Dispersion Analysis for Slow Wave Structures
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Muhammed Zuboraj*, Kubilay Sertel, and John L. Volakis
Electroscience Laboratory, The Ohio State University,
1330 Kinnear Road, Columbus, OH-43212, USA

Slow wave propagation has been of strong interest to electromagnetics because of its exotic properties that can lead to 1) small antennas, filters and RF circuits 2) novel functionalities and 3) to realize high power RF and optical devices. Among some noted applications of slow waves are miniaturized antennas, non-reciprocal leaky wave antennas, and directivity improvement of antennas and also slow wave circuits in high power microwave amplifiers and oscillators. These aforementioned applications require various dispersion characteristics suitable to each particular application.

In this work, we present a theoretical model of fourth order dispersion using Coupled Transmission Lines (CTLs). The mechanism of coupling and impact of circuit elements on wave slowdown is explained in the model. The coupling parameters in the model clearly demonstrate the impact of anisotropic loading of birefringent materials to achieve fourth order degenerate band edge modes. The model provides a simple intuitive and graphical view of mode coupling process. Thus, the role of material and geometrical parameters are readily incorporated into the model so that they can be utilized to design novel slow wave structures for future research. Finally, the model is verified using full-wave simulation of already designed 'butterfly' slow wave structures and a sample BWO design is presented to demonstrate the utility of the fourth order degenerate band edge modes.