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DESIGNING OF BAND STOP FREQUENCY SELECTIVE SURFACE FOR 5G APPLICATION

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ABSTRACT

The widespread use of mobile phones has led to the placement of mobile phone base stations everywhere in the modern world. According to scientific research, however, these mobile base stations have increased the degree of radio frequency exposure, leading to problems with health issues. As a result, a single layer, band stop FSS for WiMAX (3.3 GHz to 3.7 GHz) and 5Gn78 (3.3 GHz to 3.8 GHz) band is presented with an integrated single sided FR-4 substrate to lower the levels of RF exposure within building walls. To provide dual band response, polarization insensitivity, and broad angle of incidence stability with a reduced size, the design develops from a fractal cross dipole. Results obtained indicate that the suggested FSS element shape has a stable frequency response with attenuation levels of at least 20 dB for both transverse-electric (TE) and transverse-magnetic (TM) polarizations when the angle of incoming wave is adjusted from 0° to 60°.

Keywords: Frequency selective surface, WiMAX Band, 5G n78 band, Dual Band FSS

1. INTRODUCTION

Theneed for communication data has increased as a result of the development of multimedia entertainment applications and smart devices like tablets, smart watches and smart phones. The use of the Internet of Things (IoT), device-to-device and machine-to-machine communication has recently come under scrutiny by a number of researchers, which has increased demand for communication data [1, 2]. According to a recent report it is predicted that global mobile traffic will increase more than ten times over current figures. As a result, the fifth generation (5G) of communication is anticipated to advocate for a massive data transmission to resolve the issues with mobile traffic congestion.One of the suggested strategies for achieving the goal of 5G communication is to deploy smaller cells in order to increase the available bandwidth for data transfer [3, 4].

The aforementioned method does handle larger communication data, but it also causes base station numbers to increase exponentially. The expansion of mobile base stations provides a possible risk of electromagnetic

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interference (EMI) or radiation to human life as well as some sensitive electronic equipment, either directly or indirectly [5].

Additionally, the X-band frequency is frequently used for satellite communication as well as airport radar systems [6, 7]. For detecting reasons, these systems frequently consume a lot of power, which severely interferes with other wireless devices. The intensive care unit (ICU) in a hospital, for instance, is equipped with a variety of delicate medical devices that are used to support human life and the storage facility for military elements, such as communication devices for military explosive materials and flammable liquid, which are sensitive to these electromagnetic radiations. Protecting against all of these undesirable electromagnetic radiations is consequently crucial.

A planar periodic array structure called a frequency selective surface (FSS) is built up on top of a dielectric substrate from either radiating or non-radiating elements. FSS is being presented as a solution to the aforementioned issue since it behaves like a spatial filter that selectively blocks specified frequencies while remaining transparent to other frequency signals [8].The FSS works according to frequency, as opposed to microwave filters, angle of incidence, and electromagnetic wave polarizations, which can only work in one of these three ways. A bandpass or bandstop filter is therefore often used in the construction of FSS. Additionally, FSS is frequently used as the beam switching solution for smart antenna systems, the sub-reflector to improve the performance of theantenna, RFIDs, resonant beam splitters, electromagnetic interference (EMI) protection and lenses, even though the adjustment of the radar cross section is thought to be the most exciting feature of this technology [9]-[14]. Antennaradomes and Radar cross-section control (RCS) are now the two most well-knownapplications of FSSs.Their performance is constrained by design issues including the requirement for insensitivity and compactness to incidence angle, as well as EM wave polarization, which makes it necessary to enhance their design features. Since FSS is used so widely, it is important to consider how easily existing buildings and equipment may be integrated into the system as well as interoperability with other devices.

In this paper, a polarization- and angular-independent dual band FSS design is put forth. Without compromising the stability of the polarization, the unit cell size is decreased. Section 2 discusses the design specifics, including the square loop FSS's measurements. Section 3 describes the simulation using computer simulation technology (CST) software and discussions. Finally, section 4 presents the proposed FSS's conclusion and its long-term effects.

2. FSS DESIGN AND ANALYSIS

The designed band stop FSS for WiMAX and 5G n78 band is made of a single-sided FR-4 dielectric substrate with dimensions of 20x20 mm^2, thickness of 1.6 mm, relative dielectric constant of 4.4, and loss tangent of 0.02. Table 1 displays the FSS structure's specifications whereas Fig. 1 depicts the proposed FSS unit cell for WiMAX and the 5Gn78 band.

