

DESIGN OF A DUAL-BAND FREQUENCY SELECTIVE SURFACE WITH HIGH SHIELDING EFFECTIVENESS AND PHASE LINEARITY FOR ELECTROMAGNETIC PROTECTION IN NEXT-GENERATION COMPUTING AND IOT SYSTEMS

Kousik Roy^{1*}, Pratik Dey², Kamlesh Kumar Chaurasia², Sandeep Kumar Mahto², Pankaj Kumar Mandal², Vishal Kumar², Shruti Pandey¹ and Subrata Kumar Majumdar³

¹Department of Computer Science and Engineering, Bengal College of Engineering and Technology, Durgapur-713212, West Bengal

²K.K.Group of Institutions, Dhanbad-828109 (Jharkhand), India

³Department of Mechanical Engineering, Sanaka Educational Trust, Durgapur-713212, West Bengal

*Corresponding Author Email ID: kousikroy002@gmail.com

ABSTRACT

In this paper, an ultra-compact $16 \times 16 \times 1.6$ mm³ dual-band Frequency Selective Surface (FSS) is proposed for EM interference shielding in computing and IoT devices. The FSS demonstrates two stop bands (6.96–10.22 GHz with a suppression of 38 dB, and 12.34–13.82 GHz with a suppression of 28 dB), with a peak shielding effectiveness of 88 dB. The structure remains stable against TE/TM waves at diverse angles, and surface currents at 8.28 GHz affirm resonance localization. Near-linear reflection phase facilitates smart antennas, beamforming, and reconfigurable RF modules and is therefore suitable for secure, AI-driven IoT platforms.

Keywords: Frequency Selective Surface, Dual-Band, Shielding Effectiveness, IoT, Electromagnetic Interference, Phase Linearity, Edge Computing.

1. INTRODUCTION

As smart technologies and edge-based IoT networks continue to grow, electromagnetic compatibility is increasingly becoming a design issue. Interfering devices commonly experience mutual electromagnetic interference resulting in data loss diminished performance or hardware malfunctions. Next-generation computing and IoT systems increase the need for sophisticated EM shielding to provide system integrity and data security [1]. Dual-band frequency selective surfaces (FSSs) address this demand by providing selective attenuation over several bands with polarization and angular stability [2], while maintaining high shielding effectiveness and phase linearity in broadband environments [3]. Compact miniaturized unit cell dual-band FSSs with convoluted metal structures are appropriate for space-constrained IoT applications [4], while energy-selective surfaces (ESSs) advance shielding by wideband coverage and material breakthroughs [5]. Tunable FSSs provide adaptive shielding in dynamic wireless environments [6]. Multifunctional and active FSSs with p-i-n diodes deliver EM switching as well as polarization control [7], and substrate integration such as glass allows for varied applications, such as Wi-Fi/WLAN shielding [8].

Unidirectional stable resonance at any angle and polarization is achieved by a single layer FSS cross-shaped with interdigital capacitance on corners of patches on one side of the substrate [9]. A tripole unit cell FSS on both sides of FR4 substrate is presented in Reference [10], which gives a good shield from 3.2 to 8.82 GHz to cover the C and X bands.

2. DESIGN METHODOLOGY

Figure 1 shows the simulated dual-band FSS unit cell (16×16 mm², 1.6 mm thick), consisting of a periodic resonant array on an FR4 substrate ($\epsilon_r = 4.4$, loss tangent = 0.02). Designed through full-wave