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5P13 - OPTIMIZING COMPACT MARX GENERATOR NETWORKS FOR CHARGING CAPACITIVE LOADS: SEQUENTIAL TRIGGERING AND PRACTICAL CONSIDERATIONS

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Efficient pulse charging of small high-voltage load capacitors with Marx-generators is limited by the parasitic capacitance within the Marx network. Yet the stray capacitance to ground is essential for proper Marx erection. For successful triggering, this capacitance can not be much smaller than the inter-stage capacitance. In earlier work, Marx-network designs were shown that transfer energy with perfect efficiently [1]. Ideal network-component values are determined by constraints imposed by energy and charge conservation and by network resonant-frequency symmetries. Energy transformation in lossless linear networks between states of purely magnetic and/or purely electrostatically stored energy must exhibit waveforms that are periodic in time [2]. This intrinsically time-domain problem is then recast in the frequency domain where the network resonant frequencies must be arranged with prescribed harmonic relationships. In the final design step, Marx-network resonant-mode frequencies are assigned to be odd harmonics of the fundamental frequency, and simultaneous switch triggering is required.

For regular network solutions, only the zero and third harmonic and fundamental frequencies carry appreciable energy. Thus, other modes may be ignored, and stray capacitances to ground may be set to a common optimal value. When the total parallel parasitic capacitance to ground exceeds the Marx capacitance or approaches the total inter-stage capacitance, ideal solutions are no longer found.

Sequential triggering breaks the harmonic symmetry and invalidates the ideal solutions. The few percent of energy remaining induces high frequency oscillations in the circuit that could lead to early component failure. Correction attempts have had limited success except for mid-stage Marx triggering, which shows significant benefits.

1. C. J. Buchenauer, "Optimizing Compact Marx Generator Networks,"IEEE Transactions on Plasma Science: Special Issue –Pulsed Power Science and Technology 2010.
2. C. J. Buchenauer, "Temporal Symmetries in Lossless Linear Networks that Efficiently Transport or Transform Electrical Energy,"SDAN 46, October 2015: http://www.ece.unm.edu/summa/

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