Analysis and Computation of the Radiation and Mutual Coupling in Large Waveguides Slot Arrays

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Because of their high power capabilities and simple geometrical configuration, rectangular waveguide slot antenna arrays have found relatively broad applications such as in radar and communication systems. There has been an extensive study on the design and analysis methods for a single waveguide slot in a waveguide, as well as on waveguide coupling of a radiating slot to a feeding slot, etc. Among them, the integral equation method using method of moments (MoM) technique has been found to be well-suited for these kinds of problems. However, in the calculation of the MoM operator matrix, the evaluation of internal and external admittance terms involving certain integrals must be done carefully, since one can experience numerical difficulties due to the singularities present in the integrands.

In this study, the method of moments (MoM) has been employed for the analysis of resonant and traveling wave slot antenna array problems involving thousands of slots. The above mentioned numerical difficulties arise in these more complex array type problems as well. Therefore useful, efficient and robust algorithms are developed in this study for the evaluation of all the important internal and external self admittance terms, which correspond primarily to the diagonal elements in the MoM operator matrix. In particular, a hybrid modified ray-mode representation of the dyadic modal waveguide Green's functions is developed for the evaluation of the internal self-admittance terms which can make the summation of modal series within the integrals for the MoM operator matrix converge more rapidly. This approach is an extension of the technique utilized in the MoM analysis of infinite periodic structures and is an extension of the work in [1]. Other approaches for dealing with the convergence problems have also been presented elsewhere for single slots, e.g. [2]. The present MoM method is employed to calculate the radiation patterns of numerous broadwall slot antenna arrays, i.e., both resonant and nonresonant waveguide slot antenna arrays using either offset or inclined slots. The patterns thus computed via MoM account for the array mutual coupling. Numerical results are presented to indicate the utility of the method developed here. In conclusion, the purpose of this work is to arrive at robust numerical procedures to deal with a large number of slots in a rectangular waveguide array that is useful in practical applications, such as those involving a large number of stacked waveguides with each guide containing a large number of slots.

References

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