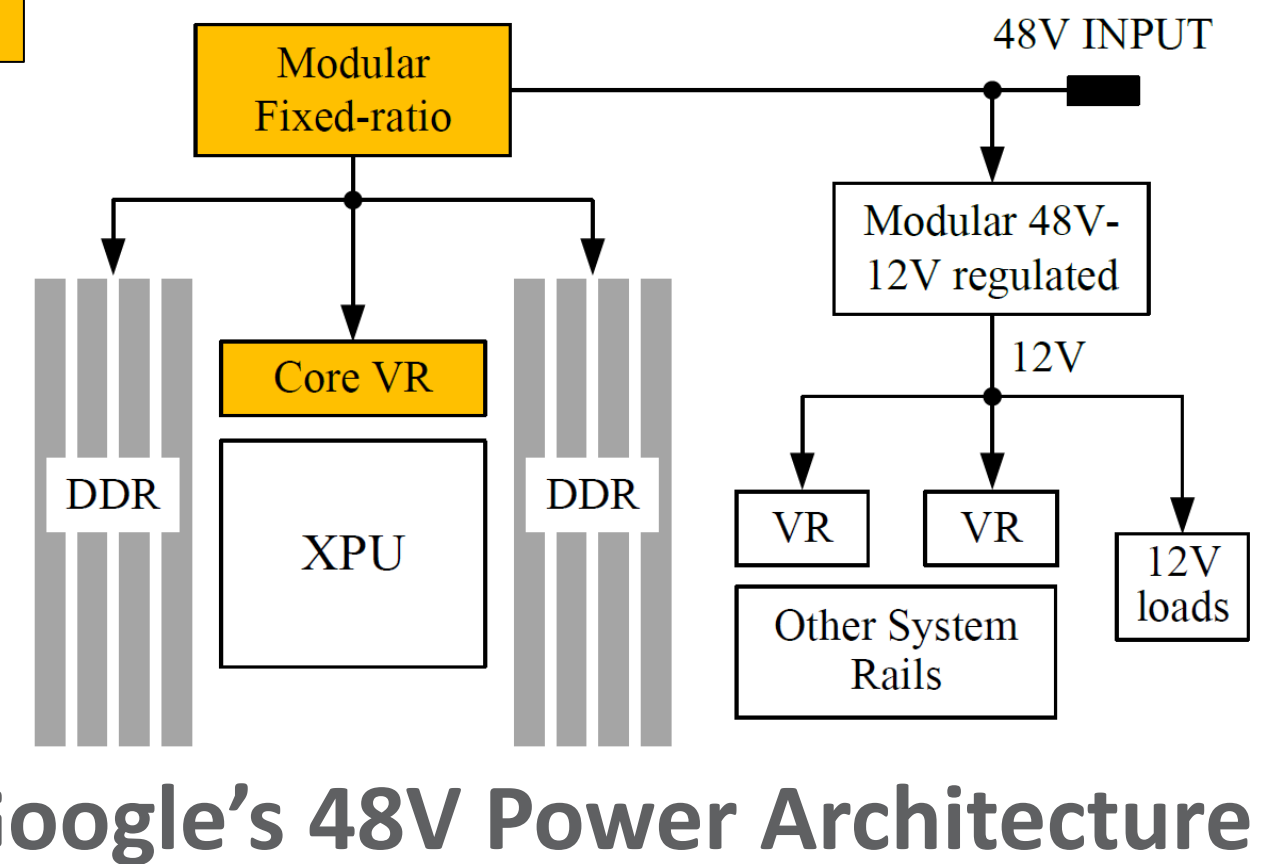
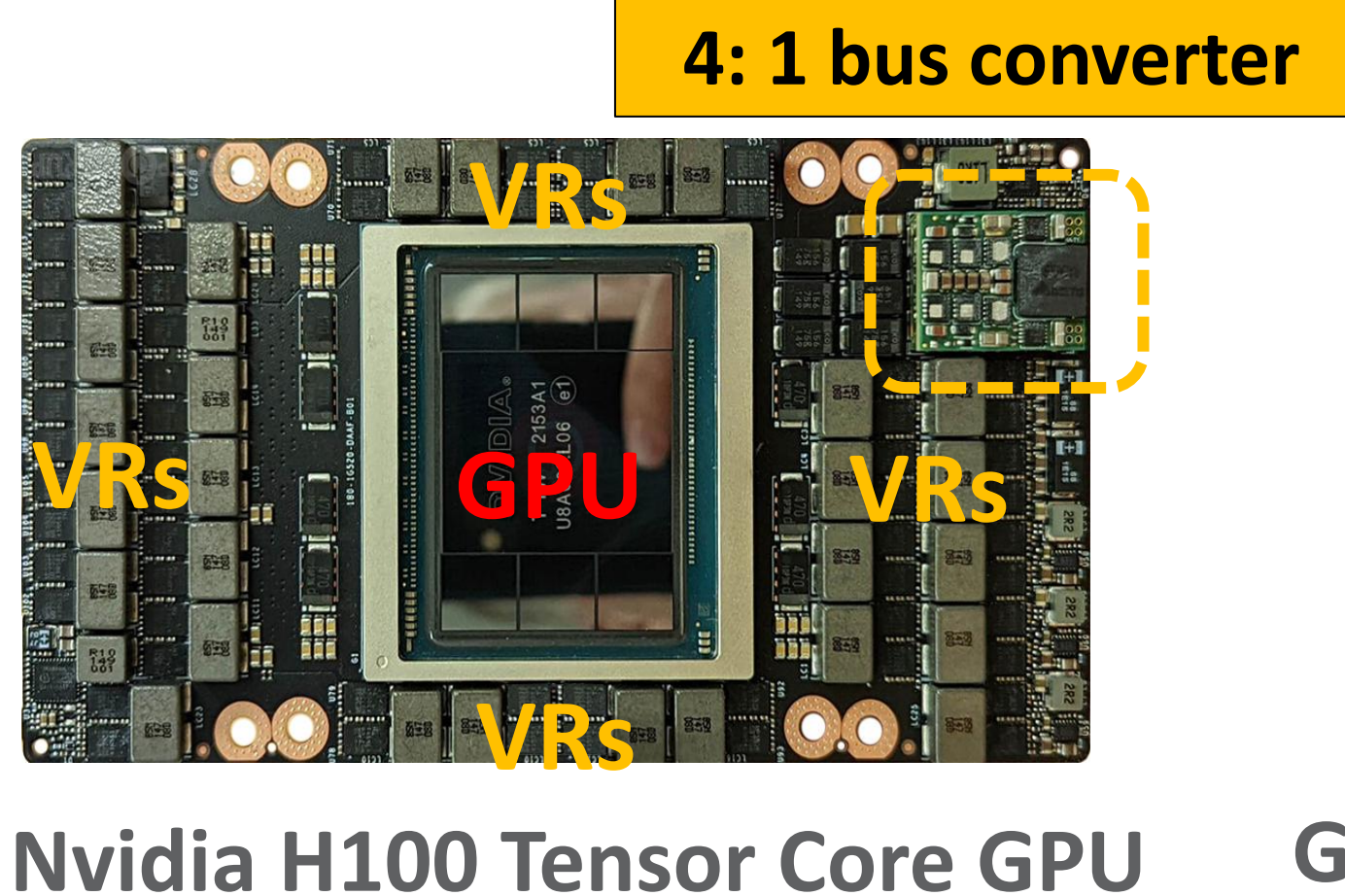
