Design and Development of Frequency Selective Surfaces for Microwave Filtering Applications

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Doctor of Philosophy

By

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CHAPTER 4 SUMMARY, CONCLUSION AND FUTURE SCOPE

4.1. Summary and Conclusion

4.2. Future Scope

4.1. Summary and Conclusion

Due to the diverse applications FSS, researchers have increasingly focused their attention on this area of study. In recent years, various bandstop and bandpass structures have been introduced. Researchers have explored two-layer structures and incorporated vias to achieve angular stability in bandstop configurations. In the current research, a single straight-line FSS structure has been devised to block specific frequencies in satellite downlink signals.

In existing literature, achieving a rapid roll-off in the bandpass response of FSS structures often involves employing Substrate Integrated Waveguide (SIW) structures or vias, introducing complexity to the overall design. However, in the present research, an innovative approach has been taken where the bandstop resonance frequencies are strategically adjusted at the passband edges. This adjustment aims to achieve a swift roll-off in the frequency response without the added complexity associated with SIW structures or vias.

The following section discusses the present thesis's theoretical improvements and research findings.

Chapter One of This Thesis provides a thorough literature overview of the badstop and bandpass FSS, basic concepts of FSS and motivation and objective of the research work.

In Chapter 2, high angular stability dual-band (C- and X-band) stop frequency selective surface based spatial filter has been designed for blocking the satellite downlink frequencies. The unit cell of the structure consists of vertical and horizontal dipoles having two folded arms. The transmission coefficient of the filter in the designated satellite frequency bands, i.e., 3.7-4.2 GHz and 7.25-7.75 GHz has been obtained less than -10 dB. The current distribution and the equivalent circuit model of the unit cell have been illustrated to explain the resonance behavior and response of the filter. The proposed structure gives a stable response up to 85^0 of oblique incidence for both TE and TM polarizations. A prototype of the proposed structure has been fabricated, experimentally tested, and validated with simulation results.

In Chapter 3, a novel frequency FSS based spatial bandpass filter for TM-polarized waves has been presented. The unit cell of the proposed FSS consists of a dielectric substrate with two conducting layers on opposite sides. One magnetic resonator is placed on the top conducting layer, while two pairs of electric resonators are positioned on the bottom conducting layer to provide a fast roll-off bandpass characteristic. The simulated values of the -3 dB to -10 dB roll-off factor for the proposed structure are 140 dB/GHz and 280 dB/GHz on the lower and upper sides of its passband, respectively. These simulated roll-off factors are compared with the simulated results of the band-pass FSSs reported in the literature, demonstrating an advantage (has fast roll-off and very simple design) of the proposed filter over the filters mentioned in previous works. To validate the simulation results of the proposed structure, a prototype of the FSS-based filter was fabricated and tested experimentally.

A dual-bandpass frequency selective surface designed for TM polarized waves. The structure designed for single polarization (the structure has not 90^0 rotational symmetry). The FSS unit cell comprises a dielectric substrate sandwiched between two conducting layers. The top conducting layer features two magnetic resonators, while the bottom layer has two pairs of electric resonators, collectively providing a fast roll-off bandpass characteristic. The conventional single slot layer bandpass structure exhibits slower roll-off, which prompted us to make improvements. By incorporating two stop-bands and carefully adjusting their positions at the pass band edges, we successfully achieved a fast roll-off (350 dB/GHz at lower side and 82 dB/GHz at upper side of lower pass band and (107 dB/GHz at lower side and 93 dB/GHz at upper side of upper pass band). To validate the simulation results, a prototype of the proposed FSS was fabricated and conducted experimental testing. The results of the experimental tests confirmed the effectiveness and efficiency of the proposed design.

4.2. Future Scope

Examining the current bandstop FSS is valuable for creating straightforward, high-angular-stability, multiband FSS structures tailored to stop various frequencies in microwave shielding applications. By adding one more arm to the dipoles of the reported band stop structure, an angularly stable tri band structure can be designed.

The investigation into present bandpass structures is useful for crafting uncomplicated, fast roll-off, multiband bandpass structures suitable for radome applications. In the proposed structure, by adding magnetic dipoles on the top layer and electric dipoles on the bottom layer, a fast roll-off multi band FSS can be designed.