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EMC modeling of Integrated Circuits using IC-EMC

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***Abstract* — The freeware IC-EMC is a windows-based software demonstrator which aims at simulating parasitic emission and susceptibility of integrated circuits. The demonstration proposed at EMC Compo 2015 illustrates the main features of the tool and recent IC case studies analyzed with IC-EMC, including a DSPIC processor, a Package-on-Package, and a Ethernet transceiver.**

Keywords: EMC, Integrated circuits, parasitic emission, susceptibility, standards, IEC, IBIS, modeling

I. Introduction

The knowledge in integrated circuit design for electromagnetic compliance has risen rapidly over the past recent years, thanks to focused books [1-3], dedicated workshops [4] and IC-specific sessions in major EMC conferences such as APEMC [5]. At the interface between IC designers and vendors, the tool IC-EMC has been developed and made available to the EMC community [6] to ease exchanges of models and comparison with measurements, with several case studies [7] based on cooperative research with industry and dedicated training [8].

II. Software Structure

A. *EMC of ICs in practice*

The tool IC-EMC includes a conventional schematic editor, (See Fig. 1), a set of tools to help user to build EMC models, an interface to Spice for analog simulation, and a post-processor for easy comparison between measured and simulated parasitic emission and susceptibility.

A set of tools with significant added value for EMC analysis are gathered in the same environment:

- A 3D package viewer, based on the IBIS pin list and models, and simple geometrical parameters such as the die size, type of package, IO pitch, etc.
- A passive distribution network (PDN) viewer, which eases identification of basic trends in the Z(f) profile, and derive associate model
- An emission simulation environment targeted to the prediction of conducted and radiated noise as measured using IEC standard characterization methods [9]
- A near-field estimator based on elementary current dipole radiation. Near-field simulation may be compared to measurement described in XML format [10] as specified by IEC.
- An immunity simulation environment dedicated to the prediction of conducted and radiated immunity as measured using IEC standard immunity characterization methods [11].

All proposed models and approaches are built in compliance with the generic modeling philosophy described in IEC standard model approach [12]. A library of common standard models and several case studies ease the EMC simulation, as may be find in the on-line user's manual [7].

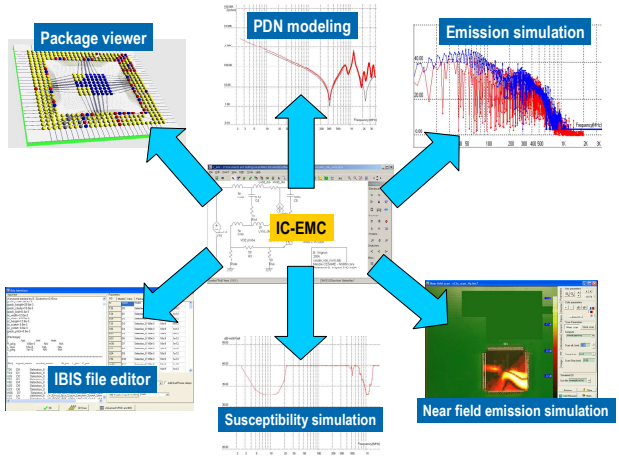


Figure 1. The IC-EMC capabilities in terms of emission and immunity prediction

III. Recent Evolutions

A. *Package-on-package*

In cooperation with VALEO [13], the handling of Package-on-package and 3D ICs has been made available in IC-EMC. IBIS descriptions for up to 16 dies may be merged in order to reconstruct accurate 3D views of stacked structures, with associate power domain tracking and RLC-based parasitic element extraction (Fig. 2).

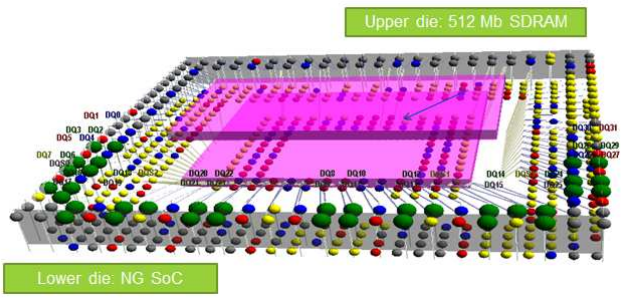
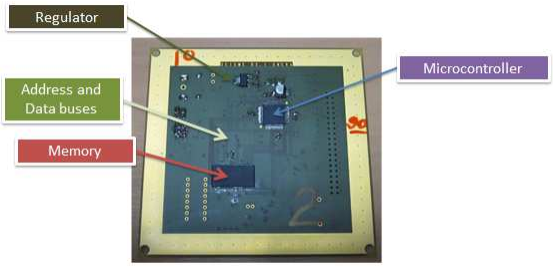


Figure 2. 3D view of the PoP analyzed by VALEO [13]



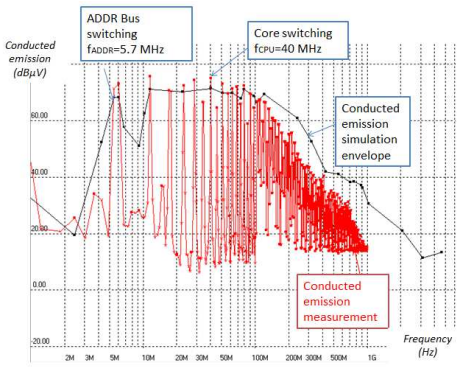


Figure 3. EMC test board for education [8] (top) and example of comparison between measured and simulated emission (bottom) [6]

B. EMC board for education

Within the frame of a one-week training session including EMC measurements on ICs, we have reused a EMC research board designed by L. Guibert, Onera as part of his PhD [14] for educational purpose [8]. The case study proposed as a demonstration includes simple ICEM model construction [12] and matching with conducted measurements, as illustrated in Fig. 3 (1/150Ω method [9]). The test board includes a DSPIC33F processor, a SRAM memory and a regulator.

C. Immunity analysis of a transceiver

In cooperation with industry [15], we have investigated the immunity of a Ethernet Gigabit Switch using the Near-field immunity scan method [11][16].

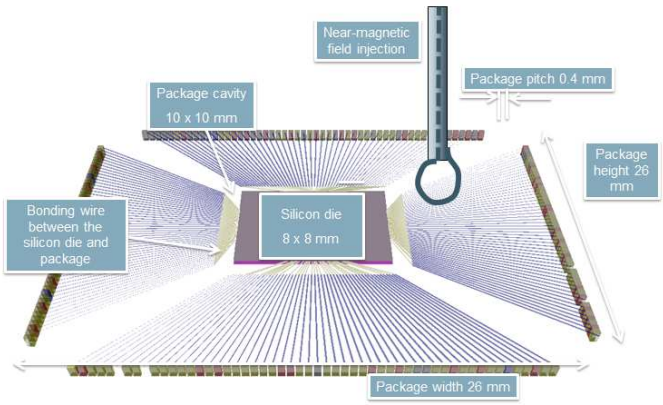


Figure 4. Coupling of a magnetic loop used for near-field injection to the leads and bondings of a QFP package [15]

We propose to build a model of the sensitive parts based on the coupling of the near-magnetic probe to the package leads and bondings. The IBIS information of the driver and receiver is combined to the PDN and decoupling components to match NFSI measurements.

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