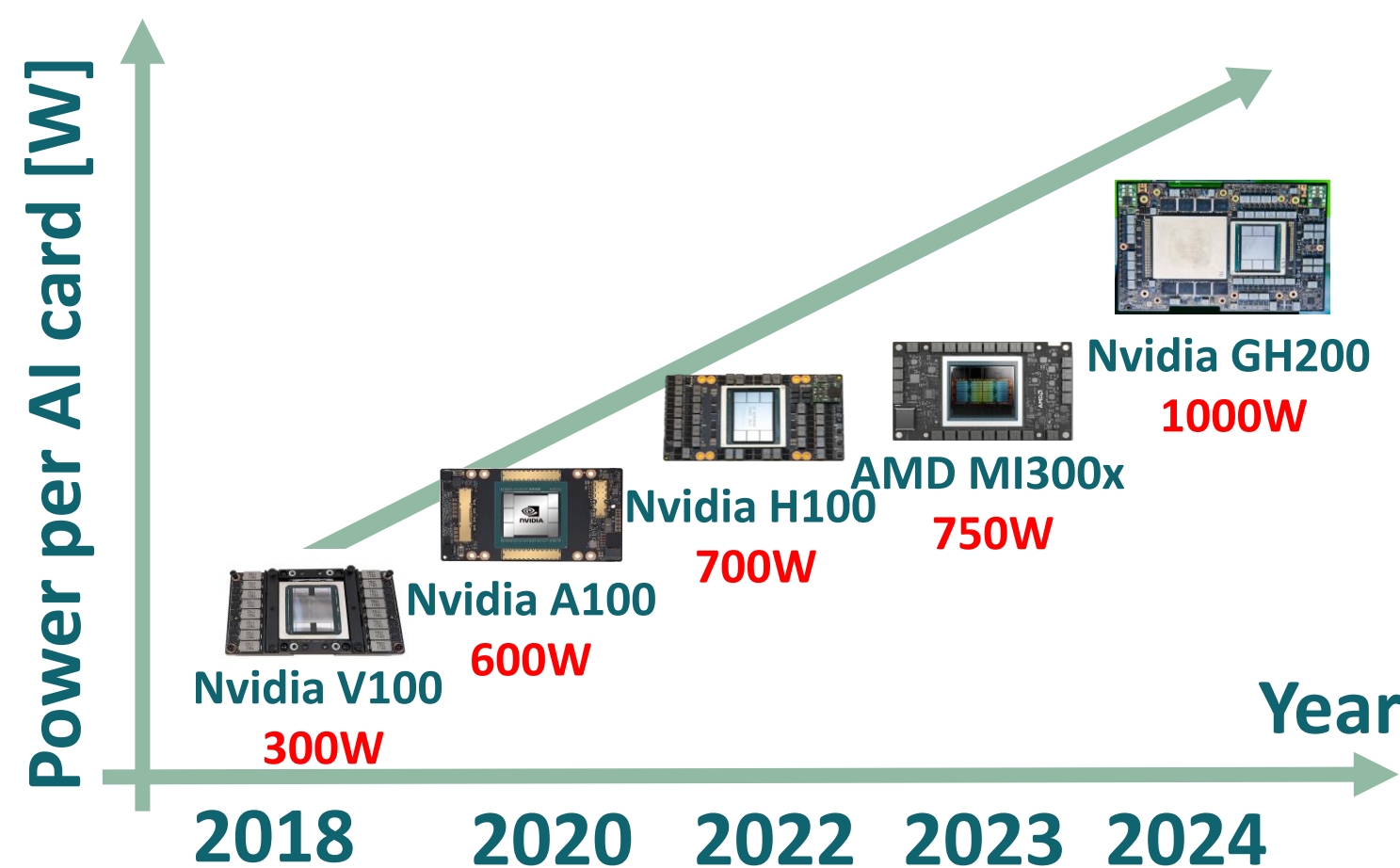


