



High Voltage, High Current Accurate Pulse Generator

TECHNOLOGY NUMBER: 2022-100

Technology ID

2022-100

Category

Hardware

Engineering & Physical Sciences

Inventor

Al-Thaddeus Avestruz

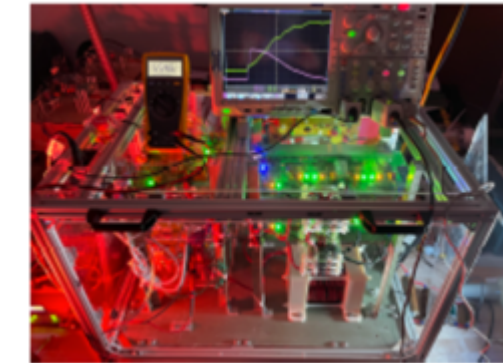
Xin Zan

Further information

Joohee Kim

jooheek@umich.edu

Learn more



OVERVIEW

A modular 4.5 kV pulse generator that delivers a 100A peak current pulse for an 800 ns flat-top duration

- Overcomes challenges designing high voltage and high current accurate pulse generators
- Reduces DC circuit interrupter stress by effectively achieving zero current switching to alleviate arcing

BACKGROUND

Power one-shot pulse generators are essential tools in many industrial, scientific, and medical applications that require a high-energy electrical pulse in response to a trigger. These generators are designed to deliver a single, high-power pulse of electrical energy in response to an input trigger signal, making them ideal for applications such as pulsed power, plasma generation, and particle accelerators. In industrial settings, one-shot pulse generators are commonly used for welding, cutting, and forming of materials, as well as for non-destructive testing of materials and components. For scientific applications, these generators are used for a range of experiments, including high-energy physics, nuclear fusion, and laser physics. Used in medical applications, one-shot pulse generators are used for diagnostic and therapeutic purposes, such as in electroconvulsive therapy for treating severe depression. With their ability to deliver high-energy pulses quickly and accurately, power one-shot pulse generators are crucial tools for advancing research and development in a wide range of fields. Therefore, a need exists for high power one-shot pulse generators that respond quickly to a trigger for industrial, scientific, and medical applications.

INNOVATION

Researchers have invented a design method and hardware results for a modular 4.5 kV pulse generator that delivers a 100A peak current pulse for an 800 ns flat-top duration, which can potentially scale to tens of kilovolts. A fast-response, flat-top current pulse can help dc circuit interrupters achieve zero current switching, which alleviates arcing, reduces semiconductor device stress, and improves circuit design while reducing stress on the device. When a current pulse with a fast rise time and flat top is applied to a semiconductor device, it creates a uniform magnetic field that counteracts the inductive voltage drop across the device, allowing the current to decrease to zero quickly and smoothly. This process reduces the likelihood of arcing, which can damage the device and decrease its lifespan.

Additionally, zero current switching can improve circuit design by reducing the need for snubbers, which are components used to suppress voltage transients caused by arcing. The innovation overcomes several challenges in designing high voltage and high current accurate pulse generators, including: (a) parasitics from the necessary large physical format that degrade pulse quality and complicate design; (b) modularity that is economical in using fewer lower voltage semiconductor switches; and (c) optimality in the tradeoff among response time, pulse flat-top duration, and component selection. Therefore, by using a fast-response, flat-top current pulse to achieve zero current switching, this DC circuit interrupter can operate more efficiently and reliably, reducing stress on semiconductor devices and improving overall circuit performance.