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Design of a Compulsator to drive a Railgun

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Compulsators are AC synchronous generators designed to maximize the short circuit current that could be delivered by the generator. Compulsators have certain advantages over capacitor banks such as higher energy density, occurrence of natural current zero and flexibility in current shaping. Hence, they have become an attractive choice as a power source for the Electromagnetic Launch (EML) applications.

A capacitor bank driven railgun was built and tested earlier in the Pulsed Power Laboratory of Indian Institute of Science, Bangalore, by one of the authors. The scope of the present work is to design a compulsator for the above mentioned railgun. The resistance and inductance gradient of the railgun are calculated using a FEM based commercial code. The effect of varying the different parameters of the compulsator on the performance of the system has been studied and is discussed in this paper. By means of the parametric study, the necessary background for the design of the actual compulsator has been achieved.

A single phase, 2-pole, rotating field, passively compensated, iron core topology has been selected for the design of the compulsator. The compulsator is designed based on mainly two conditions: (1) The instant of projectile exit is synchronized with natural current zero instant. (2) For the given mass of the rotor, the projectile exit velocity is maximized. The system has been analyzed as three magnetically coupled circuits, considering the effect of the magnetic saturation of the machine. The performance of the railgun has been analyzed for different sizes and shapes of the rotor, number of turns, switch resistances and rotor speed ensuring that the thermal and the mechanical stresses in the machine remain within the specified limits. Based on the above analysis, the compulsator is designed for the above mentioned railgun and results will be published in the final manuscript.

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