

## **Tutorial Proposal Form**

### **1. Title of Tutorial**

Design for Reliability of Power Electronic Systems

### **2. Abstract (500 word limit, If the tutorial is accepted, this abstract will be published in the conference web page, program, and proceedings)**

In recent years, the automotive and aerospace industries have brought stringent reliability constraints on power electronic systems because of safety requirements. Today customers of many power electronic products expect up to 20 years of lifetime and they also want to have a “failure free period” and all with focus at the financials. The industrial and energy sectors are also following the same trend, and more and more efforts are being devoted to improving power electronic systems to account for reliability with cost-effective and sustainable solutions. The emphasis of this tutorial is to give a framework on the design for reliability of power electronic systems and the recent research activities and paradigm shifts in this research area. It will cover the reliability requirements in different industry sectors, reliability and lifetime of IGBT modules and capacitors used in power electronic converters, and the specific design for reliability procedure for power electronic systems. Study cases on mission profile based design of photovoltaic inverters and wind power converters, and active thermal control and condition monitoring of power converters are also discussed. The approaches presented in the tutorial are also the common interest for the companies involved in the Center of Reliable Power Electronics (CORPE) at Aalborg University (<http://www.corpe.et.aau.dk/>). The tutorial will also present the views of the instructors on the future research opportunities in the area of reliability of power electronics.

### **3. Outline of Tutorial (Outline would only define the topics and the subtopics that would be covered. No detail descriptions should be included in the proposal)**

The outline of the tutorial is as follows:

- **Beyond Efficiency and Power Density - Towards Reliable Power Electronics**
  - Motivations for more reliable power electronics
  - Field experiences in power electronic applications
  - The reliability challenges in industry
  - Ongoing paradigm shift in reliability research in power electronics
- **Reliability Critical Components – Switching Devices and Capacitors**
  - Recent reliability aspect research on IGBT modules
  - Reliability of electrolytic capacitors and film capacitors for DC-link applications
- **Design for Reliability – Revisit the Design of Power Electronics from a Reliability Perspective**
  - The concept of design for reliability of power electronic systems
  - Mission profile based design example of a photovoltaic inverter
  - Mission profile based design example of a wind power converter
  - Strategies to further improve reliability – examples on active thermal control, fault-tolerant design and condition monitoring of power converters

■ **Outlook – Future Research Opportunities in Reliability of Power Electronics**

- Interdisciplinary efforts required in this research area
- Opportunities ahead of us in this research area

■ **Center of Reliable Power Electronics (CORPE) at Aalborg University – Introduction and Recent Research**

- Framework of the research activities in CORPE
- Facilities in CORPE for the research on power electronics reliability

**4. Lead Instructor (Name / Affiliation & contact information)**

**Frede Blaabjerg** ([fbl@et.aau.dk](mailto:fbl@et.aau.dk))

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**5. Other Instructor (Name / Affiliation & contact information)**

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**6. Instructor Bios: ~150 words each (Please provide a brief biography of each instructor, describing the qualifications for presenting the proposed tutorial, including the work and publications that are most relevant to the proposal)**

**Frede Blaabjerg** (F'03) is currently a Professor with the Department of Energy Technology and the Director of Center of Reliable Power Electronics (CORPE), Aalborg University, Denmark. He has intensive research work on power electronics and its applications in motor drives, wind turbines, PV systems, harmonics, and the reliability of power electronic systems. He has held more than 300 lectures national and international, most of them in the last decade are invited and as keynotes at conferences, covering various topics on power electronics, including the reliability. He was a Distinguished Lecturer for the IEEE Power Electronics Society from 2005 to 2007 and for the IEEE Industry Applications Society from 2010 to 2011. He has contributed more than 800 journal and conference papers, many of which in the last four years are relevant to the reliability of power electronic components, converters and systems. Dr. Blaabjerg received the IEEE William E. Newell Power Electronics Award in 2014, the IEEE PELS Distinguished Service Award in 2009, the Outstanding Young Power Electronics Engineer Award in 1998, and 15 IEEE Prize Paper Awards. He served the Editor-in-Chief of the IEEE Transactions on Power Electronics from 2006 to 2012.

**Huai Wang** is currently an Assistant Professor with the Center of Reliable Power Electronics (CORPE) in the Department of Energy Technology, Aalborg University, Denmark. His current research interests include the reliability of power electronic systems and reliability of capacitors for DC-link applications. He was one of the lecturers for a PhD course on Reliability in Power Electronic Systems at Aalborg University and was an invited speaker at the ECPE workshop on lifetime modeling and simulation. He has contributed more than 50 journal and conference papers, including several concept papers on the design for reliability of power electronic systems. Dr. Wang received his PhD degree from the City University of Hong Kong, Hong Kong, in 2012. He was a Visiting Scientist with the Massachusetts Institute of Technology, Cambridge, MA, USA, in 2013. He was with the ABB Corporate Research Center, Baden, Switzerland, in 2009. He serves the Guest Associate Editor of the IEEE Transactions on Power Electronics Special Issue on Robust Design and Reliability in Power Electronics.

**Ke Ma** received the B.Sc. and M.Sc. degrees in electrical engineering from the Zhejiang University, Hangzhou, China in 2007 and 2010 respectively. And he received the Ph.D. degree from the Aalborg University, Aalborg, Denmark in 2013. He is currently working as Postdoc in the Department of Energy Technology, Aalborg University, Aalborg, Denmark. His research interests are in the power electronics and reliability in the application of renewable energy generations. In the last few years he was focusing on the translating/improving mission profiles to the converter's loading and reliability performances. He is deeply taking part in the working packages for the Center of Reliable Power Electronics (CORPE), Aalborg University, where he is also involving a PhD course related to power electronics reliability. Dr. Ma received the IEEE Industry Applications Society Industrial Power Converter Committee Third Prize Paper Award in 2012 and a prize paper award at ISIE Poland in 2011.

**Marco Liserre** (F'13) is currently Full Professor and Chair of Power Electronics at Christian-Albrechts-University of Kiel, Germany. He received the MSc and PhD degree in Electrical Engineering from the Bari Polytechnic, respectively in 1998 and 2002. He has been Associate Professor at Bari Polytechnic and Professor in Reliable Power Electronics at Aalborg University, Denmark. He has published 168 technical papers, 3 book chapters and a book on Grid Converters for Photovoltaic and Wind Power Systems. These works have received more than 6000 citations. He is Associate Editor of the IEEE Transactions on Industrial Electronics, IEEE Industrial Electronics Magazine, IEEE Transactions on Industrial Informatics, IEEE Transactions on power electronics, and IEEE Journal of Emerging and Selected Topics in Power Electronics. He has been Founder and Editor-in-Chief of the IEEE Industrial Electronics Magazine, Founder and the Chairman of the Technical Committee on Renewable Energy Systems. Dr. Liserre has received the IES 2009 Early Career Award, the IES 2011 Anthony J. Hornfeck Service Award, and the 2011 Industrial Electronics Magazine best paper award.