



EPE'22 ECCE Europe – Tutorial Announcement

## **Switching Loss Measurements in Power Semiconductors**

### **Name(s) and Affiliation(s) of the Lecturer(s):**

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### **Scope and Benefits:**

After providing a brief overview over the operation principle of Double Pulse Tests (DPT), this tutorial highlights the influence of the applied sensing equipment on the measurement. We investigate side effects of current and voltage probes on the Device under Test and provide possible solutions to get better results when characterising fast-switching Wide Band Gap (WBG) power semiconductors. The limits for the DPT method and estimates regarding the accuracy and applicability of the measurement principle are derived as well.

### **Contents:**

Power Semiconductors are present in many important industry sectors. In nearly all applications, the main goal of new developments is the optimisation and reduction of switching losses to reach the maximum efficiency and minimum weight for the overall system. To do that, it is necessary to know the switching and conduction losses that these devices will produce under the expected load conditions. This knowledge is all the more important for WBG semiconductors in order to exploit their beneficial properties, such as fast switching transients and low switching losses, as these losses limit the applicable switching frequency.

Standard measurement methods, developed for silicon power semiconductors, are nearing their limits of application due to the immensely increasing requirements regarding measurement accuracy and data acquisition speed. Especially the DPT, often preferred for its short measurement time per data point, requires sensors with bandwidths as high as possible.



However, several detailed investigations have shown that not only the bandwidth but also the unintended effect of the sensor on the circuit could massively influence the measurement results of WBG DPT.

The first two topics will introduce the concept of measuring switching losses using the DPT as well as an overview of the challenges posed by WBG power semiconductors for this technique. The third and fourth topics then highlight critical problems that occur when WBG devices are to be investigated and also derive quantitative comparisons for available sensors with respect to their influence on the circuit and the errors introduced through their use. Through mathematical modelling, selection aids are then developed and validated through experimental evidence. Finally, in the fifth topic, methods are investigated that can partially counter the identified error mechanisms.

### **Schedule:**

#### **Monday, 5 September 2022 - 1<sup>st</sup> Tutorial Day - Afternoon**

|               |  |
|---------------|--|
| 14:00 – 14:45 | Introduction and Overview to Switching Loss Measurements     |
| 14:45 – 15:15 | Correctly Measuring Transient Currents and Voltages          |
| 15:15 – 15:45 | Measuring Correctly vs. Measuring the Right Thing            |
| 15:45 – 16:15 | Coffee break   |
| 16:15 – 16:45 | Available Sensors and their Suitability for DPT Measurements |
| 16:45 – 17:15 | Possibilities for Error Minimisations                        |
| 17:15 – 17:30 | Conclusions  |

### **Who should attend:**

This tutorial both targets participants that are new to the measurement of switching losses of power semiconductors as well as experienced researchers and application engineers who want to get a closer look at the details and pitfalls of such measurements.

### **Technical Level:**

Beginner and Experienced

### **About the Lecturers:**



**Sebastian SPRUNCK** studied electrical engineering at the University of Kassel, Germany, from 2010 to 2016. He received his B.Sc., M.Sc. and Ph.D. degrees in 2014, 2016 and 2021, respectively. In 2017, he started working as a research assistant at the Centre of Competence for Distributed Electric Power Technology (KDEE) at the University of Kassel where he worked on the miniaturisation of power electronic systems and on the application of wide band gap semiconductors in power



electronic devices. Since 2020, he is working at Fraunhofer IEE in Kassel, Germany, in the Converters and Drive Technology Department as Group Manager Devices and Measurement Systems. He is investigating the influences of individual technological advances, such as wide band gap semiconductors, and of broader trends, such as the German “Energiewende”, onto power electronic components, circuits and systems. His main interest focuses on the characterisation and optimisation of (WBG) semiconductor switching losses and their implementation in power electronic systems. Mr. Sprunck is a member of the VDE Association for Electrical, Electronic & Information Technologies and of the VDI Association of German Engineers e.V.



**Marco JUNG** completed an apprenticeship for communication electronics in 2003 and continued to study electrical engineering at the TH Mittelhessen University of Applied Sciences and at the University of Kassel, where he received his Diploma and M.Sc. degrees in 2008 and 2010, respectively. He continued his studies at the Leibniz University Hannover, where he received his Ph.D. degree in 2016. Parallel to his Ph.D. studies, he started working at the Fraunhofer IEE in 2010. Since 2017, he is head of the Converters and Drive Technology Department. In 2019, he additionally became a full Professor at the Bonn-Rhein-Sieg University of Applied Sciences, Sankt Augustin, Germany. At the Institute of Technology, Resource and Energy-Efficient Engineering, he is responsible for power electronics for renewable energies and electric vehicles. Mr. Jung is chairman of the IEEE Joint IES/IAS/PELS German Chapter since Jan. 1st, 2021. He is a member of the International Scientific Committee (ISC) of the European Power Electronics and Drives Association (EPE) and a member of the European Center for Power Electronics (ECPE).



**Christian LOTTIS** studied electrical engineering at the University of Kassel, Germany, from 2014 to 2021. He received his B.Sc. and M.Sc. degrees in 2019 and 2021, respectively. Since August 2021, he is working as a research assistant at the Bonn-Rhein-Sieg University of Applied Sciences, Sankt Augustin, Germany.