

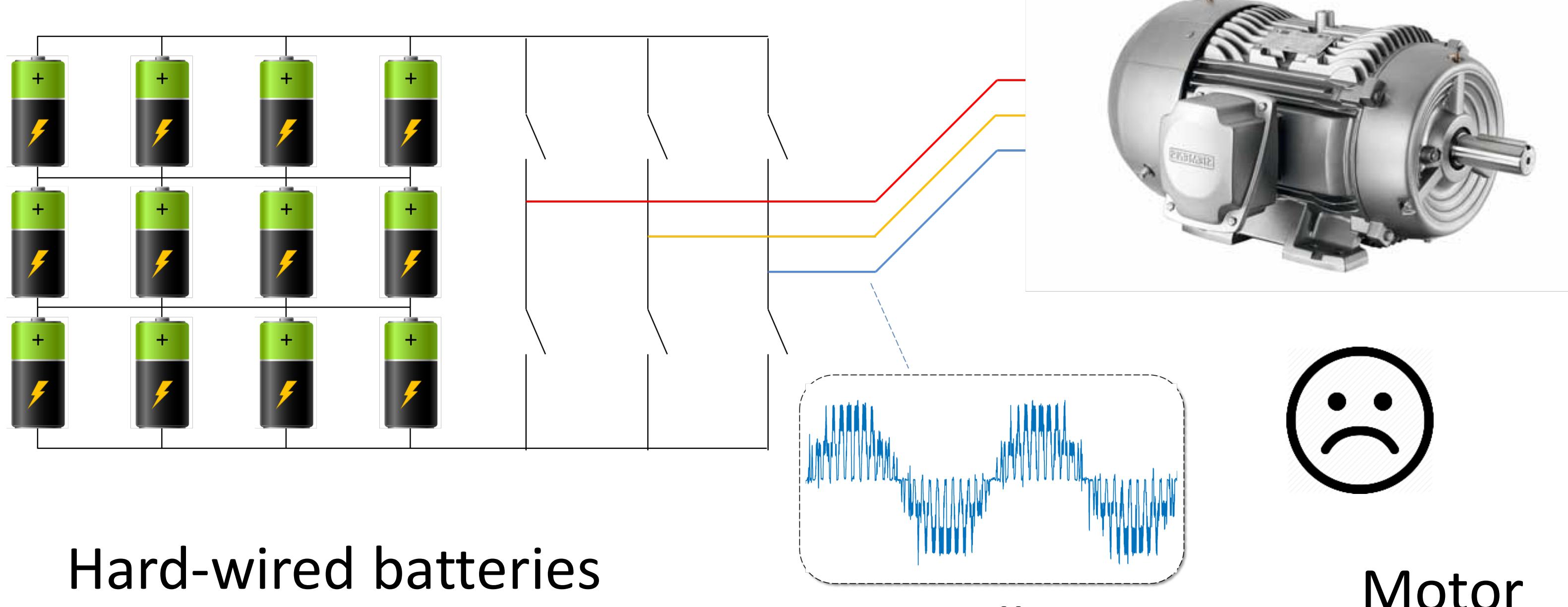


Automotive Application of an Advanced Power Conversion for Brushless Motor Control

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State of Art Electrical Vehicle and Problems



Hard-wired batteries

- Bad fault-tolerance
- Needs complex battery management circuit

- Output distortion
- Large EMI
- Large torque ripple
- Large noise
- Large insulation stress

