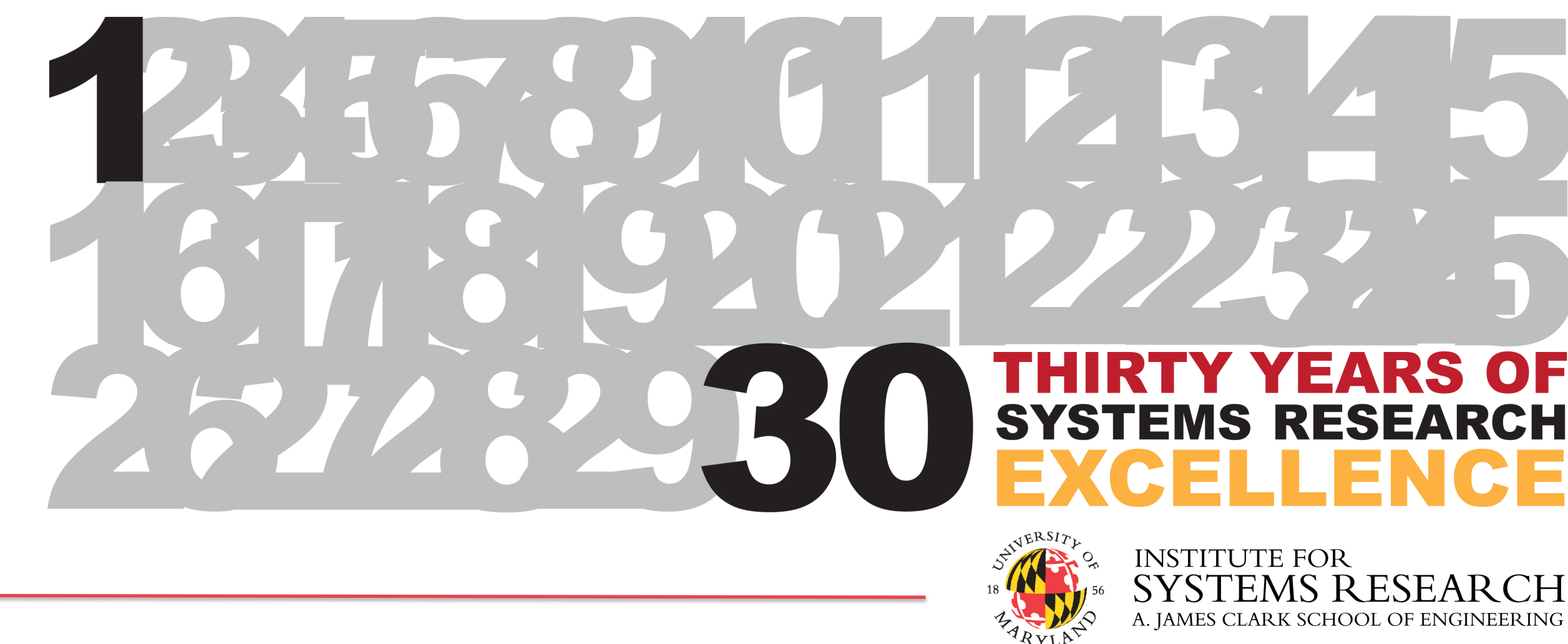


Integrated Onboard Plug-In Chargers for Next Generation Electric Vehicles

Yichao Tang, Chuan Shi, Pedro Pena, and Alireza Khaligh



Level 1 & 2 On-board Chargers

Power: 1kW – 19.2kW

Voltage: 120 – 240Vac

Typical Use: Home or office

Level 3 Off-board Chargers

Power: 20kW – 100kW

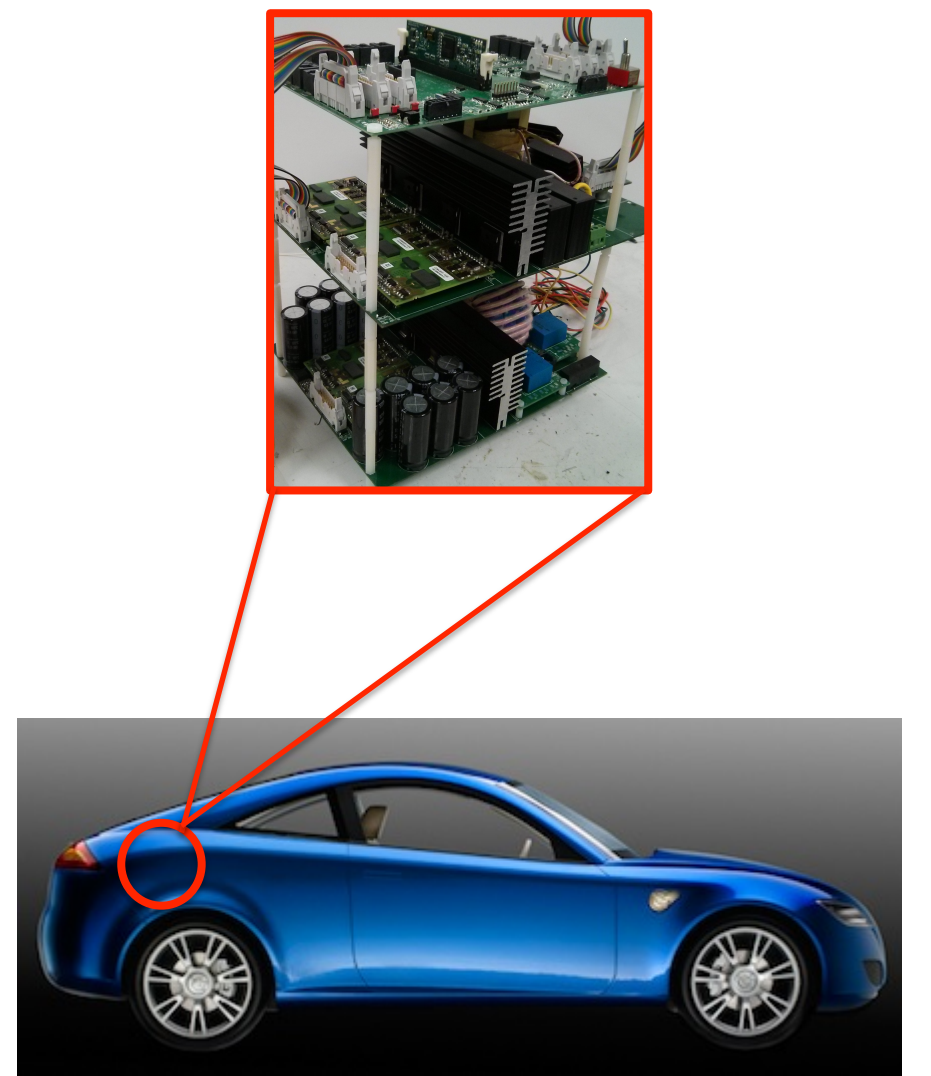
Voltage: 208 – 480 Vac or 600 Vdc

Typical Use: Commercial charging station



Future Work: Level 2 & Level 3 Integrated On-Board Chargers

- Integrate/Utilize onboard power electronics
- Increase power density
- Introduce a transformative universal solution for all level 1, level 2 & level 3 charging
- Enhance charging efficiency
- Utilize benefits of wide band-gap devices



