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Numerical Modeling for Electrical Machines with Superconducting Windings using H-A formulation

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Development of High Temperature Superconductors (HTS) electrical machines results in applications of various fields, (linear machine, axial field machine), as they have higher efficiency and power density. Numerical modeling of superconducting electrical machines is usually performed by finite element method based on their electrical behavior. H-formulation of the Maxwell's equations, is one of the models that are used tremendously due to its high flexibility and simplicity for its modeling of electromagnetic properties of superconducting materials. However, simulation of electrical machines includes more complexity, where a full vector field in a non-superconducting region adds degrees of freedom which will cause longer computation times. This paper uses a model that divides an electrical machine into two parts: the superconducting parts which are simulated with H-formulation, and non-superconducting parts (e.g. conventional conductors, machine structure) that are simulated by A-formulation. This model requires appropriate boundary conditions and continuity between these two regions, along with correct modeling of fixed and moving parts of the electrical machine, where the geometry of this model is based on a linear synchronous machine, which means the rotor is moving linearly instead of rotation.

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