Editorial for the Special Issue on Safety and Reliability of Power Electronics Components and Systems

EFFICIENCY and power density have been widely concerned with the development of power electronics, while the safety and reliability issues are attracting more and more attention in a few years due to the increasingly stringent safety requirements, e.g., in electric vehicle, consumer electronics, and aerospace industries. To understand the failure mechanisms and the safe operation area of components/systems in practical applications, comprehensive testing methods considering the operating conditions are becoming essential. Besides accelerated aging tests, multi-physics modeling, physics-of-failure analyses, degradation modeling, electro-thermal simulation, and lifetime assessment contribute to a better understanding of the failure roots in components and systems and the design of a safer system. Moreover, designing condition monitoring and health status estimation tools, fault diagnosis, fault tolerance, and active thermal management techniques help to realize the predictive maintenance of power electronic components and systems. Finally, emerging artificial intelligence (AI) and machine learning (ML) techniques are getting a lot of attention in aging data processing, remaining useful life estimation, etc. Correspondingly, we organized this Special Issue on Safety and Reliability of Power Electronics Components and Systems to collect emerging research achievements within the scope of safety and reliability of power electronics components and systems and circuits.

The call for paper of the Special Issue on Safety and Reliability of Power Electronics Components and Systems was published in March 2023. We received twenty submissions in total. Reviews were promptly organized by Guest Associate Editors from China, Europe, and South Korea. Reviewers are invited from all over the globe. After rigorous reviews, twelve papers were accepted. Because of the publication timing, six of the papers appear in this issue and the other six will appear in a later issue of TPEA. Each of these accepted papers addresses one particular challenge with innovative solutions. A few of these papers also showcase successful international collaborations on fundamental research of Safety and Reliability of Power Electronics.

The paper by K. Dai and his co-authors from Wuhan University presents a synthetical thermal model and a novel multi-objective optimization method to meet the demand for accuracy and reliability in the thermal design of high-efficiency and high-power density inverter devices. A 100 V/10 kW prototype was designed to prove the accuracy of the proposed model and optimized heatsink.

The paper by Y. Chen and his co-authors from Southeast University proposes a method to predict the parameter shift of planar transformers under thermal stress using a deep learning algorithm. The advantage and accuracy of the used Bi-LSTM algorithm have been verified in experiment.

The paper by Y. Duan and his co-authors from Hebei University of Technology presents an online on-state voltage measurement circuit for SiC MOSFETs, which solves the problems of large errors, complex structure, and low reliability of traditional on-state drain-source voltage measurement circuits.

The paper by J. Miao and his co-authors from Huazhong University of Science and Technology studies the influence of various sampling frequencies of output voltage on soft fault diagnosis accuracy of DC/DC converters, which provides a reference for the selection of signal sampling frequency for soft fault diagnosis of DC/DC converters in practical engineering applications.

The paper by D. Nayak and his co-authors from Indian Institute of Technology Delhi presents a simulation-based electro-thermal junction temperature assessment method for the SiC MOSFETs in a half-bridge configuration based on the datasheet parameters. The method has been validated on a 10 kW three-phase interleaved boost converter laboratory prototype.

The paper by Z. Xu and his co-authors from Southwest Jiaotong University, China and Aalborg University, Denmark presents a fast calculation method for IGBT junction temperature based on Fourier transform. Its effectiveness is verified through extensive simulations and experimental tests.

We appreciate the efforts of all authors who had submitted papers and we appreciate timely reviews from Guest Associate Editors and reviewers, especially at this time of difficulty. Great thanks to all Guest Associate Editors for their diligence and professional support.

- Dao Zhou, Aalborg University, Denmark
- Zhen Xin, Hebei University of Technology, China
- Shenghui Cui, Seoul National University, Korea
- Qian Wang, Wuhan University of Technology, China
- Qiao Peng, Sichuan University, China
- Li Wei, Tongji University, China
- Yingzhou Peng, Hunan University, China
- Zhiqing Yang, Hefei University of Technology, China

▪ Zhaoyang Zhao, Southwest Jiaotong University, China
▪ Zhan Shen, Southeast University, China

We would like to express our deep gratefulness to Prof. Jinjun Liu, Editor-in-Chief, for his tremendous support from the initiative throughout the final stages of this Special Issue. Finally, we would like to thank the CPSS TPEA staff involved with the production and technical support of this Special Issue. We look forward to seeing more great papers on Safety and Reliability of Power Electronics in CPSS Transactions on Power Electronics and Applications in the time yet to come and your continuous support of the journal.

