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Feature Review Papers in Power Electronics
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Advanced Technologies in Power Electronics and Electric Drives
Guest Editor: Prof. Dr. Ibrahim Mohd Alsofyani
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Advanced Technologies in Power Electronics and Electric Drives
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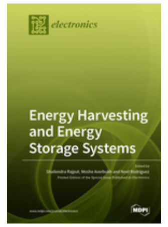
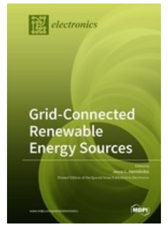


Energy Harvesting and Energy Storage Systems



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Section Editor-in-Chief

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Section Information

Power electronics has emerged as a key technology in the conversion and control of electrical power in multiple applications: electric drives and generators, renewable energy systems, energy storage systems, smart cities, smart grids, power systems, transport (vehicles, aircraft, ships, and others), industrial, medical, military, telecommunications, consumable and home apparatus.

This Section is devoted to publishing original research and state-of-the-art review papers on emerging technologies and trends in power electronics, including components, circuits, design, modelling, simulation, control, implementation, testing and analysis of power electronics and their applications.

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Section Power Electronics

Selected Papers

DOI:10.3390/electronics13061113

Improved Carrier-Based Modulation for the Single-Phase T-Type qZ Source Inverter

Authors: Vitor Fernão Pires, Armando Cordeiro, Daniel Foito, Carlos Roncero-Clemente, Enrique Romero-Cadaval and José Fernando Silva

Abstract: The Quasi-Impedance-Source Inverter (Quasi-Z inverter) is an interesting DC-AC converter topology that can be used in applications such as fuel cells and photovoltaic generators. This topology allows for both boost capability and DC-side continuous input current. Another very interesting feature is its reliability, as it limits the current when two switches on one leg are conducting simultaneously. This is due to an extra conduction state, specifically the shoot-through state. However, the shoot-through state also causes a loss of performance, increasing electromagnetic interference and harmonic distortion. To address these issues, this work proposes a modified carrier-based control method for the T-Type single-phase quasi-Z inverter. The modified carrier-based method introduces the use of two additional states to replace the standard shoot-through state. The additional states are called the upper shoot-through and the lower shoot-through. An approach to minimize the number of switches that change state during transitions will also be considered to reduce switching losses, improving the converter efficiency. The proposed modified carrier-based control strategy will be tested using computer simulations and laboratory experiments. From the obtained results, the theoretical considerations are confirmed. In fact, through the presented results, it is possible to understand important improvements that can be obtained in the THD of the output voltage and load current. In addition, it is also possible to verify that the modified carrier method also reduces the input current ripple.

DOI:10.3390/electronics13050937

Design of Half-Bridge Switching Power Module Based on Parallel-Connected SiC MOSFETs for LLC Resonant Converter with Symmetrical Structure and Low Parasitic Inductance

Authors: Hae-Chan Park, Sung-Soo Min, Jeong-Ho Lee, Su-Seong Park, Sang-Hyeok Lee and Rae-Young Kim

Abstract: SiC MOSFETs are used in many power conversion applications because of their superior characteristics, such as fast switching speed, low on-resistance, and high operating temperature. In certain high-power systems, SiC MOSFETs are connected in parallel to enhance their current capacity and power efficiency. However, compared with Si-based devices, the current imbalance caused by the parasitic inductance difference becomes more severe when driving SiC MOSFETs in parallel, owing to the fast switching speed. Furthermore, the power loop inductance imbalance that occurs when constructing a half-bridge with parallel SiC MOSFETs has rarely been addressed in previous studies. In this study, a half-bridge switching power module based on parallel-connected SiC MOSFETs is proposed to solve the current imbalance through a symmetric structure of the gate and power loops. The effects of the magnitude and imbalance of the gate and power loop inductances in the half-bridge structure based on parallel-connected devices are also explained. A detailed printed circuit board layout of the proposed switching power module is provided, and the inductance symmetry is verified through simulations. A double-pulse test is conducted to verify the current-balancing capability of the proposed switching power module. In addition, an LLC resonant converter is designed using the proposed switching power module, and the power loss between parallel SiC MOSFETs is compared. The experimental results indicate the total power loss error between the parallel-connected SiC MOSFETs of the proposed power module is only 1.94%.

DOI:10.3390/electronics13050847

Innovative Fault Current Evaluation Method for Active DC Grids

Authors: Julian Valbuena Godoy, Simone Negri, Francesca Oliva, Antonello Antoniazzi and Roberto Sebastiano Faranda

Abstract: DC smart grids are a promising solution for the efficient integration of renewable energy sources and loads. Still, their widespread adoption is hindered by significant challenges related to fault response, identification, and clearance. The traditional DC fault analysis method is a useful tool for straightforwardly understanding the behaviour of fault current contributions from DC converters in LVDC networks during a fault. However, when a system with multiple converters and non-negligible fault impedance need to be considered, its accuracy is severely limited due to the assumptions included in the problem solution, thus leading to the following: (a) the dependency of the results' reliability on fault impedance values and/or other converter fault current contributions; (b) the inaccuracy of the diode current estimation; and (c) the inaccuracy of the conductor joule integral. Thus, these results' data may be unreliable for designing protection systems for one converter or for an entire network. In order to overcome these issues, this paper proposes an innovative, simple numerical approach to DC fault current evaluation, which can be adopted when the number of converters become significant, or the network is complex. This method arises from the primary interest in solving the circuit to extract the indicators (current peak value and time, joule integral, etc.) necessary for designing circuit protections. This approach proved to grant two main advantages over traditional methods: (a) it provides accurate results, with no need to introduce any specific assumption; (b) it can be structured to manage an arbitrary number of converters; and (c) it reduces the computational processing times and resources necessary to simulate an entire DC network in comparison to other circuit solution software.

DOI:10.3390/electronics13061045

Analysis and Optimization of a Regenerative Snubber for a GaN-Based USB-PD Flyback Converter

Authors: Fabio Cacciotto, Alessandro Cannone, Emanuele Cassarà and Santi Agatino Rizzo

Abstract: This paper presents a high-efficiency GaN-based 65 W Quasi-Resonant (QR) Flyback converter. The converter is characterized by a wide input voltage range and a variable output voltage, and it is designed as a Switch Mode Power Supply (SMPS) for high power density USP-Power Delivery (USB-PD) applications. To increase the efficiency and power density, a regenerative snubber clamp solution has been used to limit the excursion of the drain voltage during the power switch turn-off. The activity involved the modeling of the converter, the sizing of the regenerative snubber, and the design of the flyback transformer. Furthermore, a dedicated test application board was used to verify the effectiveness of the solution. The results were compared with those obtained using a flyback converter with an RCD snubber.