

Johanson CapStrate® Technology for Pulsed-Power Detonator Systems

Enabling fast, controlled energy delivery in EBW, EFI, and related pulsed-power initiation systems

Key Takeaway:

Need faster current rise time in a pulsed-power initiation system?

CapStrate® is Johanson's custom, low-inductance solution designed to minimize discharge-path inductance, enabling faster current rise (di/dt), improved timing precision, and more reliable energy delivery for EBW, EFI, EED, and other high-current pulsed-power applications.

Executive Summary:

Advanced pulsed-power initiation systems, including Exploding Bridgewire (EBW) and Exploding Foil Initiator (EFI) technologies, require more than energy storage. System performance depends on how quickly, efficiently, and predictably that energy reaches the initiator.

Parasitic inductance within the capacitor discharge path can restrict current rise rate (di/dt), resulting in reduced timing precision, inconsistent initiation, and less predictable energy delivery.

CapStrate® addresses these challenges by minimizing discharge-path inductance and shortening the current-loop length. Compared with traditional discrete capacitor networks, CapStrate® supports:

- Faster current rise
- More precise timing
- More controlled energy delivery
- Improved initiation repeatability
- Greater reliability in high-current pulsed-power systems

Pulsed-Power Initiation Systems: Common Requirements

CapStrate® is well suited to EBW, EFI (slapper), and related pulsed-power initiation systems requiring fast, controlled energy delivery.

Despite differences in architecture, these systems share a common bottleneck: the ability to deliver energy rapidly and predictably to the initiator. In practice, inductance directly limits current rise rate (di/dt), making circuit geometry a critical design constraint.

- Fast current rise rate (di/dt)
- Low inductance (L)
- Controlled, repeatable energy delivery

$$di/dt = V / L$$

In pulsed-power firing systems, the capacitor discharge unit (CDU) and the interconnect path to the initiator strongly influence current rise rate and energy-delivery efficiency.

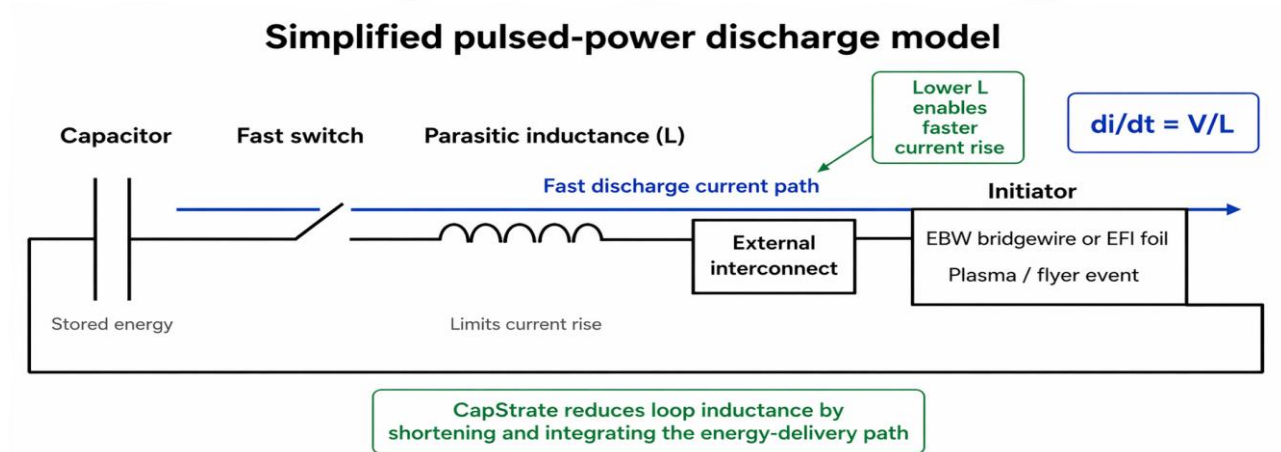


Figure 1. Simplified discharge model showing how parasitic inductance in the firing circuit limits current rise. Reducing L allows the capacitor to deliver current more rapidly into the initiator.

