Abstracts

A Frequency-Dependent Finite-Difference Time-Domain Formulation for General Dispersive Media

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A weakness of the finite-difference time-domain (FDTD) method is that dispersion of the dielectric properties of the scattering/absorbing body is often ignored and frequency-independent properties are generally taken. While this is not a disadvantage for CW or narrow-band irradiation, the results thus obtained may be highly erroneous for short pulses where ultrawide bandwidths are involved. In some recent publications, procedures based on a convolution integral describing D(t) in terms of E(t) are given for media for which the complex permittivity epsilon*(omega) may be described by a single-order Debye relaxation equation or a modified version thereof. Procedures are, however, needed for general dispersive media for which epsilon*(omega) and µ*(omega) may be expressible in terms of rational functions, or for human tissues where multiterm Debye relaxation equations must generally be used. We describe a new differential equation approach, which can be used for general dispersive media. In this method D(t) is expressed in terms of E(t) by means of a differential equation involving D, E, and their time derivatives. The method is illustrated by means of one- and three-dimensional examples of media for which epsilon*(omega) is given by a multiterm Debye equation, and for an approximate two-thirds muscle-equivalent model of the human body.

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