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Sat-Mo-Po.09-02: Investigation of modular superconducting magnetic energy storage system in power system

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As the proportion of intermittent energy sources such as wind and solar power increases in the power grid, the importance of energy storage technology in the power system becomes increasingly evident. Among various technologies, Superconducting Magnetic Energy Storage (SMES) is unique for its fast response, dynamic power compensation, high charge-discharge cycles, and long lifespan, offering promising applications. Due to the inherent properties of superconducting materials and the limitations of power conversion and refrigeration systems, it is still challenging to realize a superconducting magnetic energy storage system with tens of megajoule capacity in a single device. To address this issue, this paper proposes a modular superconducting magnetic energy storage system (M-SMES: Modular SMES), which aims to achieve modular integration and distributed deployment of SMES through advanced control techniques, thereby improving the stability and performance of the power system. This paper starts with the modeling of a single SMES, and extends to the aspects of magnets and power electronics. It proposes the topology structure of a modular SMES and its control design method. Finally, based on the distinct characteristics and operating conditions of SMES magnets, the coordinated operation mode of modular SMES and the corresponding power allocation strategy are discussed from three perspectives: synchronous operation, distributed operation, and dispersed operation.

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