The 4: 1 Switched Auto-transformer Converter for 48V Onboard Power Solutions

Authors: Xufu Ren*, Jinfeng Zhang, Borong Hu, Steve Sandler, Teng Long

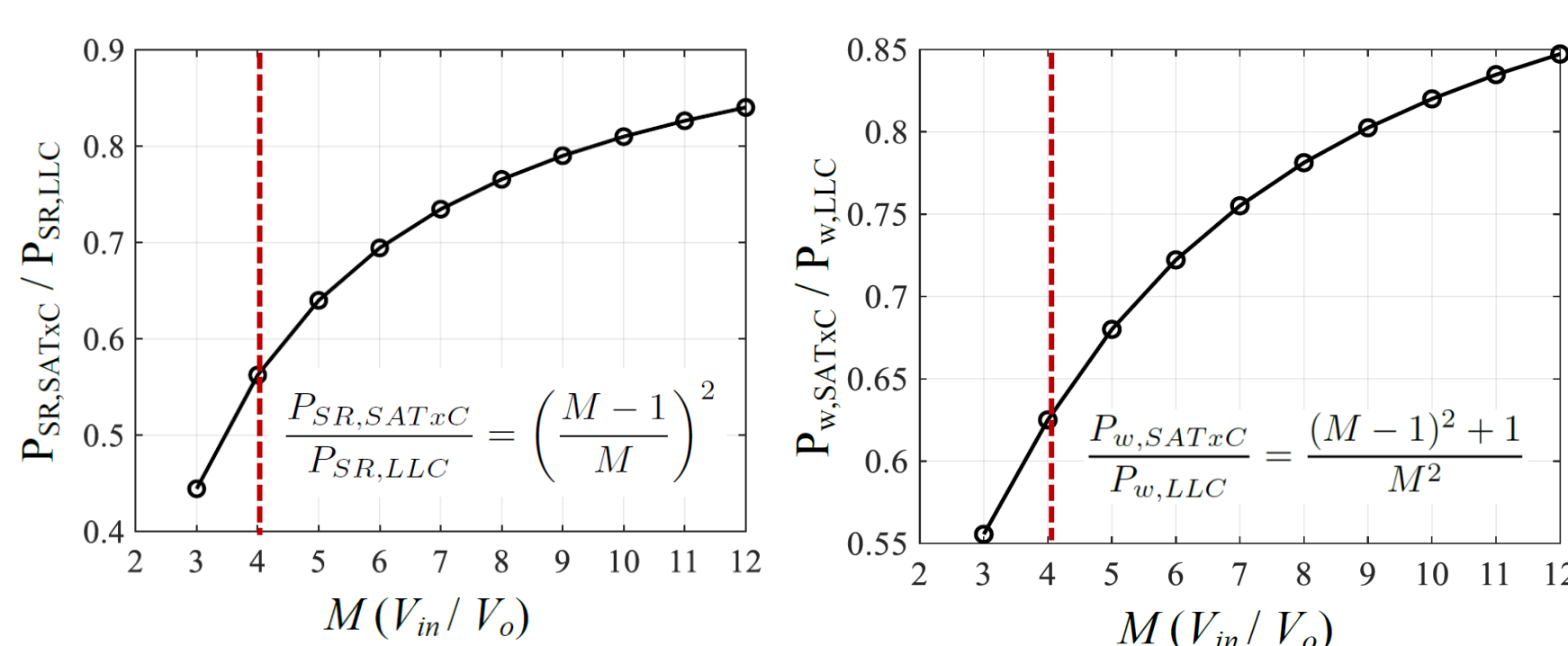
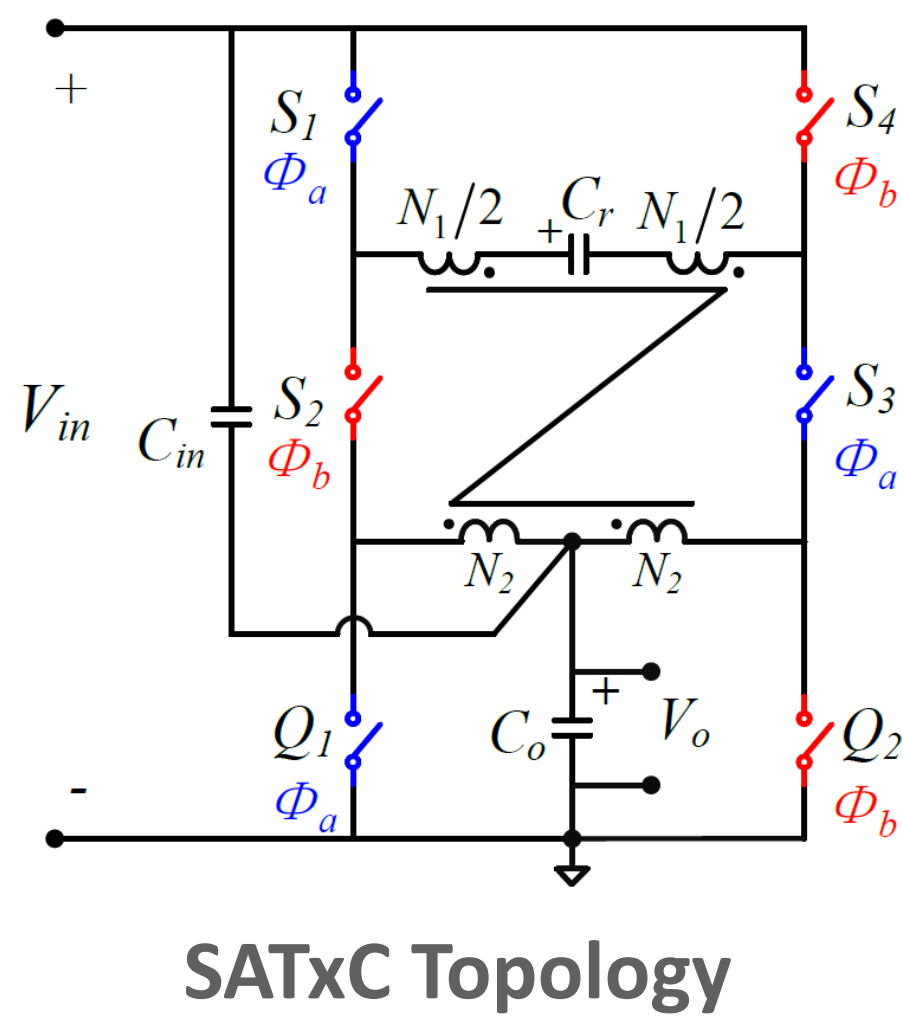
1 Background: AI Influence on Energy



- AI LLM training costs huge amount of electricity
- The GPU power consumption has a rapid increasing in recent years