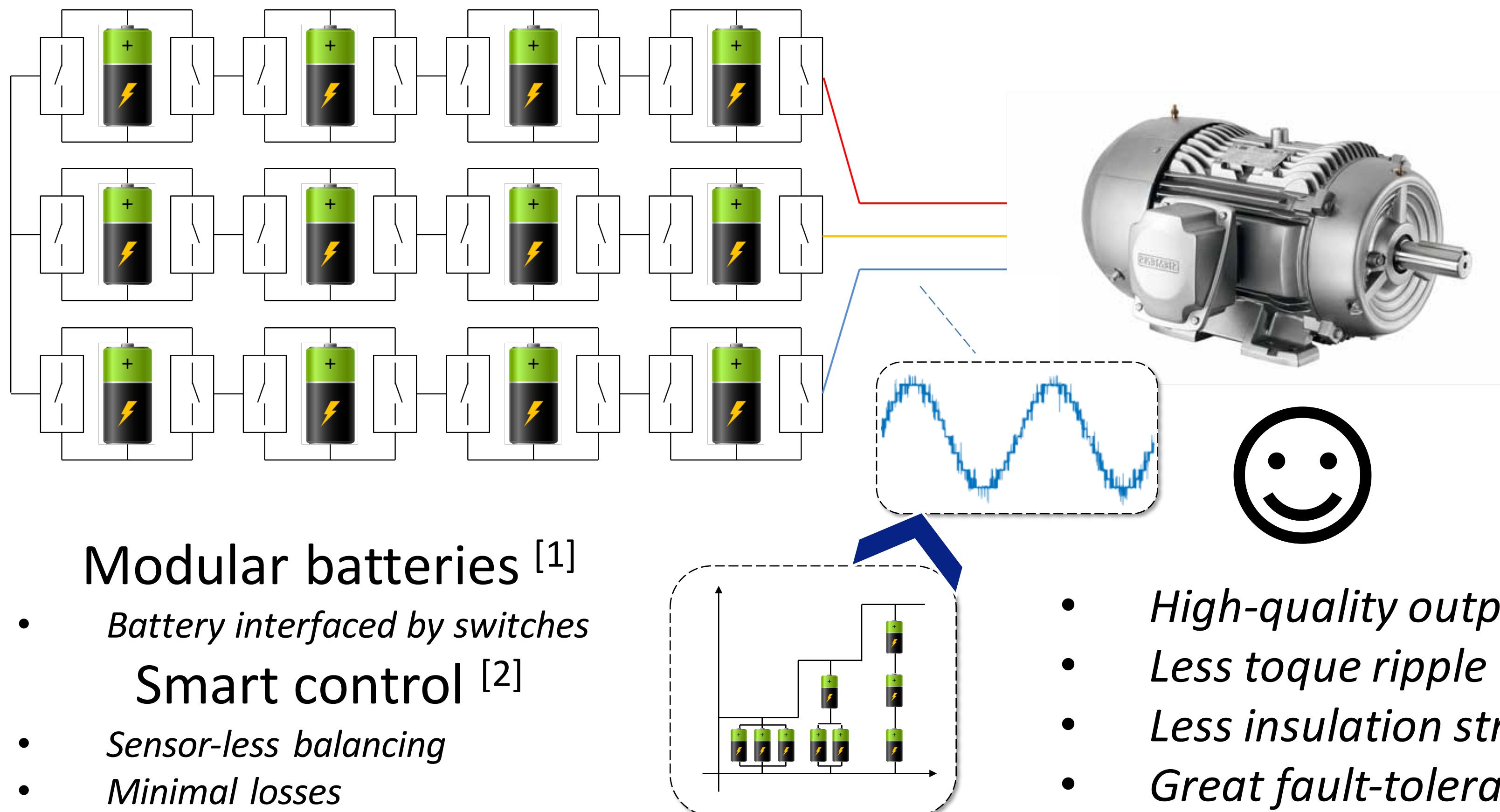


Motor

- Large torque ripple
- Large noise
- Large insulation stress

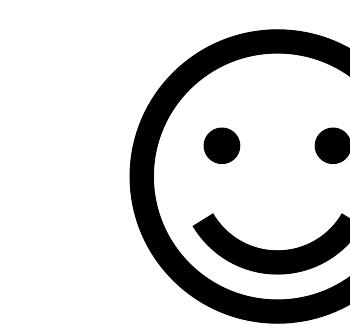


Our Solution : Intelligent Battery Modules