While inductance plays a dominant role in limiting current rise rate, discharge behavior is more accurately described by the full RLC response of the circuit, including contributions from:

- Capacitor ESR and ESL
- Switching device characteristics (e.g., spark gap, solid-state switch)
- Interconnect geometry
- Initiator impedance

Reducing loop inductance, especially within the capacitor network and immediate discharge path, remains a primary lever for improving current rise time and waveform consistency.

Exploding Bridgewire (EBW) and Exploding Foil Initiators (EFI)

Exploding Bridgewire (EBW)

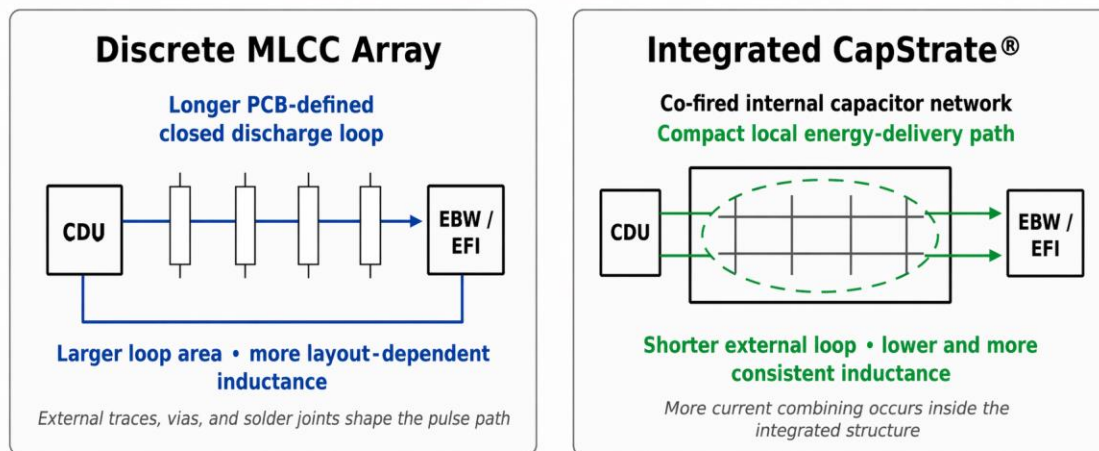
EBW detonators use a high-voltage capacitor discharge to rapidly heat a fine wire, causing it to vaporize into plasma and initiate the explosive. Reliable operation depends on delivering sufficient energy within a very short time window to achieve consistent bridgewire burst and plasma formation.

Exploding Foil Initiators (EFI / Slapper Detonators)

EFI systems operate on a similar pulsed-power principle but use an exploding foil to generate plasma that accelerates a small flyer into the explosive. Compared with EBW, EFI systems typically demand even higher current rise rates, tighter control of pulse shape, and greater consistency in the discharge path.

Why Discrete MLCC Networks Become a Bottleneck

Traditional capacitor-discharge units (CDUs) are often implemented as arrays of discrete multilayer ceramic capacitors (MLCCs) interconnected through PCB traces. While effective in many circuits, this approach introduces parasitic inductance, distributed current paths, and layout-dependent variability. Multiple solder joints also increase mechanical vulnerability under shock and vibration. Together, these



factors can reduce current rise rate (di/dt) and increase timing uncertainty in pulsed-power initiation systems.

Figure 2. Conceptual comparison of discharge-loop geometry and loop area. A discrete MLCC array relies on a longer PCB-defined loop with more external interconnects, while CapStrate® integrates the capacitor network into a compact structure that shortens the external loop and improves inductance consistency.

CapStrate® Technology: Integrated Energy Delivery

CapStrate® replaces discrete capacitor networks with a co-fired multilayer ceramic structure that integrates capacitive elements, electrodes, and interconnects into a single device. This architecture minimizes current loop length, reduces parasitic inductance, and creates a more controlled electrical geometry for consistent energy delivery.

