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New model multilevel inverter using Nearest Level Control Technique

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Abstract: In this paper a new 11 level multi inverter topology introduced by the NearestLevel Control method. By this topology we are reducing the switches for the reduction of switching losses and harmonic distortions. The reduction of power switches in the topology leads to the minimization of size and cost of the system. The new topology is compared to the different techniques present and this model is controlled by Pulse Width Modulation. The performance of this 11 level multi inverter topology is higher in the power applications where it is simulated in the MATLAB. The results are verified and compared to the various techniques.
Keywords: Multilevel Inverter, MATLAB, THD, Fundamental Switching Scheme and Nearest Level Control

I. Introduction

In the modern era, the multilevel inverters are used for the medium and high power applications. A multilevel inverter is a device which synthesize the desired output voltage from the several levels of dc voltage as input. Multilevel inverters are currently used in industries for their high power performance and covering a wide range of power. In the existing technology it may not suit the high power application which may increase the voltage stress on switch. So the switches are reduced in the existing technology for the high performance. It is the combination of IGBT and power diodes where it reduces the size.

The multilevel inverter has three categories. They are i) Neutral Point Clamped (NPC) ii) Flying capacitor iii) Cascaded H-Bridge. These inverters have power quality which reduce the switches and higher the voltage levels. They are capable of generating the stepped voltage level. In this topology when the voltage level increases, the number switches also increases which leads to the high installation size and the cost of the system. So we are going to the new multilevel inverter which reduce the switches and increase the voltage levels. The signals are generated by the Pulse Width Modulation. The PWM strategies are most operative to control the multilevel inverter. Since the Sine Pulse Width Modulation is complex, it is ideal to reduce the frequency switching losses. In this the pulse width modulation is limited by the power electronic switches which the losses are reduced. Alternative approach is which that the target is set to reduce the losses by using the minimum switches is used or minimum dc voltages and further it requires the different voltage levels. The approach consists of a basic units and connected in series where the switching frequency should endure the maximum overall voltage.

II. Multilevel inverter

A multilevel inverter is which is mostly used in industrial applications for their advantages. The neutral clamped diode use diodes and they afford multiple voltage levels which are in series connected through the different phases of the capacitor banks. A diode transfers a limited amount of voltage, therefore the voltage stress is reduced. They provide a high efficiency by the fundamental frequency.

The use of the diodes in this approach is to get the preferred voltage levels at the same voltage ratings. More number of voltage levels decrease the step level and waveform is similar to the sinusoidal. In this neutral clamped diode they have a lots of diodes and switches for the increase in levels but it is increase in size. For the reduction of size and the switches, thus we designed a new multilevel inverter.

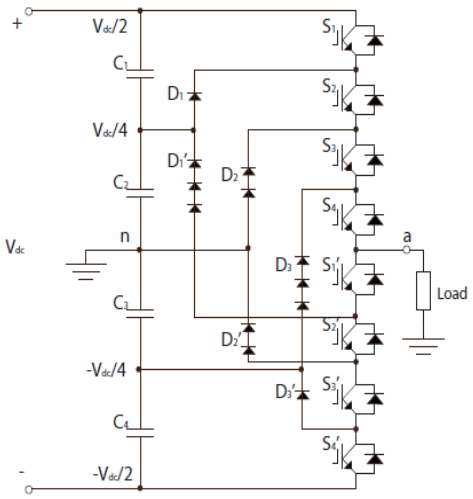

Fig1 A five level Neutral clamped diode

Table1 Switching states of a five level neutral clamped diode

Output Voltage	S_1	S_2	S_3	S_4	S_1'	S_2'	S_3'	S_4'
$\frac{V_{dc}}{2}$	1	1	1	1	0	0	0	0
$\frac{V_{dc}}{4}$	0	1	1	1	1	0	0	0
0	0	0	1	1	1	1	0	0
$-\frac{V_{dc}}{4}$	0	0	0	1	1	1	1	0
$-\frac{V_{dc}}{2}$	0	0	0	0	1	1	1	1

From the above table1 we can see the voltage of all the upper switches are turned ON.For the voltages ±Vdc/2 the current, when both voltage and current are positive goes over the four top or bottom switches. For the other states positive current, while voltage is positive, goes through the D_1diodes and negative current through the D_1diodes and also through the switches in between the clamping diodes and the load.

Table shows that some switches are on more frequently than others,as a sinusoidal output wave that involves the use of all voltage levels is produced. When the inverter is transferring active power this leads to unbalanced capacitors voltages since the capacitors are charged and discharged unequally, comparatively due to different workloads.

The flying capacitor is a series connection of capacitor clamped. These transfers the voltage to thedevices. Here the output is half of the input dc voltage. Due to high switching frequency, the switching loss will take place.

The cascaded multilevel inverter is to use the capacitors and switches and require less number of switching components. The combination of capacitor and switches is called H-Bridge, which has a

separate voltage input to each H-bridge. Each cell has a separate dc voltage and can provide three different voltages Zero, positive and Negative DC voltages.

