Free Space FSS Filter for 5GHz WLAN

Rajesh Natarajan[1], Finney Daniel Shadrach S[2], Sathish Kumar N[3]
Assistant Professor, KPR Institute of Engineering and Technology, Coimbatore

Abstract

In this paper stable band stop filter is designed using frequency selective surface with the unit cell dimension of $6\times6\ mm^2$. Design is focused to stop the 5 GHz WLAN band signals that can be act as a shield for free space. Owing to its symmetric nature of the design it gives symmetric response for both azimuth and elevation plane of polarization. The normal incidence and oblique incidence also compared to validate the figure of merit of the FSS.

1. Introduction

Innate nature of frequency selective surfaces gives full freedom to design the conducting patches as the designers wish. Miniaturization and angular independence are the terms which draw much interest among the researchers. Enormous utilization of frequency selective surfaces in different forms like radomes, spatial filters and electromagnetic shields are developed in literature. Plenty of novel designs have been proposed in [1] - [3] having stable band pass resonance. Spiral patches with different combinations in [1] and patches with interleaving strips [3] are discussed. Dual band FSS with controllable pass bands via complementary structure is introduced in [5]. Low frequency designs with miniaturization is outlined in [6] with single layer and in [7] the thickness of the substrate is reduced to $\lambda/40$ with double layer. Here we proposed a simple dipole structure closely packed with Centro symmetry on a double sided substrate to stop the particular frequency.

With the advancement in telecommunication, the use of wireless technology for information system has significantly increased. It provides an advantage of getting free of physical cabling but demands several issues to be addressed as well. The issue is to provide security for information flow in wireless local area networks (WLANs). Since WLANs are based on radio frequency, the information can be hacked by intruders. A band-stop FSS which could be posted on walls of the buildings can provide solution for wireless security. The selective nature of FSS allows other useful RF/microwave signals to pass through while blocking WLAN signals. In this paper new stop band design is proposed with polarization and angular independence. The unit cell size is reduced up to $\lambda_0/8$ without compromising the polarization stability.

2. Proposed Unit Cell

From the equation of resonant frequency $f=1/2\pi\sqrt{LC}$ it is evident that L and f are inversely proportional. So the unit cell is designed with the notion to increase the inductance in terms of patch length in limited space.

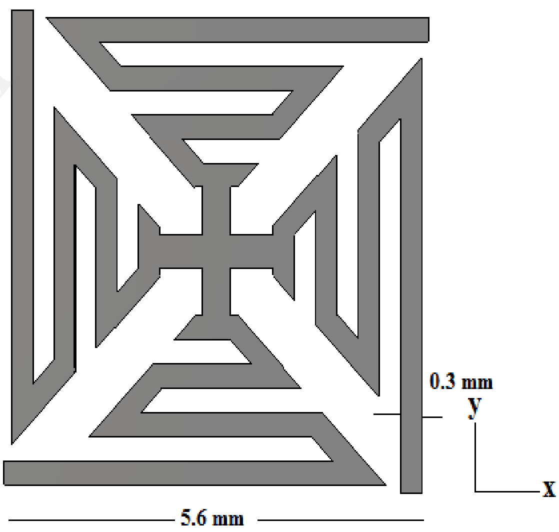

Figure 1. Proposed Unit Cell

The width of the strip is 0.3mm and length to be 5.6 mm FR 4 substrate is used with thickness of 1.6mm having loss tangent of 0.025 Floquot mode of excitation is used to read the transmission coefficient. Figure 2 shows the TE and TM mode response of the proposed design

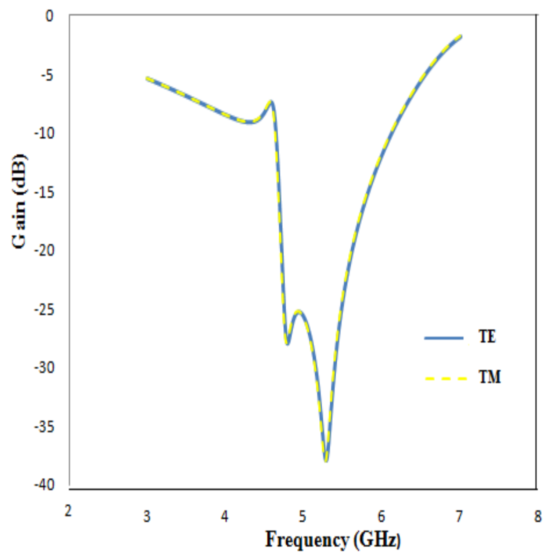

Figure 2. Simulated TE and TM mode response for normal incidence

3. Oblique incidence angle response

Practical implementations of filters and shields must perform stable for waves in all polarization and incident angles. For that the unit cell is illuminated with plane wave of different incident angles and the response is plotted. Figure 3 shows the TE mode transmittance.

