Power Electronics & EMC

Advances in power electronics see electromagnetic compatibility (EMC) playing an increasing role in device and system design. Due to constraints associated with EMC, components and mechanical design features are taking larger shares of both system volume and time spent on development. New trends, methodical design procedures to tackle problems associated with EMC are still lacking.

Development of design procedures
One focus of our work is research on simulation methods, which make predicting EMC behavior in power electronics possible. We are especially interested in the influence of the mechanical design on electromagnetic properties as a part of EMC simulation on system level. Comprehensive measurement equipment is available for verification of calculation methods.

System development and EMC-consulting
Based on customer requirements, we deal with system development for inverters, DC/DC converters and measurement equipment as well as on-site consulting. Topics include development of filters, shielding and power devices, failure and malfunction analysis, providing EMC-libraries and basic research.

Power Electronics Packaging

In the future, progress in packaging technologies will contribute significantly to the development of new applications using power-electronic systems. Current requirements e.g. cost reduction, reliability, or the integration of power semiconductor devices, sensors and control in “Smart Power” devices already increasingly necessitate the consideration of technological aspects in all design stages.

Technology-oriented system development
R&D in this area encompasses the interdisciplinary development of new packaging technologies for power electronics with special emphasis on aspects such as reliability or increasing semiconductor performance. A flexible system design enables the integration of power electronics, control components and sensors into mechatronic systems.

Characterization and modeling
Research in this area concentrates on the accompanying design in the development of new technologies in terms of the electrical and thermal characterization of packages, as well as reliability evaluation. The main focus is the modeling of coupling in highly integrated multi-chip modules.

Furthermore, we develop measurement set-ups, including thermal- and power-cycling investigations, determination of thermal impedance and device characterization at high currents.

Service Spectrum

As an interdisciplinary department with broad competency in the area of system design and comprehensive knowledge of innovative packaging of integrated circuits, we are able to provide our experience and co-operative support with the following services:

- technology-oriented feasibility studies
- analysis of substrate complexity
- technology development and evaluation
- technology-oriented RF-characterization
- antenna development and characterization
- 3D-configuration of hybrid microsystems
- 3D-package design and characterization
- design of multi-chip-modules
- prototype design and implementation
- cost estimates of system solutions

We support our customers with our skills and laboratory facilities through all phases of the development of microelectronic, microsystem technological and power electronic products - including on-site.

Feel free to contact us for more detailed information!

Contact

Fraunhofer IZM
Prof.-Dr.-Ing. Dr.-Ing. E. h. Herbert Rekhi
Gustav-Meyer-Allee 25
13355 Berlin
Phone: +49 (0)30 4 64 03-100
Fax: +49 (0)30 4 64 03-111
URL: www.izm.fraunhofer.de
Your contact for System Design & Integration:
Head of Department
Dr.-Ing. Stephan Gutowski
Phone: +49 (0)30 4 64 03-114
Telefax: +49 (0)30 4 64 03-118
E-Mail: gutowski@izm.fraunhofer.de

Equipment Highlights

Measurement tools:
- Agilent E3510A – 2-port VNA (up to 110 GHz)
- Agilent E8361A – 4-port VNA (up to 67 GHz)
- HP 4194A – 2-port amplifier (up to 100 MHz)
- Agilent 4394A – Impedance analyzer (up to 110 MHz)
- Agilent E5070A – 4-channel analyzer
- Agilent E5270A – Prec. DC parameter analyzer
- R&S ESCS30 – receiver (up to 30 MHz)
- Agilent E8361A – 4-port VNA (up to 67 GHz)
- HP 4194A – 2-port amplifier (up to 100 MHz)
- Agilent 4394A – Impedance analyzer (up to 110 MHz)
- Agilent E5070A – 4-channel analyzer
- Agilent E5270A – Prec. DC parameter analyzer
- Air and infinity coplanar probes up to 110 GHz in ESL, GSE, GSGSE configuration with pitches from 100 to 300 µm
- E1” thermal chuck up to 300°C
- Antennas, B&S (3 GHz–3 GHz)
- Coupling network, clamp-on ammeter, net replicators for low-voltage net and accessible boardnet, ESD-pistols

