



# Building A Robust Workforce in Electric Power Engineering Albuquerque, NM March 16-17, 2023



## University of Minnesota: Twin Cities Campus

Power Electronics

Multi-Phase

Multi-Level

DC / AC

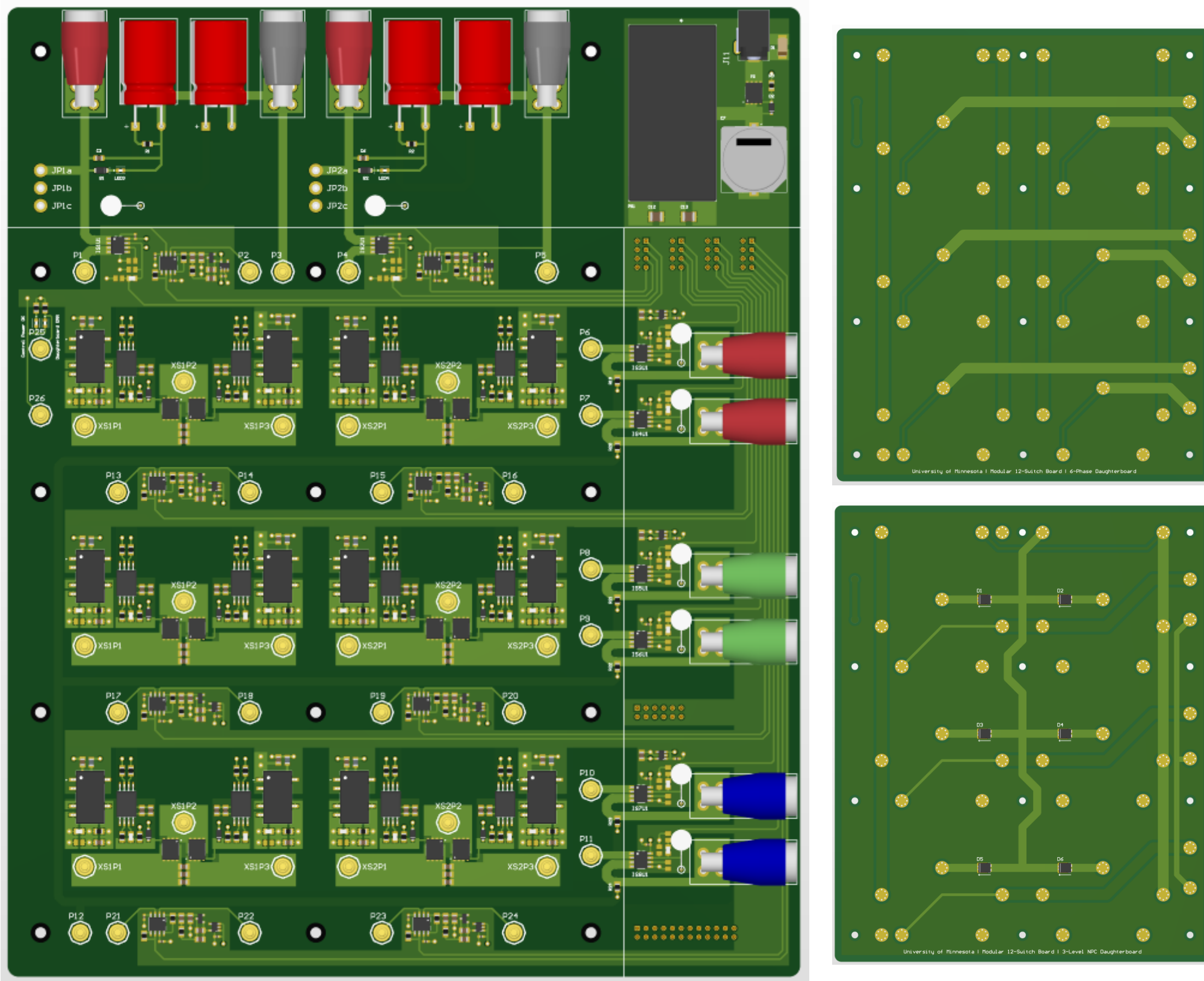
DC / DC

AC / DC

### Course Description

EE-8743: Advanced Power Electronics Lab is a graduate-level lab course presently under development. It centers around a modular power electronics breadboard that can be used to implement a range of multi-phase and multi-level converter topologies.

