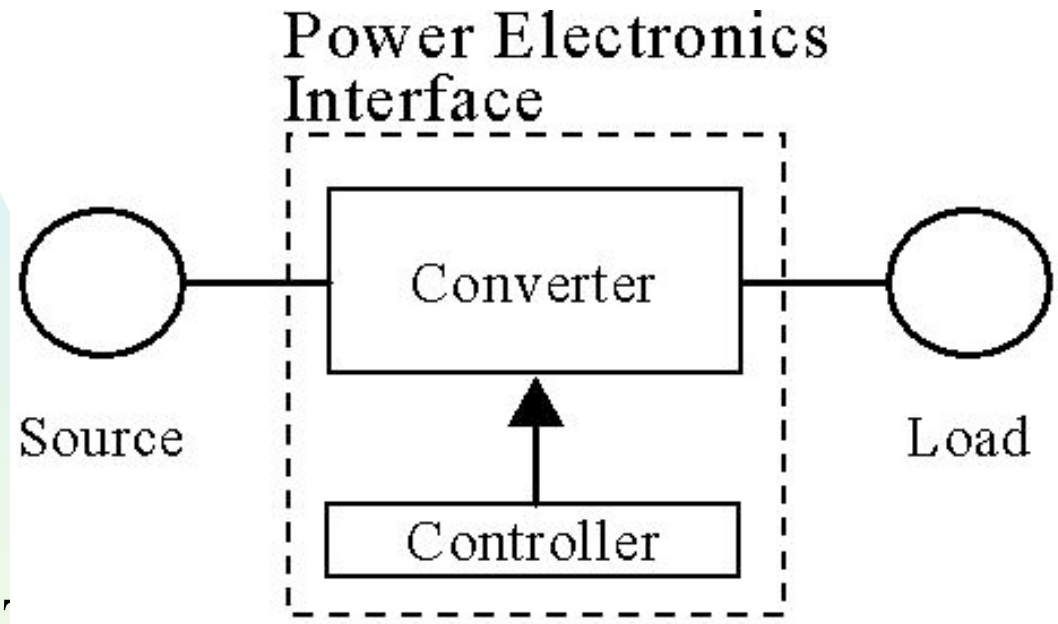
Course in
Power Electronics

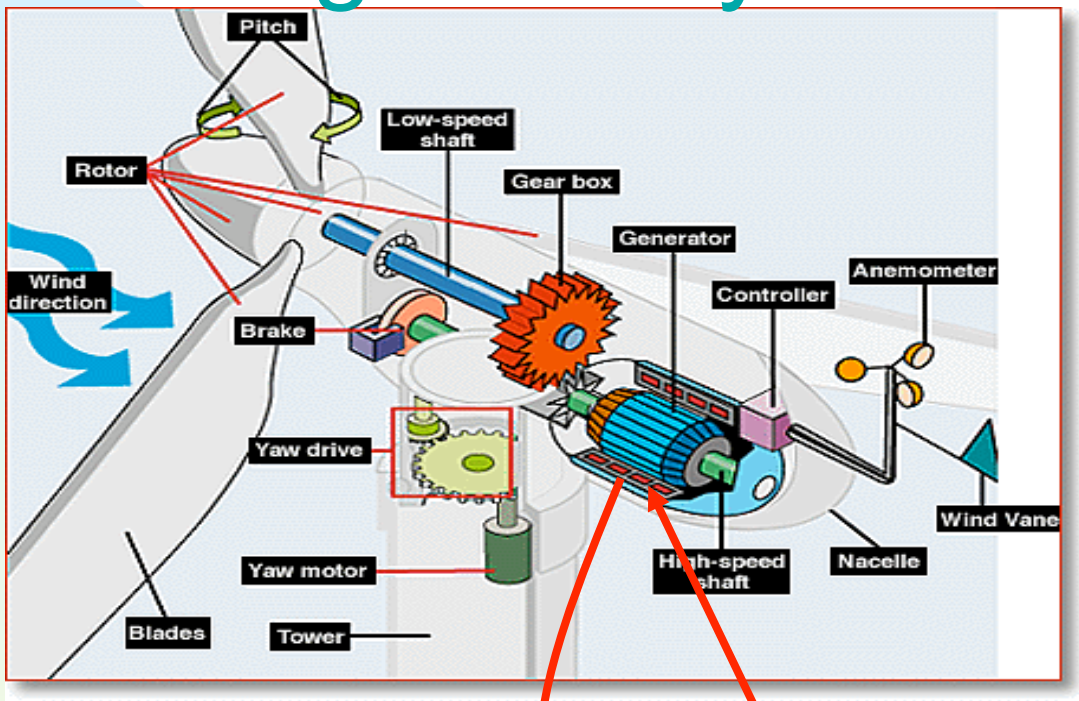


DC ⇔ DC

DC ⇔ AC

AC ⇔ Variable Frequency AC

Windmills: Example of an Integrated System



$161\,kV$

V

0

$Time$

Low-Voltage Ride-Through

$0 - 690\,V$
$10 - 60\,Hz$

Generator

