ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 7, Issue 2, February 2018

Miniaturized Dual Band Frequency Selective Surface Suitable for C and S Band in Satellite Communication

Snehasish Saha, Sourish Chaterjee, Raju Basak

***Abstract*— A theory based investigation on a dual band frequency operation of a single layer Frequency Selective Surface (FSS) is being presented throughout this paper. Easy manufacturing cost and a little dependency on the polarization of the waves are the key factors of this study. The patch type FSS is proposed by arranging the unfamiliar shaped metallic (Cu is selected as metal) square patches periodically on the dielectric sheet (Fr4- Epoxy). The proposed FSS provides a compactness of 91%. The structure exhibits as a dual band reject filters at C and S band of frequency with a band ratio about 2. The theoretical investigation is simulated by HFSS software, provided by ANSYS group.**

***Index Terms*— Frequency selective surface, Resonating frequency, Band Ratio, Compactness, Band reject filter.**

I. Introduction

An array of periodic metallic patches [1] on a di- electric slab, or a conducting sheet periodically perforated with apertures act as a frequency selective surface (FSS) [2] in the field of electromagnetic waves. Researchers in the communication field have been provided their great attention on this subject for over half a century. On basis of design, the FSS are defined in two types: patch type which is acted as band-stop filter whereas aperture type, acted as band-pass filter. FSS is widely used in case of various types of microwave device like Rader, Transponder in satellite communication etc [3- 5]. By providing different types of geometrical slots in patch type FSS its resonant frequency can be decreased, which effects in its compactness. Introducing slots in the patches also increases the operating bandwidth of the system. So a theoretical simulation process may help to investigate the frequency characteristics (normalizing transmission characteristics) of the FSSs. Basically three mathematical methods are used to analyze the characteristics of FSS: Finite Difference Time Domain (FDTD) method, Finite Element Method (FEM), and Method of Moment (MoM) [6].

A single layer patch type frequency selective surface is being proposed throughout this paper. The FSS has dual stop band characteristics with the resonating frequencies at 3.37 GHz and 7.3 GHz with an observable percentage of bandwidth and good band ratio. Insertion frequencies which have insertion loss more than 10 dB in FSS characteristics are determined as stop band frequencies (it is why the -10 dB line is defined as a reference line in the simulated characteristics and showed as a firm line). The FSS should very much usable in satellite communication through C and S band of frequency. The proposed design of the patch is achieved by couple of modifications of square shaped reference patch. The simulated transmission characteristics for all steps of modification are investigated.

II. Design

The single layer FSS structure is formed by of two dimensional metallic square patches. Size of reference patch in every unit cell is 20mm×20mm. with a periodicity of 25mm along X and Y- axis direction both. FR4-Epoxy is used as di-electric substrate material (relative permittivity 4.4). Width of di-electric material is 1.6 mm. Reference patch (unit cell design) is shown in Figure 1. These patches are designed in any either side of dielectric sheet. From the theoretical analysis of transmission characteristic using Ansoft software, resonant frequency has been got at higher frequency (10.36 GHz).

To achieve the resonating frequency at a lower range, a circular slot (with radius of 9mm) is introduced inside the square patch. The dimension of patch and the periodicity are maintained same as reference patch. Figure 2 shows the unit cell contains square patch with a circular slot. This design is further modified and another smaller patch with same shape is introduced into the circular slot to obtain dual stop band transmission characteristics. The proposed design is shown in Figure 3. Figure 4 shows 3×3 array prototype of our proposed design unit cell.

Authors:

1. *Snehasish Saha, Asst. Professor, ECE Dept., Ideal Institute of Engineering, Kalyani, India*
2. *Sourish Chatterjee, Asst Professor, ECE Dept., Ideal Institute of Engineering, Kalyani, India*
3. *Dr. Raju Basak, Principal , Ideal Institute of Engineering, Kalyani, India*

