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Editorial: Electromagnetic compatibility design and power electronics technologies in modern power systems

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Editorial on the Research Topic
Electromagnetic compatibility design and power electronics technologies in modern power systems

In today's pursuit of meeting escalating electricity demands, modern power systems are increasingly integrating renewable power generation. This energy transition results in power systems adopting a multitude of power electronics converters (Wang et al., 2022). As a result, the electromagnetic environment of these energy systems is becoming progressively intricate, imposing more stringent requirements on the electromagnetic compatibility (EMC) design. New challenges must be addressed to ensure the safety and reliability of power systems. Among these challenges, EMC theory and power electronics technologies emerge as pivotal elements in guaranteeing the secure and dependable operation of modern energy systems (Li et al., 2023). While EMC theory and power electronics technology have been extensively studied, novel challenges arise in meeting EMC standards for energy systems under evolving scenarios such as the use of wide-bandgap switches, higher switching frequencies, increased voltage, and elevated power levels (Cao et al., 2023). Thus, there is a pressing need for in-depth scientific research on EMC theory and key technologies for energy systems.

The application of power electronics in modern power systems results in a complex electromagnetic environment in which EMC issues occur. On the one hand, fast-switching devices are major sources of electromagnetic interference (EMI), which can propagate along power lines and interfere with communications devices. On the other hand, smart grids and microgrids require a large number of power electronics, and their control systems are more sensitive to EMI. Therefore, in modern power systems, much more attention should be paid to the EMC design and key technologies for power electronics utilization and reliability (Helton et al., 2023). This Research Topic will promote the research on the EMC design and key technologies for power systems and contribute to the sustainable development of power electronics.

This Research Topic consists of four highly diverse contributions related to the developments of electromagnetic compatibility and power electronics in modern energy systems. which are briefly summarized below.

Yuan et al. present a comprehensive understanding of EMI challenges in modern power electronic converters, outlining crucial directions for future research and technological advancements in the realm of electromagnetic interference. The authors investigate methods of EMI analysis and modeling, providing a comprehensive repository for studying EMI characteristics in power electronics-based applications. A modulation strategy that effectively eliminates the dead band effect while ensuring voltage utilization and output current harmonics is of great significance. Passive EMI mitigation techniques offer excellent high-frequency rejection, minimal design complexity, and high reliability, compensating for spurious parameter effects on passive filter high-frequency performance.

Yang et al. analyze different frequencies of electric fields, magnetic fields, and radio interference in a 500 kV back-to-back converter station based on real field measurements. They delve into the electromagnetic distribution characteristics in different areas. Due to complex operating conditions and the coexistence of DC and AC equipment in the same converter station, the electromagnetic field distribution around the back-to-back converter station proves more intricate than that of a single converter station or AC substation.

Liu et al. present a general methodology for synthesizing H-bridge circuit (AHC)-based active power decoupling (APD) topologies. The main idea involves inserting a rectifier/inverter in the AHC or replacing switches/diodes in the AHC with rectifiers/inverters. This method proves versatile in deriving existing decoupling circuits and introducing new circuits. Furthermore, by deepening device integration and modifying the AHC circuit structure, the method provides good scalability.

Zhu et al. propose a boost converter based on Si/SiC hybrid switches. They reveal the common mode (CM) electromagnetic interference generation characteristics of the Si/SiC hybrid switch by analyzing the CM voltage spectrum. The analysis and experimental results serve as comprehensive guidance for the design of gate drive patterns, gate resistors, and EMI suppression strategies.

In conclusion, recent years have witnessed significant progress in EMC and power electronics technologies. However, this Research Topic could not be finished without the contributions of authors and reviewers. We also express our gratitude to the Frontiers Team for inviting us to lead this Research Topic. We hope that the publication of this Research Topic can serve as a reference for experts and scholars engaged in related research, fostering the rapid development of key technologies and practical applications in electromagnetic compatibility design and power electronics technologies in modern power systems.

Author contributions

JZ: Investigation, Writing–original draft, Writing–review and editing. LY: Conceptualization, Writing–original draft, Writing–review and editing. YL: Validation, Writing–original draft, Writing–review and editing. JH: Writing–original draft, Writing–review and editing. Carlos Ugalde-CL: Writing–original draft, Writing–review and editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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