Optimize your vehicle power distribution network by integrating the DC-DC converter into the battery pack

YK Choi, Sr. FAE Automotive Vicor

Agenda

- The difficulties of battery electric vehicle (BEV) systems
- Dealing with charging incompatibility between 400V and 800V
- Integration of charger and 48V power delivery network (PDN) into the battery pack
- How to reduce heat, cost and weight
- Benefits of high-density power modules in 48V zonal PDN

The challenges of battery electric vehicle systems

Achieving compatibility between the vehicle and the roadside charger

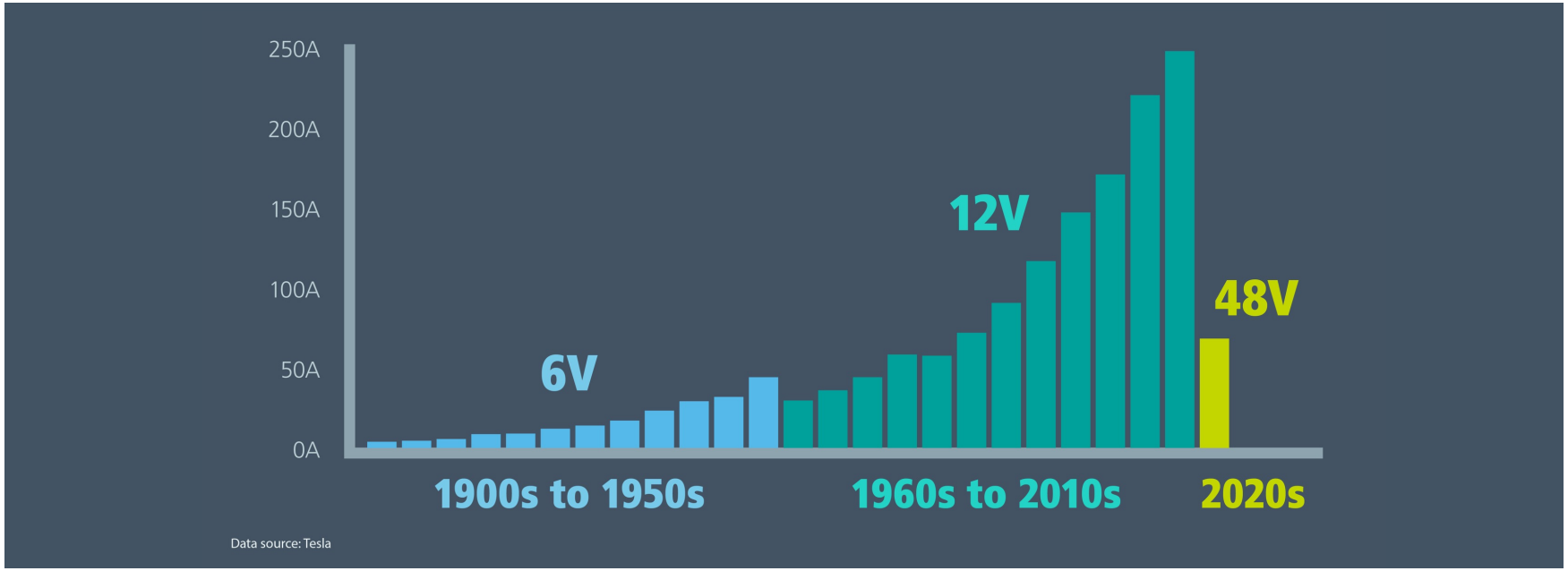
- Dealing with system complexity
- Minimizing weight
- Power dissipation

How to deal with increasing BEV loads while they evolve from 12V to 48V

- Motor loads
- Non-motor loads
- Functional safety loads

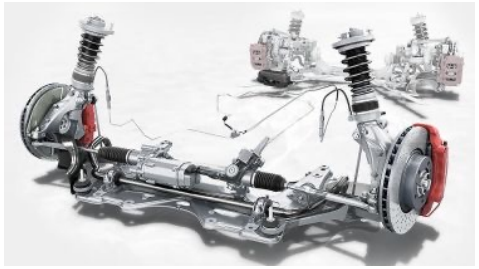
Historic snapshot of automotive power demand: 48V is here

- Current draw on low voltage has hit an all-time high

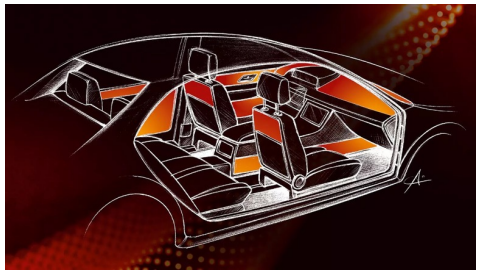


Loads that are moving to 48V

- Higher-power loads are moving to 48V
  - Motor loads
    - Active suspension, cooling fan, blow motor, sunroof motor, power trunk
  - Non-motor loads
    - ADAS computer, IR-warmer, heated windshield, audio amp, head lights, electric seats
  - Functional safety loads
    - Electric steering motor, intelligent electric braking, rear wheel steering



