University of Idaho

ECE 529
Utility Applications of Power Electronics

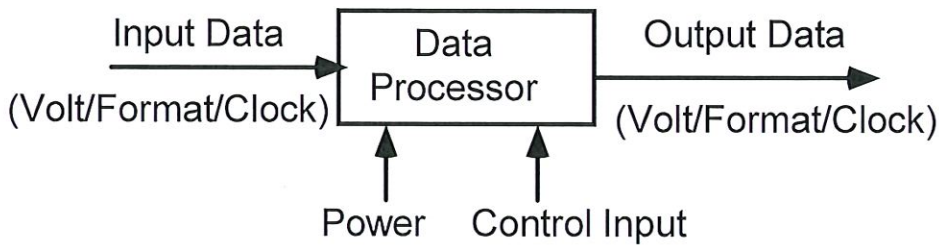
Session 2

L2 1/8

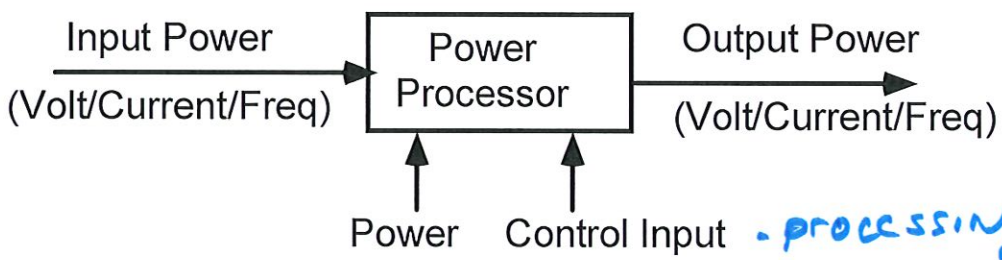
ECE 529: Lecture 2
Basic Power Electronics

I. Power Converters

A. Basic Purpose for Information Electronics



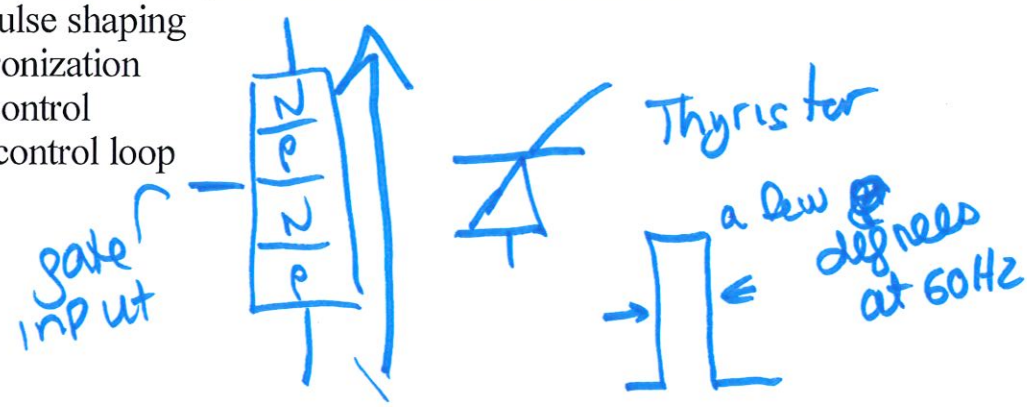
B. Basic Purpose for Power Electronics



- processing measurements & commands (closed loop control)