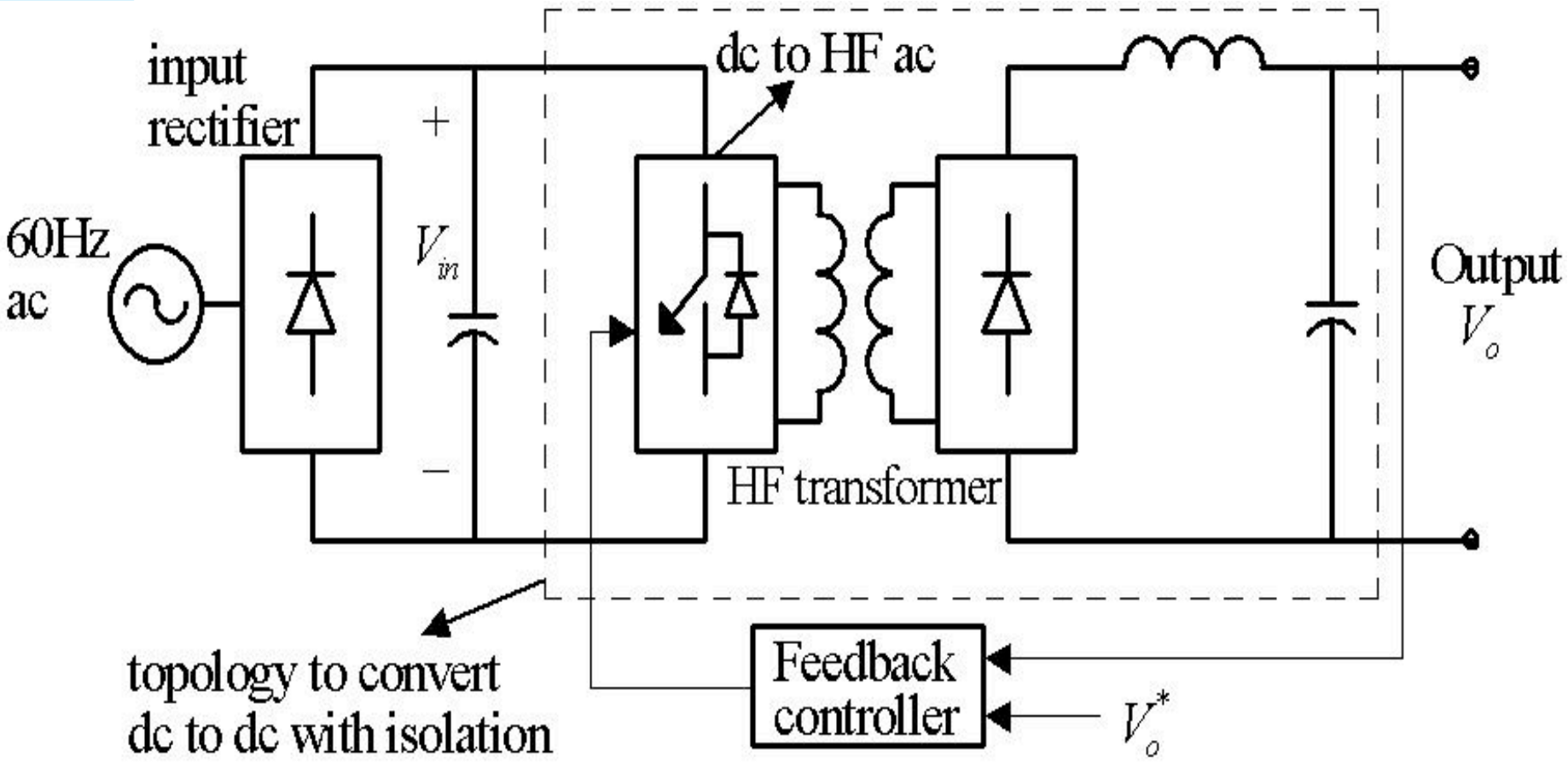
$690\,V$

$34.5\,kV$

$60\,Hz$

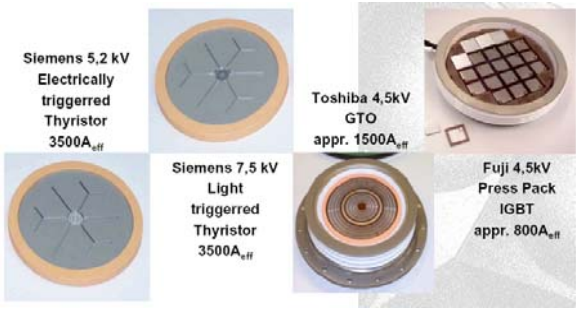
Power Electronics Converters

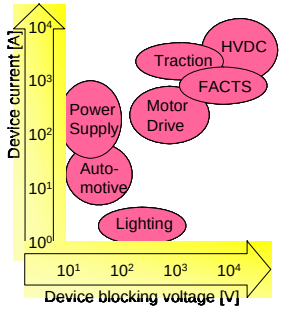
Another Example : Switch-Mode DC Power Supply



High Efficiency is very important:

- Diodes, Thyristors, MOSFETs, IGBTs, GTOs, etc used as Switches

