Advanced Power Electronics Lab

Hardware Lab Kit for Education and Research
Developed through ONR Funding

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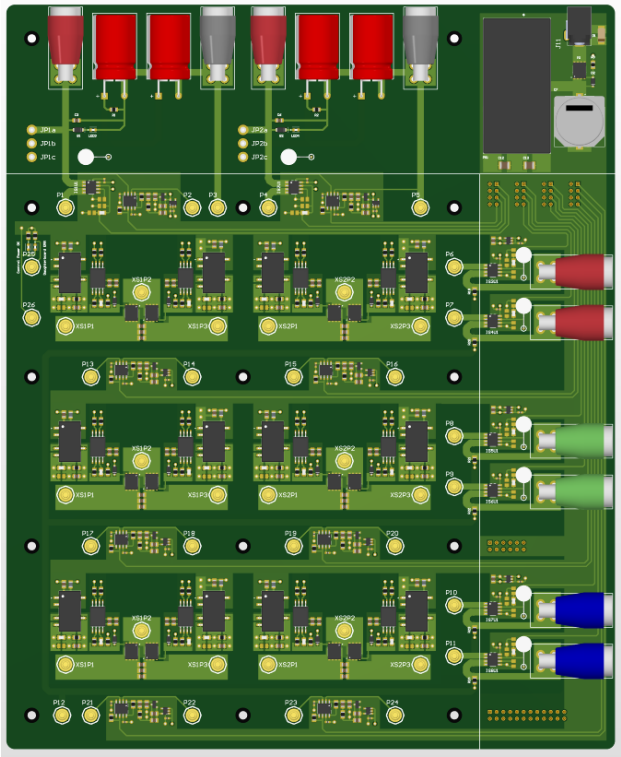
Modular Daughterboard Approach



12-Switch Power Electronics Breadboard (PEB)

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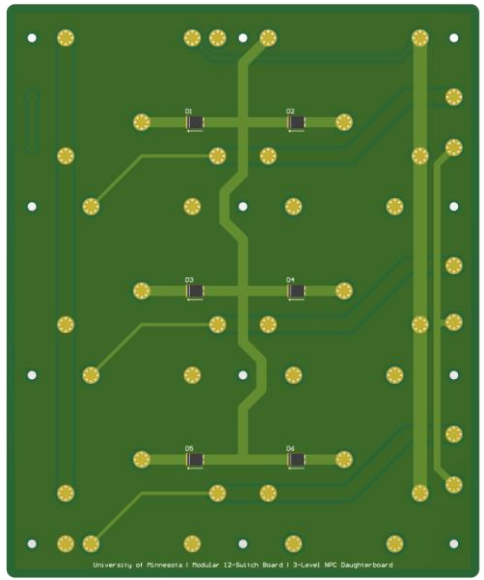

