

Effect of Periodicity on Percentage Bandwidth of a Wide Band Frequency Selective Surface (FSS)

Priyanka Deb Sinha¹, Riya Bhattacharyya², Partha Pratim Sarkar³

P.G. Student, Department of Engineering & Technological Studies, University of Kalyani, Nadia, West Bengal, India^{1,2}

Professor, Department of Engineering & Technological Studies, University of Kalyani, Nadia, West Bengal, India³

ABSTRACT: This paper deals with the variation of percentage bandwidth with the variation of periodicity of a two dimensional array of a Frequency Selective Surface (FSS). Five designs of Frequency Selective Surfaces are proposed which shows how the percentage bandwidth varies with the periodicity of FSS . Recognizable results are obtained by designing a FSS consisting of a two dimensional array of rectangular patch of dimensions 30mm x 20mm. Slot dimensions and the patch dimensions are kept unchanged throughout all the five designs. Only the periodicity of the FSS is changed consecutively. It is noticed that if the periodicity of the FSS is kept 35mmX25mm then a percentage bandwidth of 55.20% is obtained, but when the periodicity of the FSS is made 31mmX21mm then the percentage bandwidth increases to 94.36%. The FSS designs and their results are been discussed in this paper.

KEYWORDS: Frequency Selective Surface, Method of Moment, Periodicity, Bandwidth.

I. INTRODUCTION

An assembly of identical elements arranged in a one- or two-dimensional infinite array is known as a periodic surface [1]. A periodic array of patches on a dielectric substrate or apertures of regular or arbitrary geometries within a metallic screen is considered to be a Frequency Selective Surface (FSS). These frequency selective surfaces possess the property to reflect or transmit the incident electromagnetic radiation. So they can be used as filters of electromagnetic radiation and are also considered to be the wireless counterpart of electrical filters in microwave engineering [1-3]. From the past few decades numerous research works have been carried out on FSS [3-8]. Generally there are two types of frequency selective surfaces, the first one being aperture type FSS and the other is patch type FSS. If resonance characteristics is present in the periodic elements of the FSS then aperture FSS will exhibit total transmission at frequencies near resonant frequencies, while the patch FSS will exhibit total reflection. Thus aperture type FSS is used as band pass filter whereas patch type FSS is used as band reject filter [4]. For more efficient use of reflector antennas in satellite communication FSSs are used to reduce the weight of the satellite as well as to increase the lifetime of the satellite. It also protects the RADAR system by using radomes. FSSs are also used in electromagnetic shielding applications. In home appliances such as microwave oven, the window screen is made of FSS which blocks the harmful microwave radiations and passes the harmless visible spectrum. Without disturbing the aero dynamical properties of airborne objects such as rockets, missiles, etc, conformal FSS can be mounted on them [5]. Wide band frequency selective surfaces are used in microwave and optical communication systems [6]. There are several techniques that have been proposed for the analysis and design of the frequency selective surface. In this paper the designs and simulations of the proposed FSS is done by Ansoft Designer V2.2.

II. RELATED WORK

Primarily the FSS structure consists of two dimensional arrays of rectangular-shaped patches. The dimension of the patch is 30mm X 20 mm as shown in fig1 . The patches are considered to be present on one side of a thin dielectric slab and the copper coating on the other side of the slab is completely removed. Slot of dimensions are introduced as shown in fig1.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 4, April 2016

Periodicity is defined as the distance between the center of the two consecutive patches both in horizontal and vertical directions. In fig2 “a” is the periodicity in the horizontal direction and “b” is the periodicity in the vertical direction. The dielectric constant is taken to be 2.8 (Acrylic sheet) and height of the dielectric is taken to be 1.6mm. Now keeping all these parameters constant the periodicity of the FSS is varied from 35 mm to 31 mm in the horizontal direction and 25 mm to 21 mm in the vertical direction consecutively in a decreasing manner and the transmission characteristics is studied. The variation of periodicity in both the horizontal and vertical direction is tabulated in table 1.

