EXPERIMENTAL AND THEORETICAL STUDY OF DIGITAL CIRCUITS SUBJECT TO ELECTROMAGNETIC INTERFERENCE

Bayram, Y., Khan, Z.A., Volakis, J.L.
The Ohio State University, ElectroScience Laboratory, 1320 Kinnear Road, Columbus, OH,43212,USA

This work will present experimental and theoretical study of digital circuits exposed to Electromagnetic Interference. We will particularly study an inverter subject to RF interference. The primary goal of this study is to experimentally observe the effects of electromagnetic interference on time delay and logic characteristics of an inverter operating near GHz range. Besides, we will also validate the measurements with the existing theoretical approaches in the literature.

The typical approach to represent the ambient field coupling to interconnects is to employ distributed voltage and current sources along the interconnects derived via quasi-static analysis. In this work, we replace external field coupling with an equivalent voltage source channel adjacent to the inverter input and output signal traces. This configuration also accounts for the signal integrity effects due to the on-board cross coupling.

Numerical validation of the measurement requires either time-domain analysis with SPICE or mixed time-frequency domain analysis via harmonic balance method to tackle the non-linearity of the inverter. In this analysis, we break the whole problem into two parts: EM structure and Circuit structure. The former consists of the whole PCB structure including interconnects while the latter only contains the sources and the inverter. To analyze the EM structure, we employ multi-port approach. In other words, we represent the EM section with an N-port broadband S-parameter network. Then, the resulting S-parameter model is used in SPICE in conjunction with inverter SPICE model for time-domain analysis.

The S-parameter characterization of the circuit board is done with both PEEC (Partial Element Equivalent Circuit) via PCBMod (Simlab Product) and full wave analysis. The former does not include retardation effects; thus leading to less reliable characterization at higher frequencies. However, the latter produces well accurate results at the frequency range of interest.

As an alternative to S-parameter port modeling, we will also validate the measurements via harmonic balance method. To do so, we solve the EM-structure in frequency domain at the harmonics of the input signal while the circuit part is handled in time-domain via SPICE analysis. The results will be shown and a comparative study of the existing techniques will be presented.

Abstract Submission Form

2004 National Radio Science Meeting

Abstract: bayram14982

Date Received: September 20, 2004

1. (a)
Yakup Bayram
The Ohio State University
ElectroScience Laboratory
1320 Kinnear Road
Columbus, OH
43212 United States
bayram.2@osu.edu
   (b) +1-614-292-7981
   (c)
2. E - Electromagnetic Noise and Interference
3. (a)
4. I - Invited Paper, Program chair: Danilo Erricolo
5. This paper is intended to be submitted to the special session on EMI/EMC Modeling and Validation organized by Danilo Erricolo.