A Saturating Magnetic Switched, Blumlein High Voltage Pulse Generator.

Abstract: The Blumlein charged line generator is designed with a saturating magnetic switch. This allows rapid recharge and robust switching, which can tolerate arcing without switch damage. This shows the versatility of this unique circuit. High rep rate is intrinsic.

Operation

Fig 1 shows the circuit implemented here. Two lumped element charged lines were constructed . Using coax would be difficult, as the cables would, by necessity, be quite long. Of course the lumped design reduces rise time to that determined by one cell. Here 5 cells were constructed, for each line . Line length is T. L1 is the main switch and is made of CMD5005 ferrite.

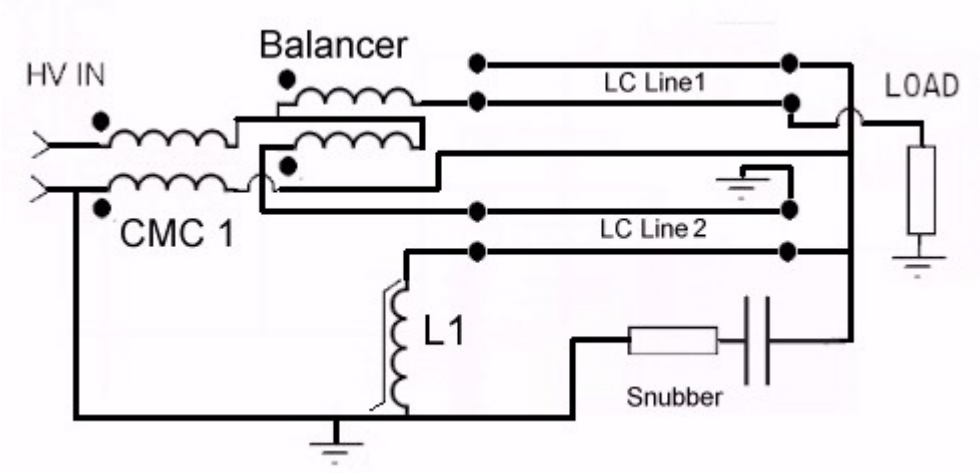

Fig 1 Blumlein Pulse Generator

In operation a 300 nS , 100 nS rise time 1300V pulse is fed into the input. This passes through CMC1 consisting of a tightly twisted wire pair wrapped around a flat closed ferrite core made of type 43 material, used in EMI suppression. A high mu, Nickel Zinc ferrite should be used. The drive is then coupled through a ferrite balancer made of the same transmission line pair, but the two windings are cross linked as shown. This forces current balance for the two outputs. The two outputs produce balanced charging (by the pulse) of the two LC lines 1 and 2.These lines are series coupled , and in this circuit, the load is grounded. Charging (negative voltage) fills lines 2 and 1. This is shown in Fig 2.

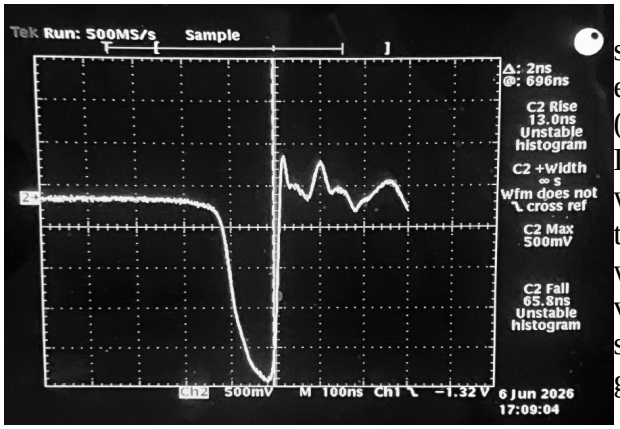

Fig 2 Saturator Voltage

After charging is complete, The ET product of the saturator L1 is set to start saturating and connecting that end of the negatively charged line string to ground (mode conversion). The positive going edge traverses Line 2 and hits the line junctions and is reflected as a wave front returning to the saturator, delivering energy to the load. A forward mismatched positive going wave is produced at Line 2 output, which is adding to voltage reversed drive from line 1. The two lines add in series, and a positive voltage pulse is delivered to the grounded load.

The time it takes to deplete the lines is two, one way trip times, T. Pulse length is 2T. Impedance of the generator output, is twice the LC line impedance, as they appear in series. Lines measured at 77 ohm impedance.

Fig 3 is the output wave form. 2.49 kV delivered to a 160 ohm load. Lines 1, 2 are 77 ohm impedance. Pulse width 77 nS . Rise time 36 nS. Part of the rise time represents the residual line lump response whose elements are 455 nH and 100 pF. This has a lumped element rise time of 15 nS. The balance is from saturator switching. A single stage peaker could easily speed this up. A snubber of 100 ohms and 120 pF was used to reduce overshoot in the primary pulse. This is shown in Fig1

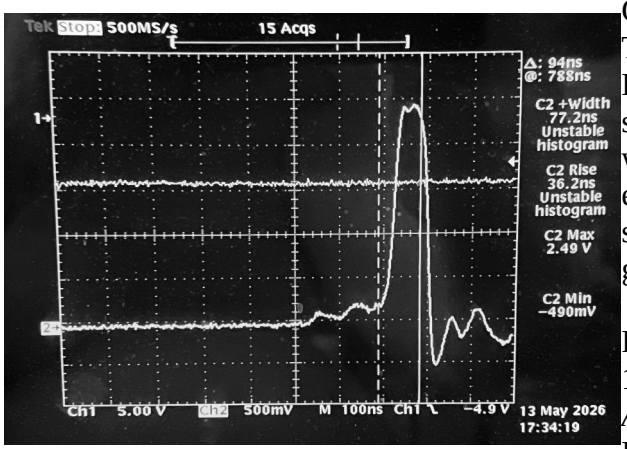

Fig 3 Output Voltage

Conclusion

This prototype shows the feasibility of constructing a Blumlein pulse generator with saturating magnetic switching. A very robust pulser is created that can withstand arcing without destruction. Magnetic elements isolate the drive generator from the power switch. This circuit is an example of a mode conversion generator.

References.

1.Blumlein, A.D., *Improvements in or Relating to Apparatus for Generating Electrical Impulses*, British Pat. 589,127, filed Oct. 10, 1941, issued June 12, 1947.

2. Mesyats, Gennady A. (2005). *Pulsed Power*. Springer. pp. 13–14, 125. ISBN 0306486547.