

“Neutral Point Clamped (Npc) Type Multilevel Inverter”

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Abstract : Concept of the multilevel inverter is same as the other inverter which is to converts Direct current (DC) to Alternating current (AC) .The inverted current can be at any vital voltage and frequency with the use of pertinent transformers, switching, and control circuits. From the source like batteries, solar panel, wind turbine, or fuel cell the inverter will convert the DC electricity to AC electricity. In this modern technology, Power electronics is very important where it used in a great variety of product. With the high potential in high power for industry, multilevel inverter will become most popular for so many applications.

INTRODUCTION

There have three main features by using multilevel inverter. The most reason is ability to reduce the voltage stress on each power device due to the use of multiple levels on the DC bus. Even at low switching frequencies, smaller disturbance in the multiple level inverter AC side waveforms can be achieved with the step modulation technique. Such as in traction system, when voltage is imposed by an application is very important. Multilevel inverters contain different power semiconductors and capacitor used as voltage source. Output voltages of multilevel inverters consist of the inclusion of the capacitor voltages due to the commutation of the switches. The function of power semiconductors is represented by an ideal switch with several actions. Therefore, the output voltages waveforms of multilevel inverter have many levels. Moreover, they can reach high value voltage, while the power semiconductors must endure only reduced voltages.

switching losses, the experimented multilevel inverters only produce 2.1W and 2.2W switching losses.

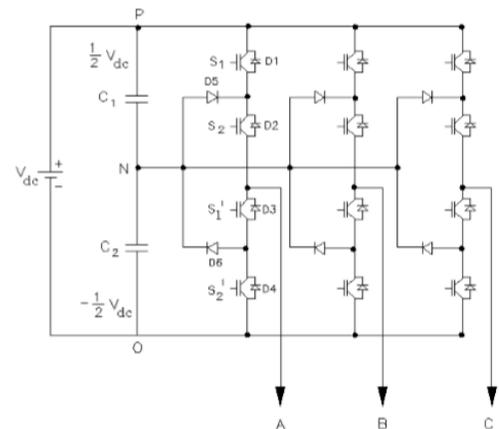


Fig 1: 3 phase NPC Multilevel Inverter

I. PROBLEM STATEMENT

The typical voltage source inverters gives the output voltage at the poles with levels $+V_{dc}/2$ or $-V_{dc}/2$ which is the DC link voltage also known as two level inverter. To attain a quality output voltage or current waveform with minimal number of ripple content, it needs high switching frequency along with other discrete pulse width modulation techniques. In high voltage and power application the two level inverters have some constraint in operating at high frequency mainly because of switching losses and restriction of equipment rating.

II. OBJECTIVE

NPC type Multilevel inverters plays vital role in the field of power electronics and being extensively used in various industrial and commercial applications because it possess low electromagnetic interference and the efficiency is considerably high. NPC Multilevel inverters have become more favoured over the years in electric high power application with the affirmation of less disturbances and the contingency to operate at lower switching frequencies than typical two-level inverters. This multilevel inverter will also be compared with two-level inverter in simulations to investigate the advantages of using multilevel inverters. It is observed that NPC multilevel inverter produce only 22% and 32% voltage THD whereas the two-level inverter for the same test produces 115% voltage THD. For other simulation, while practising lower switching frequency, it is observed that when the two-level inverter develops 25.1W

III. SIMULINK MODEL

The simulation model is shown in the figure below. The implementation of 3 phase Neutral Point Clamped Multilevel inverter in MATLAB software is done. In this model MOSFET is used as switching device, opto-isolator is used to give gate pulse to the thyristor. The output voltage is taken between line to line and phase to phase. The total THD counts up to 32%. The output current and voltage waveform is shown in the figure. A common neutral point is taken outside and grounded

