Advanced Statistical Strategy for Generation of Non-Normally distributed PSP Compact Model Parameters and Statistical Circuit Simulation

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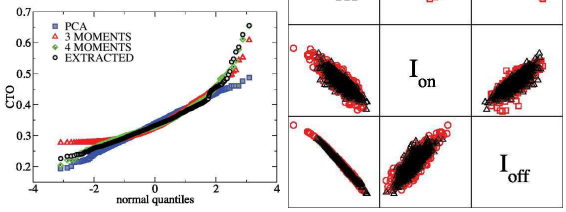
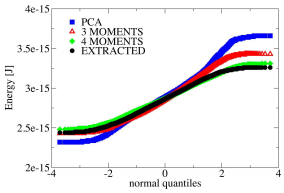
Statistical variability (SV) is one of the fundamental challenges for future nano-CMOS scaling and integration. Variability aware design is essential to achieve competitive yield and reliability in the manufacture of circuits and systems. In order to develop effective variability aware design technologies, it is essential to have a reliable and accurate statistical compact model extraction and generation strategies. In this study, a nonlinear power method (NPM) is presented that preserves the non-normal distribution and the correlation between the extracted statistical compact model parameters in the statistical compact model generation process. The results indicate that, at the expense of small additional computational effort, statistical compact model parameters generated by a NPM approach are significantly better at capturing the tails and non-normal shape of statistical parameter distributions when compared with principal component analysis (PCA). The statistical NPM compact model generation strategy is implemented in the GSS statistical circuit simulator RandomSpice. The improved accuracy of the new approach is validated in the statistical timing simulation of simple digital circuits. Results regarding the distribution of the generated parameters, correlations between important figures of merit and distributions obtained from circuit simulations are illustrated in Figs 1a, 1b and 1c respectively.



(a) Extracted and generated distribution for one of the statistical compact model parameters CTO.

(b) Correlation between electrical parameters. Bottom-left: Comparison between direct SCM and PCA; Top-right: Comparison between direct SCM and NPM approach.



(c) QQ plots of the rise and fall time delays of inverter and power dissipation simulations using directly extracted, PCA and NPM generated SCM parameters.