Electronic Power Conversion

Power Electronics Applications

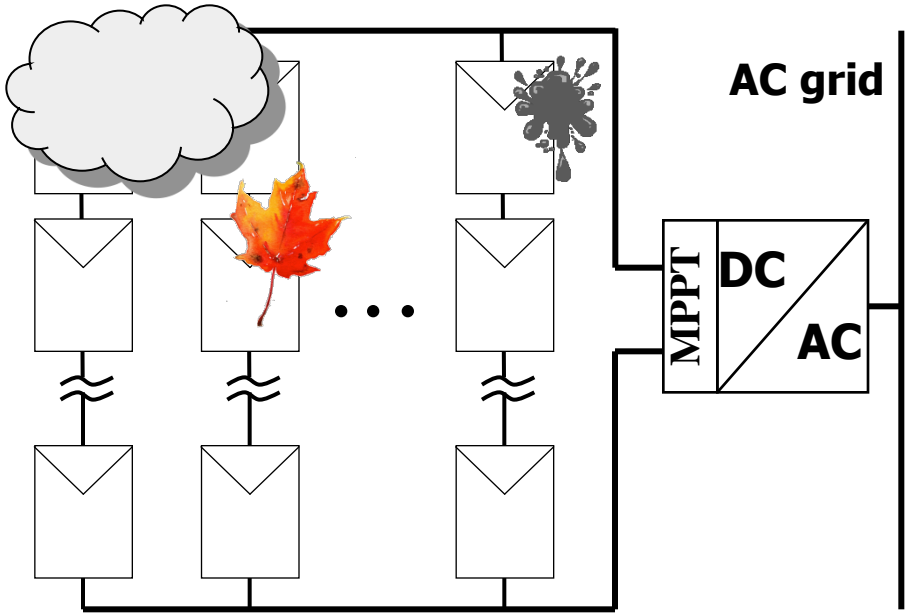
Power electronics applications (topologies covered in ET4119)

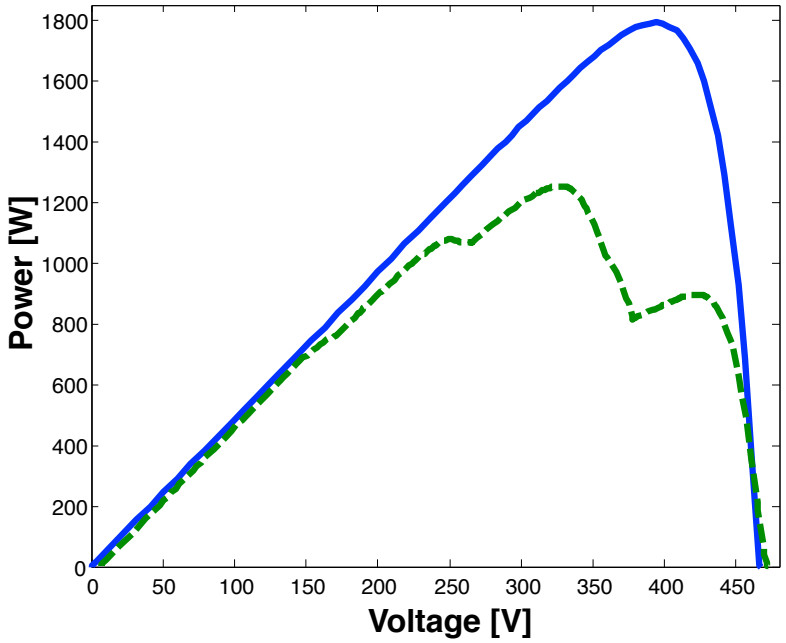
- Hard switching, PWM controlled

- PV maximum point tracker/dc-dc converter (boost)
- Automotive 42/14V dc-dc converter (buck)
- Off-line consumer power supply (flyback)
- PV inverter (full bridge inverter)
- HID lamp ballast (boost + stacked buck)

