Abstract

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Full-bridge modular multilevel submodule-based high-voltage bipolar pulse generator with low-voltage dc, input for pulsed electric field applications

High-voltage (HV) pulse generators (PGs) are the core of pulsed electric field applications. Applying HV pulses produces electrical pores in a biological cell membrane, in which if the size of the pores increases beyond a critical size, the cell will not survive. This paper proposes a new HV-PG based on the modular multilevel converter with full-bridge submodules (FB-SMs). In order to alleviate the need of complicated sensorless sensor-based voltage balancing techniques for the FB-SM capacitors, a dedicated self-regulating charging circuit is connected across each FB-SM capacitor. The individual capacitor charging voltage level is obtained from three successive stages, namely, convert the low-voltage dc input voltage to a high-frequency square ac voltage, increase the ac voltage level via a nanocrystalline step-up transformer, and rectify the secondary transformer ac voltage via a diode FB rectifier. The HV bipolar pulses are formed across the load in a fourth stage through series connected FB-SMs. The flexibility of ing and bypassing the FB-SM capacitors allows the proposed topology to generate different pulse-waveform shapes, including rectangular waveforms with specifically reduced dv/dt and ramp pulses. The practical results, from a scaled-down experimental rig with five FB-SMs and a 1-kV peak-to-peak pulse output, validate the proposed topology.