

# IMPLEMENT THREE-LEVEL NEUTRAL POINT CLAMPED (NPC) POWER CONVERTER WITH SELECTABLE TOPOLOGIES AND POWER SWITCHING DEVICES

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## Abstract

The multilevel began with the three level converters. The fundamental thought of a multilevel converter to fulfill higher power to use a progression of power semiconductor switches with a few lower voltage dc source to perform the power transformation by combining a staircase voltage waveform. Regardless, the output voltage is smoother with a three level converter, in which the output voltage has three conceivable values. This results in less harmonics, yet on the other hand it has more sections and is more unpredictable to control. In this project, three level inverter topologies and Sinusoidal pulse width modulation, strategy has been connected to characterize the exchanging example for three level inverter that minimize the harmonic distortion at the inverter output. Mat lab Simulation result will be analyzed.

## Keywords

SPWM (sinusoidal pulse width modulation), THD (total harmonic distortion), Space vector,

## 1. Introduction

Now a day's several industrial applications have begun to need high power. Some appliances within the industries but need medium or low power their operation. Using a high power supply for all industrial loads might prove helpful to some motors requiring high power, whereas it should harm the other loads. Some medium voltage motor drives and utility applications need medium voltage. In this project we have a tendency to done three different types of modulation techniques and conclude the THD for all the modulation techniques. From this we will understand that within which modulation technique the most quantity of input voltage issued by knowing the THD [1].

## Types of Multilevel Inverters

Multilevel inverters are three types:

- 1) Diode clamped multilevel inverter;
- 2) Flying capacitors multilevel inverter;
- 3) Cascaded H-bridge multilevel inverter.

## 2. Diode Clamped Multilevel Inverter

The main idea of this inverter is to use diodes and provides the multiple voltage levels through the various phases to the electrical device banks that are in series [2]. A diode transfers a restricted quantity of voltage, thereby reducing the strain on different electrical devices. The most output voltage is half the input DC voltage. It's the most downside of the diode clamped structure electrical converter. This drawback may be resolved by increasing the switches, diodes, capacitors. Attributable to the capacitor equalization problems, these are restricted to the three-levels. This kind of inverters provides the high efficiency as a result of the fundamental frequency used for all the change devices and it's a simple technique of the rear to back power transfer systems.

An  $m$  level inverter leg requires  $2 \cdot (m - 1)$  switching devices and  $(m - 1) \cdot (m - 2)$  clamping diodes. For a three-level inverter,  $m = 3$ , so it needs four switching devices and two clamping diodes per leg as shown in Figure 1.

1. For an output voltage of  $V_a = V_{dc}$ , all the upper-half switches of a-phase leg are turned ON, i.e., S1 and S2 are ON.
2. For output voltage of  $V_a = V_{dc}/2$ , only S2 and S3 are ON
3. For output voltage of  $V_a = 0$ , all the lower-half switches of a- phase leg are turned ON, i.e., S3 and S4 are ON.

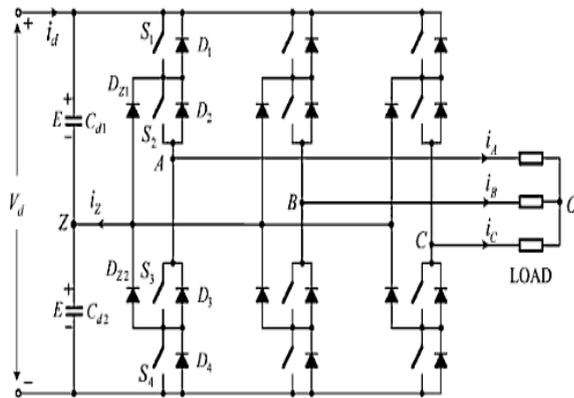


Fig. 1. Three-level diode clamped inverter

Table 1 shows the voltage levels and their corresponding switch states. State condition “1” means the switch is ON, and state “0” suggests that the switch is OFF. It should be noticed that there are two complementary switch pairs. These pairs for one leg of the inverter are (S1, S3) and (S2, S4).

Voltage level $V_s =$	$S_{A1}$	$S_{A2}$	$S_{A3}$	$S_{A4}$
$V_{dc}$	1	1	0	0
$V_{dc}/2$	0	1	1	0
zero	0	0	1	1

Table 1. Switch states for various voltages of a phase leg

Thus, if one among the complementary switch pairs is turned ON, the other often same try should be OFF. Two switches area unit always turned ON at the same time. Output voltage waveform of a three-level inverter is as shown in Figure 2.

