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Published in:
Applied Sciences (Switzerland)

DOI (link to publication from Publisher):
10.3390/app13053110

Publication date:
2023

Document Version
Publisher's PDF, also known as Version of record

applied sciences

Editorial

Power Electronic Applications in Power and Energy Systems

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1. Introduction

Modern environmental policies, carbon emission reduction targets, stimulus funding for economy recovery, end-use energy efficiency, objectives for higher reliability, and service quality in energy systems are a few of the factors driving forces behind the integration of advanced control and communication technologies into energy systems. Power electronics (PE) systems, with their control and communication capabilities, are expected to be key elements of future power and energy systems, providing suitable interfaces and the bundling of different distributed energy resources (DERs) and loads into so-called active energy networks. As the coupling technology for DERs, the major advantages of PE are the potential for to improve efficiency and introduce new control possibilities for providing ancillary services to different energy systems. However, the interconnection of large amounts of unconventional and renewable-energy-based sources may cause the PE-based power and energy systems to operate in an undesirable and unpredictable fashion. Thereby, this calls for advanced PE techniques in order to ensure system integrity and accelerate deployment in future power and energy systems applications.

2. Power Electronic Applications in Power and Energy Systems

To cover the above-mentioned promising and dynamic areas of research and development, this Special Issue was launched to gather research on the applications of PE in power and energy systems. In total, 26 papers were submitted to this Special Issue, and 14 of these were selected for publication. The accepted articles in this Special Issue cover a variety of topics, ranging from the control of PE devices to a technical–economic analysis of PE-based power systems.

Considering the importance of finite control set model predictive control (FCS-MPC) methods in different power electronic applications, due to its simplicity and fast dynamics, [1] introduces an assessment of a two-level three-phase voltage source converter (2L-VSC), utilizing different MPC schemes with and without a modulation stage.

The study of [2] is related to the development of a wireless charging station using an inductive power transfer (IPT) module power supply with energy dosing and dynamic matching. A computer simulation and experimental study allowed the authors to define the ranges of parameter variation in the equivalent loads and to design the best matching so that maximum energy transfer is efficiently achieved. With the increasing prevalence of renewable generation, the frequency stability of the current power system deteriorates.

To sustain the desired level of the overall inertia, [3] focuses on the newly proposed virtual synchronous generator (VSG) algorithm, for which the concept of VSG enables the power electronic interfaces (PEIs) to emulate the external properties of traditional synchronous generators (SGs), such as inertia and primary frequency responses.

The study of [4] is devoted to a unified power flow controller (UPFC)-embedded system and its regulation based on the two variables containing the magnitude and phase angle of the output-series inserted voltage (OSIV) of UPFC. This paper is dedicated to

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Citation: Anvari-Moghaddam, A.; Davari, P.; Hegazy, O. Power Electronic Applications in Power and Energy Systems. *Appl. Sci.* **2023**, *13*, 3110. https://doi.org/10.3390/app13053110

Received: 10 February 2023
Accepted: 27 February 2023
Published: 28 February 2023

the regulation principles of active and reactive power flow gradients (PFG) for multiple characteristic independent variables (CIVs) at several selected critical points (SCP) in a system under different operation conditions.

The authors of [5] present a suitable technique for optimizing the operation of photovoltaic systems by continuously extracting the maximum power even under the worst cases of atmospheric variations.

The authors of [6] propose a suitable inverter topology to overcome the challenge of buck-typed conversion in traditional photovoltaic (PV) grid-connected inverters. The proposed inverter circuit is formed by adopting a forward converter to generate a rectified sine wave and combining with the active-clamp circuit to reset the residual magnetic flux of the transformer.

The study of [7] investigates the optimal performance for the control of Z-source inverters in the presence of uncertainties, such as parameter perturbation, unmodeled dynamics, and load disturbances, which are naturally available in any power systems. A novel robust linear quadratic integral (LQI)-based control design procedure is presented to preserve the performance of the inverter against uncertainties while a proper level of disturbance rejection is satisfied.

The study by Yang Wang et al. [8] sheds light on state-of-the-art modular multilevel converter (MMC) technologies and their operation and control in stationary applications. The conventional and advanced submodule and overall topologies of MMC configuration are also presented.

The authors of [9] propose a new transformerless high-voltage-gain DC–DC converter for low- and medium-power applications. The proposed converter has a high quadratic gain and utilizes only two inductors to achieve this gain. The findings of the paper are finally validated through a hardware prototype of 200 W of the proposed converter.

A generalized structure for a single-phase switched-capacitor multilevel inverter (SCMLI) with self-voltage boosting and a self-voltage balancing capability is studied in [10] and a detailed analysis of a general structure of SCMLI is presented afterwards. The comparative analysis of the structures is carried out with recently reported topologies to demonstrate superiority and complemented by simulation and experimental results for single-unit symmetric (9-level voltage) and asymmetric (17-level voltage) configurations.

In the study of [11], the loss resulting from the shading of the shingled string used to manufacture the shingled module is analyzed via a simulation. A divided cell is modeled using a double-diode model, and a shingled string is formed by connecting the cells in series. The shading pattern is also simulated according to the shading ratio of the vertical and horizontal patterns.

Giuseppe Marco Tina et al. [12] performed a comparative analysis of solutions to improve transient stability, both rotor angle and frequency stability. These solutions are SVC, STATCOM, a fast excitation system, and an additional parallel transmission line. Sensitivity analyses were performed to evaluate the effects of the location of the three-phase fault line and the most effective SVC or STATCOM installation bus. Based on these analyses, a worst-case fault is considered, and the critical fault clearing time is determined as an engineering parameter to compare different solutions.

In [13], the authors investigate the photo-sintering process for the absorber layer of Cu_2ZnSnS_4 solar cells. A Cu_2ZnSnS_4 layer was grown using hot-injection and screen-printing techniques, and the characteristics of the photo-sintered Cu_2ZnSnS_4 layer were evaluated using X-ray diffraction, Raman spectroscopy, energy-dispersive X-ray analysis, Ultraviolet-visible spectroscopy, and field emission scanning electron microscopy.

Finally, the authors of [14] present a new maximum power point tracking (MPPT) framework for photovoltaic (PV) systems based on the remora optimization algorithm (ROA) subjected to standard and partial shading conditions. The studied system includes a PV array, a DC/DC converter, and a load and MPPT control system.

Author Contributions: Writing—original draft preparation, A.A.-M., P.D. and O.H. All authors have read and agreed to the published version of the manuscript.

Acknowledgments: We would like to take this opportunity to thank all the authors for their excellent contributions in this Special Issue and the esteemed reviewers for their time spent in reviewing manuscripts and their valuable comments which contributed to improvement of the articles.

Conflicts of Interest: The authors declare no conflict of interest.

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