Title: Pulsed Power Circuit Design Techniques for Electromagnetic Launchers

Abstract:

The railgun, an electromagnetic launcher, is a powerful weapon that can propel projectiles to very high velocities (Mach 6-7). Nowadays it is becoming popular due to its low projectile cost and safe storage (because of the absence of explosive materials). However, it requires a very high pulsed current of the order of hundreds of kA with a rise time of a few milliseconds. Pulsed power supplies (PPS) are used to generate such high pulsed currents. This thesis focuses on several design aspects of PPS for efficiently driving a railgun.

Using circuit simulations, an efficient methodology for designing semiconductor switch-stacks for capacitive PPS (CPPS) is proposed, which can withstand high-voltages and high-currents.

A gate-drive circuit necessary for triggering all the thyristors of this stack simultaneously is designed using datasheets and circuit simulations.

With a combination of circuit simulations and 3-D electromagnetic-mechanical coupled simulations, the current maintainable meat grinder (CMMG), an inductive PPS, is analyzed and compared with CPPS. It is shown that the CMMG-driven-railgun is much more efficient than the CPPS-driven-railgun.

A new topology of inductive PPS is proposed and simulated. This topology restores a substantial portion of the residual energy, thereby reducing the possibility of muzzle arc. It also allows real-time velocity control.