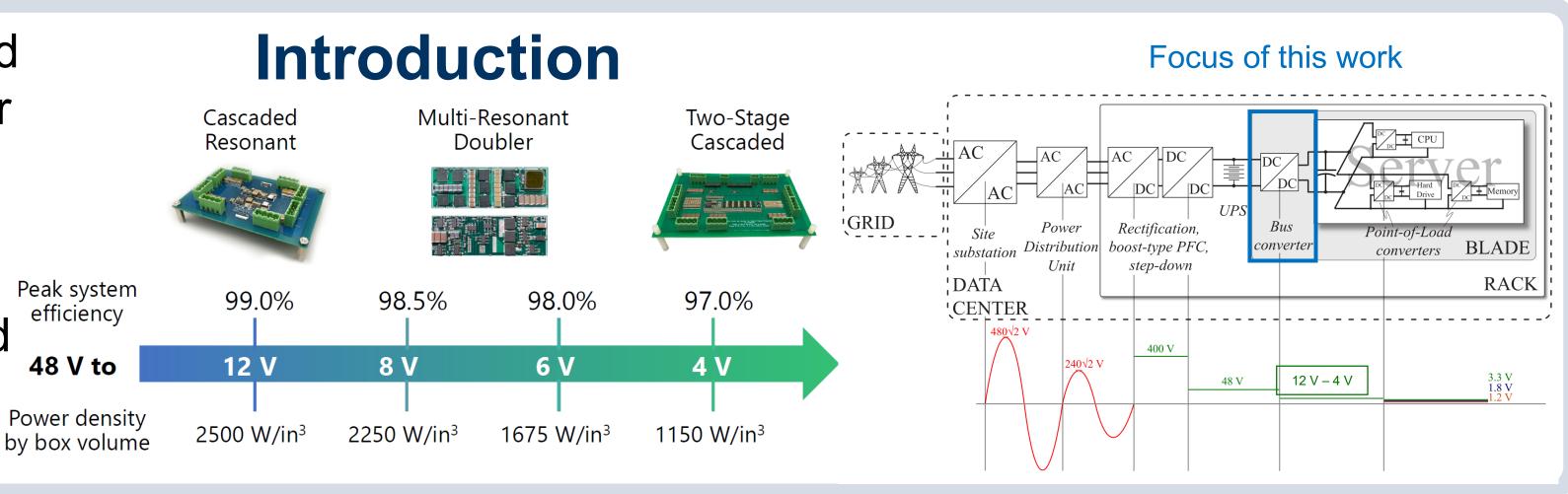
Hybrid Resonant Switched-Capacitor Converters: Achieving Ultra-Efficient and Compact High-Step-Down DC-DC Power Conversion for Datacenters Rose Verziehao jos

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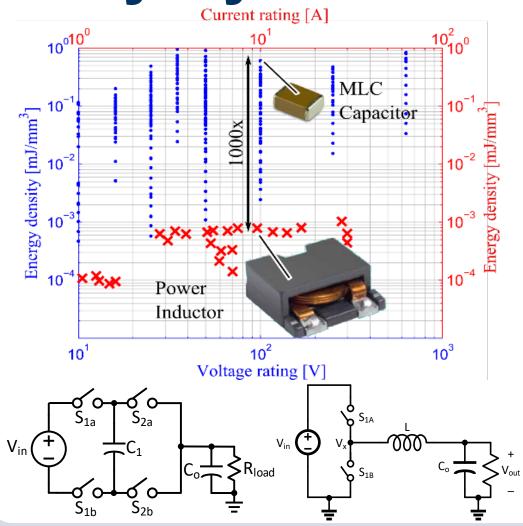
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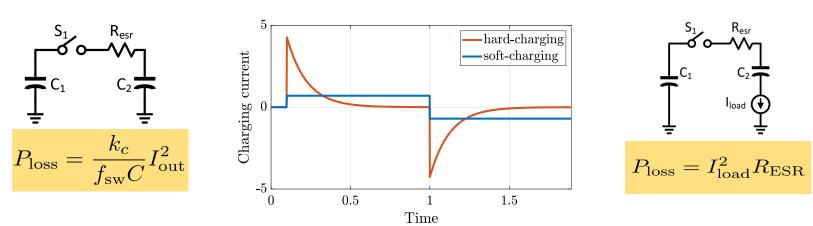
This work presents a family of high-performance hybrid resonant switched-capacitor (SC) power converters for datacenter power delivery, from 48 V_{dc} to an intermediate bus voltage (12, 8, 6 or 4 V_{dc}). This technology can achieve significantly higher efficiency and power density than the current state-of-the-art and has the potential to greatly reduce the power distribution loss in future datacenters.



