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Performance Analysis of phase shifted SPWM Technique for Three Phase Diode Clamped Three Level Inverter

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ABSTRACT

The Primary function of VSI is to convert fixed DC voltage into variable AC voltage at required voltage and frequency. The diode-clamped multilevel inverter employs clamping diodes and cascaded dc capacitors to produce ac voltage waveforms with multiple levels. The inverter can be generally configured as a three-, four-, or five-level topology, but only the three-level inverter, often known as neutral-point clamped (NPC) inverter, has found wide application in high-power medium-voltage (MV) drives. The dc input voltage of the inverter is normally split by two cascaded dc capacitors, providing a floating neutral point. The control of the neutral-point voltage deviation is also elaborated.The dc supplies are normally obtained from multipulse diode rectifiers. Phase shifted PWM Technique is analyzed and its performance will be compared. Simulation results will be presented to analyze the performance of the PWM techniques. The simulation results will be verified using experimental results
Keywords : SPWM, MV, DC, NPC, PWM, VSI, ASD, UPS, FACTS, SHE

I. INTRODUCTION

Inverter is device which converts electrical energy in DC form into AC form. The main objective of static power converters is to produce an AC output waveform from a dc power supply. These are the types of waveforms required in adjustable speed drives (ASDs), uninterruptible power supplies (UPS), static VAR compensators, active filters, flexible ac transmission systems (FACTS) and voltage compensators. The primary function of a voltage source inverter (VSI) is to convert a fixed dc voltage to three-phase ac voltage with variable magnitude and frequency.

In voltage source inverter thyristor, IGBT, MOSFET, GTO can be used as switches. Generally thyristor are not used because they require forced commutation. Single-phase voltage source inverters (VSIs) and current source (CSIs) can be found as half-bridge and full-bridge topologies.

II. METHODS AND MATERIAL

A. Need of three Level Inverter

The output voltage contains higher values of Total Harmonic Distortion(THD), hence fundamental component gets reduced. In two level inverter there are more switching stresses on the devices. Such inverters are not applicable for high voltage application. The higher voltage level are not produced in two level inverter. Since higher switching frequency is used, hence switching losses are high. Where high-quality voltage waveforms are required, power converters, specifically inverters are constructed from power switches and the ac output waveforms are therefore made up of discrete values. This leads to the generation of waveforms that feature fast transition rather than smooth ones. For instance, the ac output voltage produced by the VSI of a standard ASD is a three-level. Although this waveform is not sinusoidal expected its fundamental component behaves as such. This behavior should be ensured by a modulating technique that controls the amount of time and the sequence used to switch the power valves on and off. The modulating techniques most used are the carrier-based technique (e.g., sinusoidal pulse width modulation, SPWM), the space-vector (SV) technique, and the selective-harmonic-elimination (SHE) technique, phase shifted pulse width modulation. The discrete shape of the ac output waveforms generated by these topologies imposes basic restrictions on the applications of inverters.

B. Three Phase Diode Clamped Three Level Inverter

In the recent past the multilevel power converters have drawn a tremendous interest in the field of high voltage and high power applications field in industries. The multilevel inverter approach allows the use of high power and high voltage electric motor drive systems. Using the multilevel inverter concept, a divide and conquer approach allows more flexibility and control over the discrete components that makeup the system. In the researches on multilevel inverters, their corresponding PWM control strategies are the emerging research areas. In high power and high voltage applications, the two level inverters, however, have some limitations in operating at high frequency mainly due to switching losses, dv/dt and di/dt stresses in power semiconductor devices and constraint of the semiconductor power device ratings. For high voltage applications two or more power devices can be connected in series to achieve the desired voltage ratings and in parallel to achieve the current ratings. Multilevel inverters can increase the power by the series connection of power semiconductor devices.

Working

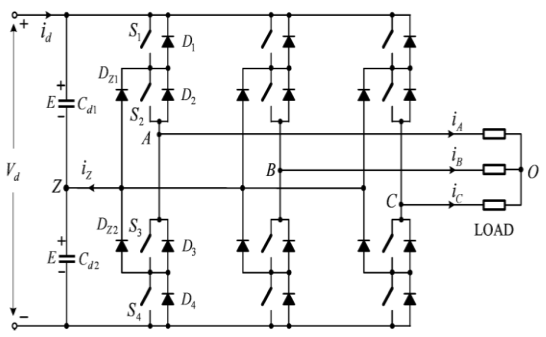

Figure 1. Three-level diode clamped inverter

SWITCHING STATE OF THE THREE-LEVEL DIODE CLAMPED INVERTER.

