

## Organisational Information

Sign up at: [www.ecpe.org/events](http://www.ecpe.org/events)

Registration Deadline:  
30 October 2024

### Participation Fee:

Part 1 2-3 July	Part 2 6-7 Nov.	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 via 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.

## Organisational Information

**Organiser** ECPE e.V.  
Ostendstrasse 181  
90482 Nuremberg, Germany  
[www.ecpe.org](http://www.ecpe.org)

**Technical Chair** Prof. Dr. Uwe Scheuermann,  
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**Venue** Novotel Erlangen  
Hofmannstr. 34  
91052 Erlangen, Germany



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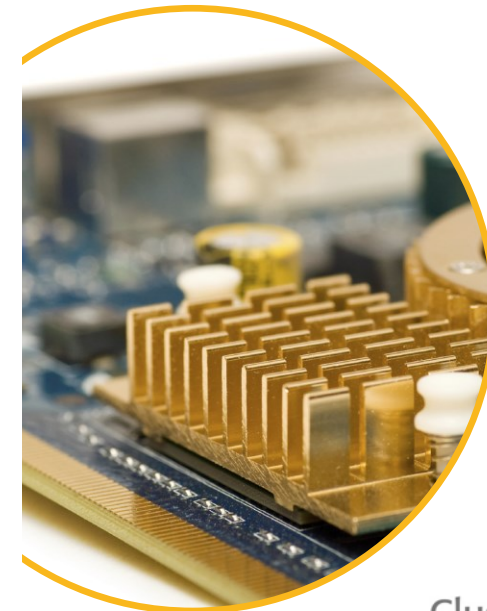


European Center for  
Power Electronics e.V.

## ECPE Tutorial

# Thermal Engineering of Power Electronic Systems Part 2: Thermal Management and Reliability

6 - 7 November 2024  
Erlangen, Germany



# Thermal Engineering of Power Electronic Systems Part 2

6 - 7 November 2024  
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 3<sup>rd</sup> 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

Wednesday, 6 November 2024

09:30 Start of Registration

09:45 Welcome  
ECPE e.V.

10:00 Short Summary of the Results of  
Tutorial Part1  
Arendt Wintrich

10:20 Semiconductor-Level Thermal and Electrical  
Failure Mechanisms  
Francesco Iannuzzo

11:30 Temperature and Reliability: Package-Level  
Failure Mechanisms I  
Uwe Scheuermann

12:10 Lunch

13:10 Temperature and Reliability: Package-Level  
Failure Mechanisms II  
Uwe Scheuermann

14:10 Thermo-/Damage-Sensitive Electrical  
Parameters  
Francesco Iannuzzo

15:00 Thermal Impedance Measurement -  
Preparation  
Arendt Wintrich

15:15 Introduction to Experiment  
Arendt Wintrich

15:30 Coffee Break

16:00 Thermal Impedance Measurement – Results  
and Interpretation  
Arendt Wintrich

16:15 Extraction and Application of Thermal  
Networks  
Martin Pfof

17:30 Wrap up 1st Day

18:00 End of 1st Day

19:30 Dinner

## Programme

Thursday, 7 November 2024

08:30 Start of 2nd Day

08:30 Design for Reliability  
Uwe Scheuermann

09:30 Lifetime Models based on Power Cycling Test  
Uwe Scheuermann

10:00 Coffee Break

10:20 Mission Profile based Lifetime Estimation  
Francesco Iannuzzo

11:15 Electro-Thermal and Thermo-Mechanical  
Simulation  
Martin Pfof

12:30 Lunch

13:30 Thermal Simulation of Complex Power  
Packages Considering Reliability Issues  
Andreas Simon-Kajda

14:30 Special Effects and Alternative Cooling  
Technologies  
Arendt Wintrich

15:15 TIM Materials  
Arendt Wintrich

15:45 Wrap up 2nd Day, Final Discussion, Feedback

16:00 End of Tutorial

Course instructors:

- Prof. Francesco Iannuzzo, Aalborg University
- Prof. Martin Pfof, TU Dortmund University
- Prof. Uwe Scheuermann, Friedrich-Alexander-Universität Erlangen-Nürnberg
- Andreas Simon-Kajda, Siemens Industry Software
- Dr. Arendt Wintrich, Semikron Danfoss