Editorial

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Biographical notes: Caisheng Wang received his BS and MS degrees from the Chongqing University, China, in 1994 and 1997, respectively, and PhD from Montana State University, Bozeman, MT, in 2006, all in Electrical Engineering. From August 1997 to May 2002, he worked as an Electrical Engineer and then Vice Department Chair in the Zhejiang Electric Power Test & Research Institute, Hangzhou, China. Since August 2006, he has joined the Wayne State University, where he is currently a Professor at Department of Electrical and Computer Engineering. His current research interests include modelling and control of power systems and electric vehicles, power electronics, energy storage devices, distributed generation and MIcrogrids, alternative/hybrid energy power generation systems, and fault diagnosis and online monitoring of electric apparatus. He was an associate editor of the *IEEE Transactions on Smart Grid* and several other international journals.

Mengqi (Maggie) Wang received her BS in Electrical Engineering from the Xi'an Jiaotong University, Xi'an, in 2009 and PhD in Electrical Engineering from North Carolina State University, Raleigh, NC, in 2014. She is currently an Associate Professor with the Department of Electrical and Computer

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Fang Luo is a new Empire Innovation Associate Professor at SBU. His research interests include high power-density converter design, high-density EMI filter design and integration, and power module packaging/integration for wide band-gap devices. He is a co-PI in NASA funded University Leadership Initiative project Center for High-Efficiency Electrical Technologies for Aircraft (CHEETA). He is a senior member of IEEE, a member of AIAA and ASME. He holds two US patents and has authored/co-authored numerous journal and conference papers. He is an Associate Editor of IEEE Transactions on Power Electronics. He is a recipient of NSF CAREER Award.

Mario Cacciato received the MS in Electrical Engineering in 1996, and PhD in Electronic Engineering in 2000. Since 2011, he is an Associate Professor at the DIEEI, University of Catania, where is currently teaching Electrical Machines and Power Electgronics. He is an author of more than 180 technical papers. He is a member of the IEEE Industrial Electronics and IEEE Power Electronics Societies. He is also a member of the European Power Electronics Association (EPE), chair of the Steering Committee EPE – IEEE PELS and member of EPE Executive Council.

As the USA and the rest of the world move forward to decarbonise the transportation sector by electrifying powertrain and producing significantly more electricity from clean and renewable sources, electric vehicles (EVs) become logical alternatives to internal combustion engines (ICEs). There will be no U-turns on this trend as all the major traditional car manufacturers such as General Motors and Ford Motor Company have announced their plans for an all-electric future, not even to mention the new rising stars such as Tesla in the EV industry.

EVs can broadly include plug-in hybrid electric vehicles (PHEVs), fuel cell vehicles (FCVs) and pure battery electric vehicles (BEVs). Advanced power electronics converters, fuel cell and battery management systems, and motors and motor drives are developed to enhance energy performance, decrease operating costs, and increase the lifespan of electric powertrains and EVs in general. The study on power converters and electric motors as well as the research on fuel cell and battery management for vehicle/powertrain electrification and hybridisation, are urgently needed to promote the use of EVs. Nevertheless, electric powertrain for EVs and hybrid EVs is a multidisciplinary area, which is of great interest to and is being studied by different communities, including electrical engineering, mechanical engineering, control, power electronics, computer science, physics, chemistry (such as material science), etc. To this end, it is beneficial for researchers in one area to get a chance to look at the research activities in the other areas, which was the objective of this special issue.

This special issue includes seven high-quality papers, which cover a wide range of topics on powertrain electrification and hybridisation: from new power converter topologies and control methods to electromagnetic interference (EMI) noise mitigation, power converters and associated components at cryogenic temperatures, and to suitability study of 72 V permanent magnet brushless DC (PMBLDC) motors for light motor EVs,

and further extended to studies on fuel cells on water distribution and performance analysis of centrifugal compressors under plateau and frigid conditions.

EMI is one of the greatest challenges in the development of high-efficiency and high-power-density power electronic converters, particularly when wide bandgap (WBG) semiconductor devices are used due to their high di / dt and dv / dt. The paper by Liang and Bai from the University of Tennessee provides a comprehensive literature review on common-mode EMI noise mitigation methods for single-phase power factor correction (PFC) converters. The paper first introduces different EMI compliance standards and EMI sources and modelling, and reviews different common-mode EMI mitigation methods such as active and passive filters and impedance balance methods.