<Active suspension>

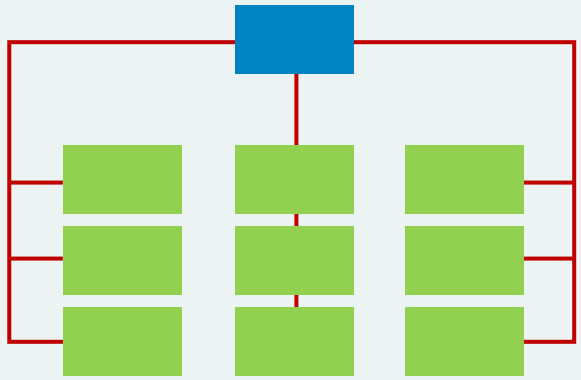


<IR Warmer>

Evolution from centralized to zonal, responding to increased loads

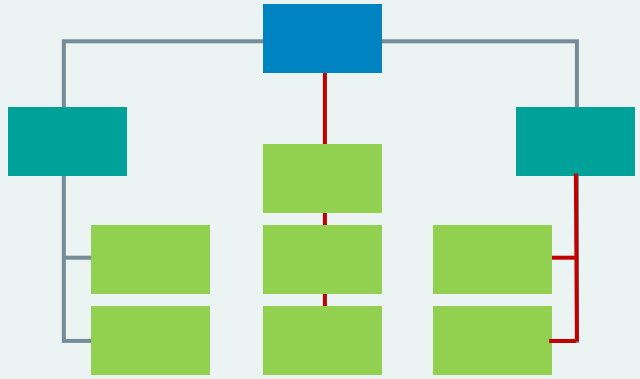
Past

Distributed E/E architecture



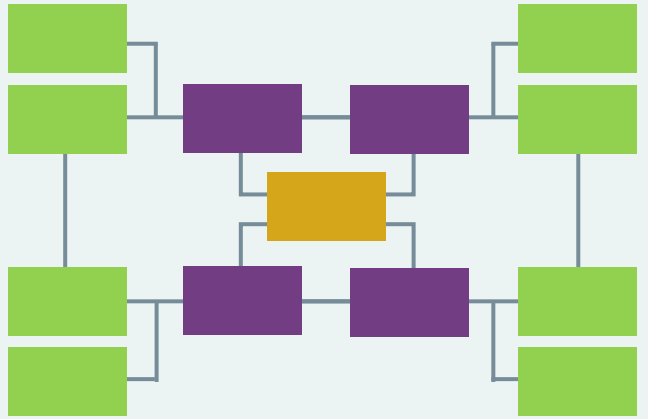
Present

Domain centralized E/E architecture



Future

Zonal E/E architecture with high-performance computing unit



Optional ECUs such as central gateway

Central high-performance computing unit

Function-specific automotive ECUs

Automotive ethernet connection

Domain-specific ECUs

CAN BUS connection

Zonal ECUs

Optimizing your 48V zonal deployment

Solution integration at battery system assembly

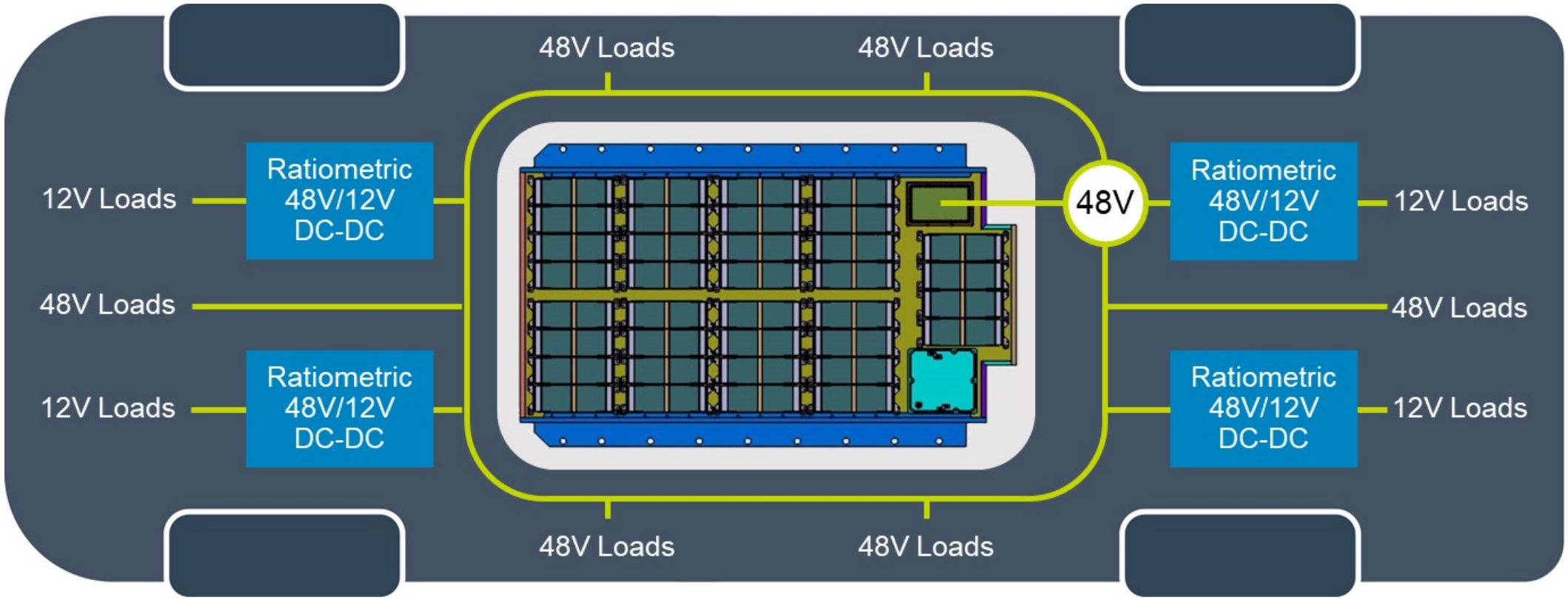
Charger

- Recent BEV: 800V base
- Charging infrastructure: 400V or 800V
- 800V BEV should be able to charge at a 400V station

