PowerAmerica

Medium Voltage Fast Charger

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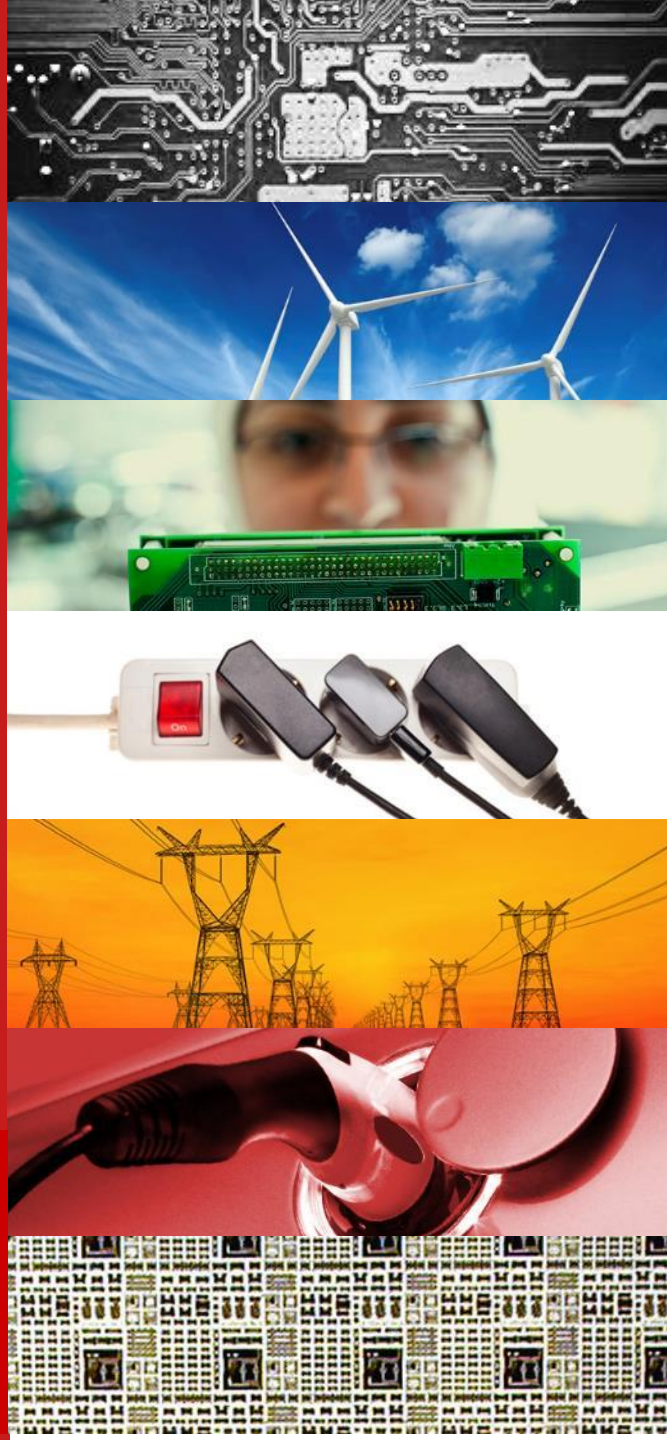


Project Objectives

- Develop a modular medium voltage (MV) WBG Fast Charger using commercial WBG semiconductor power devices
  - Single-phase MV DC charger replaces the 3-ph 480 V equivalent
  - Results in system-level cost savings (2x-4x)
  - Loss reduction (2x) and size reduction (5x-10x)
- Establish building blocks for commercializing WBG medium-voltage rectifiers
- Take the technology from concept to commercialization

Why Medium Voltage Fast Charger?