Maximum Power Point Tracking in PV systems

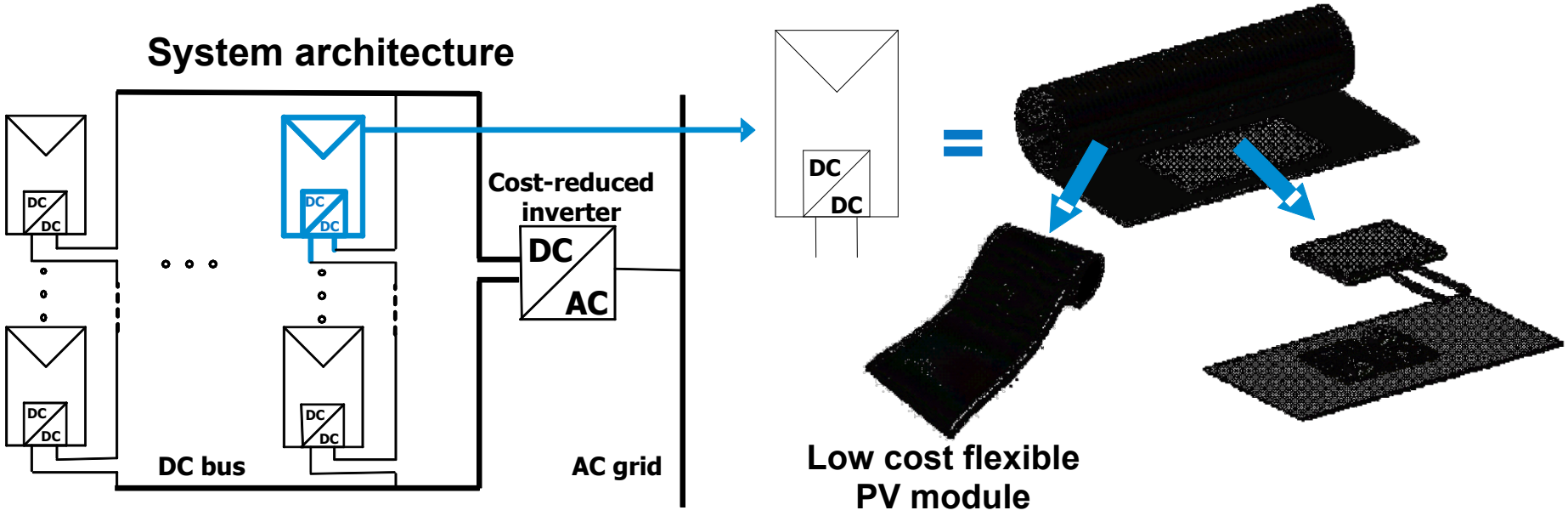
- Maximum power point tracker – high efficiency converter that presents an optimal electrical load to a solar panel or array





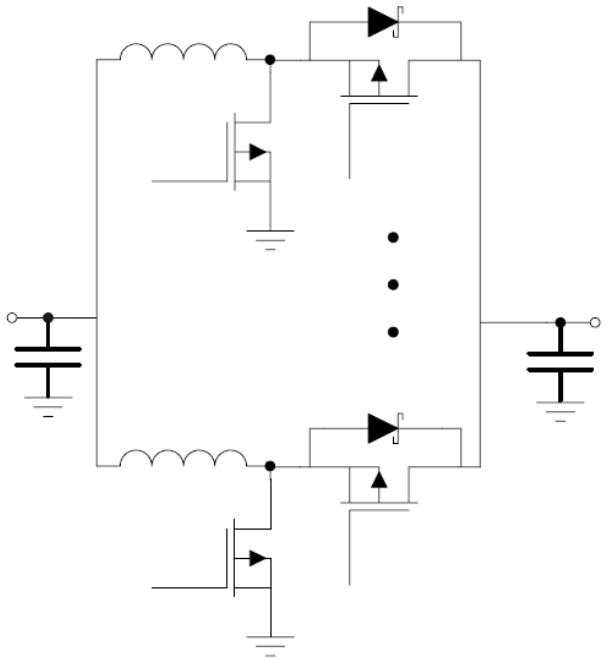
PV panel integrated dc-dc converter

- MPPT on converter level
- Converter has to be efficient, reliable AND cheap!



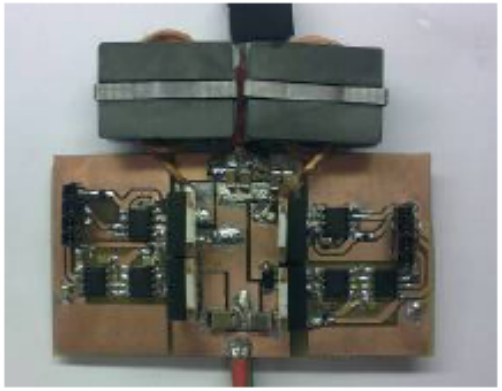
PV panel integrated dc-dc converter

- Vin 8-17V, Vout 48V, max power 120W, no isolation required
- Boost converter
- Small passives required
- High frequency switching and interleaved

