

Thermal Engineering of Power Electronic Systems Part II

19 – 20 October 2021
Nuremberg, Germany

Thermal engineering of power electronic systems is a key to achieve high performance and reliability. The focus of the tutorial is the thermal design and validation of a power electronic inverter exemplified by a 100 kW SEMIKUBE 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 modeling of a power board with 3D CFD thermal analysis.

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, 19 October 2021

- 09:30 Start of Registration
- 09:45 Welcome
ECPE e.V.
- 10:00 Short Summar of the Results of Tutorial Part 1
Arendt Wintrich
- 10:20 Semiconductor-Level Thermal and Electrical Failure Mechanism
Francesco Iannuzzo
- 11:20 Temperature and Reliability: Package-Level Failure Mechanisms I
Uwe Scheuermann

12:00 Lunch

- 13:00 Temperature and Reliability: Package-Level Failure Mechanisms II
Uwe Scheuermann
- 14:00 Thermo-/Damage-Sensitive Electrical Parameters
Francesco Iannuzzo
- 14:45 Thermal Impedance Measurement - Preparation
Arendt Wintrich
- 15:00 Introduction to Experiment
Arendt Wintrich

15:15 Coffee Break

- 15:45 Thermal Impedance Measurement – Results and Interpretation
Uwe Scheuermann
- 17:30 Wrap up 1st Day
- 18:00 End of 1st Day

19:30 Dinner

Programme

Wednesday, 20 October 2021

- 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 Cooling Technologies - Overview
Uwe Scheuermann
- 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, Semikron Elektronik
- Andreas Simon-Kajda, Siemens Industry Software
- Dr. Arendt Wintrich, Semikron Elektronik