48V zonal PDN

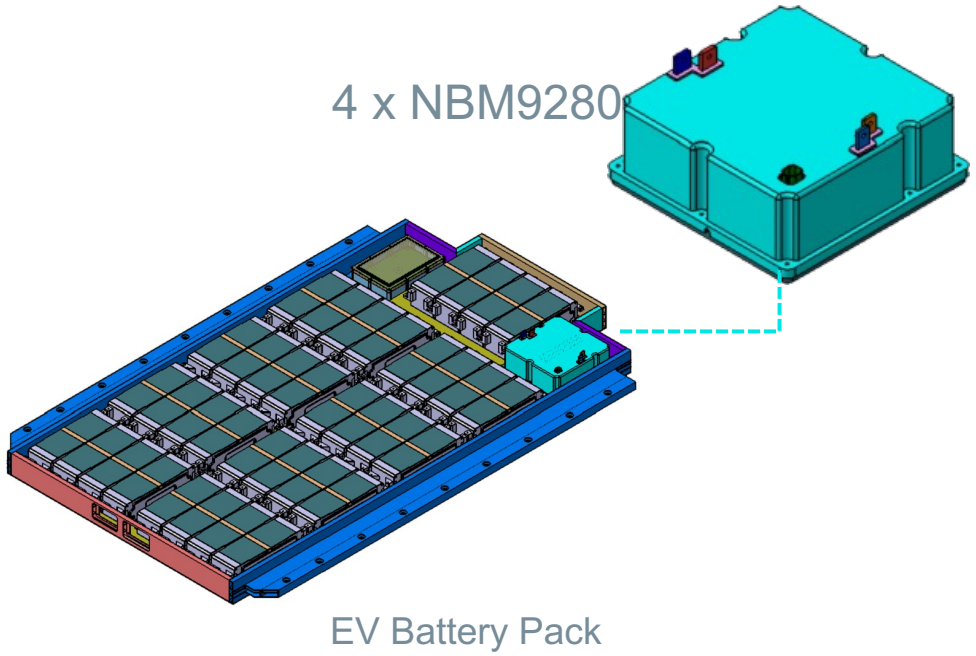
- Vehicle systems are more complex
- Future architecture
- 12V loads requires up to 250A (3kW)
- New vehicle system comes with 48V and zonal controller at PoL

Proposed 48V power delivery network

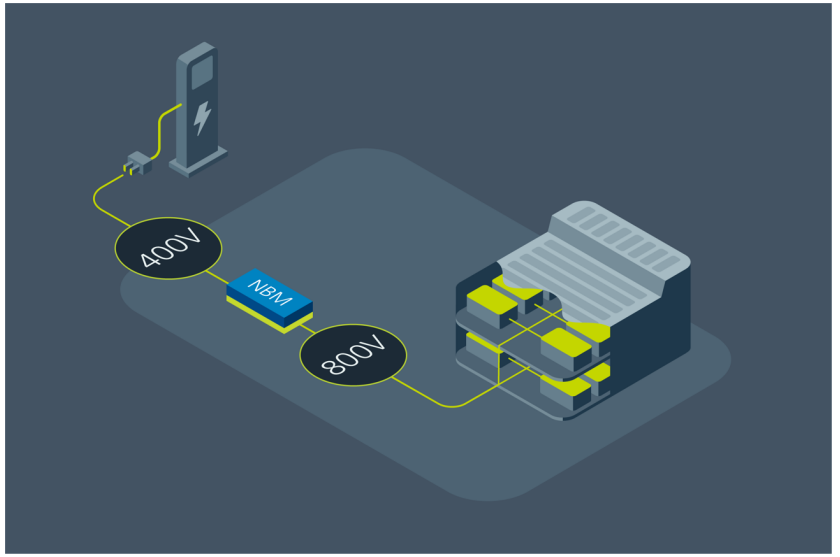


Charger solution – enabling 800V charging at a 400V station

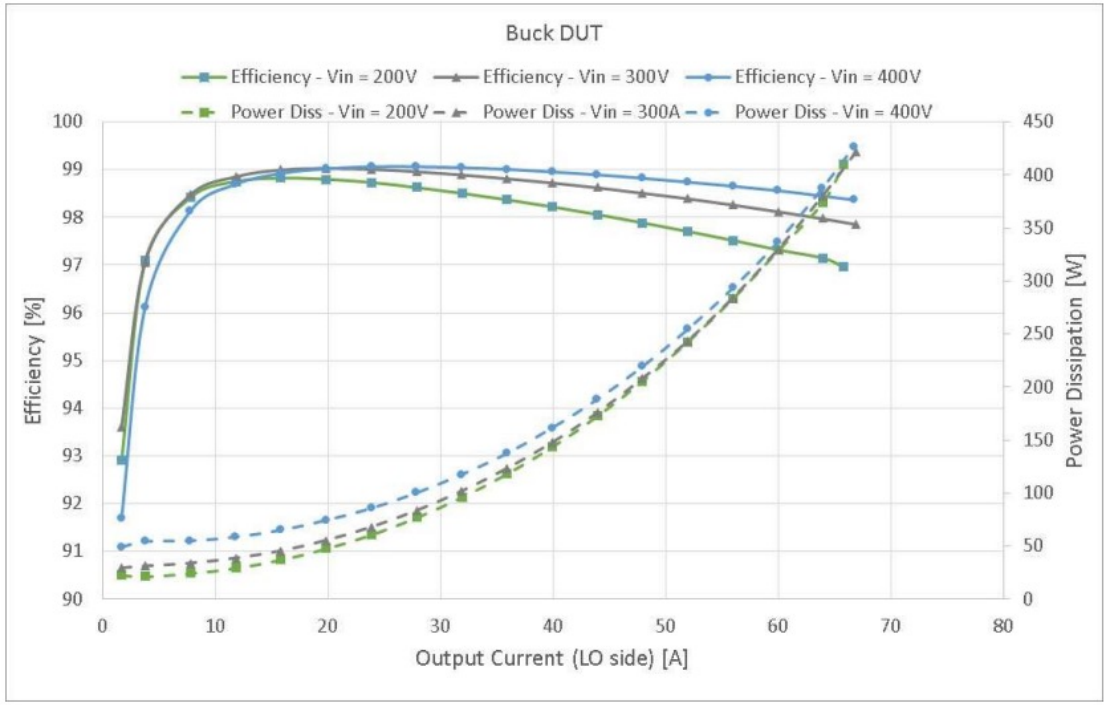
- Charger solution with Vicor NBM9280 x 4 parallel