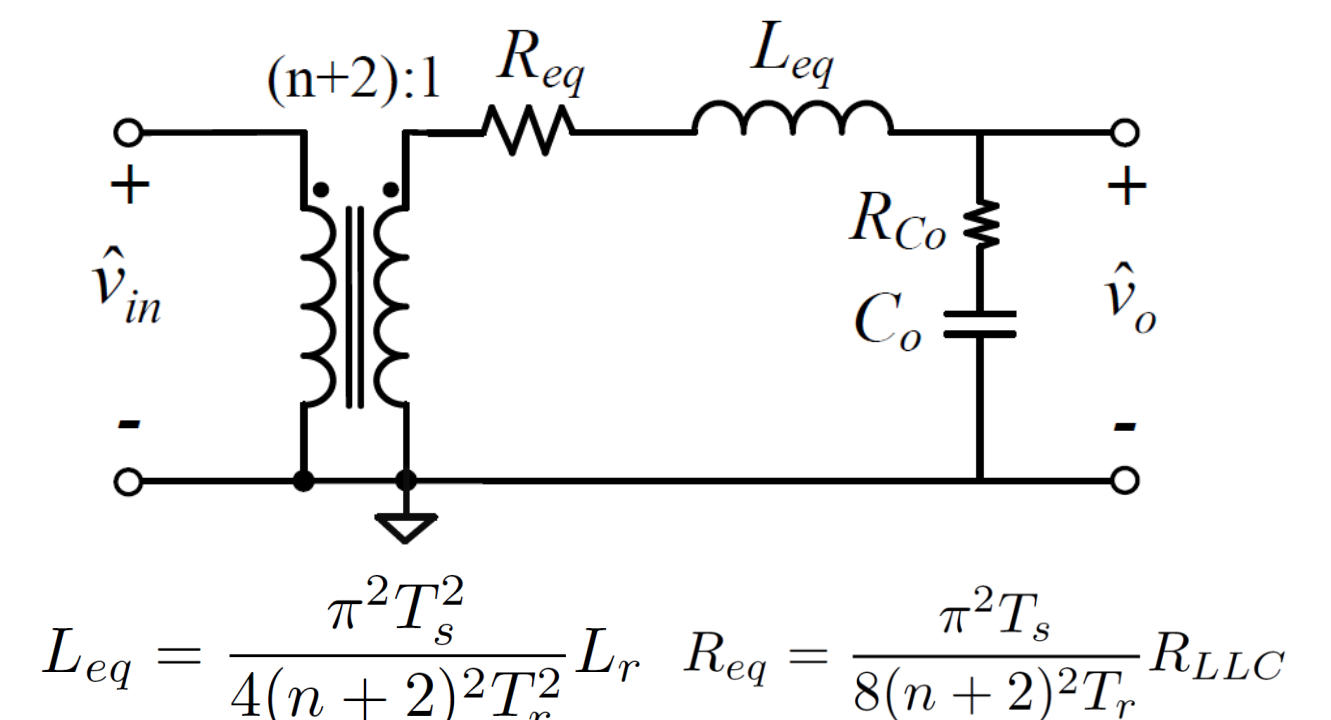
- Strict spatial constraints on onboard power supply → highly efficient and compact design