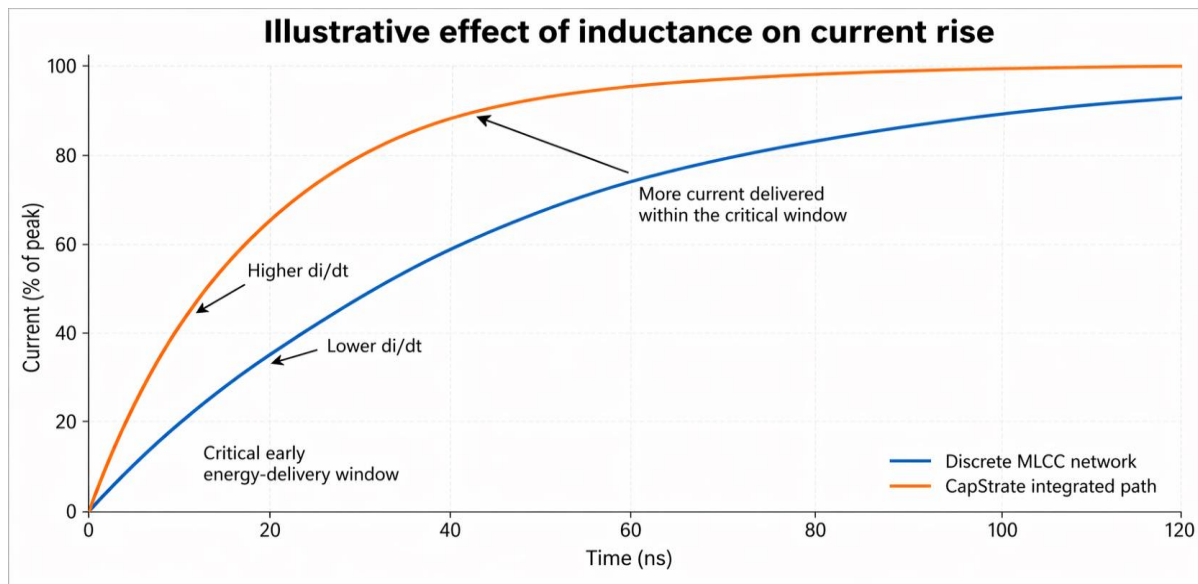


Figure 3. Illustrative current-rise comparison for a discrete MLCC network versus an integrated CapStrate® path.

Performance Advantages in EBW and EFI Systems

Capability	System-Level Benefit
Improved current rise rate (di/dt)	Supports faster bridgewire burst and more consistent foil explosion or flyer acceleration
Controlled energy delivery	Improves repeatability of the initiation event and reduces waveform variability.
Enhanced timing precision	Lower, more consistent inductance helps reduce timing spread between channels.
Mechanical robustness	Monolithic ceramic construction reduces solder-joint count and improves shock/vibration resistance.
Compact, application-specific form factors	Designed to optimize size, weight, and power (SWaP) in tightly constrained system layouts.

Beyond EBW and EFI: Broader Pulsed-Power Applications

CapStrate technology is also relevant to other pulsed-power initiation and ignition systems where low inductance and fast, controlled energy delivery are critical. Examples include advanced electro-explosive devices (EEDs), multi-point initiation systems requiring synchronized firing, and other high-current pulsed ignition circuits.

Why Johanson

Johanson brings 60+ years of capacitor design and manufacturing experience for defense and high-reliability applications. As a privately held, U.S.-based manufacturer with North American production, ITAR-compliant, AS9100-certified, and ISO14001-certified facilities, Johanson delivers strong process control, traceability, and long-term program support.

With custom design support, MIL-STD screening, advanced high-reliability testing, flexible ceramic formulations, and BME/PME capabilities, Johanson provides CapStrate® solutions engineered for demanding EBW, EFI, and pulsed-power initiation applications.

Conclusion

As detonator technologies evolve toward higher precision, greater safety, and operation in harsher environments, the capacitor discharge network increasingly becomes a limiting factor. By integrating energy storage and delivery into a low-inductance, controlled-geometry ceramic structure, CapStrate® enables faster current rise, improved timing precision, and greater reliability for EBW, EFI, and related pulsed-power initiation systems.

Talk to our technical team about your pulsed-power design.

Contact our engineers at <https://www.johansondielectrics.com/contact/ask-a-question/>

or simply scan the QR code:

