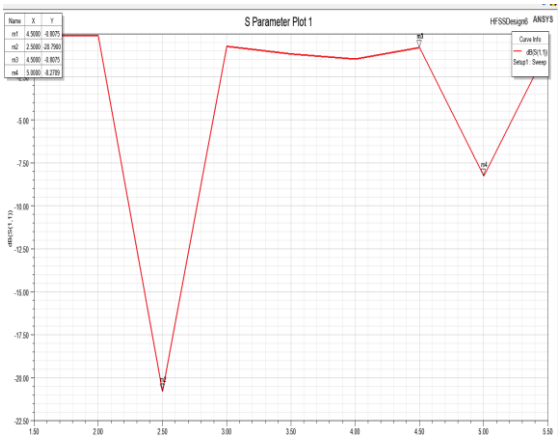

Fig.6. Microstrip slotted patch antenna with EBG structure

The EBG structure at lower frequency does not radiate more, so the EBG when incorporated in the microstrip antenna there will be less radiation radiations leaking from the sides. The surface waves that will get supressed will be less for S band. The use of EBG structure is more useful at higher frequency as the higher frequency will radiate more and the EBG will suppress waves of the radiating antenna.

Return loss at different frequencies with EBG and without EBG

Frequency	*Return loss (dB)without EBG*	*Return loss (dB)with EBG*
2.5Ghz	*-11.53 dB*	*-20.79 dB*
3.0Ghz	*-5.80 dB*	*-0.73 dB*
3.5Ghz	*-8.78 dB*	*-1.17 dB*
4.5Ghz	*-2.61 dB*	*-0.80 dB*
5.0Ghz	*-18.51 dB*	*-8.27 dB*

Fig.7. Comparision between the traditional antenna and antenna with the EBG structure.

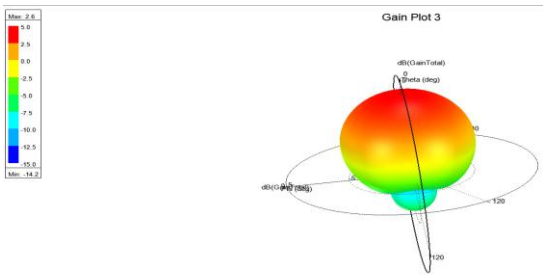

Fig.8.Gain of the traditional Microstrip antenna.

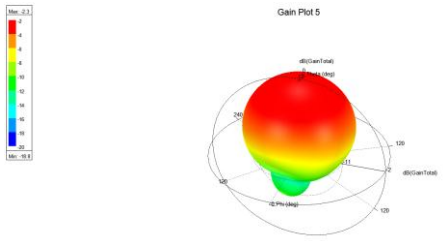

Fig.9. Gain of the EBG based microstrip antenna

The fig 8 and 9 shows the maximum gain at which the antenna radiated

5. CONCLUSION

The microstrip patch antenna with fork like EBG for the S band has achieved. The fork like structures are incorporated on the substrate which supresses the surface waves. From this paper, we have the parameters with respect to S band .The electromagnetic band gap structure has been introduced .This structure can be used at higher frequency which will give more benefits to the antenna.

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