

A Compact Frequency Selective Surface with Multi Frequency Operation

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Abstract

This paper deals with the theoretical investigation on multi-band Frequency Selective Surface (FSS). The FSS is designed by cutting different slots into square shaped patch keeping same periodicity throughout. Compared to conventional square patch FSS, the designed FSS can provide reduction in resonant frequency resulting in size reduction up to 90%. The multiple (four) resonating frequencies have been obtained with the help of this design. Theoretical investigations have been done by Ansoft Designer® software.

Keywords: Frequency Selective Surface, Method of Moment, Slot, Size Reduction, Resonating Frequency.

I. INTRODUCTION

An array of periodic metallic patches on a substrate, or an array of slots within conducting sheet periodically, forms a frequency selective surface to propagate electromagnetic waves. Such structures have been well known in antenna theory for over half a century. At microwave wavelengths, such structures were easy to manufacture and employ in antenna design. Literally two generic geometries are typically discussed [1]. The first geometry, commonly referred to as an inductive FSS, performs similarly to a high-pass filter. The second case, or capacitive FSS, is similar to a low-pass filter. If the periodic elements within a FSS possess resonance characteristics, the inductive FSS will exhibit total transmission at wavelengths near the resonance wavelength, while the capacitive FSS will exhibit total reflection [1]. Frequency selective surfaces which find widespread applications as filters for microwave and optical signals have been the subject of extensive studies in recent years. These surfaces comprise of periodically arranged metallic patch elements or aperture elements within a metallic screen [5] and exhibit total reflection (patches) or

transmission (aperture) in the neighborhood of the element resonance [2]. FSSs are widely used in wireless communication system. They are often employed in the reflector antenna system of a communication satellite [2] or deep space exploration vehicle for multi frequency operations.

Here in this paper the proposed FSS structure has been theoretically analyzed by Ansoft designer® software.

II. DESIGN

The FSS structure consists of two dimensional arrays of patches. The arrays of metallic patches are aligned on the top of a glass PTFE substrate of dielectric constant 2.8 and thickness 1.6mm in the conventional FSS structure as shown in fig.1. Each patch size is 20mm X 20 mm as shown in fig 2. Periodicity is taken 23 mm X 23 mm for constructing the array of patches.

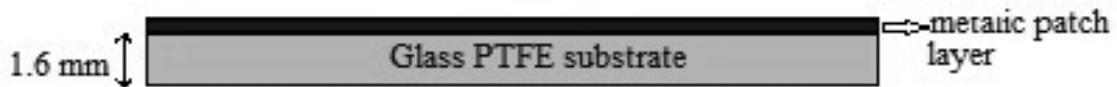


Figure 1: Layered structure of the conventional FSS

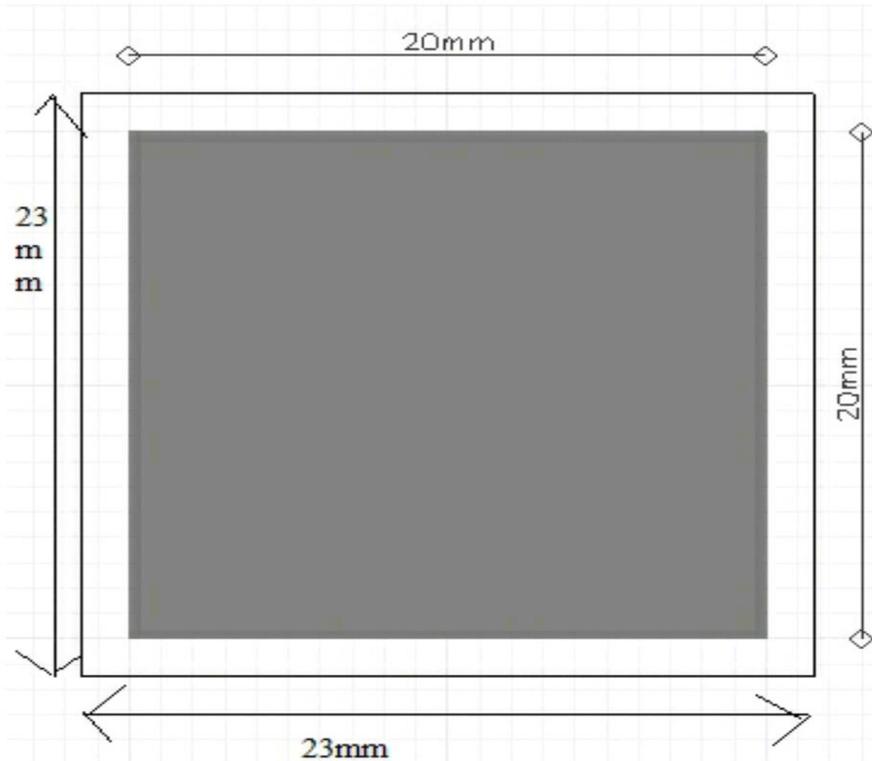


Figure 2: Unit cell of conventional FSS structure

Now we design the modified FSS array by etching out different slots of specific line width and line gap from the square patch element as shown in fig. 3. Periodicity is taken 23mm both in x and y-directions as shown in fig 4.

