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Frequency Selective Surfaces to Improve the Performance of Fractal Antenna over X Band

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ABSTRACT: Frequency selective surfaces are used with antennas to improve their various parameters like radiation pattern, directivity, gain and bandwidth. These find significant role to improve antenna performance on the higher frequencies. There are different type of FSS screens used according to their shapes there may be variation in response. the FSS screen used is a conventional solid interior type of FSS. The gain is increased all over the X band 8GHz to 12GHz. Significant improvement in the gain is observed.

KEYWORDS: Microstrip, FSS, Wide band

I. INTRODUCTION

Frequency selective surfaces are periodically arranged conducting metal or array which acts as spatial filter either to absorb or reject certain band of frequencies.

Depending on this they are mainly divided as bandpass and Bandstop filters. The principle of working for these is when it acts as Bandstop it is reflecting the waves radiated from the antenna. Which are again reflected back from antenna in turn which induces the effect of gain improvement.

If the bandpass scenario is used we can prevent unwanted frequencies from interference or isolation purpose. There are many applications of FSS as they are tuned with varying their spatial geometry. The basic principle behind the FSS screen is reflection or absorption phenomena. The FSS acts as filters which allow or prevent certain band of frequencies to propagate. For increment in the gain of antenna reflection or prevention characteristic of the FSS is used that contributes to the in phase radiation from the antenna which results in the increment of the gain or directivity. The antenna used is a monopole fractal antenna. It is operating over whole X band .

The gain improvement is depending upon factors like distance of the FSS screen from the antenna , periodicity of the elements of FSS , material used for FSS etc. the gain improvement upto 2 db is considered as significant. In this fractal antenna operating over X band is considered for gain improvement[1]. The gain improvement achieved is about 3.5 db.

II. RELATED WORK

Fractal antennas

The fractal antenna designed is combination of different fractals. The micro strip feeding is used with tapering. The ground is optimized and semi-circular in nature. The substrate material used is FR4 of height 1.6 mm.

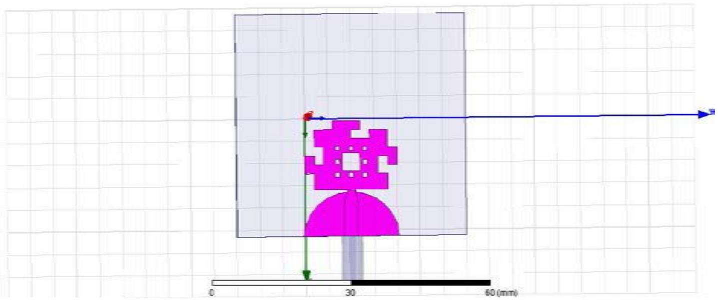

Fig.1. fractal antenna

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Frequency selective surfaces

The frequency selective surface designed is a conventional solid interior type of FSS. The cell size is 16 mm x 16 mm and the periodicity is maintained at 16.5 mm. the cell are placed in order of 5 x 5 or 4 x 4 respectively. The substrate used for the FSS screen is FR4 of height 1.6 mm . the FSS screen is placed over the antenna plane at the distance of half wavelength or quarter wavelength.

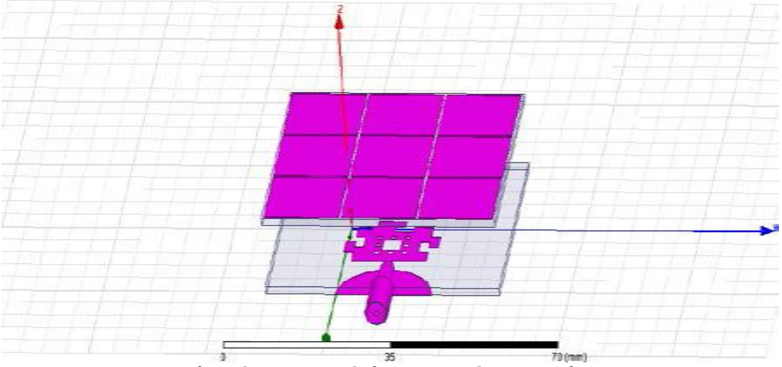

Fig.2. – fractal antenna with frequency selective surface

III. PROPOSED METHOD

Main focus of the work is towards gain improvement of the antenna over the whole X band. To achieve this FSS with band rejection characteristics is to be designed. As it will reflect the waves in phase the gain improvement can be achieved.
To fulfill this very purpose we need to suspend the FSS screen over the antenna. As the distance of the screen plays a very vital role in the gain improvement we need to optimize the distance by observing and testing the same on different heights from the plane of the antenna. For designing we have to focus on the band rejection criteria of the FSS which gets reflected by the reflection coefficient of the FSS screen. The region where it is having the highest reflection can be used for those band of frequencies. As we are working on the X band it is designed with that band rejection characteristics over the same band.
The analysis of the FSS screen is done by plane wave excitation method. The FSS screen is applied with plane wave at both the ends and the transmission and reflection coefficients are compared for the reflection area where the gain increment is actually possible. The simulation setup is shown in fig. 3 below FSS screen is excited by planes waves on both the sides to see the effect. The observation noted are reflection coefficient and transmission coefficient.