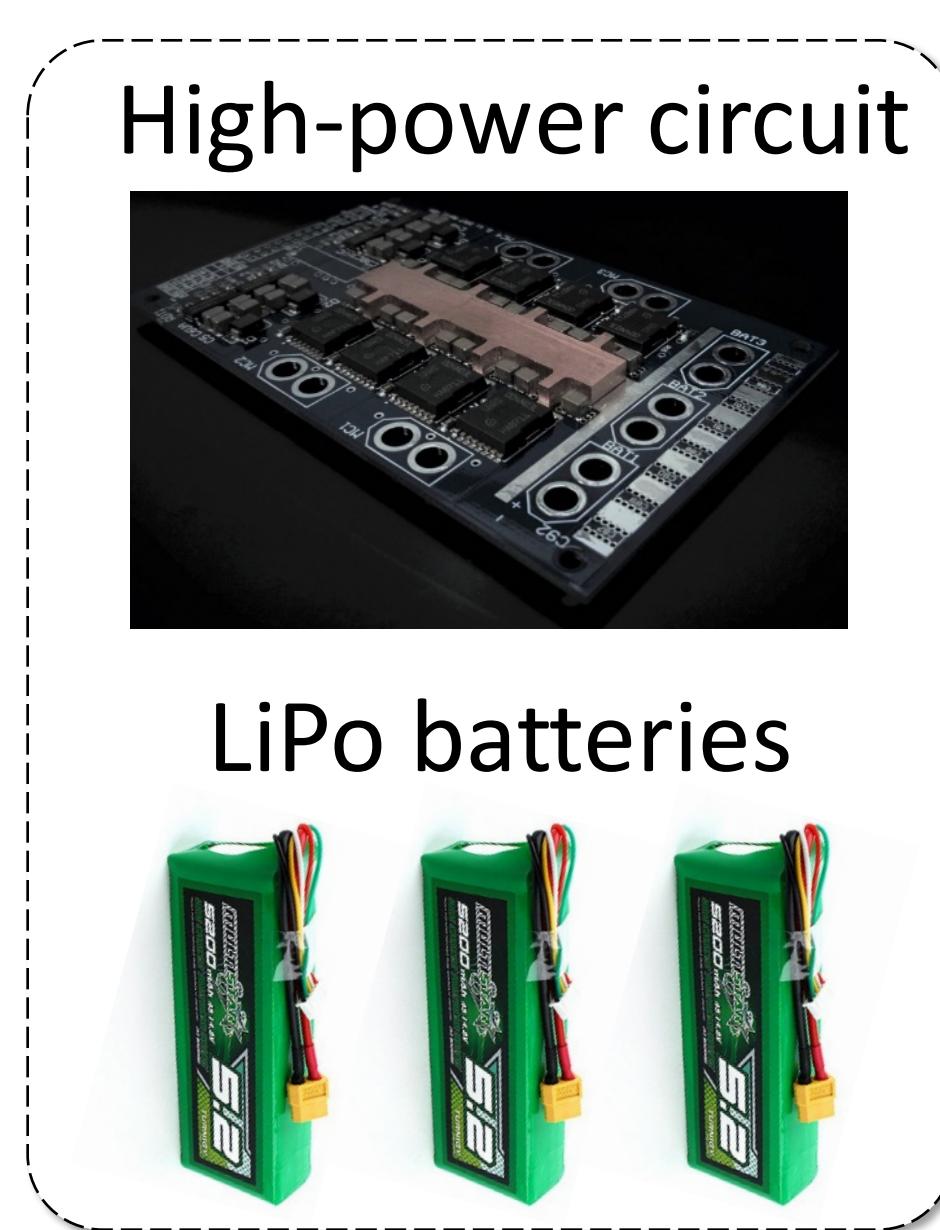
Modular batteries [1]

- Battery interfaced by switches
- Smart control [2]
- Sensor-less balancing
- Minimal losses

