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A bipolar, high repetition rate nanosecond pulse generator based on Blumlein-line and TLT

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Abstract: Bipolar pulses have advantages in reducing muscle contraction and increasing electric field uniformity in the treatment of tumors. In order to study the bio-medical effects in the treatment of tumors exposed to bipolar and high pulse repetition frequency (PRF) nanosecond pulse electric fields, a compact pulse generator which meets the requirements above is needed. A novel configuration which can provide bipolar and high PRF pulses based on Blumlein-line and transmission line transformer (TLT) is proposed in this paper. Utilizing the wave processes in charging and discharging of the Blumlein-line, the generator can produce bipolar nanosecond pulses. The use of fast solid-state power switches allowed the system work at high frequencies. TLT was applied to the generator, so that the number of switches used was greatly reduced and compact system was achieved. In this paper, the pulse forming processes of the topology under impedance matching conditions are theoretically analyzed. And the changes of the output waveforms with mismatched loads are explained. Then the design of the generator is introduced in the paper, including the design of the Blumlein-line and TLT and the control strategy of the power switches. Additionally, the generator has been simulated in a PSpice platform, and a prototype has been developed in the laboratory. The simulation and test results verify the operation of the generator. Finally, the generator produced bipolar pulses for matched loads with amplitudes of 0-3 kV, pulse width of 100 ns, and repetition frequencies of 0-100 kHz. It can provide a hardware foundation for research on the bio-medical effects of exposure to bipolar high PRF nanosecond pulse electric fields.

Authors: Mr BIAN, changhao (Chongqing University); Mr LI, Pan (Chongqing University); Prof. MI, Yan (Chongqing University); Mr WAN, Jialun (Chongqing University); Dr XU, Jin (Chongqing University)

Presenter: Mr BIAN, changhao (Chongqing University)

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