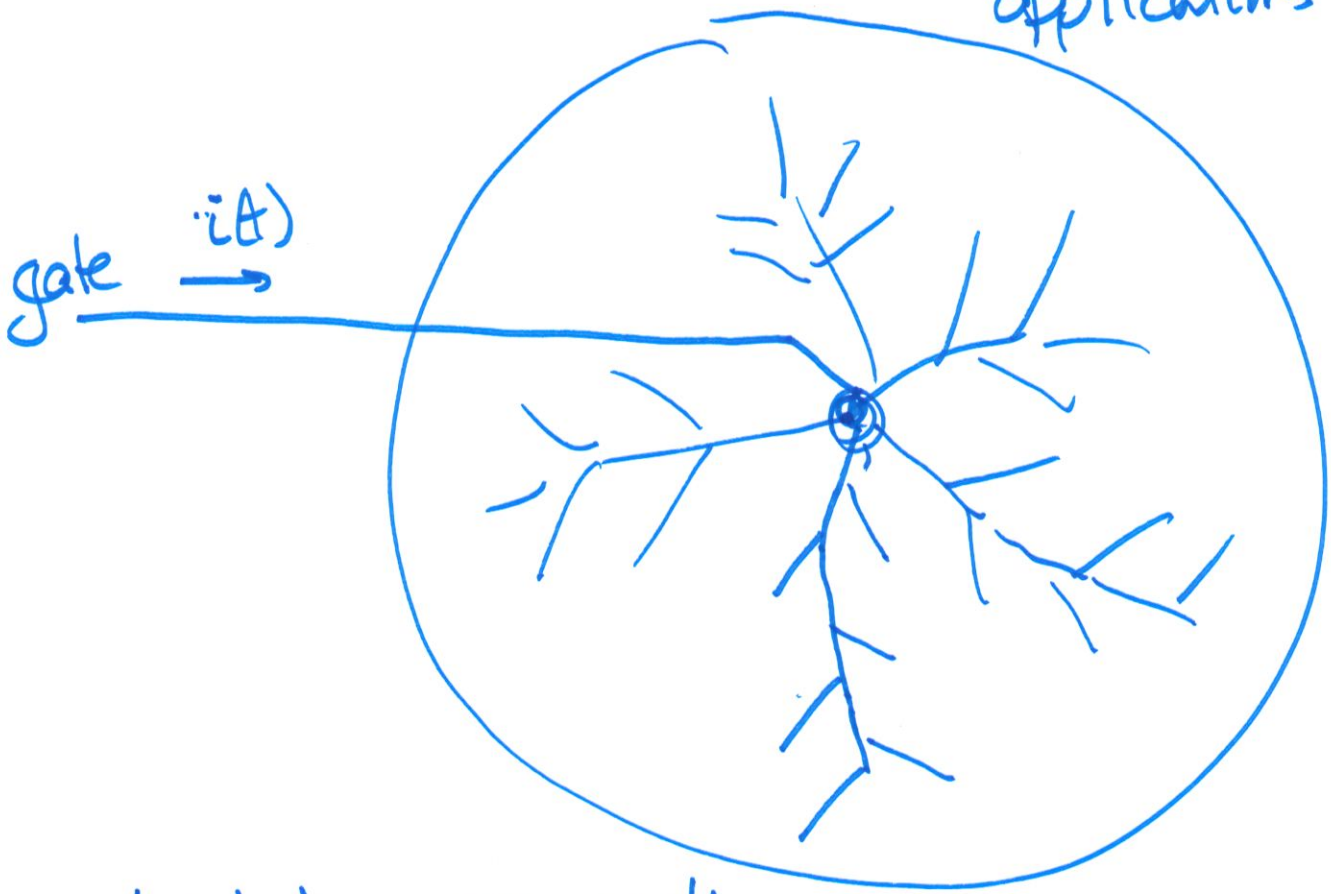
C. Complete Power Converter versus Power Electronic Circuit

1. The power electronic circuit consists of the switching devices and passive elements (generally inductors and capacitors)
2. The power converter is a system that includes controls for:
   - A. Gate pulse shaping
   - B. Synchronization
   - C. Inner control
   - D. Outer control loop



Thyristor - mostly used in very high MVA applications } low losses

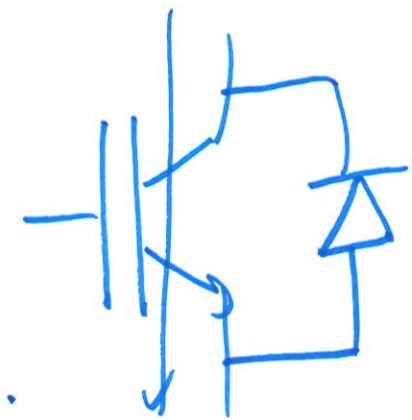
- up to about 8 inches diameter



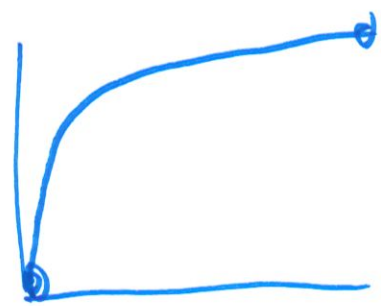
- This
- can carry up to about 8-10 kA
- can block up to about 8kV when off

- Latches on with a short, sharp pulse
- only turns off at a natural current zero

- Insulated Gate Bipolar Transistor (IGBT)