The paper by Jia and Huang from Inner Mongolia Power Company, China presents a new low-frequency oscillation suppression method for a seven-level hybrid T-type nested neutral point clamped (NPC) converter. Multilevel converters are normally used for medium voltage (over 1 kV) variable frequency (MVVF) motor drives in the powertrain of high-speed electric trains, heavy-duty EVs, and vessels. With the advancement of WBG devices, multilevel converters are now also being considered for low voltage (below 1 kV) applications as they can significantly reduce dv / dt. However, multilevel converters also have some issues that need to be addressed. For example, large low-frequency fluctuations on the flying capacitors are one of the issues in the seven-level hybrid T-type nested NPC converter. The paper proposes a method for suppressing such large low-frequency oscillations and further facilitates the application of multilevel converters to electric powertrains.

The paper by Alaas, Chen and Wang is a collaborative work between three universities in Saudi Arabia and the USA. The paper presents a hierarchical cascaded multilevel converter (HCMC) with continuous uniform state-of-charge (SOC) management for battery storage systems. Battery storage is critical not only for BEVs but also for PHEVs and FCVs. Battery packs in EVs consist of many cells/modules connected in series and parallel to achieve the desired voltage and power ratings. It is then essential but challenging to manage those cells/modules in a large battery pack to guarantee they are operated with a balanced SOC profile. The proposed HCMC can help achieve individualised battery management with a uniform SOC profile, which is critical for the healthy operation of the whole battery pack. The proposed converter and control method can be extended to utility-scale battery energy storage systems in power systems with high penetration of renewable energy.

The paper by Dhananjaya and Kumar from Canara Engineering College Mangalore and Nitte Mahalinga Adyanthaya Memorial Institute of Technology, India, investigates the suitability of 72 V PMBLDC motor for light motor EVs instead of 48 V motor. The paper presents a comprehensive analysis of the performance of a 72 V PMBLDC motor and validates the suitability of its application for light motor EVs compared to the 48 V motor. The characteristics of the motor that were compared between the 72 V and 48 V motor are torque, speed, power, efficiency, etc. The comparison results show that the 72 V motor has superior characteristics such as increased torque and efficiency.

FCV is another important category of transportation electrification. The research on FCVs has gained momentum again in many countries. Fuel cells' performance under conditions needs to be carefully studied. The paper by Gao and Ma from Tongji University, China, studies the influence of plateau and frigid environmental conditions on the performance of the centrifugal compressor based on the model modification. The

paper proposes a centrifugal compressor model based on a universal performance MAP method. The effects of low ambient temperature and low ambient pressure on the performance of the centrifugal compressor are studied based on the proposed model. The working range of the centrifugal compressor is restricted in the plateau and frigid environment, and the consumption of the compressor is increased. The results of this paper provide insight into the performance research of FCVs in the plateau and frigid environment. The water content in fuel cells plays an important role in the fuel cells' performance; however, the water status cannot be directly observed due to the fuel cell structure limits. The paper authored by Ma, Kang and Yang also from Tongji University, China, presents an indirect measurement method using the electrochemical impedance spectroscopy (EIS) data to characterise the internal water content status of the fuel cell. In the paper, by changing the working temperature and current density of the fuel cell stack, the EIS data of the stack and the battery are obtained through experiments. According to the experimental results, changing the operating temperature has a significant impact on the low-frequency impedance results. This paper also compares the effects and technical feasibility of two solutions, controlling the relative humidity of the reactant gas and controlling the working temperature. The comparison of experimental results show that changing the relative humidity of the reactant gas and changing the fuel cell operating temperature have close effects on the impedance modulus of the fuel cell. The proposed method provides a sufficient cost-effective way for the operation optimisation for fuel cells

The trend of electrification across different transportation platforms puts higher requirements of power density and efficiency for power electronics converters. Cryogenic cooled power electronics system provides a new way to achieve these goals. The paper authored by Ul-Hassan, Azadeh, Emon and Luo from Stony Brook University, USA, presents a detailed review of low operating temperature power electronics converters and their constituent components, including semiconductor devices, passive components, and superconducting machines. This review covers the performance comparison and characteristics of potential materials and technologies for power devices, inductors, and capacitors. It also provides a brief overview of the state-of-the-art for cryogenic power converters and superconducting machine development, as well as cryo-cooling methods.

We truly appreciate the great effort from all authors who had submitted papers to this special issue and, more importantly, the timely reviews from guest associate editors and reviewers, especially at this unprecedented time of challenge. We are also very thankful to Dr. Xubin Song, Editor-in-Chief, for initiating this special issue, providing the opportunity to organise it, and for his tremendous support during the whole process. We also would like to express our deep gratitude to the IJPT staff for their swift support that eventually made this happen. We hope this special issue will provide powertrain professionals with a glance at power electronics research and help attract more readers, particularly power electronic researchers, to the journal.