Point-of-Load Pulse Emulator for High-Performance Testing

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Research Question

How can we emulate the load of a 4kW pulsed power converter for accurate testing?

Methods

Explored switched-resistor and switched-inductor solutions.

Computed maximum allowable parasitics to achieve desired performance under worst-case conditions (slew 222A in 5ns).

Ran LTspice simulations to analyze dynamic responses with real switch implementations.

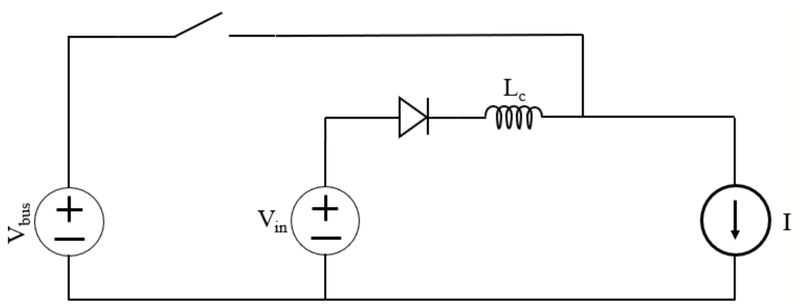

Fig. 1: model for an inductive-input converter switched to emulate a pulse at the bus with a commutating inductance.

Results

We can compute the maximum allowable commutating inductance for the topology in Fig. 1 to be:

$$L_{c-max} = \frac{V_{bus} - V_{in}}{I} t_{rise} \text{ [H]}$$

Under worst-case conditions:

$$L_{c-max} = 67.5\text{pH}$$

LTspice simulations of the switched-resistor network in Fig. 2 showed ability to match desired slew rates with ideal switches.

LTspice simulations of the switched-resistor array with a 10Ω Ohmite TKH45 resistor (ESL of 14.5nH) and a EPC2035 GaNFET show ringing on the turn-off portion of the pulse.

This ringing comes from the interaction of the resistor's ESL and the switch's output capacitance.

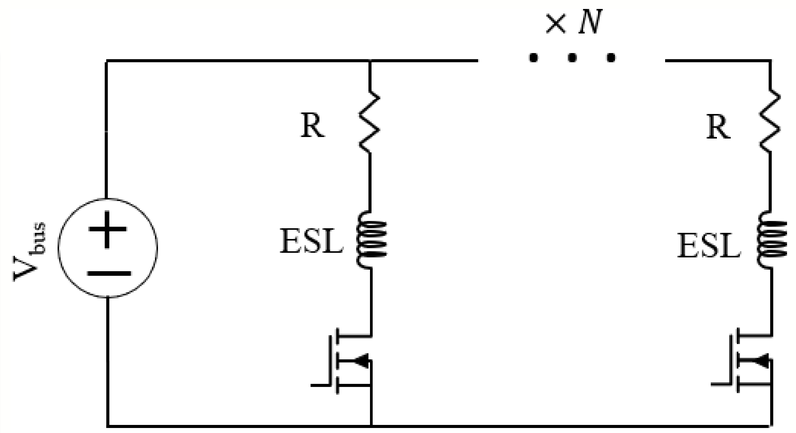

Fig. 2: switched-resistor array with parasitic ESL

Conclusion

The switched-inductor solution faces too many challenges in terms of parastics to be viable. The switched-resistor solution is promising, but choosing the right components and physical layout will be key to optimizing performance.

Future Work

Choose components, lay out the switched-resistor array in Altium, and test a physical implementation on the bench.

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