Modeling Microstrip Feeds using the Finite Element-Boundary Integral Method

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Electromagnetic interference (EMI) is an increasingly important issue for high-speed, mixed-signal circuit applications. The high data transfer rates in modern circuitry leads to new modes of signal coupling amongst circuits. Mixed-signal circuits are especially vulnerable to EMI due to the physical proximity of digital, analog, and radio frequency (RF) circuit components and interconnections between the elements. Interactions can occur via substrate, surface wave, and circuit-to-package-to-circuit couplings as well a host of other more complex routes. It is important to understand the phenomenology of the sources of EMI within complex circuits to minimize the impact of EMI. In the past, low-frequency approximations have sufficed to account for EMI routes within low-speed circuits. However, with increasing speed and hence bandwidth, models that account for distributed effects are increasingly important. One approach has involved the use of microwave circuit parameters, e.g. S-parameters, in a cascade network. This is suitable for design of microwave systems; however, it is difficult to use for EMI analysis. Other methods, involving various hybridizations of S-parameters and the popular circuit design tool SPICE have been used. The best approach, as the frequency of operation increases, is a full-wave model. Since modern mixed-signal circuits are tremendously complex, it is impractical to use a full-wave model for the entire circuit and package volume. Hence, the need to investigate each source of EMI to understand how emissions from one point in a circuit couples into another point. One area of particular interest is EMI emissions from pins that connect transmission lines or components to a circuit board.

Microstrip structures are some of the most basic transmission lines, or signal routing paths, in use for high-speed (e.g. wide bandwith) signals in mixed-signal devices. In this paper, a finite element-boundary integral (FE-BI) method is used to investigate the electric fields in the near vicinity of a feed pin for a microstrip line. The FE-BI method permits volumetric evaluation of the electric field. Once the field structure in the immediate vicinity of the pin is understood, an improved feed model will be developed that is more efficient that current methods and hence will enable more complex models, necessary for assessing the near vicinity interactions in a circuit.