Leaky Wave Effects on Source Driven/Terminated Three-Dimensional Interconnects

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Over the past two decades a considerable amount of effort has been devoted to understanding leaky waves on two-dimensional transmission lines integrated into inhomogeneous, planarly-layered media. It is now recognized that virtually all such printed transmission lines can support modes that leak energy into space-waves, surface-waves, or both types of waves. This energy leakage is often considerable as undesirable, resulting in poor transmission quality and spurious coupling, crosstalk, and radiation. There are also applications where this energy leakage is desirable, such as in the design of novel couplers, and in leaky-wave antennas.

Leaky waves on three-dimensional interconnects have received much less attention. In particular, from the two-dimensional analysis it is evident that the exact nature of the current density on the line, together with the value of the propagation constant, plays a critical role in determining if a mode will be leaky or not. However, it is not clear what types of excitations and terminations will lead to currents on three-dimensional interconnects that leak energy. For example, if an interconnect excitation and termination is such that a true transmission line mode is established on the structure, and the interconnect is sufficiently long, energy leakage should correlate well with the effects predicated by the two-dimensional analysis. However, if the interconnect is short, or the current on the structure does not resemble a transmission line mode, leakage effects on the three-dimensional interconnect may be quite different than that predicted by the two-dimensional analysis. In this paper we will investigate several three-dimensional interconnect geometries, with realistic excitations and terminations, to study the correlation between two-dimensional transmission line effects and three-dimensional interconnect phenomena.