

# Effect of Periodicity Variation on a Hexagonal Slotted Square FSS

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**ABSTRACT:** A light weight, reduced size frequency selective surface (FSS) is initially designed to meet the broadband characteristics. To enhance its bandwidth a regular hexagonal slot has been drawn on the metallic patch. The effect of varying periodicity on the frequency characteristics and current density is studied. Useful conclusions are drawn from the above observations.

**KEYWORDS:** Frequency Selective Surfaces, broad band, slots, periodicity.

## I. INTRODUCTION

FSS [1] has been designed for their widespread applications as spatial microwave and optical filters for more than four decades. FSS are usually constructed from periodically arranged metallic patches of arbitrary geometries or their complimentary geometry having aperture elements similar to patches within a metallic screen. These surfaces exhibit total reflection or transmission, for the patches and apertures respectively, in the neighborhood of the element resonances. Planar and curved FSSs are used for many applications [2-5] including the design of radomes, dichroic surfaces for reflectors and subreflectors of large aperture antennas. Analysis of different types of FSS structures like the Jerusalem cross, annular ring, and square loop and square patch have been carried out earlier. In this paper, analysis based on periodicity variation of a square metallic patch with an embedded hexagonal slot has been carried out.

## II. DESIGN OF THE FSS

The FSS consists of an array of metallic square patch each of size 20mm x 20mm with a regular hexagonal slot [6-8] etched on it as shown in Fig. 1 below.

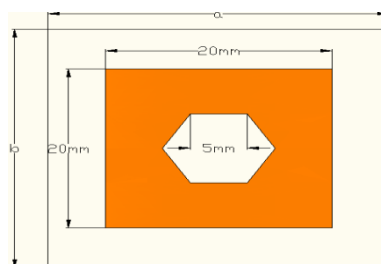


Fig. 1 Unit cell structure of the proposed FSS  
(Orange Colour indicating Copper and white colour indicating substrate)

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The metallic patches are supported by a dielectric substrate with relative dielectric constant of 2.8. Each side of the hexagon is 5mm. The distance between the centres of the patches is called periodicity. The horizontal and vertical periodicity is a mm and b mm respectively as shown in Fig. 2. The proposed FSS is designed for three different periodicities viz. a=b=30mm, a=b=40mm and a=b=50mm.

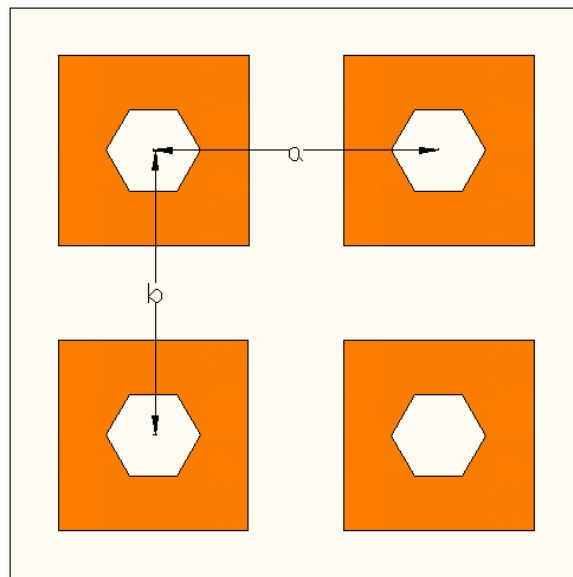


Fig. 2 Four element FSS with periodicities

**III. RESULTS AND DISCUSSION**

The Frequency selective Surface is analysed by using Ansoft HFSS 13.0 which works on Finite Element Method (FEM). Normalized Transmitted Electric Field and Surface current density are observed for the frequency range 3GHz to 9GHz.

*A. Analysis of Normalized Transmitted Electric Field vs. Frequency*

Normalized transmitted electric fields vs. frequency for the FSS structure is simulated for the frequency range of 3GHz to 9GHz. The results are shown in Fig. 3. The resonant frequencies obtained for periodicities a=b=30mm, a=b=40mm and a=b=50mm are observed to be 7.7 GHz, 5.9GHz and 5.2 GHz. The percentage bandwidths recorded at respective resonant frequencies are 31.16%, 13.55% and 7.69% respectively. Summary of the result is shown in Table 1.

