Elektrotechnik

Katharina Scharff

Evaluation of Interconnects up to 100 GHz Using Machine Learning

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Summary

This thesis presents a contribution in the area of the modeling of electrical interconnects on printed circuit boards up to 100 GHz.

The physics-based via modeling is an efficient numerical method that can simulate printed circuit boards to a high degree of accuracy. In this work its correlation to full-wave methods up to 100 GHz is shown for a variety of interconnect models. Line coding has become an important element of the signal integrity design and is briefly introduced. Figures of merit that can evaluate the signal integrity performance of interconnects are discussed. The common method is the simulation of eye diagrams in time domain. The weighted power sums are presented and extended as a general-purpose figure of merit that does not rely on time domain simulations.

Different types of printed circuit board models, ranging from single via models and via arrays to more complex structures, are developed. They are the basis for parametric studies that include several thousand model variations each. The via stub effect is investigated for a differential via pair and a via array. The implications of using different line codings in the presence of a via stub are analyzed. Crosstalk is a major source of noise and here it is studied with parameter variations for isolated via arrays as well as a more complex structure with two connected via arrays. Around 27,000 model variations are simulated to investigate key parameter dependencies.

Optimization algorithms are an important tool to improve the design of interconnects. Here, the Bayesian Optimization is applied to maximize the transmission through a single via and the weighted signal-to-crosstalk ratio for a via array with multiple crosstalk aggressors. The emerging technology of machine learning is applied to the design of high-speed interconnects. The parameter variations of the generated link models as well as the weighted power sums are the basis for several studies. Different machine learning algorithms are tested for the prediction of the transmission and crosstalk of an interconnect with two via arrays. Different ideas to reduce the size of the training dataset are discussed. The capabilities of artificial neural networks are tested for a model that includes a backplane and a daughtercard board. The focus is on the reliability of the predictions as well as potential error sources.

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