3-Level NPC Daughterboard

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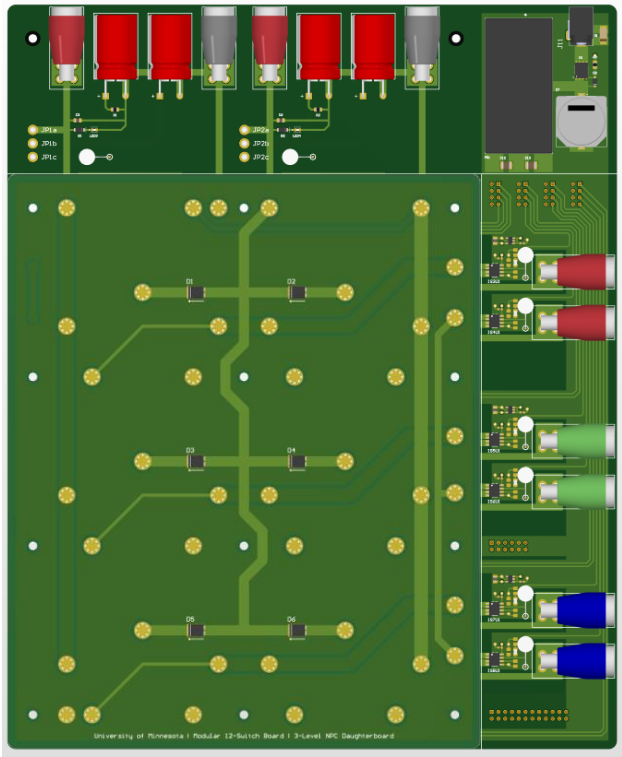
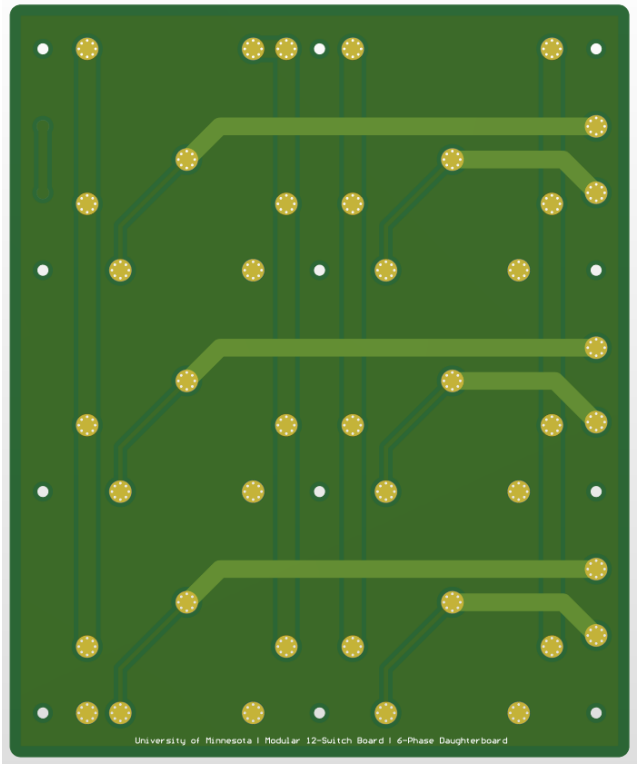
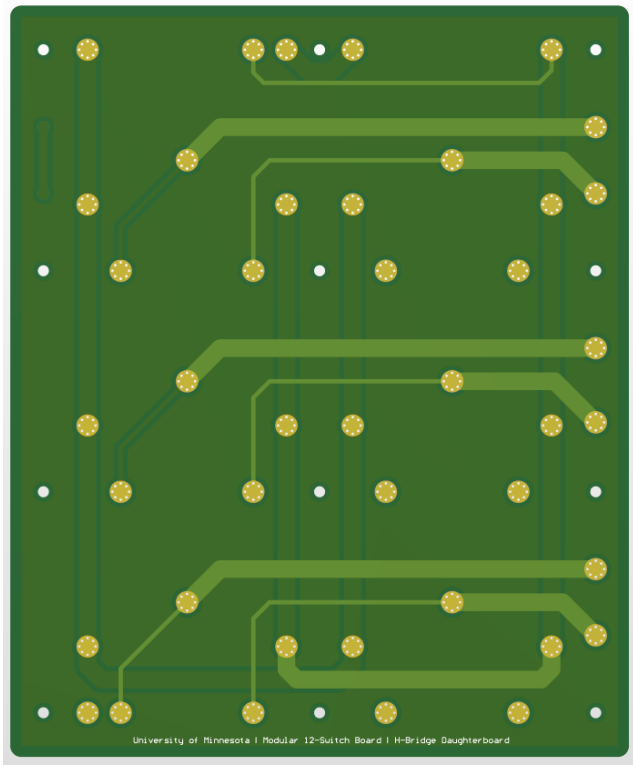