Prolec GE Transformer
3-ϕ 75kVA 4160V-480V
3,100L 1200kg

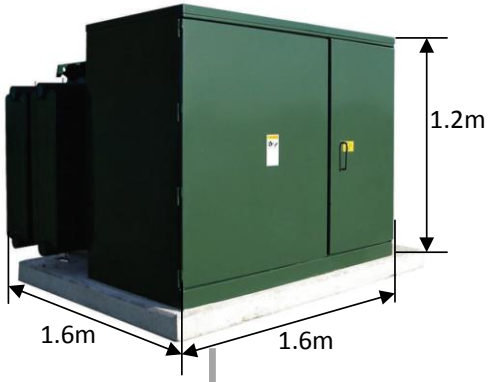
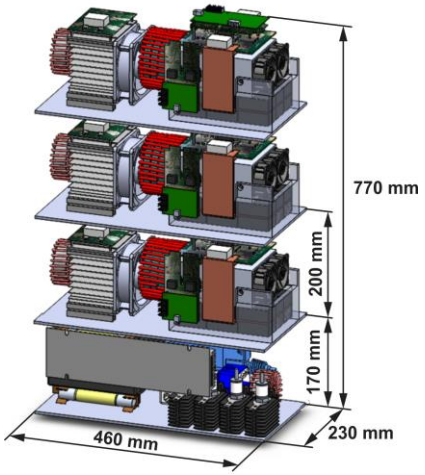


ABB Terra 51
50kW Fast Charger
1200L; 400kg

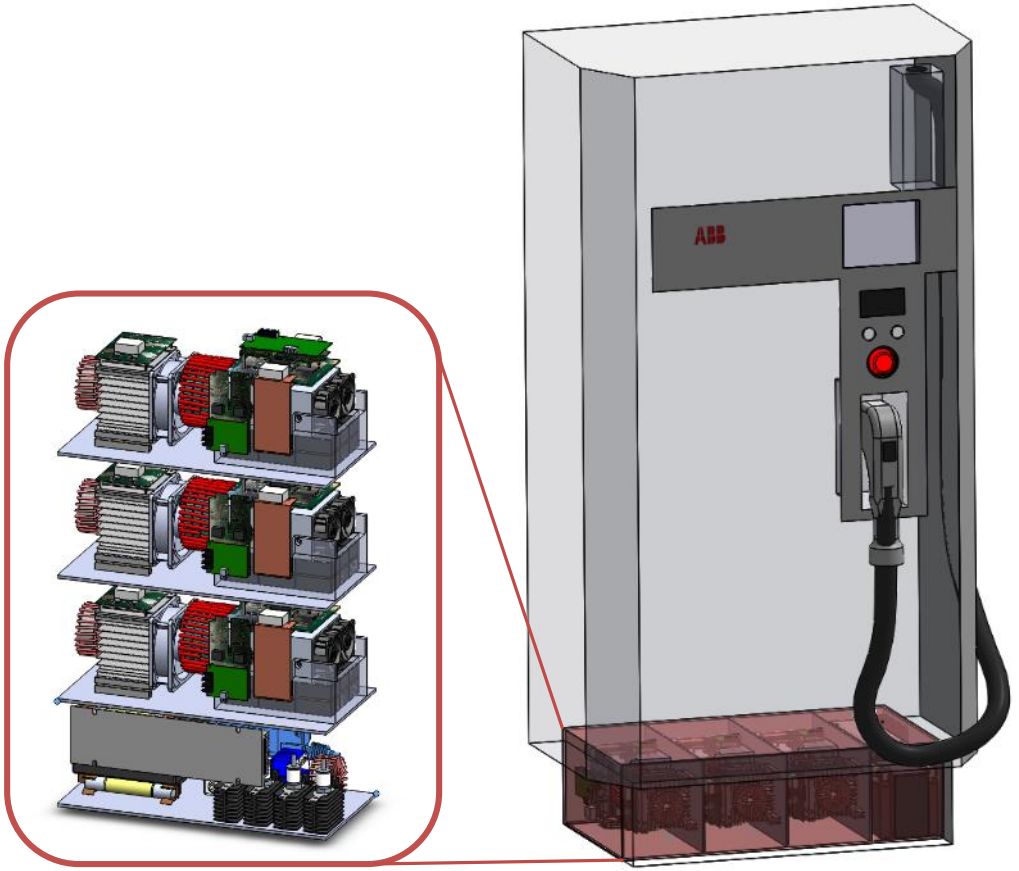
Power America
50kW MV Fast Charger
100L; 60kg*



