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Design of the Alfvén Eigenmodes excitation power supply on J-TEXT

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Alfvén Eigenmodes are instabilities which are considered to be excited by high-energy particles in tokamak plasma. In the future fusion reactor, Alfvén Eigenmodes may change the distribution and transportation of alpha particles. Therefore, the study of Alfvén Eigenmodes is very significant. In present tokamaks with relatively low parameters, external antennas are often used to excite the Alfvén Eigenmodes. The J-TEXT tokamak device is also equipped with the corresponding excitation coil. Under the typical operating conditions of J-TEXT, the excitation frequency needs to be in the range of 200 kHz to 700 kHz and the current needs 30A. At the same time, the frequency of the excitation signal is also required to be automatically scanned once time in 300ms. Based on the above requirements, we have completed the design of the excitation power supply.

The main circuit includes uncontrolled rectifier, buck converter and MOSFET full-bridge series resonance inverter. In order to achieve the resonant frequency of automatic scanning, on one hand, the resonant capacitor is adjusted on-line; on the other hand, the controller automatically tracks the resonant frequency. In the implementation process, we divide the whole frequency range into several pieces. For each one of them, we need to match different resonant capacitor. Specifically, the resonant capacitor is arranged in the form of a fixed capacitor in parallel with an adjustable capacitor. The adjustable capacitor we used is a vacuum ceramic capacitor. When one of the electrodes is rotated, the effective area of the capacitor electrodes can be adjusted, so as to change the capacitance value. In design, the rotation of the capacitor electrode is driven by a brushless DC motor, with a corresponding and continuous change of the capacitance.

The inductance of the excitation coil installed on J-TEXT device is 37.5uH. A 1nF adjustable capacitor is applied to the experiment. In the last campaign, we picked up the 2.3nF fixed capacitor so that the resonant capacitance changed from 3.3nF to 2.3nF. Finally, the formal plasma discharging experiments have been carried out on the J-TEXT. The results shows that the excitation frequency could be changed from 450 kHz to 510 kHz in 300ms; the output current can reach 50A. In general, the experimental results verify the feasibility of the design. During the symposium, the detailed design and test results of the power supply will be given.

Eligible for student paper award?

Yes

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