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Core and copper loss effects on the stepped impedance transmission line pulse generator

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The effects of core and copper losses on a novel magnetic compression based stepped impedance transmission line pulse generator circuit is presented. Design equations are derived and presented which take into account the current leakage into neighboring cells, losses due to magnetizing inductance currents, losses due to saturable cores and copper losses in the saturated inductance windings. It is shown that discharging an initially charged lumped element transmission line with saturable inductor switches in each cell can result in optimized energy transfer between cells of different capacitances even in the presence of lossy circuit elements, provided the cell capacitances are in a certain fixed sequence independent of the cell inductances, but dependent on the cell losses and leakage currents. The use of pre-charge voltage in such stepped impedance magnetic compression line provides voltage multiplication in addition to pulse compression without the use of transformers, but in practice the voltage multiplication effect is limited by the losses leading to saturation and a relatively short line, containing not more than approximately 4 cells.

Keywords: Magnetic compression; energy transfer; voltage multiplication; minimum core volume, core losses, copper losses, current leakage.

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