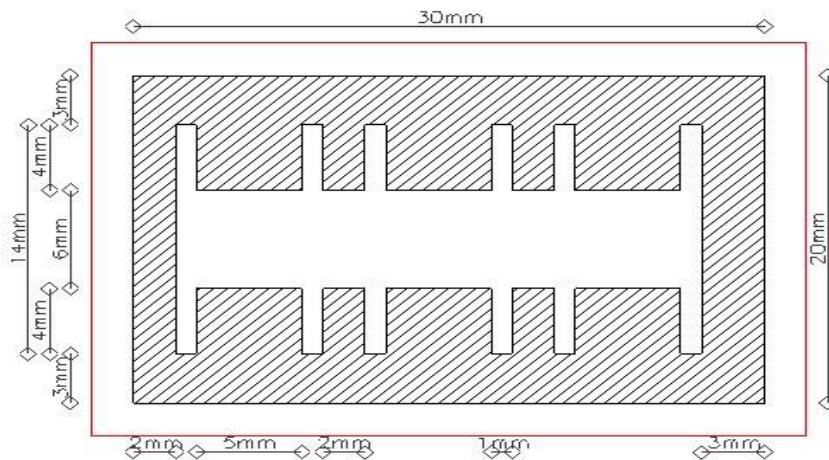


Fig. 1. Proposed FSS structure

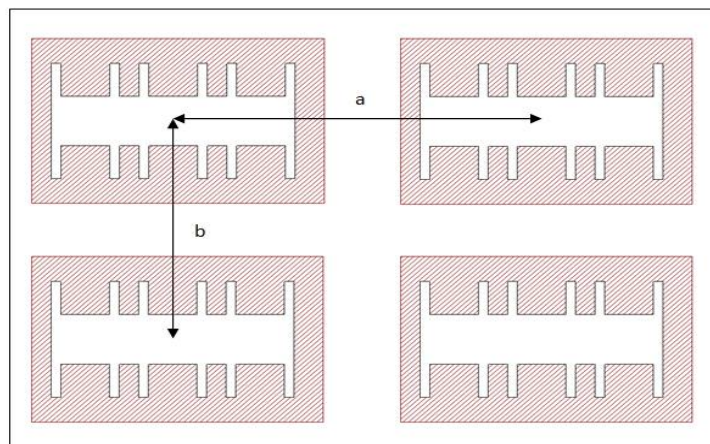


Fig 2: 4 unit cells of FSSs showing periodicity in both horizontal and vertical directions.

III. RESULTS AND DISCUSSIONS

The transmission characteristics of the designed FSSs are studied and the simulated observations are tabulated in Table 1. The transmission characteristics of the proposed FSSs are shown in fig 3-7.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 4, April 2016

For the FSS with periodicity 35mmX25mm, the resonant frequency is obtained at 4.42 GHz as shown in Fig 3. The percentage bandwidth obtained for this FSS is 55.20%.

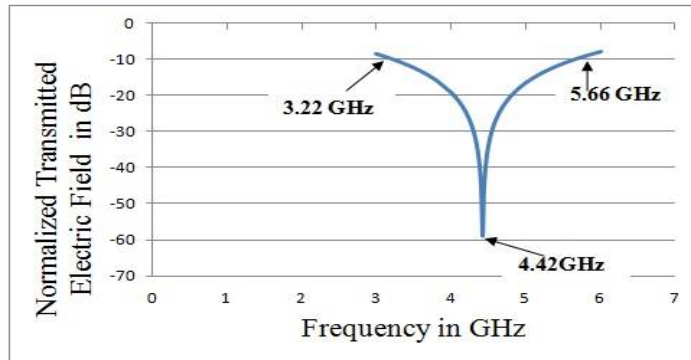


Fig 3: Transmission characteristics of FSS 1.

When the periodicity is decreased to 34mmX24mm, the resonant frequency is obtained at 4.32 GHz as shown in Fig 4. The percentage bandwidth obtained for this FSS is 61.80%.

