The Fundamental Properties of Statistical Power Balance Method at the General Homogeneous Environments

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Nowadays, full-wave numerical methods of Maxwell's equation, such as the finite-element method, finite-difference time domain method, and method of moments, require highly expensive burdens in terms of computation time due to the growing complexity of electromagnetic environments or systems for analysis. An alternative approach is to assess the statistical treatment of electromagnetic (EM) fields, but this has been regarded as the heuristic approach unless the constitutive parameters of the propagation medium are random variables. The valuable theory to relate this statistical analysis in a stationary medium to Maxwell's equation was established for the reverberation chamber (RC) based on the plane wave integral representation with the ensemble average. This ensemble average is usually considered to be physically equivalent to the volume average of a fixed boundary value problem. However, the relation was only proved for a perfectly conducting boundaries possessing the Dirichlet conditions.

Recently, the power balance method (PWB) was proposed to statistically analyze the complex yet homogeneous missile-like system in conjunction with the concept of the EM topology (I. Junqua, J. Parmantier and F. Issac, Electromagnetics, 7-8, 603-622, 2005). This method, although the statistical approach, clearly enables us to readily identify EM propagations on the complex geometries. In this presentation, we will thus provide definite links between statistical results of the PWB and solutions of a deterministic approach at the general homogeneous environments and clarify its some important natures and conditions for this statistical description of the EM fields of deterministic collections. A two-dimensional (2D) lossy cavity driven by a line source, having an extreme condition of incidence attributed to a single component of complex electric field in an ideal case, is utilized as a physical model for this purpose. The environmental loss is characterized by a global quality factor Q, hence its boundary conditions are not specified by the explicit classical form. The mean coupling cross width, a 2D analogy of the mean coupling cross section, is defined for the PWB analysis. Numerical computations are performed and profound understanding of several important physical characteristics of the basic parameters are investigated. Various effects such as the environmental loss and the frequency, etc. on these fundamental parameters are also discussed in this presentation.