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Electronic design automation libraries –

Part 3:
Models of integrated circuits for EMI behavioural simulation

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FOREWORD

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IEC 62014-3, which is a technical report, has been prepared by IEC technical committee 93: Design automation.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
93/146/DTR	93/157/RVC

Full information on the voting for the approval of this technical report can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until 2005. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

ELECTRONIC DESIGN AUTOMATION LIBRARIES –

Part 3: Models of integrated circuits for EMI behavioural simulation

1 Scope

The objective of this Technical Report (TR) ICEM (Integrated Circuit Electrical Model) for Components is to propose electrical modelling for integrated circuit internal activities. This model will be used to evaluate electromagnetic behaviour and performances of electronic equipment.

1.1 General

Integrated circuits integrate more and more gates on silicon and the technologies are faster and faster. To predict the electromagnetic behaviour of equipment, it is required to model IC interface switching and their internal activities as well. Indeed IBIS and IMIC models are focused mainly on interface activity predictions (cross-talk, overshoot, etc.). See IEC 62014-1.

This report describes a model for EMI simulation due to IC internal activities. This model gives more accurately the electromagnetic emissions of electronic equipment by taking into account the influence of internal activities. This model gives general data which could be implemented in different format such as IBIS, IMIC, SPICE, etc.

During the design stage of the application that will exploit the IC, it becomes useful to predict and to prevent electromagnetic risks with the CAD tool. Accurate IC modelling is necessary to run on these simulation tools.

Three coupling mechanisms of the internal activities for emission (Figure 1) are proposed in the ICEM model:

- conducted emissions through supply lines;
- conducted emissions through input/output lines;
- direct radiated emissions.

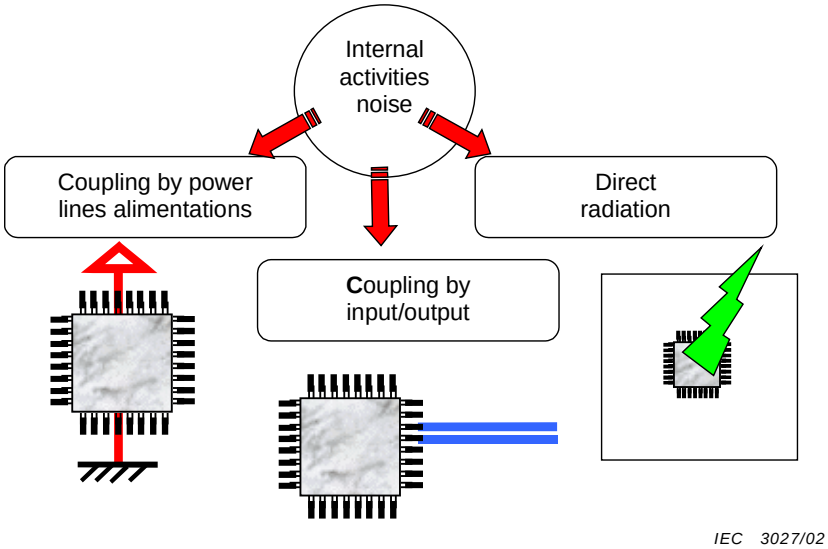

Figure 1 – Mechanisms for parasitic emission covered by ICEM

This report proposes a model that addresses those three types of coupling in a single approach. The elements of the model would be kept as simple as possible to ease the identification and simulation process.

1.2 Philosophy

The purpose of this report is to provide data to enable printed-circuit-board level (PCB) electromagnetic tools to compute the electromagnetic fields produced by integrated circuits and their associated PCB. These data can be extracted from measurement methods, as described in IEC 61967, or obtained from IC simulation tools.

1.2.1 Origin of parasitic emission

The origin of parasitic emission in IC is due to the current flowing through all the IC gates (*Iv* and *Iv*) during high to low or low to high transitions as shown in Figure 2.