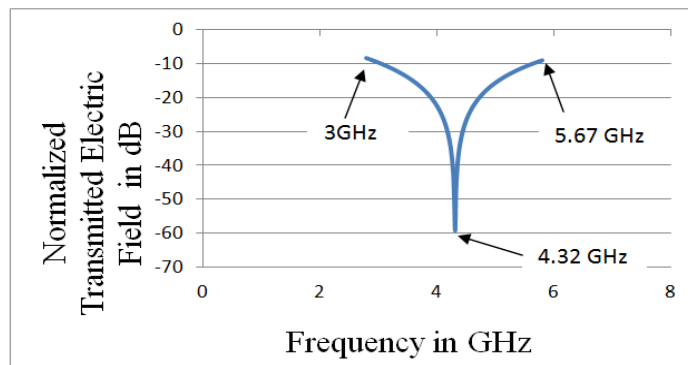


Fig 4: Transmission characteristics of FSS 2.

When the periodicity is further decreased to 33mmX23mm, the resonant frequency occurs at 4.18 GHz as shown in Fig 5. The percentage bandwidth obtained for this FSS is 69.37%.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 4, April 2016

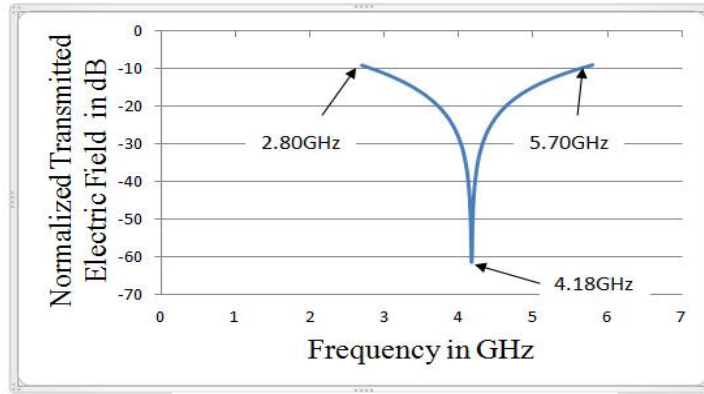


Fig 5: Transmission characteristics of FSS 3.

Further decreasing the periodicity to 32mmX22mm, the resonant frequency is obtained at 3.94 GHz as shown in Fig 6. The percentage bandwidth obtained in this case is 77.41%.

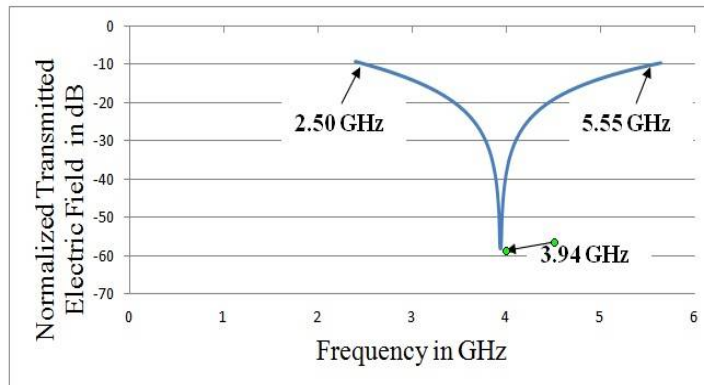


Fig 6: Transmission characteristics of FSS 4.

For the FSS with periodicity 31mmX21mm, the resonant frequency is obtained at 3.55 GHz as shown in Fig 7. The percentage bandwidth obtained for this FSS is 94.36%.

