Chapter 7

Conclusion and scope of further work

This thesis proposes compact models for the analysis of high-speed interconnects. The interconnect structures studied are common in the VLSI, PCB, MCM, and RF environment. Models are developed using the variational method combined with the transverse transmission line technique. The author feels that this technique offers the most generalized and simple solution to such a class of problems. The method of analysis, though approximate, is suitable for symmetric and coplanar interconnect structures discussed in this thesis.

7.1 Consolidated contributions

This thesis aims at providing a holistic solution to the problem of signal integrity commonly encountered in high-speed interconnects. The proposed analytical models aid to compute and manage the characteristic impedance, line parameters, damping factor, and coupling coefficients. All together four different types of interconnect geometries are analyzed in this work. These include a microstrip line with adjacent ground tracks, coplanar interconnects with adjacent ground tracks, microstrip line with a GPA, and coupled microstrip lines with ground track insertions. Thus a class of interconnect structures that resemble to microstrip line and stripline are studied. The proposed modeling is supported by exhaustive field simulations, obtained using CST Microwave Studio, and a systematic set of measurements. The results exhibit excellent degree of accuracy in most cases and are valid on a range of material constants and interconnect geometries.

The models are quasi-static in nature and the proposed theory is valid upto a few GHz (in most cases upto 5 to 7 GHz). This incidentally happens to be the range of frequency commonly used in modern day interconnects. It is felt that beyond these frequencies dispersion phenomena will be encountered. Suitable extensions to the proposed theory can be developed in the future to take care of these dispersion phenomena. The appendices given in this thesis can aid designers and engineers to obtain elaborate design data and useful empirical formulae. The proposed theory is translated into front end software, FastEx that happens to be the culminating point of this work.
7.2 Scope of future work

The proposed models are quasi-static and are therefore limited to lower frequencies applications only. It is felt that suitable extension can be built up on this hypothesis to take frequency dispersion into account. Currently, the model is valid up to a few GHz only. While this is generally the frequency range of operation for today’s digital system, dispersive phenomena once incorporated, the model can find wider applications into RF, MMIC, and MIC circuits.

The applications of GPA, DGS, and perforated ground plane structures are opening a new and exiting area of practical research. These areas include the design of various microwave components. The model proposed in chapter 5 can prove to be a first step design procedure and various extensions can be built on this theory to incorporate frequency dispersion phenomena for use at higher frequencies.

Chapter 6 proposes a compact model for coupled microstrip lines with intermediate ground track insertion. An immediate extension to this work could be the development of an equivalent circuit of the coupled interconnect lines with intermediate ground tracks. This would help develop the capacitance and inductance matrices, and perform the transient analysis of the coupled lines.