Dyadic Green's Functions for Circular Waveguide-Based Spatial Power Combining Applications

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The work described here was motivated by the necessity to develop a modeling environment for the analysis and design of circular waveguide-based amplifier antenna arrays for spatial power combining. In this design, an array of dielectric resonators or printed antennas inside a circular waveguide fed by a hard horn is coupled to MMIC amplifiers by coaxial probe feeds, which eliminates the multimoding effects in amplifier networks and efficiently isolates the receive and transmit antenna arrays. The analysis is based on the integral equation formulation for induced surface current density with dyadic Green's functions of a circular waveguide resulting in a generalized scattering matrix for coupled waveguide transitions.

Traditionally, dyadic Green's functions for closed-boundary circular waveguides are obtained in terms of eigenfunction expansion using Hansen vector wave functions *L, M,* and *N*. For the waveguide-based scattering/radiation problem described above, it is convenient to use the eigenmode expansion in terms of TE and TM modes of a circular waveguide. Here we present a procedure of deriving electric-type dyadic Green's functions for an infinite or terminated circular waveguide due to an arbitrarily-oriented electric point source. The components of Green's dyadics are obtained in a series form, where the transverse (cross-sectional) eigenvectors of TE and TM modes are normalized by power and the longitudinal part along the waveguiding direction is obtained in a closed form subject to the fitness condition at infinity or the appropriate boundary condition at a termination. This formulation allows for modeling three-dimensional current sources in a circular waveguide environment and provides a physical insight into the hybrid nature of the scattered field. The numerical experiments on the excitation of different waveguide modes were performed by varying the position, orientation, and amplitude of the point sources, and the convergence of Green's functions was studied in the near-field and far-field regions for a single-mode and overmoded waveguide. The numerical analysis of scattering and radiation characteristics of printed and dielectric resonator antennas operating in a circular waveguide will be shown and discussed in the presentation for a few representative structures.