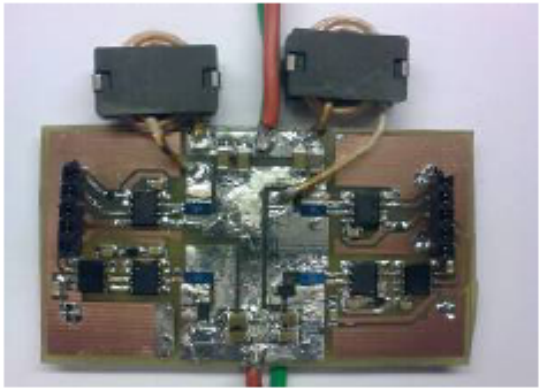


PV panel integrated dc-dc converter

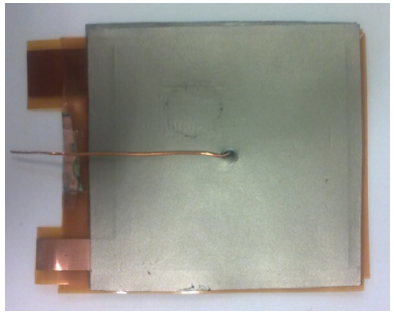
- Different devices GaN vs. Si
  - Faster, lower losses -> higher switching frequency
  - The same topology, double the switching frequency 300kHz vs 600kHz