Charger System Diagram

Design Challenges

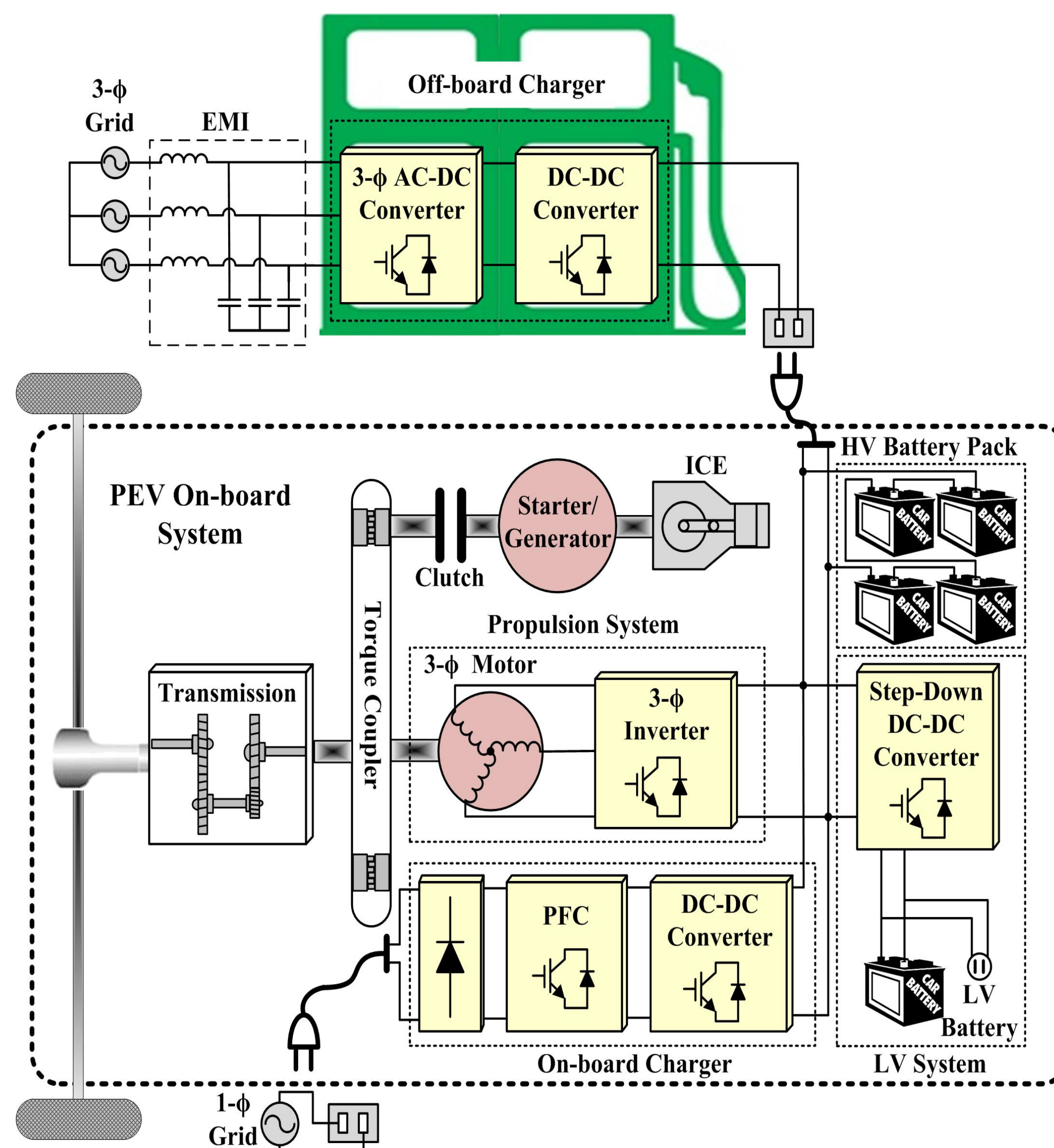
- Wide range of battery voltages
- High efficiency especially at light load
- Power density
- Compatibility with universal Grid
- Low EMI

System Constraints

- Charging standards
- Charger size
- Grid impact (low THD)

