

Organisational Information

Sign up at: www.ecpe.org/events

Registration Deadline:

4 July 2023

Participation Fee:

Part I 11-12 July	Part II 25-26 Oct.	Both Tutorials	
770,- €*	670,- €*	1.250,- €*	Industry
655,- €*	520,- €*	955,- €*	University
240,- €*	180,- €*	380,- €*	Students/ PhD stud.**

* plus VAT; **students seats are limited

- The regular participation fee includes dinner, lunches, coffee/soft drinks. The reduced (PhD) students fee includes all the above except for dinner (can be booked for an extra fee of € 50,-*).
- The presentations will be provided by email via a download link short before the event. A printed version of the tutorial handout is available on request (€ 50,-*).
- Upon receipt of registration confirmation via email you are signed-up for the event. The invoice will be sent by email.
- 25 % discount for participants from ECPE member companies.
- 10 % discount for participants from ECPE competence centres.
- Further information (hotel list and maps) will be provided after registration and can be found on the ECPE web page.
- Cancellation policy: Full amount will be refunded in case of cancellation up to 2 weeks prior to the event. After this date and in case of no-show 50 % of the fee is non-refundable (substitutes are accepted anytime).
- The number of participants is limited to 35 attendees.

➤ 06/06/23

Organisational Information

Organiser ECPE e.V.
90443 Nuremberg, Germany
www.ecpe.org

Chairman Prof. Dr. Uwe Scheuermann,
Friedrich-Alexander-Universität Erlangen-
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Venue Hotel Holiday Inn Nürnberg City Centre
Engelhardsgasse 12
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Source: Holiday Inn Nürnberg City Centre
Source front page: Fraunhofer IISB.

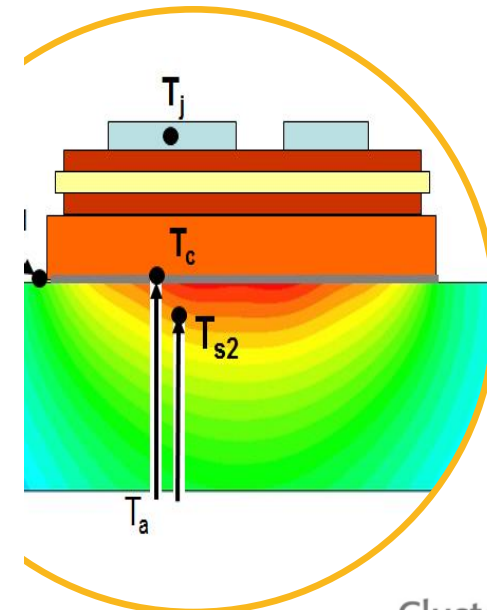


European Center for
Power Electronics e.V.

ECPE Tutorial

Thermal Engineering of Power Electronic Systems Part I: Thermal Design and Verification

11 - 12 July 2023
Nuremberg, Germany



Cluster
Leistungselektronik

Thermal Engineering of Power Electronic Systems Part I

11 - 12 July 2023
Nuremberg, Germany

Thermal engineering of power electronic systems is a key to achieve high performance and reliability. With a clear focus on power modules the tutorial addresses the thermal design and validation of power electronic components exemplified by a 100 kW IGBT converter equipped with additional thermal sensors. The attendees should have basic knowledge on power semiconductor devices and power electronics systems.

Part 1: After a review of the basic theory of heat transfer, the calculation of losses in a voltage source inverter will be explained. For selected stationary operating conditions, the expected device temperatures of the sample converter will be calculated from datasheet values. Application of online tools to facilitate this process will be demonstrated. Participants can choose between FEM simulations and equivalent thermal network calculation with LTspice™ to simulate these operating conditions. The results are compared to thermal measurements using thermocouples and an IR camera.

Furthermore, a 3rd practical training group will deal with the comparison of a simulated power board with measurement and calibrate afterwards the simulation model

Part 2: Following a brief summary of the results of the first part, failure mechanisms, both at semiconductor and package levels will be introduced. After that, thermo-/damage-sensitive parameters will be discussed, together with theoretical background of thermal impedance measurement. A practical experiment about measurement of thermal impedance with standard laboratory equipment will end the first day. The second day will start from concrete design for reliability concepts, then aim straight at lifetime estimation, based on both power cycling and mission-profile approaches. Advanced electro-thermal and thermo-mechanical simulation will follow, and an overview about cooling systems will conclude the 2-day tutorial.

All presentations and discussions will be in English.

Programme

Tuesday, 11 July 2023

09:30 Start of Registration

09:45 Welcome
ECPE e.V.