2 Topology: Switched Auto-transformer Converter (SATxC)

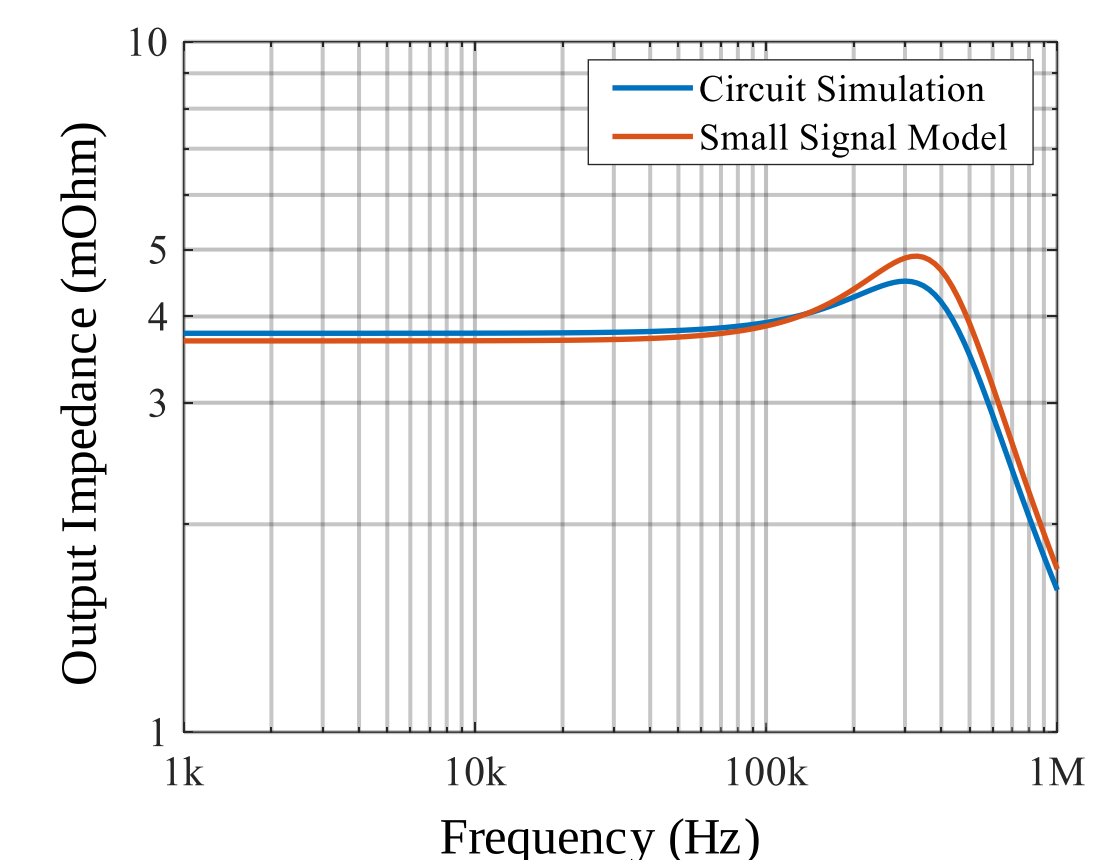
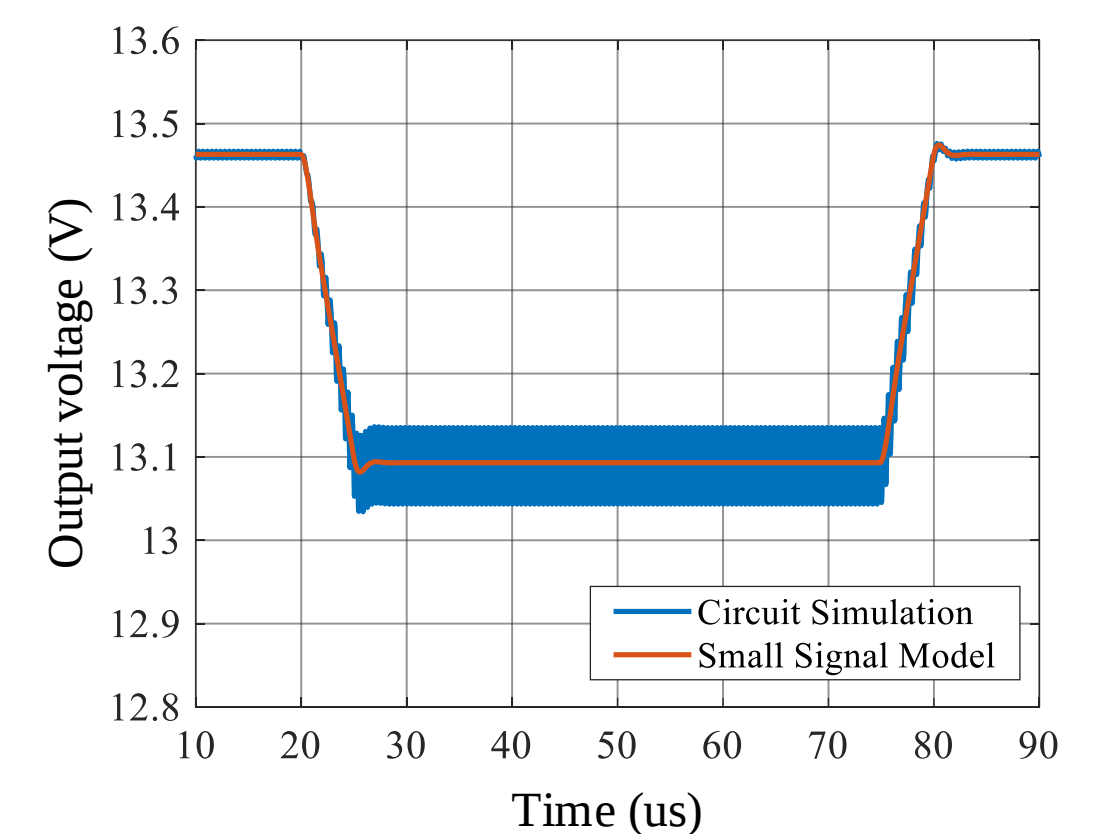


- Reduced transformer turn-ratio ($N_1/N_2 = 2$)
- 44% loss reduction on SR conduction loss
- 37% loss reduction on secondary winding loss