3-Level NPC Inverter

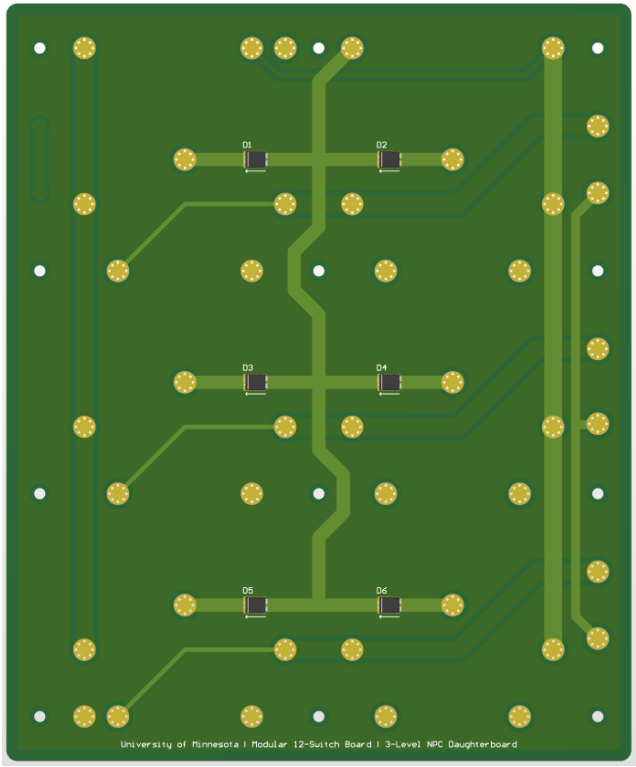
Example Daughterboards



3/5/6 Phase, Active Rectifier
DAB, PSFB

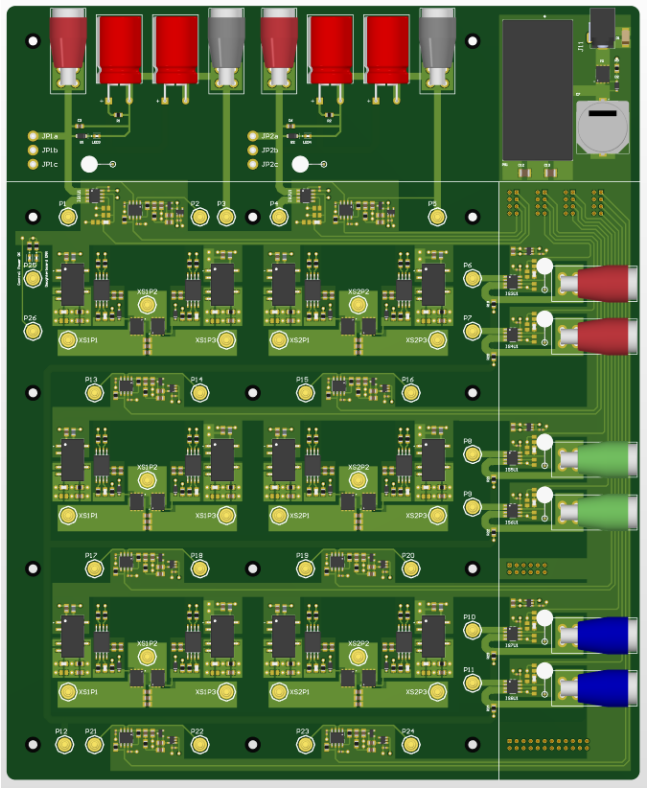


H-Bridge,
Cascaded H-Bridge (with 2 setups)



