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Modeling BipolarMarx Generators for Maximum Pulse Repetition Rate Estimation

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This paper presents the n stage dynamic model generalization for bipolar Marx Generators, during the capacitors charging mode, to estimate the generator pulse repetition rate.
Bipolar Marx Generators are based in modular solid-state switching stages. Their operating principle can be reduced to two operating modes; Mode-I - Capacitors charging and Mode-II –Output pulse forming. In mode I, n capacitors are charged, roughly in parallel, from a dc power supply, Udc. In mode II the n stage capacitors are switched in series across the load. Using nowadays solid-state switching stages [1⊠2] it is possible to obtain positive and/or negative voltages pulses with higher frequencies in comparison with classic hard-tube switching. Nevertheless, as the number of stages increases the operating frequency is limited by internal parasitic impedances.
This study presents the synthesis of state space model of the Marx Generator equivalent circuit for n stages operating during capacitors charging (Mode 1).
The equivalent circuit consists of n stages connected in cascade, where each stage is an RC circuit in which the resistance R represents the impedances of the semiconductors and conductors in each stage.
The model enables the evaluation of the charging time of the n stage capacitors. Then, the maximum pulse repetition rate for the n stage Marx Generator can be calculated as a function of the number of stages, and the voltage decay allowed for the capacitors (usually less than 10%). Given a needed pulse repetition rate the model can suggest the optimum number of stages (n) so that the working voltage of each stage can be selected.

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[2] H Canacsinh, JF Silva, B Borges, "Voltage droop compensation based on resonant circuit for generalized high voltage solid state Marx modulator", IEEE-APEC, 3637-3640, 2016.

Authors: CANACSINH, Hiren (ISEL/INESC-ID/GIA2P2); DOS SANTOS REDONDO, Luis Manuel (ISEL Instituto Superior de Engenharia (PT)); Mr LUCIANO, Tiago (ISEL); ROCHA, Luis (ISEL/INESC-ID/GIA2P2); Dr SILVA, J. Fernando Alves (IST-UL / INESC-ID)

Presenter: CANACSINH, Hiren (ISEL/INESC-ID/GIA2P2)

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