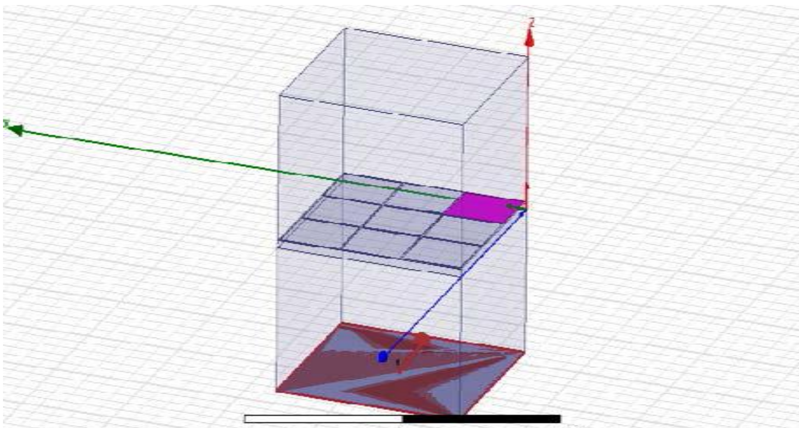

Fig.3. – plane wave analysis of frequency selective surface.

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For analysis of antenna gain with effect of FSS we have to arrange the FSS on the top of the antenna with observations at different heights. The effect of the reflection of the waves from the FSS towards antenna surface gives the extent upto which we can enhance the gain of the antenna. Fig 2 above shows the same arrangement for their placements.
For simulation purpose two EM simulators are used here namely HFSS and CST MWS which gives results which can be compared for more accuracy. The practical measurement needs VNA setup which gives more accurate and real time results of the same.

IV. SIMULATION RESULTS

Simulation of the antenna and FSS basically focuses on observing basic criteria of the same.as antenna is mainly observed for return loss which shows its band of operation and secondly most important is the parameter which we need to enhance is the gain of the antenna, both the results are produced. The antenna gain is simulated for both the cases with the FSS and without FSS, which clearly shows the enhancement in the gain of the antenna.

Secondly the FSS is also simulated for the observation of band of interest for enhancement of the Gain of the antenna.

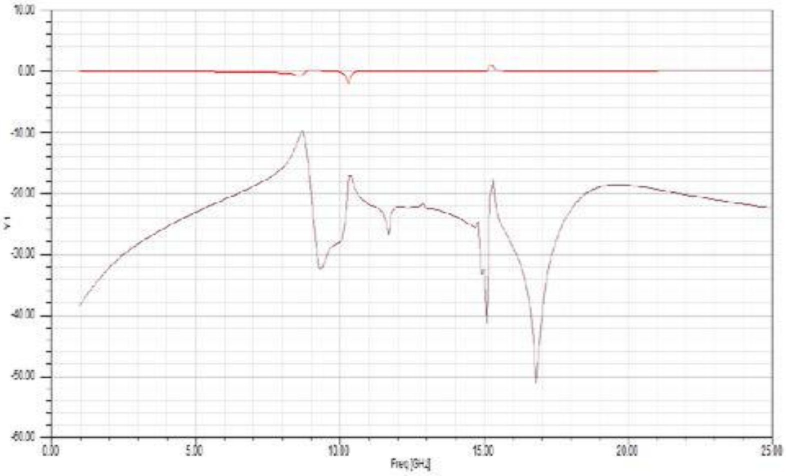

Fig.4. – comparison of transmission and reflection coefficients of FSS(red trace is reflection)

The area where transmission is lowest and reflection is more is the area of interest. In fig 4 above the analysis result the total X band is covered under the area of interest it means it can be used to increase gain at that band.