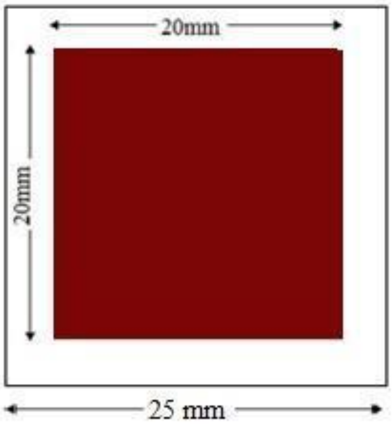

Figure 1 Unit cell of reference patch

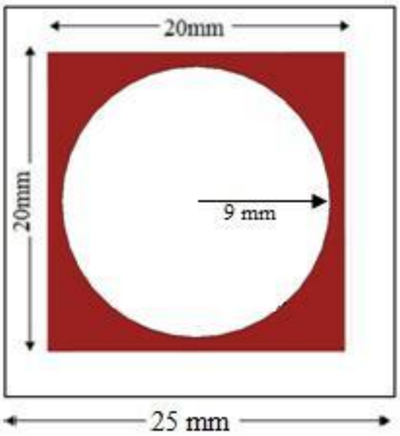

Figure 2 Unit cell of circular slotted square patch.

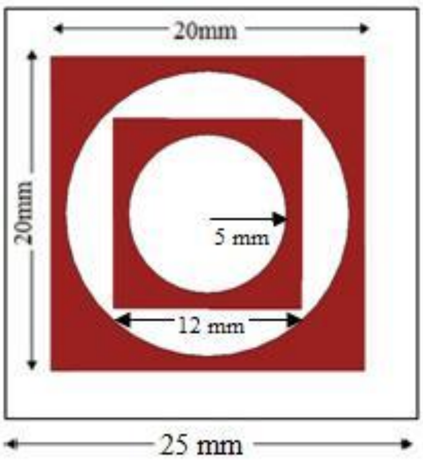

Figure 3 Final proposed FSS unit cell

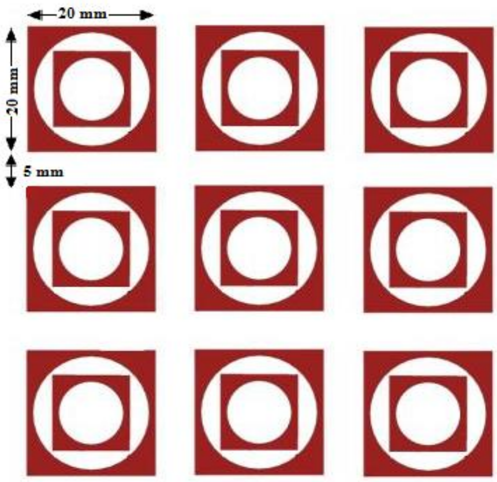

Figure 4 3×3 array prototype of proposed FSS unit cell

III. SIMULATED RESULT ANALYSIS

Normalized transmission characteristics after simulating the reference patch (Figure 1) are shown in Figure 5. The resonant frequency is achieved at 10.36GHz with 50.19 percentage of bandwidth. To increase the compactness of the design, a circular slot is introduced inside the square patch, 1st modified design. Figure 2 shows the 1st modified design. Figure 6 shows the normalized transmission characteristics of the said patch design. It resonates at 3.97GHz and about 90 percentages of compactness is achieved. The normalized transmission characteristics of our proposed design are shown in Figure 7. Dual stop band are achieved at 3.37 GHz and 7.3 GHz with 18.6 and 27.1 percentages of bandwidth. The band ratio is 2.16, enough to overcome the adjacent channel interference problem. All of the simulation processes are done in HFSS simulator and -10 dB line is considered as reference level. The frequency band with normalized transmission coefficient below -10 dB is treated as stop band. The simulated results are enlisted and shown in Table 1 to observe the improvement of transmission characteristics with modification of design.

