Empowering Future Electric Aircraft with a Flying Capacitor Multilevel Inverter Utilizing Optimal Passive Components

Berkeley Power and Energy Center

Motivation and Application

- Air travel accounts for ~200 million tons of CO_2 emissions annually (3% of US greenhouse gas emissions)[1]
- Air travel demand doubles every fifteen years
- Electrification of flight requires efficient, lightweight, and reliable power conversion

Credit: Boeing

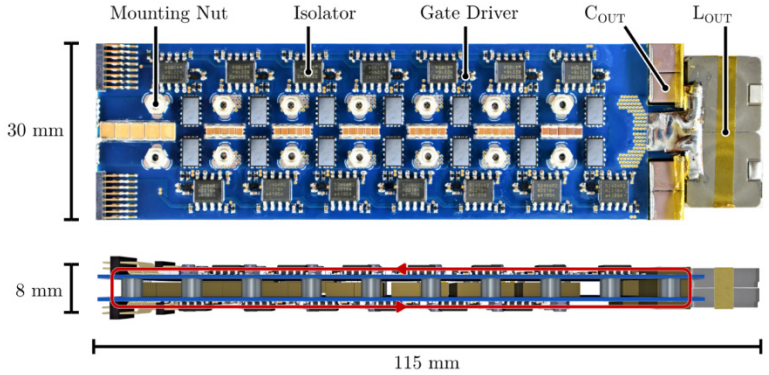
Credit: NASA

fuel consumption 60%

NOx emissions 80%

acoustic noise 71dB

Hardware Prototype

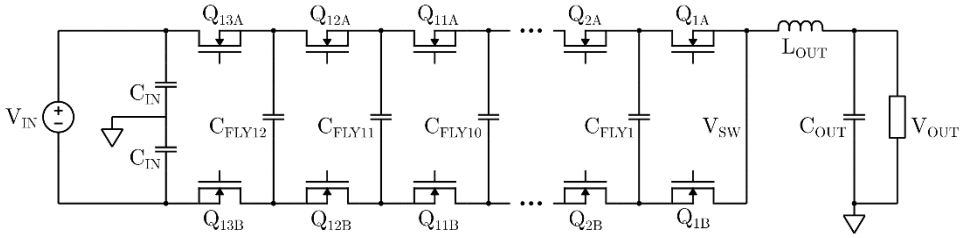


- 10 kW, 800 V, 14-level FCML
- Sandwich-style layout with two printed circuit boards
- Ultra-thin design, only 8 mm thick!

Key Converter Parameters	
Input Voltage	800 V_{DC}
Output Voltage	270 V_{RMS}
Effective Switching Frequency	1.95 MHz
Peak Output Power	10.3 kW
Peak Overall Efficiency	98.2 %
Gravimetric Density	170 kW/kg
Volumetric Density	370 kW/L

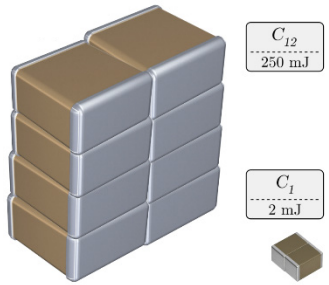
FCML with Optimal Passive Component Selection

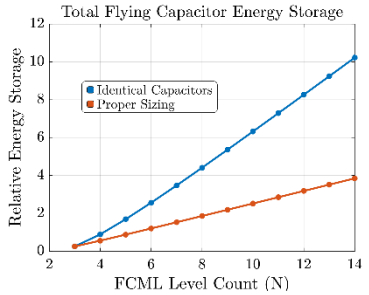
Simplified 14-level FCML schematic



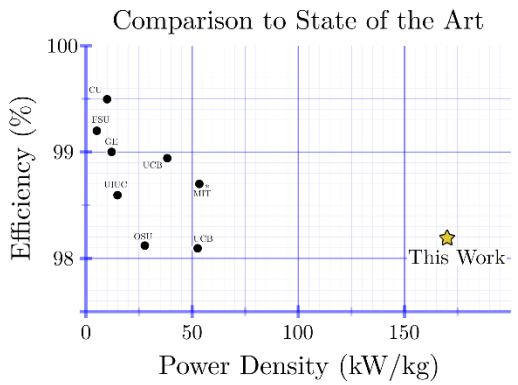
Capacitor Sizing

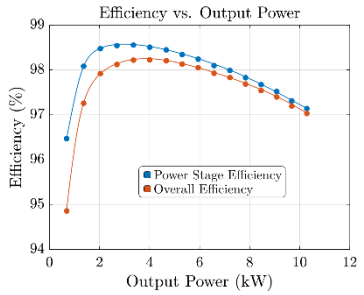
- Conventional approach utilizes large, identical capacitors
- Proposed approach optimally selects unique capacitors for each flying capacitance
- **Enables > 50% reduction in size**

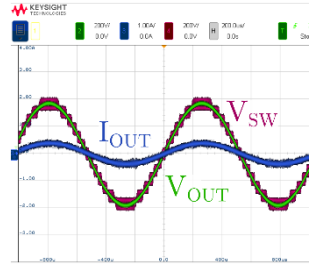




Experimental Verification







- **Highest power density** among state-of-the-art aircraft inverters
- Excellent capacitor balancing and **low output distortion** despite the small size of the converter

References:
[1] https://www.epa.gov/greenvehicles/fast-facts-transportation-greenhouse-gas-emissions

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