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Design of Compact Frequency Selective Surface (FSS) by Loading Slits and Slots

Dhiman Biswas, Nilesh Mukherjee, Partha Pratim Sarkar

Abstract- ***This paper deals with the theoretical investigation on a reduced sized Frequency Selective Surface (FSS). The FSS is designed by loading slit and slot into square patch. It has been observed, how the variation of the dimension of the slot and slit results in shifting of resonant frequency . Compared to conventional square patch FSS the designed FSS can provide reduction in resonant frequency resulting in size reduction up to 87% corresponding to resonant frequency of 2.44 GHz..Theoretical investigations have been done by Ansoft Designer® software.***

Keywords: Frequency Selective Surface, Size Reduction, slot. slit

I. INTRODUCTION

Frequency selective surfaces (FSSs) are the wireless counterpart of electrical filters. A two dimensional array of metallic patches on a dielectric slab or that of distance slots within a metallic screen constitutes a frequency selective surface (FSS) for electromagnetic waves in microwave engineering[2]. In literature two generic geometries are typically discussed. The first geometry, commonly referred to as a aperture type FSS, performs similarly to a band-pass filter. The second case, the patch type FSS, performs similarly to a band-reject filter[1]. If the periodic elements within an FSS possess resonance characteristics, the aperture type FSS will exhibit total transmission at wavelengths near the resonant wavelengths, while the patch type FSS will exhibit total reflection. They are used in various applications, such as band pass radomes for radar; sub reflectors for dual frequency reflector system microwave, optical and infrared filters etc[1]. FSS structures are basically analyzed by three methods - Finite Difference Time Domain (FDTD) , Finite Element Method (FEM) and the Method of Moment (MoM)[3]. Here in this paper, the proposed FSS structure have been analyzed theoretically by Ansoft Designer® software which based on MoM.

II. DESIGN OF FSS

The reference patch is a two dimensional metallic copper patch of 30mmx30 mm as shown in fig.1

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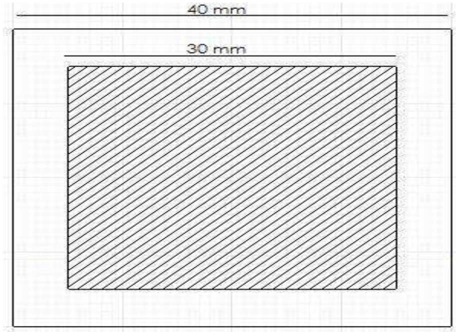

Fig1.FSS with reference patch

The patches are considered to be present on one side of a thin dielectric slab of glass PTFE having relative permittivity of 2.4 and thickness of 1.6mm . Periodicity is taken 40 mm both in x and y-directions. The dimensions are shown in the fig1.

The following proposed designs of FSS are obtained by loading circular shaped slot with radius 2 mm at centre (12,3) and six slits at various positions . The dimensions of the proposed designed FSS are shown in Fig.2.

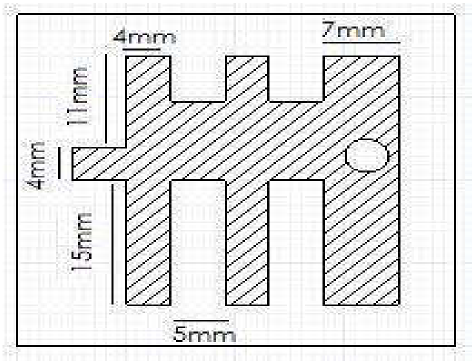

Fig2. FSS with proposed first design

Three slits of dimension 5.5 mm x 5 mm, 5.5 mm x 5 mm and 11mm x 5mm(at left most edge of upper part) have been loaded in the upper part and three slits of dimension 11 mm x 5 mm (at left most edge of lower part) ,15 mm x 5 mm,15 mm x 5mm have been loaded in the lower part.

Now, we are modifying the design by omitting the slot and compresed the structure and the design becomes as follows

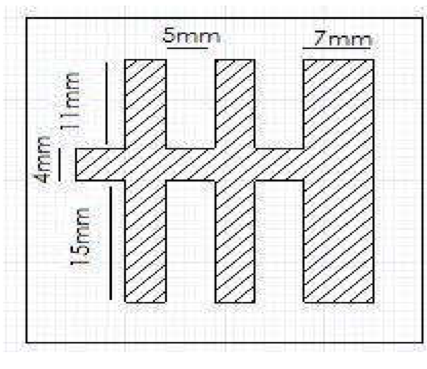

Fig3.FSS with proposed second patch

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The loading positions of slits remain same but their dimensions have been changed three slits of dimension having 11mm x 5 mm (at left most edge of lower part) and three slits of dimensions having 11mm x 5 mm have been chosen. Now, the dimensions of the slits have been kept and the only change is that a circular slot of radius 2 mm at the center (12,3) has been loaded. The structure becomes as follows

