Reduction of Signal Delay and Crosstalk in Electronic Packages Using Expert System Techniques

Tajana Simunic, J.W. Rozenblit

Center for Electronic Packaging Research
Department of Electrical and Computer Engineering
University of Arizona, Tucson, AZ 85721
(602)621-8946, Fax: (602)621-2999
email:simunic@ece.arizona.edu

ABSTRACT

The expert system design of transmission line geometry is presented. The design focuses on reduction of crosstalk and signal delay in microstrip lines. First level of design utilizes the whole range for each design parameter and gives satisfactory cross section geometry as a result. The second level optimizes the geometry with respect to the chosen parameters.

Reduction of Signal Delay and Crosstalk in Electronic Packages Using Expert System Techniques

Tajana Simunic, J.W. Rozenblit

Center for Electronic Packaging Research
Department of Electrical and Computer Engineering
University of Arizona, Tucson, AZ 85721
(602)621-8946, Fax: (602)621-2999
email:simunic@ece.arizona.edu

Package design requires expertise in electrical, mechanical, thermal and many other areas. Often only qualitative knowledge is available that is provided by experts in the field. The knowledge has been encoded in form of rules as a part of the expert system. In this case the expert system design is used for reduction of crosstalk [1] and signal delay on a system of one quiet and one driven microstrip line of identical crossection geometry that are terminated by characteristic impedances (see Figure 1).

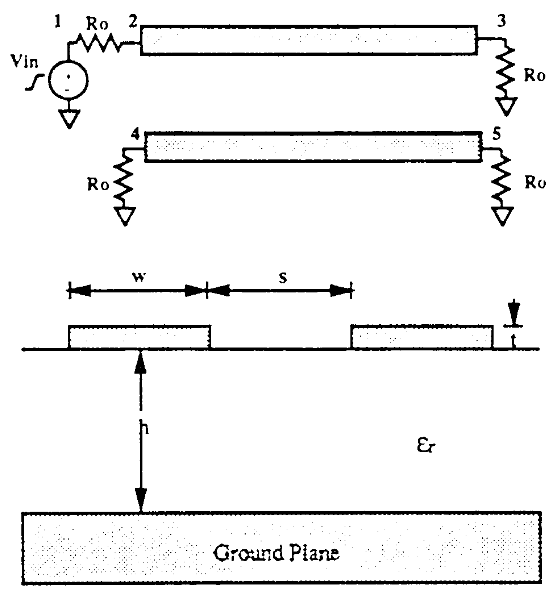

Figure 1: Definition of the system to be designed

The expert system was developed along the guidelines of the Artificial Intelligence (AI) production system concepts [2]. AI production system consists of database, operators and search strategy. Database is a set of all states where each state contains a set of attributes of the interconnect geometry: spacing, width, thickness, height and dielectric constant (see Figure 2).

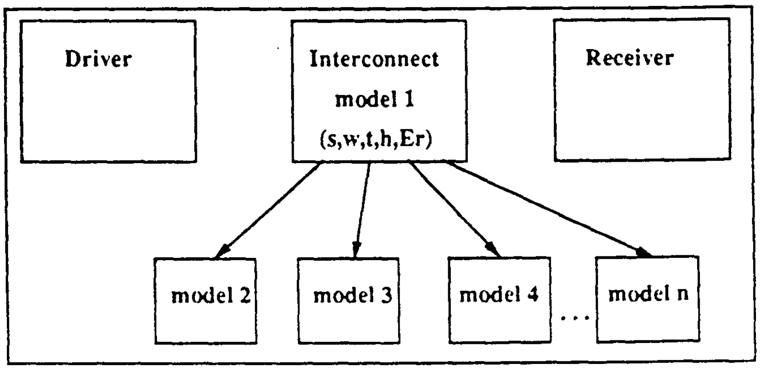

Figure 2: Definition of Database

Operators affect change on the interconnect geometry and are encoded in form of rules as a part of rulebase. Every parameter of transmission line cross section plays a role in reduction of coupling noise and signal delay. For some of the five parameters the direction of change can be generalized regardless of the state of the other four parameters. In that case the rule returns either increase or decrease as a direction of change of that given parameter. For parameters which depend on current state of geometry, two simulations are needed at the endpoints of user-defined intervals to determine the behavior of a given parameter with respect to user-chosen objectives.

Search is used to obtain either satisfactory design or a failure to meet user-defined constraints. Two levels of search are provided within the expert system module. Each of the levels utilizes a depth-first search as defined by priorities of change for each parameter. Both of the levels use the rulebase for a direction of change for a parameter that is chosen and first and second order polynomial approximations to determine the exact amount of change.

Level 1 is used for rough design. It utilizes the entire parameter interval as given by the user. UAMOM [3] with Feller's approximation of crosstalk [4] or UANTL [5] are used as means of evaluation of the design. Tradeoff between crosstalk and signal delay design is performed if there is a conflict in conclusions of the rules consulted in rulebase. The final output of Level 1 is a geometry that either meets user's constraints or is incapable of meeting them.

Input into Level 2 is a successful design from Level 1. Since Level 1 uses the entire range of parameters, Level 2 is provided as means of optimizing design. For example, Level 1 would have chosen the maximum spacing in order to reduce crosstalk, while really only a slightly higher value of spacing is needed to meet user's constraints.

A typical session with the expert system consists of providing the system with initial geometry and the objectives to be met. The maximum values for crosstalk and/or signal delay are defined. The geometrical parameters are chosen. The priorities for change are assigned together with the minimum and maximum values for each of the parameters. Next the design continues in depth-first search manner according to priority assigend to each parameter. Rulebase is consulted for direction of change and numerical methods are used to define the amount of change of a given parameter. The new geometry is created and evaluated by simulation. The results are fed back to the expert system which iterates on design until no further improvements can be made or successful design is achieved.

The expert system provides good means of design when only qualitative rules are available. In order to be more effective, the design needs to include more of the areas in electrical domain and other domains of packaging. The long term objective of this effort is to evolve the expert system into an intelligent VLSI package design support tool.

References

[1] M. Basel Al-Masri,"Reducing coupling noise in VLSI packges using expert system techniques," Thesis, University Of Arizona, Tucson, Arizona, 1992.

[2] P.H.Winston, "Artificial Intelligence," *Addison-Wesley Pub.*, Mass.,1992.

[3] M. R. Scheinfein, "Method of Moments TEM Trannsmission Line Parameter Calculator," User's Guide, University Of Arizona, Tucson, Arizona, 1986.

[4] A. Feller, H.R. Kaupp, and J.J. Digiacomo, "Crosstalk and reflections in High-Speed digital systems," *Fall Joint Computer Conference*, 1965.

[5] J.C. Liao, O.A. Palusinski, J.L. Prince, "University of Arizona Simulator for Nonlinearly Terminated Transmission Line Network," User's Guide, University Of Arizona, Tucson, Arizona, 1986.