

MACHINE LEARNING-DRIVEN POWER INTEGRITY CHARACTERIZATION FOR PRINTED CIRCUIT BOARDS

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This report delves into the critical issues of power integrity (PI) prediction in printed circuit boards and proposes innovative machine learning-based solutions. Firstly, the article outlines the importance of PCB power integrity and its challenges in modern high-speed digital systems, including voltage fluctuations, noise, and ground bounce [1]. Subsequently, it provides a detailed analysis of the strengths and weaknesses of existing power integrity simulation software (e.g., Cadence Sigrity, ANSYS SIwave, and Mentor HyperLynx), highlighting their limitations in computational resource consumption and high user expertise requirements for large-scale designs.

To address the limitations of traditional methods, this work introduces machine learning-based approaches for power integrity prediction. Through data-driven rapid modeling, the integration of optimization algorithms, and the application of automation and edge computing technologies, machine learning significantly enhances the efficiency and automation level of power integrity prediction. The work elaborates on commonly used machine learning algorithms (e.g., linear regression, support vector machines, random forests, and neural networks) and their applications in power integrity prediction, particularly in rapid prediction, design optimization, noise and voltage fluctuation prediction, and automated design.

Furthermore, this work proposes a transposed convolutional neural network (TCNN) combined with baseline curves for impedance prediction, addressing the oscillation issues in traditional methods when predicting peak impedance [2]. By leveraging multiple baseline curves to provide impedance trends for each category and extracting local features from sample data using TCNN, more accurate impedance prediction is achieved.

Finally, we discuss the deployment of machine learning models in Cadence Skill software and validates the significant improvement in impedance prediction efficiency through comparisons with traditional simulation tools. This research not only provides a new technical pathway for PCB power integrity prediction but also lays the foundation for further studies in related fields.

References:

1. Swaminathan M., Torun H. M., Yu H., Hejase J. A., & Becker W. D. Demystifying Machine Learning for Signal and Power Integrity Problems in Packaging. *IEEE Transactions on Components, Packaging and Manufacturing Technology*, Vol. 10, No. 8, 2020. pp. 1276-1295. <https://doi.org/10.1109/TCPMT.2020.3011910>.
2. Chew L. W. The effect of higher order model decoupling capacitors in the design of a power delivery network. *2012 4th Asia Symposium on Quality Electronic Design (ASQED)*, Penang, 2012, pp. 117-122. <https://doi.org/10.1109/ACQED.2012.6320486>.