Level 2 On-board Charger

- Power Density, Efficiency, Reliability
- Cost, Volume & Weight

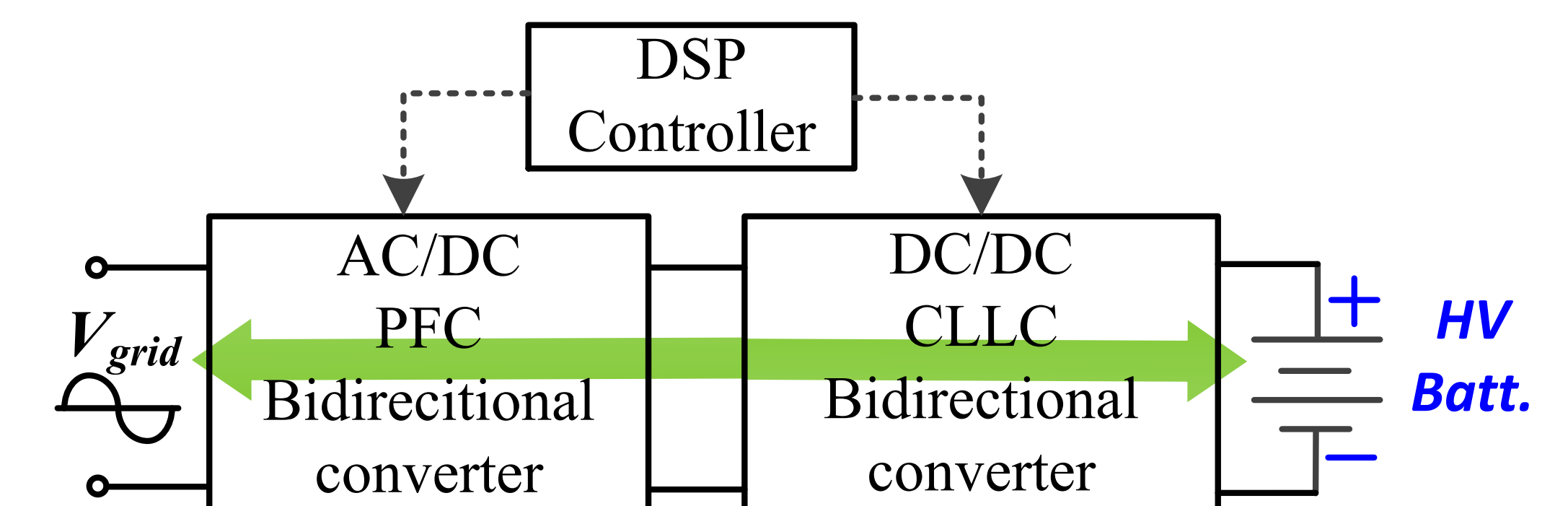


Prototype and Results

Technical Methods

Control stage

- DSP controller
- Digital control system

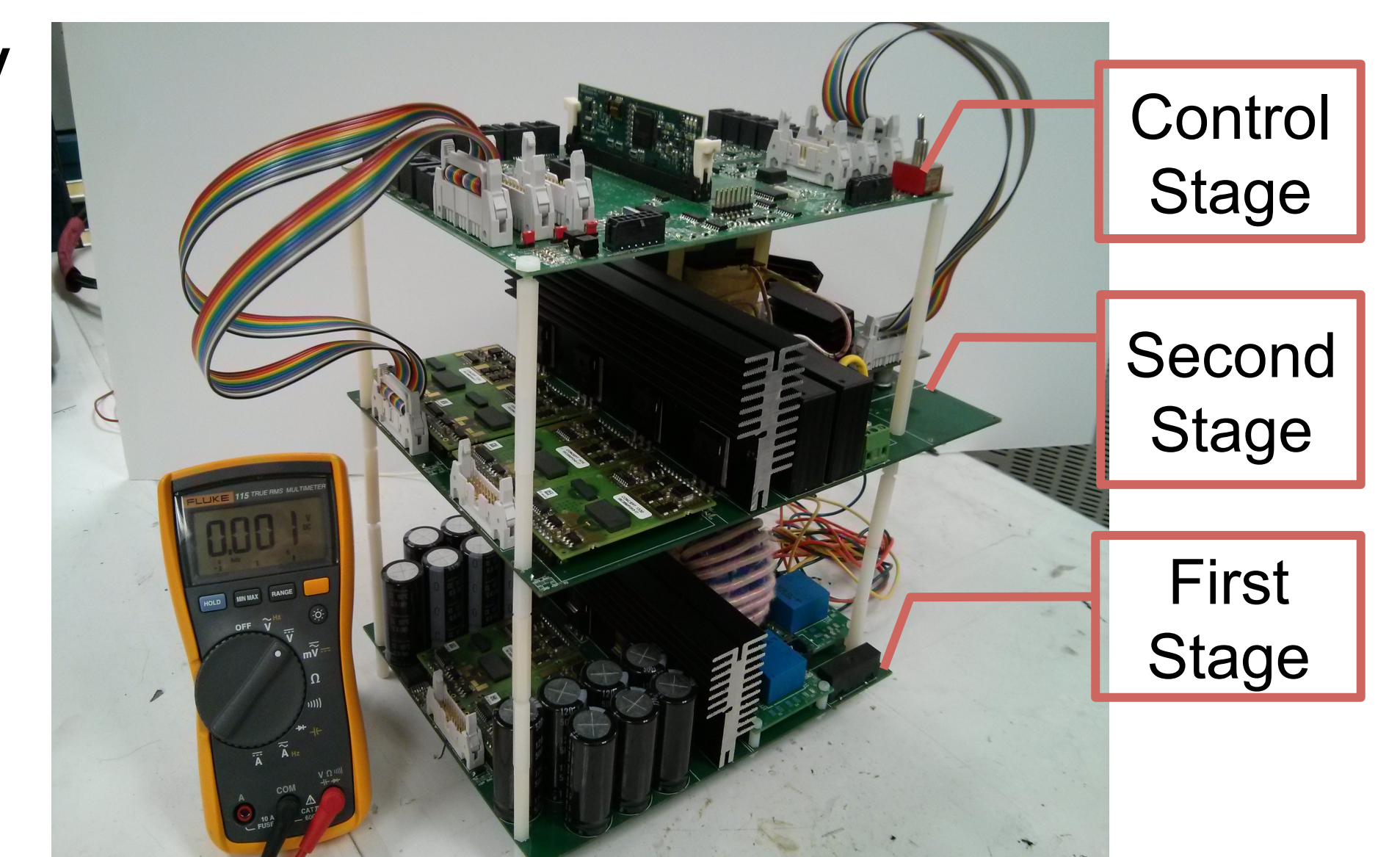


First stage

- Boost active PFC topology
- Interleaved technology

Second stage

- CLLC resonant converter
- Electromagnetically integrated transformer



Experimental Results: 7.6 kW Charger

PFC: 0.999

THD: 3.61%

Voltage Ripple: 3%

Frequency Range: 151kHz – 195kHz

Output Voltage Range: 200V – 420V

Input Current Ripple: 2%