DESIGN A FSS USING JERUSALEM CROSS STRUCTURE AS A BSF FOR SATELLITE APPLICATIONS AT 10GHz

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ABSTRACT

In this paper we present how to design FSS as a Band Pass Filter (BPF) or Band Stop Filter (BSF). Filter is used to pass the desired frequency and block the undesired frequency. "FSS stand for Frequency selective surface have a property that it reflects plane wave in-phase" and suppress the surface waves. FSS can be used as a filter, reflector, polarizer, absorber, etc. Here we designed FSS which is acts as a Band Stop filter, which operate at 10GHz resonant frequency. This type of filter can be used for satellite applications, radar and biomedical. For the analysis of band stop filter transmission and reflection coefficient can be obtained with the help of Ansoft Designer tool. This type of filter design can improves the certain parameters like VSWR, gain, efficiency, return loss in antenna.

Keyword: - *Periodic Structure, Filters, FSS, and Ansoft Designer 4.0 etc….*

1. INTRODUCTION

Periodic structures is an assembly of element which are identical are arranged in such a manner that it create one dimensional or two dimensional array. Periodic array can be excited by the two methods, (1) By an incident plane wave, (2) individual generator connected to each element. FSS has a property that it reflects plane wave in phase and suppress the surface wave. FSS have been used in radio frequency region of EM spectrum, can be used as a reflector, polarizer, absorber, filter, etc. Here we are used FSS as a filter. The advantage of using double dipole FSS is that reduce the size of antenna, by replacing filter and application as diverse the aforementioned microwave oven, antenna and modern meta materials.

A filter is a device that passes electric signals at certain frequencies or frequency ranges while preventing the passage of others. Filter circuits are used in a wide variety of applications. In the field of telecommunication, band-pass filters are used in the audio frequency range (0 kHz to 20 kHz) for modems and speech processing. In our work, periodic structure is used as band stop filter. Here the oldest element Jerusalem cross structure is sandwich between the two dielectric.

All the simulation have been perform using Ansoft Designer tool 4.0.

1.1 Theory of Periodic Structure

Periodic structure are easy to understand difficult to design, because if we simply change the frequency for different application. We have to deal with the variation of angle of incidence and polarization.

"Angle of incidence of the periodic structure is inversely proportional to the bandwidth". When the frequency changes, transmission and reflection curve will also changes.

In case of passive array, the incident plane wave will partially transmitted in the forward direction (E^t) and partly reflected in reverse direction (E^r). Under resonance condition, grating lobes will be zero.

1.2 Design Equations

Under resonant condition and for no grating lobes the amplitude of the reflected signal may equal E^i while E^t =0. It is customary to define the specular reflection coefficient as

$$\Gamma = \frac{E^r}{E^t}$$

Where E^r and E^t in general are referred to the plane of the array. Similarly the transmission coefficient is defined as

$$T = \frac{E^t}{E^i}$$

Length of dipole is given by $L = \frac{\lambda}{2}, \frac{\lambda}{4}$. And the gapping between two dipole $g = \frac{\lambda}{20} = \frac{0.4c}{f_r}$, c is speed of light.

