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Design and study of a new type of series active filter for the 10MW-level high power and high stability DC power supply

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The output power of high stability dc power supply system which drives the water-cooled magnet of Steady High Magnetic Field Facility (SHMFF) can reach up to tens of megawatt, so that the circuit usually adopts the realization scheme of Silicon-controlled rectifier plus LC filter. And in order to generate low-ripple magnetic field required by the High field nuclear magnetic resonance and other applications, the DC current ripple should be restricted to 10ppm or lower. The obstacle to improve current ripple is the uselessness of the suppression of low-frequency (50-150Hz) voltage ripple by the LC passive filter.
For the improvement of this parameter, the method commonly used is to add a series active filter device at the output end, which includes two ways: transformer coupled current injection and transistor linear adjustment. In this paper, we propose a new scheme of using a high-frequency switching power supply which is series connection at output of the original power supply system as a series active power filter. Compared to the traditional way, the new scheme has advantages of lower control complexity and less power loss, and thus higher engineering feasibility. And due to its high response speed, it can realize good compensation for the low-frequency component of 300Hz, and further reduce the requirement for LC passive filter. In addition, when the output current is low, it is fully supplied by the active filter instead, which can improve the performance of the power up stage easily.
In this paper, firstly an overall scheme is determined, including specific topology structure, ripple component extraction of the output voltage and other key issues. Then the relevant control strategies are introduced and verified by simulation. Finally, a small prototype is made to verify the feasibility of the scheme.

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