ECE 529
Utility Applications of Power Electronics
Session 9
Diode and Thyristor Rectifiers

- DC voltages
- L-R voltage
- Current commutates to D2
- Ac currents -- DC inductors bypassed
- Varn (V_{o,s} - V_{o,hi})
- Positive rail to ground
- Negative rail to ground
- L-R voltage
- Pole-to-pole volts
- Vs
- Ideal Source
- Ideal Inductor
- RL
- RL

\[ E_1, E_2, E_3 = R_{th} \times 2\pi f L \]
\[ E_S = R_{th} \times 2\pi f (\leq 60) L \]
\[ T_3 \text{ is more forward biased than } D1 \]
\[ V_{POS, NG} \]
- Phase A only

\[ i(t) = i_A(t) + i_S(t) + i_L(t) \]

120°

- DC current:

- Now include dc inductors: DC voltages:

Large inductor

- Zoom in (pole to pole)

- Voltage or Resistor

- 6 pulse ripple
Single Switch DC/DC Converters: Buck Converter (step down)

- One controlled switch

\[ V_o = D \cdot V_d \]

Using average values

Voltage Sourced Converters

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

Inductor current

\[ i_L = \frac{D \cdot V_o - V_d}{L} \]

Switch and diode currents

\[ i_d = D \cdot i_o \]

Using average values

Voltage Sourced Converters

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Single Switch DC/DC Converters: Boost Converter

- One controlled switch

\[ V_o = V_d/(1-D) \]

Using average values

- Input current can be continuous
- Can combine with rectifier

Voltage Sourced Converters

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Single Switch DC/DC Converters: Buck/Boost Converter

- One controlled switch

\[ V_o = D \cdot V_d/(1-D) \]

Using average values

Voltage Sourced Converters

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Half Bridge Converter

- Start from buck converter
- If split 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 R-L circuit
- Different avenues to improve quality of the voltage and current waveform
- Scaling to high power applications
- Different topologies as a result

Voltage Sourced Converters

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Adding Open-Loop Switching Control for Power Electronics

**DC-DC Converter Option 1:** Unidirectional Power Flow Support

- ATP Implementation

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![Power Circuit Diagram](image)

Input (voltage stiff)  
Output

- current stiff with inductor
- voltage filtered by capacitor

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![Gate Controls Diagram](image)