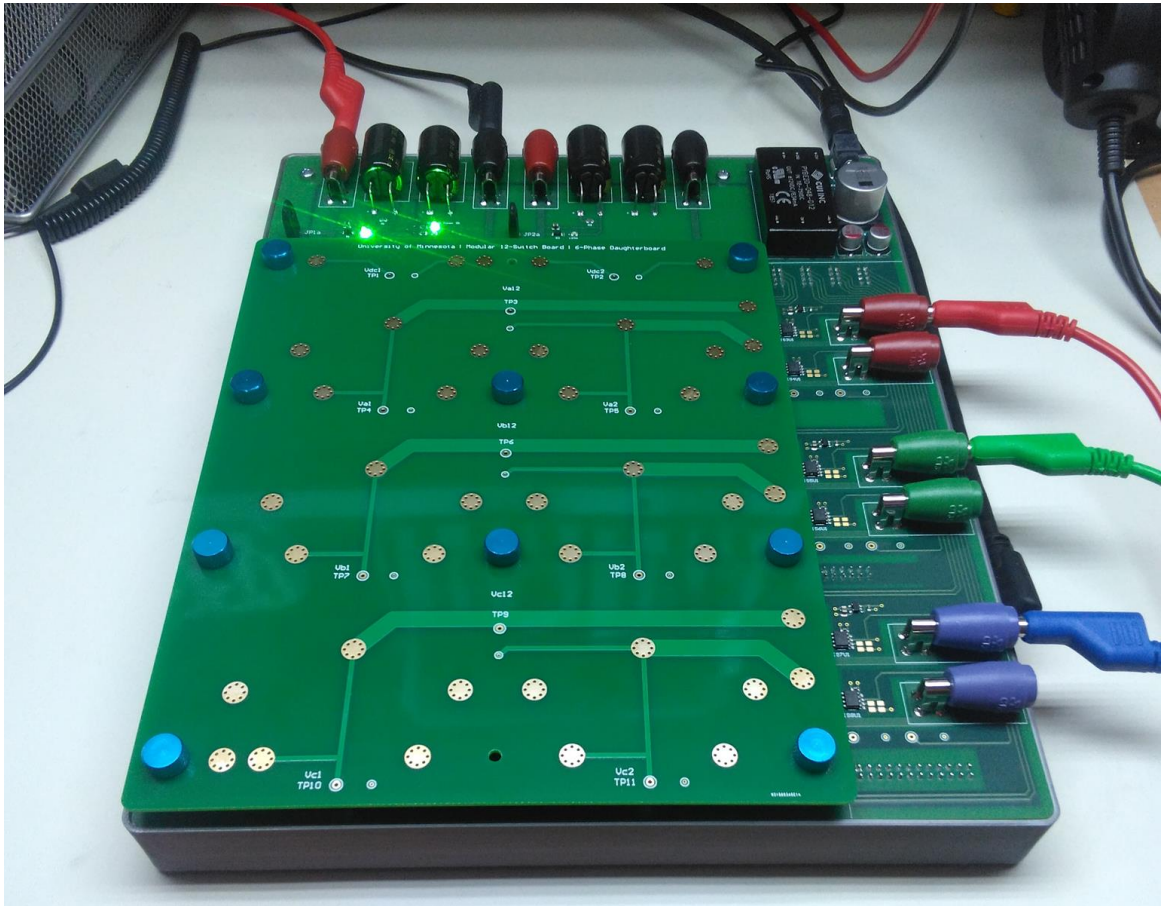
3-Level NPC

Modularity and Extensibility



- Controller interfaces with Sciamble Workbench
- Custom daughterboards can be used to implement novel converter topologies
- Multiple PEBs can be combined to implement more complex drives
  - 5-level (3ph) cascaded h-bridge can be implemented using 2 setups
- Multiple setups can be combined to implement larger systems (microgrids)
- Beyond lab exercises, platform could be used for:
  - student projects
  - research

12-Switch Prototype



- Development of a set of lab exercises using the 12-switch prototype is in progress.

