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DESIGN OF CURRENT-PULSE POWER SUPPLY FOR TEARING MODE CONTROL ON THE J-TEXT TOKAMAK

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Tearing Mode (TM) creates magnetic islands in the tokamak. Using external resonant magnetic perturbation (RMP) coils is a convenient method to affect magnetic islands. To avoid mode locking and major disruption, the stabilization of TM control by using RMP is a promising method. A new method for applying modulated magnetic perturbation is presented to suppress magnetic island and accelerate island rotation. The phase difference between TM and external RMP is denoted by Φ. RMP has a stabilizing (destabilizing) effect on island when $0.5\pi<\phi<1.5\pi$ ($-0.5\pi<\phi<0.5\pi$) and an accelerating (decelerating) effect when $\pi<\phi<2\pi$ ($0<\phi<\pi$). Moreover, a net suppression effect has been proved by numerical simulation result when $\pi<\phi<2\pi$. Based on this mechanism, if RMP is applied to the phase region of $\pi<\phi<2\pi$, magnetic island can be suppressed and accelerated in every island rotation period.
J-TEXT tokamak has a set of RMP system which contains four sets of in-vessel saddle coils. To achieve the mechanism above, a bipolar current-pulse power supply with magnetic island phase detected system is applied to TM control. In the phase region of $\pi<\phi<2\pi$, the power supply gives positive current-pulse to accelerate island, and in the region of $0<\phi<\pi$, it gives negative current-pulse to double the effect. The island phase detection should be accurate and current-pulse power supply should have rapid current changing edges to have expected effect. In this paper, the working principle of the current-pulsed power supply is elaborated. The power supply contains a H-bridge inverter using IGBTs to provide high power high frequency bipolar current for inductive load. A six-pulse rectifier with a LC filter is used for DC source. A DC/DC chopper is added on bus to have a faster response of adjusting load current amplitude. Before the H-bridge, a set of boost capacitors with a diode is designed to steepen current changing edges. It will store the energy of inductive load on current falling edge and boost voltage on current rising edge. To ensure phase region accurate, current edge changing should be less than 100 us. The current frequency should follow the TM frequency changing from 1 kHz to 7 kHz and amplitude should be 3 kA in maximum. Based on calculation and simulation results, the capacitance should be suitable to keep the balance between current changing speed and capacitors voltage. A power supply prototype has been made to obtain experiment results. Because of the leakage inductance on bus, there is a voltage spike at the IGBT turn-off moment. A snubber circuit is designed for inverter to reduce the voltage spike.

Eligible for student paper award?

No

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