Analysis of Transmission of a Signal through a Complex Cylindrical/Coaxial Cavity by Transmission Line Network Methods

Charles L. Bopp*, III, Chalmers M. Butler, and Frederick M. Tesche
Holcombe Department of Electrical and Computer Engineering
331 Fluor Daniel EIB
Clemson University, Clemson, SC 29634-0915
cbopp@clemson.edu cbutler@eng.clemson.edu fred@tesche.com

The transmission of time-harmonic and transient signals through a complex cylindrical cavity is investigated by methods akin to microwave circuit techniques. The complex cavity may be thought of as multiple cascaded and overlapping coaxial and circular-cylindrical regions or sections with perfectly conducting walls. The sections may have different axial and radial dimensions and may be filled with material having different electrical and magnetic properties. The first and last sections are coaxial cavities or guides in which only TEM modes exist, allowing one to readily perform measurements and accommodate excitation and termination of the complex cavity.

The adjacent sections constituting the cavity have common planar interfaces or boundaries with apertures that may be looked upon as junctions at which two or more waveguides or transmission lines join. An interface may contain more than one aperture and, hence, may be part of the boundary of more than two sections. The guides may support only TEM waves remote from these junctions, they may support higher-order modes, they may support both, or they may support no wave at all. If two guides having a common junction each support only one mode, the junction may be viewed as a two-port network. If additional modes are supported, the number of ports of a network increases. In any event, one can define scattering parameters for each junction in the complex cavity. And these S-parameters can be determined for each junction independently by formulating and solving relatively simple integral equations that account for the junction structure and the nature of the joining guides. Once the junctions have been identified and the scattering parameters for each determined, a composite waveguide or transmission line network can be developed and the overall input/output transfer function for the network representation of the complex cavity can be found by microwave circuit techniques. In addition, as a bit of lagniappe, the scattering parameter network description lends itself readily to the BLT transmission line analysis.

This method of analyzing a complex cavity is under investigation and the results are to be compared with those obtained from more traditional solution methods based on coupled integral equations with eigenfunction kernels. Scattering parameters for the junctions have been obtained and are being compared with measured values under the condition that the cavity is particularized to the simple junction plus an input and output section.