A Lattice-Based Equivalent Circuit Model for Frequency Selective Surfaces

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The analysis of frequency selective surfaces (FSS) typically consists of simulation through commercial software packages, full-wave EM treatment (e.g. using Floquet boundary conditions), or circuit models based on RLC components. Although simulation and full-wave techniques are usually very accurate, they can be computationally expensive and may afford little physics-driven intuition for the purpose of design. Robust circuit models can provide a more intuitive understanding of FSS operation, but they tend to treat FSS as bulk structures, avoiding the complicated electromagnetic interactions between individual unit cells but achieving less flexibility or accuracy. It is of interest, therefore, to develop new models that achieve a balance between the accuracy of full-wave techniques and the intuitive nature of circuit models.

This work highlights efforts investigating an analytical technique that represents an FSS as an infinite lattice of lumped impedance elements. In particular, each individual unit cell in the FSS is assigned its own self impedance, and coupling between any two unit cells is represented by mutual impedance elements. Further, each unit cell is treated as a single port in an N-port network. The reflection characteristics of this N-port network are determined by calculating the equivalent impedance of the impedance lattice. This is accomplished using a lattice Green's function solution to a finite difference equation. To demonstrate the utility of the new model, the performance of a rectangular aperture FSS is calculated and compared to simulation results. The potential application of the model to more complicated FSS designs – including those with multiple layers and N-fold symmetry – is also discussed.