Electromagnetic modeling of composite metallic and dielectric structures

A unified general approach is presented for the electromagnetic analysis of arbitrary structures that consist of metallic bodies embedded into linear piecewise-homogeneous media. It is based on formulating a set of integral equations and its solution using the method of moments.

The analyzed structure is divided into regions with homogeneous media. Using the equivalence theorem, fictitious electric and magnetic currents are placed on the surfaces bounding these regions. A set of integral equations is formulated based on the boundary condition for the tangential component of the electric field. Unknowns in these equations are the equivalent sources, which include currents induced in metallic bodies.

The integral equations are solved by dividing the analyzed structures into surface elements (bilinear quadrilaterals and triangles) and using the polynomial approximation for the distribution of surface currents over these elements. By considering adjacent elements, the continuity equation is automatically satisfied. Special treatment is included of junctions of wire-like elements and metallic surfaces. The Galerkin procedure is used for testing. The kernels of the integral equations are carefully treated, to improve cpu time and maintain high accuracy.

Models of excitations are developed with the aim to provide an accurate description of the analyzed structure and match computed results with experiments. These models include excitations by external fields (plane waves), localized excitations, and deembedding procedures for transmission lines and waveguides.

For large electromagnetic systems, a diakoptic approach is developed. The original system is subdivided into smaller subsystems, each of the subsystems is solved individually to obtain an equivalent representation in terms of surface electric and magnetic currents, and these solutions are combined into the final solution.

The presented set of techniques is implemented in leading industry-standard software. It is capable of accurately and efficiently analyzing virtually any system encountered in antenna, microwave, RF, and EMC practice.

References

[1] Kolundzija,B.M., Djordjevic,A.R., Electromagnetic modeling of composite metallic and dielectric structures, Artech House, Boston, 2002.

[2] Kolundzija,B., Ognjanovic,J., Sarkar,T., Tasic,M., Olcan,D., Janic,B., Sumic,D., WIPL-D Pro. v6.0, WIPL-D, Belgrade, 2006.