Si based converter

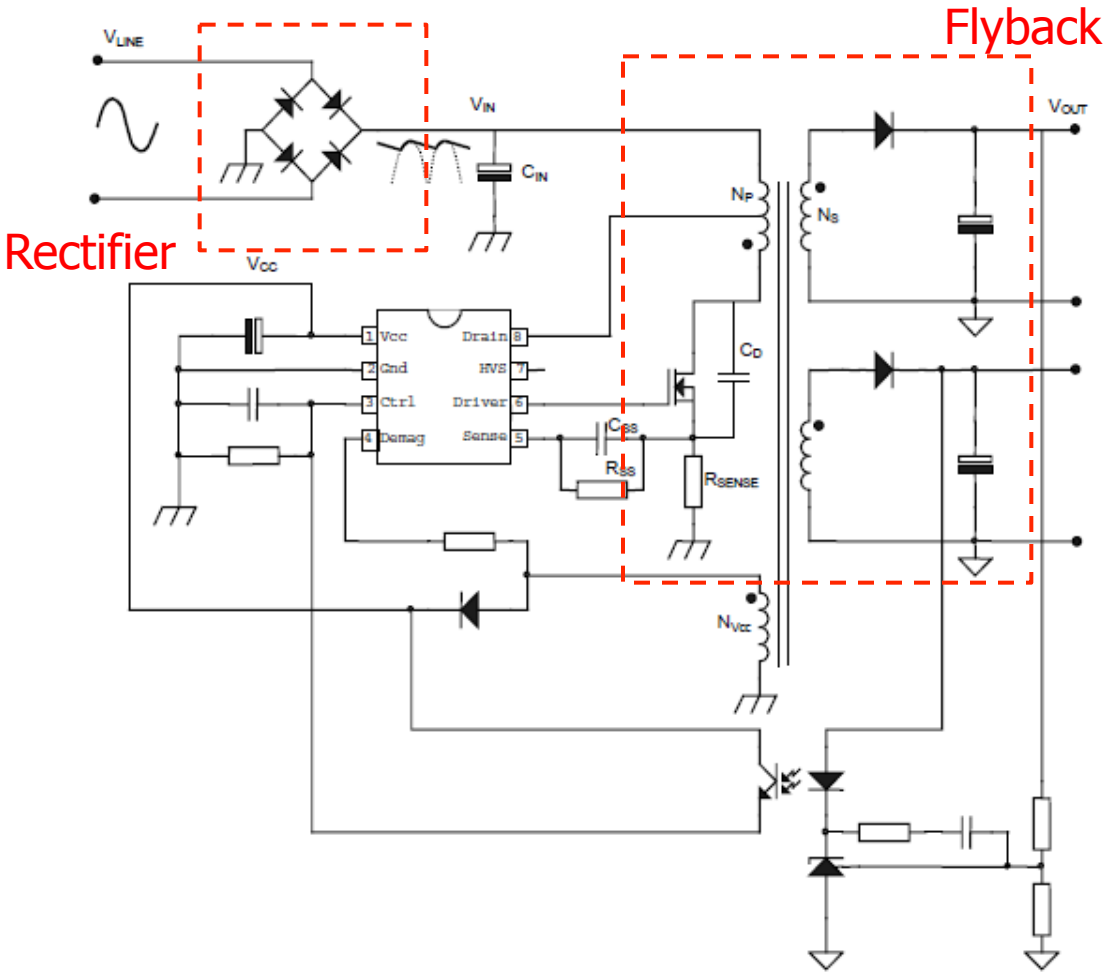


GaN based converter

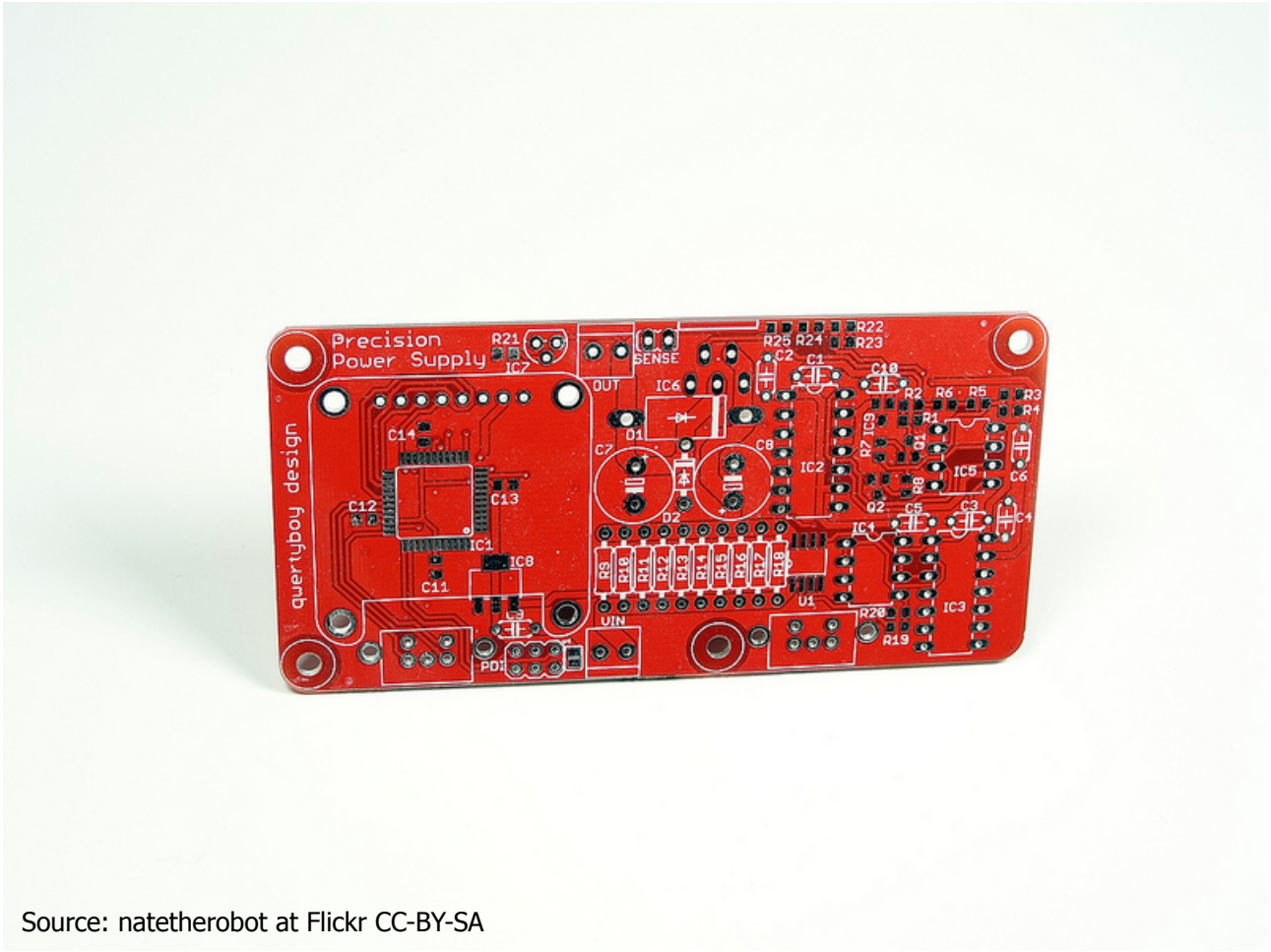


Off-line consumer power supply

- Universal mains input 85V AC – 277 V AC 50/60 Hz, ~100W
- Isolation required, cost crucial – low component count
- Flyback (boundary condition mode) – 50-100kHz



