

Power Converter Systems

Graduate Course EE8407

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Ryerson Campus

Topic 8

Other Multilevel Voltage Source Converters



Five-Level NPC/H-Bridge Inverter System with dual 18-pulse rectifier
LEDAR, Ryerson University

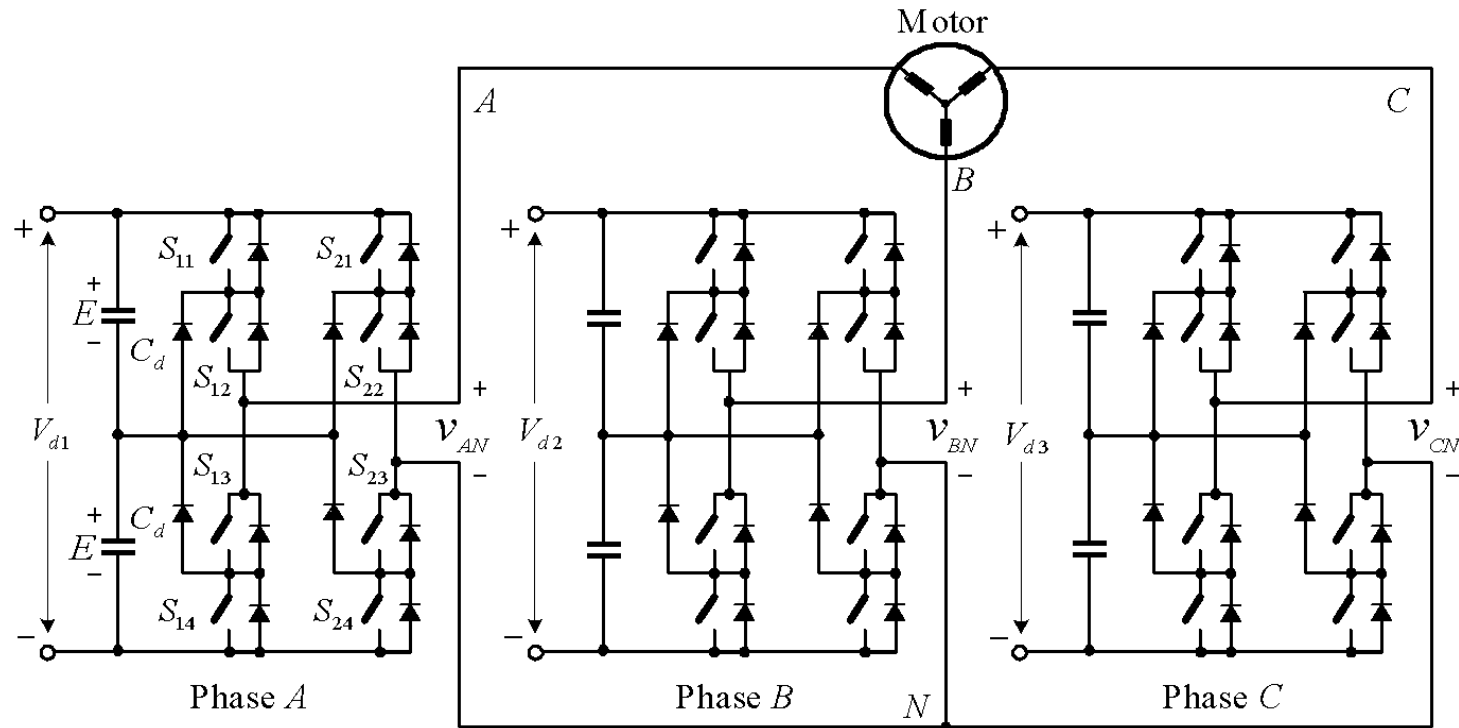
Other Multilevel Voltage Source Converters

