

Miniaturized ultra-wideband antenna using microstrip negative index metamaterial

ABSTRACT

A three left-handed metamaterial unit cell antenna is presented in this article for ultra-wideband applications. Each left-handed metamaterial unit cell is a combination of a modified octagonal split-ring resonator, an octagonal spiral resonator, a capacitance-loaded strip, and a wire in order to achieve a design that simultaneously exhibits both negative electrical permittivity and negative magnetic permeability, which promises an extraordinary index of negative refraction to enhance the radiated power of the antenna, consequently improving the antenna system. The antenna design was etched on an FR4 epoxy substrate (Farnell Electronic Components Limited, Selangor D.E., Malaysia) with an evident compact size of $25 \times 25 \times 1.6$ mm³. Return loss measurements demonstrated that this antenna achieves 94% bandwidth for a voltage standing wave ratio less than 2 over the frequency band of 5.2-13.9 GHz, with a maximum gain and directivity of 3.85 dBi and 5.45 dB, respectively, at 10.5 GHz. These measurement results show good agreement with those of the simulations as well as good omni-directional characteristics within its operating frequency band. The proposed metamaterial antenna is compact and highly directive and has a tunable operational frequency especially for ultra-wideband applications.

Keyword: Left-handed metamaterials; Metamaterial antenna; Split-ring resonator; Ultra-wideband