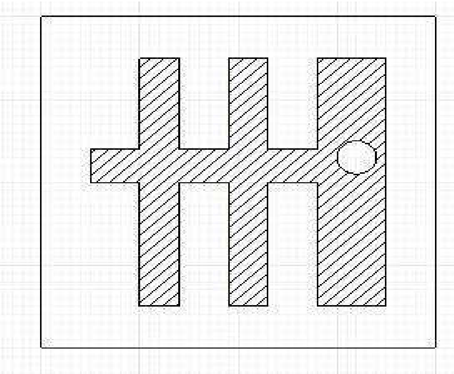

Fig4.FSS with proposed third patch

Finally, keeping the dimensions of the slits same, the location of the 2 mm radius circular slot)is shifted left at center(-8,1).

The design of the final model looks like as follows

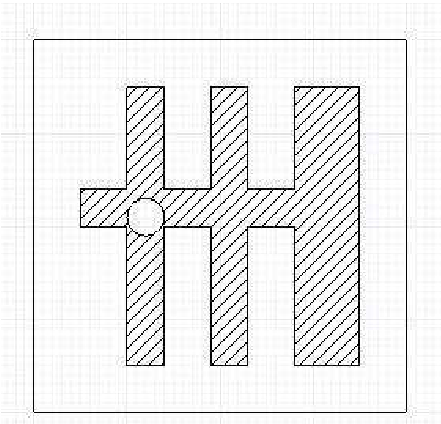

Fig5. FSS with proposed fourth design

III. RESULT

Computed transmission characteristics for reference patch [fig.1] using Ansoft is plotted in Fig.5, which shows that the FSS resonates at 6.73GHz considering the first frequency band.

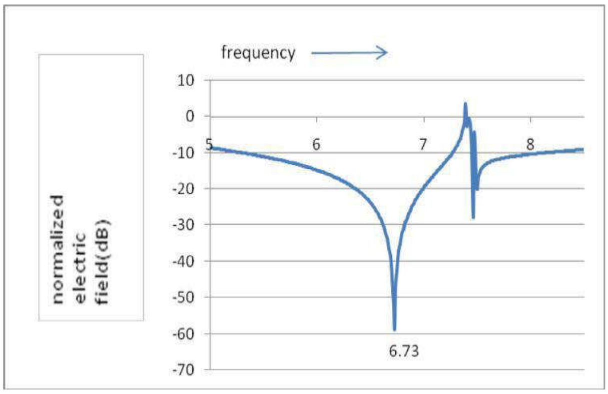

Fig.6 Transmission Characteristics of reference FSS (corresponding to Fig.1)

Computed transmission characteristics for proposed FSS [fig.2] using Ansoft is plotted in Fig.6,which shows that the Fss resonates at 2.78 GHZ and it is needed to measure the compactness of the structure with respect to the reference patch. The required perimeter for the modified FSS is 291.552 mm. The side of the new square patch is 72.88 mm and the percentage of size reduction

$[(72^2-30^2)/72^2]$=83% (approx).Here it is considered only the first resonating frequency.

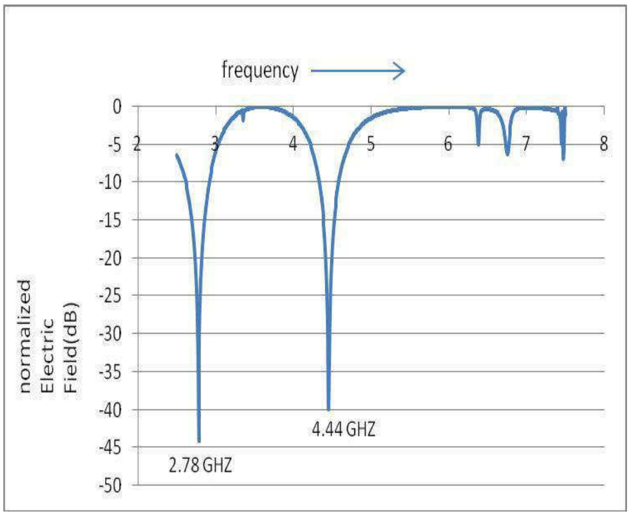

Fig.7 Transmission Characteristics of proposed FSS (corresponding to Fig.2).

Computed transmission characteristics for proposed FSS(fig.3) using Ansoft designer® is plotted in Fig.7, which shows that the FSS resonates at 2.46 GHZ and the 86.63% Size reduction has been achieved.

