

Design of Novel Shaped Compact Frequency Selective Surface with Multi-Band Application

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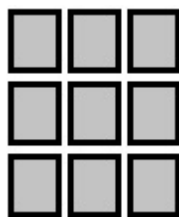
ABSTRACT: This paper presents the design of a Novel Shaped Compact Frequency Selective Surface used in wireless multi-band applications as a band reject filter. Three resonating frequencies are obtained at **3.57 GHz**, **7.07 GHz**, & **10.73 GHz**. This FSS is designed by cutting slots of various shapes and dimensions in the 20mm X 20mm square patch keeping same periodicity (23mm X 23mm) throughout. Size reduction up to 90% is also achieved in this design. Theoretical investigation has been done by Ansoft Designer Software V2 which works on the Method of Moment.

KEYWORDS: Frequency Selective Surface, Compact, multi-band application, Resonating Frequency, Method of Moment.

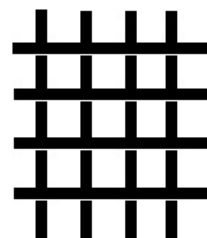
I. INTRODUCTION

In recent years, Frequency Selective Surface is used as a filter in the wireless communication system [1]. It was used as Cassegrainian Sub Reflectors in parabolic dish antennas in early days. In voyager, Galileo & Cassini space missions, the dual-reflector antennas associated with a frequency selective surfaces (FSS) sub reflector made it possible to share the main reflector among different frequency bands [2-5]. Due to this, the lifetime of the space craft is increased and worked properly. Now the FSSs are used in airborne radiators, absorbers and electromagnetic band gap materials also [6].

A typical FSS is a 2-d infinite metallic array printed on a dielectric slab separated by a finite periodicity from each other[7]. Two types of generic geometries of FSSs are there. The first one, commonly known as a **patch type FSS**, acts as a **band-reject filter**, exhibits **total reflection** at resonating frequency and another type is **aperture type FSS** which exhibits **total transmission** at resonating frequency performing similarly to a **band-pass filter**[8]. The proposed FSS design is theoretically investigated by Ansoft Designer Software V2 which works on the Method of Moment.



Patch type FSS
Aperture type FSS



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II. RELATED WORK

An array of periodic metallic patches on a substrate, or a conducting sheet periodically perforated with apertures, constitutes a frequency selective surface to propagate electromagnetic waves shown in Fig 1.

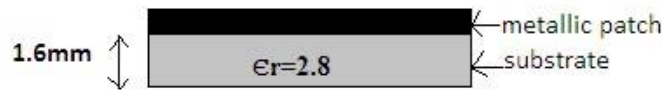


Fig 1: Layered Structure of the Conventional FSS

Primarily, the reference patch is a 2-D copper patch of 20mm X 20 mm, mounted on a dielectric material, (relative permittivity is 2.8 & thickness is 1.6mm) shown in fig 2. The periodicity is taken as 23mm X 23mm.

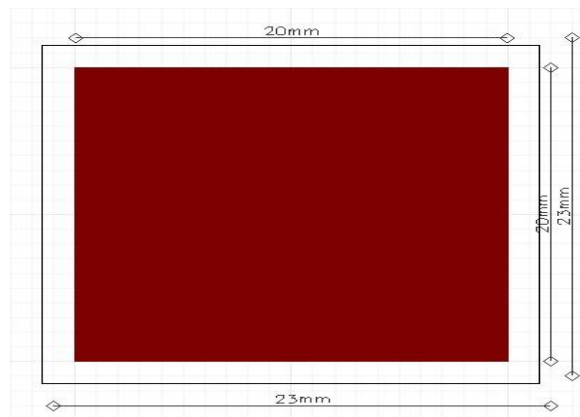


Fig 2: FSS with Reference Patch

By cutting slots of line width 1mm and having gap of 1mm between each slot mentioned in fig 3 are loaded on reference patch we get the modified FSS.

