PhD First Year Report on Theoretical and Experimental Studies on Enclosed Slot Antennas for Spatial Power Combining

ABSTRACT

Spatial power combining provides a viable solution to the realization of solid-state power sources and amplifiers at microwave and millimeter-wave frequencies, with power levels that cannot be achieved by a single solid-state device. For the past decade, we have witnessed a rapid development in spatial power combining for microwave and millimeter-wave applications. But most of the research works worldwide are in the experimental demonstrations of such combiners whose models are generated using general-purpose EM packages.

The commercial software like HFSS, XFDTD use volumetric meshing so that arbitrarily shaped structures can be modeled. These EM packages employ the finite element method (FEM) and finite-difference time domain (FDTD) method, to obtain the field throughout the structure at the nodes of the grid. However, these packages are not able to model the fields of very large EM structures such as large-scale antenna arrays encountered in spatial power combining. They are also very time-consuming.

More rapid EM modeling is achieved when surface discretization is used, as in the Method of Moments (MOM). This requires customized Green's function development for different types of structures. A method for developing spectral Green's functions for a semi-infinite, partially filled rectangular waveguide terminated by a perfectly conducting ground plane is proposed.

Spectral Domain Method of Moments (MOM) is formulated for the enclosed planar antennas inside rectangular waveguide. The vector integral equation is first scalarized into coupled set of scalar integral equations in terms of unknown electric currents. Galerkin's procedure for MOM is applied to transform the integral equations into a system of linear equations. Piecewise-sinusoidal functions are used as basis and weighting functions in the longitudinal direction and pulse functions are used in the transverse direction.

The simulation result of the full-wave analysis of electric-type (patch, strip) antenna inside a rectangular waveguide is presented. First, the simulation result is checked for it's convergence. Secondly, results are compared with the published results for the accuracy of the simulated results. Then, it is used to compute the full-wave analysis of the enclosed planar antenna inside a rectangular waveguide.

Guide: Assoc. Prof. Lei Zhu
School of Electrical & Electronic Engineering
Nanyang Technological University
Singapore