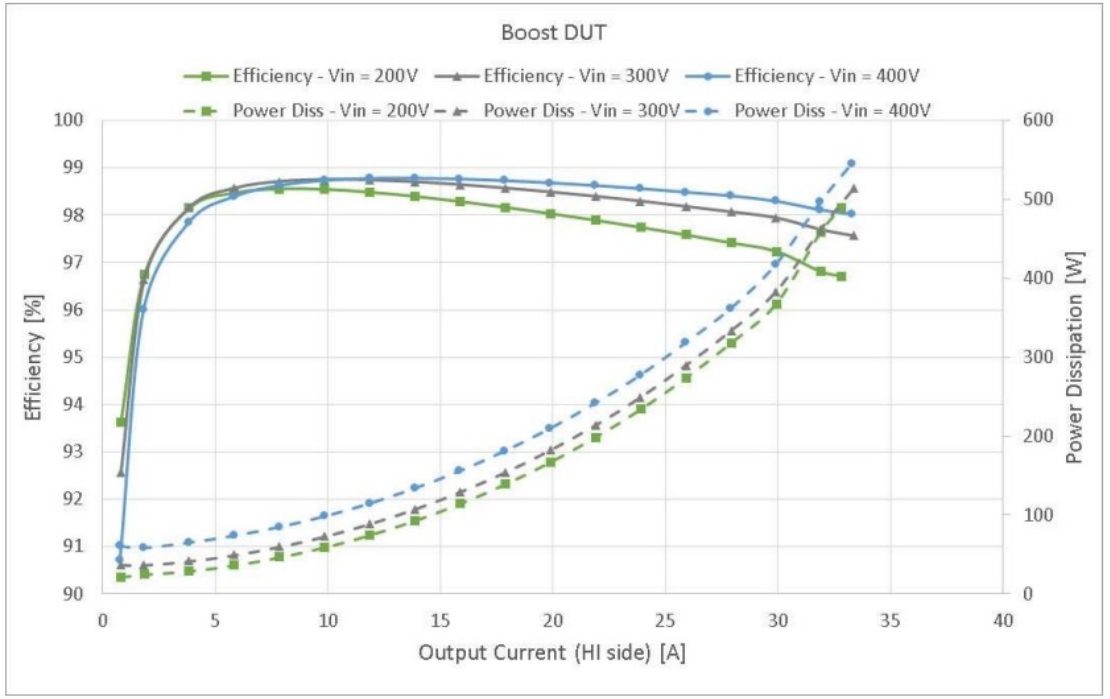


- Application example



NBM9280 delivers high efficiency

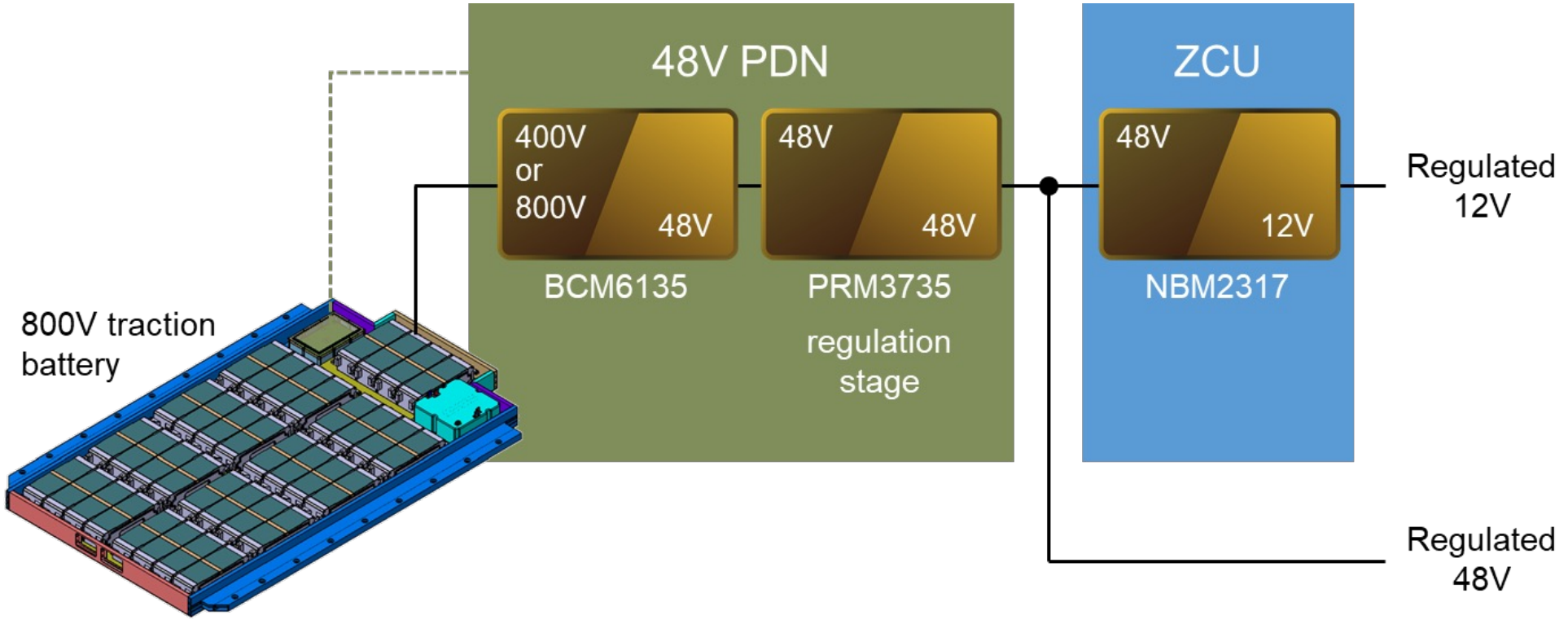




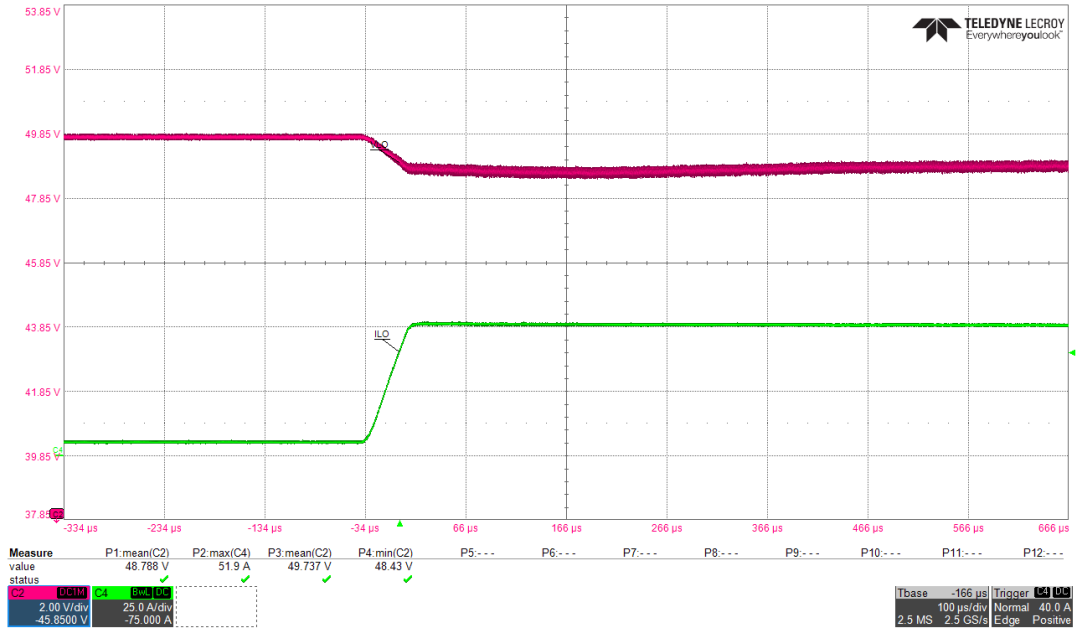
Coolant Temperature: 50°C

Source: Vicor

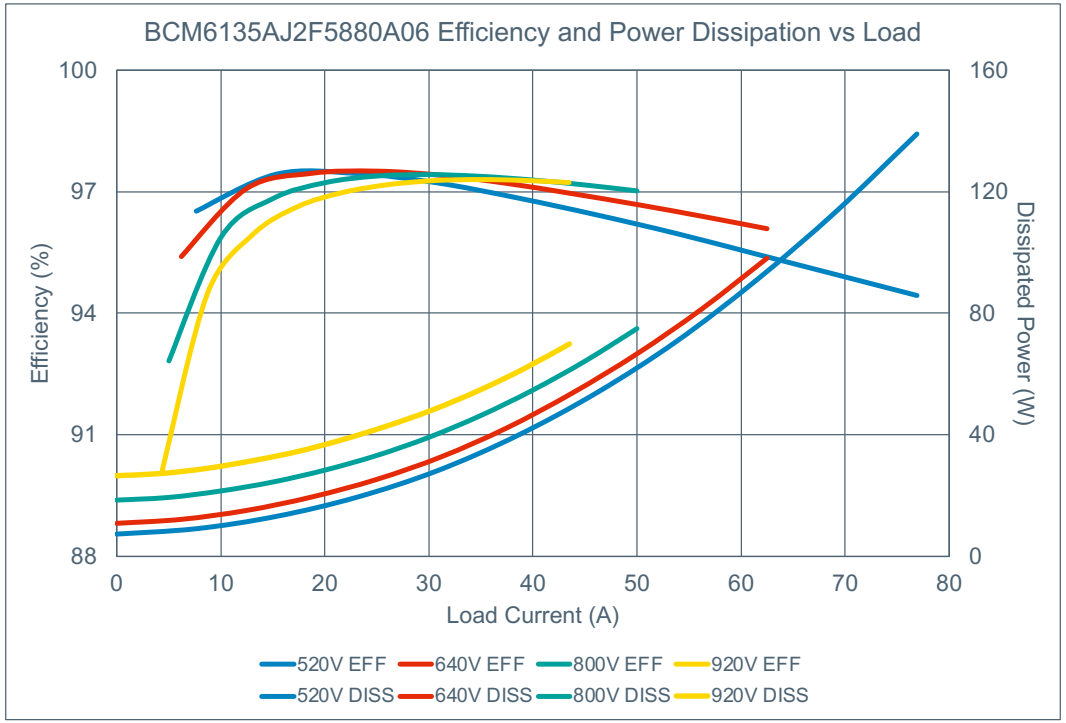
