ID 032

Compact High Voltage Pulse Generator Based on Magnetic-Core Tesla Transformer

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Abstract— This paper presents a compact and portable high voltage pulse generator based on magnetic-core Tesla transformer for driving an UWB high power electromagnetic source. In order to optimize the performance of the high voltage pulse generator, a novel open-loop cylindrical magnetic-core using the quad-division lamination structure is proposed and manufactured. The designed high voltage pulse generator using the proposed magnetic core has a battery-powered operation and compact size of 280mm × 150mm in length and diameter, respectively. The high voltage pulse generator can produce a voltage pulse waveform with peak voltage of 450kV, a rise time of 1.5ns, and pulse duration of 2.5ns at the 800V input voltage.

Keywords-component; high power electromagnetics; high voltage pulse generator; Tesla transformer

I. INTRODUCTION

Recently, the vulnerability of electronic devices to high power electromagnetic (HPEM) threats have been studied widely [1]. Ultra-wideband (UWB) HPEM source capable of producing output power in the gigawatts range allows real susceptibility investigation of electronic devices as well as their protection and hardening against HPEM threats [2]. In the future, UWB HPEM source tends to be higher pulse repetition rate, compact and portable size for the efficient testing in a variety of conditions.

The magnetic-core Tesla transformer is suitable for compact size and high repetition rate because it has high efficiency and only one spark-gap switch. The most commonly known generators based on the magnetic-core Tesla transformer are SINUS and RADAN series. In this paper, a novel magnetic-core using the quad-division lamination structure is proposed. The high voltage pulse generator using the proposed magnetic-core is evaluated.

II. Development of High Voltage Pulse Generator Based on Magnetic-core Tesla Transformer

A. Design and Construction of high voltage pulse generator

Table I lists electrical parameters of the designed Tesla transformer.

TABLE I. Electrical Parameters of the Tesla Transformer

Parameters	Values	Parameters	Values
L_1	237nH	R_1	0.1mΩ
L_1	133mH	R_2	200Ω
C_1	25uF	R_{k1}	17mΩ
C_2	40pF	L_{k1}	40nH

In table I, C_1 and R_1 are the capacitance and resistance of primary circuit except parasitic element. The corresponding elements of secondary side are marked up as C_2 and R_2. R_{k1} and L_{k1} represent stray inductance and a stray resistance of the primary circuit, respectively.

The high voltage pulse generator is shown in Fig. 1. The generator has 280mm length and 150mm diameter.

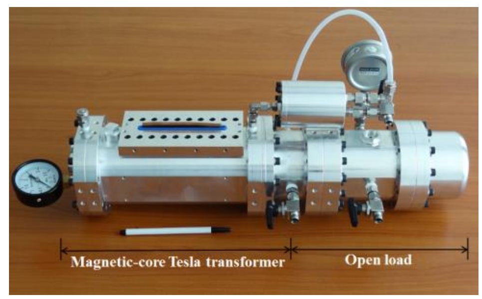

Figure 1. Photograph of high voltage pulse generator with open dummy load

B. Test Results

At 800V charging voltage of C_1, the output pulse of C_2 is nearly 450kV in peak voltage with charging time of 2μs. The voltage gain of the transformer is 563 and the energy conversion efficiency is about 50%.

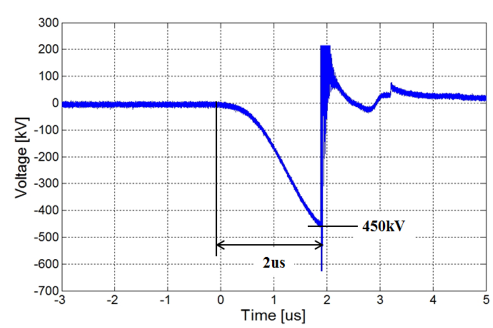

Figure 2. Output voltage waveform of secondary capacitor

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