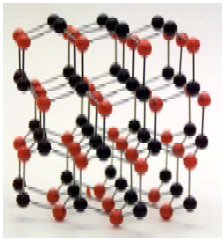




Beyond Silicon: New Materials

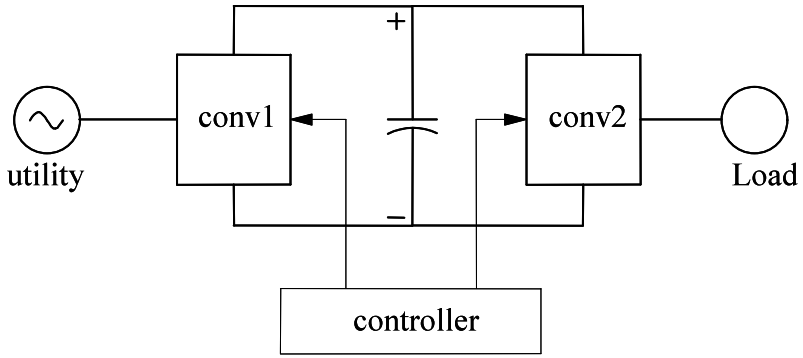
Key Parameters:

	Si	4H-SiC	Diamond	
Bandgap	1.1	**3**	5	eV
Breakdown field	0.3	**3**	10	MV/cm
Max electron velocity	1.0	**2**	3	10^7 cm/s
Thermal conductivity	1.5	**5**	20	W/cmK