TABLE I

| Periodicity (mm) | Resonant Frequency(GHz) | Lower Cut off Frequency (GHz) | Upper Cut off Frequency (GHz) | Bandwidth (GHz) | Percentage Bandwidth (%) |
|------------------|-------------------------|-------------------------------|-------------------------------|-----------------|--------------------------|
| 30mm             | 7.7                     | 6.3                           | 8.7                           | 2.4             | 31.16                    |
| 40mm             | 5.9                     | 5.5                           | 6.3                           | 0.8             | 13.55                    |
| 50mm             | 5.2                     | 5                             | 5.4                           | 0.4             | 7.69                     |

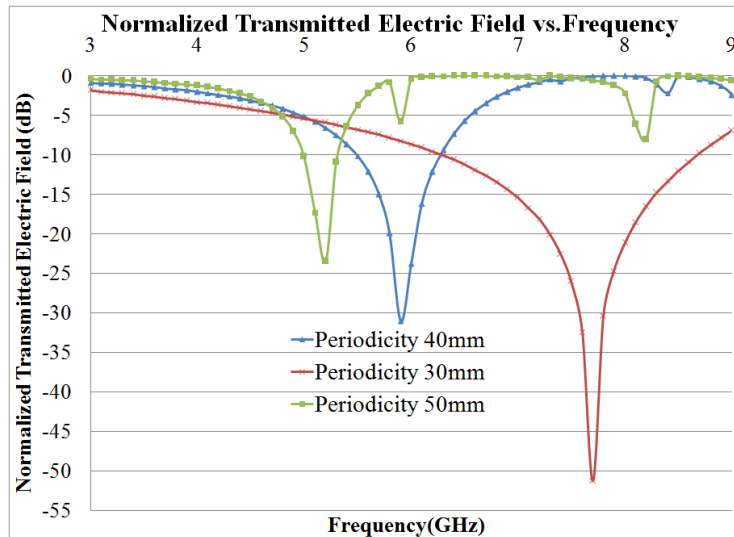


Fig. 3 Normalized Transmitted Electric Field vs. Frequency Plot

*B. Analysis of Surface Current Density*

Surface current density on the metallic patch at resonant frequencies for three different periodicities is shown in Fig 4, Fig 5 and Fig 6 respectively.

