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EDITORIAL

IEEE ACCESS SPECIAL SECTION EDITORIAL: ADVANCED ENERGY CONVERSION SYSTEMS BASED ON MULTI-PORT ELECTRICAL MACHINES

Over the last decade, with the merits of high efficiency, compactness, and flexibility, energy conversion systems based on multiple-electrical-port and multiple-mechanical-port electrical machines have attracted widespread attention from both academia and industry. This concept has been adopted in many industrial applications, such as wind power generation, ship shaft power generation, ship electric propulsion, electric vehicles, rail transportation, more/all electric aircrafts, and ac/dc microgrids. Due to the ever-increasing demand for highly reliable and cost-effective energy conversion systems, advanced machine/converter topologies, modeling approaches, control strategies, and reliability, evaluations of multi-port electrical machines and drive systems are in great need.

This Special Section focuses on electrical machines and drives, power electronics, control theories and technologies, energy utilization, and industrial applications, which matches the interdisciplinary and application-oriented nature of IEEE ACCESS. Hence, this Special Section will be of great significance to readers dedicated to the disciplines mentioned above, which have attracted a large number of contributions from both academic and industrial communities.

The Call for Papers aroused great enthusiasm in the scientific community and received 25 submissions. Out of these, eight articles were accepted for inclusion in the Special Section after a thorough review process by the referees.

In [A1], Li *et al.* first build a steady equivalent circuit considering the uncontrolled rectifier and the grid impedance to study the harmonic distribution characteristics. This article improves the conventional control method by adding a harmonic control loop to prevent harmonic currents from being injected into the machine or the grid, which is then applied in the fundamental synchronous frame.

In [A2], Hu *et al.* propose a coordinated control strategy by considering machine side converter (MSC) and grid side converter (GSC) together to overcome the problems and improve the control capability under grid voltage unbalance. The results demonstrate that the proposed control can effectively achieve the control objectives of overall wind turbine system under grid voltage unbalance and provide excellent dynamic and stable performance.

In [A3], Wang *et al.* compare the dual-stator axial-field flux-switching permanent magnet (DSAFFSPM) motors with E- and U-core stator modular segments, as well as different stator/rotor-pole combinations. The operation performance of the DSAFFSPM machines is explored using the MMF-permeance model method. A more comprehensive theoretical analysis, not limited to numerical calculation, is presented.

In [A4], Wu *et al.* propose a method to diagnose the open-circuit faulty phases and faulty points of the six-phase permanent magnet synchronous motor (PMSM) drive circuit. The least mean square error (LMS) adaptive filtering algorithm is used to filter out the vibration and noise. The change of energy entropy can simplify the double-bridge arm open-circuit fault to the single-bridge arm open-circuit fault, which reduces the number of fault characteristics. The experimental results prove that the proposed method can accurately diagnose the open-circuit faults of the six-phase PMSM drive system.

In [A5], Liu *et al.* propose an asymmetric-primary axis-flux hybrid-excitation generator (APAFHG) to provide a controllable maglev force that compensates for the ripple of axial force fluctuation. The finite element analysis results show that the proposed generator can be implemented for the decoupling control operation of power and levitation forces, which is suitable for vertical axis wind turbines.

In [A6], Boldea *et al.* review recent progress in doubly fed induction generators (DFIGs) and various forms of brushless doubly fed generators (BDFGs) characterized in terms of topology, design, performance, and advanced control for healthy and faulty load conditions in the hope of inspiring new, hopefully, groundbreaking progress for wind and hydro energy conversion, and in vehicular and on the ground standalone generator applications.

In [A7], Bakbak *et al.* propose a dual-port wind-energy conversion system. A double-fed permanent-magnet synchronous generator (DFPMSG) forms the central part of the system, where the concentrated single-layer winding configuration of the generator enables electric and magnetic isolation between the ports. The unique design issues of the proposed system include determining the slot/pole combination using wind data and determining the minimum reactive power requirement for the port with a direct grid connection.

In [A8], Liu *et al.* review recent advances in control technologies for BDFGs under different operation conditions, e.g., grid-connected ac power generation with normal and faulty grids, standalone AC power generation with normal and special loads, and dc power generation. The progress

of sensorless control technologies for BDFG-based power generation systems is also discussed. The classification and comparison are carried out to discover the similarities and differences between these control technologies. This article was written in the hope of inspiring new groundbreaking progress for high-performance BDFG power generator applications.

In conclusion, we would like to thank all the authors who submitted their research articles to our Special Section. We highly appreciate the contributions of the reviewers for their constructive comments and suggestions. We also would like to acknowledge the guidance from the IEEE ACCESS Editor-in-Chief and staff members.

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APPENDIX: RELATED ARTICLES

[A1] Z. Li, X. Wang, M. Kong, and X. Chen, "Bidirectional harmonic current control of brushless doubly fed motor drive system based on a fractional unidirectional converter under a weak grid," *IEEE Access*, vol. 9, pp. 19926–19938, 2021.

[A2] S. Hu, G. Zhu, and Y. Kang, "Modeling and coordinated control design for brushless doubly-fed induction generator-based wind turbine to withstand grid voltage unbalance," *IEEE Access*, vol. 9, pp. 63331–63344, 2021.

[A3] S. Wang, K. Lin, M. Lin, Y. Kong, D. Xu, N. Li, and P. Wang, "Comparative study of E- and U-core modular dual-stator axial-field flux-switching permanent magnet motors with different stator/rotor-pole combinations based on flux modulation principle," *IEEE Access*, vol. 9, pp. 78635–78647, 2021.

[A4] Y. Wu, Z. Zhang, Y. Li, and Q. Sun, "Open-circuit fault diagnosis of six-phase permanent magnet synchronous motor drive system based on empirical mode decomposition energy entropy," *IEEE Access*, vol. 9, pp. 91137–91147, 2021.

[A5] J. Liu, Q. Zhang, R. Wang, J. Hu, L. Zhang, and B. Cai, "An asymmetric-primary axis-flux hybrid-excitation generator for the vertical axis wind turbine," *IEEE Access*, vol. 9, pp. 92318–92325, 2021.

[A6] I. Boldea, L. N. Tutelea, C. Wu, F. Blaabjerg, Y. Liu, M. G. Hussien, and W. Xu, "Fractional kVA rating PWM converter doubly fed variable speed electric generator systems: An overview in 2020," *IEEE Access*, vol. 9, pp. 117957–117968, 2021.

[A7] A. Bakbak, M. Altintas, M. Ayaz, H. T. Canseven, M. Boztepe, O. Akin, and E. Mese, "PMSG-based dual-port wind-energy conversion system with reduced converter size," *IEEE Access*, vol. 9, pp. 118953–118967, 2021.

[A8] Y. Liu, M. G. Hussien, W. Xu, S. Shao, and E. M. Rashad, "Recent advances of control technologies for brushless doubly-fed generators," *IEEE Access*, vol. 9, pp. 123324–123347, 2021.

WEI XU (Senior Member, IEEE) received the double B.E. and M.E. degrees from Tianjin University, Tianjin, China, in 2002 and 2005, respectively, and the Ph.D. degree from the Institute of Electrical Engineering, Chinese Academy of Sciences, in 2008, all in electrical engineering.

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Dr. Liu has been invited to give tutorials on brushless DFIG for two conferences, such as the 2019 IEEE International Conference on Electrical Machines and Systems (ICEMS2019) and the 23rd China Power Supply Society Conference (CPSSC2019). He has organized special sessions on multi-port electrical machines for four conferences such as ICEMS2019, ECCE Asia2020, ICEM2020, and IEEE-PEMC2020.

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