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Evaluation of Hybrid Bouncer Systems for High Precision Klystron Modulators

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Recent advances in the development of linear particle accelerators bring back new challenges regarding the design of pulsed power converters. On one hand, pulses quality (e.g. flat-top ripple, stability and repeatability) becomes more and more important because it directly influences the beam acceleration parameters. On the other hand, the need of reliable systems often requires a capacitor discharge topology in association with a bouncer circuit in order to perform a pulse shape correction by compensating the main capacitor bank voltage droop.

This paper presents a complete study of a novel hybrid topology of such a bouncer circuit. This topology allows to merge the advantages of the open loop passive resonant bouncer topology and the active bouncer one. The principle consists in using a closed loop controlled linear current ballast associated with a well-known parallel LC-based resonant bouncer circuit. This association leads to improve the pulse shape correction made by the passive bouncer alone and leads to a stronger robustness against the parameters deviation (closed-loop operation). Additionally, the losses created in the linear ballast are limited since only a fraction of the modulator current flows in it. First, the merits of such a bouncer topology are established through an analytical study and a comparison with other topologies. The latter is then completed by numerical simulations in order to show the trade-offs between the passive elements size and the linear ballast losses. Key points of the design, including the choice of passive elements and control strategy are provided and the implementation of a reduced scale prototype is described.

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