Study on dependency of resonant frequency of a frequency selective structure on periodicity

Pragati Jaiswal[1], Swagata Chowdhury[1], Debashruti Das[1], Sayan Chakraborty[1], Manoj Kumar PAIN[1], Partha Pratim SARKAR[2] ,

[1] Dept. of Electronics and Communication Engineering, Camellia Institute of Technology, West Bengal University of Technology, Kolkata, West Bengal, India

[2] Dept. of Engineering & Technological studies, University of Kalyani, West Bengal, India

e-mail: mail2mkpain@gmail.com

Abstract: The paper presents the investigation regarding the dependency of resonant frequency of a Frequency Selective Surface (FSS) having square patches, on the periodicity. We have done theoretical study on a FSS having patches of dimension 7.5 mm × 7.5 mm but different periodicity values, using Electromagnetic Simulation Software Ansoft Designer version 2.0.

Key Words: Microstrip, Frequency Selective Surface

1 INTRODUCTION

A frequency selective surface (FSS) may be of two types. A two dimensional array of patches on a dielectric slab or a two dimensional array of apertures within a metallic screen form a patch or aperture type FSS which find numerous applications today. The applications include radomes for fighting aircraft, sub-reflectors for multi-frequency operations(1-8) in satellite communication and home appliances like microwave oven. Resonant frequency, pass-band, stop-band or band separation of an FSS depends on the structure of the FSS. A number of studies has been done on FSS. Among them, study on compact ness, improving bandwidth, multiband FSS etc. are few of them. Detailed study reveals that, not only shape, but also the positioning of the patches affects resonant frequency. Our study is to find out the nature of dependency. For theoretical analysis of the FSS, generally three methods are used – Finite Difference Time Domain (FDTD) method, Finite Element Method (FEM) and the Method of Moment (MoM). Among these three MoM is the most complicated but it provides best result. Now different electromagnetic simulation softwares are available for theoretical analysis based on the mentioned methods. Our computational method is MoM and we have used Ansoft software for theoretical analysis.

2 DESIGN OF THE FSS:

The patches of dimension 7.5 mm × 7.5 mm has been considered. The Dielectric Constant of the substrate, for all of them has been considered to be 6.3. The FSS has been considered to be infinite array of square patches with the same value of periodicity in both the directions. For all the cases we have studied, the resonant frequency is studied for different periodic values, starting from '0.3 times of the Perimeter of the patch' to 'the Perimeter of the Patch'.

3 THEORETICAL STUDY:

First the infinite array of square patches of dimension 7.5 mm × 7.5 mm for different periodicity values has been studied. As the side itself is 0.25 times of its perimeter, we have started studying the resonant frequency of the designed Frequency Selective Surface from periodicity equal to 0.35 times of the perimeter of each patch. The study was done using Ansoft. The results, we have obtained is shown in table 1.

Periodicity in terms of Perimeter	Resonant Frequency Fr (GHz.)
0.3	18.7
0.35	15.55
0.4	13.5
0.45	12.15
0.5	11.25
0.55	10.55
0.6	10
0.65	9.55
0.7	9.15
0.75	8.85
0.8	8.55
0.85	8.25
0.9	8
0.95	7.75
1	7.55

Table 1: Variation of resonant frequency with periodicity.

4 . RESULTS AND DISCUSSION:

Transmitted electric field has been obtained experimentally for the FSS having square patches of dimension 7.5 mm × 7.5 mm and hence resonant frequency has been noted for different periodicity value. The same structure has been analyzed using Ansoft. Figure 1 shows results shows Transmitted electric fields Vs Frequency.

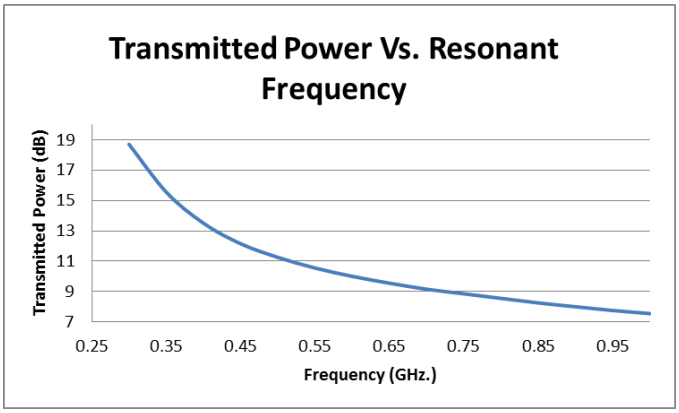

Fig. 1 Variation of resonant frequency with periodicity

5 CONCLUSION:

Though there is a thumb rule to find out the resonant frequency of FSS, that, the perimeter of a square patch is equal to the wavelength corresponding to resonant frequency, our study shows, that, the resonant frequency has an appreciable dependency on periodicity of the patches. Figure 1 shows that, the change of resonant frequency with periodicity is very sharp for lower periodicity values and the same is enough flat and linear while the values of periodicity are close to that of the perimeter the patch.

6 REFERENCES

1. Agrawal V, Imbriale W. Design of a dichoric cassegrain subreflector. IEEE T ANTENN PROPAG 1979; 27: 466- 473.

2. Lee S.W, Zimmerman M.L, Fujikawa G, Sharp R. Design for ATDRSS tri-band reflector antenna. IEEE AP-S 1991; 2: 666-669.

3. Ueno K, Itanami T, Kumazawa H, Ohtomo I. Characteristics of frequency selective surfaces for a multiband communication satellite. IEEE AP-S 1991; 2: 735-738.

4. Wu T.K. Frequency Selective Surface and Grid Array. 1st ed. New York, NY, USA: Wiley, 1995

5. Sarkar D, Sarkar P. P, Chowdhury S. K. Theoretical and experimental investigation on the frequency selective property of an array of slotted dipoles. INDIAN J PHYS PT-B 2003; 77: 399-403.

6. Hsing Yi Chen, Yu Tao. Bandwidth enhancement of a U slot patch antenna using dual band frequency selective surface with double rectangular ring elements. MICROW OPT TECHN LET 2011; 53: 1547 – 1553.

7. Ray A, Kahar M, Das M, Sarkar S, Biswas S, Sarkar P.P. Studies of compactness of frequency selective surfaces by cutting B slot or keeping different spacing between rectangular patches; National Conference on Computers, Communication & Controls – 11 (N411), 29th & 30th April 2011, R.V. College of Engineering, Bangalore, India.

8. Ray A, Kahar M, Biswas S, Sarkar D, Sarkar P.P. A dual Tuned Complementary Structure Frequency Selective Surface for WLAN Applications. Journal of Microwave, Optoelectronics and Electromagnetic Applications 2012; 11: 144 – 153.

7 ACKNOWLEDGMENT

The authors are thankful to DETS, Kalyani University, for extending the support by allowing them to use the facility.