Multilayer Resonator Model for High Impedance Ground Planes: Terminated Test Case

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This work is a preliminary study of a transmission line model for an electrically small antenna above a high-impedance surface (HIS) ground plane. In the region where the antenna covers the HIS layer, the combined structure can be modeled as a multiconductor transmission line with lumped element loads. If the antenna width is relatively narrow, the multiconductor transmission line is approximately modeled by stacked microstrip lines. In this work, we examine a terminated stacked microstrip line structure in order to verify that the stacked microstrip model correctly models the electrical length of an HIS-backed antenna. By considering a terminated structure, we can separate the guided wave behavior from the radiation mechanism.

Multilayer transmission lines were recently used by (F. Elek and G. V. Eleftheriades, IEEE Microw. Wirel. Compon. Lett., 14, 9, 434-436) to analyze wave propagation on a shielded EBG surface. We use a similar approach to represent the combined microstrip line-HIS structure. In our model, discontinuities in the HIS are modeled as lumped circuit elements using well-known closed-form expressions. The structure is fed by either differential or probe excitation of the upper microstrip (antenna) layer. The upper microstrip layer and the HIS layer are both terminated by lumped impedances. The circuit model then predicts the frequency-dependent impedance behavior of the terminated HIS-backed microstrip structure. These predictions are compared with full-wave simulation.