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Design of Solid-state Marx Modulator with Fast Rising Time and Short Pulse Width

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This paper describes the design of the solid-state Marx modulator with fast-rising time and short pulse width for various applications such as accelerator and plasma application. By stacking of SiC-MOSFETs, the designed specifications are satisfied as 10 kV, under 50 ns of pulse width, under 15 ns of rising time. The designed circuit consists of the ON switches for applying pulse to the load and the OFF switches for pull-down the pulse that is closely related to the rising and falling time of output pulse, respectively. Compared to conventional Marx generator using diode, the OFF switch connected in parallel with load provides discharging path for the stored energy on the parasitic capacitance and allows short pulse width owing to fast falling time. In order to provide complementary driving signal and power for ON/OFF switches, the simple control algorithm with minimum component count and reliable drive circuit against to the noise is proposed. Besides the circuit design, compact configuration for minimizing the inductance and synchronizing all the signal is essential to shorten the rising, falling and pulse width. Based on the proposed circuit, the detailed design and implementation of ns Marx modulator is presented such as the layout of Marx cell for minimizing inductance, the artwork of PCB for synchronizing fast gate signal, and resonant converter based charging circuit for compact arrangement. In addition to the experiment with resistor load for verifying the performance of developed modulator, the results of application study including PAW (plasma activated water) application as well as the kicker system for accelerator will be introduced in the following paper.

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