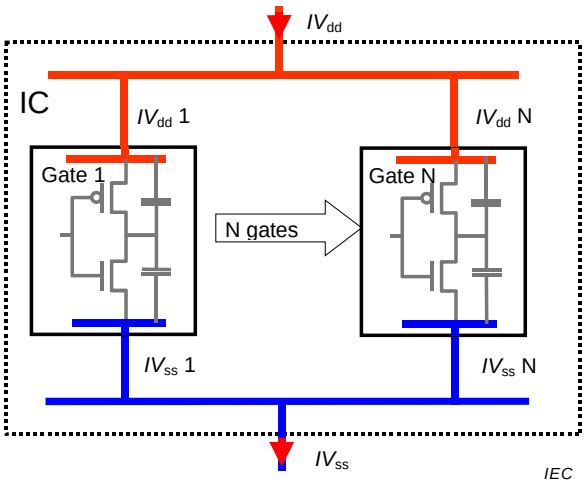

Figure 2 – The basic mechanism for parasitic emission is due to the current driving by all the gates

The combination of several hundred thousands of gates lead to very important peaks of current, mainly at rise and fall edges of the clock circuit. For example Figure 3 plots the number of gates switching versus the time for an IC integrating 1 000 000 transistors. Consequently, high current spikes are created inside the die and induce voltage drops of the internal voltage references.

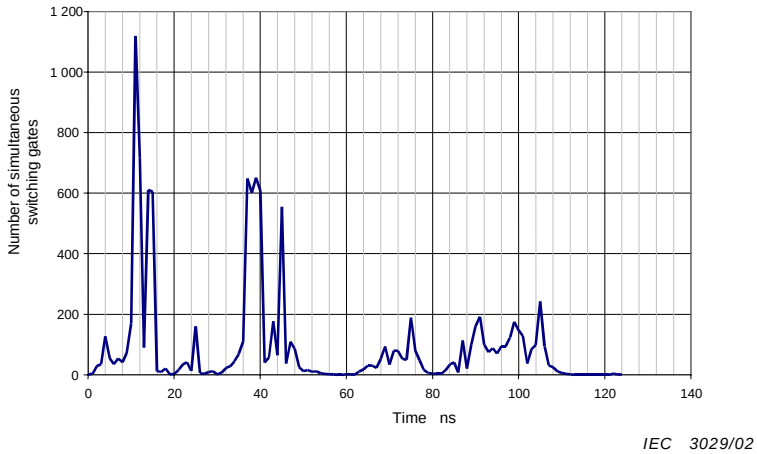

Figure 3 – Number of switching gates versus time

1.2.2 Conducted emission through power-supply lines

The current spikes created inside the die are partially reduced thanks to the on-chip decoupling capacitance. Anyhow, a significant portion of the current spikes is present at the power-supply pins of the chip. This current could be measured according to IEC 61967 or other methods permitting to have the power-supply currents.

1.2.3 Conducted emissions through input/output lines (I/O)

The internal voltage drops generated by the current spikes create noise on the I/Os through direct connection, parasitic capacitive and inductive couplings and/or through common impedance. The PCB wires connected to the I/O can act as antennas and propagate electromagnetic emissions. The measurement set-up is done according to IEC 61967.

1.2.4 Direct radiated emissions

The internal current flowing in low impedance loops generates electromagnetic fields which can be measured in near field according to IEC 61967.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61967-1, *Integrated circuits – Measurement of electromagnetic emissions, 150 KHz to 1 GHz – Part 1: General conditions and definitions*

IEC 61967-4, *Integrated circuits – Measurement of electromagnetic emissions, 150 kHz to 1 GHz – Part 4: Measurement of conducted emissions, 1 Ω /150 Ω direct coupling method*

IEC 61967-6, *Integrated circuits – Measurement of electromagnetic emissions, 150 kHz to 1 GHz – Part 6: Measurement of conducted emissions – Magnetic probe method*

IEC 62014-1, *Electronic design automation libraries – Part 1: Input/output buffer information specifications (IBIS version 3.2)*