

Broadband Cross-Polarization Conversion Using Metasurfaces

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Controlling electromagnetic (EM) wave polarization is vital for applications like imaging, optical sensing, biotechnology, and communication. Traditional methods, such as the optical activity of crystals and the Faraday Effect, while effective, are limited by bulkiness and narrow bandwidths, making them unsuitable for modern needs. Metasurfaces, engineered two-dimensional structures, offer a compact and versatile alternative, enabling advanced functionalities like reflect arrays, polarization-sensitive devices, and radar cross-section reduction. This innovative approach addresses the limitations of conventional methods, providing scalable and efficient solutions for contemporary technological demands [1].

This paper introduces the design, simulation, and experimental validation of a broadband metasurface optimized for enhanced cross-polarization conversion across the X-band frequency range. The metasurface, designed as a reflective cross polarization conversion (CPC) structure, incorporates concentric circular split-ring resonators (C-SRRs) on an FR4 substrate, effectively transforming circularly polarized waves into their orthogonal counterparts upon reflection. The proposed design achieves a remarkable 3 dB fractional bandwidth, representing the highest reported bandwidth for a CPC metasurface on an FR4 substrate with a metallic ground plane. The layout of the proposed design which is simulated by 3D EM simulator is given in Fig. 1. The prototype is implemented and shown in Fig. 2. The simulations and measured results align closely, demonstrating a reflection coefficient dip of -39 dB at the resonant frequencies with minimal power loss as shown in Fig. 3. The cross-polarization coefficients, confirming effective polarization conversion, are shown in Fig. 4. The fabricated prototype validates this methodology, demonstrating its potential for advanced communication systems and radar technologies.

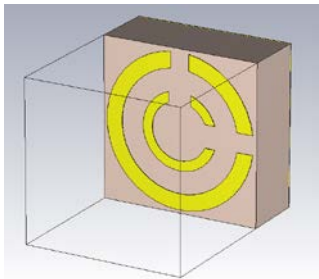


Figure 1: Schematic of the proposed concentric circular split-ring resonator (C-SRR) unit cell.



Figure 2: Prototype of the unit cell featuring concentric circular split-ring resonators (C-SRR).

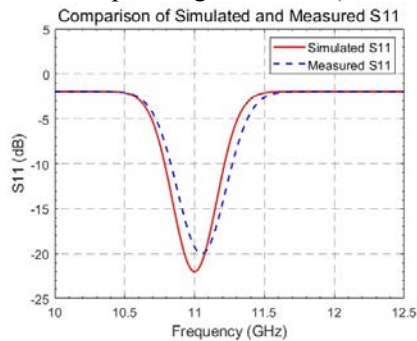


Figure 3: Comparison of simulation and measurement results

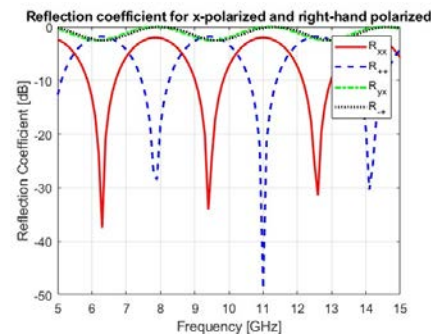


Figure 4: Cross-polarization coefficients

References:

[1] A. Eroglu, RF/Microwave Engineering and Applications in Energy Systems. Wiley, 2022, ISBN: 978-1-1192-6879-6.