EE-464 STATIC POWER CONVERSION-II

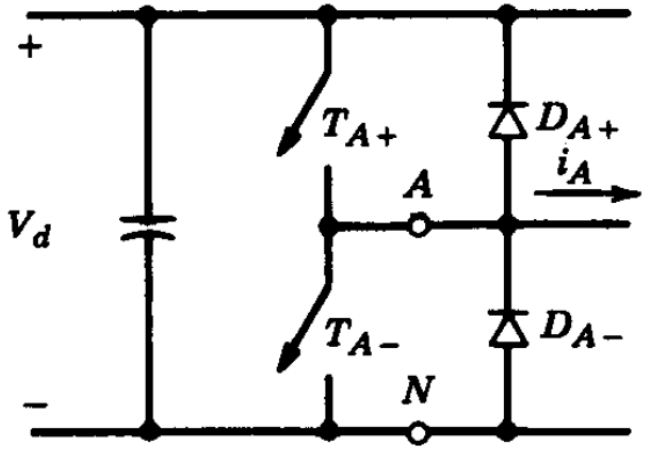
Multi Level Inverters

Ozan Keysan

keysan.me

Office: C-113 • Tel: 210 7586

Effect of Blanking (Dead) Time



There has to be off time between swithcing instants to present short circuit of Vd (can be up to $2 - 3\mu s$)

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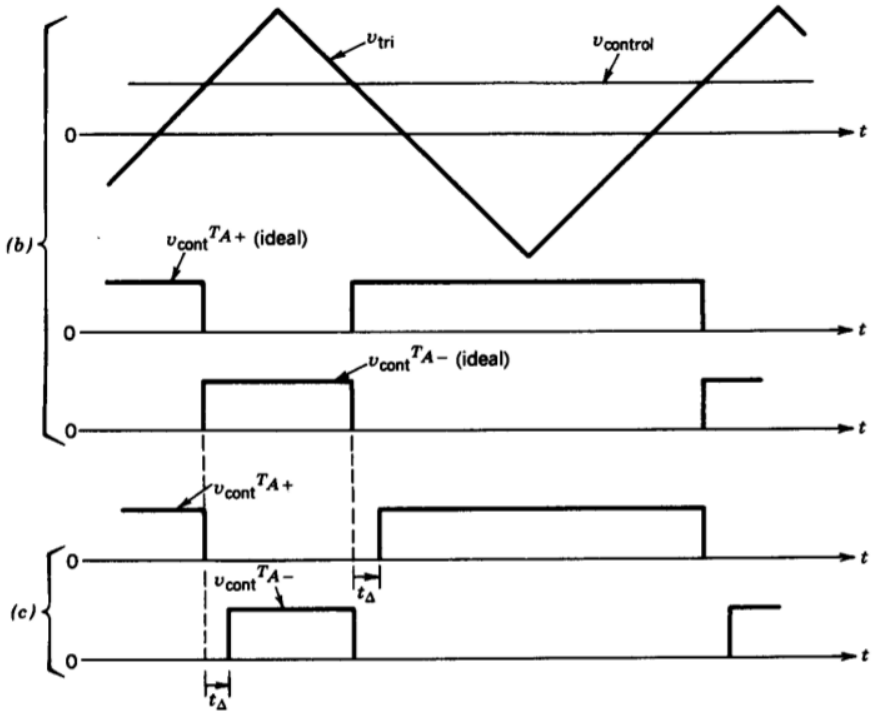

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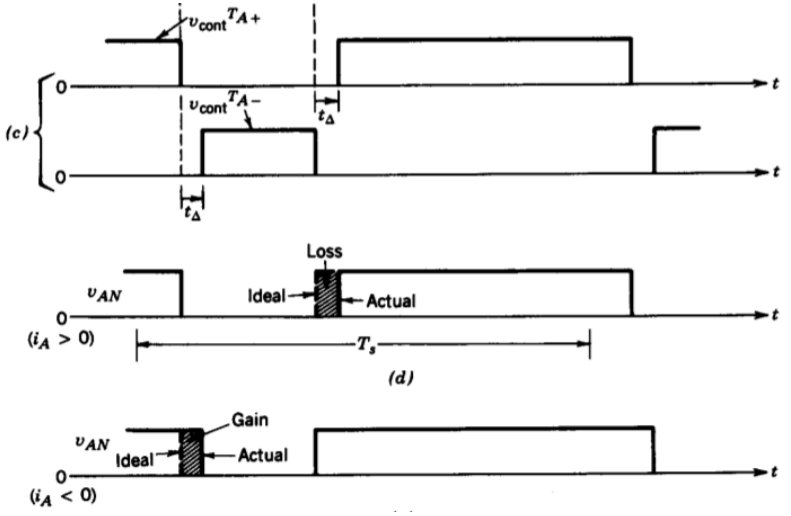


Results in non-linearity in the voltage output

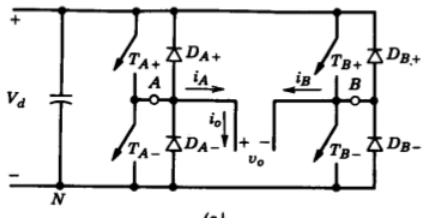
[Reading assignment for curious students]