Lecture Topics

- **NPC/H-Bridge Inverters**
- **Flying-Capacitor Inverters**

NPC/H-Bridge Inverters

• Five-Level Topology

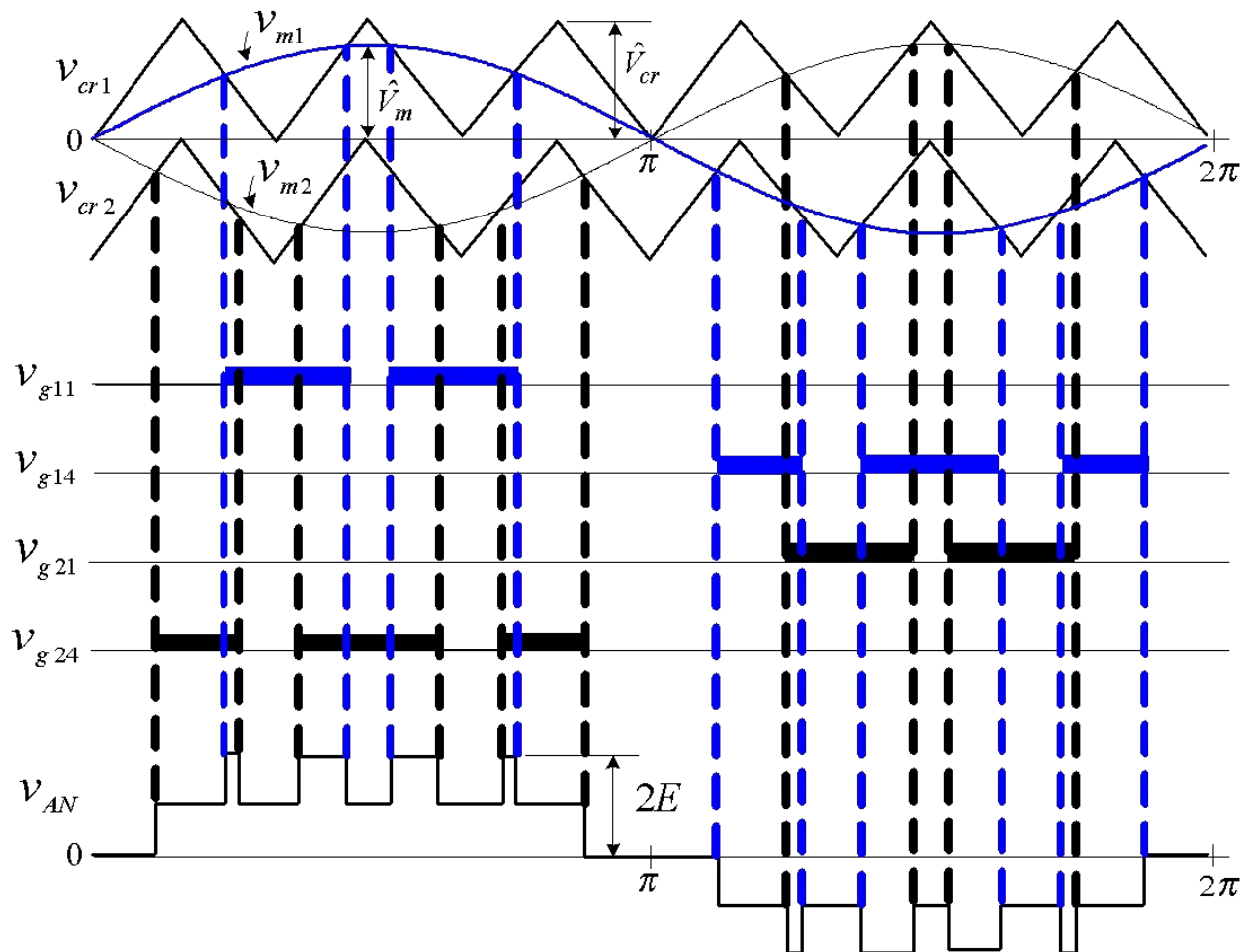


Compared with three-level NPC Topology:

- Voltage levels increases from three to five
- Inverter output voltage and power are doubled
- Device count is doubled

