A Study of Infinite Planar Arrays of Waveguide-Fed Slots

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Waveguide-fed planar slot arrays have been used in a number of space-borne radars. External mutual coupling between radiating elements of a large slot array has been studied as an infinite array problem (Yee, IEEE Transactions on Antennas and Propagation, 40, 775-781, 1992). The infinite array model works well for small number of finite elements in the H-plane (Scharstein, IEEE Transactions on Antennas and Propagation, 38, 1186-1191, 1990). We investigated the infinite array model for possible applications in the design and analysis of a large slot array. The active admittance of a single radiating slot in the presence of an infinite array of slots with alternating offsets is formulated in terms of an integral equation for the unit cell. The integral equations are solved by the method of moments using an entire-domain Galerkin approach. The computed value of the slot admittance in the infinite array environment is found to have a significantly smaller value of bandwidth compared to that of an isolated slot radiator. The impedance bandwidth is further limited for a planar sub-array embedded in a large number of such sub-arrays. Each sub-array consists of stacked rectangular waveguides containing longitudinal broadwall radiating slots, and a feed waveguide that excites the radiating waveguides by means of centered-inclined coupling slots. A study of an infinite array consisting of alternating slot displacements in adjacent waveguides yielded a greater amount of bandwidth for the active admittance. Such a configuration was proposed by Svensson et al. (Microwave Journal, 104-112, Nov. 1999). We have also analyzed large arrays consisting of sub-arrays by considering each sub-array as a unit cell of a periodic structure, thereby approximating the external mutual coupling.

Numerical results have been generated for the active admittance characteristics and the impedance of each sub-array input port as well as the radiation pattern over a range of frequencies of interest. Computed results have been validated using results obtained from the commercial finite element program HFSS. These results will be presented in the symposium.