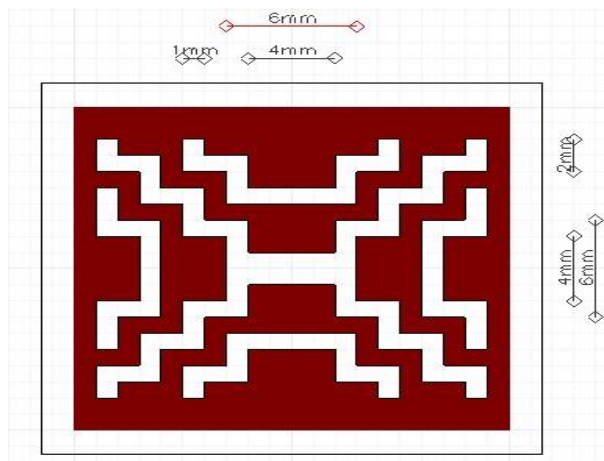


Fig 3: FSS with Final Modified Patch

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III. EXPERIMENTAL RESULTS

Computed transmission characteristics for reference patch [Fig.2] using Ansoft Designer® is plotted in Fig.4, which shows that the FSS resonates at 11.19GHz while considering the first frequency band.

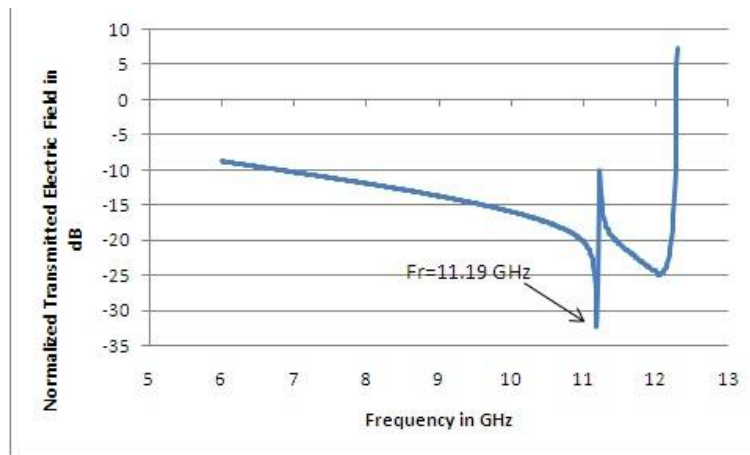


Fig 4: Transmission Characteristics of fig 2

By investigating the transmission characteristics of fig 3, three bands are found and the corresponding resonating frequencies are at **3.57 GHz, 7.07 GHz, 10.73 GHz** shown in fig 5.

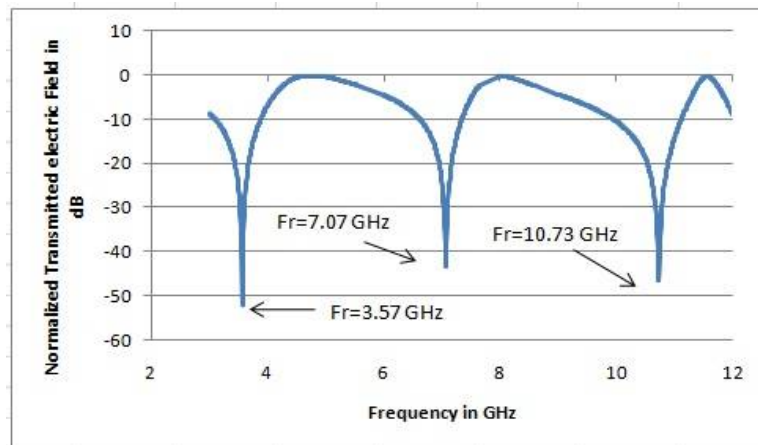


Fig 5: Transmission Characteristics of fig 3

In the modified FSS multiple resonating frequencies have been obtained. The resonant frequencies with bandwidth and percentage bandwidth have been shown in tabular form in Table 1.

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	Reference Antenna	Final Proposed Antenna		
Resonant Frequency(GHz)	11.19	3.57	7.07	10.73
%BW	48.88	21.85	10.47	11
%Size Reduction	----	90		

Table 1: Summarization Table

To obtain the resonating frequency at 3.57 GHz it would require the area of the patch is 1278 mm² approximately. The area of the reference patch is 130mm²(approx). So the size reduction of $[(1278-130)/1278]*100\%=90\%$ (approx) has been achieved with the help of this proposed design.

IV. CONCLUSION

In the final design i.e. fig 3, the first resonating frequency is 3.57 GHz and size reduction is achieved upto **90%**. Considering the percentage bandwidth of the three reflection bandwidths are 21.85%, 10.47%, 11% respectively. It has been also seen that a broadband has been split to multi band with modification of the square patch. In this design the reference patch is modified step by step processes, resonant frequency decreases in each step of modification. Hence the final design can be treated as broad as well as multiband FSS.

The final proposed FSS is applicable in satellite communication, multimedia application like mobile, T.V. and satellite radio.

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