Off-line consumer power supply



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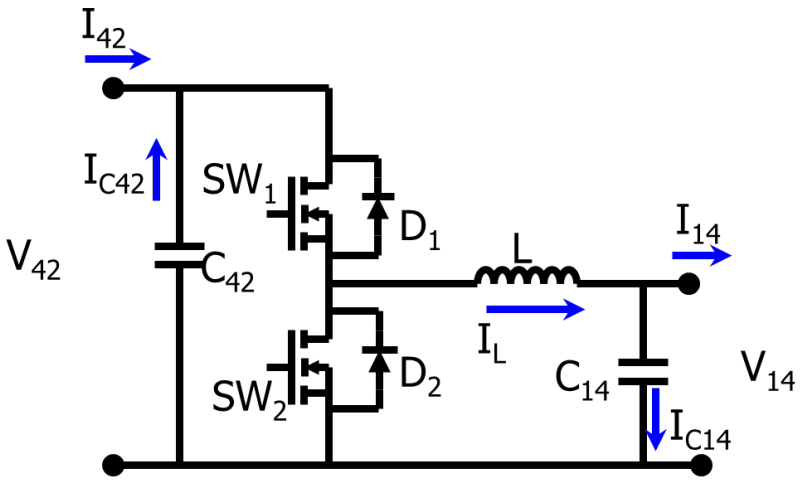
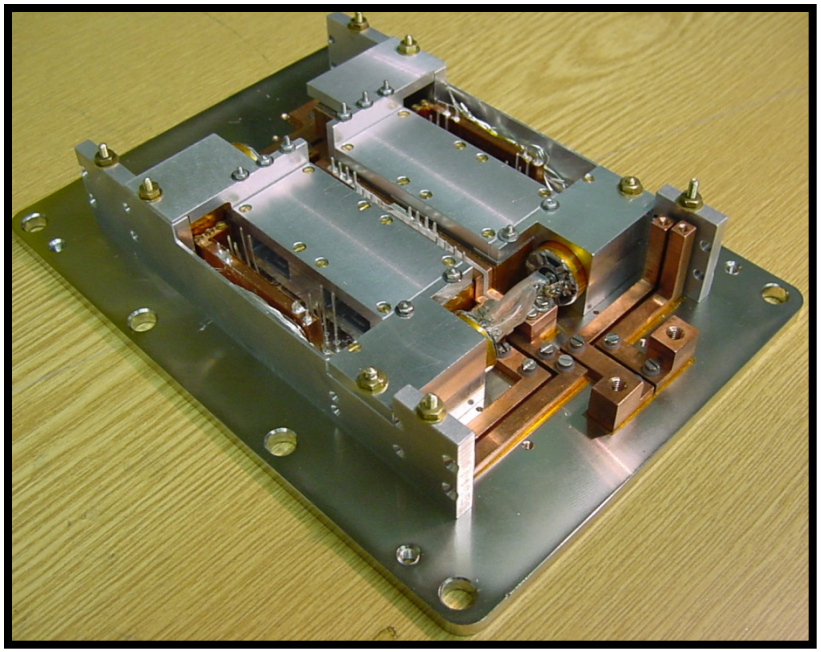
Automotive 42/14V dc-dc converter

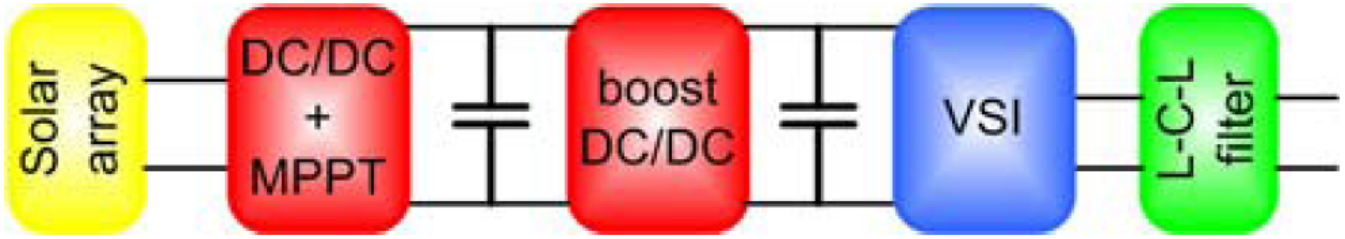
- 2kW, 42V/14V converter, no isolation
- High temperature (cooled with boiling water), high power density
- Buck (bidirectional), 100kHz
  - 7kW/l – very high (desktop power supply is 100W/l)