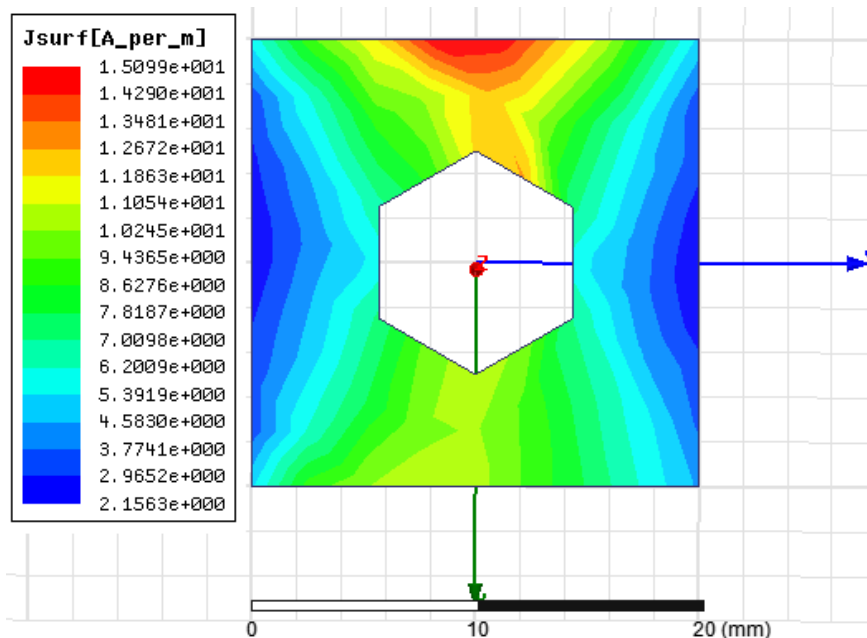


Fig. 4 Current density for periodicity a=b=30mm and resonant frequency 7.7GHz

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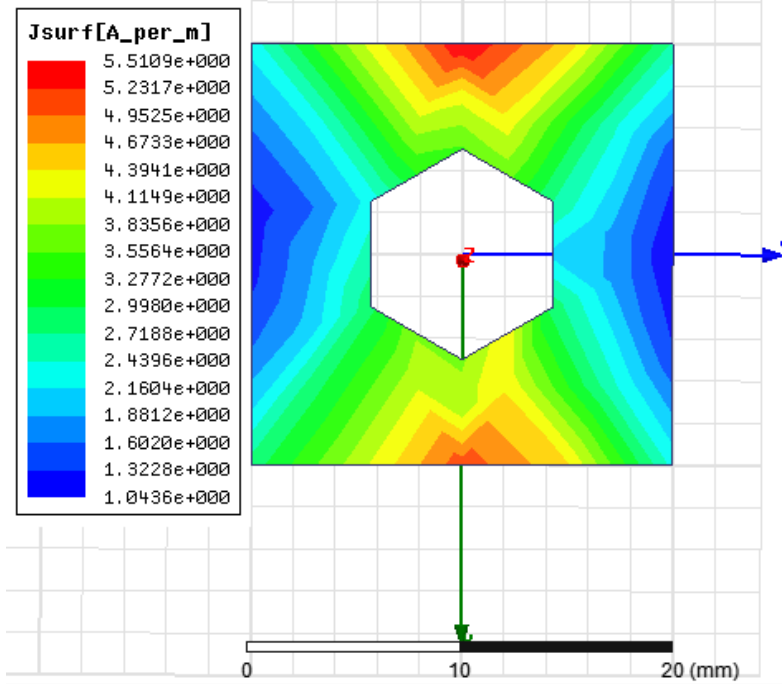


Fig. 5 Current density for periodicity  $a=b=40\text{mm}$  and resonant frequency 5.9 GHz

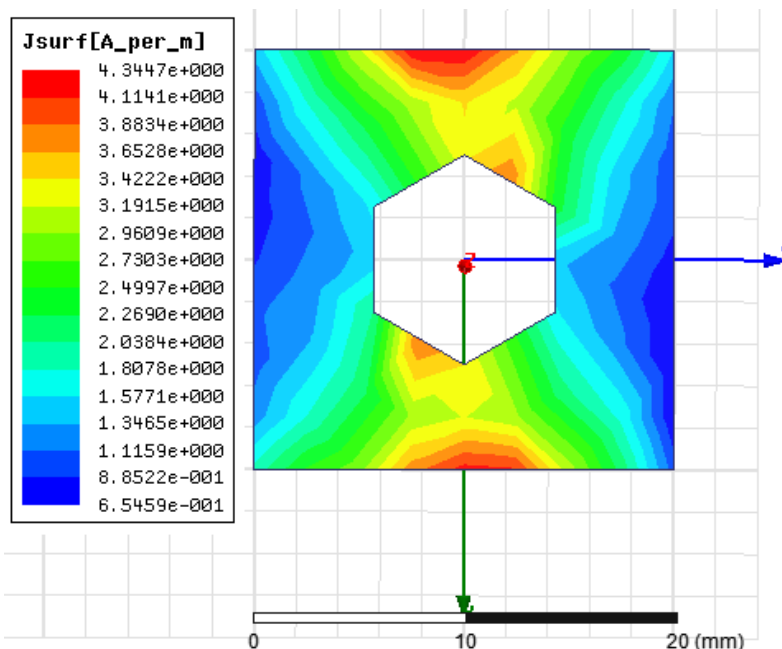


Fig. 6 Current density for periodicity  $a=b=50\text{mm}$  and resonant frequency 5.2 GHz

**IV. CONCLUSION**

In this paper it is seen that for the hexagonal slotted square FSS design the resonant frequency decreases with the increasing distance between two metallic patches i.e. with the increasing periodicity. It is also to be noted that surface

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current density too decreases with increasing periodicity which might be one of the reasons leading to the decrease in resonant frequency of the FSS structure.

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