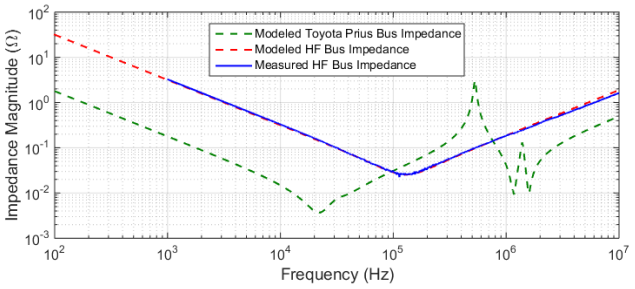
LOW INDUCTANCE DC POWER BUS

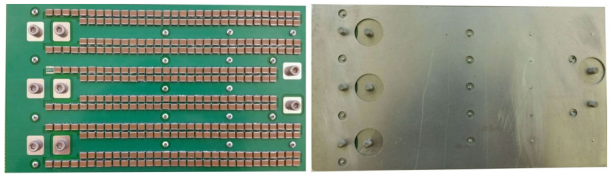
US Patent No. 10,084,310
SD# 13679.1
Technology Readiness Level: 3
First principles are well understood, key parameters have been identified, potential applications have been identified, and a prototype has been fabricated but not yet integrated into a full converter system.

A low-inductance DC power bus for high frequency, high temperature operation in electric drive systems and next-generation power electronics

A new generation of power electronic conversion systems are being enabled by wide-bandgap (WBG) devices. Applications in civilian and defense sectors are already realizing improved power density and efficiency in power converters that utilize silicon carbide (SiC) and/or gallium nitride (GaN) switches. However, as semiconductor switches become capable of greater hold-off voltage, higher switching frequency, and higher junction temperature, limits on converter performance will depend on the balance of the system: device packaging, filter components, and thermal management as examples. To fully realize the benefits of WBG device in an inverter, the DC link capacitor must support high frequency switching, be co-located with the switches to mitigate parasitic inductance, and be capable of higher temperature operation (due to switch proximity). To this end, Sandia researchers have developed a low-inductance DC power bus for high frequency, high temperature operation in electric drive systems and next-generation power electronics.

The low-inductance DC power bus demonstrates substantial reductions in parasitic inductance over conventional DC link systems by using a printed circuit board to maximize planar capacitance and carefully controlled capacitor placement. Utilizing ceramic rather than standard electrolytic or film capacitors helps to achieve higher operating temperatures and improved thermal management. Parallel capacitor placement provides low shunt impedance to high-frequency current components and smooths current spikes created by switching operations. Beyond electric vehicle drive systems, this system may be relevant in electric drive applications where high-frequency switching and/or high temperature operations are desired.





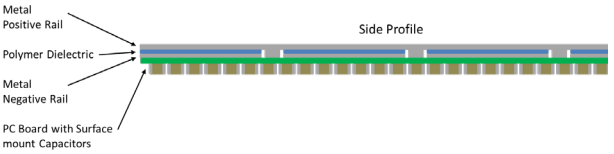


Fig. 1 (top): Magnitude bode plots of existing and proposed DC bus. Fig. 2 (middle): Photos of assembled board. Fig. 3 (bottom): Profile illustration of capacitor concept.

TECHNICAL BENEFITS

- Reduced parasitic inductance
- High frequency operation (>100 kHz)
- High temperature operation and improved thermal management
- Increased power density with reduced overall size
- Supports WBG devices
- May be fabricated with simple PCB assembly methods

INDUSTRIES & APPLICATIONS

- Automotive
- Electric drive systems / electric vehicles
- High frequency switching
- Grid-tied power systems
- Geothermal
- Oil and gas

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