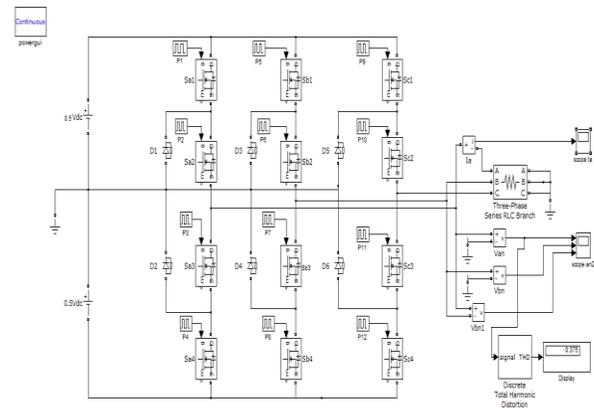


Fig 2: MATLAB Simulink Model

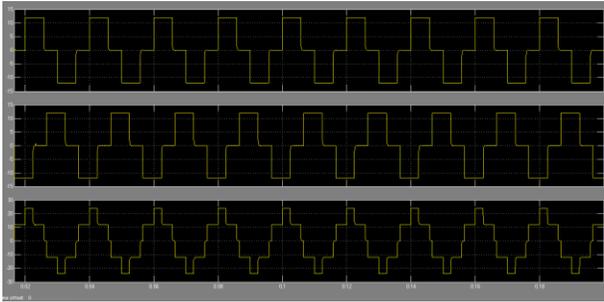


Fig 3: Output line and phase voltage

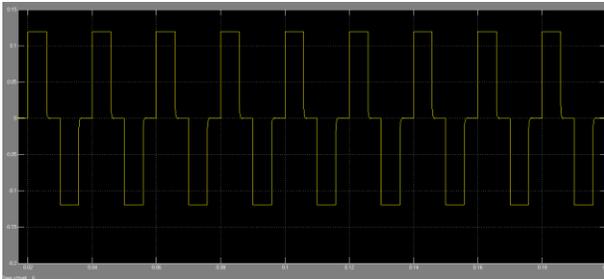


Fig 4: Output current

IV. SYSTEM COMPONENTS

Table 4.1 – System Component

SR. NO.	TYPE OF CIRCUIT	COMPONENT REQUIREMENT
1.	Control Circuit	
		Pulse Transformer
		Transistor
		Diodes
		Capacitors
		Resistors
2.	Driven Circuit	Opto-Isolator
		Photo Transistor
		Op-amp
		Regulator IC
3.	Power Circuit	Power MOSFET
		Clamping Diode
		Resistive load

V. WORKING PRINCIPLE

The NPC type multilevel inverter consists of three sections. Control circuit, Driven circuit and Power circuit. The control circuit is the controller of the inverter consisting of a PIC microcontroller which generates the appropriate gate pulses

for the MOSFET. The control circuit gets an AC source supply for its functioning. The gate pulses which switch the MOSFET on or off are coded in MPLAB software. The Driven circuit is the driver of the inverter consisting of opto isolator TLP250 op-amp to provide amplified signal to MOSFET and regulator to give the required regulated supply. The third section is the Power circuit consisting of power MOSFET, diodes and load. The gate pulses is given to the gate terminal of the respective MOSFET through the opto isolator. The switching of the respective MOSFET is done by using PWM technique. The programming for PWM is stored in the PIC microcontroller. We get the stepped output in the steps of $0, -V_{dc}, +V_{dc}$. By shifting the phase by 120° and 240° we can get 3 phase stepped output. The levels indicate the operation or ON time of a particular MOSFET or sometimes two.

Table 5.1: Switching sequence

S_1	S ₂	S ₃	S ₄	S ₅	S ₆	S ₇	S ₈	Output
1	0	0	1	0	0	1	1	$0.5V_{dc}$
0	0	1	1	1	0	0	1	V_{dc}
1	0	0	1	0	0	1	1	$0.5V_{dc}$
0	0	0	0	0	0	0	0	0
0	1	1	0	0	0	1	1	$-0.5V_{dc}$
0	0	1	1	0	1	1	0	$-V_{dc}$
0	1	1	0	0	0	1	1	$-0.5V_{dc}$
0	0	0	0	0	0	0	0	0

VI. ADVANTAGE

1. Staircase waveform quality: Multilevel inverters not only generate the output voltages with very low disturbance, but also can minimise the dv/dt stresses; therefore electromagnetic compatibility (EMC) issue can be decreased.
2. Input current: Multilevel inverters can draw low disturbance input current.
3. Common state voltage: Multilevel inverters produce lower common state voltage, therefore, the stress in the bearings of a motor coupled to a multilevel inverter can be shortened. Further, voltage can be wiped by using leading modulation technique such as that proposed in.
4. Switching frequency: NPC type Multilevel inverters can conduct at both elemental switching frequency and high switching frequency. It should be considered that lower switching frequency generally means lower switching loss and higher efficiency.
5. Reduced harmonic distortion: Selective harmonic eradication technique along with the multilevel advancement outcomes the total harmonic distortion to decrease in the output waveform without using any filter circuit.

VII. DISADVANTAGE

Sadly, multilevel inverters do have some limitation .

One particular drawback is the high number of power semiconductor switches needed. Despite lower voltage rated switches can be utilized in a multilevel converter, each switch needs a linked gate drive circuit. This may cause the overall system to be more overpriced and complicated.

VIII. CONCLUSION

The following conclusions have been made on Three level NPC inverter. The performance of the three- phase three-level twelve switch inverter has been observed that performance of the inverter is improved by employing SPWM control scheme. Compared with conventional methods, this method has the advantage of ease implementing, specially the inverters with more levels. From the simulation results, it is observed that the generated voltage spectrum is much improved with the increase in steps or level of the inverter. The practice of three level inverters reduces the harmonic components of the output voltage compared with the two-level inverter at the same switching frequency. The total harmonic distortion (THD) value is reduced as the level of the inverter is increases. So no need of additional reactors or transformers to eliminate the harmonic components.

IX. FUTURE SCOPE

1. Actual lab operations on the topologies for simulation verification.
2. Simulations on the Neutral-Point Clamped Multilevel inverter with a voltage balancing modulation, such as those that were mentioned, instead additional balancing circuit.
3. Multilevel and two-level inverter later loss comparison.

X. REFERENCES

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