

Guided Wave Scattering and Radiation Solution for Conducting Bodies of Revolution Using the Method of Moments and Modal Excitation

Wendell A. Brokaw^{1,2}, Jie Chen², Thomas X. Wu², and Griffin Gothard¹

¹ Harris Corporation, Melbourne, FL 32902

² School of EE and CS, University of Central Florida, Orlando, FL 32816

A novel full wave analysis method to determine the scattering parameters and the radiation field intensities of arbitrary Body of Revolution (BOR) radiators consisting of impenetrable media is explored through derived components of modal analysis and the method of moments (MoM). Modal excitation is utilized to excite the structural feed; allowing for a more accurate measure of the scattering parameters of the total structure as opposed to the use of external excitation sources. The derivation of the mode matching method introduces a novel approach to achieving a frequency independent coupling matrix that will reduce the computational requirements for iterations utilized in the solution of multi-step discontinuous junctions. An application of interpolation functions across a single element of the MoM's traditional basis function approach allows for the ability to facilitate the meshing of complex structures. The combined field integral equation method is implemented in the analysis method to assure the mitigation of spurious solutions that can be problematic for electric field integral equation solutions that are predominant in many MoM based codes. The structures of interest represent bodies of revolution (BOR), which maintains that the structures must exhibit rotational symmetry about the longitudinal, or directional, axis. The complexity of the domain of structures that can be treated with the analysis method will be significantly reduced through the use of BOR symmetry of the structure. The proposed method for the solution of structures will include the comprehensive treatment of Boundary Value Problems (BVP's) through modal analysis, aperture treatment, and an application of the method of moments.

Solutions for BOR radiating structures can be divided into two regions of analytical concern, the inner guided wave region and the outer radiating region. Modal analysis will be used to determine the scattering matrix of the inner guided wave region. The modal analysis will consist of subdividing the inner region into a number of finite step discontinuities, and the method of mode matching will be implemented to numerically solve the BVP's at each step discontinuity for a finite number of modal field distributions. The surface field equivalence principle will be applied to treat the aperture in order to produce an equivalent problem that supplants a source magnetic current density and an induced electric current density across the aperture that will radiate in the presence of the outer structural material of the BOR radiator. An algorithm utilizing the MoM is applied to solve integral equations that are defined to treat the surfaces of the BOR structure using electromagnetic boundary conditions.



The application of the MoM will develop the field intensities on the aperture with complete consideration of the outer structural boundaries of the BOR radiator. The field intensities on the aperture will be related to the inner guided wave region through electromagnetic boundary conditions, and an admittance matrix will be numerically calculated. The admittance matrix will then apply to the inner guided wave region's scattering matrix to determine the reflection and transmission coefficients at the input of the BOR radiator. The antenna shown to the left is characterized using the proposed solution method, and the comparative results of measured and predicted radiation patterns are shown to the right. The HATCH designations in the legend of the comparative results reflect the proposed method.