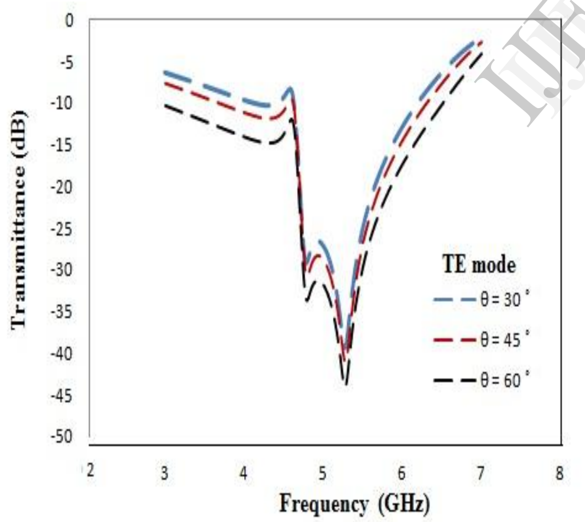

Figure 3. Oblique Incidence Response for TE mode

There are minor deviations in gain is noticed when the angle of incidence is varied. This is occurred in TM mode transmittance also that is plotted in figure.4. Some ripples are introduced at 6.5 GHz but the design provide sufficient stop band performance from 5.2 GHz-5.8GHz for the proposed application.

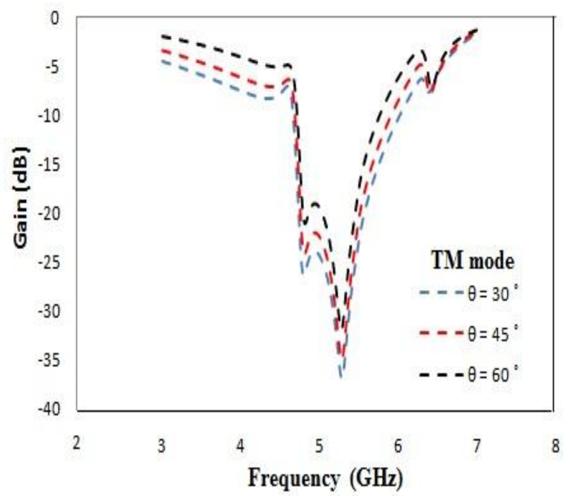

Figure 4. Oblique incidence response for TM mode

In this design inductive patches are etched on both side of the substrate and the transmission coefficient is noted. Complementary structures based on Babinet's principle are used to further reduce the dimension. The effect is portrayed in Figure 5.

$$L = \mu_0 \frac{D}{2\pi} \log\left(\frac{1}{\sin\left(\frac{\pi w}{2D}\right)}\right) \quad (1)$$

$$C = \epsilon_0 \epsilon_{eff} \frac{2D}{\pi} \log\left(\frac{1}{\sin\left(\frac{\pi s}{2D}\right)}\right) \quad (2)$$

equation 1 and 2 are useful in finding inductance and capacitance value of the FSS structure .strip width w, patch dimension D, periodicity s and the substrate thickness all are cumulatively deciding the performance of the FSS.

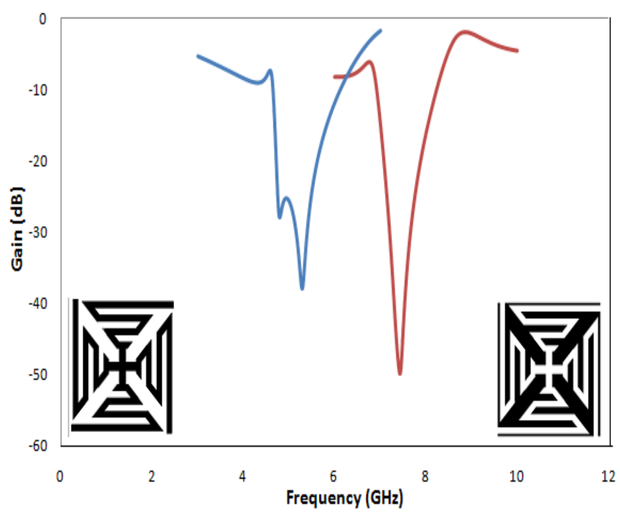

Figure 5. Complementary Response

4. Conclusion

Stop band filter has been designed with angular and polarization stability. It has given 800MHz bandwidth at 20 dB. The proposed structure is compact and has 60% center frequency reduction compared to crossed dipole structure of same dimension. Next work will focus on tunability of the design and further reduction in dimension without causing the stability

5. References

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