Simulation tools:
- General Multi-Physics: 3D-Simulator (Ansys)
- Heat simulation (Rohrer)
- Electromagnetic: 2D field simulation (Ansoft, ANSYS, Microwave Studio, FastHenry, Maxwell 3D, Q3D Extractor)
- EM 2D and “2 1/2”D simulators (Maxwell 2D, Line 2D, Momentum)
- Circuit simulators (Simplepl, Advanced Design System (ADS), Ansoft Designer)
- Mechanical 3D-design (Solidworks)
**System Design & Integration**

The department System Design & Integration develops methods and tools used for customized and technology-oriented design of electronic systems. Theoretical methods form the basis for simulations of all kinds of electromagnetic as well as thermal and mechanical behavior and coupling. Using such a characterization approach makes it possible to analyze, evaluate and compare different technologies right in the design phase. This leads to an optimized design flow, considering the particular specifications of the systems to be designed.

**Prototypes and demonstrators**

By extending existing systems through additional functions, such as sensors, actuators or passive displays on RFID systems, prototypes of innovative products are assembled. System demonstrators are developed at Fraunhofer IZM for model-based characterization and parameterization of advanced packaging technologies. In turn, these methods are used in the design process of 3D SiP devices to select appropriate technologies and to enable an automated component placement, which is based on algorithms, optimization, and is suitable for the technology in question.

**Package Design & Characterization**

In order to meet the ever increasing demand for smaller, cheaper and higher-performance convergent microelectronic systems with computing and communication functions, advanced electronic packages – e.g. 3D, MCUB, micromolded printed circuit boards (PCB) and embedded components (e.g. antennas) are needed.

**Wireless Sensor Systems**

Future microelectronic packages as well as micro- solution technologies will have a higher packing density while function integration further increases the number and types of new applications. Interlinking several self-sufficient sensor nodes in a self-organized wireless sensor network allows the coverage of large areas without setting up an additional communication infrastructure. Furthermore, actuators can be integrated to achieve a certain degree of mobility. One example of application would be integrating such systems in agile micro robots, which cooperates with each other and can then autonomously explore areas inaccessible to humans.

**Advanced System Development**

With ongoing advances in miniaturization and concurrently increasing functionality in complex electronic systems, system designers face growing challenges both in terms of selecting the appropriate technologies and applying the optimal models to evaluate particular system parameters.

**Vertical Integration of Heterogeneous Systems**

An important research aim is developing a methodology for the physical design of vertically integrated, heterogeneous systems. Scientific methods are derived from characterization, modeling and parameterization of advanced packaging technologies. In turn, these methods are used in the design process of 3D SiP devices to select an appropriate technology, as well as to enable an automated component placement, which is based on algorithms, optimization, and is suitable for the technology in question.

**Model-based system characterization**

By developing and applying new methods for characterization and modeling of systems, we optimize design processes and open up new fields of application. A holistic approach to system design leads to reliable and fail-tolerant microsystems, which can withstand harsh environments. Thus, system design – e.g. with integrated energy harvesting – can be assessed in terms of cost, operating time and volume before the first prototypes are even built providing a basis for developing an optimized system.

**System Design & Integration Lab at Fraunhofer IZM**

The System Integration Lab provides a wide variety of measurement equipment and techniques to assess the characterisation of technology demonstration prototypes and test platforms.

**Equipment**

- Includes a vector network analyzer, which runs up to 110 GHz, and a special anechoic chamber with an operational bandwidth of up to 170 GHz for the measurement of radiated electromagnetic noise and the characterization of new antenna designs.

**Wireless Sensor Systems**

**Prototypes and demonstrators**

By extending existing systems through additional functions, such as sensors, actuators or passive displays on RFID systems, prototypes of innovative products are assembled. System demonstrators are developed at Fraunhofer IZM for model-based characterization and parameterization of advanced packaging technologies. In turn, these methods are used in the design process of 3D SiP devices to select an appropriate technology, as well as to enable an automated component placement, which is based on algorithms, optimization, and is suitable for the technology in question.

**Package Design & Characterization**

In order to meet the ever increasing demand for smaller, cheaper and higher-performance convergent microelectronic systems with computing and communication functions, advanced electronic packages – e.g. 3D, MCUB, micromolded printed circuit boards (PCB) and embedded components (e.g. antennas) are needed.