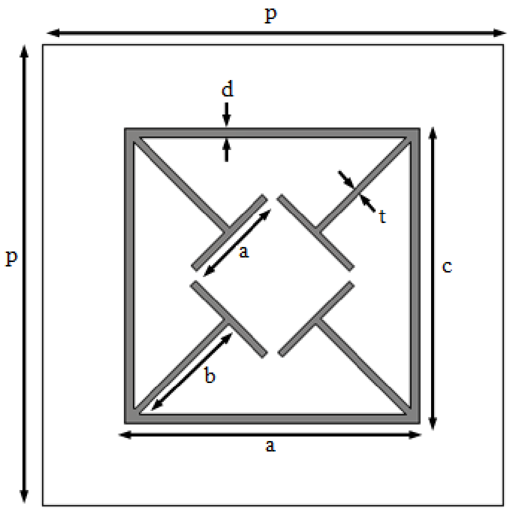

Fig.1.Proposed FSS unit cell for WiMAX and 5G n78 band

Table.1. Parameters of FSS

Variable	**p**	**a**	**b**	**c**	**d**	**t**
Size (mm)	20	4.4	6.25	12.8	0.4	0.3

3. RESULTS AND DISCUSSION

a. Transmission Coefficient:

Figure 2 depicts the S parameter in terms of S11 (dB) and S21 (dB) versus frequency. The graph shows that the proposed dual band FSS discards wireless communication transmission at the WiMAX band's downlink frequency (3.3 GHz to 3.7GHz) and the 5Gn78 band's uplink frequency (3.3 GHz to 3.8 GHz). It has a broad bandwidth ranging from 3.4 GHz to 3.7 GHz. By using computer simulation technology, the outcomes of the intended FSS have been simulated.

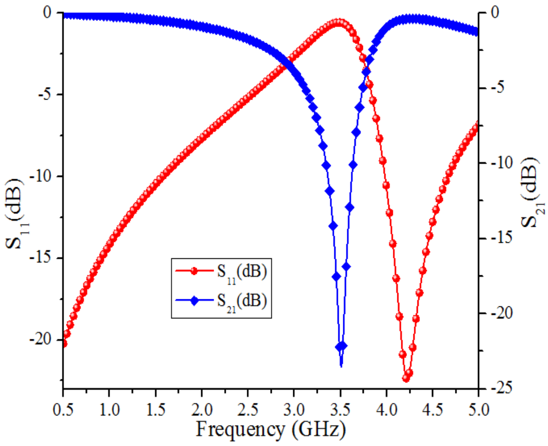

Fig. 2. Simulated transmission Coefficient of dual band FSS

b. Incidence Angle Variation:

To evaluate the polarization characteristics, the transmission response for TE mode and TM mode is illustrated in Figures 3 and 4 at various incidence angles. For both TE and TM mode, it has been noted that the FSS's frequency response is stable. Additionally, the incidence-angle insensitivity of the structure means that the bandstop transmission response is largely unchanged at incident angles below 30^0, suggesting that it may be employed for more complex applications.

The resonance frequency and band width at TE and TM are shown in table 2. By comparing the data in table below, it can be shown that the proposed dual based FSS has homogeneity throughout its whole array structure. The dual-based FSS mentioned above assessed for both TE and TM types of characteristics.The resonance frequency for both the TE and TM polarizations is practically the same, around 3.5 GHz, and the bandwidth decreases between 50° and 60°. Therefore, both on the higher band and on the lower band, the resonance frequency varies.

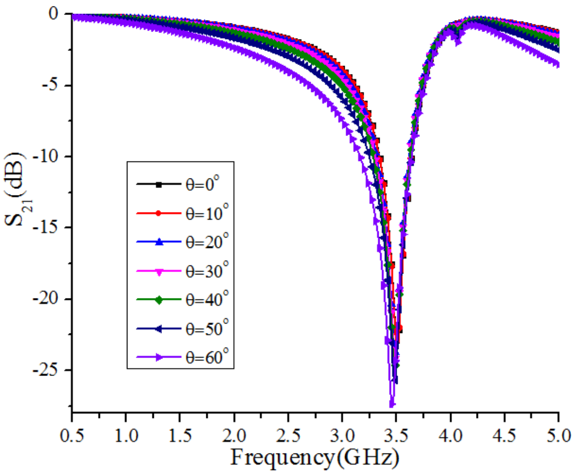

Fig.3. Incident angle variation (TE mode)