48V power delivery network solution



BCM6135 provides high transient response and efficiency



- 0µF capacitor applied to V_{LO}
- Chroma electronic load 1A/µs

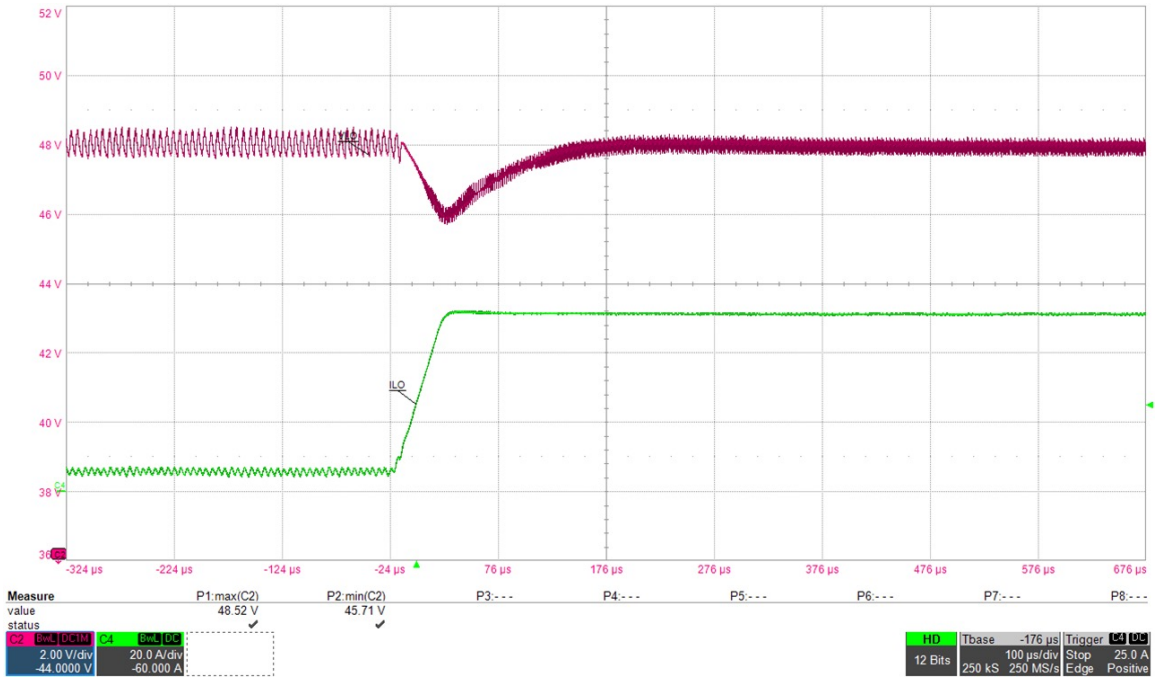


T_{CASE}: 25°C

