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Design of a high power and low parasitic inductance resistor

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A current-pulsed power supply (CPPS) with rapid rising and falling edges, which is used for tearing mode (TM) feedback control, has been developed for magnetic perturbation coils on the J-TEXT tokamak. A bleeder resistor ranging from 200 m Ω to 1000 m Ω is required in the CPPS. When CPPS works regularly in 0.3 seconds with frequency ranging from 1 kHz to 3 kHz, the bleeder resistor will generate heat which can reach tens of thousands of Joules. And instantaneous power of the bleeder resistor can also reach several megawatts. Besides, in order to reduce the spike voltage during the insulate gate bipolar transistor (IGBT) turn-off switching transient in CPPS, the low parasitic inductance of the bleeder resistor is required.

Through the above description, if the wire wound resistor is considered as the bleeder resistor in CPPS, the wire with smaller cross section or longer length will be adopted in order to meet resistance value. However, the wire with smaller cross section will be fused by high instantaneous power. Or the longer wire will have more parasitic inductance. The application of a graphite resistor can avoid these problems. On one hand, the graphite with high temperature resistance, is suitable for high power applications. On the other hand, the resistivity of special treated graphite can reach $1.7 \times 10^{\circ}(-5) \Omega \cdot m$, which is about 1000 times that of copper conductor. Hence, the graphite resistor can be designed with a shorter length and larger cross section. In order to further reduce the parasitic inductance, the graphite resistor is divided into several graphite rods which are placed side by side and connected in series. The parasitic inductances in different layouts of graphite resistor are analyzed through the simulation, and at last, the two-rows and six-columns layout is adopted. The test result of parasitic inductance is about 242 nH, which is agree with the simulation result. Finally, graphite resistor is applied in CPPS and experiment results verified the effectiveness of the designed graphite resistor. Meanwhile, the graphite resistor with low parasitic inductance can be also applied in other high power occasions.

Eligible for student paper award?

No

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