3 Impedance Modelling

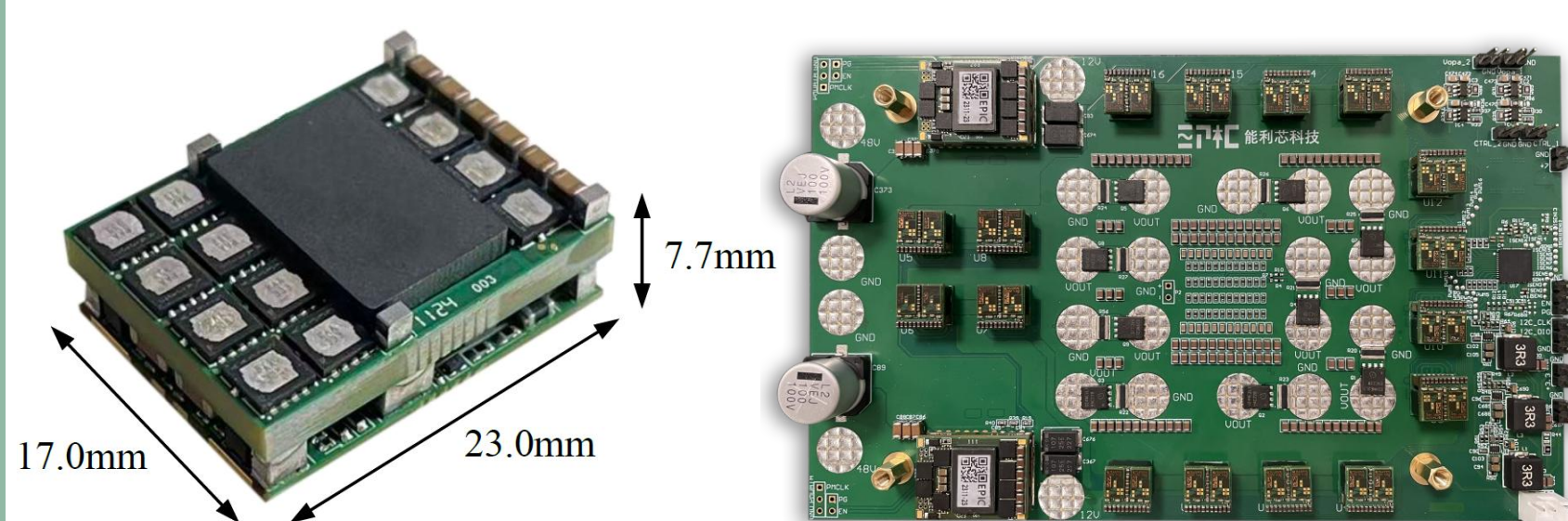


$$L_{eq} = \frac{\pi^2 T_s^2}{4(n+2)^2 T_r^2} L_r \quad R_{eq} = \frac{\pi^2 T_s}{8(n+2)^2 T_r} R_{LLC}$$



