High-voltage generator for energetic materials

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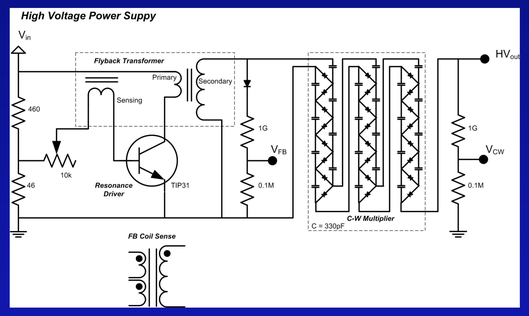
Electrical HV Testing

Electrical energy can be used to initiate a reaction in energetic materials so understanding their electrical properties over a wide range of voltages is of interest to many researchers. There are a number of challenges in exploring the electrical properties of energetic materials, not the least of which is the development of a high voltage generator. The test instrument developed for use in our work is described here.



This circuit uses a resonant driven flyback transformer to pump a Cockcroft-Walton (1932) voltage multiplier. The key property of the multiplier is that voltage drops rapidly as current flows. This makes the generator a very sensitive conductivity meter.

The multiplier is shown above with 3 stages each comprised of of 4 “voltage doubler” circuits in series. The current system requires only 1 stage to be present to achieve 30kVDC. Notice that after this point considerable power must be added increase the voltage.

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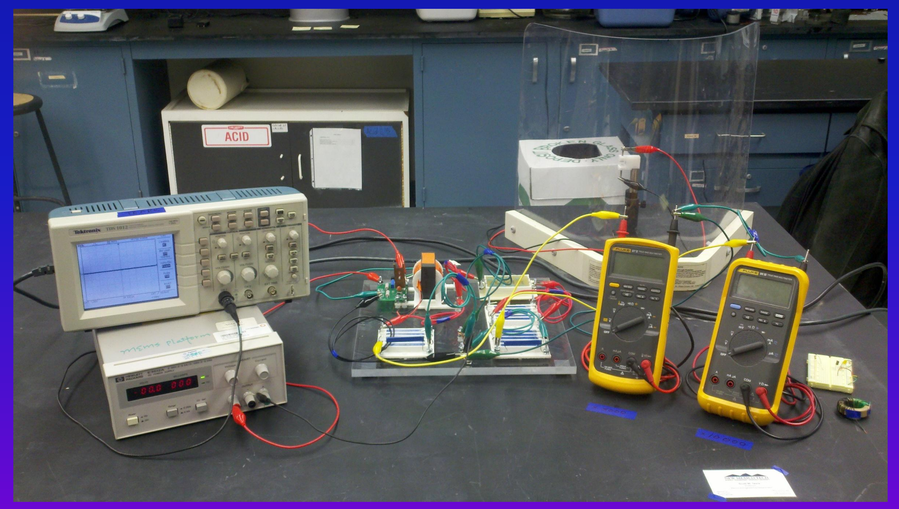
Abstract

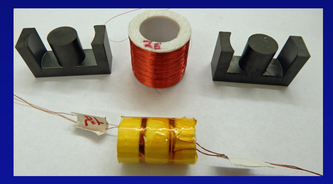
The electrical properties of energetic materials are important from the perspective of both intentional and unintentional ignition events. The electrical characteristics of energetic material pellets depend on several factors, including the chemical composition, density, and the physical dimensions of the material. Electrical testing of energetic materials requires careful control of the electric field magnitude and electrode shape as well as the behavior of the high voltage generator during electrical discharge. This paper discusses a high voltage generator that is very sensitive to current flow at voltages greater than 30kVDC. This generator has been used in testing several energetic materials over a range of physical dimensions and densities to investigate electrical punch through events.

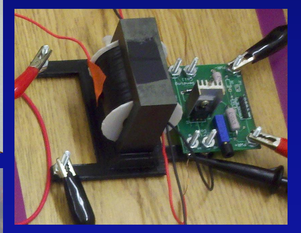
Complete System

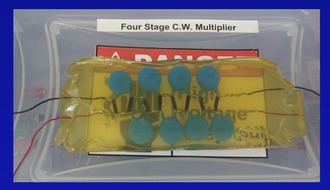


Construction

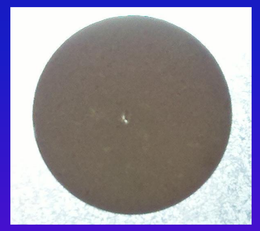
The flyback transformer is constructed by winding insulated wire onto concentric bobbins and a ferrite core inserted. The flyback and resonator circuit board are mounted together. A single stage of the Cockcroft-Walton multiplier is shown. The bobbins and stand are made using a 3D printer and PET+ filament.







The sample holder/ electrode assembly was also 3D printed and incorporates a self-aligning sample mounting tool. The electrodes connect between high voltage and ground. A pressed PETN pellet 1mm thick and 19mm in diameter shows the a hole induced by a high voltage punch through arc formed at a voltage of ~10kVDC at ~65% TMD.



References

J.D. Cockcroft, E.T.S. Walton, Proc. Roy. Soc. A, (129) 477, 1932.

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