Editorial: Special Section on Patent-Related Short Articles

WITH great pleasure, we would like to present the inaugural TPEL letters special section, "*Patent-Related Short Articles,*" which focuses on a collection of short articles describing new ideas and concepts in the areas of power electronics that have been patented in recent years. The letters from this special section aim to improve the visibility of recently patented ideas to a wide range of audiences. It can also highlight the new development since the patent filing, idea adoption in practice, and the impact of power electronics development on the industry and society.

In response to the call for letters, the total number of manuscripts received in this Special Section was 50, and 15 articles were accepted for publication. The topics of the accepted letters include power semiconductor devices, power converter topologies, modulation, and control schemes, as well as some advanced and practical applications in power electronics, etc. The short summaries of the accepted letters are provided in the following paragraphs.

In [A1], Kheirollahi et al. present a fully-soft-switched dc solid-state circuit breaker (SSCB) with a novel inductor–capacitor–capacitor (LCC) active injection circuit (AIC). Aided by this proposed LCC-AIC, a complete zero current switching can be achieved for both the main and auxiliary switches in transients, which can greatly improve the reliability of the SSCB.

In [A2], Awal et al. propose a double synchronous unified virtual oscillator controller for grid-forming voltage source converters to achieve simultaneous synchronization in both positive- and negative-sequence, which enables synchronization to three-phase balanced and unbalanced, as well as distorted grids, without the need to switch to a backup controller or the subsequent use of a phase-locked loop during a fault event.

In [A3], Badapanda et al. propose a novel solid-state modular crowbarless high-voltage direct-current power supply and its advanced control techniques. The proposed power supply can provide both the 24-pulsed input and ripple-free high voltage output with high reliability, regardless of its input voltage variation, output voltage requirements, and the number of faulty power modules.

In [A4], Joshi et al. review the patents from 2010 to 2022 on the topic of high-performance liquid cooling solutions for high heat flux power semiconductor devices, briefly summarize the thermal-fluid performance capability of each technology, and provide several future directions on this topic.

In [A5], Sarnago et al. present a multilevel electroporation pulse generator for biomedical applications, which can achieve zero voltage ripple and reduced bus voltage capacitance with the help of a linear output voltage regulation method. The performance and safety of this proposed generator have been demonstrated experimentally in laboratory and operation room treatments.

In [A6], Huang et al. present a single-turn lateral coupled inductor, which can achieve inverse coupling for fast transient response in multiphase converters and a lower inductor dc resistor for high converter efficiency. Different implementations of this laterally coupled inductor, i.e., in single-phase and two-phase converters embedded inside motherboards or vertical modules, are presented.

In [A7], Guillen et al. present a multioutput resonant inverter equipped with gallium nitride (GaN) high electron mobility transistors (HEMTs) and evaluate various modulation strategies in terms of efficiency under different switching modes for the proposed HEMTs.

In [A8], Liu et al. propose a hybrid-type dual active bridge topology with a dc blocking capacitor for an ultra-wide input voltage, which can expand the gain range by introducing voltage offset across the dc blocking capacitor and operating in both single-stage and two-stage modes. A corresponding multimode modulation scheme is also proposed to search out the operating boundary of the optimal modes.

In [A9], Le et al. introduce the implementations of power interposer technology (PIT) for integrated power converters. A buck converter with two GaN FETs, capacitors, and a gate driver stacked on a 0.28-mm-thick silicon die that hosts a 3-D substrate-embedded toroidal microinductor is used for illustrating the advantages of PIT.

In [A10], Gong et al. propose a reinforcement learning (RL)-based sliding mode control (RL-SMC) for a hybrid static synchronous compensator (STATCOM) with varying coupling parts as well as its comprehensive design procedure. Its effectiveness and advantages are demonstrated via simulations and experiments.

In [A11], Zhang et al. present a novel hybrid multilevel converter with both silicon (Si) and silicon carbide (SiC) devices, where the SiC power devices operate at a very high switching frequency and Si power devices operate only at the desired fundamental frequency to achieve goals such as high fundamental output frequency, high efficiency, and low cost. The development of this converter topology for hybrid electric aircraft applications and some future research directions are also presented.

In [A12], Mazumder captures, in brief, a core innovation in the two patented technologies. The underlying focus of the two technologies is to demonstrate how discrete energy transfer can be achieved, which leads to enhanced power-conversion efficiency in one case and a mechanism for packetized energy transfer that can enable the cotransfer of information and energy.

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In [A13], Wang et al. propose the new available power and energy analysis for battery energy storage systems (BESS) using active life balancing control techniques. The effectiveness of this proposed active life balancing control in extending the lifetime of BESS using EV-retired batteries has been demonstrated using batteries retired from Nissan Leaf.

