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Optimal Design of High Frequency Transformer Based on Fe-based Amorphous

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With the wide application of power electronic technology in pulsed power supply, high frequency and high voltage transformer has become one of the research hotpots. Magnetic core materials such as Ferrite and Nanocrystalline have excellent high frequency performance. However, they are seldom applied to high power situation by the limits of its manufacturing process. Though Fe-based amorphous has been widely used in the power frequency transformers, this material is rarely applied to high frequency high power transformer. In view of the fact that Fe-based amorphous is easy to cut, convenient to wind and capable of high power, the feasibility of Fe-based amorphous in high frequency transformer is presented in this paper, and the optimal design based on the finite element method and genetic algorithm of Fe-based amorphous transformer is proposed to achieve maximum efficiency.

The optimization objective of efficiency is achieved by changing the geometric parameters to optimize the winding size and the number of turns. Besides the main objective, it has four constraints: total losses, temperature, flux density and core window. Through the combination of Comsol and Matlab, the total losses and temperature of the transformer calculated by finite element method were plugged into the genetic algorithm instead of the theoretical value. It has improved the optimization accuracy and solved the theoretical problem in calculating the Fe-based amorphous loss and temperature.

According to the optimal design results, a 15 kHz, 2.5kVA prototype transformer with 230V input voltage and 1.5 kV output voltage has been designed and tested in the series resonant power supply. Experimental results are presented to indicate the Fe-based amorphous can satisfy the efficiency requirements of high frequency transformer using the optimization algorithm. The optimal design has a strong guiding significance for the application of Fe-based amorphous magnetic cores in the high frequency and high power devices.

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