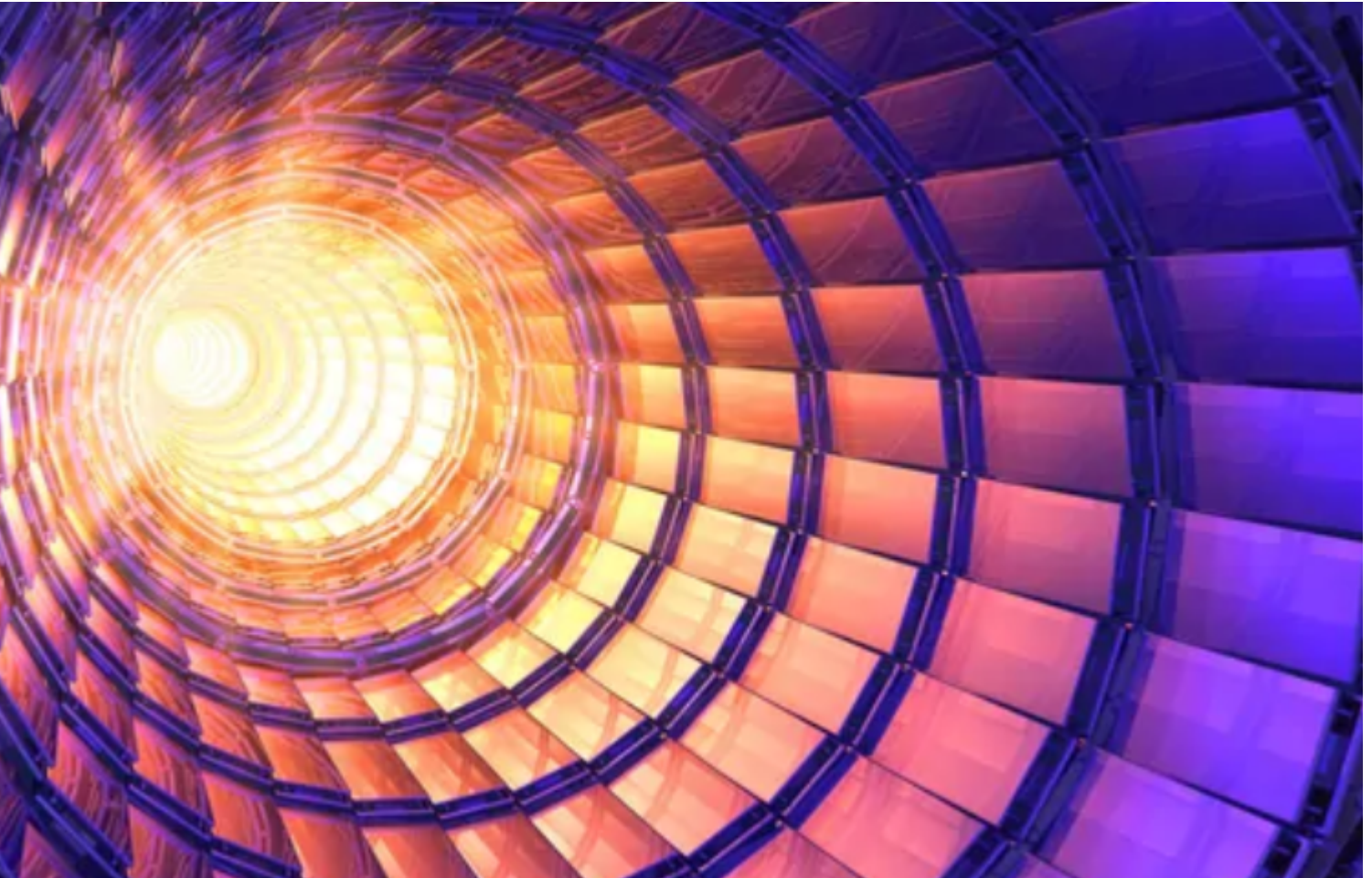


GENERATING HIGH VOLTAGE PULSES WITH MARX GENERATORS



Pulsed energy drives a wide range of high-energy applications, from particle acceleration to fusion research and electromagnetic pulse (EMP) simulation. Marx generators play a critical role in generating those high-voltage pulses by amplifying lower voltage DC inputs. Here, we'll cover how Marx generators operate, recent advancements enhancing their efficiency and reliability and the critical role of capacitors in shaping their performance.

In Marx generators, capacitors are charged in parallel using a low-voltage power source. Resistors or inductors are used to control the charging rate and to isolate the capacitors, ensuring they remain charged until a discharge is initiated.

When the voltage across the capacitors reaches the breakdown voltage of the spark gaps (i.e., discharge initiation), the spark gaps conduct, creating a temporary series connection of the capacitors. This configuration combines the voltages of all the capacitors, resulting in an output voltage much higher than the original charging voltage. The rapid, simultaneous discharge generates high-voltage pulses.

Innovating for Efficient and Simple Marx Generators

Ongoing research and development in Marx generator technology aims to simplify designs, improve the efficiency of energy delivery and broaden their functional capabilities.

Impedance-Matched Marx Generators (IMGs) are ideal for fusion and other next-generation pulsed-power systems due to their extended operational lifetimes, fast rise times and high repetition rates. Advancements in pulse shaping offers precise control over output waveforms, which is essential for applications like nonthermal plasma generation.

Integrating solid-state switching technology into Marx generators is enhancing their reliability without impacting their ability to maintain the voltage and current requirements of advanced military and aerospace applications. For the same audience, there's an effort to miniaturize Marx generators for space- and weight-constrained applications.

Capacitor Functions in Marx Generators

Capacitors play a critical role in energy storage within Marx generators. Charged in parallel, each capacitor achieves the same voltage level while remaining insulated from the full output voltage until the discharge process begins. This configuration ensures efficient energy storage and controlled release.

At discharge, the series configuration allows capacitors to support voltage multiplication to achieve the target output voltage. The output voltage is the sum of the voltages across each capacitor.

In collaboration with resistors, capacitors also influence discharge characteristics like discharge rate. The RC time constant ensures capacitors fully charge before discharge begins for efficient energy transfer. Further, capacitance value and configuration determine the speed at which energy can discharge through the load, offering control over pulse duration and shape.

Selecting Marx Generators

When choosing capacitors for Marx generators, consider:

- **Voltage Rating:** Choose capacitors rated 1.5 to 2 times the Marx generator's maximum operating voltage to handle over-voltage and ensure reliability.
- **Capacitance Value:** Higher capacitance stores more energy but can increase pulse width and rise time. Match the capacitance to your output needs.
- **Capacitor Type:** Common capacitor types (i.e., ceramic, film, electrolytic) have inherent performance differences. Ceramic and film capacitors are ideal for high-frequency pulses due to their fast response and reliability under tough conditions.
- **Operating Environment:** Consider temperature and insulation needs to avoid performance issues in harsh conditions.
- **Impedance Matching:** Select capacitors with proper impedance for the best output voltage and performance.

Explore Knowles' [specialty film capacitors](#) designed specifically for pulse energy applications. With their superior stability, durability and precision under extreme conditions, these capacitors are the perfect solution for demanding high-energy systems.

[Learn More](#)

If you need help selecting from our portfolio please [contact us](#) and we can guide you through the selection process.



2777 Hwy 20
Cazenovia, NY 13035



(315) 655-8710



[Contact Knowles](#)