Switching State	Device Switching Status (Phase A)				Inverter Terminal Voltage v_{AZ}
	S_1	S_2	S_3	S_4	
P	On	On	Off	Off	E
O	Off	On	On	Off	0
N	Off	Off	On	On	$-E$

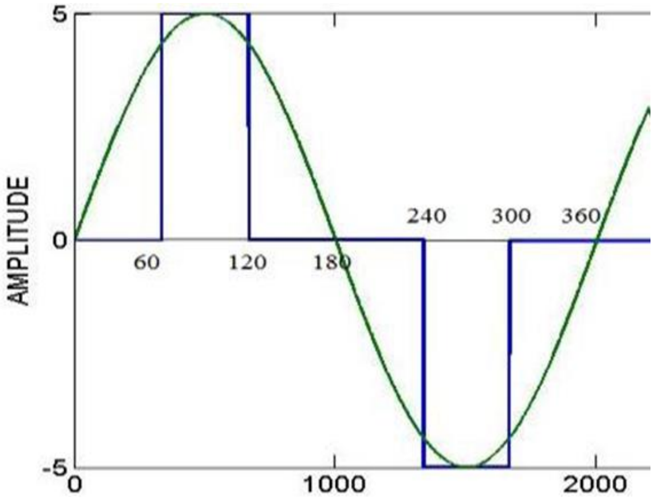

Figure 2. Desired pole voltage for three level

3.SINUSOIDAL PULSE WIDTH MODULATION

Sinusoidal pulse width modulation is a method of pulse width modulation used in inverters. An inverter produces an AC output voltage from a DC input by using switching circuits to simulate a sine wave by producing one or more square pulses of voltage per half cycle. If the widths of the pulses are adjusted as a means of regulating the output voltage, the output is said to be pulse width modulated.

With sinusoidal or sine weighted pulse width modulation, several pulses are produced per half cycle. The pulses near the edges of the half cycle are always narrower than the pulses near the center of the half cycle such that the pulse widths are proportional to the corresponding amplitude of a sine wave at that portion of the cycle. To change the effective output voltage, the widths of all pulses are increased or decreased while maintaining the sinusoidal proportionality.

With pulse width modulation, only the widths (on-time) of the pulses are modulated. The amplitudes (voltage) during the "on-time" is constant unless a multi-step circuit is used. The line-to neutral voltage of a 3-phase inverter has two voltage levels.

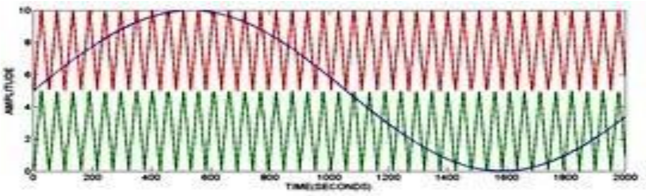

Figure 3. Comparison of Sine and triangular wave for Three Level

SPWM

Phase shifted SPWM Technique

In general, a multilevel inverter with m voltage levels requires (m – 1) triangular carriers. In the phase-shifted multicarrier modulation, all the triangular carriers have the same frequency and the same peak-to-peak amplitude, but there is a phase shift between any two adjacent carrier waves, given by

$$\Phi cr = 360°/ (m – 1)$$

The modulating signal is usually a three-phase sinusoidal wave with adjustable amplitude and frequency. The gate signals are generated by comparing the modulating wave with the carrier waves.

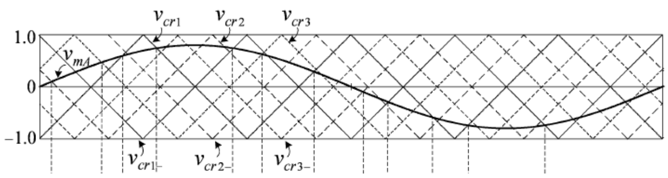

Figure 4. Phase shifted sinusoidal PWM modulation.

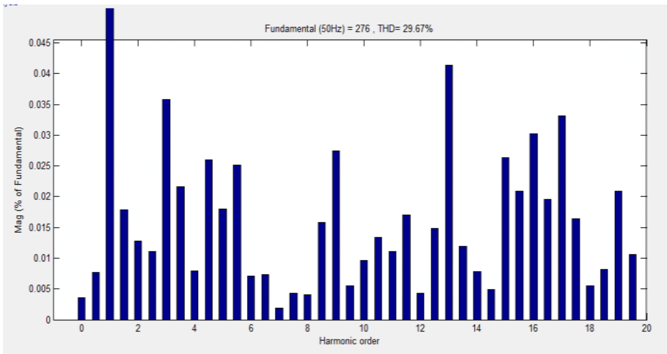

Figure 2. Spectrum Analysis of Phase shifted sinusoidal PWM modulation.

