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Power Amplification with Static and Dynamic Load Current Multipliers

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We describe new opportunities of pulse power multiplication using the load current multiplier concept (LCM) [1]. The LCMs were already demonstrated to increase current both in inductive energy storage and pulse forming line systems [2], including experiments at the enhanced current of 1.7 MA on Zebra [3]. Recent successful validation of this approach on Z for the current up to 10 MA [4] allows to envision evolution of the concept on large pulse power generators when the load current rise-time could be decreased and the load power could be amplified. This would allow higher temperatures attainable in magnetically compressed plasmas such as MagLIF [5] when sharper load current ramp implies mitigation of the magnetic Rayleigh-Taylor instability dominantly limiting the compression ratio. We first analyze operation of a static LCM having its proper parameters unchanged in time and a plasma inductive or a plasma flow switch prior to load. We further consider the dynamic current multiplier concept in which the magnetic flux extruder inductance increases in time during the pulse power event. The abovementioned configurations are theoretically shown to provide both higher load current and peak power with respect to unmodified generator. Numerical examples are given for 1 MA generator as an example of proof-of-principle experiment, for Z accelerator and for Petawatt-class generator [6] parameters.

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[3] V.L. Kantysrev et al, Phys. Plasma 21, 031204 (2014).

[4] G. Laity et al, "Initial Evaluation of the LCM Concept on Sandia Z Accelerator", Int. Power Modulator and High Voltage Conference, July 5-9, San Francisco, CA, USA, 2016.

[5] S.A. Slutz, et al., Phys. Plasmas 17, 056303 (2010).

[6] W.A. Stygar et al, Phys. Rev. ST Accel. Beams 18, 110401 (2015).

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