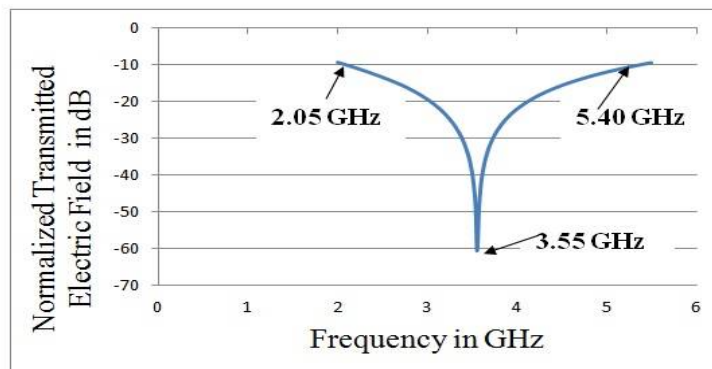


Fig 7: Transmission characteristics of FSS 5.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 4, April 2016

TABLE 1.

FSS	Periodicity	Lower cut off frequency(in GHz)	Higher cut off frequency(in GHz)	Resonant frequency(in GHz)	%Bandwidth
1	35mmx25mm	3.22	5.66	4.42	55.20%
2	34mmx24mm	3	5.67	4.32	61.80%
3	33mmx23mm	2.80	5.70	4.18	69.37%
4	32mmx22mm	2.50	5.55	3.94	77.41%
5	31mmx21mm	2.05	5.40	3.55	94.36%

IV. CONCLUSION

From the obtained simulated results it has been observed that the FFS with the lowest periodicity, i.e , 31mmx21mm possesses the largest bandwidth while the FSS with largest periodicity, i.e, 35mmx25mm possesses the smallest bandwidth among all the five proposed designs of FSS. FSS with periodicity 35mm x 25mm possesses a percentage bandwidth of 55.20%, but when the periodicity is decreased to 31mm x 21mm in FSS 5 the percentage bandwidth is enhanced up to 94.36%. Hence it can be concluded that FSS with larger periodicity possesses smaller bandwidth and vice-versa. Also the resonant frequency decreases with decreasing periodicity.

REFERENCES

- [1] Ben A. Munk, "Frequency selective surface Theory and design", (New York, John Wiley & Sons Inc,2000).
- [2] B. Munk, Finite Antenna Arrays and FSS (New York, Wiley & Sons, 2003).
- [3] Rimi Ghosh, Debasree Chanda, Partha Pratim Sarkar, "WIDE BAND FREQUENCY SELECTIVE SURFACE USING PATCH ELEMENTS LOADED WITH CIRCULAR RING SLOTS", IJEEE, Vol. No.7, Issue No. 01, Jan-June, 2015.
- [4] A Ray, M Kahar and P P Sarkar, "A bee-hive frequency selective surface for Wi-Max and GPS applications", Indian J Phys (October 2013) 87(10):1011–1015 DOI 10.1007/s12648-013-0329-x.
- [5] Tanumay Mandal, Partha Pratim sarkar, "A Dome Shaped Curved Fss with Extra Wide Band Applications:Design and Theoretical Analysis", IOSR Journal of Electronics and Communication Engineering (IOSR-JECE)e-ISSN: 2278-2834,p- ISSN: 2278-8735. Volume 8, Issue 1 (Sep. - Oct. 2013), PP 53-55www.iosrjournals.org.
- [6] Tanumay Mandal , Gobinda Sen, Susanta Mahato, Partha Pratim Sarkar, "Studies on compactness and wideband of frequency selective surface (FSS) by cutting slot within square-shaped patch", , National Conference on Communication, Measurement and Control, Vol-I, 14th August, 2012.
- [7] Rimi Ghosh, Dr. Debasree Chanda Sarkar, Dr. Partha Pratim Sarkar, "Compact, MultiBand Frequency Selective Surface design for Communication Purpose", International Journal of Emerging Technology and Advanced Engineering, Volume 4, Issue 4, April 2014.
- [8] R. Ghosh, D. Chanda (Sarkar), P. P. Sarkar, "Design of Compact, Multi Band Frequency Selective Surface ", IJECT Vol. 6, Issue 1, Jan - March 2015.