### Power Electronics Breadboard



### Description

- 6 Half-Bridge Modules with Isolated Gate Drivers
- 2 Independent DC Link Capacitors
- 4 Input Voltage and Current Sensors
- 6 Differential Voltage Sensors
- 6 Output Current Sensors
- Controller integrates with Sciamble Workbench

### Proposed 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)
- 3-Level Flying Capacitor Inverter (3ph)
- 5-Level Cascaded H-Bridge (3ph)

#### Modular Multi-Level Converters

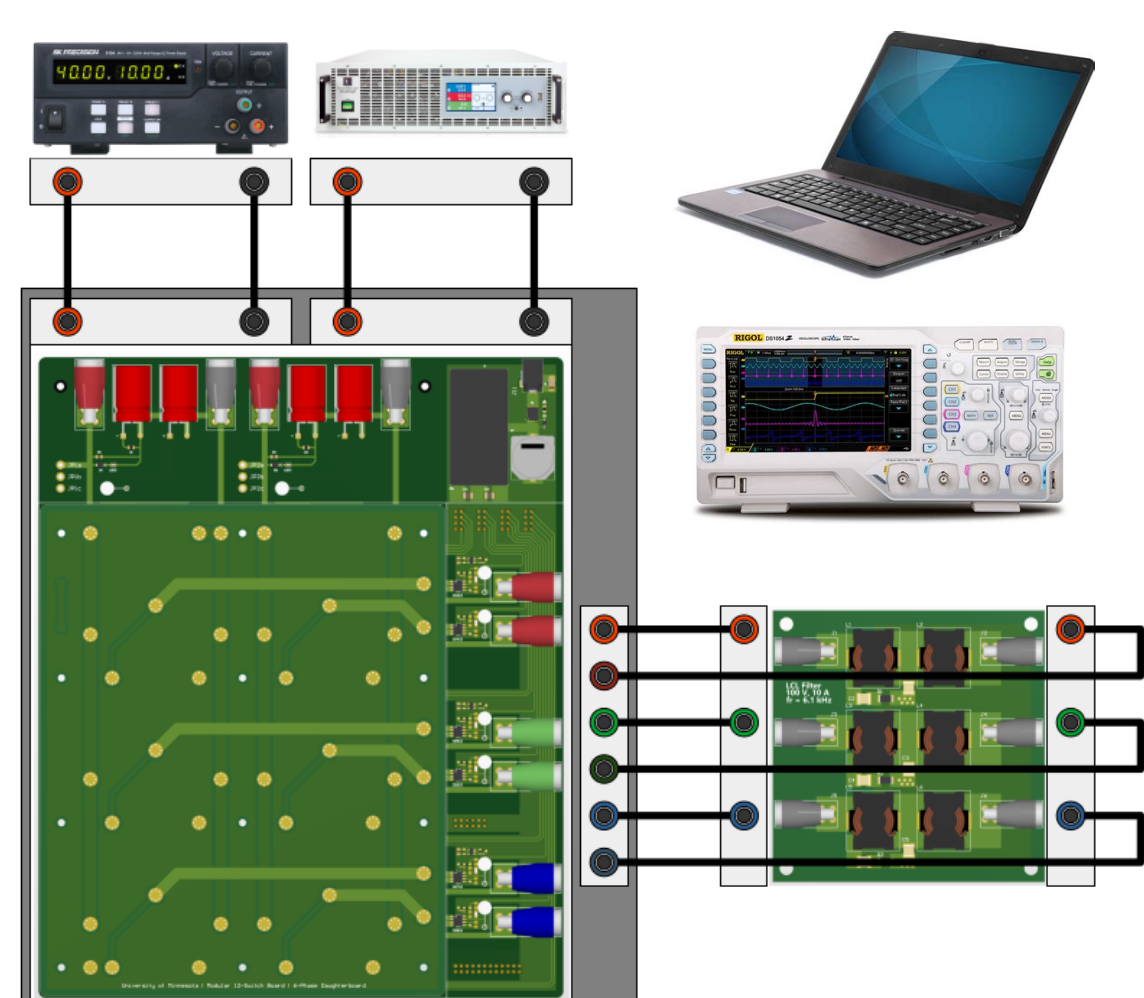
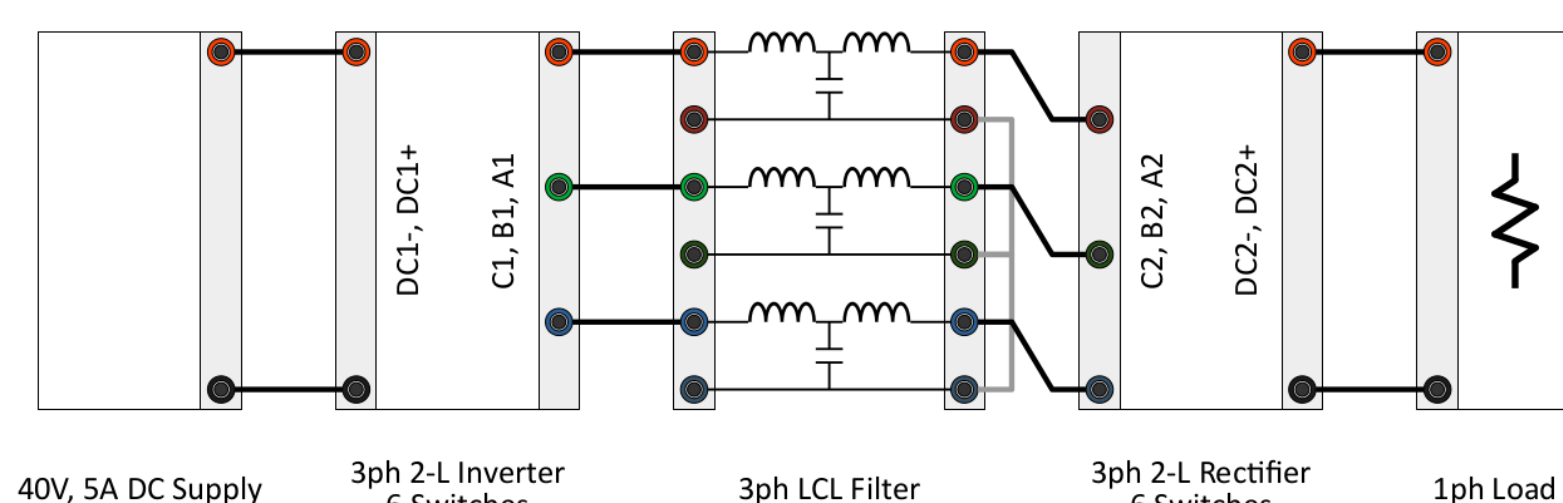
- 4-Level MMC (half-bridge SMs) (1ph)