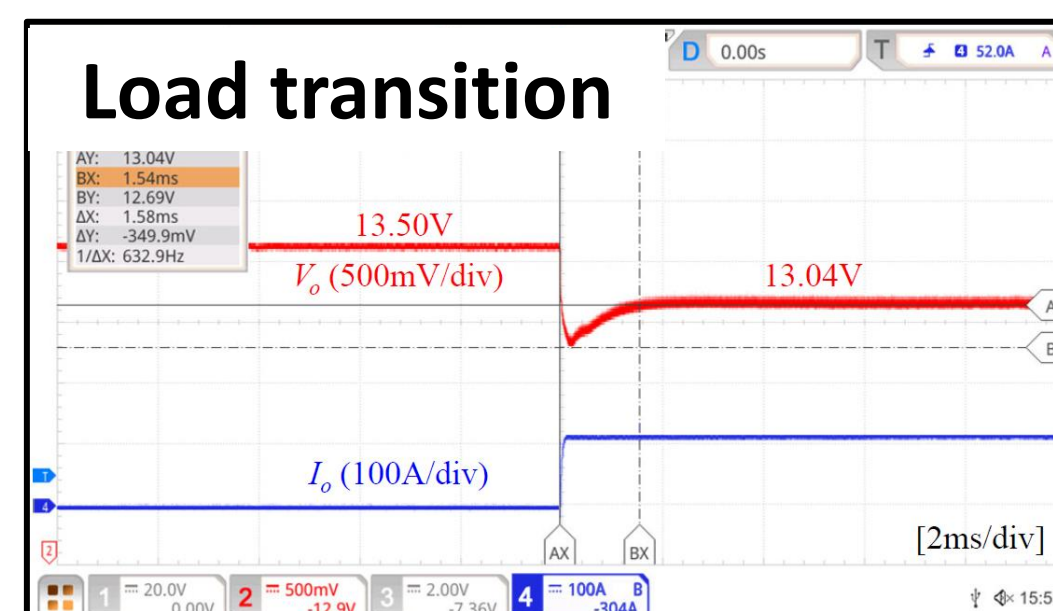
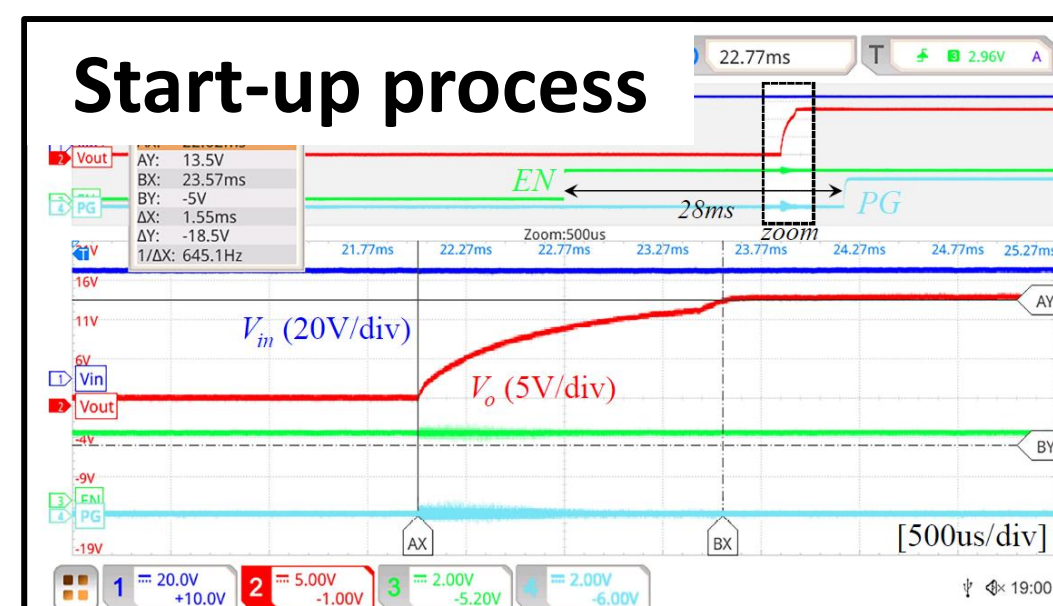
Inherent droop resistance for current balancing under parallel operation