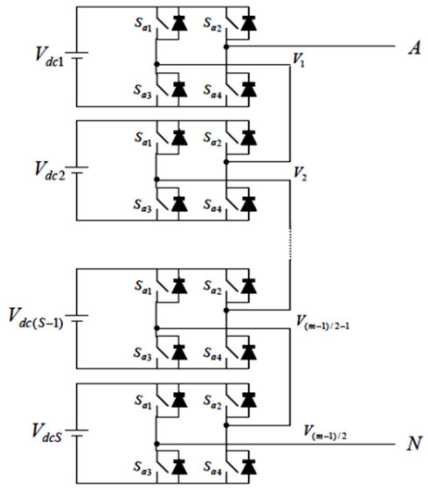

Fig.2 Conventional Cascaded multilevel inverter

The single-phase structure for11-level conventional cascaded inverter is illustrated in Fig above. Each separate dc source is connected to a single-phase full-bridge.Each inverter level can generate three different voltage outputs, $+vdc$, 0 and $-vdc$ by connecting the dc source to the ac output with different switching combinations of the four semiconductor switches T1,T2,T3 and T4.

To obtain $+vdc$, switches T1 and T2 are tuned on, while $-vdc$ can be obtained by tuning on switches T3 and T4. By turning on T1 and T3 or T2 and T4, the output voltage is 0. The ac outputs of each of the full-bridge inverter levels are connected in series such that the synthesized voltage waveform is the sum of the inverter outputs.

m= 2n +1 (1)

N= 2(m-1) (2)

where m is the number of levels, ‘n’ is the number of dc sources, and N is the number of switching devicesin each phase. The most recognized SPWM which can be realistic to a conventional cascaded multilevel inverteris the Phase-Shifted SPWM. This modulation technique is virtually the same as the conventional SPWM technique which is applied to a conventional single phase full-bridge inverter. The only difference between them is that the Phase-Shifted SPWM utilizes more than one carrier. The number of carriers used per phase is equal to twice the number of dc sources per phase.

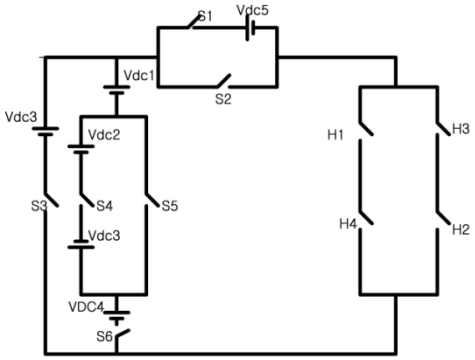

Fig.3 Circuit diagram of a new multilevel inverter

The Figure 3 shows the general representation of Novel cascaded multilevel inverter topology using modified nearest level control strategy .This system is used to convert DC to AC source using nearest level control. First half represents the level generator which is used to convert DC into stepped DC output waveform. This level generator has high switching frequency. The power source is mostly present in level generator. Only 6V of DC supply is given to each power source.

Second half represent the polarity generator which converts stepped DC into AC. It will works under low switching frequency mostly RL load is connected with polarity generator the circuit represented will be in H model. It consists of five input power sources to which power is given to the circuit & is present in level generator side.

III. PWM TECHNIQUES FOR MULTILEVEL INVERTER

The switches in the multilevel inverter circuit are generated according to the switching tables. PWM technique is nothing but the pulses, which is active to turn on and turn off the switches used in inverter. The two main advantages of PWM are the control of the output voltage amplitude and fundamental frequency in addition to decreasing the filter requirements for reducing the harmonics. To create a sinusoidal output voltage in a single phase inverter the switches must be controlled in a definite sequence. To do that a reference sinusoidal waveform is required. The reference waveform is also called the modulation or control signal and it is compared to a carrier signal.

Carrier signal is usually a triangular signal which controls the switching frequency while the reference signal controls the output voltage amplitude and its fundamental frequency. In PWM technique, the carrier and reference waves are mixed in a comparator. When reference signal has magnitude higher than the carrier signal (triangular wave), the comparator output is high, else low. The comparator output is processed in a trigger pulse generator in such a way that the output voltage wave of the inverter has a pulse width in arrangement with the comparator output pulse width.

IV. MATLAB/Simulation

The name MATLAB stands for MATrix LABoratory. MATLAB was written originally to provide easy access to matrix software developed by the LINPACK (linear system package) and EISPACK (Eigen system package) projects. MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programmingenvironment. It is a modern programming language environment, it has sophisticated data structures, contains built-in editing and debugging tools, and supports object-oriented programming. These factors make MATLAB an excellent tool for teaching and research.