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Frede Blaabjerg received the Ph.D. degree in electrical engineering from Aalborg University, Aalborg, Denmark, in 1995. He was with ABB-Scandia, Randers, Denmark, from 1987 to 1988. He became an Assistant Professor in 1992, an Associate Professor in 1996, and a Full Professor of power electronics and drives in 1998 at Aalborg University, where he became a Villum Investigator in 2017. He is also honoris causa at Universitatea Politehnica Timisoara (UPT), Romania, and the Tallinna University of Technology (TTU), Tallinn, Estonia. He has published more than 600 journal articles in the fields of power electronics and its applications. He is a coauthor of four monographs and editor of ten books in power electronics and its applications. His current research interests include power electronics and its applications, such as in wind turbines, PV systems, reliability, harmonics, and adjustable speed drives.

Dr. Blaabjerg received 32 IEEE Prize Paper Awards, the IEEE Power Electronics Society (PELS) Distinguished Service Award in 2009, the EPE-PEMC Council Award in 2010, the IEEE William E. Newell Power Electronics Award in 2014, the Villum Kann Rasmussen Research Award in 2014, the Global Energy Prize in 2019, and the 2020 IEEE Edison Medal. He was nominated in 2014–2019 by Thomson Reuters to be between the most 250 cited researchers in engineering in the world. He was the Editor-in-Chief of IEEE TRANSACTIONS ON POWER ELECTRONICS from 2006 to 2012. He was a Distinguished Lecturer of the IEEE Power Electronics Society from 2005 to 2007 and the IEEE Industry Applications Society from 2010 to 2011 and 2017 to 2018. From 2019 to 2020, he has served as the President of the IEEE Power Electronics Society. He is also the Vice-President of the Danish Academy of Technical Sciences.

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Wu Chen (Senior Member, IEEE) was born in Jiangsu, China, in 1981. He received the B.S., M.S., and Ph.D. degrees in electrical engineering from the Nanjing University of Aeronautics and Astronautics, Nanjing, China, in 2003, 2006, and 2009, respectively. From 2009 to 2010, he was a Senior Research Assistant with the Department of Electronic Engineering, City University of Hong Kong, Hong Kong. In 2010 and 2011, he was a Postdoctoral Researcher with the Future Electric Energy Delivery and Management Systems Center, North Carolina State University, Raleigh, NC, USA. Since September 2011, he has been an Associate Research Fellow with the School of Electrical Engineering, Southeast University, Nanjing, China, where he has been a professor since 2016. His main research interests include soft-switching converters, power delivery, and power electronic system integration.

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Haoze Luo (Member, IEEE) received the B.S. degree in electrical engineering and automation and the M.S. degree in power electronics and power drives from the Hefei University of Technology, Hefei, China, in 2008 and 2011, respectively, and the Ph.D. degree in power electronics and power drives from Zhejiang University, Hangzhou, China, in 2015. From January to April 2015, he was a Visiting Researcher with Newcastle University, Newcastle upon Tyne, U.K. From October 2015 to May 2018, he was a Postdoc with the Department of Energy Technology, Aalborg University, Aalborg, Denmark. From May 2018 to September 2019, he was a Senior R&D Engineer with Dynex Power Inc., Lincoln, U.K. Since October 2019, he has been with Zhejiang University, as a Research Fellow. His research interests include packaging technology and reliability assessment for high-power modules. Dr. Luo is currently an Associate Editor for the IET Power Electronics and has been a Guest Associate Editor for the IEEE JOURNAL OF EMERGING AND SELECTED TOPICS IN POWER ELECTRONICS. Dr. Luo was the recipient of the Outstanding Reviewer of IEEE TRANSACTIONS ON POWER ELECTRONICS (2021).