Proposed Set of Experiments

2-Level Converters

- Half-Bridge Inverter (3, 5, or 6ph)
- Active Rectifier (3ph)

Full-Bridge Converters

- H-Bridge Converter (3ph)
- Dual Active Bridge (1ph)
- Phase-Shifted Full Bridge (1ph)

Multi-Level Converters

- 3-Level NPC Inverter (3ph)
- 5-Level Cascaded H-Bridge (3ph)

Future Expansions:

Modular Multi-Level Converters

- 4-Level MMC (half-bridge SMs) (1ph)

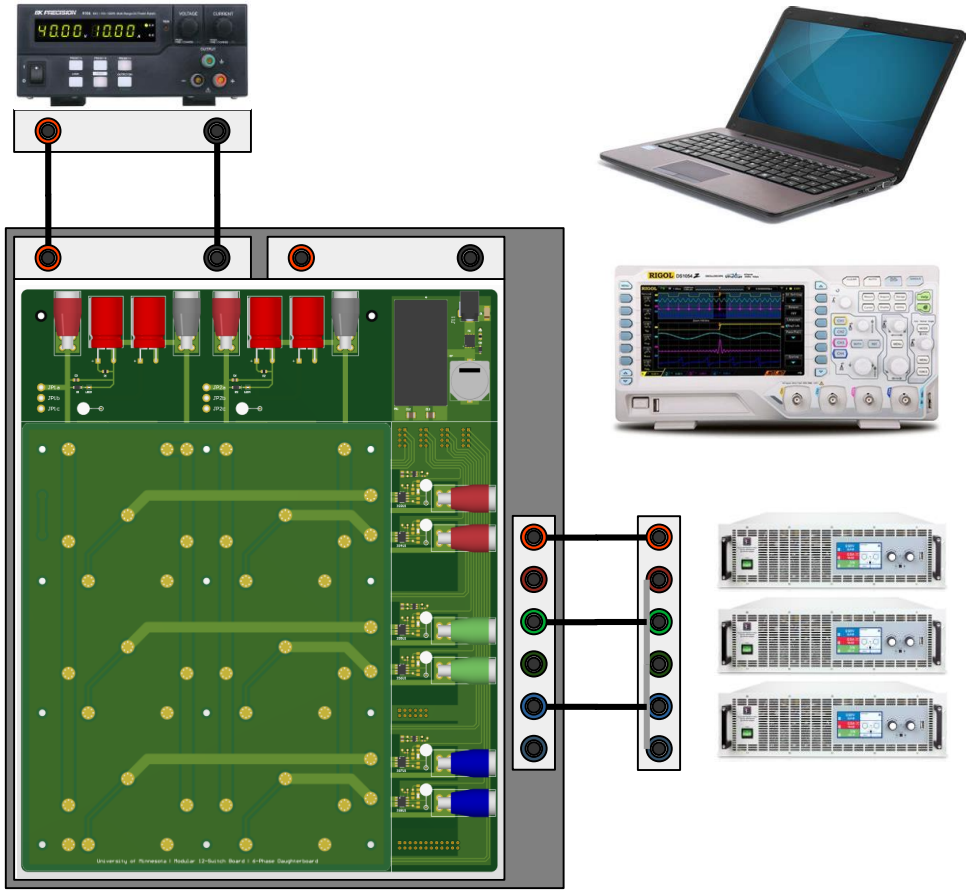
Other Multi-Level Converters

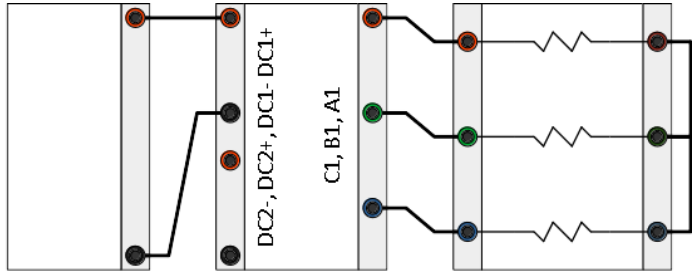
- 3-Level Flying Capacitor Inverter (3ph)
- 7-Level NPC Inverter (1ph)
- 7-Level Flying Capacitor Inverter (1ph)

