Guided-Wave Analysis of Antennas with Electromagnetic Bandgap Ground Planes

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Antennas backed by Electomagnetic Bandgap (EBG) ground planes are quite attractive for low-profile and conformal antenna applications. Certain antenna types, such as dipoles or spirals, can be placed much closer to an EBG ground plane than to a metallic conducting ground plane. An EBG ground plane also limits interaction between the antenna and its immediate environment, which can help maintain pattern shape and impedance bandwidth when the antenna is mounted on an object or vehicle. As a result, many EBG-backed antenna designs have been published recently.

EBG-backed antennas are usually created by designing the EBG surface and antenna separately, then modifying the antenna to account for detuning due to the near-field interactions between the antenna and the EBG ground plane. This work aims to improve understanding of the interaction between the antenna and EBG surface, enabling the antenna and EBG to be developed in tandem for more flexible and effective design.

The author asserts that the antenna-EBG system can be represented as a transmission line in which one conductor is the EBG surface. A generalized mathematical analysis of wave propagation on such a line is presented, including characteristic impedance and dispersion behavior. Next, the behavior of a previously-published EBG-backed antenna design is analyzed within this context, identifying the relationship between the EBG-backed transmission line mode and the antenna pattern and impedance performance.

The analysis of the previously-published design finds that surface wave modes of the EBG surface also strongly influence the performance of the EBG-backed antenna. Surface waves can be strongly excited outside of the EBG's surface wave band gap, which can result in radiation pattern deformation.