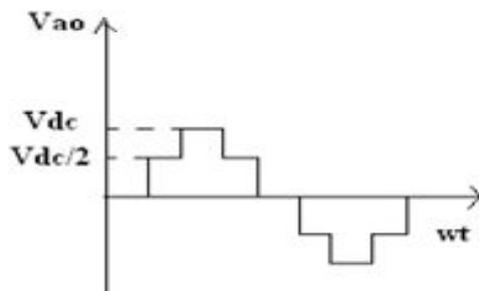


Fig. 2. Output voltage waveform of a three level inverter

**PWM Techniques**

1. Sinusoidal Pulse Width Modulation (SPWM)
2. Space Vector Modulation (SVM or SVPWM)
3. Selective Harmonic Elimination (SHE)

**3. Sinusoidal Pulse-Width Modulation**

In this theme, three sinusoidal reference waves every shifted by 120° are used, Figures 3, 4 and 5. A triangular carrier wave is compared with the reference signal similar to a phase to generate the gating signals for that phase [3]. Magnitude and frequency of resultant wave depends on the magnitude and frequency of carrier wave. Within the gift configuration, modulation index (which could be a quantitative relation of peak price of reference wave to peak price of carrier wave) is varied within the vary 0.7-0.95. In multiple-pulse modulation, all pulses are an equivalent width. Vary the pulse width in step with the amplitude of a sine wave evaluated at the middle of an equivalent pulse.



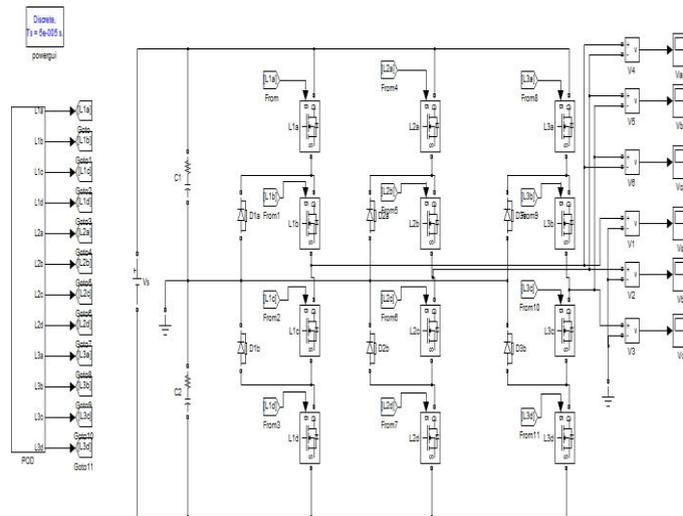


Fig. 9. SPWM circuit in MATLAB

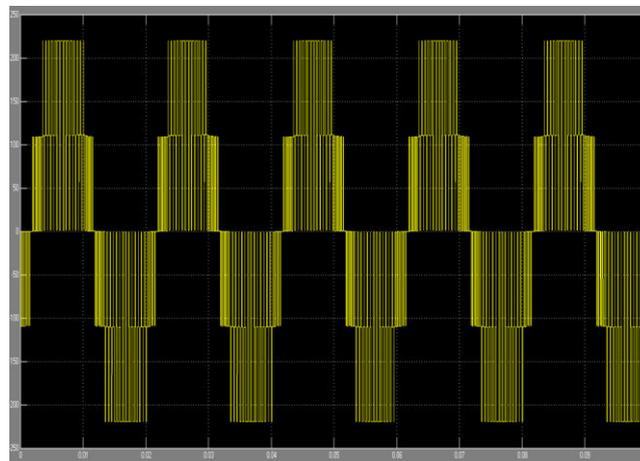


Fig. 10. Output waveform for SPWM

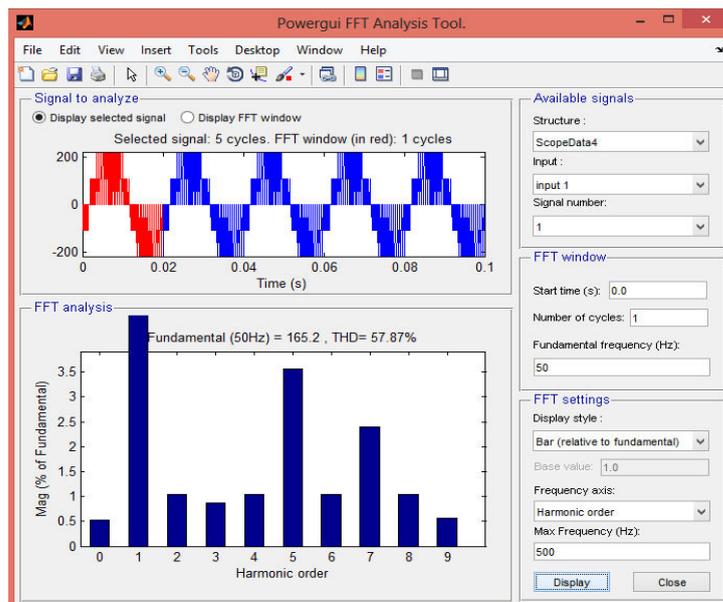


Fig. 11. FFT analysis for SPWM

## 5. Conclusion

- A Diode Clamped Multilevel inverter is controlled by different PWM techniques.
- Multilevel converters have matured from being a rising technology to a well-established and enticing answer for medium-voltage high-voltage applications.
- Three topologies and a number of other modulation way shave found industrial application. Initially, the upper power rates in conjunction with the improved power quality are the main market drive and trigger for analysis and development of structure converters.
- However, the continuous development of technology and the evolution of industrial applications will open new challenges and opportunities that could motivate further improvements to multilevel converter technology.

## 6. References

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