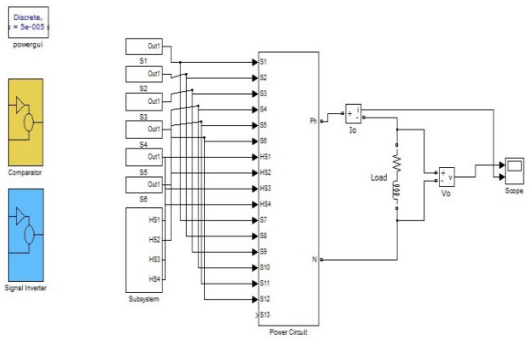

Fig.4 Overall circuit diagram in MATLAB

The above figure shows overall block diagram new model multilevel inverter. The block comprises of power guide comparator, signal inverter, multilevel inverter voltage measurement, and current measurement & RMS value with RL load. Each block has sub system.For in comparator block two signals are associated in sine wave is compared with repeated signal. It helps to gain output during half cycle. The signal inverter input is acquire from the comparator output. They are to switches concluded input is given from 10 switches. Six switches are given as input for level generator switches. Remaining four switches are given as input to polarity generator and DC supply is taken as output from this multilevel inverter. One is phase and other is neutral and these output is connected across the RL load. Current measurement is connected parallel to the RL load to measure voltage value I_{rms} is taken as output from the current measurement, $VrmsV_{rms}$ is taken as output from the voltage measurement.

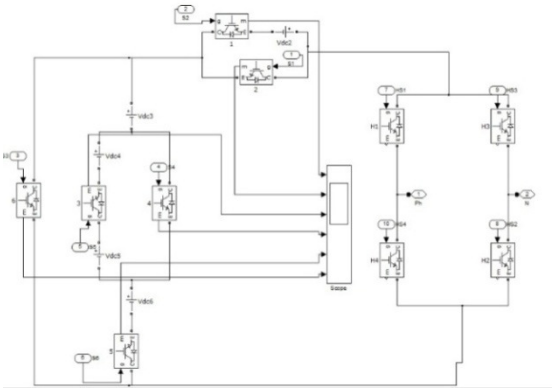

Fig.5 Multilevel inverter in MATLAB

V. Results and discussions

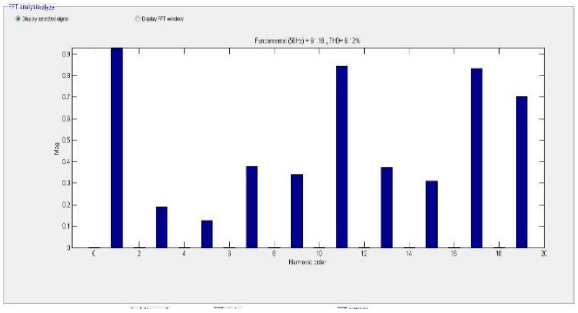

Fig.6 THD waveform for a new model multilevel inverter using nearest level control technique

THD rate is about 6.12% for new-model multilevel inverter in NLC technique.

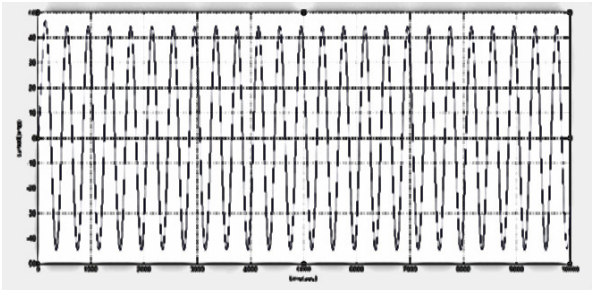

Fig.7 Current waveform of a new multilevel inverter using the nearest level control technique

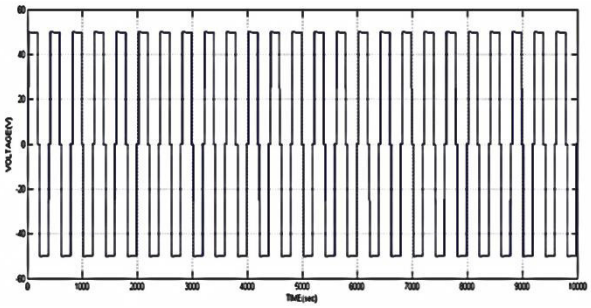

Fig.8 Voltage waveform of a new multilevel inverter using the nearest level control technique

The voltage of phase & neutral of the multi-level inverter circuit, X-axis indicates the time and the Y-axis indicate the voltage.X-axis is varied depend upon time.

V. Conclusion

In this paper a Nearest Level Control for multilevel inerter is discussed. It is determined that the nearest control is functionally equivalent to 1) proper common mode voltage 2) opt for the switching frequency form first to last switch the duty cycles are terminated. The PWM method is much more difficult to handle the tasks when particular switching patterns are preferred, switching sequence and duty cycles are chosen so we go for nearest level method.

The simulations results are shown above that the THD waveform in a bar format for the rate to be distinguished and surveyed by the current and voltage waveform of a new model multilevel inverter using a nearest level control.

In this project it also defines that, by reducing the switches and sources in inverter structure using nearest level control, it does not affect the RMS value and THD. The Total harmonic distortion (THD) is also reduced. When number of levels in inverter increases, we can use nearest level control with reduced switches and sources.

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