Saturating Magnetic , Thyratron Trigger Generator, Employing Magnetic Protection.
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Abstract: An LC inversion , pulse compressed, high voltage generator is switched by a saturating magnetic . The magnetic elements on the input, and saturators, provide isolation from tube arcing events at the generator output.

Introduction
The LC inversion, pulse compressed generator is employed to trigger a thyratron. A variant of the Blumlein, this generator provides voltage doubling at the output. It is simple, and robust, in this very difficult service. Conventional switching is replaced by a CMD5005 saturator, L1. L2 is a second stage peaker and is used to speed up the rise time to 13 nS and 3400V amplitude . A P6015 probe (90 MHz probe, and TDS 644, 500 MHz scope) were used to produce the waveform in Fig2.

Circuit Description and Operation
The circuit of Fig 1 was built and tested. L1, L2 used CMD5005 ferrite. L1 is the primary switch. The two capacitors , and L1, L2, and balancer, must be of high voltage design. C1, C2 were 12 kV 500pF .

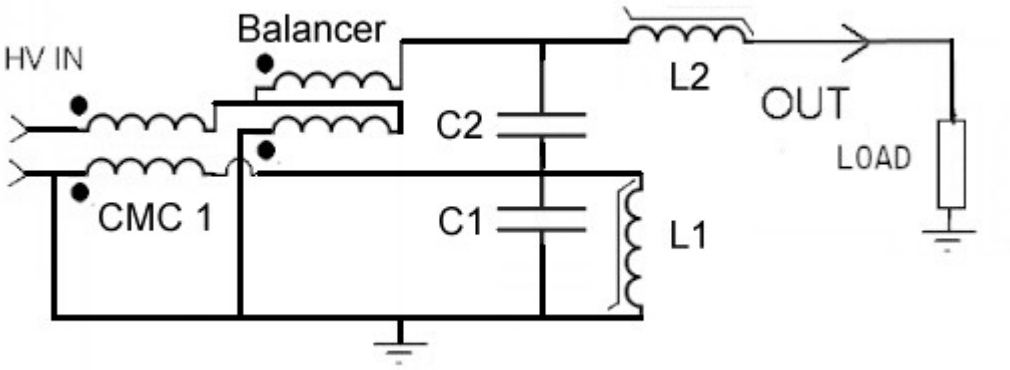
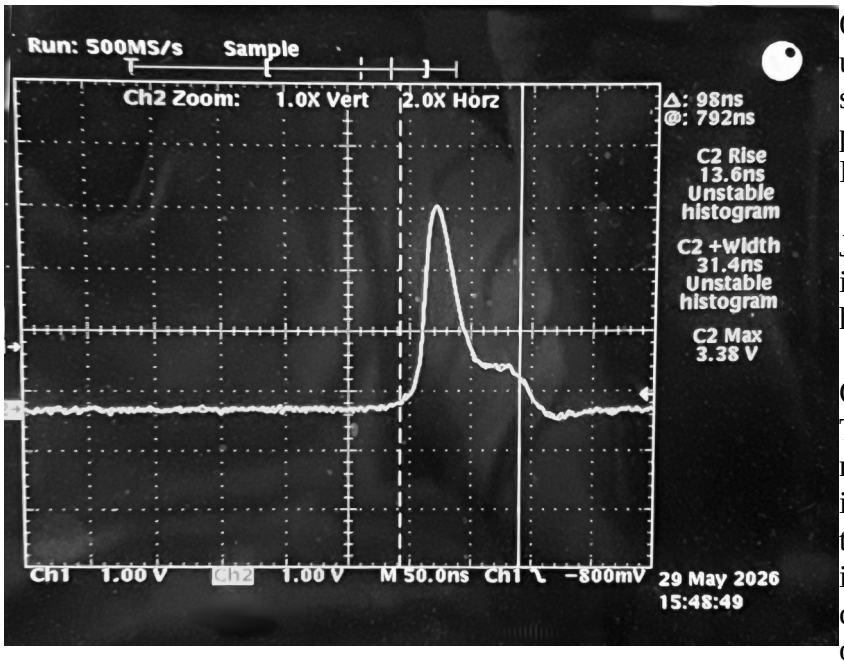


Fig 1 LC Inversion Generator.

A high voltage pulse of 1400 V amplitude is applied to the input, of 300 nS pulse length, rise time 100 nS. CMC 1 is a tightly twisted wire pair designed to provide common mode isolation to the driver . The magnetic balancer forces equal currents at the two outputs. Here again, the windings are similar to the CMC, but the windings are cross coupled, thus forcing current balance.

In operation, the balancer forces equal currents to flow, charging the two capacitors in opposition. The return center tap, is through CMC1. The two capacitors are charged in opposition, and so the net voltage with respect to ground is zero. Just as the capacitors charge to maximum, the ET product of L1 is chosen to start saturating. The L1, and parallel C 1 of this circuit ring backward, inverting the voltage on the bottom capacitor. These then add, to produce double the voltage of a single C, hence doubling the output voltage as desired. Now L1 produces some pulse compression, however it is easily improved with a peaking stage. L2 is added to snip off the nose of the drive pulse. This produces the wave form of Fig 2. 13 nS rise time.

The pulse compressed generator provides excellent isolation from tube arcing. Note the primary saturated switch will shunt kick back energy to ground. This ground referenced switch is a very important protection, as it can absorb any transient delivered to it. Moreover voltage developed across the top C 2 will be driven back into the balancer. When differential voltage is applied to the balancer output, the two windings appear in series and hence a very high inductive impedance. This is a door that is driven shut by the return pulse from a fault. This provides primary isolation to any kick back from a fault. Note the balancer must be designed to never saturate, as this is primary protection to the drive pulse.



Output voltage is 3380 V. The tail is useful to make certain the thyratron stays triggered. It is characteristic of pulse compression to have a tail. Ideal in this application.

Jitter in this circuit is controlled by input pulse amplitude. This is easily held to 0.1% or better.

Conclusion

The magnetically pulse compressed, magnetically isolated generator is an ideal solution , for thyratron triggering. It is robust and essentially indestructible. Additionally this circuit can support high rep rate operation.

Fig 2 Output Voltage

Appendix A:

Mode Conversion as a Design Method

This generator is an example of a mode conversion circuit. This means the following. Energy is delivered in the top horizontal plane by differential manipulation and conventional circuit technique. But it floats and is best thought of, as a horizontal layer plane. Now the load and ground can be thought of, in a vertical plane that intersects the floating plane (hence the common mode term frequently encountered). Moreover these planes are typically linked by a saturating magnetic. When the magnetic saturates, a low impedance path is formed between the two planes. Now energy stored in the top plane is delivered to the load which resides in the vertical common mode plane, This saturation produces mode conversion to deliver the energy to the vertical plane, common mode load. This is a useful thinking tool in understanding this sort of generator. Additionally the Max Bank generator employs the same design concept. All saturating generators will employ this concept.

References:

1. G. N. Glasoe and J. V. Lebacqz. Pulse Generators, volume 5 of MIT Radiation Laboratory Series. McGraw-Hill, New York, 1948.