Design of Frequency Selective Surface for WLAN, C-Band and X-Band Filtering Mechanism

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Abstract

A single substrate layer FSS is periodically arranged on the FR4 substrate with a thickness of 1.6 mm is proposed for triple band stop filtering applications. The proposed layout comprises of basic conductive elements on each facet of the substrate. A square loop is placed on the top of the substrate blended with two folded arms is placed in it.The incorporation of the conductive surface with appropriatedimensions stimulates three-band operation in 4.1–6 GHz, 6-8 GHz, and 8–12.1 GHz for the WLAN, C-Band, and X-band are included in the frequency bands respectively. For theband stop FSS structure, a stable frequency response is attained from different angles and to reduce the transmission loss.

Index Terms—*Frequency selective surfaces (FSSs), three-bandoperation,folded arms,WLAN,C-band, X-band , square loop.*

1. Introduction

Frequency selective surface has widespread applications in various fields such as filter, antenna,radar cross-section reduction, radomes,shielding,etc. FSS is a periodic array of a similar unit cell arranged in a set order for the operations such as stop and pass band filter [1]. The structure also has properties that may vary with incident angle and polarization which find application in various fields. The main drawback of the conventional LC filter is that it fails to exhibit multiple functions [1]. The proposed structure is to improve the performance in pass band for wireless communication as well as to increase the frequency stability at oblique angles. There are various techniques for thefrequency selective surfaceanalysis [2].
In [3], the stable response is provided for all modes of polarization to reach stability to be higher. In [5], the proposed design is composed of simple elements on both facets of the substrate which exhibits astop band from 3 to 16 GHz.
Wireless technology is widely usedthroughout the entire world by the people. Wireless technologies like wireless devices,WLAN,cellular phones,WiMAX.WLAN, an alternative to technology LAN, uses the Radiofrequency technique to transmit and acquire records through the air. As a result, the want for confused out connections is decreased, thereby balancing connectivity with device versatility. WLAN is also widely diagnosed as a sturdy, price-effective solution.The FSS with a single FR4 substrate is designed for triple band to avoid filtering applications. The designed layout consists of easy conductive factors on every aspect of the substrate. A square loop is mounted on the top layer combined with two folded arms is included within it. The addition of the conductive surface with suitable dimensions stimulates three-band operation in 4.1–6 GHz, 6-8 GHz and 8–12.1 GHzare

blanketed inside the frequency bands respectively. For the designed structure of band stop FSS, a solid frequency reaction is acquired from one of a kind angles and to reduce the transmission loss, sizeable wireless purpose networking choice for a big variety of packages.

2. Unit Cell Design And Analysis

The suggested unit cell configuration is shown in fig 6. From the design, it is seen that unit cell is 10 x10 mm^2 which is mounted on a FR4 substrate layer (w=10mm)with 1.6 mm thick withloss tangent of 0.02 and dielectric constant 4.4.In the bottom aspect of the substrate, a square loop of outerand innerdimensions are 10 x 10 $mm^2$and 9 x 9$mm^2$is mounted. On the top aspect square loop with the inner dimension 8.4 x 8.4mm^2(w2=8.4mm) and outer dimension 9 x9 mm^2 (w1=9mm) is mounted. The two folded arms with the inner dimension of 6.3 x 3.2mm^2 and outer dimension 6.9 x 3.8 mm^2 (w3=3.8mm,w4=6.9mm) is attached with the square loop. Inside each folded arm another folded arms of inner dimension 4.4 x 1.9 mm^2 (w7=4.4mm, w6=1.9mm) and outer dimension 3 x 1.5 mm^2(w9=3mm, w8=1.5mm) is attached. At the corners of the two folded arms a square of 0.6 x 0.6 mm^2(s=0.6mm) is placed.
FSS consists of two ports. Theinput signal is illuminated through the input port and the output port through which frequency in the pass through FSS, so FSS falls in the category of two port network. As FSS is a two port network the performance of FSS can be evaluated using S-parameter.
In step 1,only square loop is fixed in the bottom layer of the cell. In step 2, square loop is adopted in the top aspect of the unit cell .In the step 3,bended arms are placed in the square loop. In step 4 again folded arms are placed inside the existing folded arms. In the final step the third folded arms are placed and the corners of the outer folded arms are attached with Small Square.
Thehigh frequency simulator simulates the FSS structure and the respective S_{21} curves are acquired. From the obtained result, it is seen that in step 1 resonance does not occur. In step 2, resonance occurs around 4.4 GHz for the square loop. In step 3,with the folded arms inside square loop only one resonance occurs at 4.8 GHz. In step 4 again folded arms are placed inside the existing folded arms and the resonance occurs around 6.2 GHz and in the next band it starts to resonate around 9.4 GHz. In the last step the folded arms and square patch are used and then resonance occurs at 4.5 GHz, 7.4 GHz and 8.856 GHz which extend the FSS performance to WLAN and X-band, C-band. When D=1.4mm, then FSS can be used for various filtering mechanism.

