Registration (Fax Reply)

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Register before **29 Januay 2009**

Participation fee:

- ☐ **€ 480,-*** for industry
- ☐ **€ 380,-*** for universities

The fee includes the tutorial dinner, lunch, coffee/soft drinks and handouts.

With the confirmation of seminar registration you will receive the invoice. (* plus 19 % VAT); 50 % discount for ECPE Member Companies

Number of participants is limited to 35 attendees.

Sender:

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title, given name, name

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company, department

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full address

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phone, fax

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e-mail

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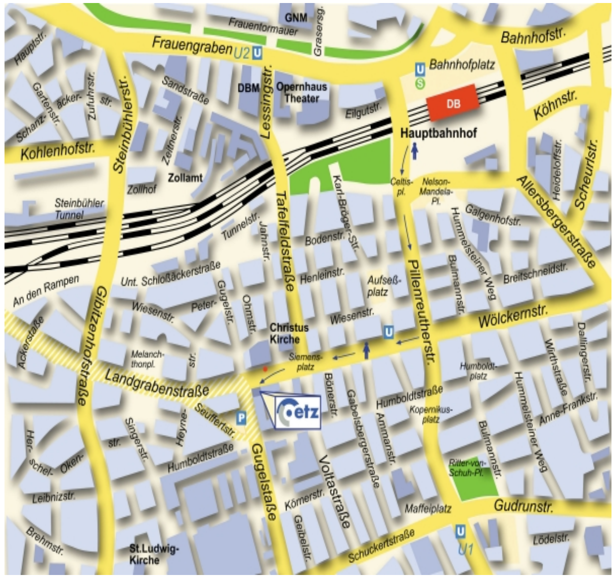
date, signature

Organisational information

Organiser:	ECPE e.V. 90443 Nuremberg, Germany www.ecpe.org
Course instructor:	Prof. Dr. Dieter Silber; University of Bremen
Organisation:	Ingrid Bollens, ECPE e.V. +49 (0)911 / 81 02 88 – 10 ingrid.bollens@ecpe.org
Place of seminar:	ECPE e.V. (in etz-building) Landgrabenstrasse 94 90443 Nuremberg, Germany



Further information (hotel list and maps) will be provided after registration.

ECPE European Center for Power Electronics e.V.

ECPE Tutorial

Power Semiconductor Devices & Technologies

5 – 6 February 2009
at ECPE (etz-building)
Nuremberg, Germany

Introduction

ECPE Tutorial "Power Semiconductor Devices & Technologies"

5 – 6 February 2009
Nuremberg, Germany

The tutorial starts with the presentation of relevant basic principles of modern power semiconductor devices:

Blocking capability of the devices, unipolar and bipolar current transport and gate control will be discussed. Diodes, MOS transistors (including Cool MOS) and IGBTs will be treated in detail including their dynamical properties, safe operation and temperature limits. As a consequence, the benefits expected from wide band gap semiconductors (SiC, GaN) will be discussed.

This introductory part is also the base for the next part devoted to power device models and the increasing role of virtual prototyping in power electronics.

The following chapters will demonstrate the state-of-the art and development lines of monolithic smart power devices and intelligent IGBT/MOSFET control circuits. Finally a short overview of hybrid power electronic integration and the most relevant aspects (cooling, reliability and EMC problems) will be presented.

This tutorial is aimed at engineers who are engaged in power electronics and want to improve their knowledge and understanding of power devices including the developments expected in near future.

The course instructor is Prof. Dieter Silber (University of Bremen), Co-instructors are Dr. Peter Turkes (Infineon Technologies, Munich) and Dr. Reinhard Herzer (Semikron, Nuremberg).
All presentations and discussions will be in English.

Programme

Thursday, 5 February 2009

9:30 *Start of registration*

10:00 **Welcome, Opening**
T. Harder, ECPE e.V.

10:15 **Introduction: What is required from Power Devices?**
D. Silber

10:45 **Summary of basic Semiconductor and Device Physics**
D. Silber

11:30 **Power Diodes**
D. Silber

12:00 *Lunch*

13:00 **Power MOSFETs and Super Junction Devices:**
D. Silber

13:45 **Insulated Gate Bipolar Transistor (IGBT):**
D. Silber

14:30 **Wide Bandgap Devices**
D. Silber

15:00 *Coffee Break*

15:30 **Modelling and Virtual Prototyping I:**
Power Devices
P. Tuerkes

16:00 **Modelling and Virtual Prototyping II:**
Influence of Parasitic Elements
P. Tuerkes