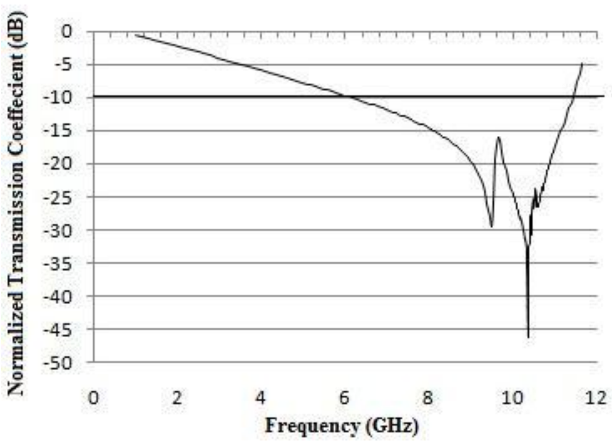

Figure 5 Normalized transmission characteristics (simulated) of reference patch

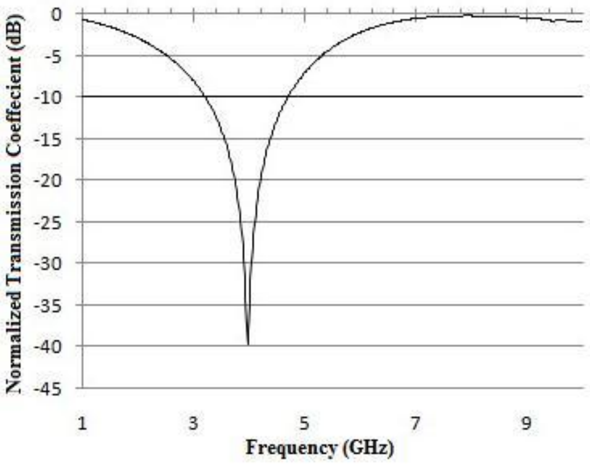

Figure 6 Normalized transmission characteristics (simulated) of 1st modified design

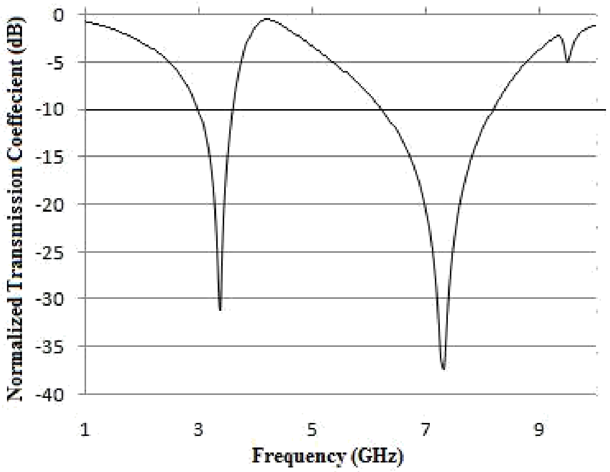

Figure 7 Normalized transmission characteristics (simulated) of final modified unit cell

FSS Design	Resonating Frequencies (GHz)		Percentage Bandwidth (GHz)		Size Reduction
	Band 1	Band 2	Band 1	Band 2	
Reference design (Figure 1)	10.36	-	50.19	-	-
First modified design (Figure 2)	3.97	-	35.7	-	90%
Second modified design (Figure 3)	3.37	7.3	18.6	27.1	91%

Table 1 All simulated result data arrangement in tabular form.

IV. CONCLUSION

Here the proposed FSS design is theoretically investigated. The design has the merits of dual stop band frequency characteristics in microwave communication. The operating bands are observed in between 2.98- 3.61 GHz and 6.28- 8.26 GHz which satisfy the C and S bands of frequency in satellite communication. Single layer FSS is easy to set up and the design is symmetrical along to horizontal and vertical direction. Dual band response has also merits of good band ratio (= 2.17) which is very good to overcome channel interference in communication system.

ACKNOWLEDGMENT

The authors are very thankful to ANSYS group for providing HFSS software, which is very useful for the simulation part of the work. The authors pay their sincere gratitude to the managing group of Ideal Institute of Engineering for their auspicious inspiration in this type of research oriented works and also to all the faculty and staff members of this esteemed academic institution for their valuable helps in this subject.

REFERENCES

[1] P.P Sarkar, D. Sarkar, S.Sarkar, S.Das, S.K.Chowdhury."Experimental investigation of the Frequency selective property of an array of dual tuned printed dipoles", Microwave Opt. Techno l lett.31 (2001), 189-190.

[2] Munk, B. A., Frequency Selective Surfaces: Theory and Design, Wiley, New York, (2000)

[3] A. E. Farahat and K. F. A. Hussein "spatial filters for linearly polarized antennas using free standing frequency selective surface", Progress In Electromagnetics Research M, Vol. 2, 167–188, (2008).

[4] P. Samaddar, S. De, S. Sarkar, S. Biswas, D.C. Sarkar, P.P. Sarkar,"Study on Dual Wide Band Frequency Selective Surface for Different Incident Angles", International Journal of Soft Computing and Engineering (IJSCE), ISSN: 2231-2307, Volume-2, Issue-6, January 2013.

[5] PhD Thesis of P.P.Sarkar, Some Studies on FSS, Jadavpur University 2002.

[6] N.D. Agarwal, W.A. Imbraile,"Design of a Dichroic Cassegrain Subreflector", IEEE Trans, AP-27(4), pp. 466-473, 1979.