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ANALYSIS OF STACKED LINEAR TRANSFORMER DRIVERS FOR APPLICATION IN NUCLEAR FUSION PROPULSION

Abstract

This paper will discuss the analysis of stacking Linear Transformer Drivers (LTD) as the primary pulse power generator for a nuclear fusion propulsion system. Based on recent vehicle design studies produced by NASA and UAH, and emerging physics insights in the open literature, magneto-inertial fusion (MIF) appears to represent a leading approach and physics regime for low cost light weight development of fusion reactors for in-space propulsion. MIF requires pulsed power, and one of the potential challenges is designing a circuit that can deliver large pulses of electrical power at frequencies of 10 Hz. LTD's have the potential to enable the combination of high instantaneous power and high frequency repetitively pulsed operation necessary for an MIF-based propulsion system. The first step is to develop a simple circuit model of a stack of LTD and determine the governing ODEs or PDEs. We will then develop a 3D model of some of the more promising circuits using the Finite Difference Time Domain (FDTD) method to study those circuits and the fields generated in more detail. Finally, we will explore the possibility of recharging the LTD capacitors via flux compression from a magnetic nozzle. This will be performed in a very simplified manner in order to flesh out some basic engineering criteria. The larger rep-rate is key in the development of ground based nuclear fusion systems but the reduction in size and mass of the LTD will make them a key development step toward nuclear fusion propulsion systems.