A Low Profile Wideband Single-Arm Spiral Antenna Using EBG Structures

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Electromagnetic band-gap (EBG) structures exhibit unique electromagnetic properties that have led to a wide range of applications in electromagnetic devices. In this paper, electromagnetic bandgap structures are utilized to enhance the bandwidth of a low-profile 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, thus, significantly increasing the bandwidth, 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. Two EBG surfaces are investigated for this antenna: one utilizes a periodic structure of rectangular patches and one uses a periodic structure with fork-like patches. 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 are investigated theoretically using Ansoft Designer which uses a full-wave method of moments solver. Parametric study to understand the effect of geometrical and substrate parameters on antenna performance (impedance bandwidth and radiation patterns) is carried out. It has been shown that the proposed antenna with both EBG surfaces significantly improve the antenna bandwidth. The design details along with simulation and experimental results will be presented.