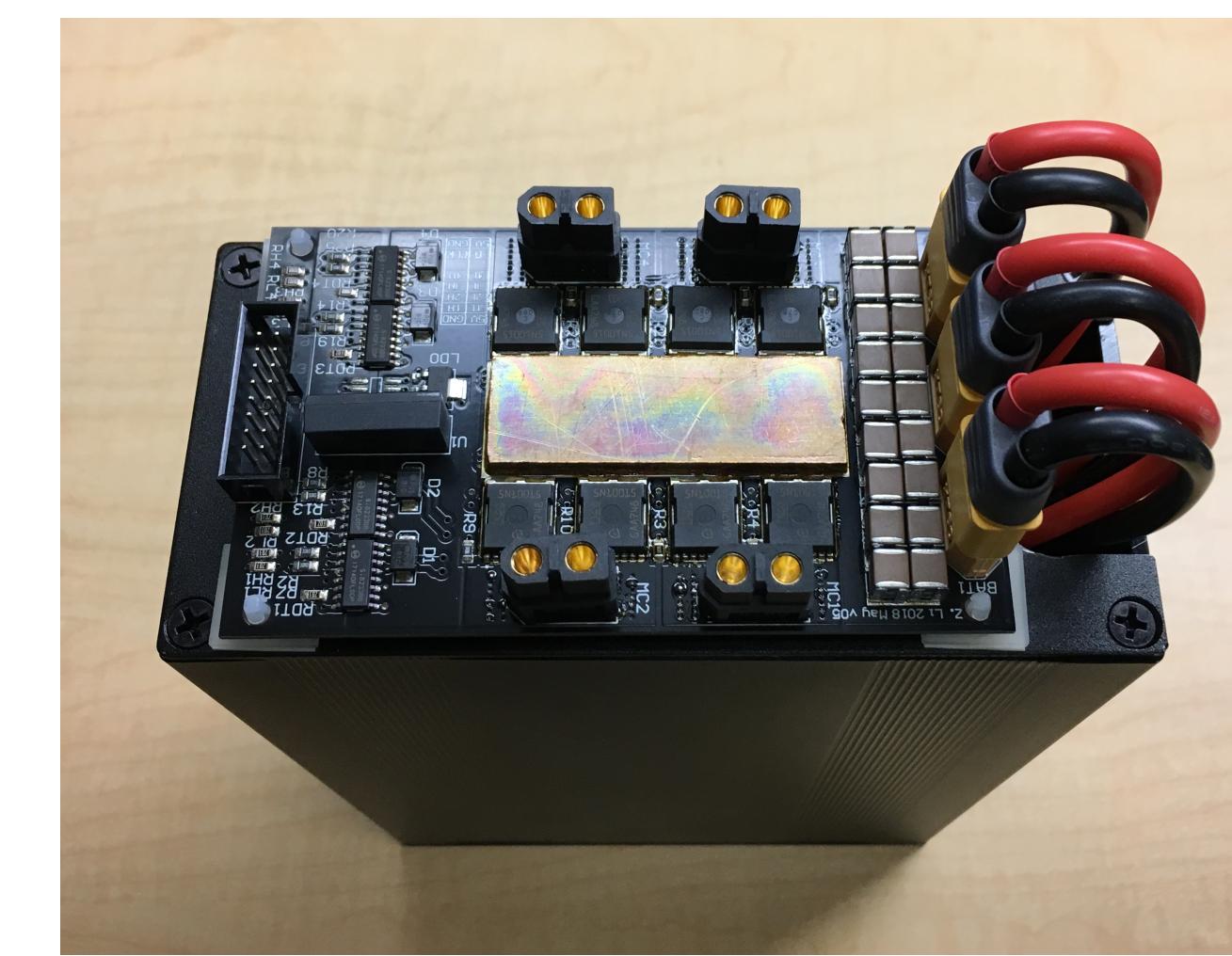


- High-quality output
- Less torque ripple
- Less insulation stress
- Great fault-tolerance

