High-Frequency Propagation on Nonuniform Multiconductor Transmission Lines

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A nonuniform multiconductor transmission line (NMTL) is described by the telegrapher equations. There are various approaches to the solution of these equations [1]. From a computational point of view, one can divide the line into a set of sections, approximate the line as uniform in each section by some sort of section average, solve each resulting approximate section analytically, and multiply the resulting set of chain matrices to obtain an approximate solution for the entire transmission line. As discussed in [2] one can improve on this by adding a small variable term to the average and use the sum rule of the product integral to obtain a correction which reduces the reflections at the section boundaries.

In this paper we adopt a different approach. While the previous approximations work well for wavelengths of the order of the section length (or even somewhat less), the present approach is based on a high-frequency approximation (thereby being a complementary technique). Previous papers have explored some aspects of this with the assumption of equal modal speeds (all N modes). Here we form a similar normalization of the voltage and current vectors by the square root of the characteristic impedance matrix and separate the waves into the two propagation directions with coupling between the two. This yields a WKB type of leading term plus corrections based on the sum rule of the product integral followed by a (matrizant) series expansion of the correction product integral. It should be noted that the WKB approximation has often been used for single-conductor (plus reference) nonuniform transmission lines. Here, however, it is generalized to multiconductor nonuniform transmission lines.

REFERENCES:

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