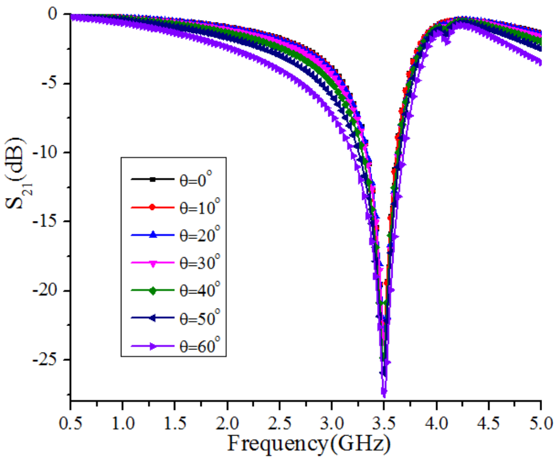

Fig. 4. Incident angle variation (TM mode)

Table.2. Different stages under various incidence angles

Angle	**Resonance Frequency (GHz)**		**Frequency Band (GHz)**	
	TE	**TM**	**TE**	**TM**
0º	3.50	3.51	3.34-3.64	3.33-3.60
10º	3.50	3.51	3.33-3.64	3.32-3.61
20	3.48	3.50	3.31-3.62	3.33-3.62
30	3.48	3.50	3.30-3.62	3.32-3.63
40	3.48	3.48	3.28-3.63	3.29-3.62
50	3.47	3.49	3.24-3.64	3.25-3.64
60	3.47	3.49	3.16-3.64	3.19-3.68

c. Parametric Variations

The width of the dipole strip “a” and “t” is further varied for parametric analysis as shown in figure 5 and 6. The resonant frequency likewise a change as the copper strip’s “a” and “t” width does. The width change in relation withfrequency is depicted in table 3. It indicates that the resonant frequency varies from 3.53 GHz to 3.42 GHz when the square patch’s width of changes from 4 to 4.8 mm by adjusting the parameter "a." In contrast, the resonant frequency moves from 3.41 GHz to 3.56 GHz as the square patch's width (“t”) varies from 0.20 to 0.40 mm. After comparing the parametric values, it is found that the strip width of 0.3 mm provides good resonance properties.

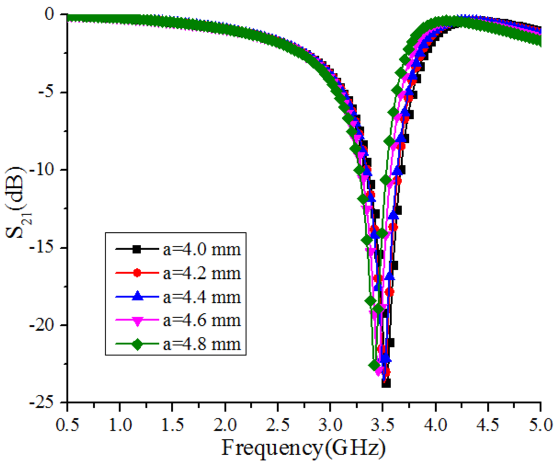

Fig. 5. FSS S21 plot (a Variation)

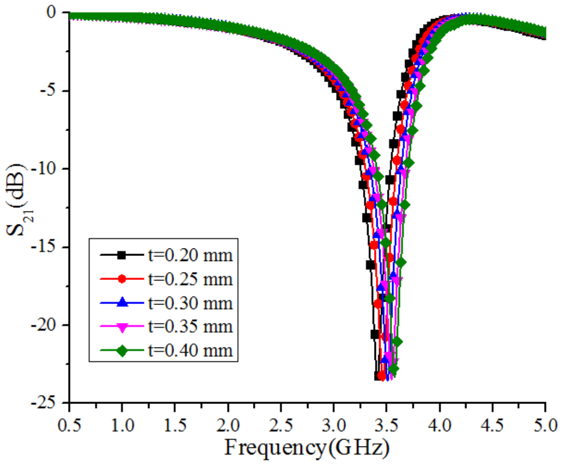

Fig.6. FSS S21 plot (t Variation)

Table.3. Width variation with respect to frequency

Width (a) mm	**Frequency (GHz)**	**Width (t) mm**	**Frequency (GHz)**
4.0	3.53	0.20	3.41
4.2	3.51	0.25	3.46
4.4	3.50	0.30	3.50
4.6	3.45	0.35	3.54
4.8	3.42	0.40	3.56

4. CONCLUSION

A novel bandstop frequency selective surface has been presented for minimizing electromagnetic radiations by changing the building walls with FSS. This specifically built FSS excludes the worldwide mobile communication system, which includes the 5Gn78 spectrum and the ISM band for GSM with WiMax.The suggested FSS's performance is enhanced by the parametric change of the element's length, breadth, inter-element spacing, and element shape. The simulated FSS unit cell findings from computer simulation technology microwave studio have been used to assess the intended FSS's structural makeup. The FSS framework can be expanded in the future to accommodate various broadband uses.

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