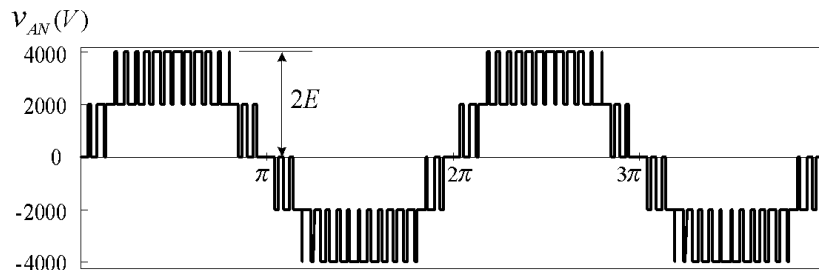
NPC/H-Bridge Inverters

- IPD Modulation

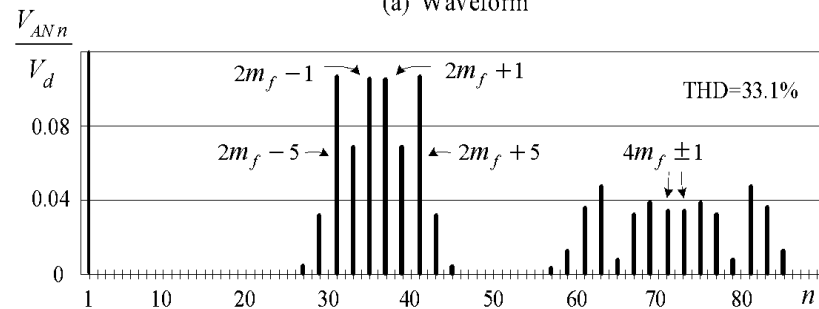


NPC/H-Bridge Inverters

• Waveforms and FFT (Five Level)