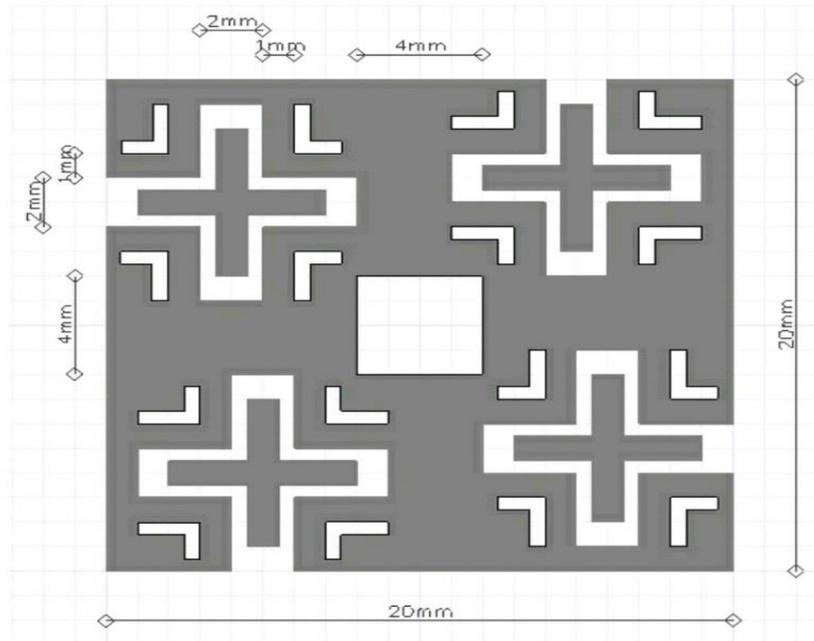


Figure 3: Unit cell of the proposed FSS structure

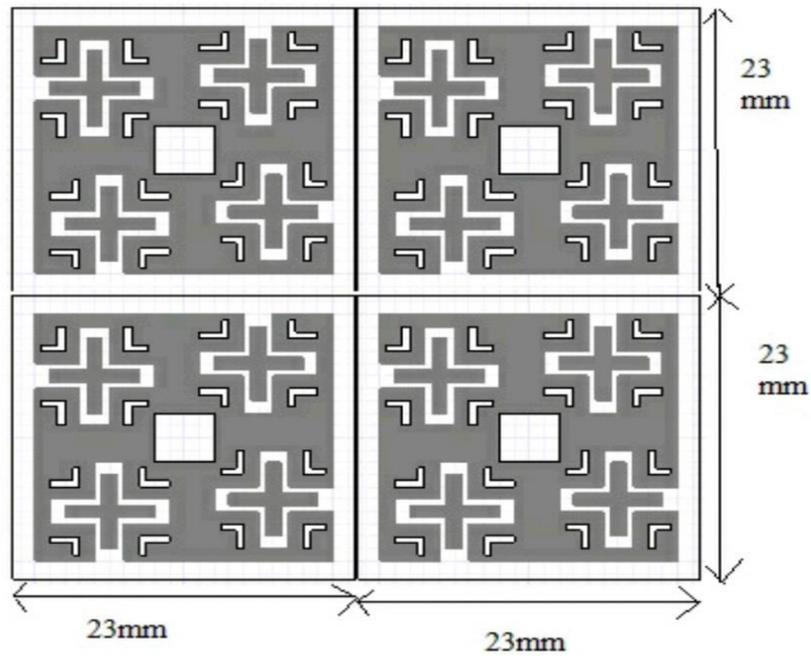


Figure 4: Two dimensional arrays of patches with different slots

III. RESULTS & DISCUSSIONS

Computed transmission characteristics for reference patch [Fig.2] using Ansoft Designer® is plotted in Fig.5, which shows that the FSS resonates at 11.19GHz while considering the first frequency band.

