ID 052

# A Compact HEMP Test System based on Movable Electrode

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**Abstract—A compact HEMP test system was introduced. The core component was a high-voltage pulse generator with a RC circuit. Unlike normal spark gap switches used in other generators[1], however, a movable electrode was built in, which makes it possible to be triggered by means of adjusting the gap distance. The output waveform characterizes 2.5ns rise time, 23ns pulse width and 10kV maximum voltage. With a TEM cell and 50Ω matched load, it can produce 50kV/m electromagnetic field in laboratory.**

***Keywords—HEMP Generator; EMP; Spark Gap Switch; Movable Electrode;***

## I. INTRODUCTION

There is a need of standard electromagnetic field with known waveform to test small devices. The IEC gives 50kV/m a significant value of HEMP field, which can be simulated with low-height TEM cell in a small place. However, kinds of spark gap switch are indispensable to form a wave front with nanosecond rise time. These switches have dispersion on break down voltage and break over time.

Thus, a switch with a movable electrode was fabricated. The gap distance can be adjusted from outside by a cylinder. The gap is so long that it can hardly self-break down before being triggered. Then the gap was shortened to form a discharge spark, conducting the path and decreasing the inductance.

## II. CONSTRUCTION OF THE GENERATOR

### A. *Structure of Movable Electrode Switch*

In order to move the electrode outside the switch, the cavity was divided into two isolated parts: one is for the switch and another one is for a cylinder which can push its piston forward or backward. The following figure shows the details:

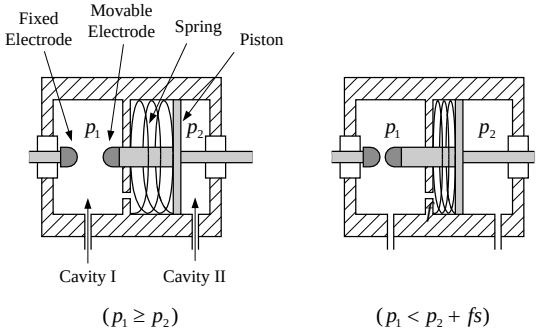


Fig. 1 A fig to show how the movable electrode moves

There are two electrodes in the Cavity I, which has invariant pressure of nitrogen denoted as $p_1$. The Cavity II, with a piston and spring, is size-changeable. The pressure caused by compressed air, is denoted as $p_2$. Whenever $p_1 \geq p_2$, the piston is at the end of the right side, making the connected electrode far from another. If the $p_2$ increases, the piston starts to compress the spring, the electrode moves and as a result, the gap distance decreases. It won't hold too long before the whole gap breaks down.

### B. *Principle of the Generator*

The equivalent circuit of the generator was a typical RLC circuit. When $R > 2\sqrt{\frac{L}{C}}$, the voltage got from the resistor approximates:

$$u_R(t) \approx U_0\left(e^{-\frac{t}{RC}} - e^{-\frac{t}{L/R}}\right) = U_0\left(e^{-\frac{t}{\tau_2}} - e^{-\frac{t}{\tau_1}}\right) \qquad (1)$$

where $\tau_1 = L/R$, $\tau_2 = RC$.

We chose $R = 50\Omega$ and in order to get a double exponential waveform with 2.3ns/25ns, $L$ and $C$ were respectively 56.8nH and 666.7pF, with which the whole circuit were determined.

## III. THE MEASUREMENT AND TEST OF THE SYSTEM

A TEM cell was made to form an EMP field and test the object in it. The size was designed to make the wave impedance 50Ω, which is matched with both sides. In our measurement test, a coaxial attenuator was connected to decay the amplitude of the output pulse, whose input impedance was also used as the load. The setup of the experiment can be seen in Fig. 2.

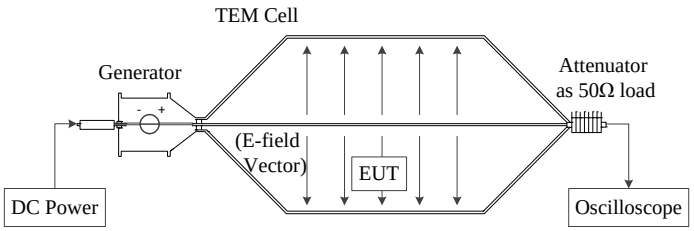


Fig. 2 The setup of the HEMP test system

## IV. CONCLUSION

A HEMP test system was made with kinds of movable electrode switch built in and the compact size and stability was achieved.

## REFERENCES

[1] TAN Jian-wen, SHI Li-hua, LI Yan-xin, ZHANG Li-qun and XIE Yan-zhao, "Development and experimental research on the fast rise time EMP generator", High Power Laser and Particle Beams, Vol.16, No.11, Nov. 2004, pp1434-1436.