*projected packaged weight and volume

System Specifications

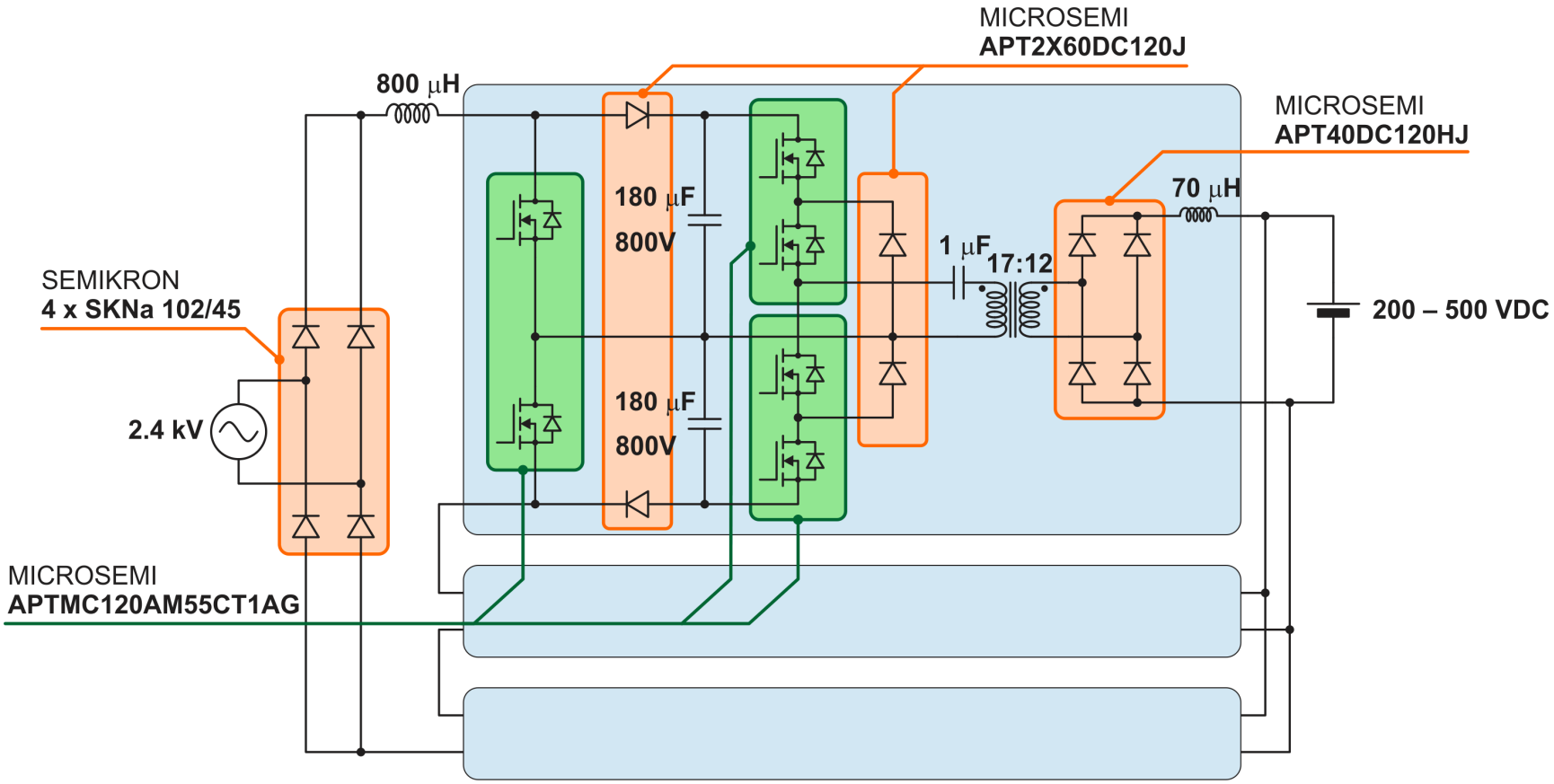
- 50 kW (25 kW demo in BP1)
- 2,400 Vac to 400 Vdc
- η ≥ 95%, PF ≥ 0.98, THD ≤ 2%
- 10x size reduction
- 4x weight reduction
- Simple install w/o step-down transformer



MV Fast Charger
V = 81.5 L m = 60 kg

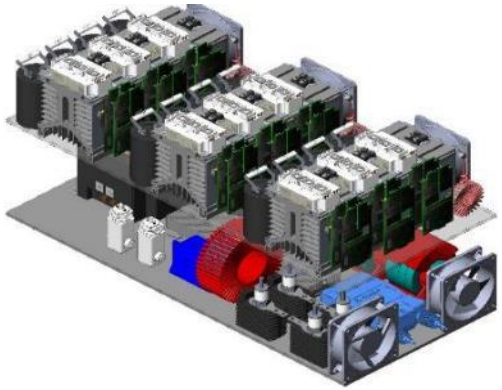
Commercial Fast Charger
V = 1200 L m = 400 kg