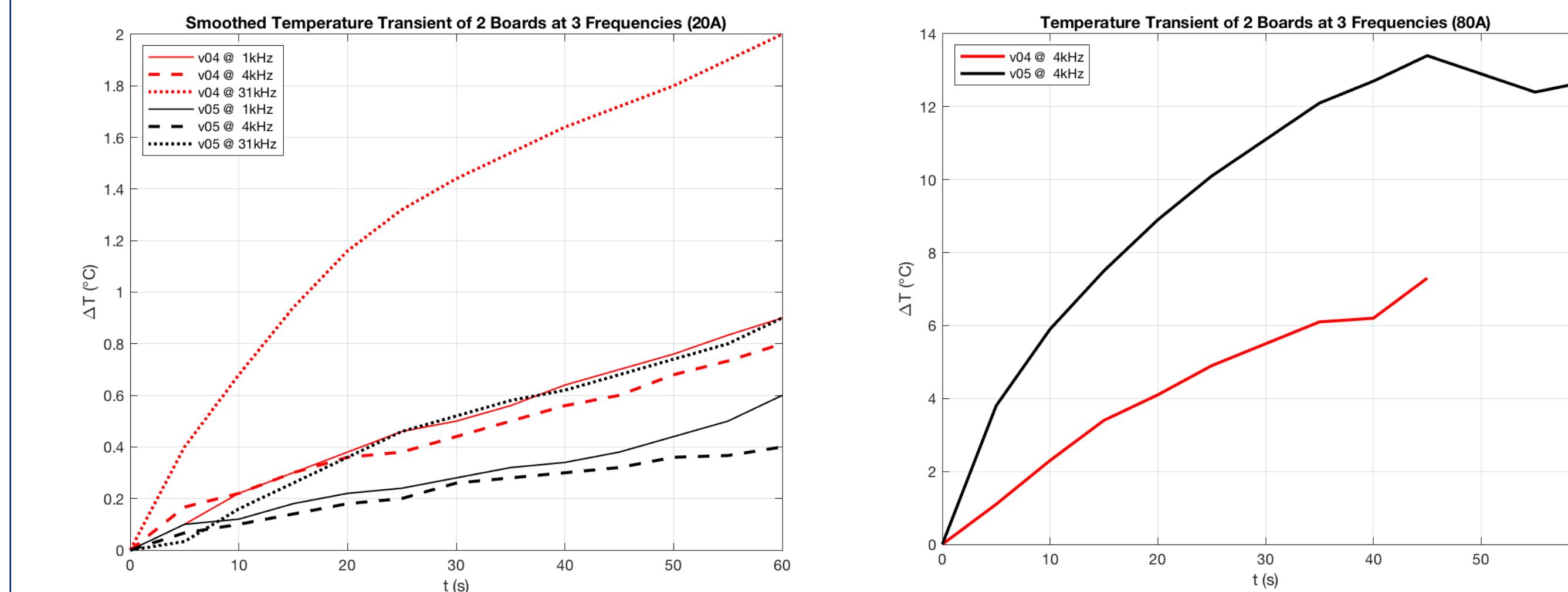
Module Design



Intelligent battery module



Electrical & Thermal Testing



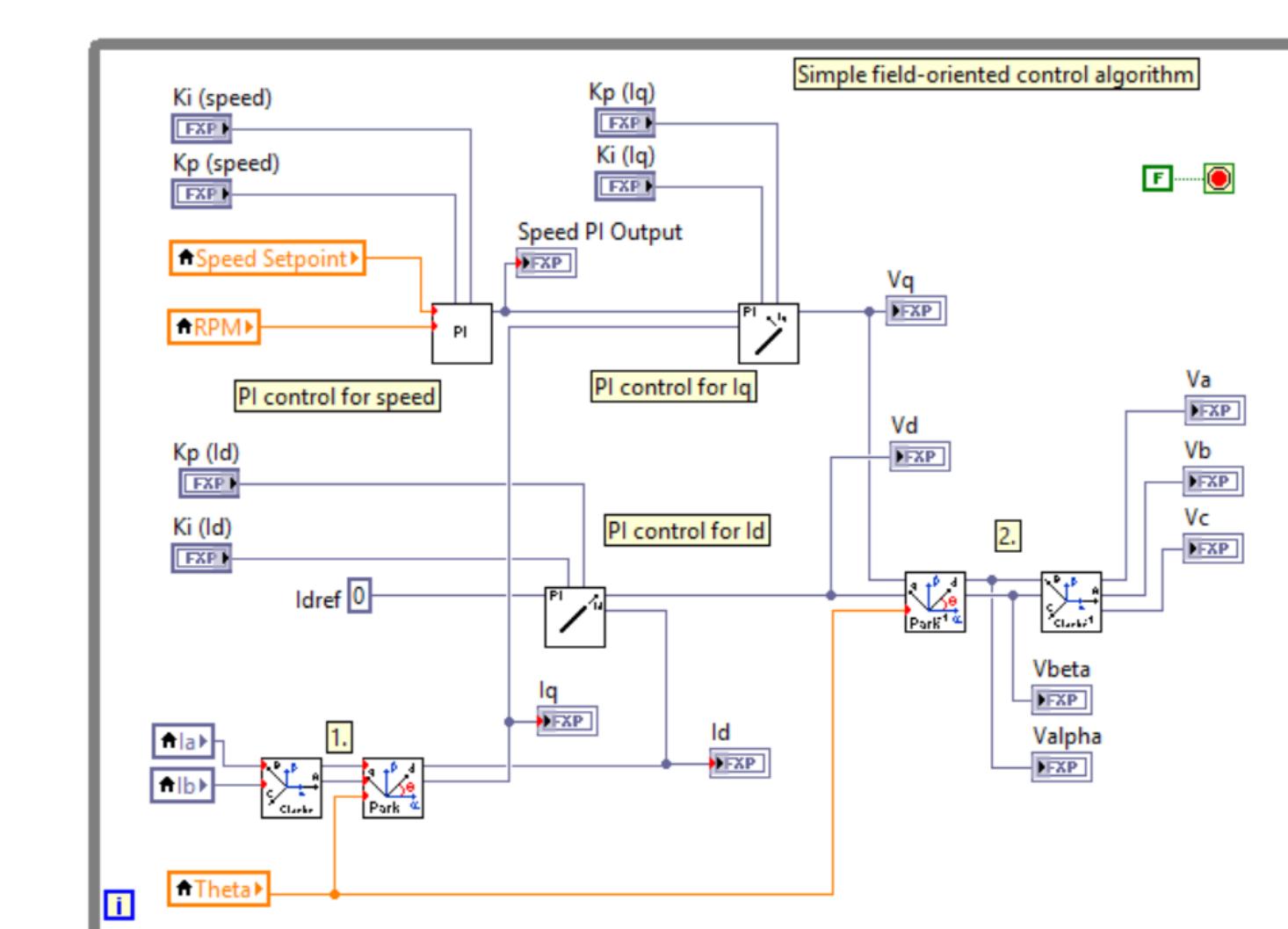
MOSFET selection:

- Frequency and dead-time: ~4kHz optimal
- Losses dominated by R_{DS}
- Thermal capacity of copper sufficiently large

