Ultra Wideband Low Profile Single-Arm Spiral Antenna Using Electromagnetic Bandgap Structures

Mohammad Saed
Texas Tech University, Lubbock, Texas, USA

Email: mohammad.saed@tu.edu

Electromagnetic band-gap (EBG) structures exhibit unique electromagnetic properties that have led to a wide range of applications in electromagnetics. In this paper, electromagnetic bandgap structures are utilized to enhance the bandwidth of a low-profile, unidirectional, one-arm Archimedean spiral antenna built on a thin substrate and backed by a ground plane. It is well known that placing a ground plane (a perfect electric conductor) closely behind a spiral antenna to make the radiation unidirectional severely limits the antenna bandwidth. In order to mitigate the ground plane effect, and therefore increasing the bandwidth significantly, electromagnetic band-gap structures are employed. Specifically, the one-arm spiral is placed over an EBG surface which in turn is backed by a ground plane. Several types of EBG surfaces are investigated for this antenna. These surfaces use a variety of periodic patch shapes. To simplify the construction, the patches are not connected to the ground plane. The EBG surfaces behave as artificial magnetic conductors in the frequency band of operation. The use of EBG structures with planar antennas such as microstrip and printed dipoles was investigated in the literature, primarily, to suppress surface waves resulting in increased antennas efficiency and better radiation patterns. Some attempts to incorporate EBG structures with spiral antennas appeared in the literature. However, they differ greatly from our proposed configurations, both in the EBG structure used as well as the obtained results.

The proposed antenna configurations were investigated theoretically using Ansoft Designer which uses a frequency domain full-wave method based on the method of moments. Furthermore, theoretical simulations in the time domain were carried out using the FDTD technique. Parametric studies to understand the effect of geometrical and substrate parameters on antenna performance (impedance bandwidth and radiation patterns) is carried out. Theoretical results were verified experimentally. It has been shown that the proposed antenna improved the bandwidth greatly. The design details along with simulation and experimental results will be presented.