Abstract

Linear Transformer Drivers: Compact Pulsed-Power Technology for High Energy Density Experiments

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Pulsed power is the process and/or technology by which one stores energy over a long period of time and then discharges (or transfers) the energy over a much shorter period of time. With the energy held constant, power amplification can be achieved by having a discharge time that is shorter than the charging time, since power is the rate at which energy is delivered. By stringing together multiple pulsed-power stages, a very large overall power amplification can be achieved. This is the process used by the Z machine at Sandia National Laboratories, the world's most powerful, fully electrical, pulsed-power device. The Z machine produces 80 TW of electrical power in the form of a current pulse that rises from 0 to 20 MA in 100 ns—however, Z's architecture is based on Marx generators, which have discharge times on the order of microseconds; thus, multiple pulse-compression stages are needed to achieve the 100-ns power pulse, and each stage introduces energy losses and inefficiency. In this talk, I will review a newer pulsed power technology called the linear transformer driver (LTD). The LTD is one of the greatest advances in pulsed power technology since the invention of the Marx generator in 1924. In an LTD, the capacitors for the prime energy storage are packaged in a very low inductance metal cavity. This enables a current pulse with a 100-ns rise time to be generated in a single stage. This compact technology could enable a 300-TW electrical generator (e.g., the proposed "Z-300" machine) to be built in a footprint the size of today's Z machine. A machine such as this would enable extraordinary experiments in high energy density physics (HEDP) to be conducted, including (possibly) fusion ignition experiments. To vet this technology in various HEDP applications, research is being conducted at Sandia and at universities throughout the US and abroad. This talk will review these research efforts.