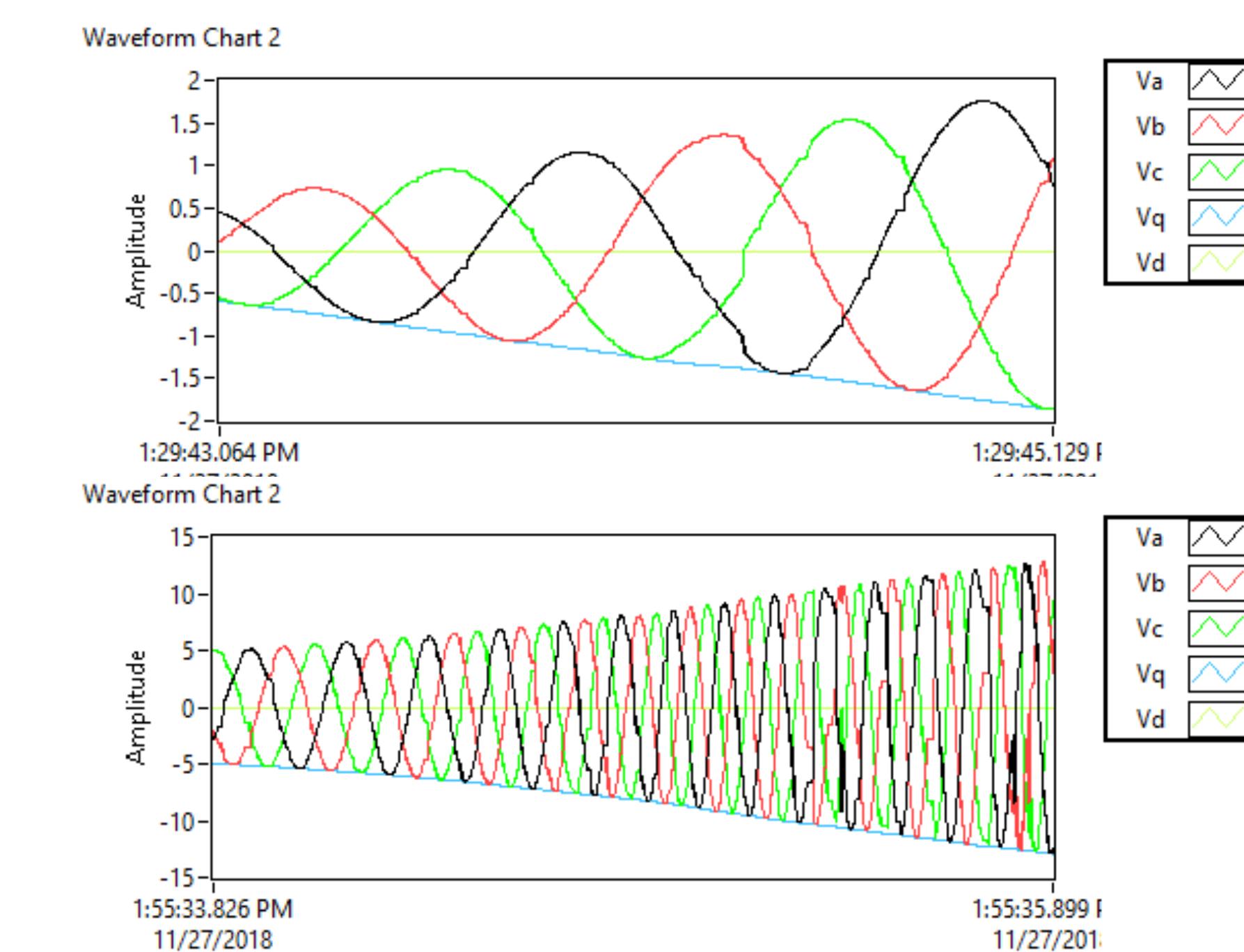
Thermal Pad Comparison

Thickness (mm)	k (W/mK)	ΔT (°C)	Cost / board	Digikey PN
0.127	1.8	0.24	\$4.28	1168-1384-ND
0.5	1.5	1.11	\$4.70	BER161-ND
1	1.0	3.33	\$2.67	3M156051-ND
2	1.5	4.44	\$8.05	BER164-ND