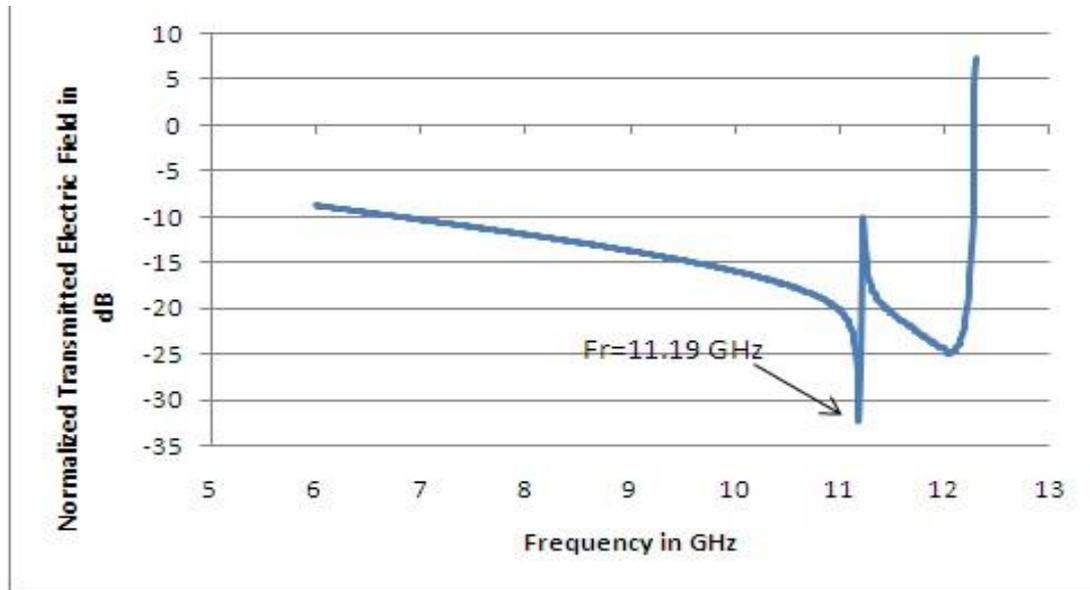


Figure 5: Study of normalized transmitted electric field vs. frequency (corresponding to FSS of Fig.2)

Computed transmission characteristics for proposed FSS [Fig.3] using Ansoft is plotted in Fig.6, which shows that the FSS resonates at 3.54 GHz while considering the first frequency band. Before designing the FSS with proposed grid, the first resonating frequency is obtained at 11.19GHz [Fig.5]. To obtain the resonating frequency at 3.54 GHz it would require the area of the patch is 1300.76 mm² approximately. The area of the reference patch is 130.114mm² (approx). So the size reduction of $[(1300.76-130.114)/ 1300.76]*100\% =90\%$ (approx) has been achieved with the help of this proposed design.

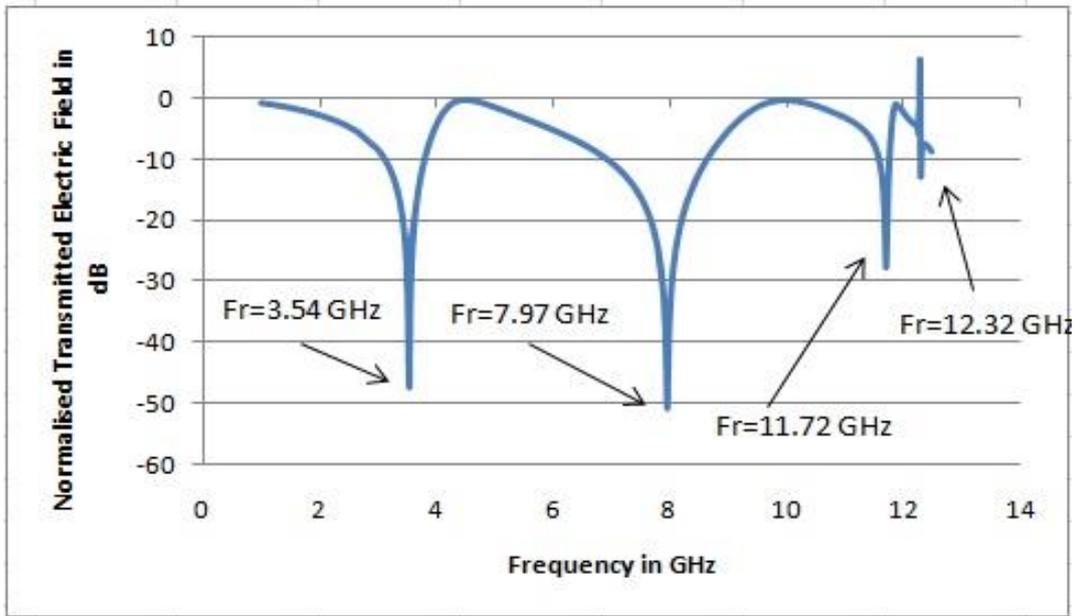


Figure 6: Study of normalized transmitted electric field vs. frequency (corresponding to FSS of Fig.3)

In the modified FSS multiple resonating frequencies have been obtained. The resonant frequencies with bandwidth and percentage bandwidth have been shown in tabular form.

Table 1: Summarized Results

Sl. No.	Design of FSS	Resonating Frequency (in GHz)	Band width (in GHz)	Percent age bandwidth
1.	Patch without slot (fig2)	11.19	5.47	48.89%
2.	Patch with slot (fig3)	3.54	0.68	19.21%
		7.97	1.68	7.97%
		11.72	0.18	1.53%
		12.32	No Band	No Band

CONCLUSION

In this paper, a single substrate layer with single metallic plane frequency selective surface was proposed. As the relative permittivity of the air and the PTFE substrate are different from each other, a part of the wave energy is reflected at the surface. This design also gives a huge compactness about 90% (approx) with the resonant frequency of 3.54 GHz and this design is useful for different S, C, J, X & Ku-band applications in satellite communication & various microwave related communication purposes.

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