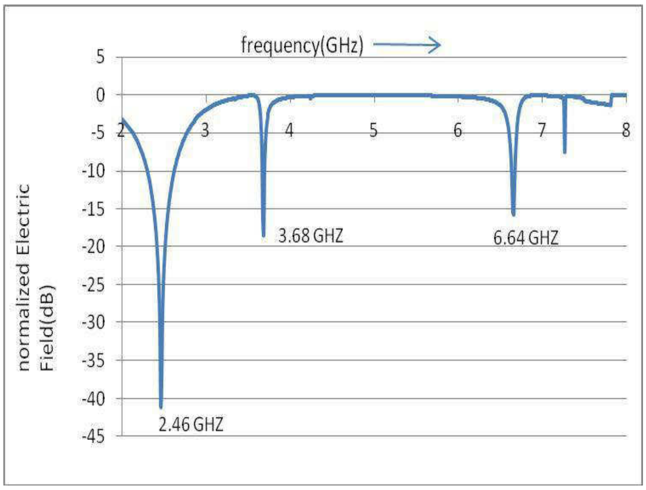

Fig.8 Transmission Characteristics of proposed FSS (corresponding to Fig.3).

Computed transmission characteristics for proposed FSS [fig.4] using Ansoft designer® is plotted in Fig.8, which shows that the FSS resonates at 2.46 GHz and the 86.63% size reduction is being achieved.

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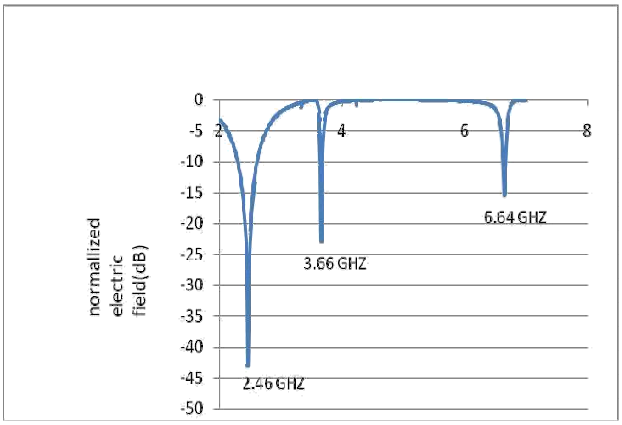

Fig.9 Transmission Characteristics of proposed FSS (corresponding to Fig.5)

Computed transmission characteristics for proposed FSS [fig.5] using Ansoft designer® is plotted in Fig.9, which shows that the FSS resonates at 2.44 GHz considering the first resonating frequency and the 87% size reduction has been achieved.

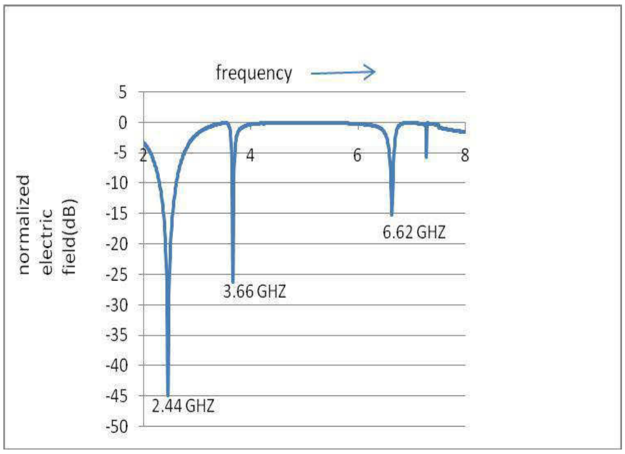

Fig.10 Transmission Characteristics of proposed FSS (corresponding to Fig.5)

Now the results which we are measured theoretically are manipulated in the tabular form. The table is Summarized Results of size reduction of the patches.

TABLE: 1.

S.L No.	Designed FSS	Resonating Frequency in GHZ	Size Reduction
1.	Reference patch	6.73 GHZ	-------------
2.	Proposed first patch	2.77 GHZ	83%
3.	Proposed second patch	2.46 GHZ	86.63%
4.	Proposed third patch	2.46 GHZ	86.63%
5.	Proposed fourth patch	2.44 GHZ	87%

IV. CONCLUSION

All the designs proposed in this paper can be implemented as band pass filter having less than -10dB transmission gain, in microwave engineering. By loading various dimension slits and a fixed radius slot (in case fig.2, the slot is not taken), it is observed that the design are being compact with respect to reference patch. In final design the center of the 2 mm radius slot is changed from (12,3) to (-8,1), the final size reduction of 87% is got. The structure works in S band. The main focus is to increase the compactness of the patch

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