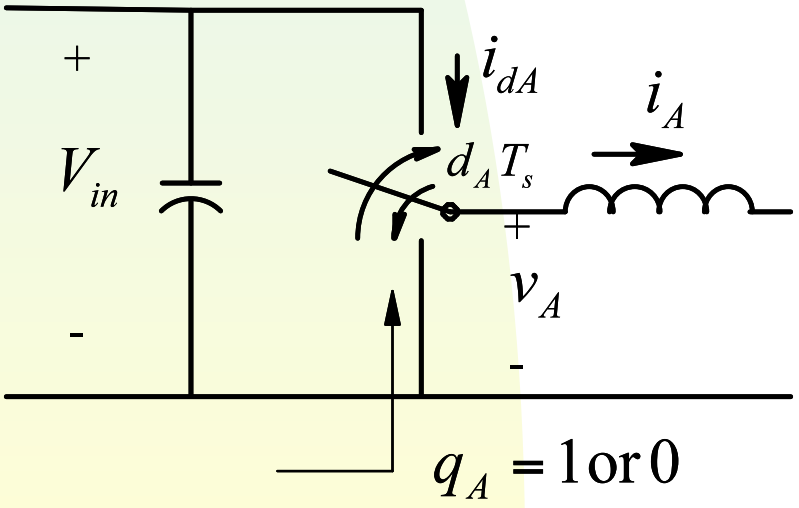
Silicon Carbide exceeds the fundamental limitations of Silicon by a factor 10-100 in improved device properties

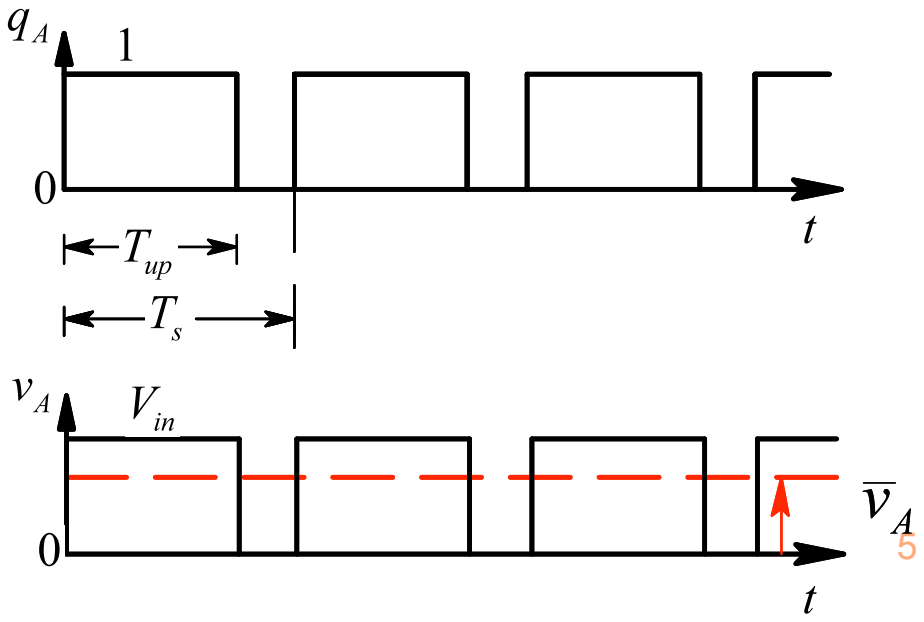
A Common Topology: Voltage-Link Converters



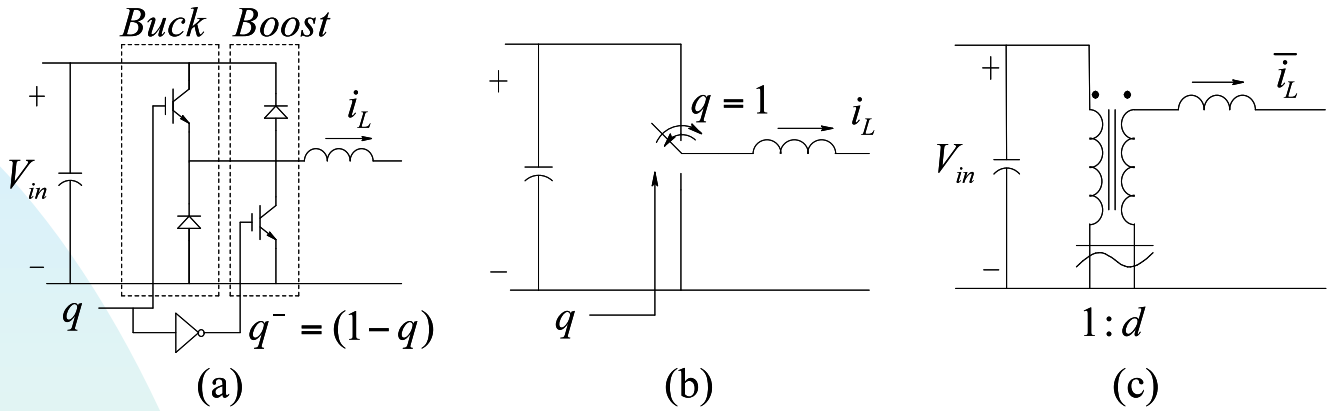
Switching Power-Pole: Building-block of converters