Why Hybrid Switched-Capacitor Converters

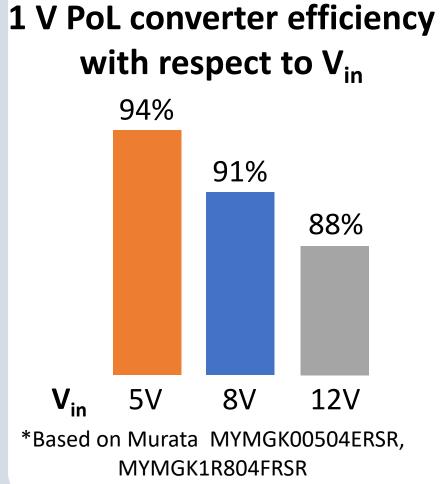


Capacitors have an energy density that is up to 1000x higher than inductors. However, their inherent charge sharing loss significantly undermines this advantage.



Hybrid switched-capacitor converters use both capacitors and inductors in the power transfer process. The inductor behaves like a current source and can help recover the charge sharing loss, through soft charging operation.

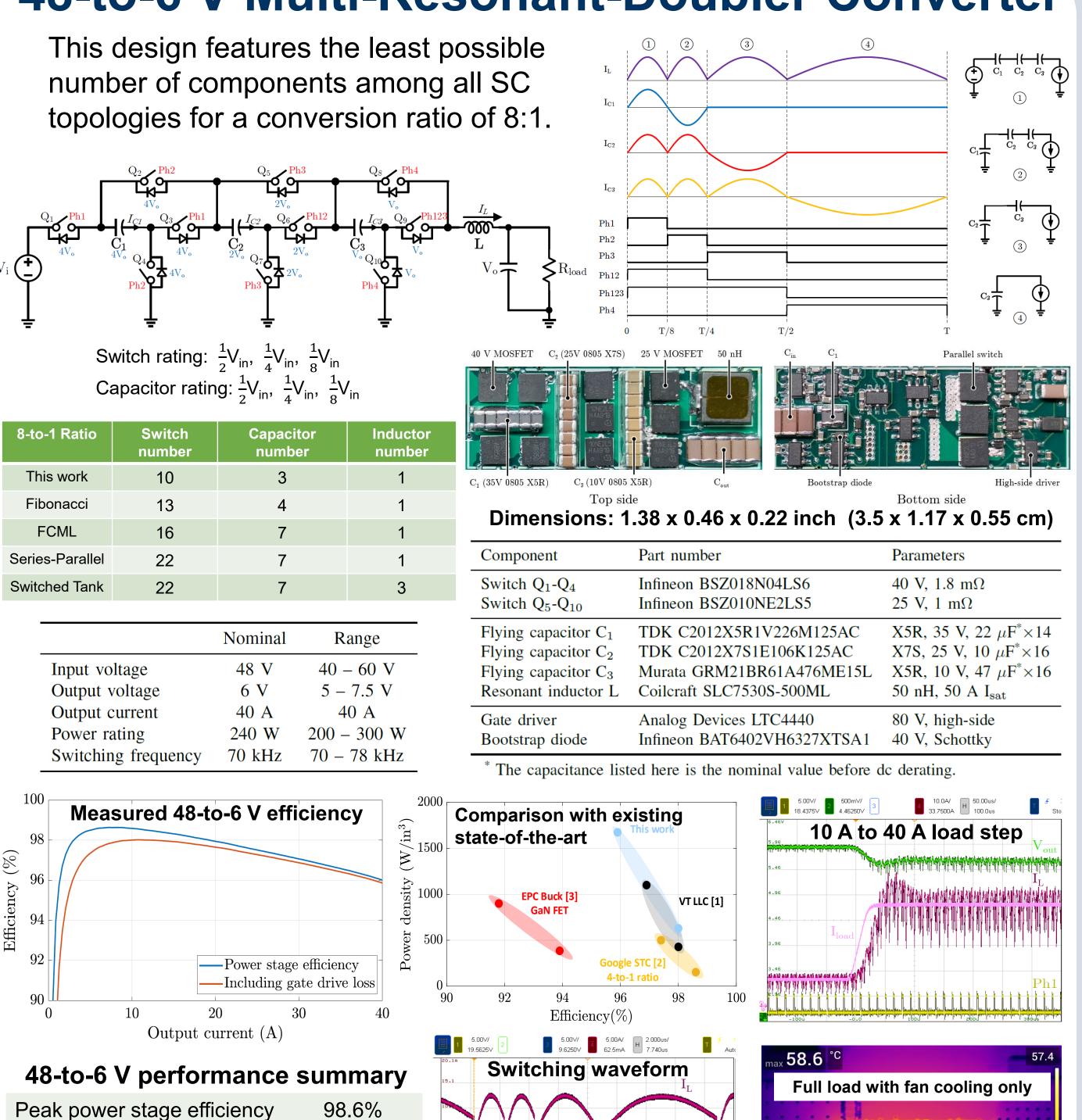
Moving Towards A Lower Bus Voltage



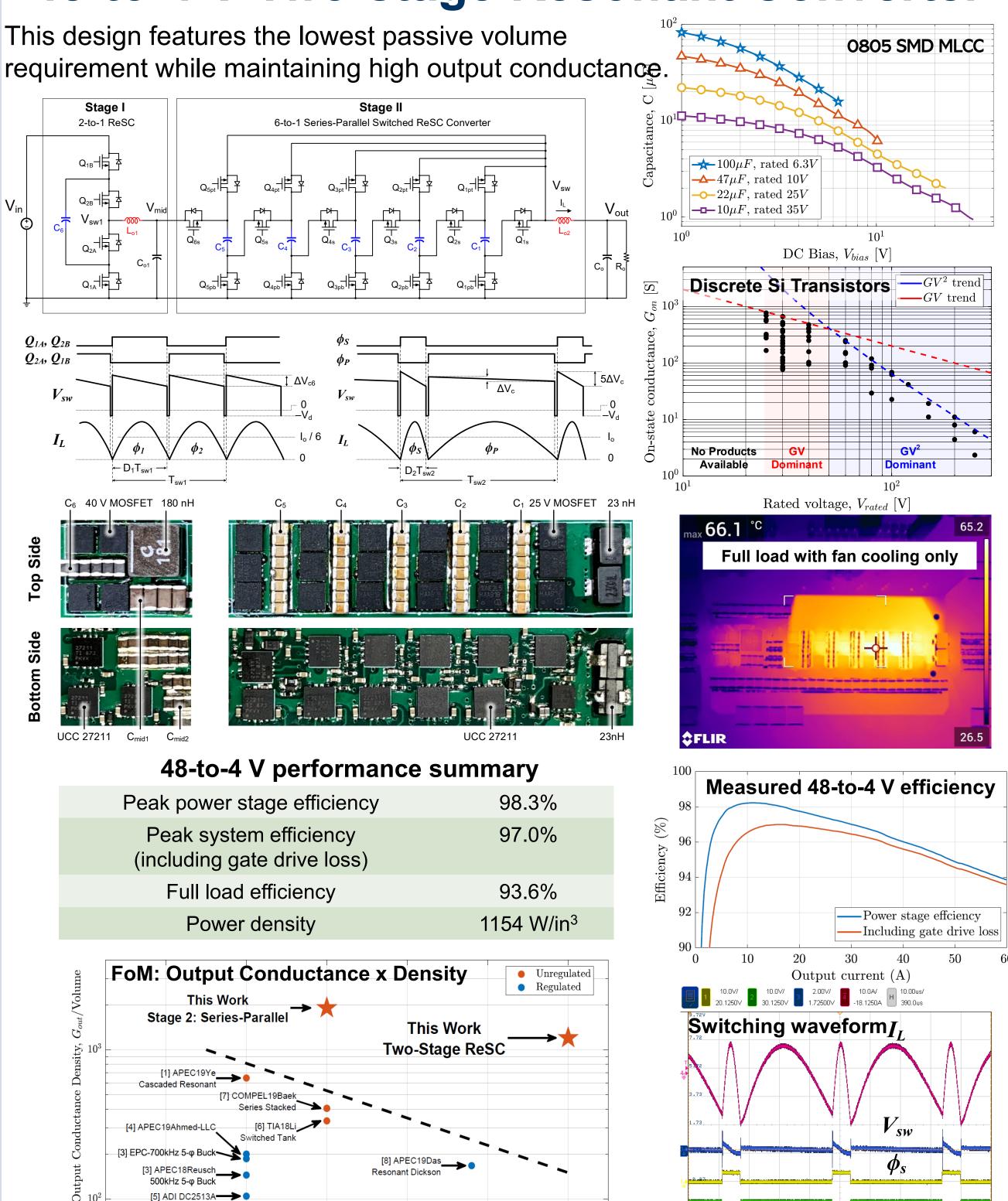
The efficiency of a Point-of-Load converter is a decreasing function of its input voltage. If the prior stage bus converter can achieve a higher conversion ratio without much extra loss, the input voltage of the PoL converter can be decreased and the overall 48V-to-PoL efficiency can be improved.

However, the component number of SC-based bus converters increases proportionally with respect to the conversion ratio, resulting in increased circuit complexity and decreased performance. To address this challenge and continue the promise of SC technologies, we developed two new Resonant SC topologies that are specifically suitable for high conversion ratios (48-to-6 V and 48-to-4 V).

48-to-6 V Multi-Resonant-Doubler Converter



48-to-4 V Two-stage Resonant Converter



Conversion Ratio, V_{in}/V_{out}

Peak system efficiency

(including gate drive loss)

Full load efficiency

Power density

98.0%

96.0%

1675 W/in³

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