Dual-band and Tri-band Fabry-Pérot Resonant Cavity Antennas Using Multiple FSS Layers

Krishna Kota*, David R. Jackson, and Stuart A. Long
Department of Electrical and Computer Engineering
University of Houston
Houston, TX 77204-4005

Two-dimensional (2-D) leaky-wave antennas (LWAs) have the ability to easily produce highly directive pencil beams at broadside. One example of a 2-D LWA is the Fabry-Pérot resonant cavity antenna using a partially reflecting surface (PRS). Recent advances in the study of these structures include techniques for bandwidth enhancement. Often the bandwidth enhancement is achieved by use of multi-layer PRSs. In some applications, multiband operation will suffice, and broadband operation is not needed. Here we examine dual-band as well as tri-band versions of the Fabry-Pérot resonant cavity antenna that use multiple metal-patch FSS layers over a ground plane to form a composite artificial ground plane, which replaces the single metal ground plane of the conventional structure.

The main design principle of the general multiband Fabry-Pérot resonant cavity antenna is that each FSS layer in the structure has a resonance frequency at which it acts as a short circuit and hence behaves as a “virtual ground plane” at that frequency. Using multiple FSS layers allows for multiple resonance frequencies; this in turn allows the establishment of different frequencies at which the overall cavity structure is resonant, and hence, radiates a beam at broadside.

Reciprocity is used to calculate the far-field pattern of a source dipole inside the structure, in which a plane wave incidence is used to illuminate the structure and the field at the source dipole location is determined (T. Zhao, D. R. Jackson, J. T. Williams, H.-Y. Yang, and A. A. Oliner, *IEEE Trans. Antennas Propagat*., vol. 53, no. 11, pp. 3505-3514, Nov. 2005). A simple transverse equivalent network (TEN) model is used to calculate the field inside the structure due to the plane-wave incidence. In the TEN shunt admittances are used to represent the metal-patch PRS as well as the metal-patch FSS layers that are above the ground plane.

An iterative design procedure is introduced that determines the optimum resonance frequency of the PRS as well as the optimum locations of the FSS layers in the artificial ground plane and the optimum dipole source location. The final design has equal directivities at two or more arbitrarily specified frequencies as well as equal radiated broadside power densities at these frequencies.

Results will first be presented focusing on a dual-band antenna structure. The design procedure will then be further extended to tri-band operation, and results for this will be shown as well.