Tunable Wideband Pulser for High Power Applications

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There has been significant interest recently in understanding the interaction of high power microwave (HPM) systems with various electrical and biological systems. In the field of wideband and ultra-wideband (UWB) HPM, the parameter space for potential sources is quite large. It is known that peak power, average power, bandwidth, center frequency, and even pulse waveform can all be important in understanding the effect of a particular source on a particular system. Similar complexity exists in understanding the interaction of WB and UWB radiation with biological systems. Tyo, *et al.*, proposed a topology that might be used for creating a waveform-agile WB pulser (Tyo, *et al.*, *IEEE Trans. Plasma Sci.*, **32**:1925, 2004). A preliminary design based on an imbalanced Blumlein concept was presented in that paper, along with measured results from a low-voltage prototype system. In this paper, we present the full design. The final system is designed to operate at charge voltages up to 50 kV with freqency content from 300 MHz through 1 GHz. The system is tunable in near-real-time using computer controlled actuators, and can be used to produce damped sinusoidal oscillations with varying bandwidths. The system has been operated at pulse repetition rates up to 1.9 kHz.

Blumleins can be made in any transmission line topology. When the device is to be used to feed a balanced load, like a TEM horn or a parallel plate transmission line, then a parallel plate Blumlein topology is often used. The parallel plate topology suffers from parasitic capacitive coupling that decreases the voltage efficiency of the output of the Blumlein. However, these parasitics can be controlled by widening the center conductor. Widening the center conductor has the added benefit of improving the match of the physical sizes of the energy storage section of the Blumlein and the output transmission line. We present two methods to dynamically tune the parallel plate Blumlein in both pulse width and in waveform. First, by moving the center conductor towards the bottom conductor, the Blumlein becomes imbalanced. This imbalance causes the transmission line circuit to ring, with the half-period of the ringing being equal to the round trip transit time on the energy storage section. If the center conductor is instead shifted upwards towards the top conductor, the output is made to have an exponentially decaying positive waveform. Since the half-period of the ringing is controlled by the length of the energy storage section, we further proposed in that the length of the storage section could be adjusted by pulling the center conductor out of the Blumlein. In this paper we present our completely developed high voltage system and mechanical control and actuation that can be used in this self-contained, laboratory pulser system.