PRM3735 provides regulated output voltage

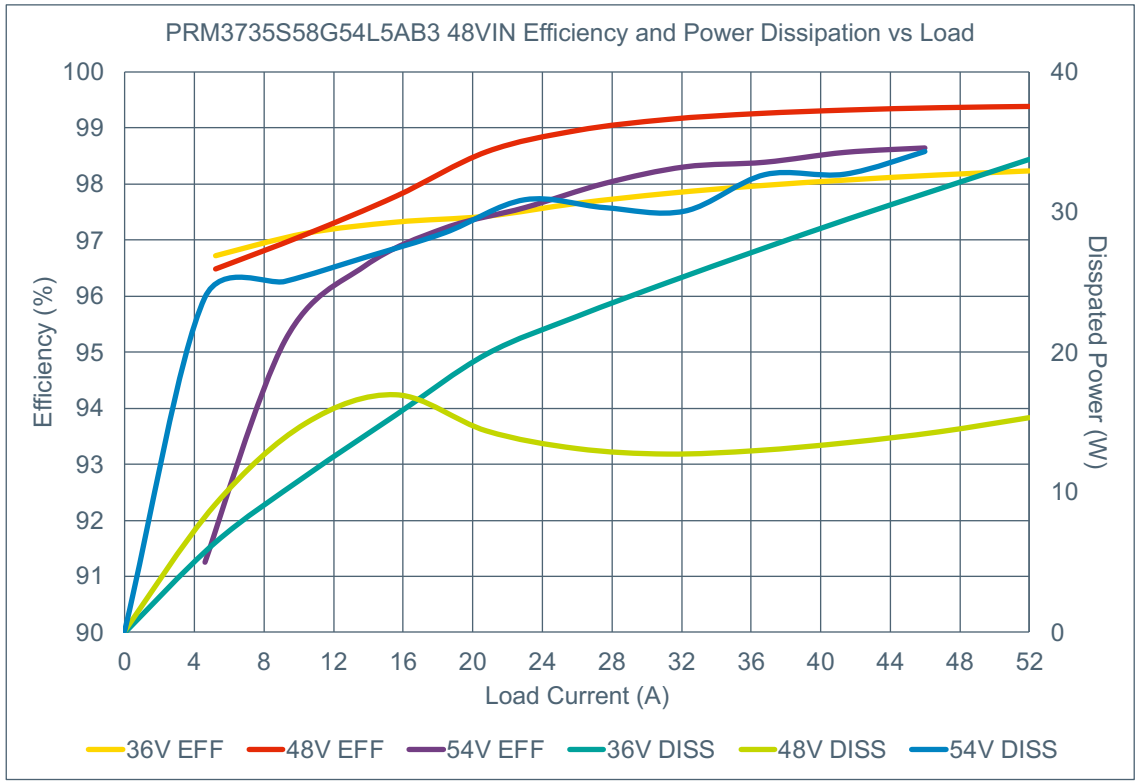
Load transient 48V/48V

- (5 – 50A,10 – 100%)



- 0µF capacitor applied to V_{LO}
- Chroma electronic load 1A/µs

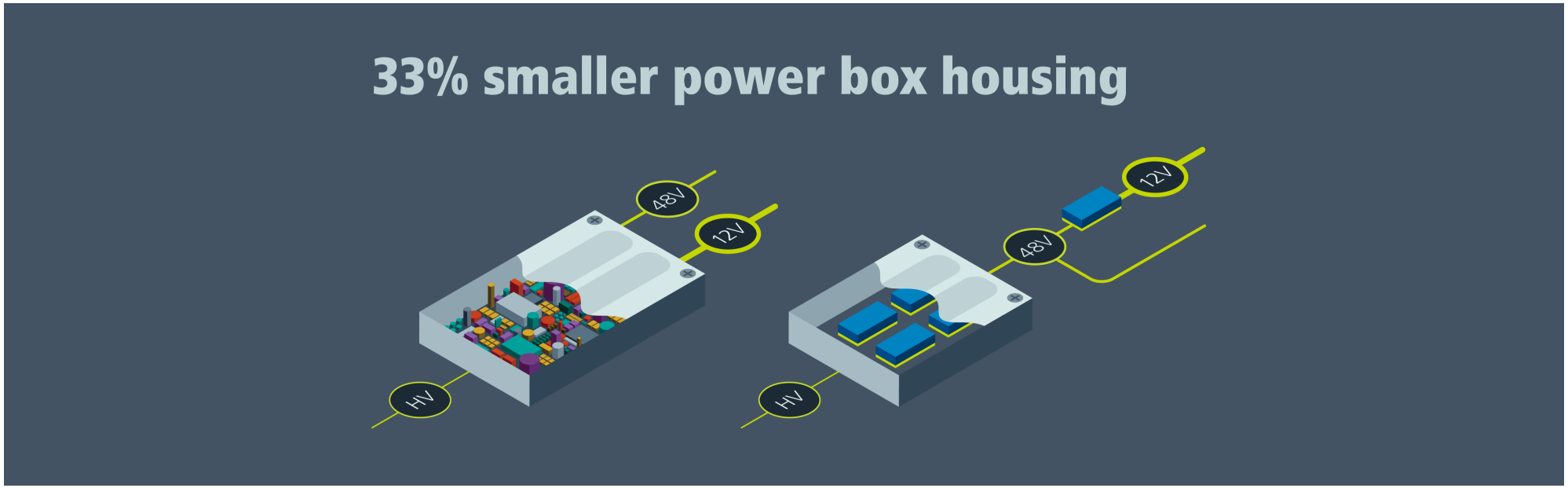
Efficiency (peak value : 99%)