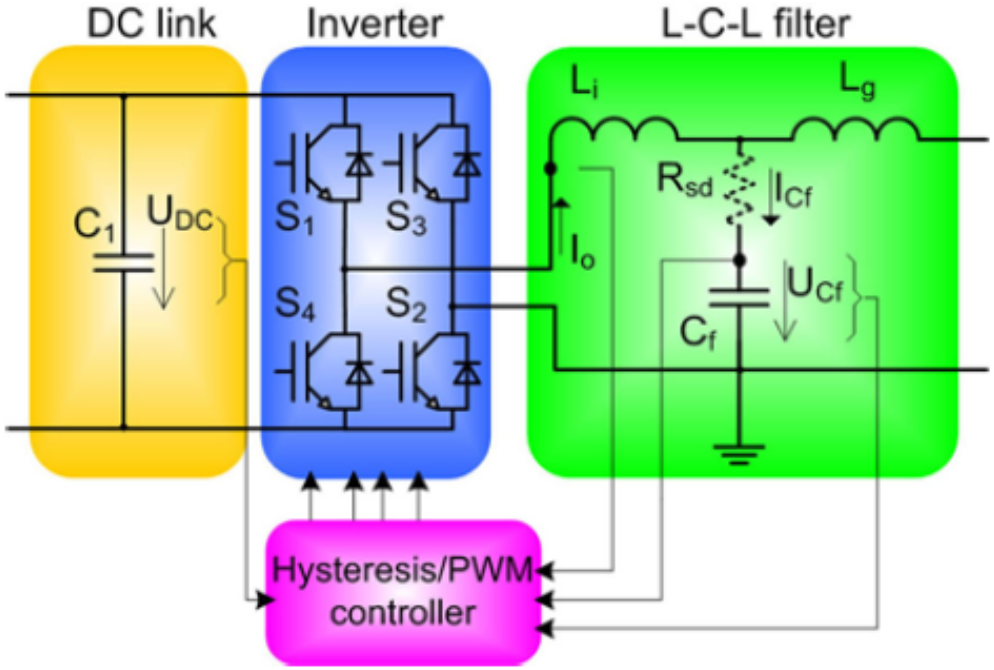




Grid connected PV inverter

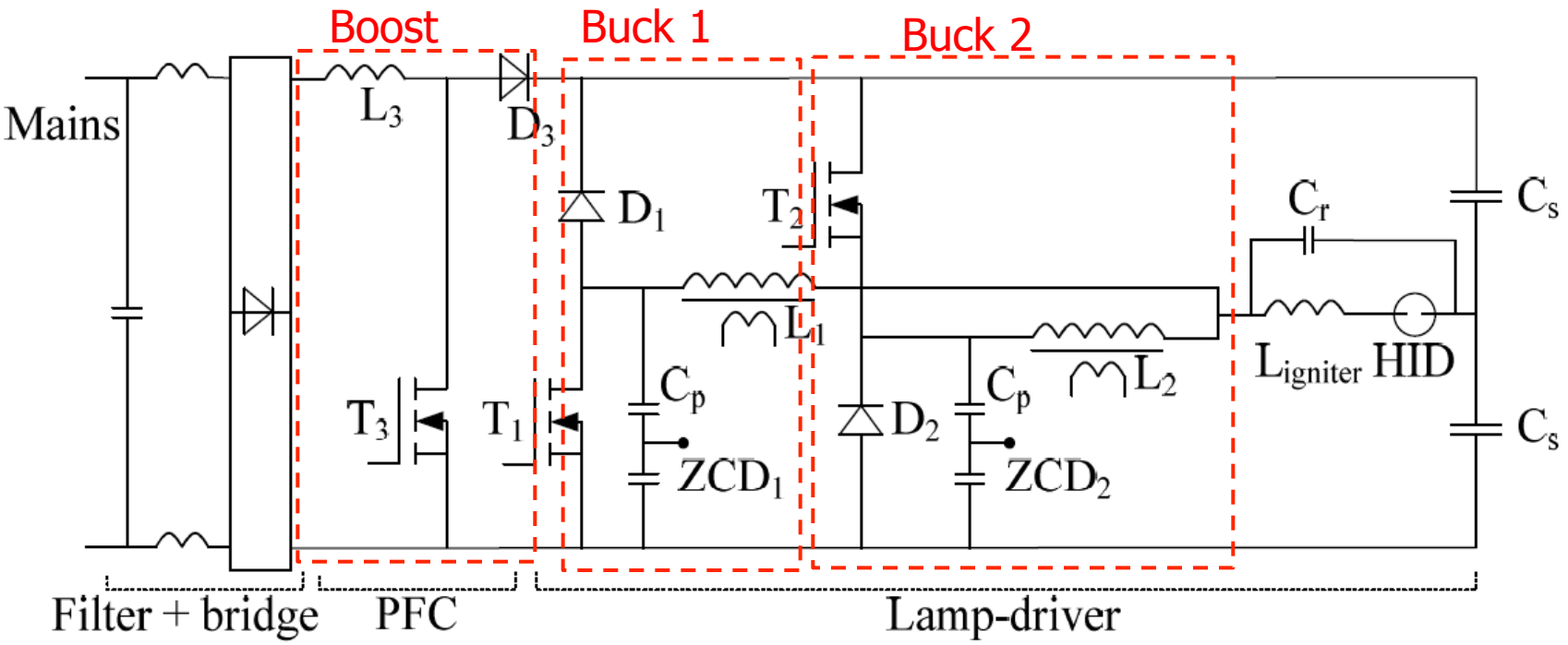
- 400Vdc input, 1.5kW, output 230Vac@50Hz
- Single phase full bridge voltage source inverter