**Matrix Converters**  
proposed as a  
**Future Expansion**  
requiring mainboard  
with bidirectional  
switches, rather  
than half-bridges

### Additional Applications

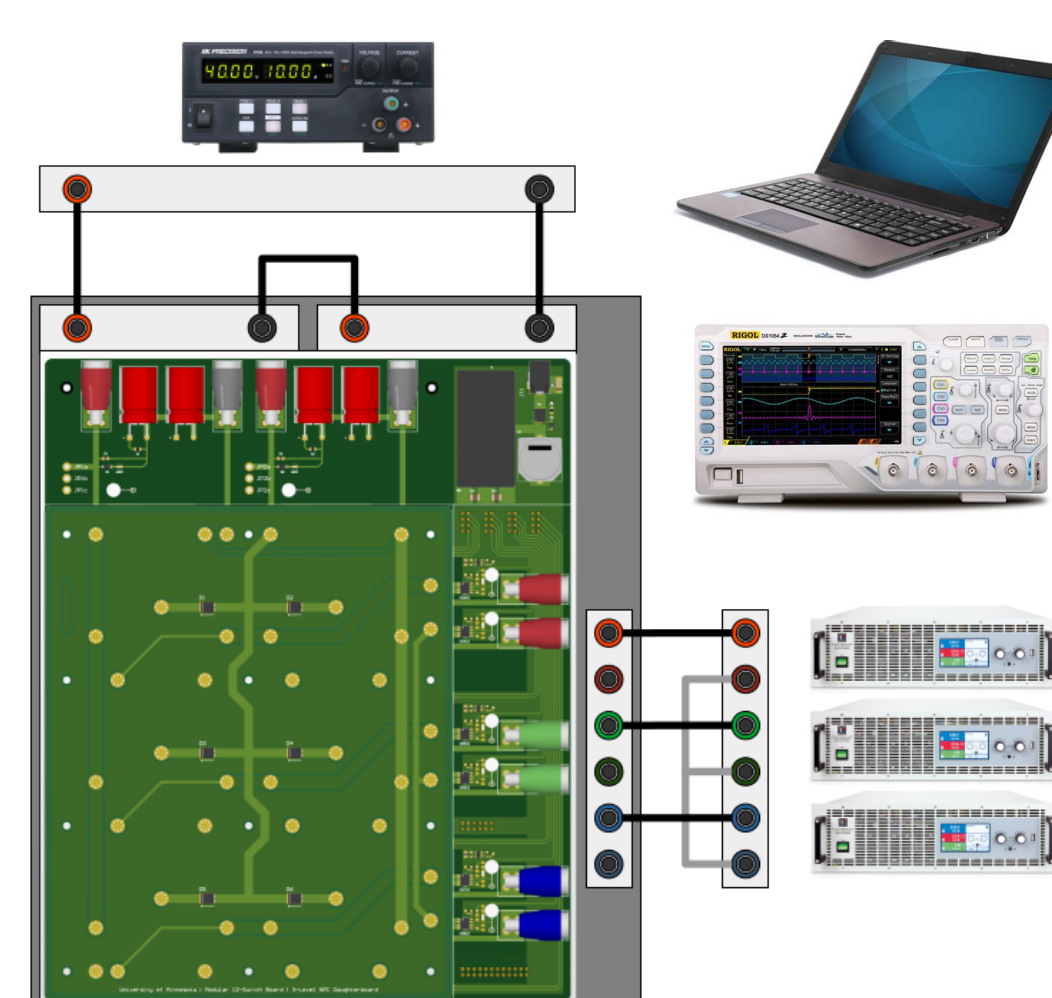
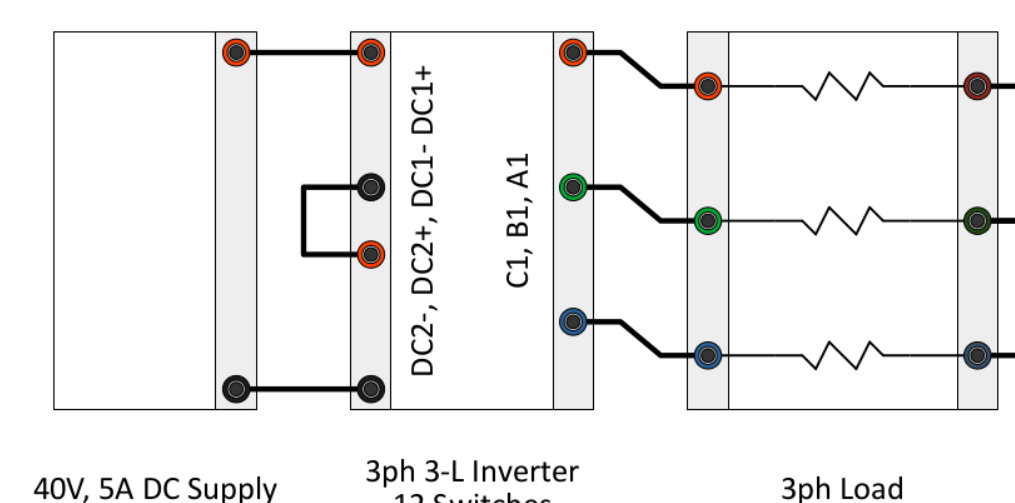
- Multiple PEBs can be combined to implement more complex drives – 5-level (3ph) cascaded h-bridge using 2 PEBs
- Multiple setups can be combined to implement larger systems (microgrids, etc)
- Beyond lab exercises, system can be used for student projects and research – use custom daughterboards to implement novel topologies

### Active Rectifier Experiment



- Demonstrates use of active rectifier to achieve sinusoidal currents drawn from the AC source, power factor control
- Unidirectional power flow from DC Supply to the DC Load
- Left Side Implements 2-Level Inverter (3ph)
- External LCL Filter
- Right Side Implements 3ph Rectifier (either active, or passive using body diodes)

### 3-Level NPC 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