2. Unit cell of FSS using Jerusalem Cross structure

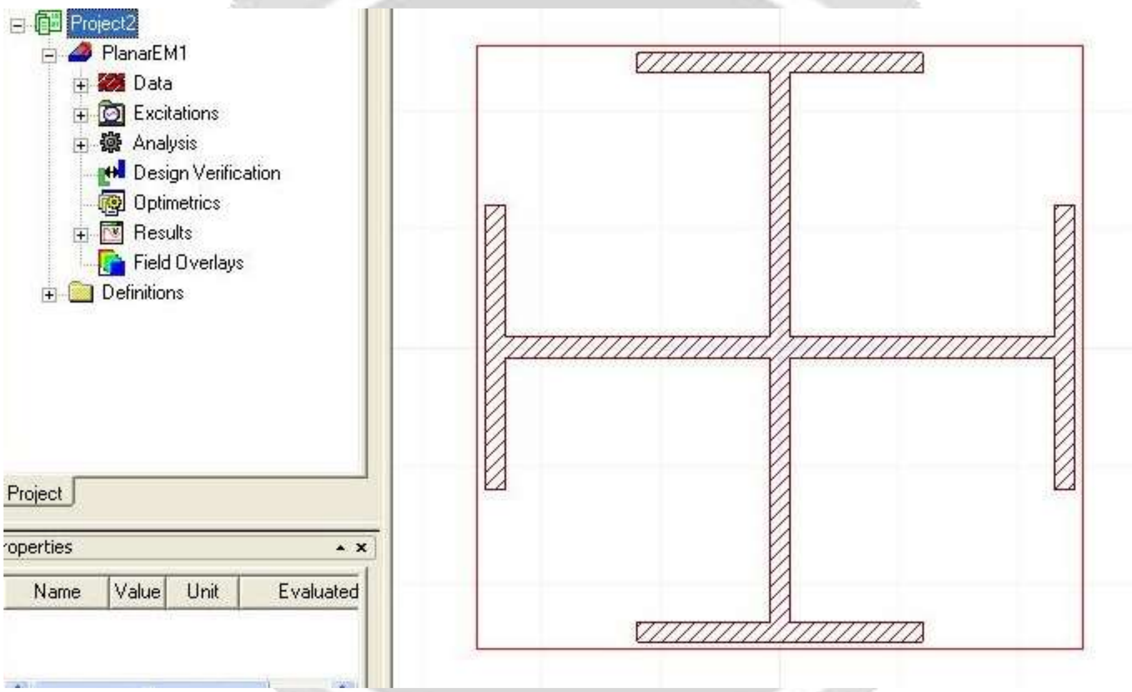

Fig -1: Front view of FSS layer using Jerusalem Cross

Unit cell of FSS using Jerusalem cross structure on Ansoft Designer. In designing of Jerusalem cross FSS structure two horizontal and vertical I section are used. FSS has three layer structure, means the conducting sheet which is excited by plane wave excitation is sandwich between the two dielectric material has dielectric constant d_1 and d_2 =2.2. As we know in Band Stop filter, a microwave filter is a two-port network which is used to control the frequency response at a certain point. Here maximum transmission in pass band and maximum attenuation in stop band.

All the curves are shown at 45˚ angle of incidence for orthogonal and parallel polarization, which resonant frequency around 10GHz E_r =2.2 dielectric slab placed on both side. Dielectric material of filter d_1 layer and d_2 layer is used.

As we know the analysis of FSS is based on Transmission coefficient (S_{21}) and Reflection coefficient (S_{11}). At the resonant frequency the value of transmission coefficient is made large in negative and the value of reflection coefficient be in the range of 0 to 1. In band stop filter absorption is 90% and the transmission is 10% at the resonant frequency.

2.1 Simulation

On the basis of mathematical calculations and from the theory of FSS model we create a double I section among many of designs of FSS i.e. Jerusalem cross. Here the length and width of the double I sections can be calculated as by the given formulae:

Length of dipole is given by $L = \frac{\lambda}{2}, \frac{\lambda}{4}$

Where $\lambda = \frac{c}{f}$, and c is speed of light, and f is operating frequency.

Here we can easily analyze the band stop characteristics of band stop filter as the dip occurs almost equal to the center frequency, where the transmission and reflection coefficient value can be calculated. The two layers are used of different width which are one is trace with 40mil thickness and upper elevation is of 0.1016cm and, other one is trace of copper whose type is signal and of 0mil thick, 20mil lower elevation and 20mil upper elevation.