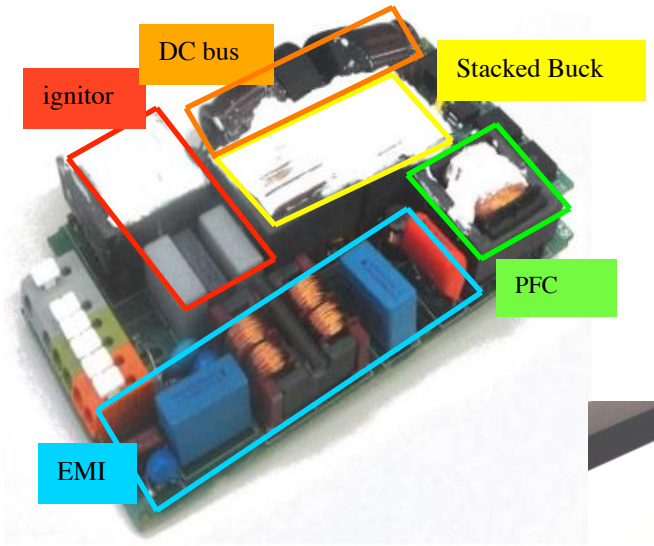
HID lamp ballast

- Boost PFC + 2 buck converters
- 150W, 83kHz

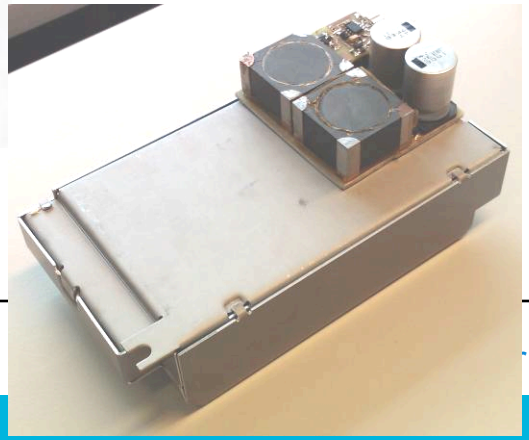


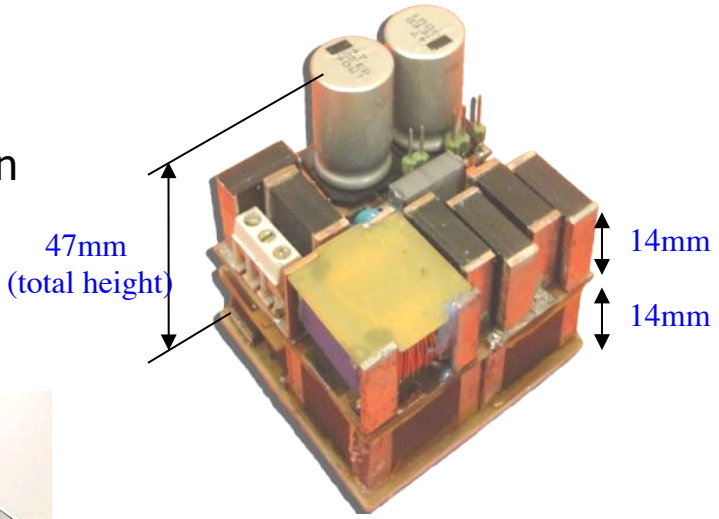
HID lamp ballast

- Keep original specs, topology and control, sw. freq. (83kHz)
- Improve thermal & spatial performance by new components and packaging method



