ECE 529
Utility Applications of Power Electronics
Session 9
Power goes DC → AC → Inverter

Voltage Sourced Inverter (VSI)

motor drive

Induction motor

diode rectifie

Regeneration
US Style Diesel Electronic Locomotive

Diode rectifier

Wheels

4 or 6 total
- Converter - bidirectional power flow
- Rectifier - power AC-DC

VSC

CSC

modeling & analysis of VSC

→ Chapter 2 of Yazdani & Iravani
- Controlled switch model
  - carries current in either direction interrupts current at next time step

### Component: SW_TACS

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<thead>
<tr>
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<th>Unit</th>
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<tr>
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<tr>
<th>Node</th>
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<td>Io</td>
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### Component: DIODE

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Output:
- 3 - Current&Voltage

NumPh 1
- PSCAD/EMTDC Implementation

[Diagram of an electrical circuit with labels and components]

[Graph showing waveforms labeled 'Isw' and 'Idiode']
Switch closed

\[ V_{dc} > V_0 \]

\[ \Delta i = \frac{(V_{dc} - V_0) \Delta t}{L} \]

\[ \Delta V = L \frac{\Delta i}{\Delta t} \]

closed switch (model)

\[ (0 - V_0) (1 - D) T_s \]

open switch (model)

volt-second balance
- EMTP-RV implementation

\[
2 \cdot \pi \cdot f \cdot t
\]
Option 2: Two controlled Switches: Bidirectional Power Flow Support

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

- Modification to controls

Graph showing waveform with time in milliseconds and voltage values.
\[ V_0 = D \frac{V_o}{V_{in}} \]
- EMTDC implementation

Interpolated switching control
EMTP-RV Implementation
Si closed - $V_{AB} = V_{AC} - \frac{\sqrt{2}}{2} V_{top}$

Si open - $V_{AB} = -\frac{V_{AC}}{2}$

$V_{AB}$ (Si open)
Early inverters for PV

Fundamental component of voltage matters for power transfer

$T = \frac{1}{60\text{Hz}}$
Open-Loop DC/AC Half Bridge Converter

Power Circuit

- Now have grounded midpoint on DC link
- Both switches need to be bidirectional

Gate Controls

- Updated son
Create sinusoidal \( m(t) \) function \( \rightarrow \) modulation function

\[ w^t \]

\[ \cos \]

\[ \Sigma \]

\( V_{m_{pu}} \)

\[ M \]
(file HalfBridgeDCAC.p14; x-var t) V:TRIA I:MM

AC voltage

V(t) is scaled version of V(t) (fundamental component)