Motor Control

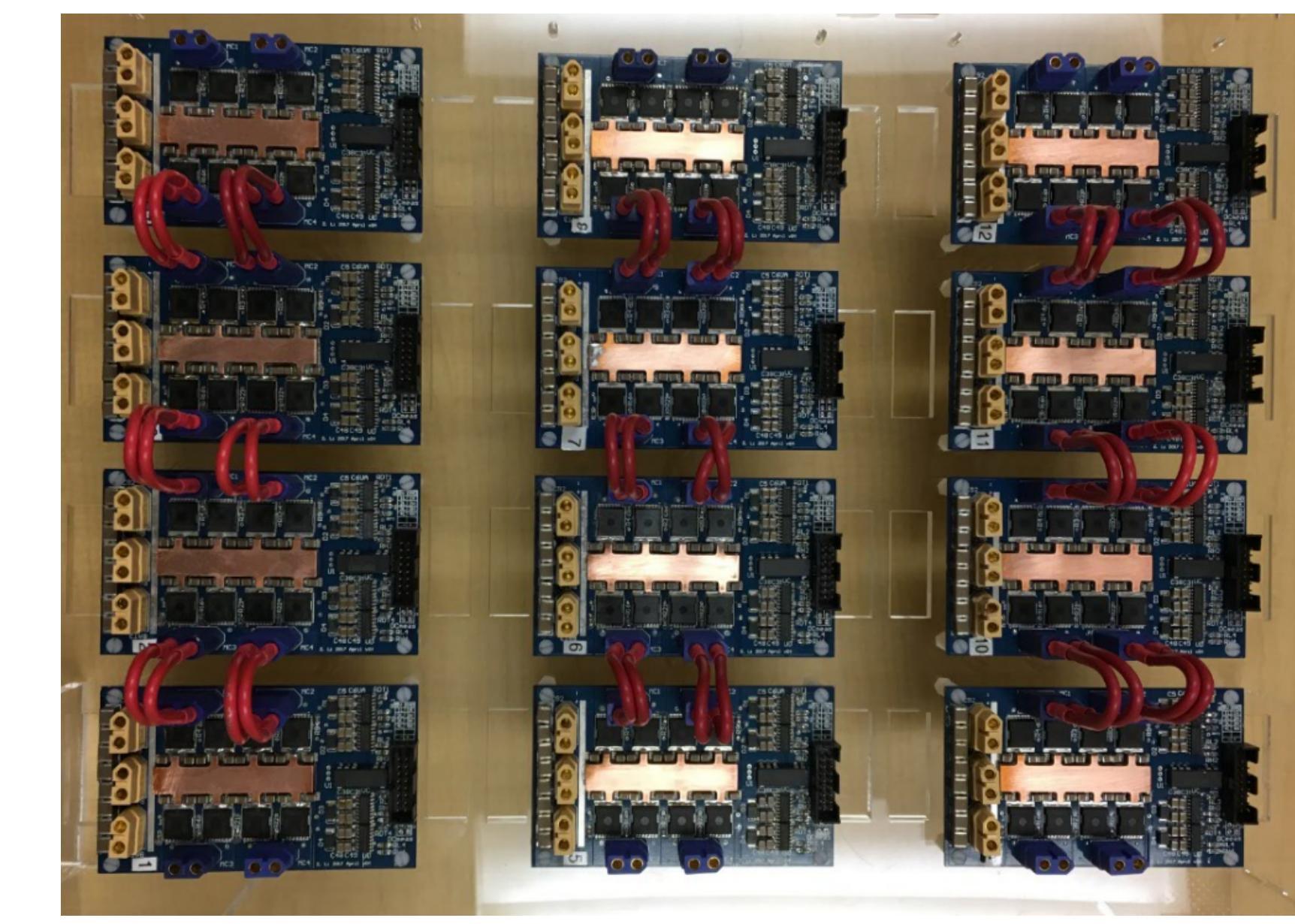


Field-Oriented Control takes full advantage of precise current control ability



Stable operation for setpoint and sensed speed changes

Future Work : Assembly



References

- [1] Goetz, Stefan M., et al. "Control of Modular Multilevel Converter With Parallel Connectivity—Application to Battery Systems." *IEEE Transactions on Power Electronics* 32.11 (2017): 8381-8392.
- [2] Z. Li, A. V. Peterchev, R. Lizana, and S. M. Goetz, "Distributed Balancing Control for Modular Multilevel Series/Parallel Converter with Capability of Sensor-less Operation," in *Energy Conversion Congress and Exposition (ECCE), 2017 IEEE*, 2017.