- Synthesis by Pulse-Width Modulation
- Bidirectional Power Flow

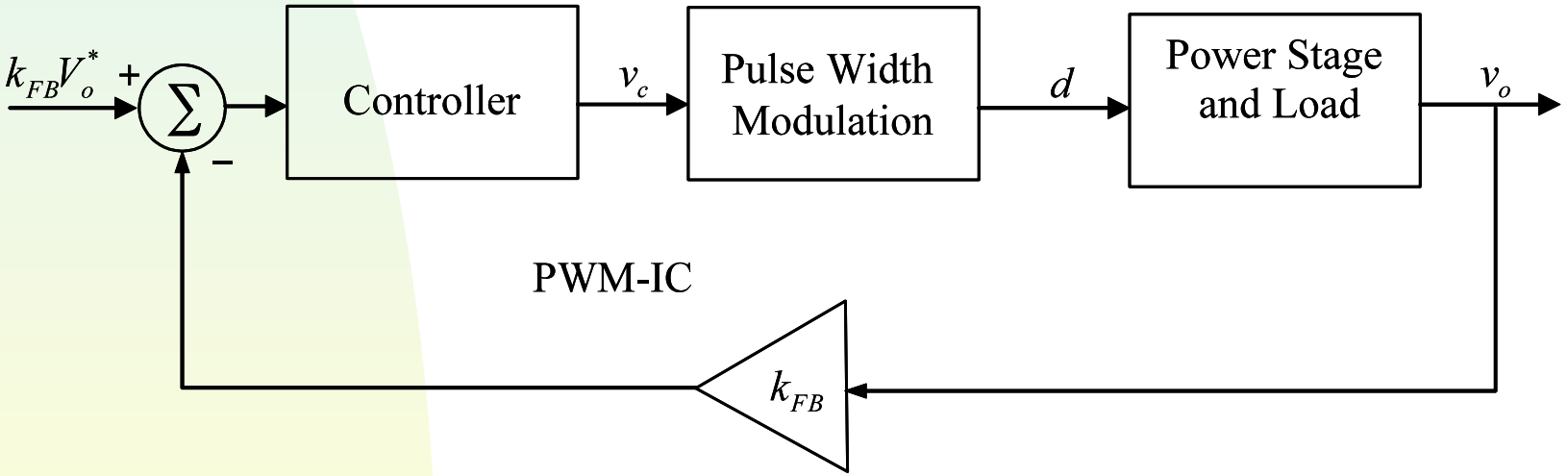




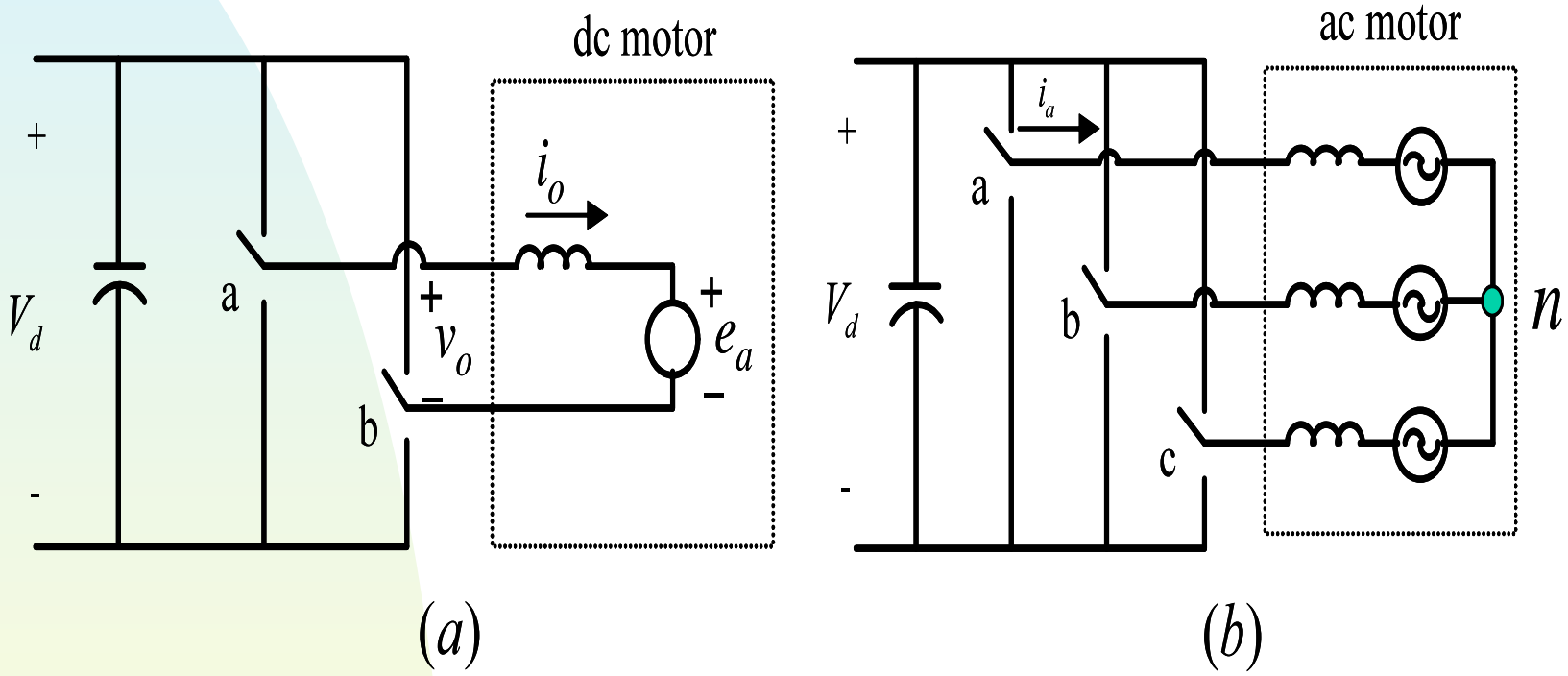
Average Representation of the Switching Power-Pole:



Feedback Control assisted by PSpice:



Converters for DC and AC Motor Drives:

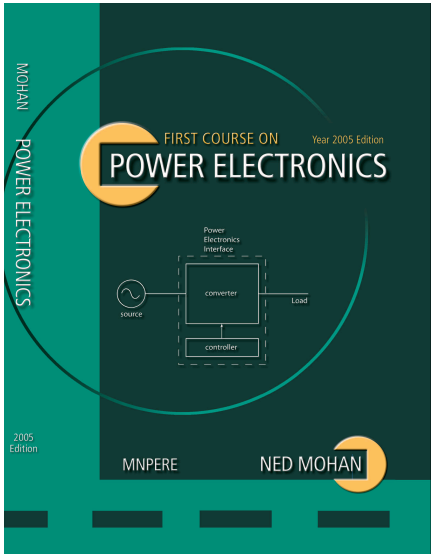


Topics Covered in this Course:

- Switch-Mode Converters
  - Buck, Boost, Buck-Boost
  - Flyback, Forward, Full-Bridge
  - DC and AC Motor Drives
  - Power-Factor-Correction Circuits
- Feedback Control
- Thyristor Converters

Textbook:

- Presentation Slides
- Solutions Manual

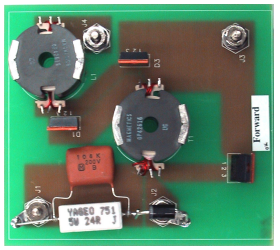


PSpice-based Lab:
(Using Student/Evaluation Version)

