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Method of Evaluating Integrated Circuit System Performance using Orthogonal Polynomials

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Intellectual Property Status

Patent Pending

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Background

The primary cause of performance degradation in modern integrated circuit (IC) systems is manufacturing process variations. Specifically, variations in IC components (e.g. CMOS devices, metal interconnects, etc.) result in performance uncertainties and inconsistencies. For example, metal interconnect thickness is dependent upon the slurry thickness in the chemical mechanical polishing step and the quality of the polishing pad. Meanwhile, the effective channel length of each CMOS device depends on the effectiveness of critical dimension (CD) controllability. As a result, variations in metal interconnect width, thickness, etc. and variations in CMOS device parameters such as gate oxide thickness, dopant density, and threshold voltages result in substantial circuit performance inconsistencies: CMOS gate delay time and voltage response, CMOS gate active and leakage power consumption, metal interconnect delay time and voltage response, etc. Consequently, there is a need to develop efficient techniques to analyze IC performance in the presence of these variations.

Invention Description

Researchers at Arizona State University have developed a method to analyze IC system performance. By incorporating the method into a software program, the method can generate IC system response (e.g. delay time, voltage response, etc.) corresponding to various IC system components such metal interconnects or CMOS devices. This technique normalizes the variables corresponding to a particular IC system and models the system using an infinite dimensional Hilbert space and a series of orthogonal polynomials. The technique solves for the coefficients of the series of orthogonal polynomials using at least one of a first equation representative of the IC system and a simulated response of an IC system.

Potential Applications

- **Analysis of Electrical Response Characteristics of Interconnect Wires** (e.g. on-chip ULSI interconnects)
- **Networks of Passive Electrical Components**

Benefits and Advantages

- **Custom Accuracy of Analysis** – method can provide an expansion of any order depending on accuracy requirements and computational resources as compared to other methods, which only provide first or second order expansions
- **Improved Accuracy of Analysis** – accounts for underlying probability distribution of the random variables that represent the interconnect system uncertainties; optimality is with respect to speed of convergence
- **Improved Solution Speed –** provides significant speed increases over the golden standard Monte Carlo simulations method (~100 times faster)