CHAPTER - 6

CONCLUSION

6.1 SUMMARY

In recent years the effect of interconnects on signal integrity, particularly in high speed Digital and Analog circuits has emerged as a major area of study in the field of Electromagnetic Interference and Compatibility. The increased clock frequency, shorter rise and fall times, and increasing levels of integration has made the problem more serious. Interconnects which were merely considered as conductive paths have started behaving as Inductors and Capacitors depending on the geometry and frequency of operation. This Thesis has been concerned with the modeling of Interconnects and Simulation for parameter extraction and cross talk analysis. Optimisation of interconnects for determining the electrical parameters and geometry for best Signal Integrity performance is also done.

6.2 SALIENT FEATURES OF THE THESIS

Finite Difference Time Domain formulation and application of the same for Modeling, Simulation and Analysis of Interconnect structures is performed. Parameter extraction, determination of lumped equivalent circuit model and study of variation of electrical parameters with variation in physical dimensions is done for a coupled microstrip line pair interconnect. Study of multilayer interconnects is done by considering a double layered structure with strip lines as interconnect configuration. Electric field wave propagation along the two layers of the specimen is studied and plotted. Reflection coefficient is calculated and plotted against frequency to identify the frequency ranges of operation best suited for maintaining Signal Integrity.

The limitations of conventional FDTD towards analyzing interconnects of smaller dimensions, increased computational time and memory requirements is due to the requirement for satisfying CFL limit for stability. However this can be overcome by applying variants of FDTD. The Graded FDTD method, in which a multilevel subgridding scheme coupled with interpolation based on finite difference approximation to Laplacian operator is applied to a modified coplanar interconnect structure with two substrates. It is
found that fields inside the graded regions are represented more clearly in the order of decrease of the cell size. The reduction in the memory requirement and computational time is also observed.

Alternating Direction Implicit (ADI)-FDTD is applied to overcome the CFL limitations, on a class of Coplanar interconnect structures. The field variations observed are verified with those obtained using IE3D a field solver and found to be highly accurate. Analysis of the interconnect structures is done to find scattering parameters, parameter extraction to find self and mutual inductances and capacitances, coupled voltage and current, and near end and far end cross talk. A novel interconnect structure, Elevated Multilayer Stacked Ground Coplanar Waveguide (EM-SGCPW) is proposed and analysed and it offers an Insertion Loss that is less than half that of traditional GCPW and is highly suitable for high speed CMOS operation.

Optimisation of interconnects towards getting optimised electrical and physical parameters so as to minimise coupling and crosstalk is undertaken. Artificial Neural Networks (ANN) based modeling and optimisation is performed on a coupled microstrip line structure and the performance of various training algorithms in the optimisation process is compared. The usefulness of the ANN model of the interconnect in determining the electrical parameters for varying physical dimensions, and hence optimisation is proved. Optimisation is also performed with Genetic Algorithm (GA) and its usefulness to support multi-objective optimisation in minimising Far-end cross talk and Near-end cross talk has also been presented. The limitations of ANN and GA towards finding a global optimised solution for maintaining signal integrity is overcome by applying a hybrid model, Neuro-Genetic Algorithm which combines the advantages of both Neural Network and Genetic Algorithm. It is found that such a hybrid model gives accurate and better results than when either is applied alone.

Thus a comprehensive study is done on Interconnect structures to identify the various interrelated factors that influences the Signal Integrity. It is concluded that selection of appropriate physical dimensions of the interconnect and placement of conductors for the given frequency of operation, and choice of suitable interconnect configuration for specific applications will ensure Signal Integrity.
6.3 SCOPE FOR THE FUTURE WORK

1. The limitations of FDTD for modeling Interconnect structures in the nanometer range can be studied and suitable modeling technique such as Method of Moments (MOM) can be adopted to study Signal Integrity performance of such interconnects.

2. To improve the efficiency of the FDTD techniques, the Multi Resolution Time-Domain (MRTD) scheme, as a high-order expansion technique, has been recently developed for the analysis of practical electromagnetic problems. The same can be used for interconnect modeling and synthesis to study Signal Integrity problems.