4 Experimental Results



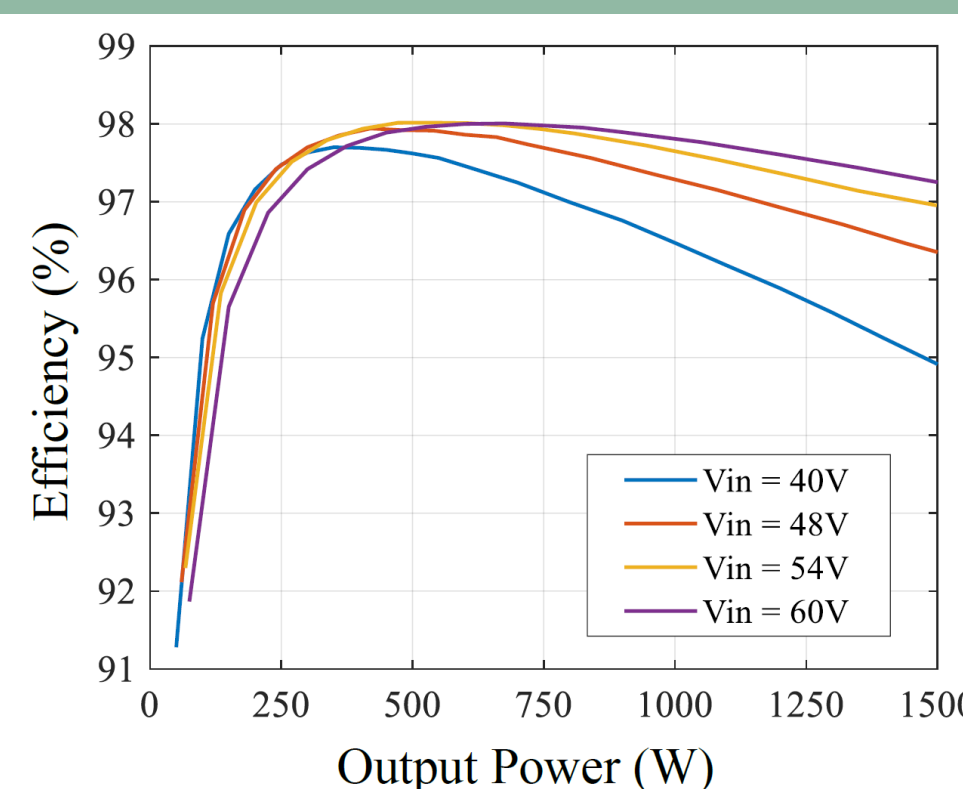
1.5kW Prototype and 2000A EVB

- The 1.5kW 4:1 bus converter has been fully tested under industry standard.
- 2000A IBA system with 2x 1.5kW IBCs, 16x multiphase VRs, and ultra-fast load steppers (>100A/ns) to emulate GPU load.



5 Efficiency and Comparison with SOTA

SOTA	Power	Peak Effi.	Full-load Effi.	Volume
This work	1.5kW	98.0%	97.0%	23/17/7.7mm
V	1kW	97.9%	97.0%	23/17/5.2mm
D	1kW	97.9%	97.1%	23/17/7.7mm
F	1kW	97.2%	96.4%	23/17/7.6mm
M	800W	98.1%	96.5%	24/18/8.6mm



6 Conclusion

Propose a 1.5kW 4: 1 fixed-ratio bus converter, which reaches the highest output power, efficiency, and power density (8.1kW/in³) among the SOTA commercial solutions.