Matrix Converters

- Direct Matrix Converter
- Indirect Matrix Converter

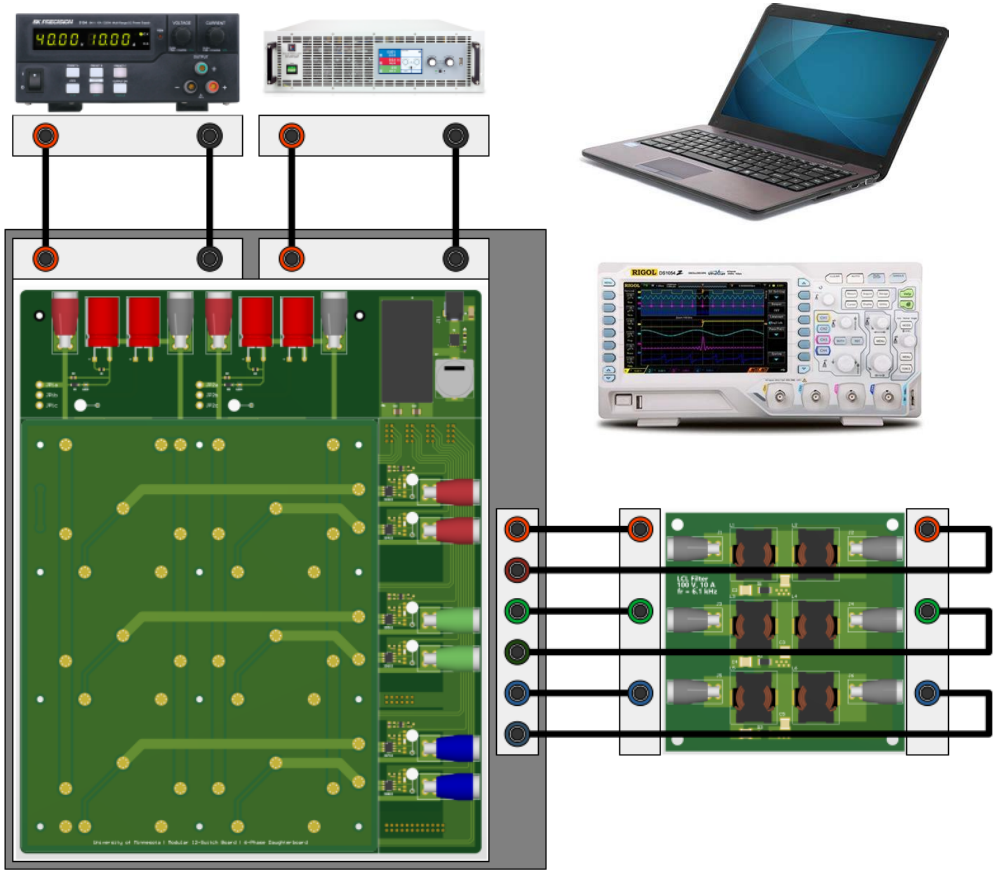
3 Phase Inverter Experiment

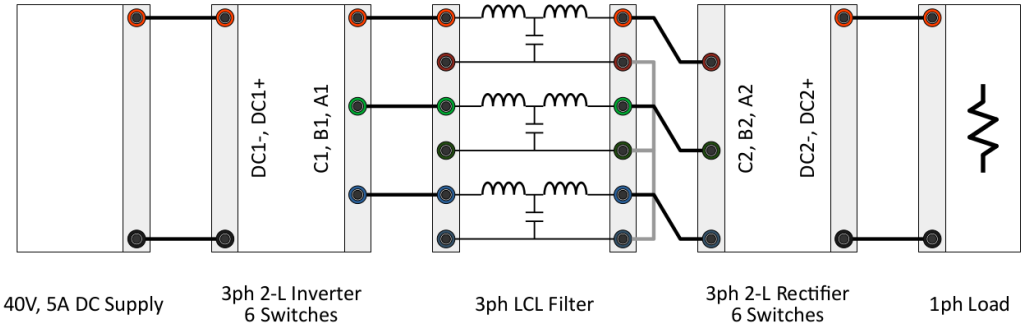




- Introduction to the system
- Demonstrates generation of 3-phase waveforms
- Load could be resistive, motor load, or active load bank