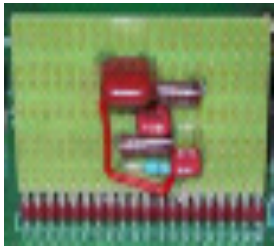
- Switching Power-Pole
- Capacitor Characteristic
- Buck, Boost, Buck-Boost Converters
- Average Modeling of dc-dc Converters
- Feedback Control: Voltage & Current-Mode
- Frequency Response in DCM
- Flyback, Forward and Full-Bridge Converters
- Soft-Switching in DC-DC Converters
- Converters for DC-Motor Drives
- Converters for 3-Phase AC Motor Drives
- Thyristor Converters

Hardware Lab: very low-cost

Switching Power - Pole Board



Magnetics Plug - In Board



Feedback Control Plug - In Board

Power Electronics Laboratory

User Manual

Department of Electrical and Computer Engineering

University of Minnesota

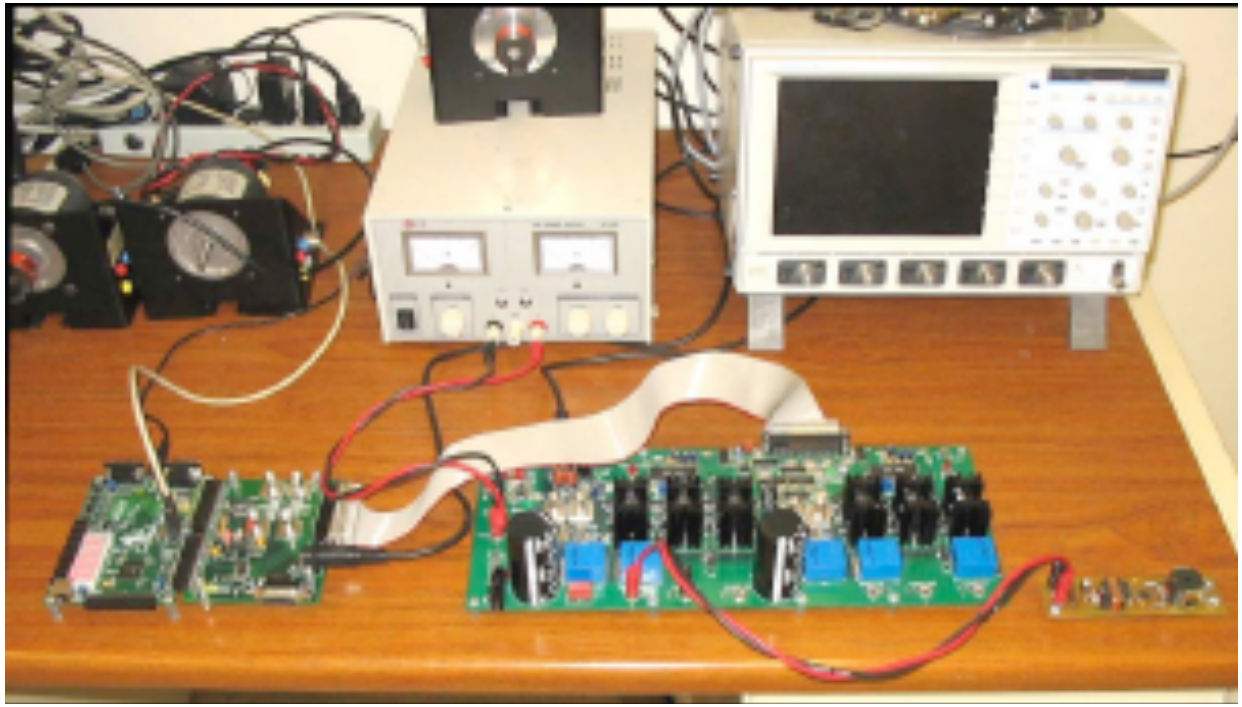
Revised: August 12, 2008

Experiments:

