Modeling of Plane Wave Incidence on a Twisted Pair Bundle for DSL Interference Estimation

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In this paper a model for the analysis of a differentially excited nonuniform multiconductor transmission line (MTL) system consisting of twisted wire pairs (TWPs) in the presence of electromagnetic interference (EMI) is presented. The objective of such a model is to analyze the susceptibility of TWP bundles to EMI in digital subscriber line (DSL) communication systems. In the past, standard MTL theory has been extended to nonuniform lines by using a cascade of electrically short uniform lines to improve crosstalk predictions in DSL systems (e.g. J. Cioffi, B. Lee and M. Mohseni, "MIMO Model Accuracy Results," *ANSI Contribution T1E1.4/2003-117*, May 19, 2003, New Orleans, LA). The presented model is an extension of this approach that is able to include the effects of EMI on the transmission lines. The problem of field coupling onto uniform MTLs has been solved in detail in the MTL literature; the solution is revisited and modified to suit the proposed approach. TWPs are modeled by the discrete rotation model (originally proposed by M.B. Jolly and C.R. Paul, "Basic EMC Technology Advancement for C3 Systems-Crosstalk in Twisted-Wire Circuits," Rome Air Development Center, Griffiss AFB, NY, RADC-TR-82-286, vol. IVC, 1978), which gradually rotates the short uniform sections to incorporate the effects of twisting. MTL theory uses equivalent sources (or forcing functions) to incorporate the effects of the impinging fields. The proposed approach takes advantage of the longitudinal discretization for the computation of these sources. Numerical results for a DSL system configuration, for which measurements are available, are presented. Effects due to wave amplitude, polarization and direction of incidence are discussed.