Modern EMC Analysis Techniques

Volume I: Time-Domain Computational Schemes

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ABSTRACT

The objective of this two-volume book is the systematic and comprehensive description of the most competitive time-domain computational methods for the efficient modeling and accurate solution of contemporary real-world EMC problems. Intended to be self-contained, it performs a detailed presentation of all well-known algorithms, elucidating on their merits or weaknesses, and accompanies the theoretical content with a variety of applications. Outlining the present volume, the analysis covers the theory of the finite-difference time-domain, the transmission-line matrix/modeling, and the finite integration technique. Moreover, alternative schemes, such as the finite-element, the finite-volume, the multiresolution time-domain methods and many others, are presented, while particular attention is drawn to hybrid approaches. To this aim, the general aspects for the correct implementation of the previous algorithms are also exemplified. At the end of every section, an elaborate reference on the prominent pros and possible cons, always in the light of EMC modeling, assists the reader to retrieve the gist of each formulation and decide on his/her best possible selection according to the problem under investigation.

KEYWORDS

electromagnetic compatibility (EMC), time-domain methods, computational electromagnetics

Preface

In writing a book on contemporary electromagnetic compatibility (EMC) analysis techniques, the authors are well aware that they are delving into a field of challenging innovations pertinent to a large readership ranging from students and academics to engineers and seasoned professionals. Nowadays, EMC technology is more pervasive than ever in many educational, social, industrial, and commercial sectors. Essentially, the widely recognized significance of EMC problems and applications has turned the interest of the scientific community toward their in-depth investigation, with an emphasis on the simulation of the relevant electromagnetic phenomena via highly advanced time-domain methodologies. This is exactly the aim of the two-volume book, which basically reflects the outgrowth of a systematic research performed by the authors for almost a 10-year period in the area of electromagnetic compatibility/interference measurement and modeling. Intended to be self-contained from the computational perspective, the book performs a detailed presentation of most time-domain algorithms, elucidating on their merits or weaknesses, and accompanies the theoretical content with a variety of real-world applications. Thus, having acquired the necessary evidence for every numerical approach, the reader is then free to decide on the best possible scheme for his/her requirements.

Outlining the first volume, devoted to the theoretical establishment of time-domain methods in terms of EMC analysis, Chapter 1 highlights the key issues for their selection as the basic toolkit and gives a brief description along with their most important categories. Thus, apart from the three well-known fundamental formulations, a record of several alternative approaches is also provided. After this preparatory work, Chapter 2 covers the theory of the former concepts, namely, the finite-difference time-domain, the transmission-line matrix/modeling, and the finite integration techniques. Assuming only some mathematics background, each algorithm is examined from different viewpoints concerning its discretization strategy, conditional stability, and convergence rate. Moreover, at the end of every section, an elaborate reference on the prominent pros and possible cons, always in the light of EMC modeling, helps the reader to get the gist of the specific method. On the other hand, all new schemes are illustrated in Chapter 3. Among them, one can discern the finite-element, the finite-volume, the multiresolution, the alternating-direction implicit finite-difference, or the pseudospectral time-domain methods, and particular attention is drawn to higher-order realizations and nonstandard spatial/temporal operators. The last section of the chapter is devoted to hybrid approaches, as a flexible means with combined computational power and adjustable features. Furthermore, the general aspects for the correct implementation of the previous algorithms are included in Chapter 4, where the most significant programming details and modeling hints receive the proper discussion. In this context, a lot of meaningful abstractions related to the excitation procedure, the lattice reflection-error suppression, the absorbing boundary conditions, the curvilinear tessellations, the frequency-dependence of constitutive parameters, and the surface impedance boundary conditions, can be pursued therein.

To bridge the gap between a cursory undergraduate and a formidable specialist's handbook, this book contains a variety of simple EMC examples, so that the core of each method is appreciated without being overwhelmed by cumbersome problems. It is stressed that the interested reader can take avail of the extensive reference list at the end of each chapter to obtain the appropriate information.

Finally, the authors thank Dr. T. T. Zygiridis for his thorough proofreading and valuable suggestions during the preparation of the manuscript. Above all, they do anticipate that the theoretical formulations and numerical results provided in both volumes will inspire the reader to expand its material beyond the stated purpose of developing robust EMC models in the time-domain and help him/her to acquire a better knowledge on the constant evolutions in this pivotal scientific area.

Thessaloniki **N. V. Kantartzis**
December 2007 **T. D. Tsiboukis**

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