Topology & Component Selection

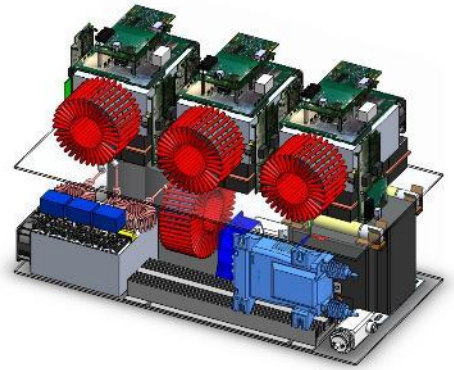


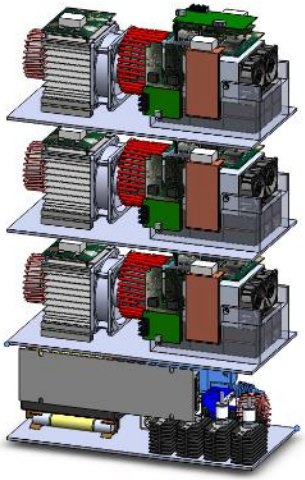
Multi-cell Boost Topology

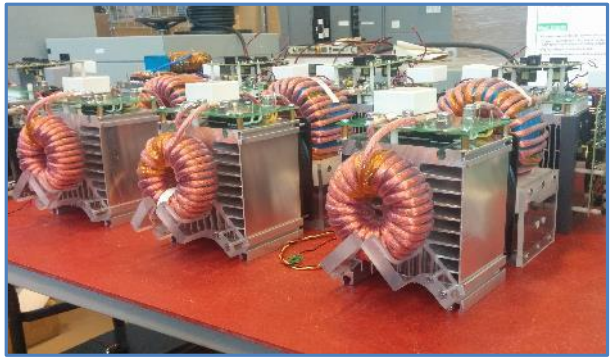
Design Process



Breadboard Module Prototype (Q2)



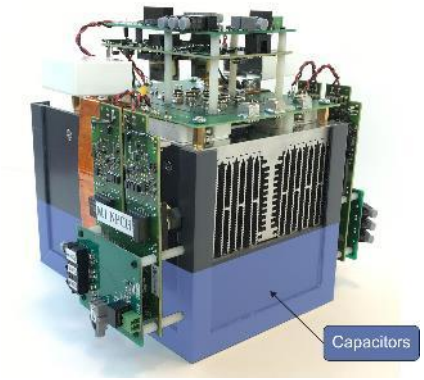




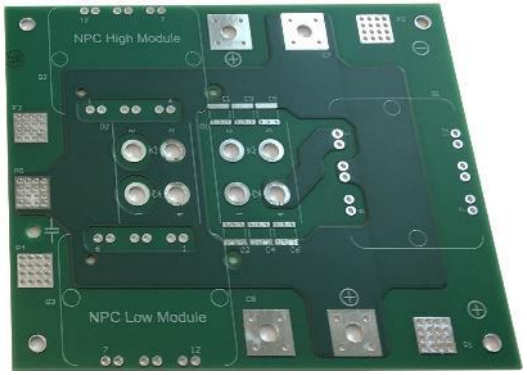
Fast Charger Prototype (Q3)

