

Title: Double elliptical resonator based quad-band incident angle and polarization angle insensitive metamaterial absorber for wireless applications

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Abstract: In this article, a double elliptical split ring resonator-based quad band [metamaterial](#) absorber (MMA) is demonstrated for applications in the microwave range. The [resonator](#) is made up of four squares outside split rings and two elliptical split rings positioned in the middle of the structure. The resonating patch is placed over an FR-4 dielectric layer with a thickness of 1.6 mm. The unit cell has an electrical size of $0.103\lambda_0 \times 0.103\lambda_0$, where λ_0 is the wavelength determined at 2.576 GHz. The MMA shows maximum absorption of 99.83% at 2.576 GHz, 99.98% at 5.648 GHz, 99.56% at 8.32 GHz, and 99.15% at 13.456 GHz with TE mode. For TM mode, at 2.576 GHz, 5.632 GHz, 8.304 GHz, and 13.44 GHz, corresponding absorptions are 99.21%, 99.67%, 99.5%, and 99%, respectively. The MMA is polarisation and incidence angle (0° to 90°) insensitivity for both TM and TE modes. The unit cell provides single negative characteristics including an EMR (effective medium ratio) of 9.71 and a Q factor (quality factor) over 25. The proposed MMA provides high [harvesting efficiencies](#) of 92.87%, 76.9%, 94.12%, and 90.97% for frequencies of 2.57 GHz, 5.64 GHz, 8.32 GHz, and 13.45 GHz, correspondingly. The equivalent circuit is modeled to understand the resonance behavior of the MMA and the circuit parameters are determined and validated using Advanced Design Systems (ADS) software. The performance of the MMA is examined using the prototype of the array of the unit cells in an experimental setup. The experimental outcome provides a close similarity with simulation outcomes indicating the good performance of the MMA. The [metamaterial](#) absorber's high performance makes it suitable for many applications, such as RF [energy harvesting](#) applications, image technologies, stealth technologies, and [radar systems](#) as well as minimizing electromagnetic interference in satellites.

Keywords: Metamaterial absorber (MMA) Double elliptical split ring resonator Quad-band absorption Microwave applications Polarization insensitivity

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