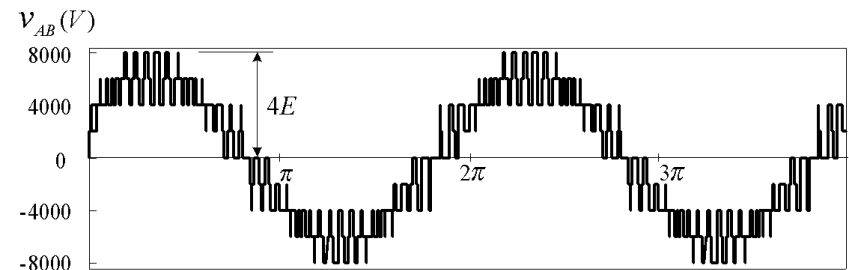


(a) Waveform

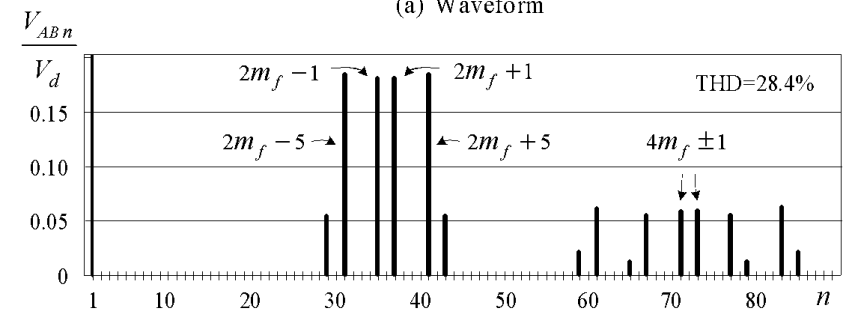


(b) Spectrum

Inverter Phase Voltage



(a) Waveform

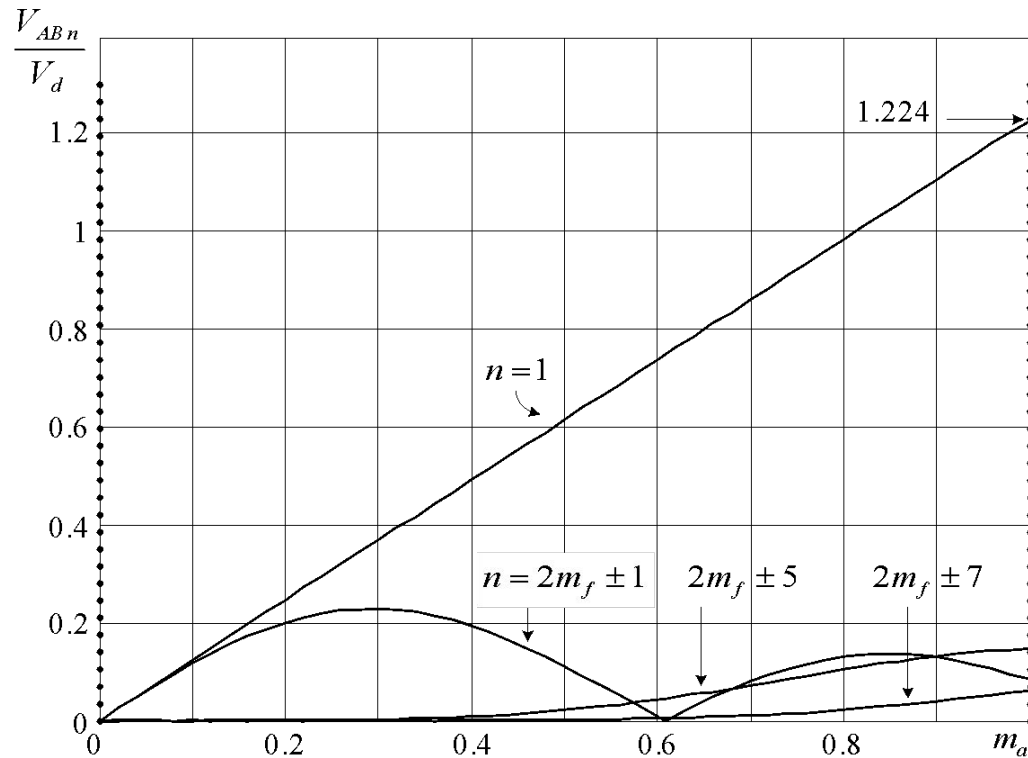


(b) Spectrum

Line-to-line Voltage

NPC/H-Bridge Inverters

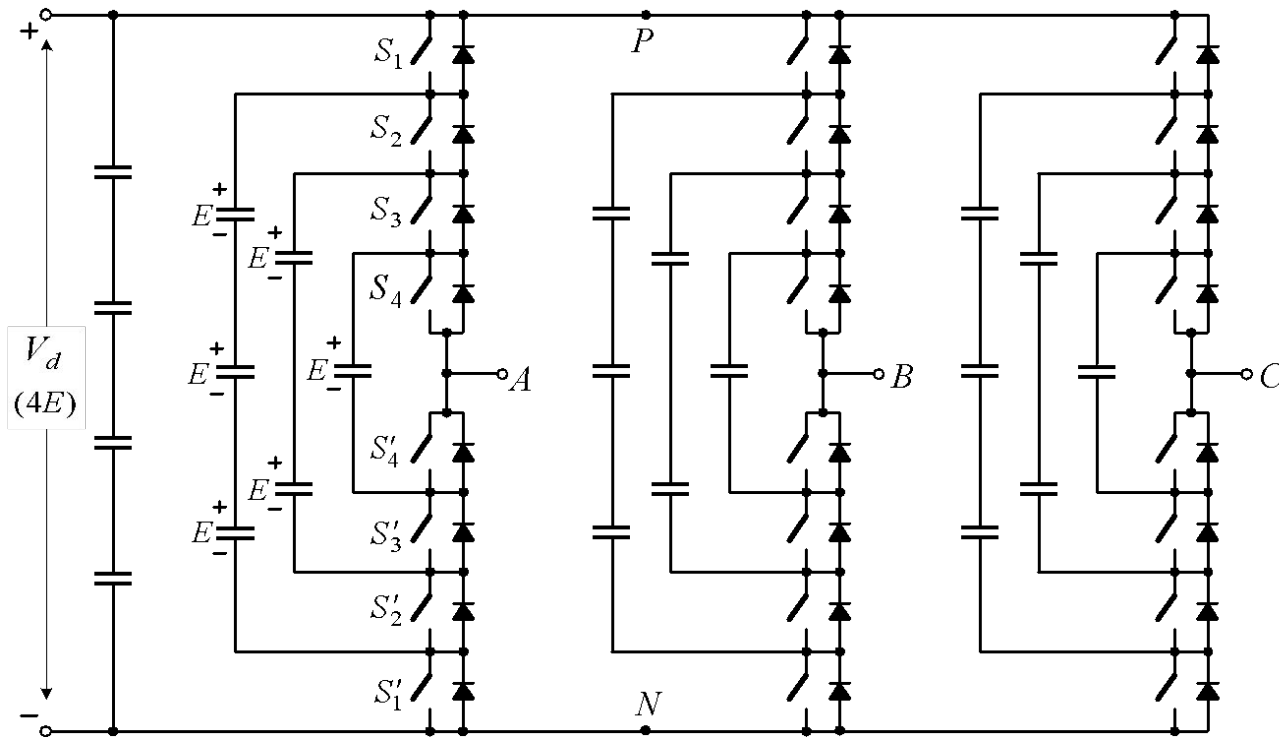
- Waveforms and FFT (Five Level)



Frequency modulation index: $m_f = 18$

Multilevel Flying Capacitor Inverters

• Five Level Topology



Complementary

Switch pairs:

S_1 and S'_1 ;

