LEGO-PoL: A Family of Extreme Performance Miniaturized Point-of-Load Converters for High Current Microprocessors

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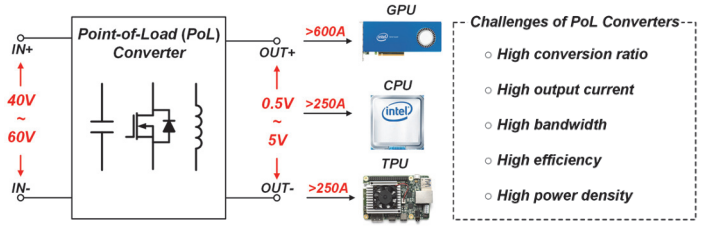
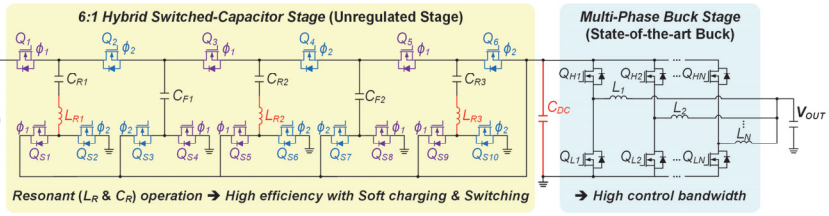
Background & Motivation

- Future data centers will contain 48V power supplies & extreme high current loads (CPUs, GPUs, TPUs)



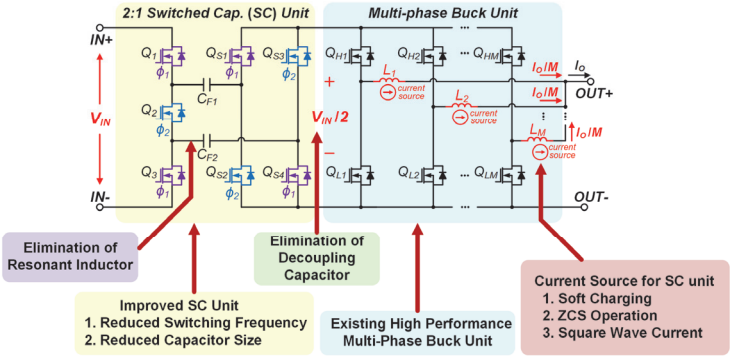
Traditional Two-Stage Hybrid Switched-Cap. Based Design



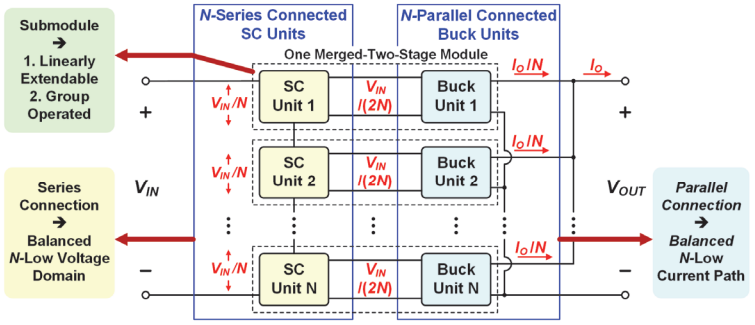
- **Resonant inductors (L_R) → Additional loss & low power density**
- **Decoupling capacitor (C_{DC}) → Low power density**

Merged Two-Stage Linear Extendable Group Operated (LEGO) – Point of Load (PoL) Architecture

- One Submodule of the Merged Two-Stage LEGO-PoL Architecture



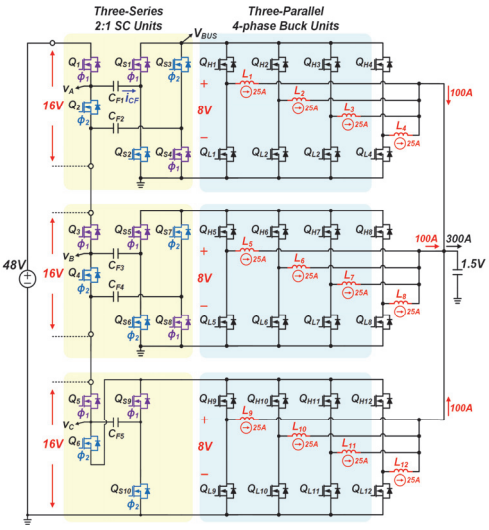
- Scalable and Modular LEGO-PoL Architecture (*N*-Submodules)



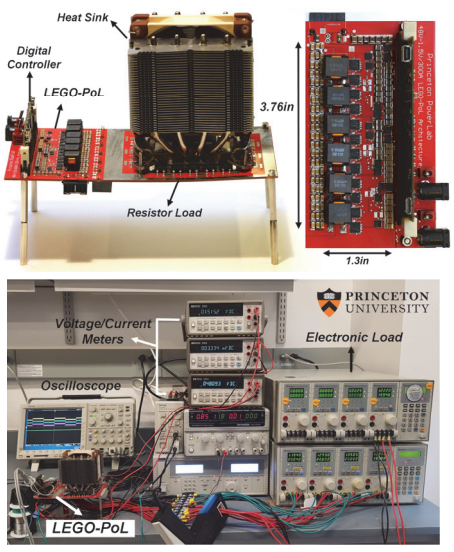
Easily Extendable to Wider Input Voltage Range & Wider Output Current Range

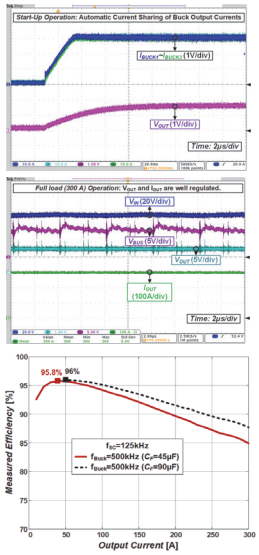
A 48 V-1.5 V/300 A Example Design with Experimental Results & 3D Packaging LEGO-PoL Converter

- Three-submodules LEGO-PoL design[1]

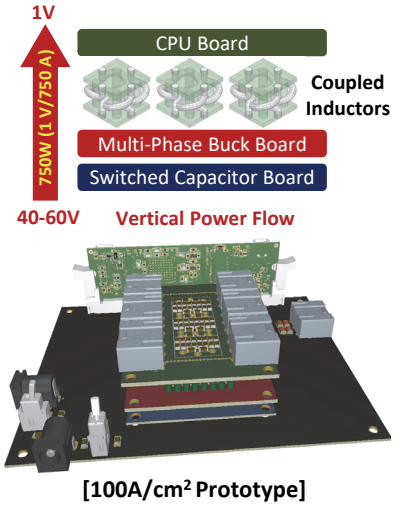


- Prototype (577 W/in³) & Measured Performance





- 3D Packaging LEGO-PoL Converter (work ongoing)



[100A/cm² Prototype]

[1] J. Baek, P. Wang, S. Jiang and M. Chen, "LEGO-PoL: A 93.1% 54V-1.5V 300A Merged-Two-Stage Hybrid Converter with a Linear Extendable Group Operated Point-of-Load (LEGO-PoL) Architecture," *2019 20th Workshop on Control and Modeling for Power Electronics (COMPEL)*, Toronto, ON, Canada, 2019, pp. 1-8.

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