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P2.090 Design of the inverter based on IEGT of acceleration grid power supply for CFETR N-NBI prototype

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China has started the research and development of the negative-ion-based neutral beam injection (N-NBI) prototype for Chinese Fusion Engineering Testing Reactor (CFETR). The prototype needs an acceleration grid power supply (AGPS) rated at 200kV/25A/3600s. A single stage inverter-type high voltage power supply is applied as AGPS of the prototype. The AGPS consists of phase-controlled rectifier, inverter, step-up transformer and high voltage uncontrolled rectifier. The inverter is the core component of this AGPS and determines the performance of the AGPS directly.

Injection enhanced gate transistor (IEGT) is a voltage-controlled device and has high switch frequency, low loss, simple gate drive and wide safe operating area (SOA). The inverter of the AGPS is designed with press pack IEGT in three phase three level (TPTL) neutral point clamped (NPC) topology, and regulated by duty cycle modulation with an inverter frequency of 150 Hz. The low inductance structure of the main circuit of the inverter can guarantee the maximum surge voltage of the IEGTs at a safety level. In order to obtain the low inductance structure, the electromechanical structure and the water cooling system of the inverter are carefully designed by structural simulations, electromagnetic simulations and thermal simulations. What's more, the drivers of the IEGTs adopt numerical controlled active clamp technology and segmented drive technology to switch off all IEGTs less than 50 μ s and ensure the safety of the AGPS when breakdown or beam-off occurs between the acceleration grids.

The detailed design of the inverter for CFETR N-NBI prototype AGPS is described in this paper. A water-cooled 3-level phase leg assembly has been constructed and tested. It has proven that the inverter designed in this paper has good performance and high reliability.

Presenter: MA, Shaoxiang (State Key Laboratory of Advanced Electromagnetic Engineering and Technology School of Electrical and Electronic Engineering Huazhong University of Science and Technology)

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