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Design of 40kV, 300us, 200Hz Solid-State Pulsed Power Modulator for Long Pulse Applications

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This paper describes the design of a high performance solid-state pulsed power modulator for long pulse applications. Output specifications of the proposed modulator are as follows: variable output pulse voltage, 1-40 kV; width, 1-300 us; pulse repetition rate, 1-200 pps; and average output power, 50 kW. Based on the structure of solid-state Marx modulator, the proposed modulator mainly consists of high-voltage capacitor charger and IGBT stack. For simultaneous charging of energy storage capacitors, a high efficiency LCC resonant inverter is proposed with multi-stage transformer and rectifier. The IGBT stack is designed based on power cell structure that provides voltage balancing between each semiconductor device and allows reliable operation against arc condition. In addition, a novel gate driving circuit is proposed not only for applying pulse to the load but also for discharging the stored energy from the capacitive load. This active pull-down function removes additional pull-down resistor and provides fast falling time with enhanced system efficiency.

The experimental results of developed capacitor charger shows 95% and 0.96 of maximum efficiency and power factor, respectively. Finally, the performance of the developed solid state modulator is experimentally verified including rated operation (40 kV, 20 A, 300 us, 200 Hz, 2.5% Droop), active pull-down operation, and reliable arc protection.

Author: RYOO, Hong-Je (Chung-Ang University)

Co-authors: Mr YU, Chan-Hun (KERI); Dr JANG, Sung-Roc (KERI)

Presenter: RYOO, Hong-Je (Chung-Ang University)

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