Bottom View

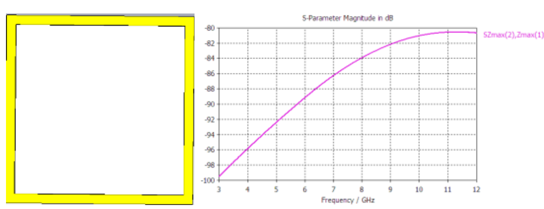

Fig1: step 1

Top View

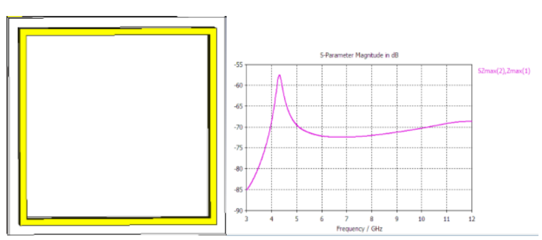

Fig 2:step 2

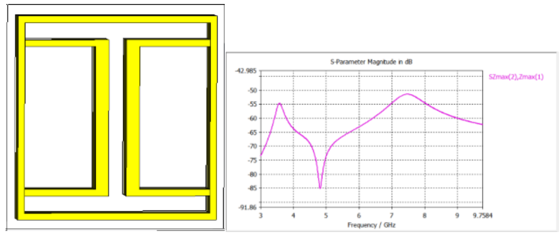

Fig 3:step 3

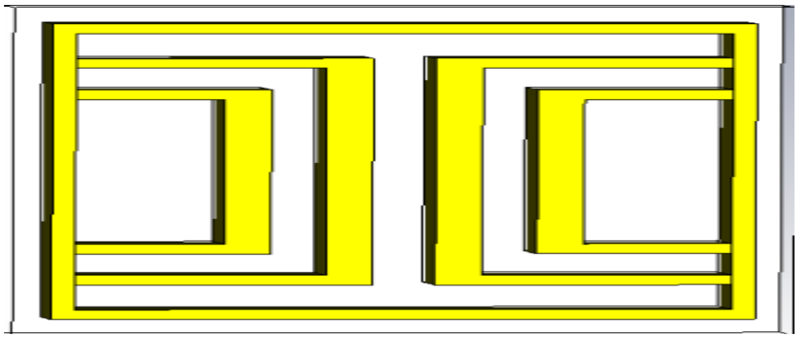

Fig 4: step 4

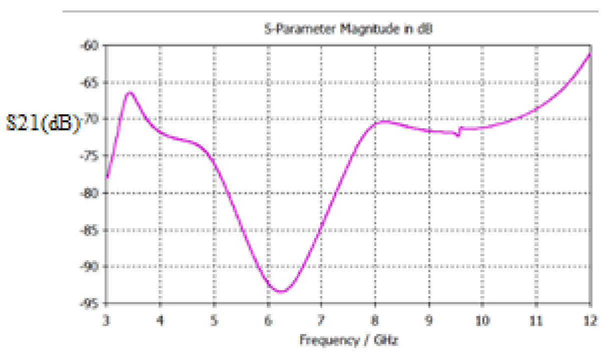

Fig 5: S_{21}curve obtained from simulating step 4

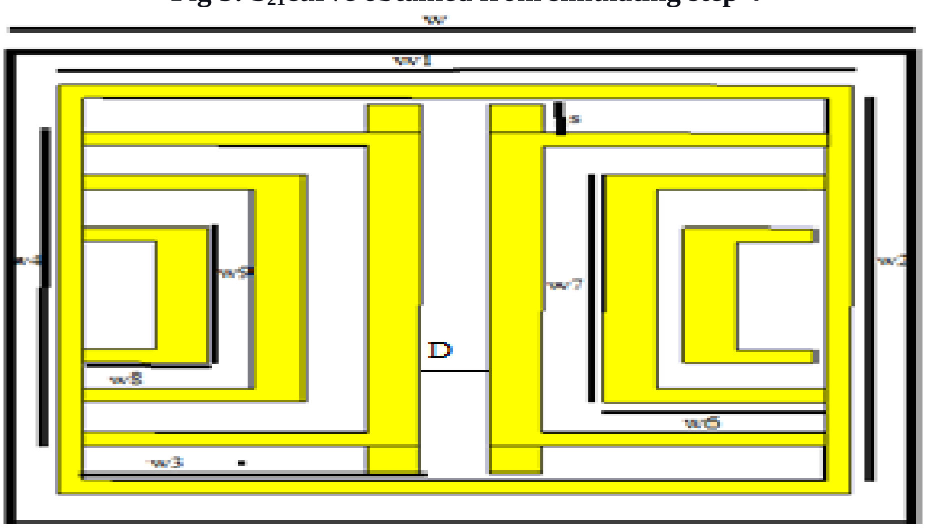

Fig 6: The proposed FSS unit cell configuration with its dimensions.

