Abstracts

Accurate modeling of lossy nonuniform transmission lines by using differential quadrature methods

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This paper discusses an efficient numerical approximation technique, called the differential quadrature method (DQM), which has been adapted to model lossy uniform and nonuniform transmission lines. The DQM can quickly compute the derivative of a function at any point within its bounded domain by estimating a weighted linear sum of values of the function at a small set of points belonging to the domain. Using the DQM, the frequency-domain Telegrapher's partial differential equations for transmission lines can be discretized into a set of easily solvable algebraic equations. DQM reduces interconnects into multiport models whose port voltages and currents are related by rational formulas in the frequency domain. Although the rationalization process in DQM is comparable with the Pade approximation of asymptotic waveform evaluation (AWE) applied to transmission lines, the derivation mechanisms in these two disparate methods are significantly different. Unlike AWE, which employs a complex moment-matching process to obtain rational approximation, the DQM requires no approximation of transcendental functions, thereby avoiding the process of moment generation and moment matching. Due to global sampling of points in the DQM approximation, it requires far fewer grid points in order to build accurate discrete models than other numerical methods do. The DQM-based time-domain model can be readily integrated in a circuit simulator like SPICE. Unlike the commercial simulators, which cannot directly handle nonuniform transmission lines, the DQMs model nonuniform transmission lines by using the same procedure as model uniform lines at the same computational cost. Numerical experiments show that DQM-based modeling leads to high accuracy, as well as high efficiency. For both uniform and nonuniform multiconductor transmission lines, the proposed DQM technique is thrice faster than a commercial HSPICE simulator.

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