DGTD Analysis of EM Interactions on Microwave Systems Loaded with Circuit Interfaced Thin Wires

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Abstract— The discontinuous Galerkin time-domain (DGTD) method is gaining popularity among computational electromagnetics (CEM) practitioners. This can be attributed to the fact that it has several advantages over the classical finite element method. The DGTD method realizes "information exchange" between neighboring spatial discretization elements using numerical flux. Therefore all spatial operations are localized within a given element leading to a block-diagonal mass matrix which is inverted very efficiently only once before the time marching starts. Consequently, if an explicit time integrator is used, the DGTD method becomes high compact and efficient.

Despite these advantages, the use of the DGTD method for analyzing electromagnetic field interactions on microwave systems loaded with cables/thin wires has been very limited. Direct application of the DGTD method for solving Maxwell equation on such structures will result in a rather inefficient simulation tool since the DGTD will call for a very fine discretization in the proximity of thin wires. To overcome this problem, in this work, electromagnetic field interactions on thin wires are modeled using the modified telegrapher's equation (MTEs), which describe a simplified relation between transient voltage and current distributions along a given thin wire. Like Maxwell equations, MTEs describes a hyperbolic system of equations, which are discretized using the one-dimensional (1D) DGTD method.

The coupling between the two matrix systems resulting from the discretization of Maxwell equations and MTEs using 3D and 1D DGTD methods is realized by introducing equivalent source terms in each equation set. A weighted electric field obtained from the 3D discretization around the wire is introduced as a voltage source in the MTEs. A volume current density obtained from the 1D discretization on the wire is introduced as a current source in the Maxwell equation describing the Ampere's law equation, respectively.

This hybrid approach does not call for fine a 3D discretization in the proximity of the thin wires increasing significantly the efficiency of the DGTD method. Numerical results, which demonstrate the applicability of the proposed scheme to realistic microwave systems loaded with thin wires, will be presented at the conference.