Further optimization in BP2

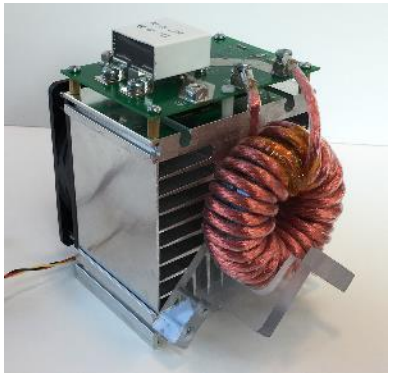
Component Optimization



NPC & Boost

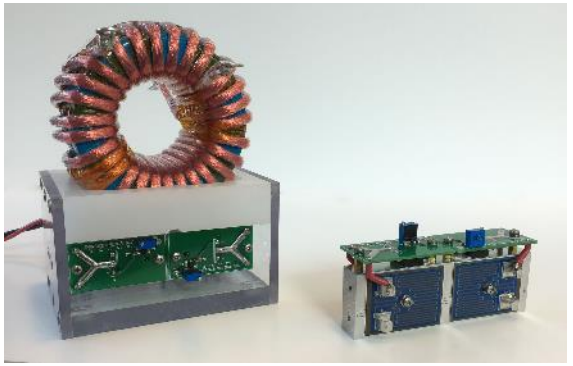


Busbar



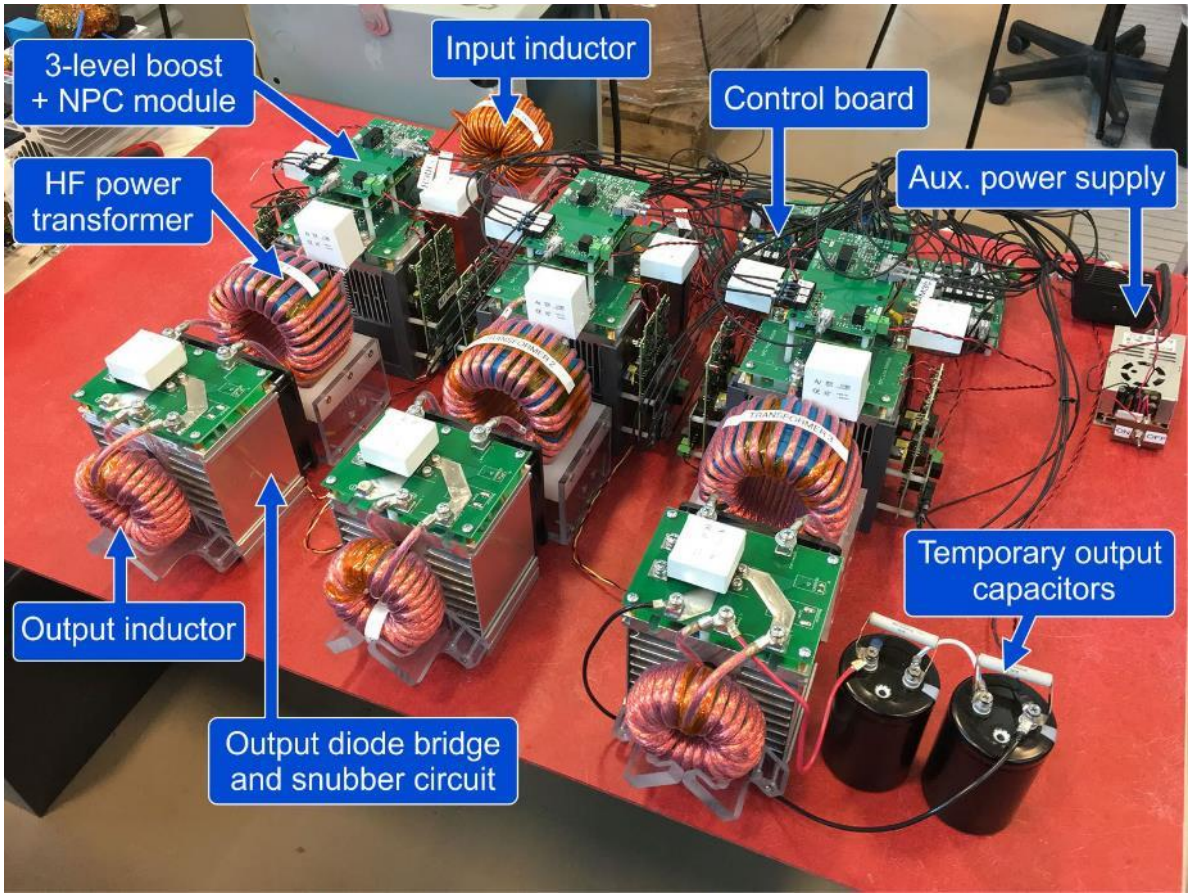
Snubber + O/P L

Control Board