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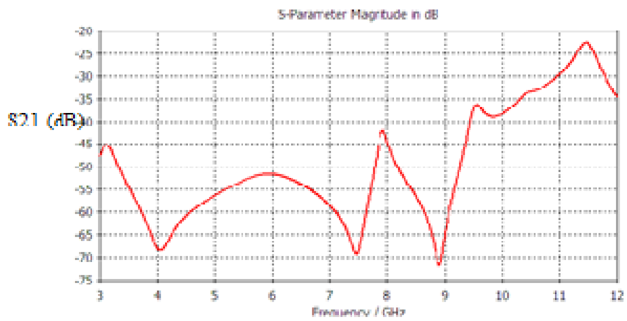

Fig. 7: S_{21}curve attained for the proposed FSS unit cell at usual incidence angle.

3. Sensitivity Analysis

When mounted in a specific location for a particular application the FSS may illuminate different signalwith different angles of incidence. Therefore an acceptable FSS should respond stably. Under changing condition , this section provokes a sensitivity analysis to accessthe efficiency of the structure with reference to this function. S_{21} curves for different angle of incidence are depicted in fig 8.It considered angles from $0^0$to 50^0 with a step of 10^0.Slight changes in the resonance frequencies around 9GHz are observed for angles greater than 30^0, which is the direct result of varying angular positions. Since the rejected frequency band is uninfluenced and remains relativelystableand constant.These improvements of the structure might be reasonably ignored. The obtained results approve the expected functionality of the designed FSS.

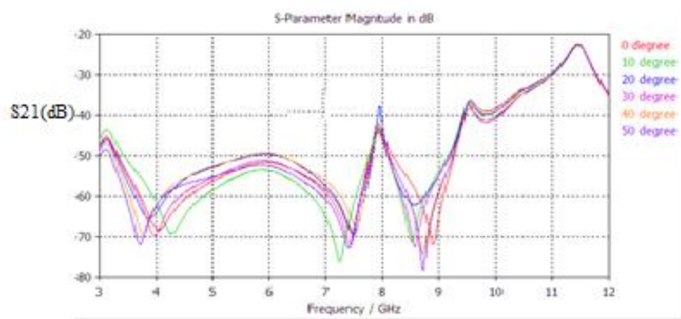

Fig. 8: S_{21}curves obtained for the proposed FSS unit cell at different angles.

4. Comparative Study

A comparative analysis is administered to shed light on the benefits of the proposed FSS over previously built FSSs.In this regard, the FSS structures in [10]-[14] are selected for comparison with the present research in terms of unit cell size, number of layers, number of operating bands, consistency with the in-service and relevant frequency bands, and incident signal attenuation values. Table I provides a description of the characteristics of [10]-[14] and the FSS specification. The present research is seen to have a smaller size than [10],[12] and [14], although it exhibits more relevant frequency bands. The unit cell at [11] also occupies a smaller area than the existing unit cell. This does not however have as many operating features as the current version. In addition, the unit cell, working within one wideband frequency spectrum. The FSS configurations in [10],[12] and [13] achieve an attenuation of 40, 140, 120 dB.The impinging signal passing through this FSS structure is experiencing an attenuation of about 80 dB when the impinging signal passing through it ,which provides an required and suitable attenuation range of FSS structures.

TABLE 1 : Comparison table with the similar previously designed FSS and proposed work

FSS design	Unit cell size (mm3)	Number of operating bands	Operating frequency bands	Attenuation
[10]	15 × 15 × 1.6	1	3.5–5–5.8 GHz WiMAX, WLAN, ISM/WiMAX	Up to 40 dB
[11]	8.8 × 8.8 × 0.762	2	X-band	-
[12]	12 × 12 × 3.2	1	Wide band operation	Up to 140 dB
[13]	10 × 10 × 1.6	1	Wide band operation	Up to 120 dB
[14]	56 x 56 x40	1	L- and S-bands	90% attenuation for 20 dB reference level
[1]	10 × 10 × 1.6	3	WiMAX, WLAN, and X-band	Up to 60 dB
ProposedFSS	10 × 10 × 1.6	3	WLAN, C-Band and X-band	Up to 80 dB

5. Conclusion

This paper propose efficient design of the frequency selective surface in which the square loop is integrated with the two folded arms in order to provide solution for multiple applications. The design FSS structure gained the frequency response which is stableat different angles. The proposed structure also attained the reduction in the transmission loss. So the newly design structure found applications in communication.

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