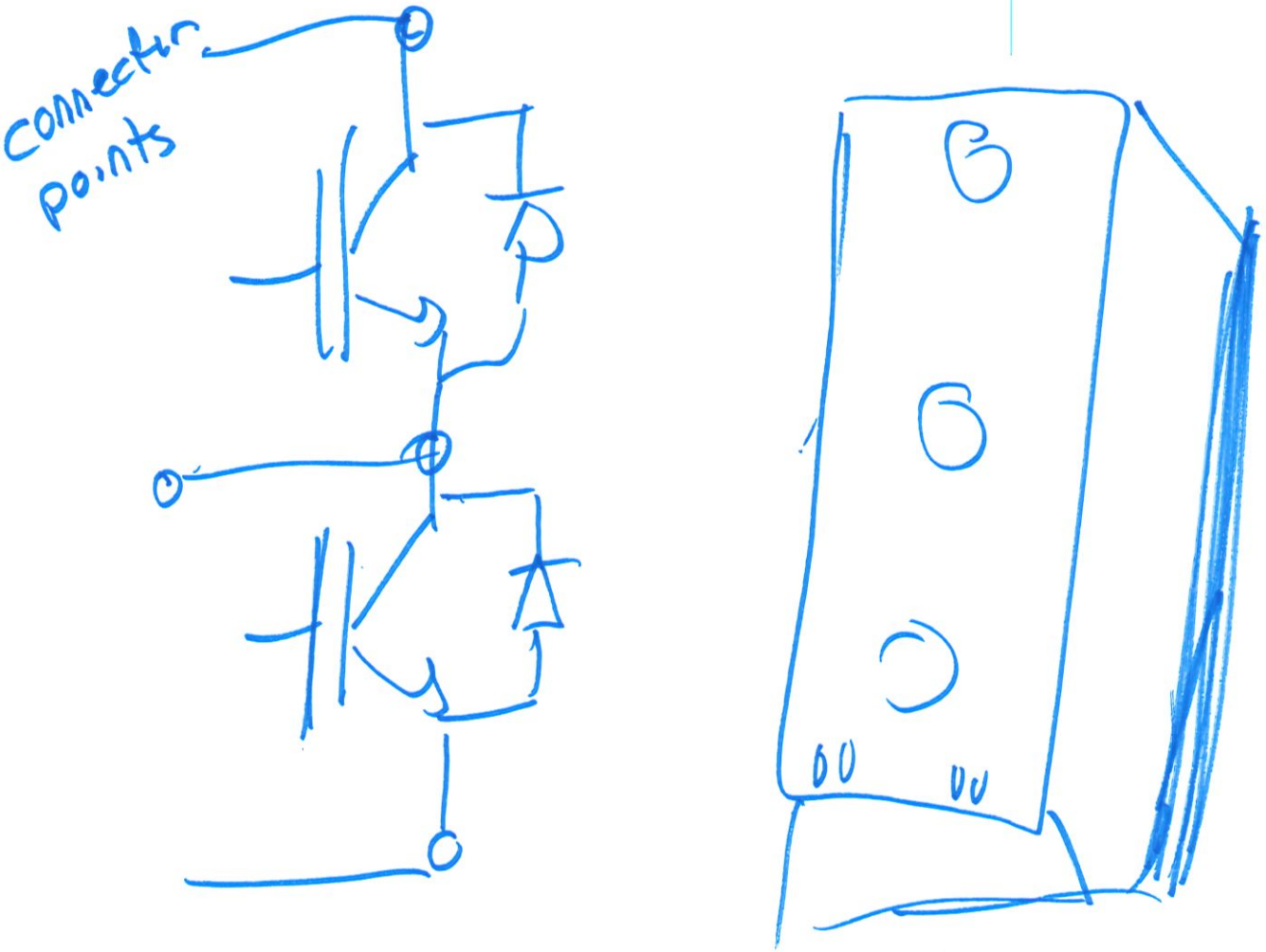


Combine properties of BJT with mosfet

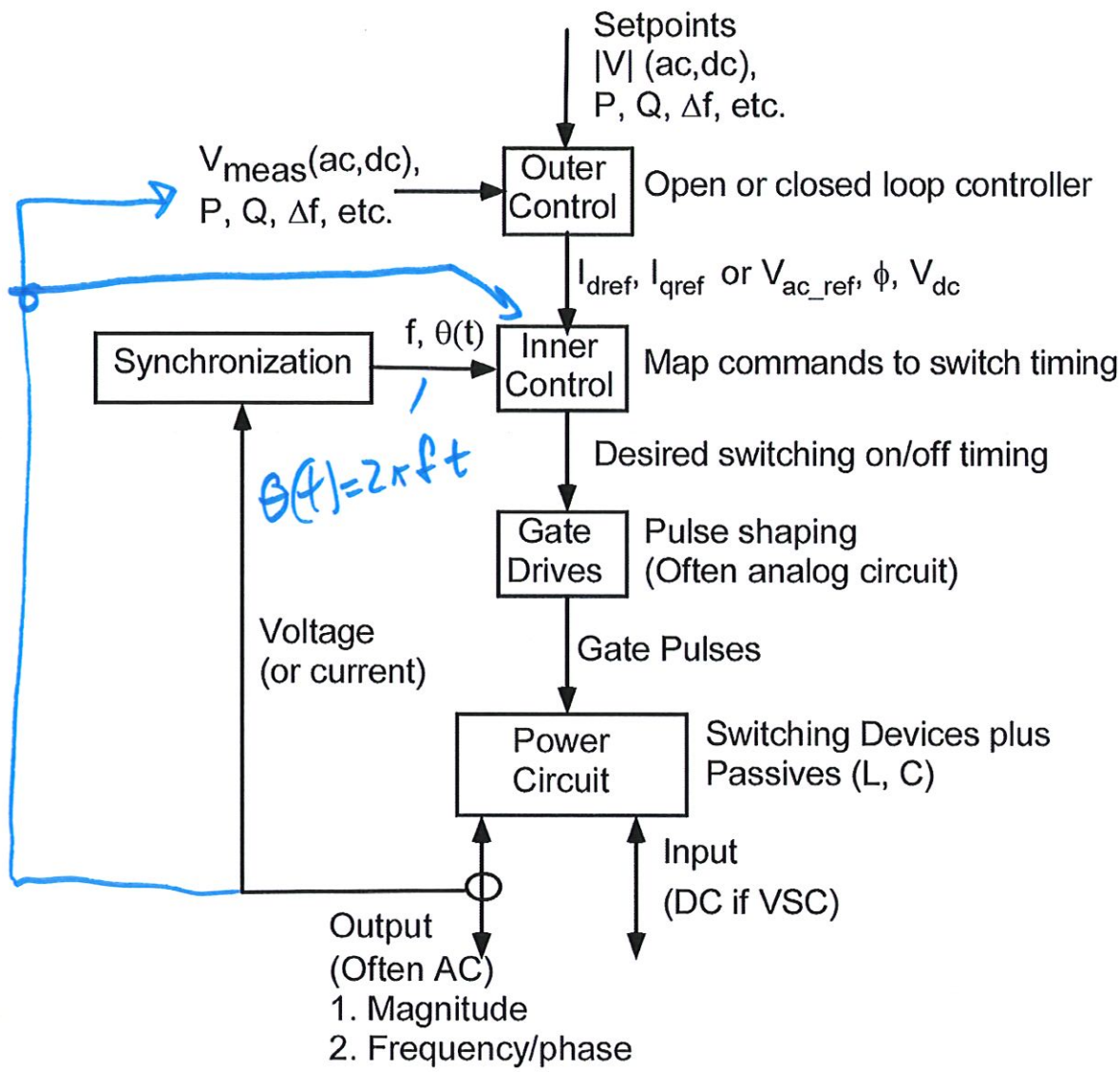


control turn on & turn off

common IGBT package



L2 5/6


Setpoints
|V| (ac,dc),
P, Q, Δf, etc.
Outer Control
Open or closed loop controller
Vmeas(ac,dc),
P, Q, Δf, etc.
Idref, Iqref or Vac_ref, ϕ, Vdc
Synchronization
f, θ(t)
Inner Control
Map commands to switch timing
θ(t)=2πft
Desired switching on/off timing
Gate Drives
Pulse shaping
(Often analog circuit)
Voltage
(or current)
Gate Pulses
Power Circuit
Switching Devices plus
Passives (L, C)
Input
(DC if VSC)
Output
(Often AC)
1. Magnitude
2. Frequency/phase

$e = N\frac{d\phi}{dt}$ $\phi(t) = \Phi_m \sin(\omega t)$

$e(t) = N\omega\Phi_m \cos(\omega t)$

9/9 27

Power Electronics in Power Systems

ECE529

Lecture 1

- Power systems increasingly utility power converters
  - » Loads
  - » Generation → exciters, wind, PV
  - » Distribution voltage support
  - » Transmission performance
  - » Bulk power transmission over long distances

DC

Power Generation

ECE529

Lecture 1

- Large synchronous generators
- Smaller distributed generators
  - » 1: Diesel generators -/gas
  - » 2: Fuel cells – depend on power electronics
  - » 3: Microturbines – power electronics
  - » 4: Wind turbines -- power electronics enhance
    - – Large installations on transmission systems
  - » 5: Photovoltaic – depend on power electronics
    - – Distribution or transmission