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# New Marx based generator using IGBTs for adjustable quasi-rectangular pulses

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The use of semiconductor switches in pulsed power field experienced big progress in the last decade. The offered intriguing characteristics, combining compactness, controllability and simplicity of control, help to build generators with controllability level which was not possible to achieve with classical switches.
This work is about a new architecture of solid-state modular Marx generator capable of creating rectangular pulses with fully controllable polarity, amplitude, pulse width, and repetition rate. The proposed structure uses half of the number of switches usually used in generators of such performance. The modular structure gives the possibility to add more stages to the generator without any additional changes.
Each generator module consists of a capacitor, two coils, inversely coupled with a shared core and two switches. Such a structure allows the parallel connection of capacitors in the charging phase. The oppositely directed magnetic fluxes subtract, thus reducing the inductance of the circuit.
During the discharge phase, the fluxes of inductors add to each other to create high inductance, considered as an open circuit. The discharge is controlled by two sets of IGBTs: the first is activated for positive pulses; and the second for negative polarity.
The proposed design can be adjusted to produce positive or negative unipolar pulses with controlled amplitude. The applied inductive charging increases the repetition rate, reduces the Joule losses improving the power efficiency and remove the necessity of charging through the load.
A SPICE simulation was applied to verify the developed model and to check the expected performance. Then the four stages prototype generator was built according to the proposed design using available on the market IGBTs with a maximum output voltage of 8 kilovolts for bipolar configuration and 16 kilovolts for the unipolar structure. All results were compared to check and confirm the validity of the proposed architecture.

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