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Numerical Model Development for CFETR CSMC Quench Detection System

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The Center Solenoid Model Coil (CSMC) is a pre-research project of CFETR, and its task is to design and manufacture the CS superconducting model coil to gain wider experience in solving the related technical problems existing in design and construction of CFETR CS coils. The expected achievement is to charge the CSMC up to the operation current of 47.65 kA and the maximum magnetic field to 12 T with a swift rump rate of 1.5 T/s without quench. Quench detection by voltage measurements is likely to be the fastest available technical solution to avoid coil's damage caused by quench, but the voltage detection is a real challenge due to large noise induced by the power supply in alternating current operation. The pick-up sensors, comprise the co-wound wire (CWW) and the co-wound tape (CWT), are used in the CSMC quench detection system for noise compensation and suppression. To accurately compensate all related induced voltage in the multi-pulse coil system, the foremost task is to estimate the static inductance matrix between the CSMC and its pick-up sensors. In this paper, a numerical model is developed for inductance calculation and analysis. Moreover, several numerical simulations with this design model to evaluate the maximum inductive noises and quench detection signals by CWW and CWT have been conducted in case of the worst test scenarios.

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