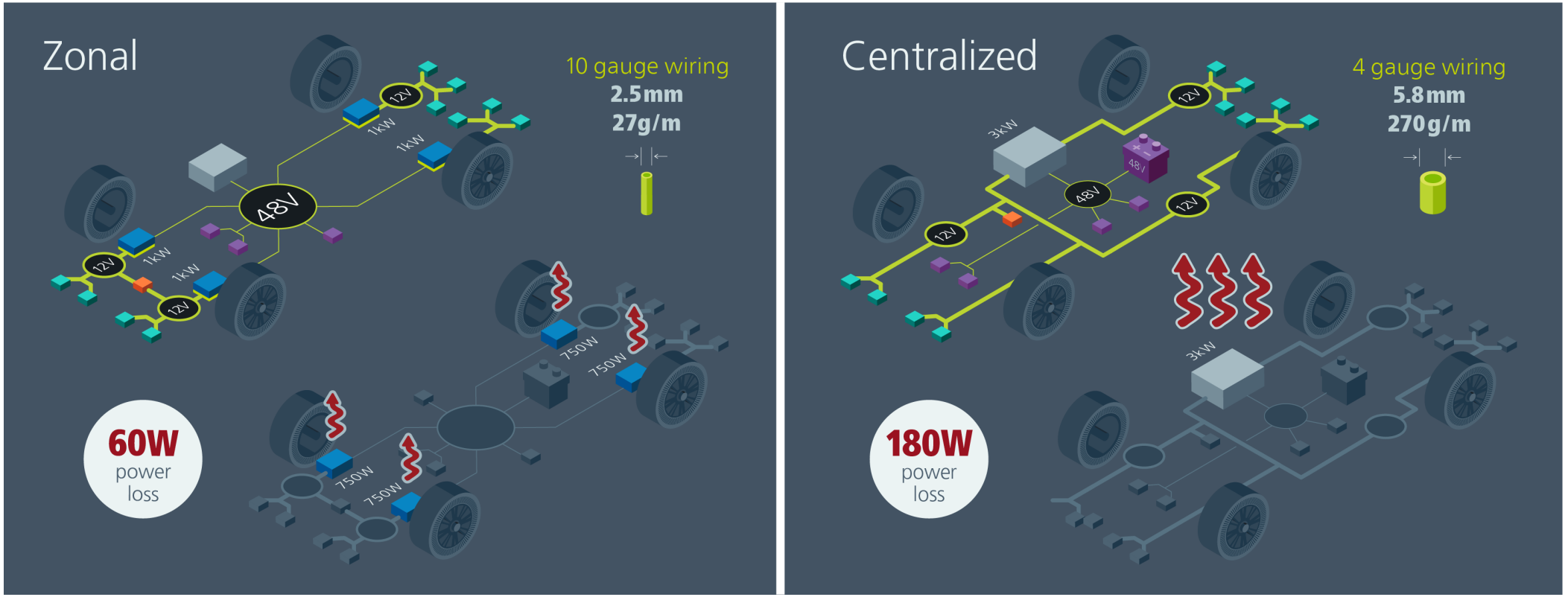
Source: Vicor

Reducing PDN size and weight using power modules

- Reduced system weight, size, cost and complexity by using battery pack's existing water coolant