MATLAB Simulation results for phase shifted SPWM Technique for Three Phase Diode Clamped Three Level Inverter.

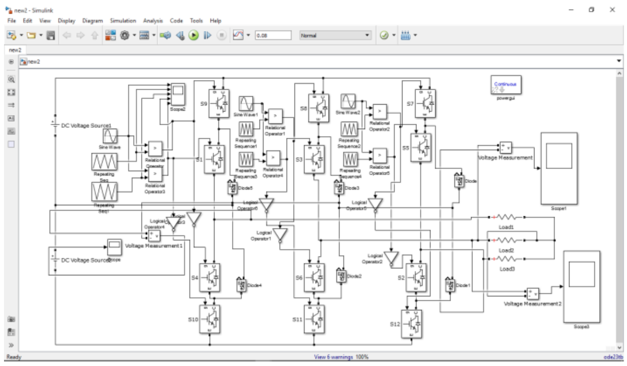

Figure 6. Circuit diagram of three level inverter.

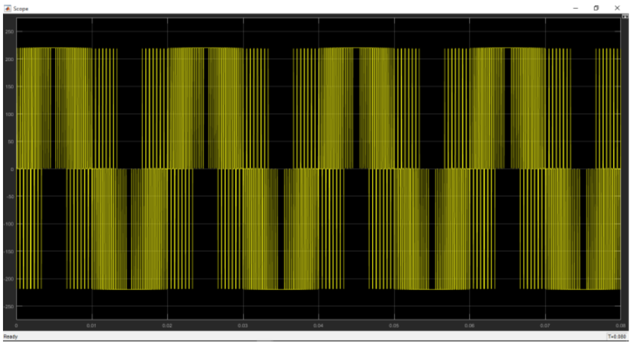

Figure 7. waveform of voltage across neutral (Van)

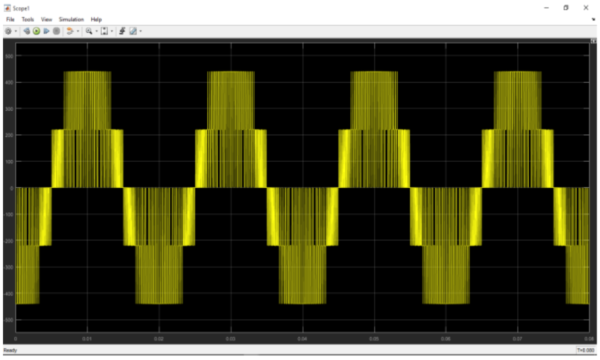

Figure 8. waveform of line voltage (Vab)

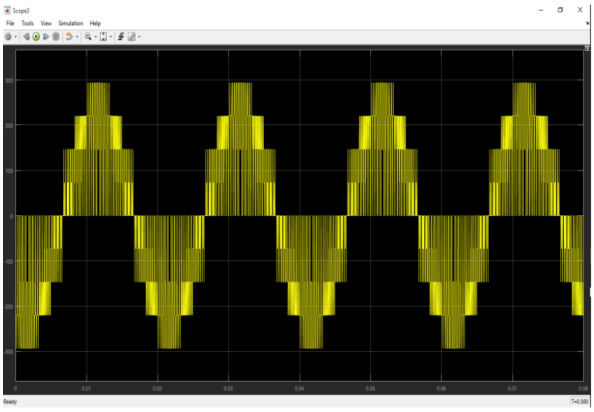

Figure 9. waveform of load voltage (Vl)

III. RESULTS AND DISCUSSION

ADAVANTAGES OF THREE-LEVEL DIODE CLAMPED INVERTER.

The Three-level diode clamped inverter has a several advantages that is

1. Common mode voltage: The multilevel inverter produce common mode voltage reducing the motor and don't damage the motor
2. Input current: Multilevel inverter can draw input current with low distortion.
3. Switching Frequency: The multilevel inverter can operate at both fundamental switching frequencies that are higher switching frequency and lower switching frequency .It should be noted that the lower switching
4. Reduced harmonic distortion: Selective harmonic elimination technique along with the multilevel topology result the total harmonic distortion becomes low in the output waveform without using any filter circuit.

APPLICATIONS OF THREE LEVEL INVERTER

Multi-level (Three level) inverters have been developed for electric utility applications.

1. Three level inverters used in static VAR compensators.
2. It enables direct parallel or series transformer-less connection to medium- and high-voltage power systems.
3. Three level inverter can be used for power supply, (hybrid) electric vehicle (EV) motor drive, reactive power (VAR) and harmonic compensation.

IV. CONCLUSION

In phase shifted SPWM the lower order harmonics are almost eliminated and also power consumed by each switch is almost same. Hence phase shifted PWM technique is used.

V. ACKNOWLEDGMENT

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