S_2 and S'_2 ;

S_3 and S'_3 ;

S_4 and S'_4 ;

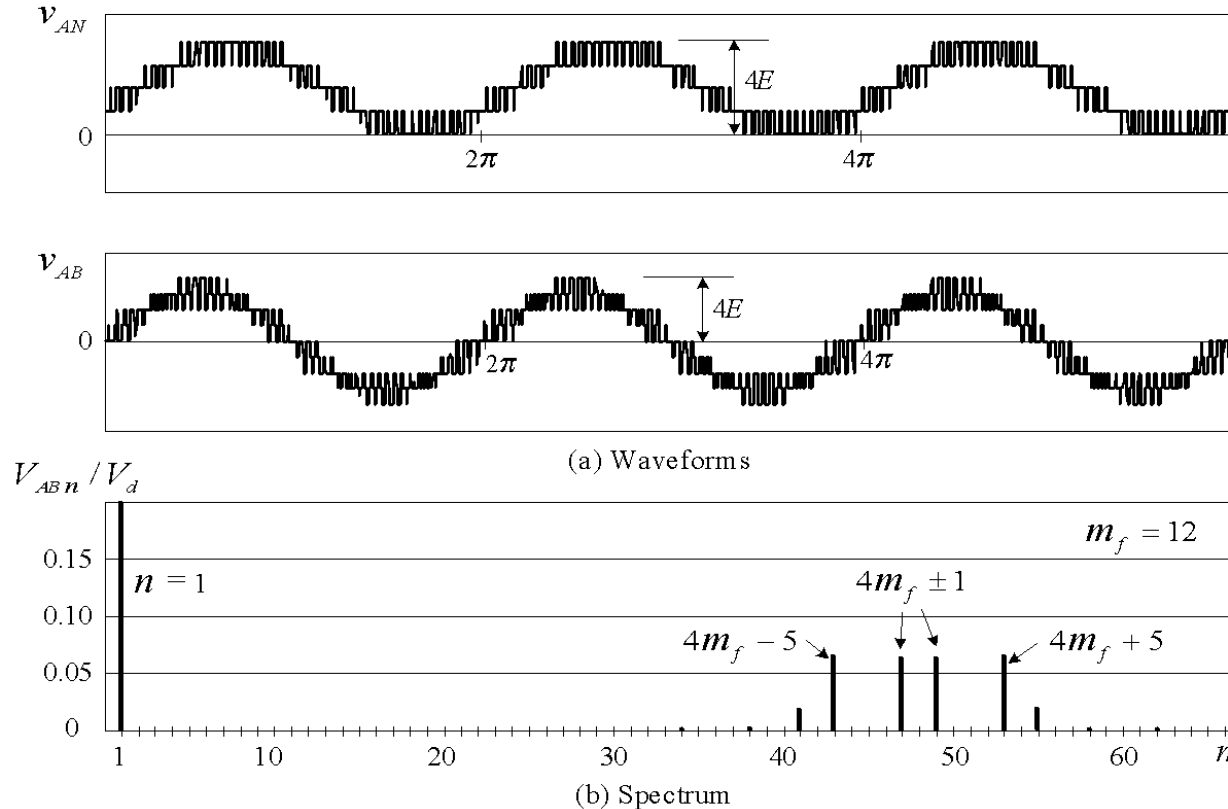
Multilevel Flying Capacitor Inverters

- Switching State (five-level)

Output Voltage V_{AN}	Switching State			
	S_1	S_2	S_3	S_4
$4E$	1	1	1	1
$3E$	1	1	1	0
	0	1	1	1
	1	0	1	1
	1	1	0	1
$2E$	1	1	0	0
	0	0	1	1
	1	0	0	1
	0	1	1	0
	1	0	1	0
	0	1	0	1
$1E$	1	0	0	0
	0	1	0	0
	0	0	1	0
	0	0	0	1
0	0	0	0	0

Multilevel Flying Capacitor Inverters

• Phase-Shifted PWM



- $f_{sw (device)} = 60(m_f) = 720\text{Hz}$
- $f_{sw (inverter)} = 60(4m_f) = 2880\text{Hz}$

Multilevel Flying Capacitor Inverters

- Summary

Features

- Low harmonic distortion with low dv/dt
- Modular design

Drawbacks

- Large number of dc capacitors
- Complex pre-charging circuits
- Difficulties in dc cap voltage balancing control



Thanks