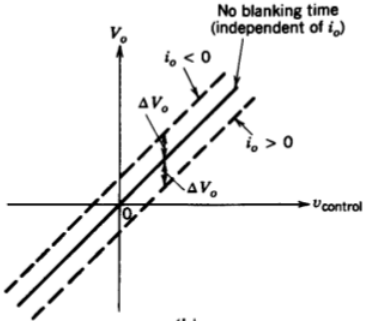
Effect of Blanking (Dead) Time

Effect of Blanking (Dead) Time

$$|\Delta V_o| = \frac{2t_\Delta}{T_s} V_d$$

Always reduce the output voltage magnitude wrt. current direction





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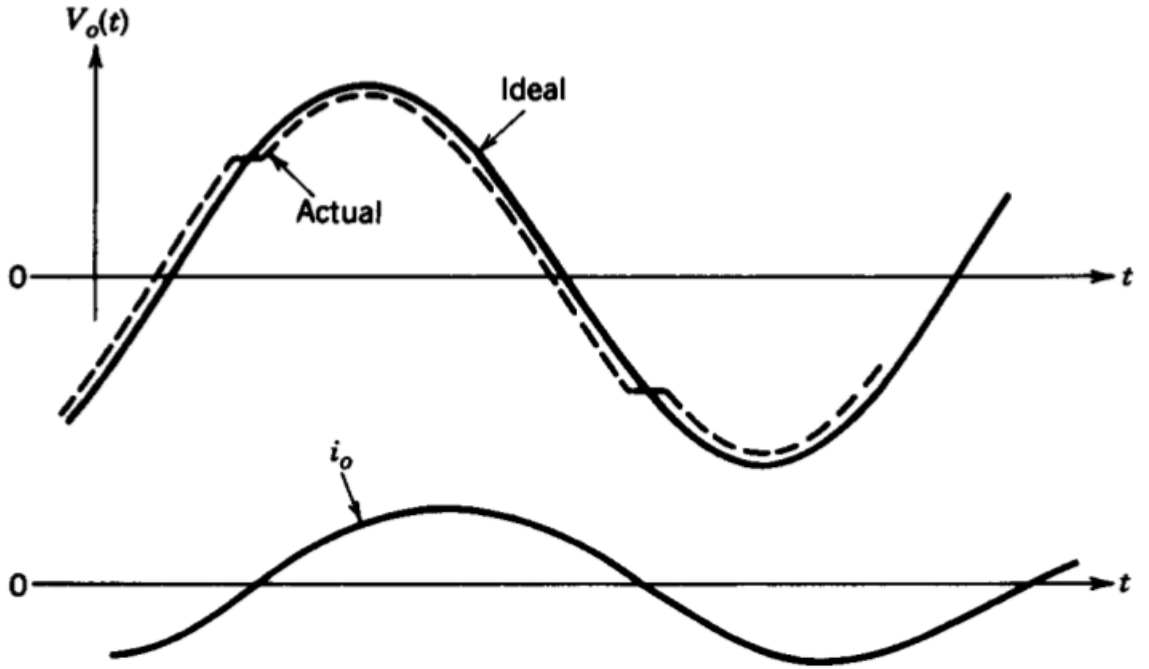

Multi-Level Inverters

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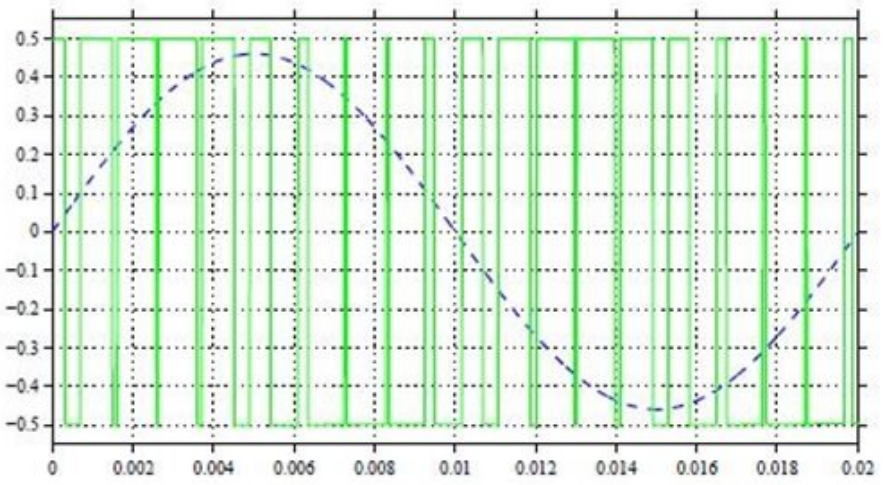
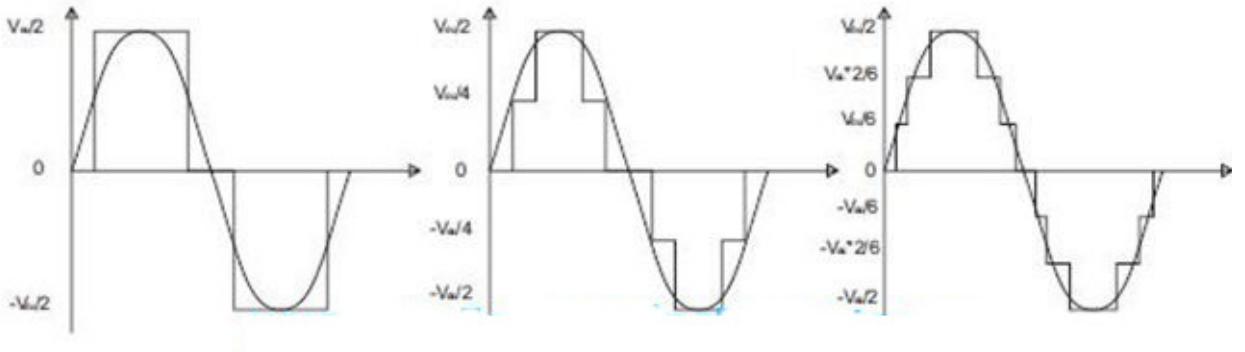
- Minimizes THD even with low switching frequencies
- Reduce EMI due to lower voltage steps

Two-Level Inverter Waveform



Multi-Level Inverter Waveforms

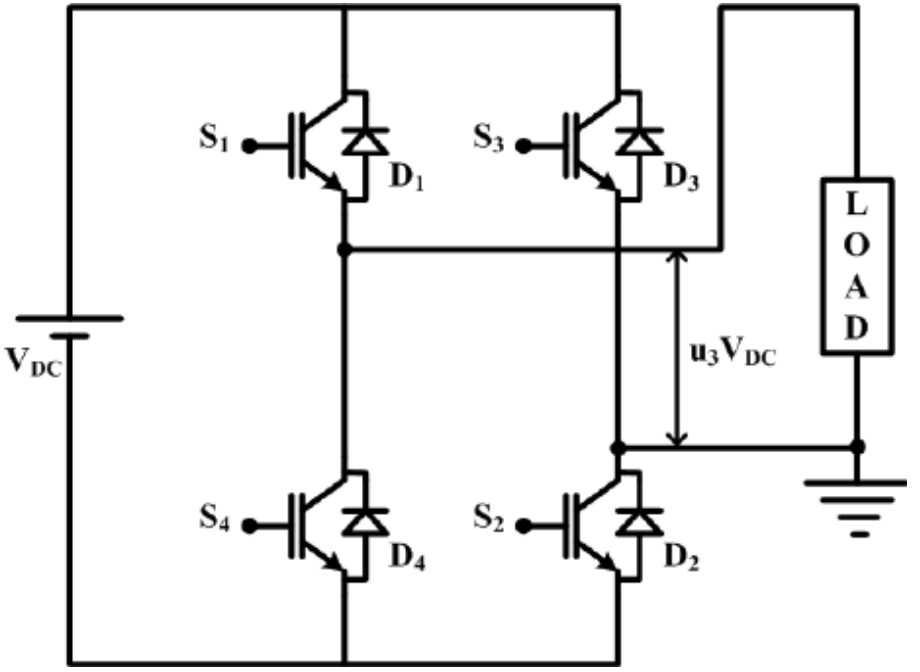


Three level,

Five Level,

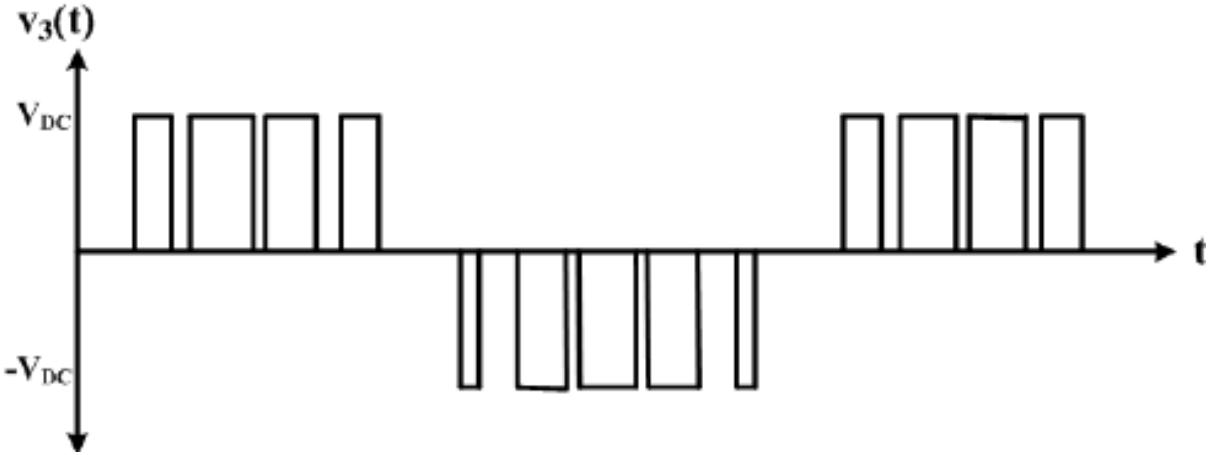
and Seven Level Inverter Waveforms

H-Bridge Inverters



H-Bridge Inverters

Three Level (unipolar) PWM Output



H-Bridges can be connected in series for higher voltages

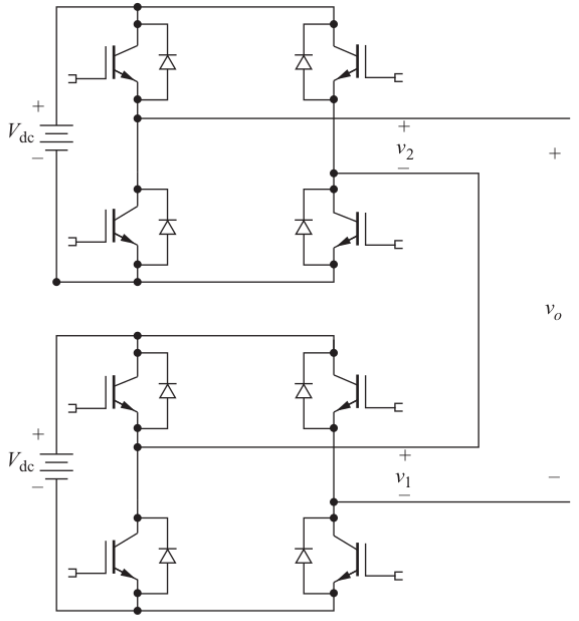
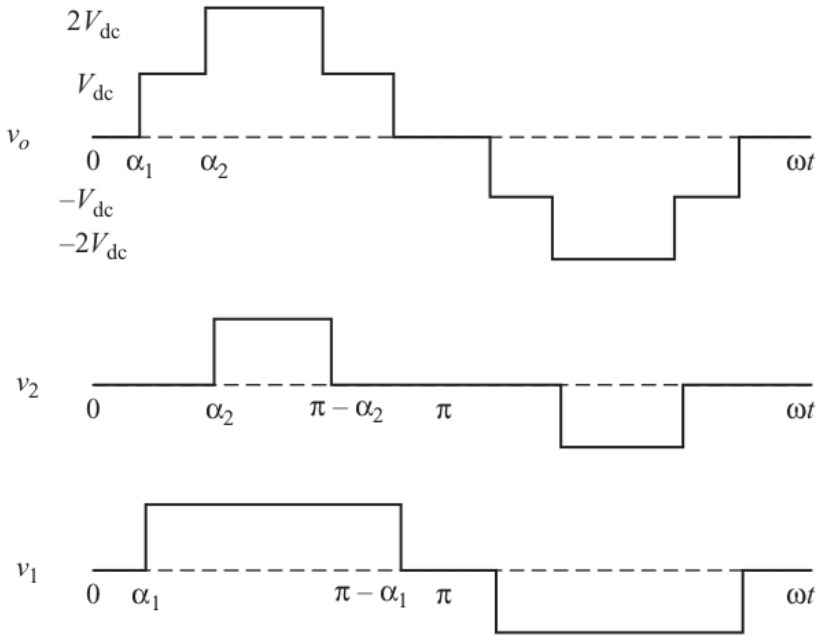


Figure 8-9 An inverter with two dc sources, each with an H bridge implemented with IGBTs.

What are the voltage levels?

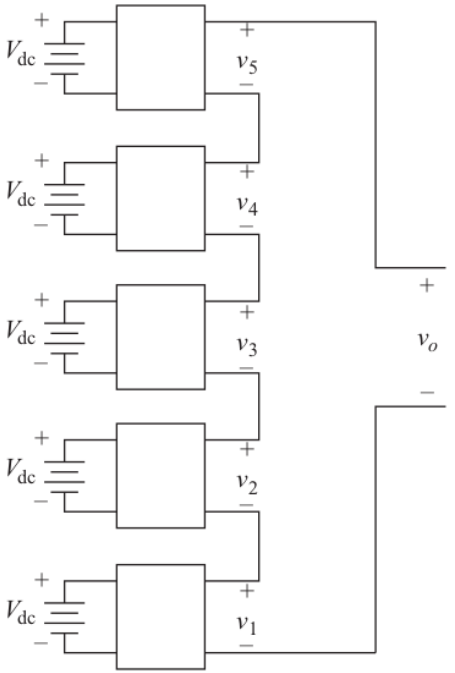
What are the voltage levels?: 2Vdc, Vdc, 0, -Vdc, -2Vdc



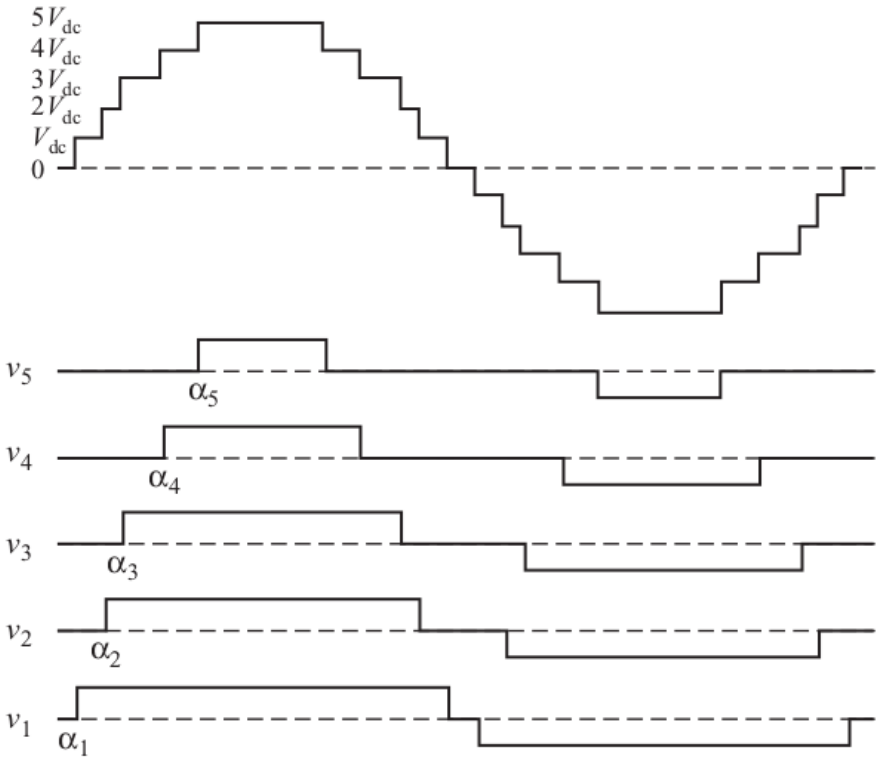
Specific harmonics can be elimination by proper α_1, α_2

Five-Series Cascaded H-Bridge Inverters

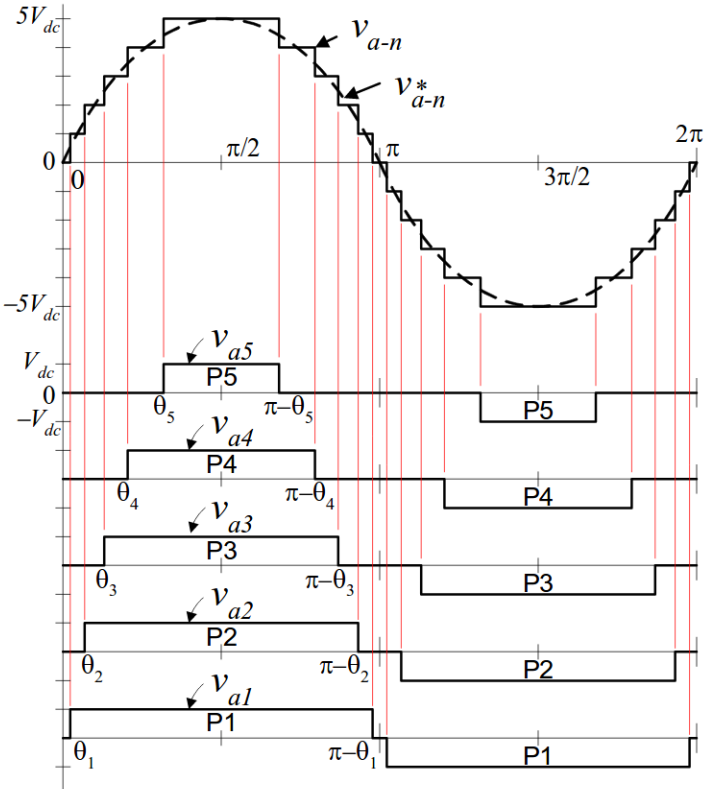
How many voltage levels?



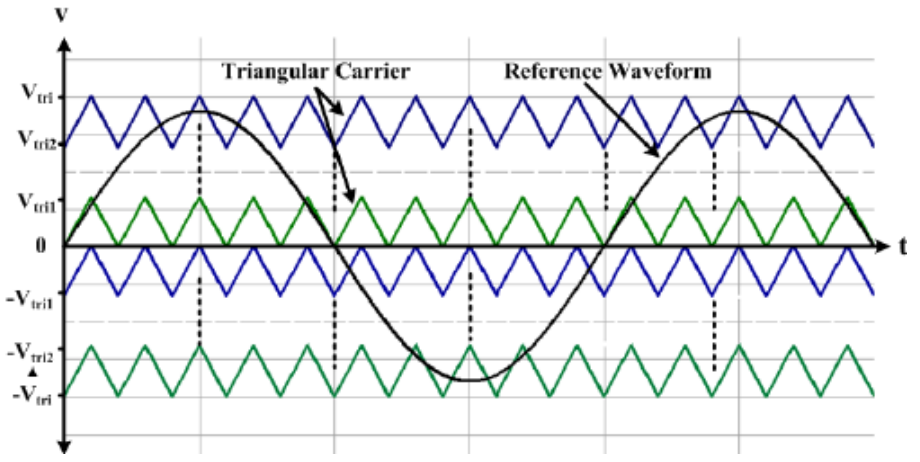
11-Level Cascaded H-Bridge Inverters



11-Level Cascaded with Five Separate Sources

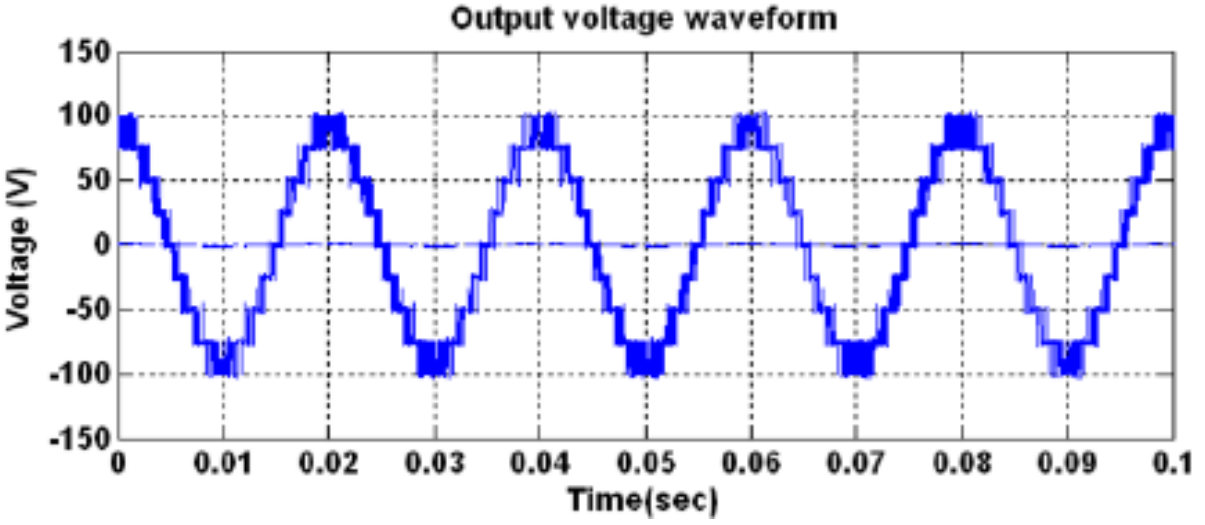


Alternate PWM Techniques

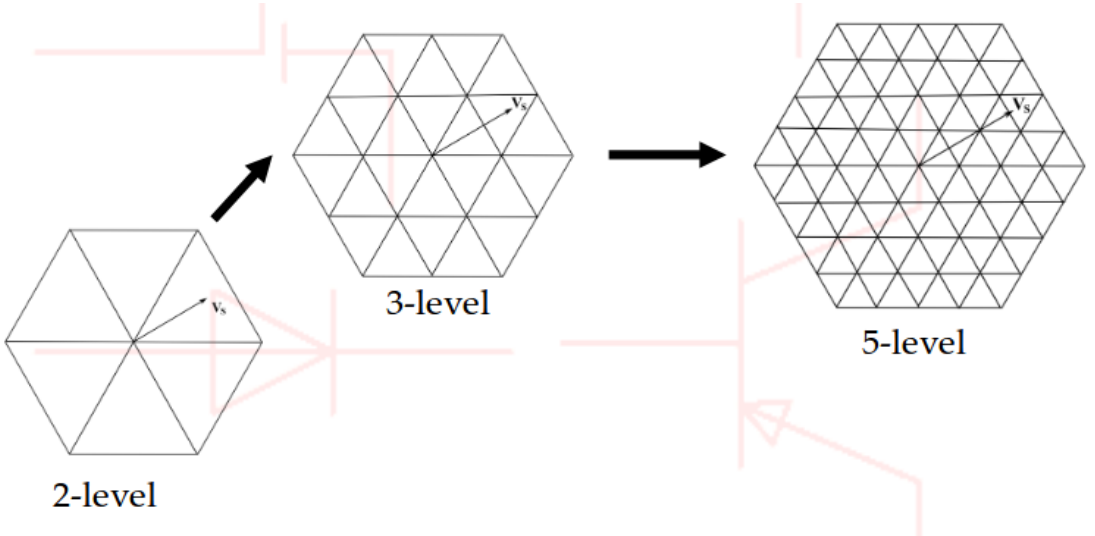


N-Level Cascaded H-Bridge Inverters

Five-level Output Voltage Waveform (fc=3kHz)

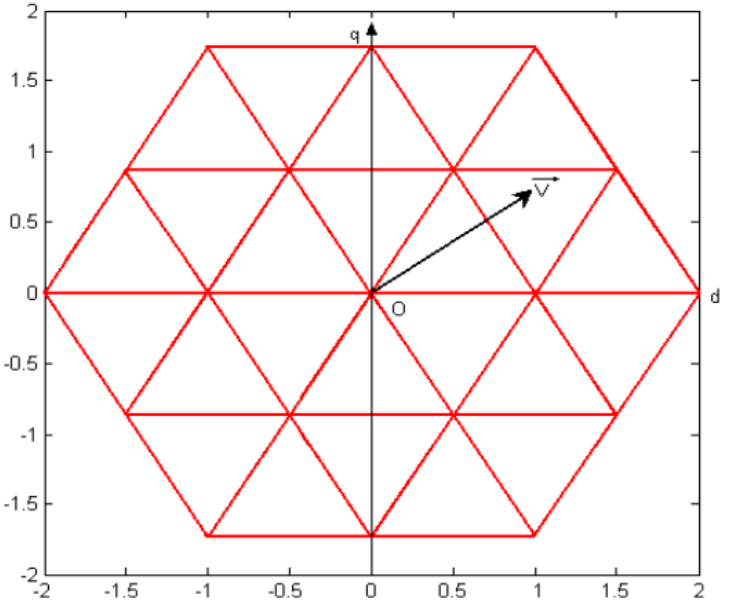


Multi-Level SVPWM



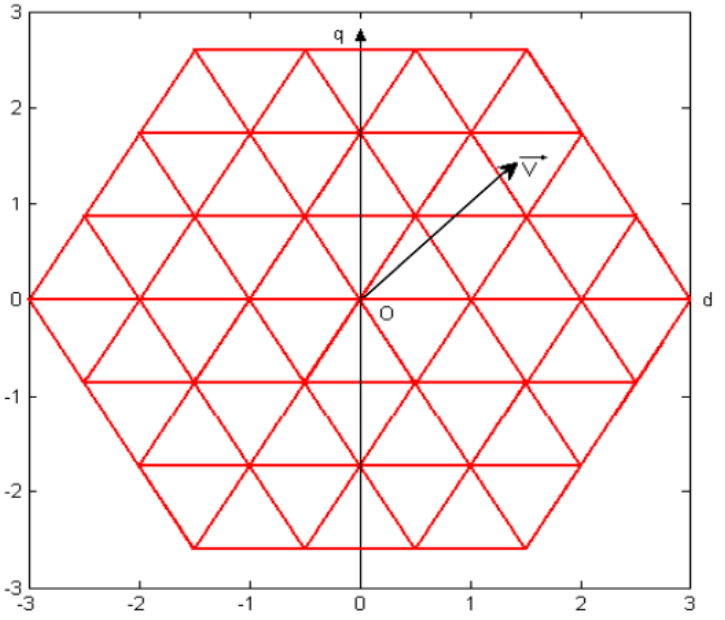
Multi-level SVPWM

3-Level



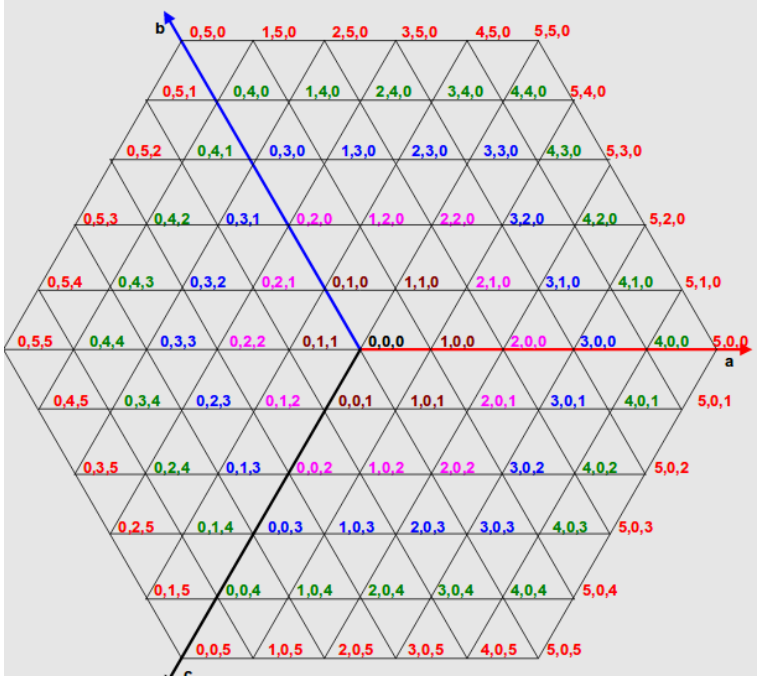
Multi-level SVPWM

5-Level



Multi-level SVPWM

Voltage Vectors of a 6-Level Inverter



Diode Clamped Multi-level Inverters

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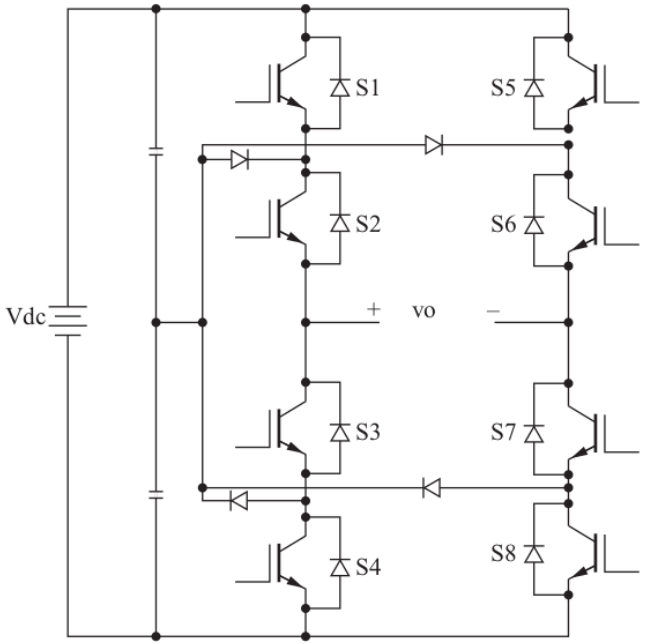
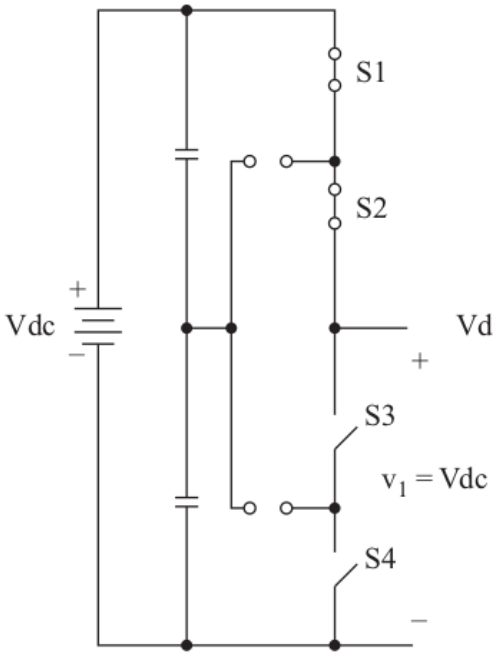


Five-level diode clamped inverter (Neutral Point Clamped (NPC))

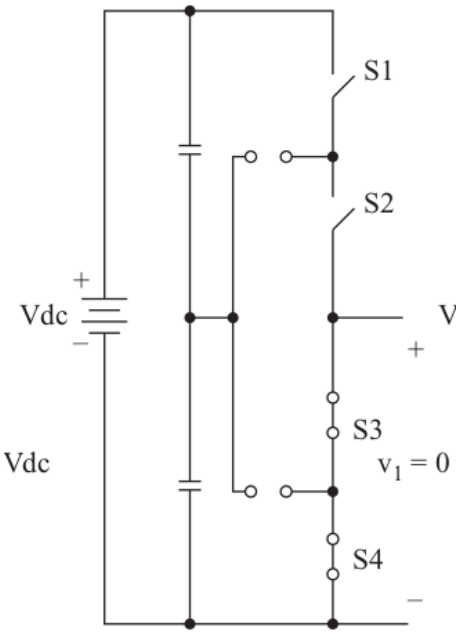
Five-level diode clamped inverter

Voltage Levels: Vdc



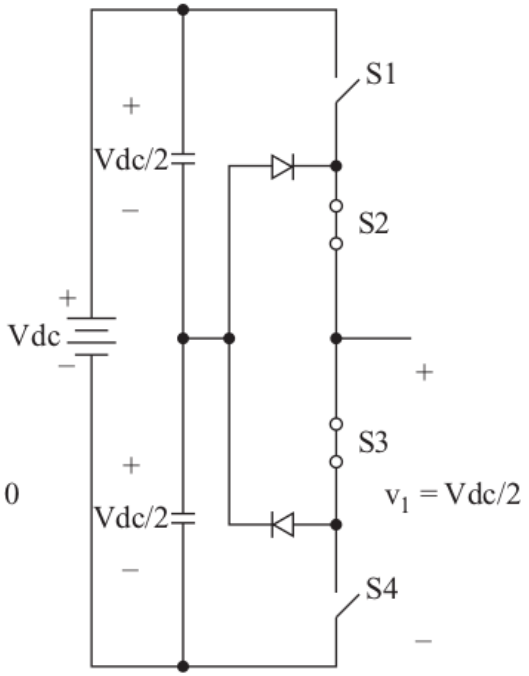
Five voltage-level diode clamped inverter

Voltage Levels: 0



Five voltage-level diode clamped inverter

Voltage Levels: Vdc/2



Even Higher Voltage Levels

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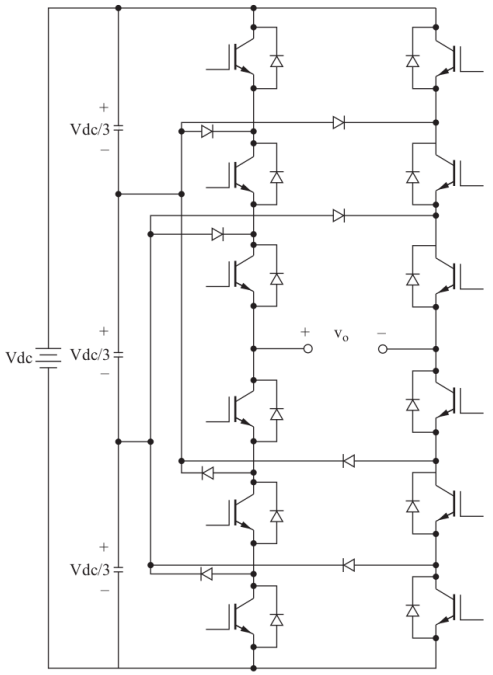
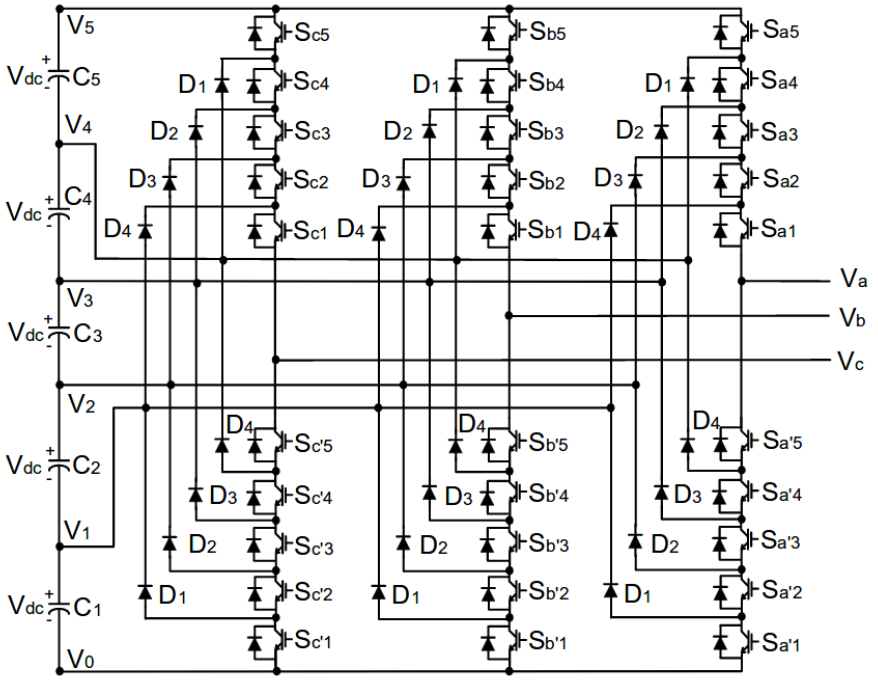
3 voltage sources cascaded



Even Higher Voltage Levels

5-Photovoltaic panels connected in series



Even Higher Voltage Levels

Switching States: Can you find the pattern?

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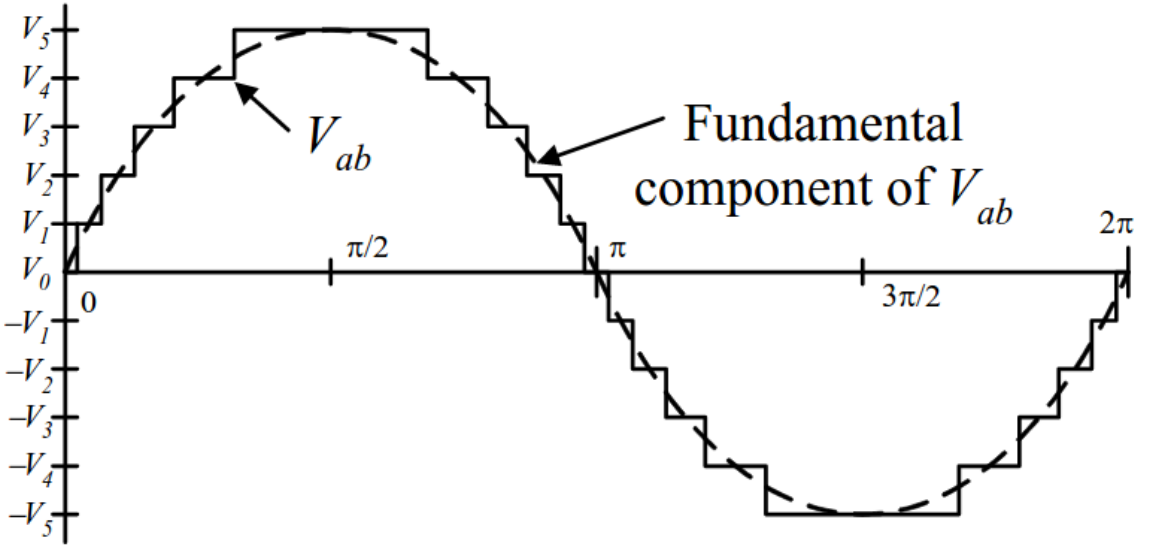
Voltage V_{a0}	Switch State									
	S_{a5}	S_{a4}	S_{a3}	S_{a2}	S_{a1}	$S_{a'5}$	$S_{a'4}$	$S_{a'3}$	$S_{a'2}$	$S_{a'1}$
$V_5 = 5Vdc$	1	1	1	1	1	0	0	0	0	0
$V_4 = 4Vdc$	0	1	1	1	1	1	0	0	0	0
$V_3 = 3Vdc$	0	0	1	1	1	1	1	0	0	0
$V_2 = 2Vdc$	0	0	0	1	1	1	1	1	0	0
$V_1 = Vdc$	0	0	0	0	1	1	1	1	1	0
$V_0 = 0$	0	0	0	0	0	1	1	1	1	1

A set of five switches is on at any time

Even Higher Voltage Levels

Line-to-line voltage



Further Reading

- Multilevel Inverter – Types & Advantages
- Introduction to MultiLevel Inverters
- Multilevel Inverters
- Multilevel Inverters: A Survey of Topologies, Controls, and Applications
- Multilevel Power Converters

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