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Development of a 0.6 MV ultra-compact magnetic core pulsed transformer for high power applications

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The generation of high-power electromagnetic waves is one of the major applications in the field of high-intensity pulsed power. The conventional structure of a pulsed power generator contains a primary energy source and a load, separated by a power-amplification system. The latter performs a time-compression of the slow input energy pulse and delivers a high-intensity power output to the load. Usually, either a Marx generator or a Tesla transformer is used as a power-amplifier. In the present case a system termed MOUNA (French acronym for 'Module Oscillant Utilisant une Nouvelle Architecture'), uses an innovative and very compact resonant pulsed transformer to drive a dipole antenna. The pulsed transformer can generate voltage pulses of up to 0.6MV, with a rise time of less than 270ns. The paper describes the ultra-compact multi-primary winding resonant pulsed transformer developed in common by Université de Pau and Hi Pulse Company. The transformer design has four primary windings, with two secondary windings in parallel and a Metglas® 2605SA1 amorphous iron magnetic core with an innovative bi-conic geometry used to optimize the leakage inductance. The overall pulsed transformer has a weight of 6kg and a volume of only 3.4 litres. The paper presents in detail the design procedure, with each of the main characteristics being separately analyzed. In particular, simple but accurate analytical calculations of both the leakage inductance and the stray capacitance between the primary and secondary windings are presented and successfully compared with results from CST simulations while core losses and saturation induction are also studied. The resonant power-amplifier output characteristics are obtained when attached to a compact capacitive load, coupled with a capacitive voltage probe developed jointly with Loughborough University. Finally, an LTspice-based model of the power-amplifier is introduced and its predictions are compared with results obtained from a thorough experimental study.

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