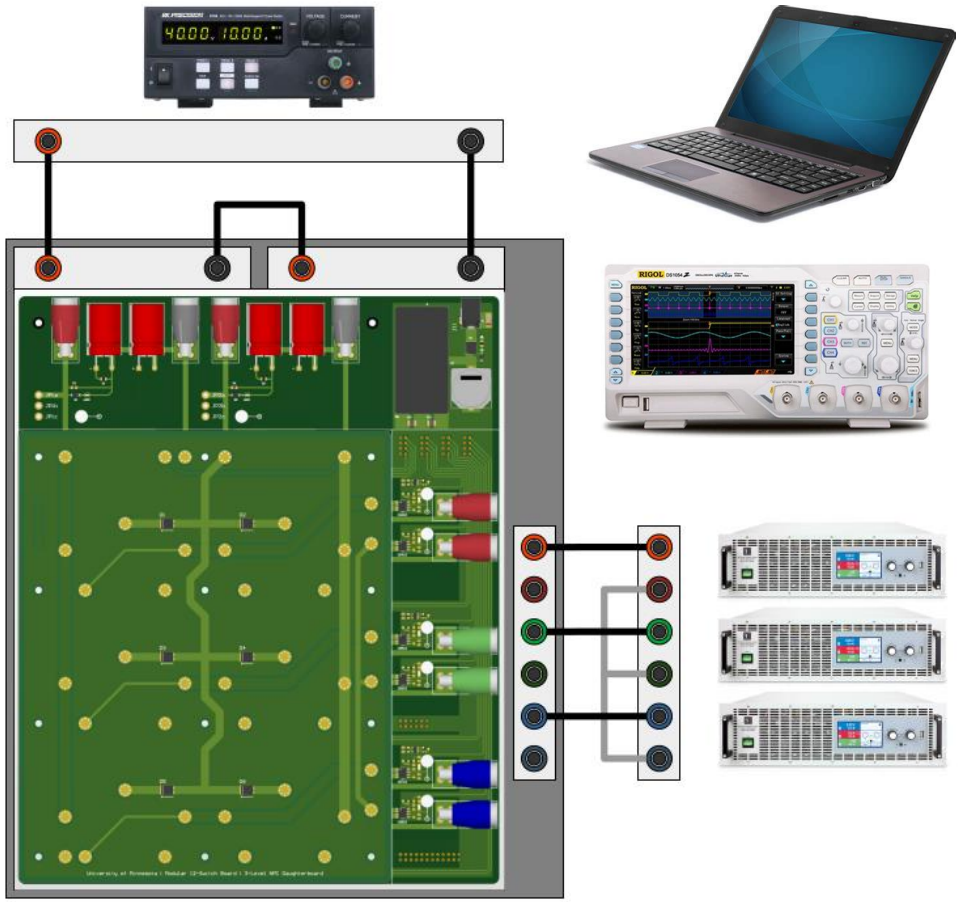
Active Rectifier Experiment

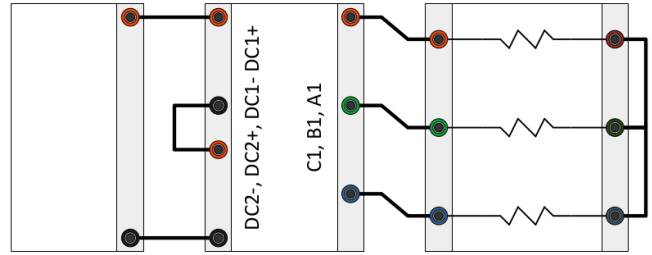




- Demonstrates use of active rectifier to achieve sinusoidal currents drawn from the AC source, control power factor
- Unidirectional power flow
- External LCL Filter
- Left and right halves of board implement 3-phase inverter and rectifier

Neutral Point Clamped Inverter Experiment





- Demonstrates the most common multi-level converter topology
- Students can observe the effect of different control schemes on the neutral current and the voltage balance between the upper and lower halves of the DC link

Cascaded H-Bridge Inverter Experiment