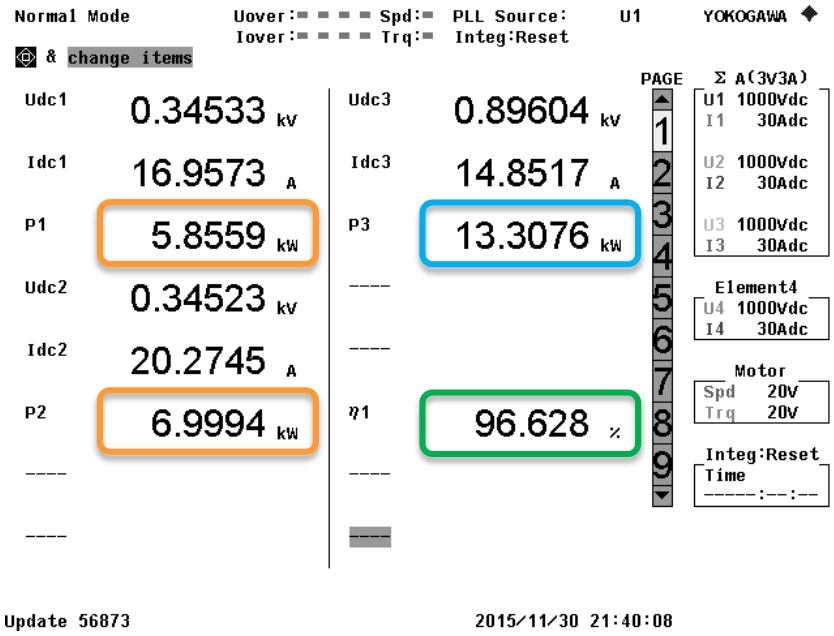
X-former + Crowbar

System Prototype

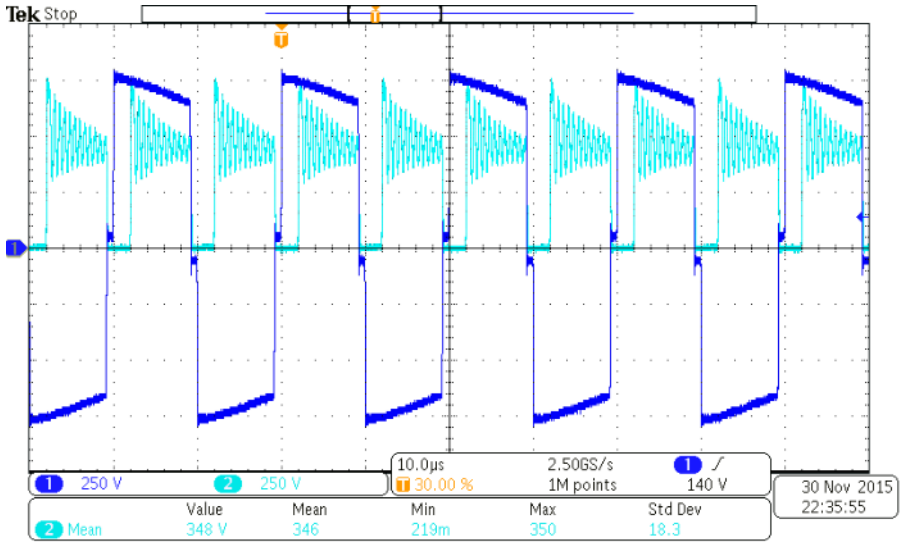


System Testing

Single module test results



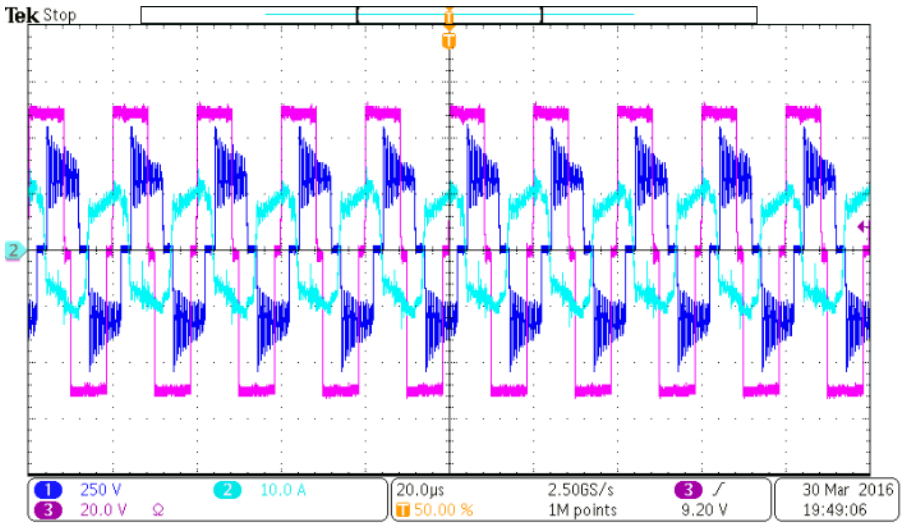
Module input power, output power and efficiency



