DESAIN DAN ANALISIS CAPACITIVE PULSED POWER SUPPLY DENGAN METODE ZERO VOLTAGE SWITCHING PADA ELEKTRO MAGNETIK *RAILGUN* MENGGUNAKAN SIMULASI POWER SIMULATOR (PSIM)

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ABSTRAK

Memprediksi kinerja *railgun* adalah tantangan karena variabilitas dinamis resistansi rel. Studi ini mengatasi hal tersebut dengan mendesain dan menganalisis Capacitive Pulsed Power Supply (CPPS) berkinerja tinggi dengan metode Zero Voltage Switching (ZVS), serta mengkuantifikasi variabilitas kinerja *railgun* menggunakan simulasi. Model komprehensif *railgun* dan CPPS kustomnya (750V-4kV, *resonant full-bridge* 200kHz dengan *dead time* 346ns, pengganda Cockcroft-Walton 2-tahap) dikembangkan di PSIM. CPPS mencapai efisiensi *switching* yang tinggi dan pengiriman daya yang stabil. Simulasi *railgun* menunjukkan gaya elektromagnetik dan akselerasi mencapai puncak tajam sebelum menurun, sementara kecepatan armatur meningkat secara linear hingga ~1,6 m/s pada 0,01 detik. Penelitian ini menawarkan pemahaman realistis tentang kinerja *railgun*, menyoroti dampak kritis induktansi rel yang dinamis dan pentingnya mempertimbangkan peningkatan prediktabilitas dan keandalan.

Kata Kunci: *Railgun*, Induktansi Rel, Variabilitas Kinerja, Catu Daya DC Tegangan Tinggi, *Zero Voltage Switching*, PSIM.

DESIGN AND ANALYSIS OF CAPACITIVE PULSED POWER SUPPLY WITH ZERO VOLTAGE SWITCHING METHOD FOR ELECTROMAGNETIC RAILGUN USING POWER SIMULATOR (PSIM) SIMULATION

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ABSTRACT

Predicting railgun performance is challenging due to dynamic rail resistance variability. This study addresses this by designing and analyzing a high-performance Capacitive Pulsed Power Supply (CPPS) with Zero Voltage Switching (ZVS), and quantifying the railgun's performance variability using simulation. A comprehensive model of the railgun and its custom CPPS (750V-4kV, 200kHz resonant full-bridge with 346ns dead time, 3-stage Cockcroft-Walton) was developed in PSIM. The CPPS achieved high switching efficiency and stable power delivery. Railgun simulations showed electromagnetic force and acceleration peaking sharply before decaying, while armature velocity increased linearly to ~1.6 m/s at 0.01 seconds. This research offers a realistic understanding of railgun performance, underscoring the critical impact of dynamic rail inductance and the importance of accounting for such uncertainties in future designs for improved predictability and reliability.

Keywords: *Railgun, Rail Inductance, Performance Variability, High-Voltage DC Power Supply, Zero Voltage Switching*, PSIM.