In [A14], Siddique et al. present the reliability, power loss, and thermal analysis of a 13-level switched-capacitor-based boost inverter topology, which has been experimentally validated with different fault conditions. These analyses, along with the fault testing, serve as a step toward design for the reliability of this 13-level topology.

In [A15], Hosseinzadeh et al. propose new circuits for multisource multilevel inverters, where the first designed circuit uses fewer switches, and the second circuit uses fewer dc sources to generate a high number of voltage levels. The performance of the proposed circuit is tested and evaluated using hardware results for different operation conditions.

The Editorial Team would like to thank the authors for their contributions and the reviewers who have voluntarily supported this Special Section and provided constructive comments and timely feedback. We hope this Special Section will provide readers with more knowledge and new inspirations from the existing patented ideas and encourage them to make further improvements and development. We believe this Special Section can enable the exchange of knowledge and facilitate further research on new concepts for power electronics technologies.

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APPENDIX
SPECIAL SECTION ARTICLES

[A1] R. Kheirollahi, S. Zhao, H. Zhang, and F. Lu, "Fully soft-switched DC solid-state circuit breakers," *IEEE Trans. Power Electron.*, to be published, doi: 10.1109/TPEL.2023.3237785.

[A2] M. A. Awal, M. R. K. Rachi, H. Yu, I. Husain, and S. Lukic, "Double synchronous unified virtual oscillator control for asymmetrical fault ride-through in grid-forming voltage source converters," *IEEE Trans. Power Electron.*, to be published, doi: 10.1109/TPEL.2022.3227729.

[A3] M. K. Badapanda, A. Tripathi, R. Upadhyay, and M. Lad, "High voltage DC power supply with input parallel and output series connected DC-DC converters," *IEEE Trans. Power Electron.*, to be published, doi: 10.1109/TPEL.2022.3233257.

[A4] S. N. Joshi et al., "A review of select patented technologies for cooling of high heat flux power semiconductor devices," *IEEE Trans. Power Electron.*, to be published, doi: 10.1109/TPEL.2023.3243546.

[A5] H. Sarnago, J. M. Burdío, and Ó. Lucía, "Electroporation pulse generator for biomedical applications with improved output voltage ripple and reduced bus capacitor," *IEEE Trans. Power Electron.*, to be published, doi: 10.1109/TPEL.2023.3240244.

[A6] W. Huang and B. Lehman, "Inversely coupled inductors with small volume and reduced power loss for switching converters," *IEEE Trans. Power Electron.*, to be published, doi: 10.1109/TPEL.2023.3241883.

[A7] P. Guillen, H. Sarnago, O. Lucia, and J. M. Burdio, "GaN-based matrix resonant power converter for domestic induction heating," *IEEE Trans. Power Electron.*, to be published, doi: 10.1109/TPEL.2023.3239160.

[A8] C. Liu, S. Liu, Y. Chen, X. Zou, and Y. Kang, "Hybrid-type DAB converter with DC blocking capacitor for ultra-wide input-voltage range," *IEEE Trans. Power Electron.*, to be published, doi: 10.1109/TPEL.2023.3242428.

[A9] H. T. Le, Y. Nour, F. Jensen, A. Knott, A. Han, and Z. Ouyang, "Silicon power interposer technology (PIT) for integrated power converter," *IEEE Trans. Power Electron.*, to be published, doi: 10.1109/TPEL.2023.3240357.

[A10] C. Gong, W.-K. Sou, and C.-S. Lam, "Reinforcement learning based sliding mode control for a hybrid-STATCOM," *IEEE Trans. Power Electron.*, to be published, doi: 10.1109/TPEL.2023.3247835.

[A11] D. Zhang and X. She, "Hybrid multilevel converter with silicon and silicon carbide devices: Impact to aviation industry and beyond," *IEEE Trans. Power Electron.*, to be published, doi: 10.1109/TPEL.2023.3253716.

[A12] S. K. Mazumder, "Coded power transfer," *IEEE Trans. Power Electron.*, to be published, doi: 10.1109/TPEL.2023.3257286.

[A13] H. Wang, M. Rasheed, R. Hassan, M. Kamel, S. Tong, and R. Zane, "Life-extended active battery control for energy storage using electric vehicle retired batteries," *IEEE Trans. Power Electron.*, to be published, doi: 10.1109/TPEL.2023.3252362.

[A14] M. D. Siddique, P. Sundararajan, and S. K. Panda, "Reliability assessment of power semiconductor devices for a 13-level boost inverter topology," *IEEE Trans. Power Electron.*, to be published, doi: 10.1109/TPEL.2023.3253776.

[A15] M. A. Hosseinzadeh, M. Sarebanzadeh, R. Kennel, E. Babaei, and M. Rivera, "New generalized circuits for single-phase multisource multilevel power inverter topologies," *IEEE Trans. Power Electron.*, to be published, doi: 10.1109/TPEL.2023.3259342.