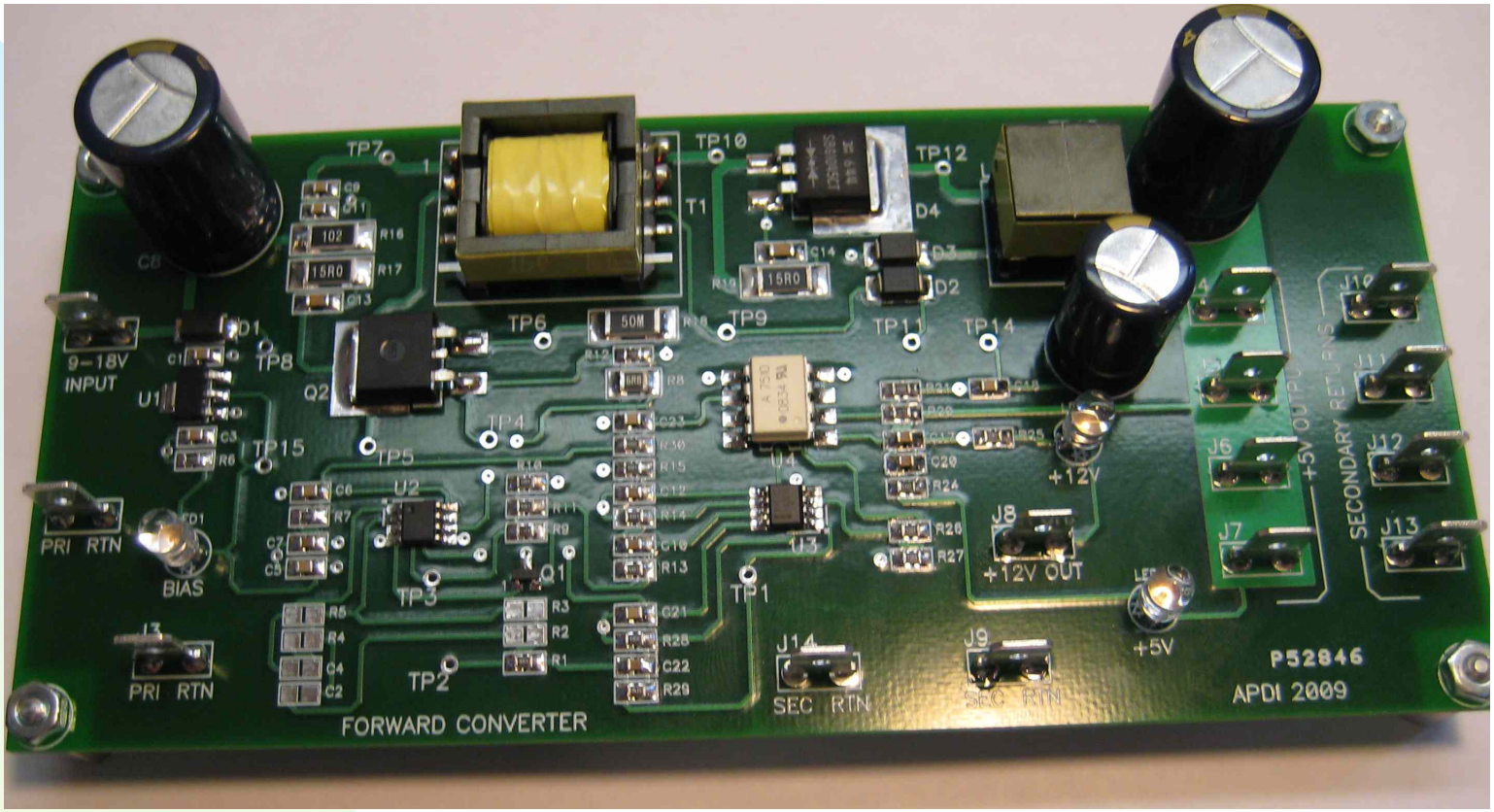
- Buck, Boost, Buck-Boost
- Feedback Control: Voltage -Mode, Peak-Current-Mode
- Flyback, Forward

Additional Experiments Using FPGAs (funded by ONR)

- Digital Control of DC-DC Converters
- Full-Bridge DC-DC Converters
- Soft-Switching in Full-Bridge DC-DC Converters
- DC Motor Drives
- 3-Phase AC Drives



Hands-on Construction Kit:



- Forward converter with regulated output
  - Components and circuit board provided.
  - Students mount (solder) components on board and test converter.

Graduate-Level Textbook: