Class notes : APE,

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Multilevel Inverter Lect:2

Three level Flying Capacitor type MLI:

- Also called multicell converter
- Instead of clamping diode capacitor to hold the voltage level
- No of switches= 2(n-1)=4
- No of diode=2(n-1)=4
- No of capacitor= (n-1)=2
- Balancing Capacitor= (n-1) (n-2)/2=1
- Any time switches ON=(n-1)=2
- The switches of each cell are complementary controlled (for example $S_1 = \bar{S_4}$)

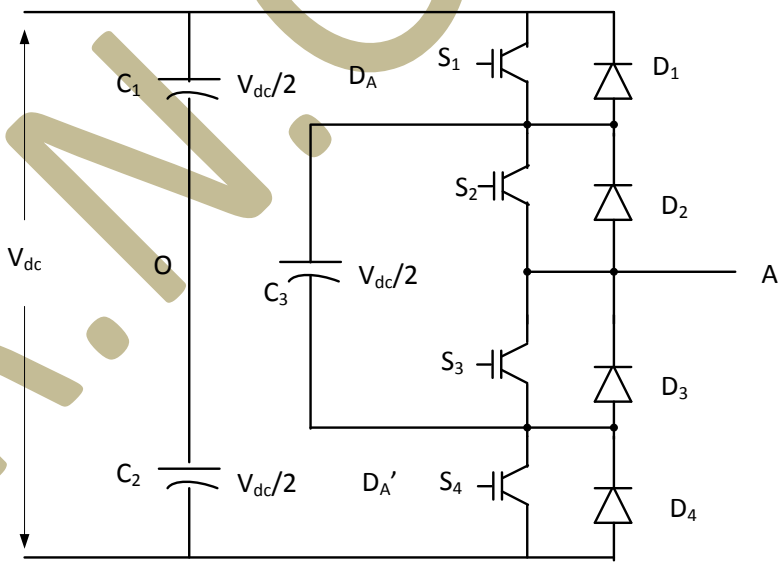


Fig.1: 3-Level Flying Capacitor Type MLI

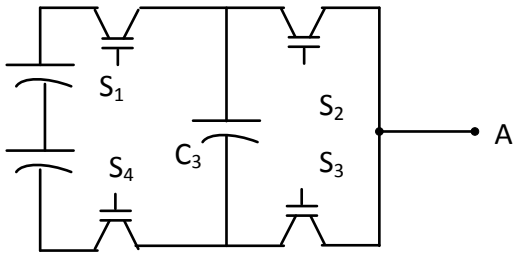
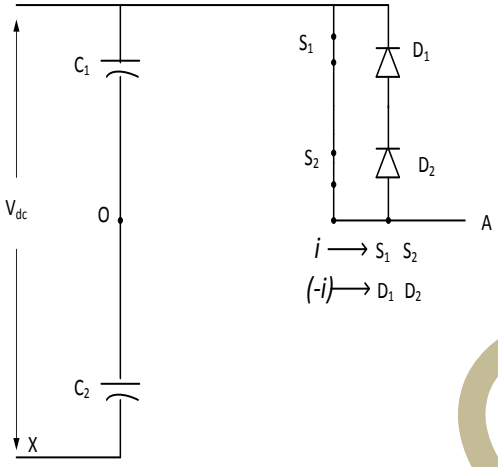


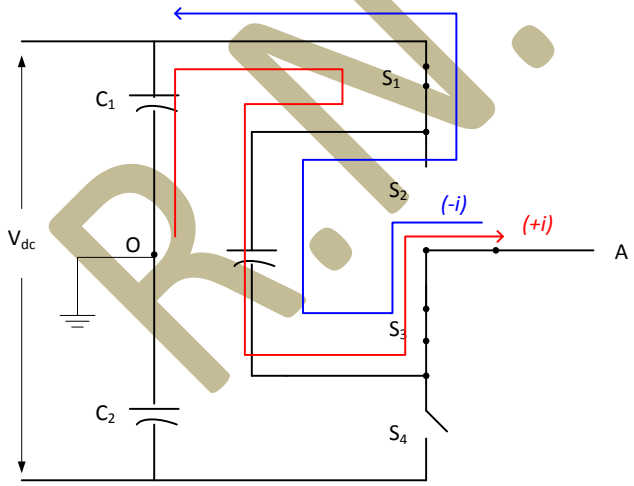
Fig.2: 3-Level FC-MLI Multi cell structured

When S1 and S2 are 'ON':



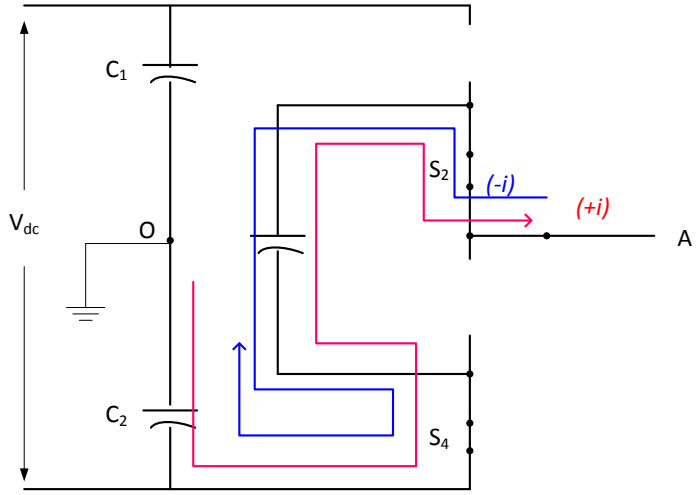
- Vao=Vdc/2
- I(+ve) : flowing through S1 and S2
- I(-ve) : flowing through D1 and D2

When S1 and S3 switches are ON:



- Vao=0
- I(+ve) : flowing through S1 and D3; Voltage across C1 reduces and Voltage across C3 increases
- I(-ve) : flowing through S3 and D1; Voltage across C3 reduces and Voltage across C1 increases

When S2 and S4 switches are ON:



- Vao=0
- I(+ve) : flowing through D4 and S2; Voltage across C3 reduces (discharging) and Voltage across C2 increases (charging)
- I(-ve) : flowing through D2 and S4; Voltage across C2 reduces and Voltage across C3 increases

When S_3 and S_4 are 'ON':

- Vao=-Vdc/2
- I(+ve) : flowing through S3 and S4
- I(-ve) : flowing through D3 and D4

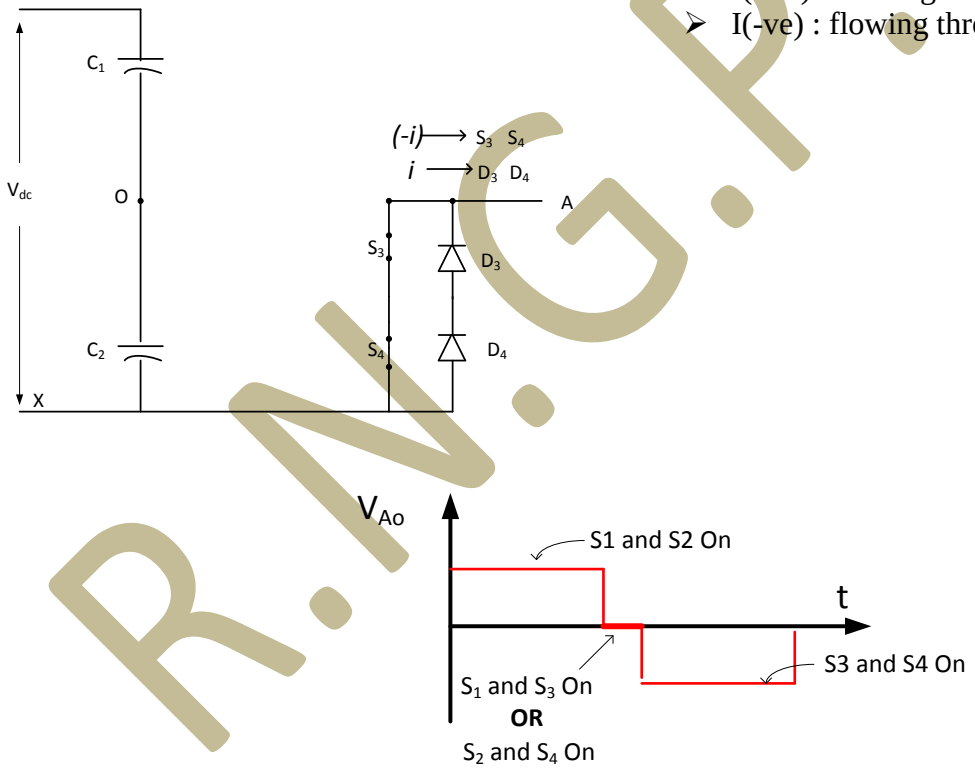


Fig.3: Output Pole Voltage V_{AO}

Difference between Diode clamped and flying capacitor type MLI:

- Here, clamping capacitor is used instead of diode, since capacitor do not block reverse voltage no of switching combination increases (switching redundancy)

- Several switching state will be able to generate same voltage level, giving the topology redundant switching state
- All capacitors are alike

Switching state of 3 level Inverter:

Switching state	S_1	S_2	S_3	S_4	V_{AO}	V_{AX}
	ON	ON	OFF	OFF	$V_{dc}/2$	V_{dc}
	ON	OFF	ON	OFF	**0**	**$V_{dc}/2$**
	OFF	ON	OFF	ON	**0**	**$V_{dc}/2$**
	OFF	OFF	ON	ON	$-V_{dc}/2$	0

Flying Capacitor type 5 Level MLI

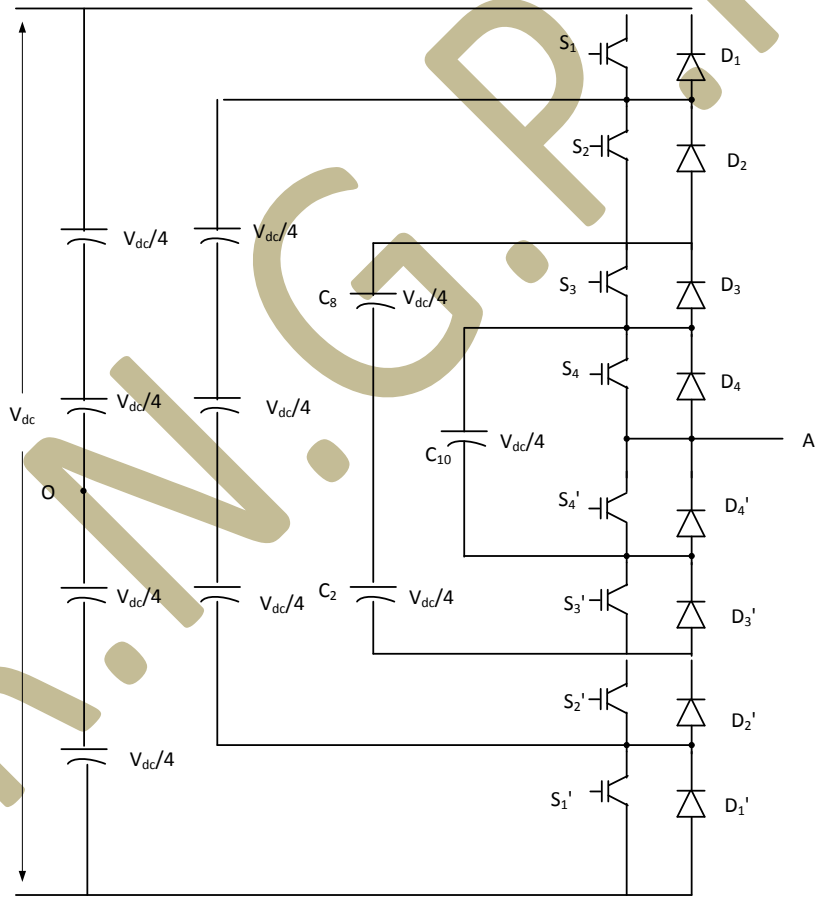


Fig.1: 5-Level flying Capacitor type MLI

- No of switches= 2(n-1)=8
  No of diode=2(n-1)=8
  No of capacitor= (n-1)= 4
  Balancing Capacitor= (n-1) (n-2)/2=6 ; Any time switches ON=(n-1)=4

Vao	**S_1**	**S_2**	**S_3**	**S_4**	**S_4'**	**S_3'**	**S_2'**	**S_1'**
Vdc/2	1	1	1	1	0	0	0	0
Vdc/4	1	1	1	0	1	0	0	0
	0	1	1	1	0	0	0	1
	1	0	1	1	0	0	1	0
	1	1	0	1	0	1	0	0
0	1	1	0	0	0	0	1	1
-Vdc/4	0	0	0	1	0	1	1	1
-Vdc/2	0	0	0	0	1	1	1	1

Features

- Large number of capacitors required
  Balancing Capacitor voltage

Advantages:

- THD is reduced
- Real and reactive power both can be controlled
- Switching combination redundancy
- Large capacitor provides capabilities during power outage

Disadvantage:

- Excessive number of storage capacitor makes the system costly and bulky
- Inverter control can be complicated