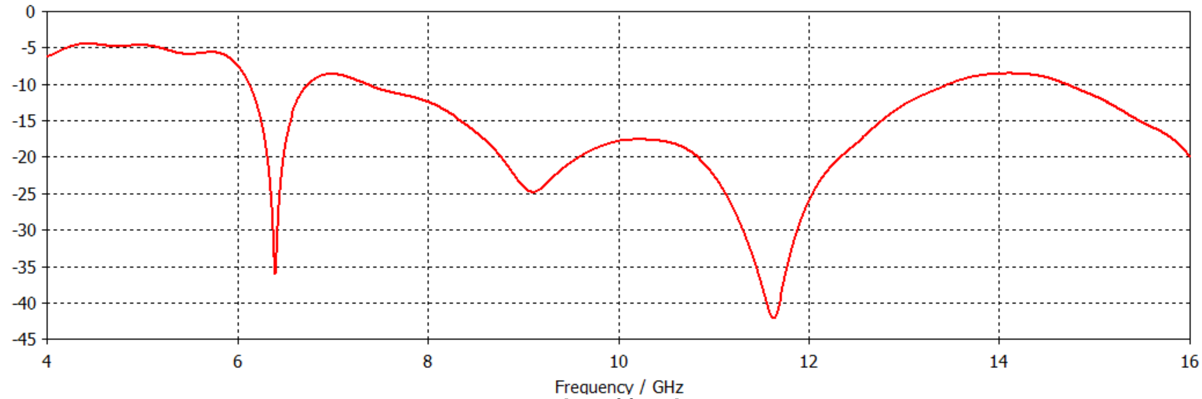

Fig.5.- return loss of fractal antenna

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The return loss of the antenna with and without the FSS screen is nearly same contains all the X band. In the above fig. 5 we can observe that reflection coefficient remains below magnitude of -15 db. The antenna below -10 db of reflection characteristics shows operation over those particular band of frequencies. Here it is operating for whole X band.

In fig.6 below we can see the gain of the antenna with and without the FSS screen is also compared there is increment of about 2 db at least all over the operating band. At some frequencies it is 3.5 db. The gain tend to increase on the higher frequency side of the operation.

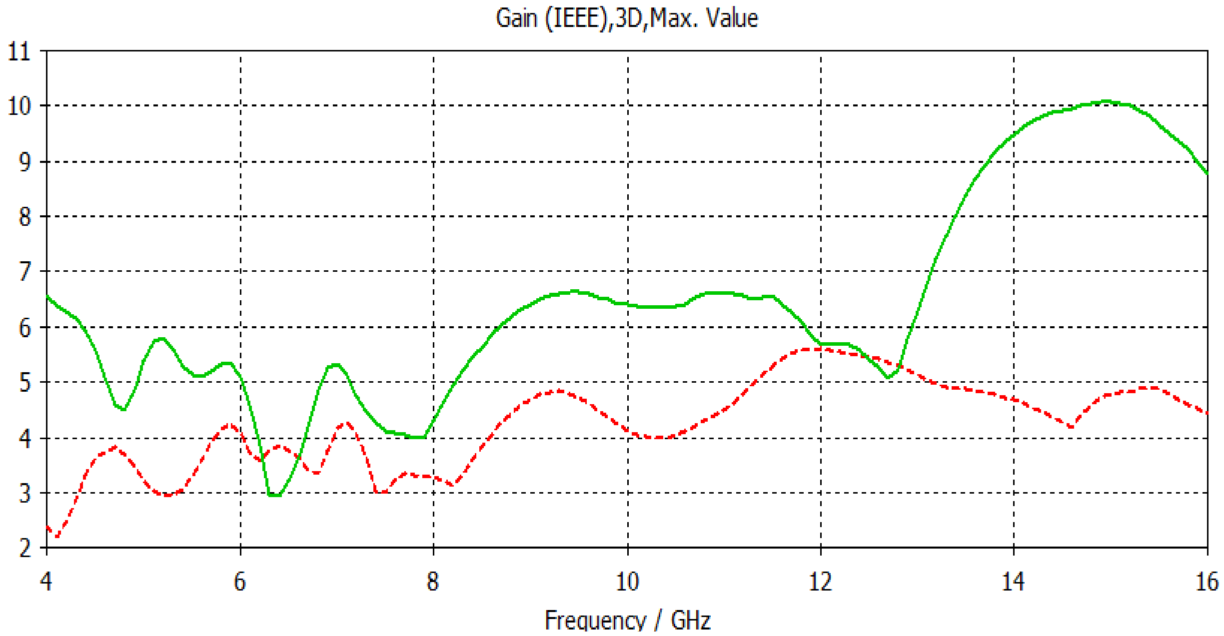

Fig.6.- peak gain of fractal antenna with and without FSS. The dashed curve shows gain of the antenna without FSS.

V. CONCLUSION AND FUTURE WORK

The frequency selective surfaces reduces or suppresses the surface wave effect which results in improvement in the performance of the antenna. The gain of the antenna can be increased by the use of the frequency selective surface. These generally shows gain enhancement at higher frequency ranges. These make frequency selective surfaces significant for the performance improvement of the antenna.

The future work is in optimization of the size of the FSS elements and their operating ranges for various antennas. The second main aspect is to optimization of the gain parameter of the antenna by balancing the other parameters of the antenna.

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BIOGRAPHY

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