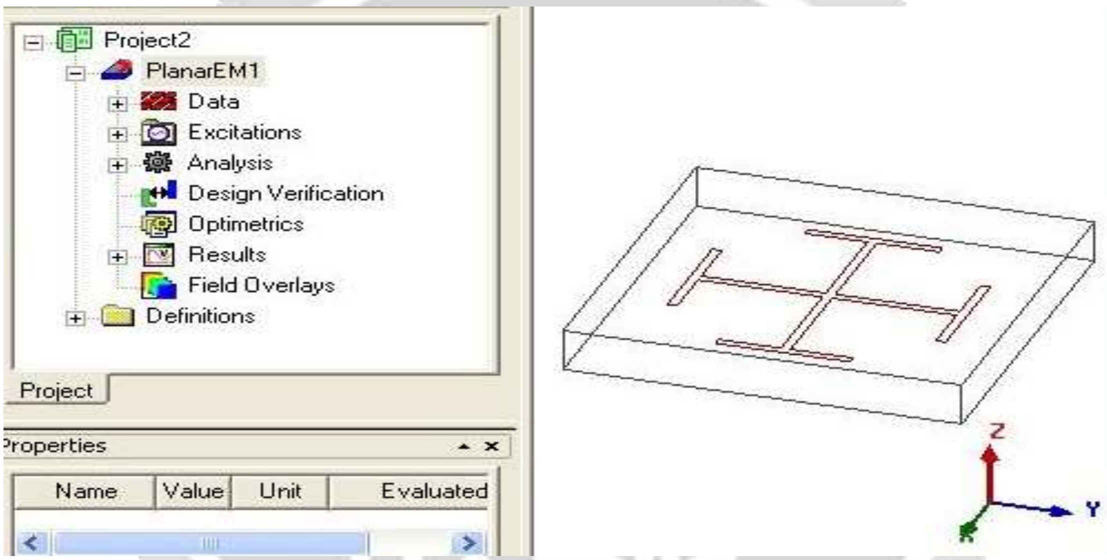

Fig -2: 3D View of FSS layer using Jerusalem Cross act as a BSF

2.2 Parametric study and result obtained

Parametric study after calculating by the help of formulae and design implementation is given is the form of table as: Here Length $_d$ is the length of FSS layer and width $_d$ is id width of FSS layer. And the total length and width is 2.12cm. The infinite array setup is given at theta=45˚ and phi=90˚.

Table -1: Parametric Study

S. no	Parameter	Value	Co-ordinates
1	Length $_d$	2.12cm	Center(-1.06,0)
2	Width $_d$	0.13cm	Center(0,-0.65)
3	Plane wave excitation	Theta=45˚, phi=90˚	
4	Length	2.12cm	
5	Width	2.12cm	
6	Dielectric 1	RT Douroid 5880tm (2.2)	
7	Dielectric 2	RT Douroid 5880tm (2.2)	
8	Transmission coefficient (T)	-40.6622	
9	Reflection coefficient (Γ)	-0.0527	

3. RESULTS

The plot shown in figure is a plot between transmission and reflection coefficient versus frequency. For the band stop filter the reflection coefficient is nearly zero which shows the perfect attenuation is obtained and the transmission coefficient which shows that at this point transmission is minimum. The obtained reflection coefficient in this simulation is -0.0527 at resonant frequency of 10GHz and the transmission coefficient is given as -40.6622 which shows the perfect impedance matching at that point.

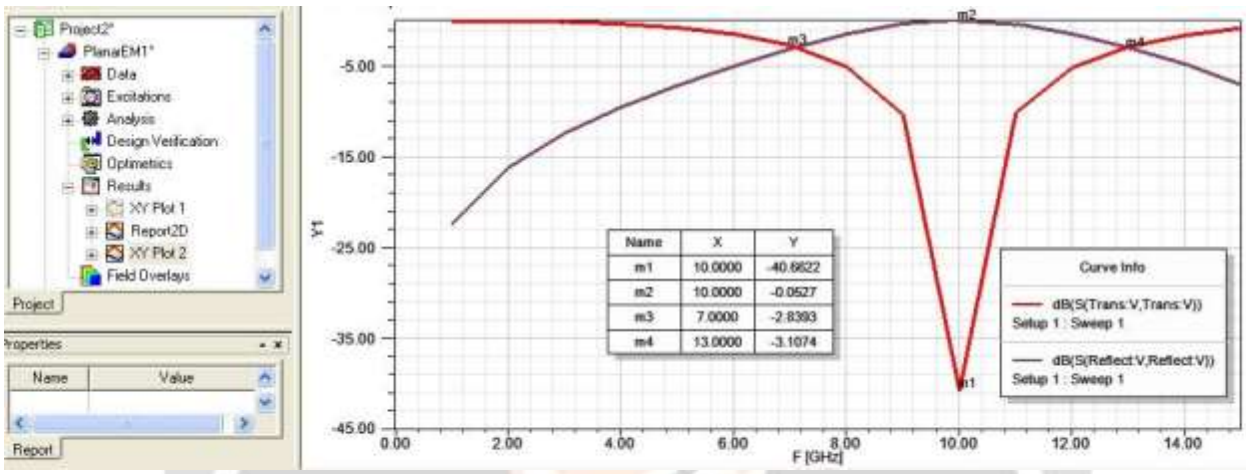

Fig -3: Transmission and Reflection coefficient plot

This is the graph of transmission coefficient and reflection coefficient. The resonant frequency is 10GHz and we know bandwidth = $f_H - f_L$, it means 6GHz operating bandwidth.

4. CONCLUSIONS

In this paper, we describe the designing procedure of FSS using Jerusalem cross structure, that can be used as a Band Stop filter at 10GHz resonant frequency. This is used for X-Band applications like biomedical and satellite application. The analysis of transmission and reflection coefficient is made by Ansoft Designer. This type of filter can be used to improve certain parameter of antenna like antenna Gain, VSWR, Return loss and Efficiency. If we change the angle of incidence the bandwidth of filter will change. FSS can be used as substrate or superstrate to improve the result of antenna can design of filter be miniaturized.

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