10:00 Heat: Basics, Examples, Heat-Exchange – I
Uwe Scheuermann

11:15 Coffee Break

11:30 Heat: Basics, Examples, Heat-Exchange – II
Uwe Scheuermann

12:45 Lunch

13:45 First Steps of a Converter Design
Arendt Wintrich
- in-between 5 minutes break -

15:40 Coffee Break

16:00 Thermal Measurements I
- basic principles and techniques
Uwe Scheuermann

16:30 Thermal Network Simulation
Nils Jahn

17:25 Introduction to Finite Element Simulation
Martin Pfof

18:20 Wrap up 1st Day

18:30 End of 1st Day

19:30 Dinner

Programme

Wednesday, 12 July 2023

08:30 Start of 2nd Day

08:30 Thermal Measurements II
- measurement techniques
- practical tips and possible failures
- practical demonstration
Thomas Heckel

09:45 Coffee Break

10:00- Practical Training: Thermal Simulations
15:00 with three options:

Thermal Network Simulation (LTspice®)
Nils Jahn

CFD Thermal System Simulation with Finite Element Method -
Martin Pfof

Execute a Thermal Measurement of a Power Board and Compare with Simulation
A. Simon-Kajda,
S. Pauls, A. Voth

For organisational reason each group is limited to 15 participants. Participation in working group 2 is subject to special modalities, see attached description.

12:30-13:30 Lunch

Inbetween coffee during group activities

15:00 Wrap up 2nd Day, Final Discussion, Feedback

15:30 End of Tutorial

Course instructors:

- Dr. Thomas Heckel, Fraunhofer IISB
- Nils Jahn, TU Dortmund University
- Prof. Martin Pfof, TU Dortmund University
- Prof. Uwe Scheuermann, Friedrich-Alexander-Universität Erlangen-Nürnberg (DE)
- Andreas Simon-Kajda, Alexander Voth, Samuel Pauls, Siemens Industry Software
- Dr. Arendt Wintrich, Semikron Danfoss

Description /Abstracts Practical Training

ECPE Tutorial – ‘Thermal Engineering of PE Systems: ‘Thermal Design and Verification’

Please make your choice between



Training 1: Thermal Network Simulation with LTspice™ – Niels Jahn

Equivalent thermal networks are an easy and powerful method to model and simulate the thermal behavior of components in power electronic systems. In this workshop, we will discuss the basics of equivalent thermal networks and demonstrate how they can be derived analytically for simple geometries and how we can determine them from measurements.

In this year, we will model an IGBT power module as a realistically complex example. Suitable equivalent thermal networks will be derived and used to determine self-heating with LTspice. Further, we will show how system simulations including both the thermal and the electrical domain can be carried out easily with LTspice.

Training 2: CFD Thermal System Simulation with Finite Element Method (FEM) with ANSYS Icepak- Martin Pfost

The goal of the workshop is to learn how to perform thermal simulation with power electronics in ANSYS Icepak. We start with a simple model to compare the finite element method with analytical simulation and at the same time to learn how to define power dissipation, materials and boundary conditions. After that we expand the model to heat spreading and discuss the possibility of using a thermal network to model heat spreading.

The next step is the extension of the model to include a heat sink with a fan. This way we learn how to model forced convection to cool a power electronics module. We discuss on how to run parametric simulation to optimize cooling. In the final part of the tutorial we look at the prepared model of the Semicube inverter: how postprocessing looks like and what it takes to simulate this model. We discuss the practical issues: MCAD import, preparation of the model, meshing, etc.

Finally we briefly review features of the software that have not been covered by the tutorial: ECAD import, coupling with other simulation modules (electromagnetics, structural mechanical, electrothermal coupling, system simulation).

Please note! Participation in this working group is subject to the following modalities:

- Passing on your data to CADFEM/ANSYS
- Compliance with the legally prescribed export control regulations
- Registration up to 1 week before the start of the event

Training 3: Developing a Power Board with 3D CFD Thermal Simulation and Thermal Measurement

Andreas Simon-Kajda, David Sulyok

Practical workshop will start with an introduction of a simulated power board. Followed by a demonstration of a measurement of the same application with the T3Ster measurement system. Topics of the measurement topic will be :

- General introduction to transient thermal measurement method – transient measurement and evaluation of the structure function from the measured temperature response; and physical interpretation of the structure function
- Determining how to measure a component – electrical setup, recommended parameters, calibration of the temperature-sensitive parameter, etc.
- Measurement of the component to determine the component’s R_{th} (i.e. junction to case thermal resistance measurement using the dual interface method (JEDEC JESD51-14 standard)
- Evaluation of the structure function
- Introduction to volume testing – measurement of multiple components, including when mounted on a PCB

After the measurements the results will be compared with the simulation results. As the results will be slightly different there will be done a calibration so that at the end the simulation results will be as good as the measurement results in order to use them for further simulation runs.

These parts together provide a brief masterclass in thermal design and characterization, using a real product to illustrate the points.