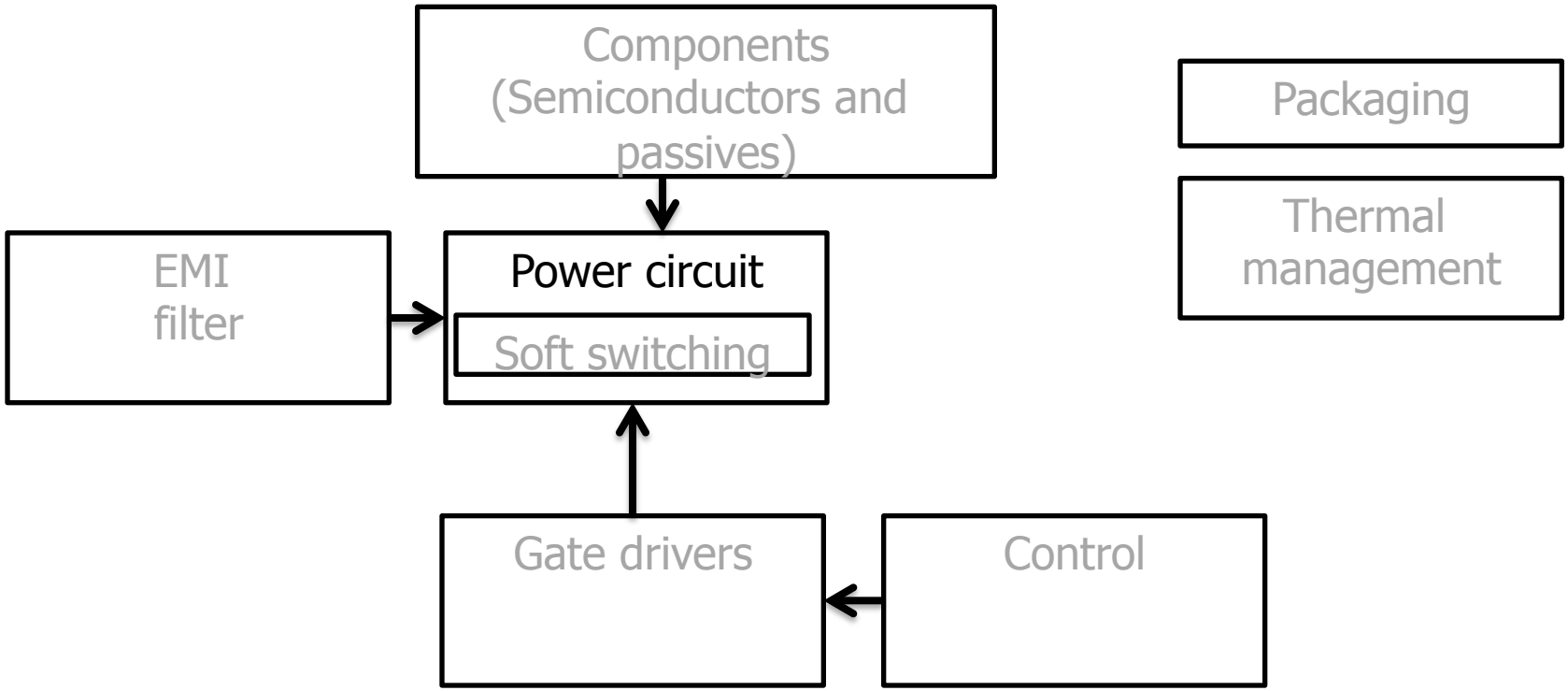
~2.5 size reduction





What have we covered?

- Basic principles of switch-mode power conversion
- Basic topologies – non-isolated and isolated (hard switched)



MSc project?

ET4003 Power Electromagnetics

ET4384 Design of low-power power supplies

ET4145 Power electronic components

ET4116 Power electronics

ET4119

You have only just embarked on the journey in the exciting world of power electronics!

Image credits

- All uncredited diagrams are from the book "Power Electronics: Converters, Applications, and Design" by N. Mohan, T.M. Undeland and W.P. Robbins.
- All other uncredited images are from research done at the EWI faculty.