ECE 529
Utility Applications of Power Electronics

Session 8
Impact of Fundament Rules of Power Electronics on Converter Topologies

- Design such that switch actions connect a voltage source (C) to a current source (L)
  » Sometime rotating machines substitute either
- Circuit design and control design to protect switches from overcurrent

Topologies

- Diode rectifiers
  - Thyristor controlled rectifiers/inverters
    » Current source converters
- DC/DC converters
- Switched mode power supplies
- Voltage sourced converters
- Transformer coupled converters
- Thyristor controlled reactor or capacitor

Spring 2021
Single Switch DC/DC Converters:
Buck Converter (step down)

- One controlled switch

\[ V_o = D \times V_d \]
Using average values

Switch frequency

Inductor current

\[ I_d = D \times I_o \]
Using average values
All 3 are unidirectional
→ Power goes from source to load

Single Switch DC/DC Converters: Boost Converter

- One controlled switch

\[ V_0 = V_d/(1-D) \]
Using average values

- Input current can be continuous
- Can combine with rectifier

Voltage Sourced Converters 5
Spring 2021

Single Switch DC/DC Converters: Buck/Boost Converter

- One controlled switch

\[ V_0 = D^*V_d/(1-D) \]
Using average values

Voltage Sourced Converters 6
Spring 2021
Half Bridge Converter

- Start from buck converter
- It splits the left side with two capacitors, can produce positive or negative output voltage
- Can use for DC-AC conversion

Basic Idea Behind VSC

- Goal is to synthesize ac voltage waveform from dc voltage source
- Current follows from voltage different across ac side
- Different avenues to improve quality of the voltage and current waveform
- Scaling to high power applications
- Different topologies as a result
Adding Open-Loop Switching Control for Power Electronics

DC-DC Converter Option 1:

Power Circuit

Switch dialog:
-- Gate controlled switch
-- Note GIFU

Input (voltage stiff)
Output
-- current stiff with inductor
-- voltage filtered by capacitor

Gate Controls

Set Duty

Comparator

LOGPUL

TRIA1

ZERO

TRIA3

TRIA

PLUS1

MINUS1

NEGTRI

PLUS1
Option 2: Two controlled Switches

- Replace diode with controlled switch
- Controlled in opposition to top switch

- Modification to controls

![Diagram of power circuit and comparator with waveforms showing voltage levels and timing]