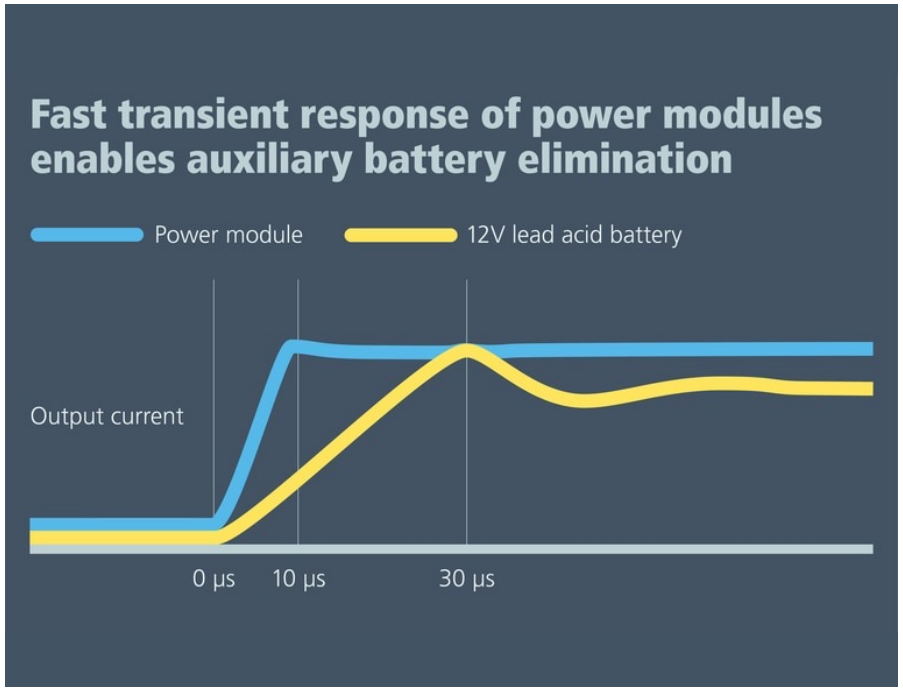


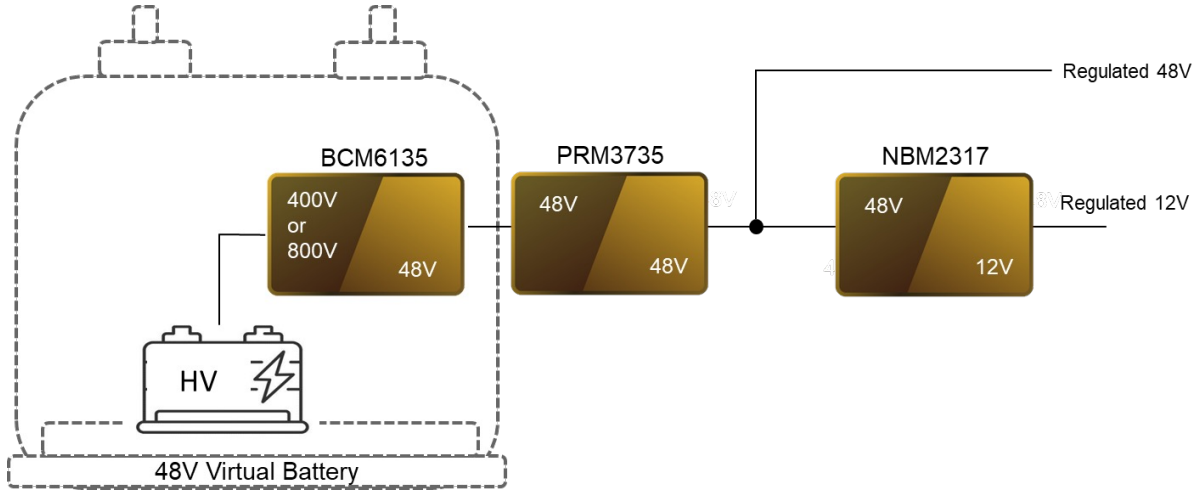
Reduces overall temperature rise, reduce costs by 30% and weight by 90%



Reducing PDN size and weight with a virtual battery

- Innovate to eliminate or minimize the battery

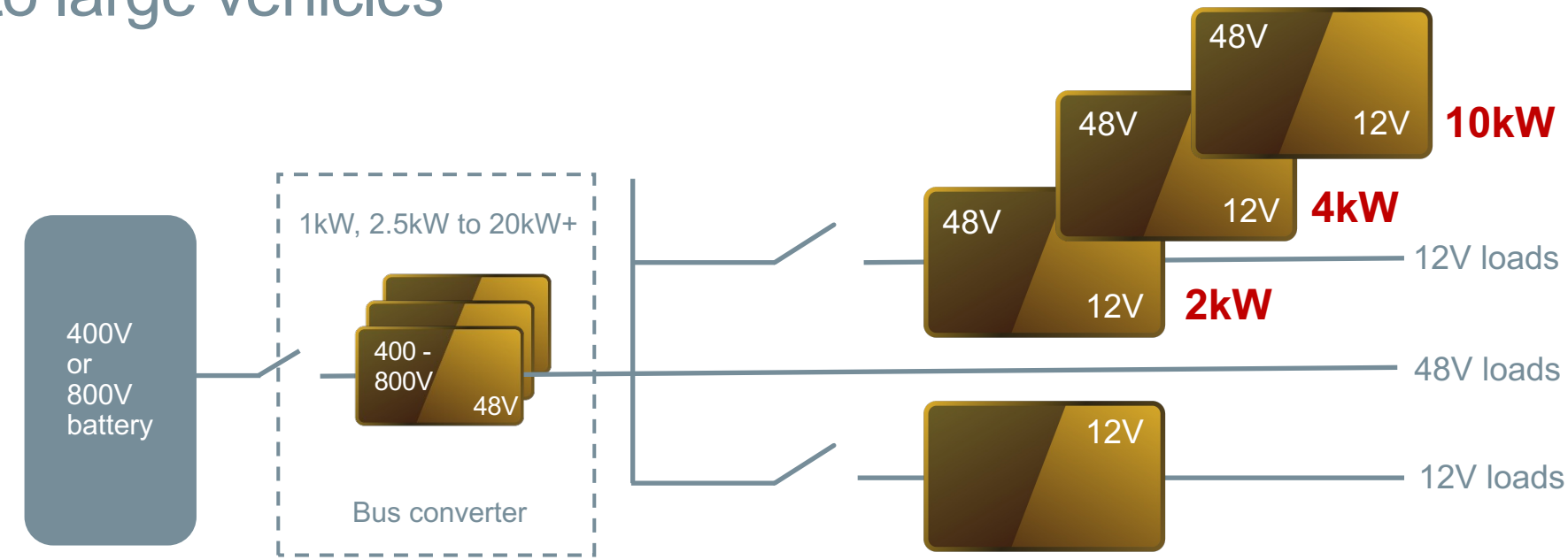




High-density power modules scale to bridge 48V-12V / 12V-48V

An architecture that offers a flexible and scalable solution from small to large vehicles

Every module can be easily paralleled or scaled to any power level



Going 48V zonal architecture saves significant weight

		Weight reduction
Wiring harness	Using 10 gauge wire (48V)	2.5 kg
Auxiliary battery	Eliminated	13.0 kg
Cooling system	45 lbs, reduced by 7%	1.5 kg
Power box housing	6 lbs, reduced by 33%	1 kg
		18 kg

Conclusion: Power modules optimize a 48V zonal deployment

- Reduce system weight, size and complexity
- Provide flexibility and scalability
- Faster time to market
- Simplify the power delivery network
- Reduce the wire harness weight and cost
- Reduce vehicle assembly time at factory
- Save costs by integrating 48V conversion in BSA housing

Thank you

Contact info

YK Choi
Vicor
+821089936050
ychoi@vicr.com