18th International Zurich Symposium on Electromagnetic Compatibility

WS-5 on Monday September 24

Title workshop	Modelling of Automotive IC Devices for EMC-Simulation
Organizer's name	Dr. Gernot Steinmair
Organizer's affiliation	BMW Group Munich, Germany

Abstract:
Most of the technical innovations in automotive industry are accompanied by new electronic systems. The growing number of electric and electronic equipment potentially increases electromagnetic emission and therefore raises the risk to miss EMC standards and to perturb the functional integrity of new and existing electronic systems. Integrated circuit devices are the main sources of electromagnetic emission as well as critical sinks for electromagnetic interference. Electromagnetic emission originating from the IC-level propagates via the component-level and potentially penetrates the automotive cable-harness resulting in EMI at the system level. In this respect, conducted emissions at signal- and power-pins of IC devices such as microcontrollers, bus drivers and PWM power drivers are of major relevance for the system-level. Unless adequate EMC measures are taken, conducted emissions spread via traces on the PCB and the component's plug connector. Once electromagnetic disturbances have penetrated the cable harness, cross-talk to neighbouring wires in the cable bundle or direct radiation to one of the vehicle's antennas is likely to cause unacceptable EMI. Numerical EMC simulation is considered a key to enable early identification of potential EMC issues and to place appropriate correction measures in time. Experience has proven, that accurate EMC simulation at the component-level and at the system-level demands sophisticated simulation models of the sources of electromagnetic emission at the IC-level. The purpose of this workshop is to present special modelling methods for IC devices like microcontrollers and power drivers. Furthermore, modelling approaches for passive PCB structures will be shown as well as some special numerical simulation tools allowing the simulation of the generated models (co-simulations of SPICE-subcircuits, VHDL/AMS-Models and PEEC-Models within one simulation process).

Speakers:
Dr. Matthias Tröscher (SimLab GmbH, Munich, Germany)
Mr. Thomas Steinecke (Infineon Munich, Germany)
Fr. Mihriban Gürsoy (University of Erlangen, Germany)
Mr. Wolfram Meyer (Siemens VDO Regensburg, Germany)
Mr. Andreas Gstöttner (University of Erlangen, Germany)
Mr. Florian Frank (University of Erlangen, Germany)

8:20-8:35 **Short introduction of agenda and project overview** (Steinmair)

8:35-9:10 **High-Accuracy IC Emission Models (ICEM) for Complex Microcontrollers**
(Steinecke)
Electromagnetic emission models for highly integrated circuits are a mandatory requirement by the automotive industry in order to simulate the noise behaviour of synchronously clocked digital or mixed-signal ICs like microcontrollers in a full system environment. General requirements for such models are a common format and low complexity. We decided for Spice-format emission models which describe the pin-accurate noise behaviour of ICs up to 1GHz and provide also the IC package and chip impedance data to interact with the surrounding printed circuit board. The format and generation process of these emission models are described in detail. There is a strong link to the presentation "Dynamic Switching Current Modelling of Digital VLSI Modules" given by Mr. Andreas Gstoettner (University of Erlangen, Germany) since these switching current models form a part of the on-chip noise description in the emission models. The emission model of the TC1796 32-bit microcontroller will be highlighted in detail. Several modelling challenges will be described and a correlation to emission measurement results will be presented.

9:10-9:45 **High Level Dynamic Switching Current Modeling of Digital VLSI Modules**
(Gstöttner)
Switching currents of synchronously clocked digital modules are the main contributor to electromagnetic emission of integrated circuits like microcontrollers. Since analog simulations of large digital modules are still impossible or at least impractical, alternative strategies based on statistical approaches will be presented.

9:45-10:20 **Behavioral Modeling of Analog/Mixed-Signal ICs for EMC Simulation**
(Gürsoy)
The talk details the development of behavioral models for power devices to assess the conducted emission with regard to EMC. The models are formulated in VHDL-AMS to account for various load conditions at power device's output.

10:20-10:35 **Coffee**

10:35-11:10 **Modelling of normative measurement methods for automotive EMC-Simulation**
(Meyer)
Within EMC-Simulation it is important to reflect the results at the standards used for measurement. Due to different coupling paths used by the versatile measurement setups 'ideal' simulation results would never be a predicting tool. This presentation shows procedures, assumptions and simplifications for modelling normative conducted emission measurement methods according to CISPR25.

11:10-11:45 **Co-Simulation of SPICE Netlists and VHDL-AMS IC Models**
(Frank)
An interface between SPICE and VHDL-AMS allowing a co-simulation within one simulation process will be presented. Difficulties concerning data exchange and time synchronization will be pointed out. The functionality of the interface will be shown by means of realistic simulation examples.

11:45-12:20 **Concerted Interaction of ICEM or VHDL-AMS based Circuit Simulations and Layout based EMC Analyses in Industrial Workflow**
(Tröscher)
New methods and software interfaces have been developed in order to take into account microcontrollers, analog/mixed-signal ICs and measurement equipment for EMC analyses on Printed Circuit Boards. A subtle concept for co-simulations of VHDL-AMS models and PEEC models in state-of-the-art software tools provides a smooth workflow for industrial applications. The ability to import SPICE equivalent circuits into the software makes it possible to include effects of measurement equipment as virtual test benches into the simulation process. Simulation and measurement results are compared.