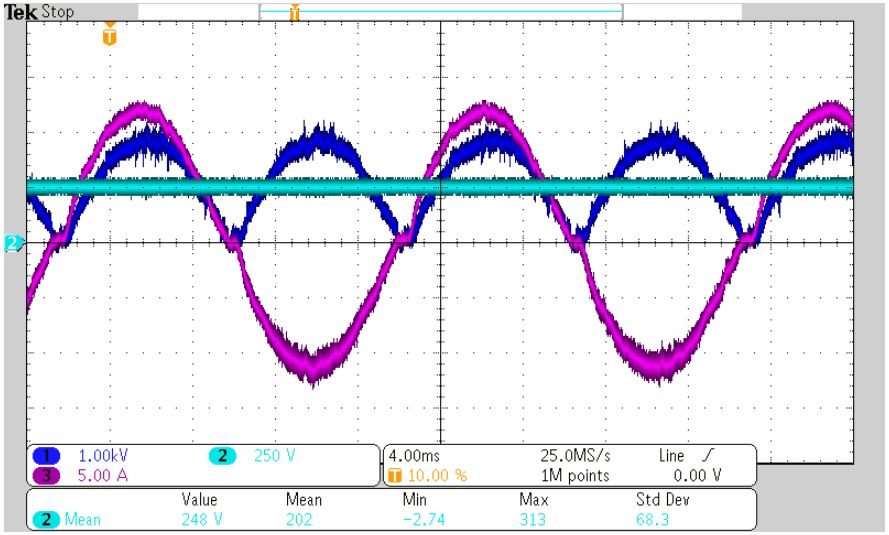
The transformer input voltage & diode bridge voltage

System Testing

Fast charger tested up to 20kW; results shown at 10.6 kW



Uppermost module transformer primary voltage, primary current, rectified output voltage (inverted)



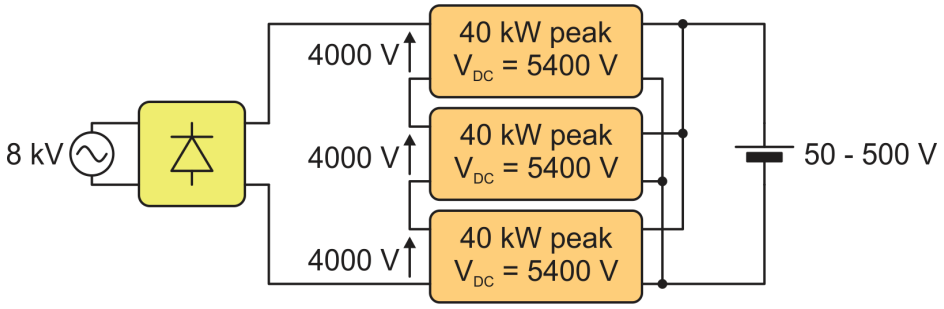
The charger input current & rectified input voltage

Student Impact

- Graduate
  - –Chi Zhang, Xinyu Liang working full time on the project towards their PhD degrees
  - –Recruiting a new domestic graduate student through ECE Fellowship
- Undergraduate
  - –Student volunteers (Michael Spears, Logan Adams, Julien Chomette, and Antonio Gonzalez) worked on capacitor design, packaging and testing
  - –Senior Design Group (Travis Tippens, Jiwan Jessup, Daniela Casilla Bracho, Garrett Somers) working on CHAdeMO interface with Nissan Leaf and the Human Machine Interface

Future Direction

- Further system optimization for efficiency and reliability
- Comply with standards and certifications necessary to serve different applications
- Demonstrate the system in the field
- Develop technology to market strategies
- Move to higher voltage & power levels using 3.3kV devices



3.3 kV devices, 120 kW peak
(based on CREE's 40 mΩ,40 A device)

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Thanks!

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