16:30 **Modelling and Virtual Prototyping III:**
Systems
P. Tuerkes

17:15 **End of 1st Day**

19:30 Dinner

Programme

Friday, 6 February 2009

08:30 Wrap up 1st Day, Discussions

09:00 **Integrated Power Devices/Smart Power I:**
System Integration
R. Herzer

09:45 **Integrated Power Devices/Smart Power II:**
PN- Isolation Technologies, Advanced Specific Technologies, Examples
R. Herzer

10:30 *Coffee Break*

11:00 **Integrated Power Devices/Smart Power III:**
SOI- Integration Technologies, Examples
R. Herzer

11:45 **Integrated Power Devices/Smart Power IV:**
IGBT Driver Solutions, IPM
R. Herzer

12:15 *Lunch*

13:15 **Power Modules I:** Typical Examples
D. Silber

14:00 **Power Modules II:** Parasitics, Thermal Problems, Future Trends
D. Silber

14:45 Wrap up, Final discussions

15:30 **End of Tutorial**

For more information on the contents of the presentations see following pages…

Contents of the Devices Lectures
Dieter Silber
University of Bremen

What is required from Power Devices?
On the basis of few typical power circuit elements the special requirements (static and dynamic properties, device triggering, safe operation area, influence of parasitics, thermal limitations) are demonstrated.

Summary of basic Semiconductor and Device Physics
This chapter contains essentially explanations of basic semiconductor and device physics in a more qualitative way. Important processes like thermal and impact (avalanche) generation, diffusion current, diode and bipolar transistor characteristics, basic field effect transistor structures are explained.

Power Diodes
I. Unipolar diodes
The advantages and disadvantages of Schottky diodes for power electronic applications are discussed including advanced structures like “merged” or “JBS” rectifyers.
II. Bipolar diodes
The influence of the stored (plasma) charge and on the on-state characteristics and the problems occurring at hard turn-off are demonstrated.

Power MOSFETs and Super Junction Devices
The development of high voltage MOSFETs and power MOSFETs from the basic MOS structure is demonstrated including the limitations for very high voltage applications. Special discussions concern Miller capacitance and the integrated reverse diode.

The basic principles and advantages of compensation super junction devices are illustrated including the special problems of the integrated reverse diodes.

Insulated Gate Bipolar Transistor (IGBT
The aim of this lecture is to obtain an understanding of the static and dynamic properties of the most important IGBT versions on the base of the electron-hole-plasma dynamics. Furthermore the safe operation limits of IGBTs will be presented.

Wide Bandgap Devices
The reasons for the enormous progress expected from devices on the base of wide bandgap semiconductor materials (high temperature range, unipolar devices up to several kV, improved dynamic properties) are presented.

Power Modules I, II
The lectures present short overview of the most important types of power modules, the cooling problems, aspects concerning the reliability and the internal parasitics. This includes isolating base plate materials, different joining techniques and integration of “intelligent” components.

"Virtual Prototyping of Power Semiconductors"

Peter Türkes
INFINEON Technologies AG
D-85579 Neubiberg
Email: peter.tuerkes@infineon.com

Introduction:

In "Virtual Prototyping" it is important to transfer the electrical and thermal behaviour of the power device into an appropriate device physics based model. In conjunction with a sufficient circuit simulation program this model will provide insight into the expected interaction of the power device and the peripheral circuitry before 'first silicon' and specific measurements are available. The outcome of those simulation results might than be basis of further re-designs of the power device.
"Virtual Prototyping" of power semiconductors is therefore most beneficial within the development process of all kinds of power devices.

Content:

Beside the active semiconductor die, power semiconductor devices comprise also housing and wiring elements. The housing is influencing the die temperature in operation due to its thermal impedance. The die temperature is also changing the electrical behaviour of the die. The wiring acts on the slopes of the voltage and current transients because of the related parasitic inductors and capacitors.
Every model of a power device, which deserves the attribute of being a 'Virtual Prototype', requires an elaborate physics based mathematical equation set which calculates the internal currents and voltages in dependence on the device temperature and the operation condition.
The basics of these physical model equations are functions of electrical currents and fields depending on external voltages which are deduced from elementary device physical laws. These functions include parameters which comprise the device geometry and the device inherent doping distribution.

1) Devices

The typical power device features like gate charging of MOS controlled transistors or conductivity modulation of bipolar transistors and diodes can be calculated by this straight forward way. This is the foundation of elementary device characteristic curves.

2) Parasitics

Others of the characteristic application relevant device numbers, defined in the data sheet like the dissipated power, are dependent on the parasitic elements related to the package and the external circuit. It is therefore quite relevant to establish an insight into the interaction of device and external parasitics by virtual prototyping means.

3) Systems

Any kind of application of a power electronic device defines a 'system'. Any system comprises several power devices which are interacting by parasitic elements and which are controlled by complex driver circuits. The investigation of power devices and their characteristic numbers inside systems demand simplification measures in order to keep the simulation effort low at a high outcome in insight.